

REGIONAL MINIMUM WAGES AND LABOR MISALLOCATION IN ITALY

GABRIELE NESPOLI[†]

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Abstract. Using a large panel of Italian firms and building on previous work by [Caselli et al. \(2023\)](#), I estimate the *employment-maximizing* minimum wage in Italy in 2022 to be €13.85 per hour. This minimum wage level would feature highly heterogeneous impacts on local labor markets, with large disemployment effects in the South and little to no bite in the North. To address this spatial imbalance, I estimate region-specific *optimal* minimum wages for the same year, finding results ranging from €7.46 per hour in Sardinia to €18.73 per hour in the autonomous province of Bolzano. Introducing regional minimum wages in Italy reduces spatial heterogeneity in employment effects *vis à vis* the national minima, strengthening the link between idiosyncratic productivity and employment gains at the local (province) level. Additionally, I document a sizeable rise in firms' monopsony power between 2019 and 2022, underpinned by labor productivity growing faster than average wages over the same period.

JEL classification: C33, J31, J38, J42, R58

Keywords: Minimum Wage, Monopsony, Regional Wage Policy, Labor Misallocation.

1. INTRODUCTION

In the past months, the Italian political debate has devoted some attention to the proposed introduction of a national minimum wage. In particular, a minimum compensation level of 9 euros was discussed by the Italian parliament in autumn 2023 ([Camera dei Deputati, 2023](#)). As scrutiny has been stalling in the Senate, Italy remains one of the only five European Union member states without a statutory minimum wage in place, together with Austria, Denmark, Finland, and Sweden ([Eurofound, 2024](#)).

In this paper, I investigate what would be the optimal (employment maximizing) level of minimum wage to be introduced in Italy. That is the value at which disemployment effects are minimized and positive employment effects are maximized. The estimation features both a national minimum wage level and region-specific minimum wage levels, setting different minimum hourly compensations across the 21 Italian regions.

Using a large panel of manufacturing firms' balance-sheet data, I construct a measure of firm labor market power starting from the output elasticities of labor and materials and inputs' revenue shares. All these variables are retrieved from a translog production function, estimated following a large body of literature that uses inputs to control for unobservables (i.e., firm-level productivity) ([Levinsohn and Petrin, 2003](#); [Wooldridge, 2009](#); [Akerberg et al., 2015](#); [Petrin and Levinsohn, 2012](#)). Conceptually, this coefficient indicates if average within-firm wages are above or below the firm's marginal productivity, allowing to determine the market regime (efficient bargaining, perfect competition, or monopsony) in which it operates.

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From this I uncover a sizeable rise in monopsony power among Italian firms from 2019 onward and a correspondent decline in the share of firms operating under efficient bargaining. In 2022 roughly two-thirds of manufacturing firms operated in a monopsony setting, while only one third of them were classified in the efficient bargaining regime.

I then categorize Italian enterprises based on productivity, average wages, labor market power, and hypothetical minimum wage levels. This classification allows to retrieve the optimal minimum wage as the value minimizing the share of firms that would be characterized by negative employment effects and maximizing the share of firms that would increase their employment in response to its introduction. This optimal minimum wage was found to be relatively stable in the first period under analysis before significantly rising after 2020 and overcoming the national median wage in 2022. I attribute this result to post-pandemic increases in productivity—which affected firms of all sizes—and to a sizeable increase in the average firm size between 2020 and 2022.

Based on concerns of heterogeneous employment effects on local labor markets, I then apply the optimization procedure at the regional level, retrieving optimal region-specific minimum wage values for the year 2022. A spatial analysis of the potential effects of their introduction reveals how regional minimum wages would increase efficiency in the whole country, relegating heterogeneity (in employment effects) at the regional level and strengthening the negative relation between local productivity and province-level disemployment effects.

The remainder of the paper is structured as follows. Section 2 summarizes the main findings of the literature regarding optimal minimum wages. Section 3 details the data used and the dataset-construction procedure. Section 4 introduces the theoretical framework employed in the analysis, from the production function estimation to the optimization procedure that allows to uncover the optimal minimum wage value. Section 5 presents the main findings, articulated in national and regional minimum wage levels. Section 6 concludes.

2. LITERATURE REVIEW

The effectiveness and broader economic impacts of the minimum wage have been the subject of extensive empirical and theoretical research, with debates centering on its effects on employment, wage distribution, firm behavior, and overall economic efficiency (Dube and Lindner, 2024).

The economics literature broadly supports its use as a policy tool to raise the earnings of low-wage workers and reduce wage inequality, with generally modest effects on aggregate employment when set at moderate levels (Dube, 2019; Arribas Cámara et al., 2024; Dube and Zipperer, 2024; Dube and Lindner, 2024; Cengiz et al., 2019). However, the risk of job loss is higher for the least skilled and in sectors with limited ability to adjust (Neumark and Wascher, 2006).

Of the huge literature on minimum wages, only a rather small and recent part focuses on the determination of their *optimal* level. In fact, most studies on the matter chose to analyze employment effects of the minimum wage.

Central to this literature is what Manning (2021) calls the “New Minimum Wage Research,” often regarded as taking its roots in the seminal paper by Card and Krueger (1994) and continuing in more recent times with works such as the one from Harasztosi and Lindner (2019), who estimate pass-through effects to consumers of the Hungarian minimum wage.

This paper goes in a different direction, studying aggregate employment effects of the minimum wage not in a real-world scenario but in the hypothetical case of its introduction in Italy, which currently lacks such a policy. Specifically, employment effects are not studied *per se*, but with the aim of determining an optimal minimum wage as the compensation level minimizing disemployment effects in the country, following the methodology set out by Caselli et al. (2023).

I thus follow a growing albeit small literature attempting to estimate *optimal* minimum wage levels. Ahlfeldt et al. (2018), for example, study the regional effects of the introduction of a statutory minimum wage in Germany in 2015. They show that the measure led to spatial wage convergence without reducing relative employment in low-wage regions. In a subsequent paper,

they find that an *employment-maximizing* regional minimum wage would need to be set at 50% of the regional median wage in Germany. This policy would increase aggregate employment by 1.1% (Ahlfeldt et al., 2022).

Studying the interaction between federal and state policy with regard to minimum wages, Simon and Wilson (2021) conclude that decentralized and centralized policy setting exhibit strategic complementarity, and that joint policy setting leads to a small welfare gain over centralization.

The following paper aims to contribute to the minimum wage policy debate dialoguing with Caselli et al. (2023), who find that the optimal (national) minimum wage level ranged from 8.25 to 9.65 euro per hour in Italy in 2018.

Specifically, this paper makes three contributions to the existing literature: (i) it studies the spatially heterogeneous effects resulting from the potential introduction of a national minimum wage in Italy; (ii) it applies the procedure developed by Caselli et al. (2023) to retrieve region-level optimal minimum wages for Italy in 2022; and (iii) it expands the results by Caselli et al. (2023) regarding the national optimal minimum wage and the evolution of monopsony power, leveraging newly available firm-level data spanning from 2015 to 2022.

3. DATA

Firm-level yearly data come from the database Orbis by Bureau van Dijk and comprise balance sheet information for around 6 million Italian firms.¹ Data on operating revenues, number of employees, non-current assets (used as a proxy for physical capital), expenditure on materials, labor costs, and the industrial sector of activity (according to the EU statistical classification of economic activities NACE Rev. 2)² were retrieved for the years 2015–2022.

The data have been cleaned to avoid the influence of extreme values. Observations showing a growth rate greater than 400% or lower than -80% for both the variable *revenues* and all inputs (*materials*, *employees*, and *capital*) were thus deleted. Observations featuring missing values for all the variables of interest or a sum of labor costs and material costs greater than total revenues were deleted, as well. Around 3,375,000 firms passed this first cleaning procedure.

As a last step, I computed the shares of labor costs and material costs on total revenues and deleted the observations where the value of at least one of these shares was either lower than 5%, higher than 200%, or missing. Companies featuring non-consecutive year-level observations are also deleted, together with the ones for which fewer than five year-level observations are available. This last step left 250,190 distinct firms in the dataset, each featuring from 5 to 8 consecutive yearly observations, and the main analysis was restricted to this sub-group.

Sector-specific price indexes, revenues, and output data are retrieved from the ISTAT website.³

4. METHODOLOGY

4.1. Labor Market Power

The analytical framework employed in this paper closely follows the one developed by Caselli et al. (2023).

A firm-level time-varying measure of labor market power, ϕ_{it} , is defined as follows:

$$\phi_{it} = \frac{P_{it}^L}{MRP_{it}^L} \quad (1)$$

¹Due to the large size of the dataset, data are obtained through an iterated automated download of many .csv files, which are later appended together by Stata.

²Note that the more recent (2023) classification NACE Rev. 2.1 was not used because both Orbis and Istat data were still classified according to NACE Rev. 2 at the time of the analysis.

³Please refer to appendix C for a detailed description of data on price indexes and revenues.

where P_{it}^L is the average labor cost paid by firm i at time t , and MRP_{it}^L is the marginal revenue product of labor, a measure of firm-specific productivity. If $\phi = 1$, the labor market is competitive, $\phi < 1$ indicates a labor market regime characterized by monopsony power, and $\phi > 1$ signals some degree of market power by firms' employees (efficient bargaining).

Following [Mertens \(2019, 2020\)](#) and [Caselli et al. \(2021\)](#), ϕ_{it} is rewritten in the following form:

$$\phi_{it} = \frac{\theta_{it}^M / \alpha_{it}^M}{\theta_{it}^L / \alpha_{it}^L} \quad (2)$$

where θ_{it}^M and θ_{it}^L are, respectively, the output elasticities of materials and labor, while α_{it}^M and α_{it}^L are the shares of materials and labor costs over total revenues.⁴

While the input shares α_M and α_L can be computed starting from the available data, the output elasticities θ_M and θ_L need to be estimated starting from a suitable production function.

4.2. Production Function Estimation

In order to compute unbiased estimates of the output elasticities, I follow a large literature using inputs to control for unobservables in production function estimations. ([Levinsohn and Petrin, 2003](#); [Wooldridge, 2009](#); [Akerberg et al., 2015](#); [Petrin and Levinsohn, 2012](#))

As inputs and unobserved productivity shocks are potentially correlated, an endogeneity bias might arise in estimating the production function. I thus employ a Wooldridge–Levinsohn–Petrin (henceforth WLP) estimator to address the simultaneity issue. The WLP estimator does not assume constant returns to scale; is robust to the Akerberg, Caves, and Frazer (ACF) critique ([Akerberg et al., 2015](#)); and is programmed as an instrumental variable (IV) estimator. This approach consists of including lags of inputs to proxy for productivity and is detailed below.

A first step is run to get rid of the pure error term in the measure of revenues and markups [De Loecker and Warzynski \(2012\)](#):

$$q_{it} = g(l_{it}, k_{it}, m_{it}) + \varepsilon_{it} \quad (3)$$

where q it is the natural logarithm of deflated revenues of firm i at time t ; and l_{it} , k_{it} , and m_{it} are the logarithms of labor, capital, and materials used by the firm, respectively. Specifically, equation (3) is estimated for every different sector, using a third-order polynomial on all inputs with year fixed-effects. This allows to separately identify expected output $\hat{q}_{it}$ and residuals $\hat{\varepsilon}_{it}$.

Then, a general production function is used:

$$\hat{q}_{it} = f_s(l_{it}, k_{it}, m_{it}, \mathbf{B}) + w_{it} + \eta_{it} \quad (4)$$

where $\mathbf{B}$ is the parameter vector containing the marginal effects and needs to be estimated, w_{it} is the firm-specific productivity (only observable by the firm), and η_{it} is the unobservable error term.

The function f_s is a revenue function, changes across different sectors and is assumed to be translog, which allows to obtain firm-level time-variant output elasticities.⁵

$$\begin{aligned} f_s = & \alpha + \beta_L l + \beta_K k + \beta_M m + \beta_{L^2} l^2 + \beta_{M^2} m^2 \\ & + \beta_{K^2} k^2 + \beta_{KL} kl + \beta_{KM} km + \beta_{LM} lm \end{aligned} \quad (5)$$

Labor is assumed to be a variable input and firms are assumed to be costs minimizers. Labor, materials, and their interactions are assumed to be endogenous and are thus instrumented with

⁴Please refer to [Caselli et al. \(2021\)](#) for the details behind this rewriting.

⁵With regard to the restrictions outlined by [Christensen et al. \(1973\)](#), the coefficients are symmetric by construction, while the estimated coefficients are not commodity-wise additive, confirming that aggregate input is not Cobb-Douglas.

the first and second lags of labor, and with the second lags of materials and capital.⁶ This choice is justified by the assumption of dynamic input adjustment (in response to a productivity shock).

Estimation is then carried out via a two-step efficient generalized method of moments (GMM), which provides an estimate for the parameter vector $\mathbf{B}$.⁷ Once marginal effects are retrieved from the vector, output elasticities of inputs can be computed for every firm-year observation:

$$\hat{\theta}_{it}^M = \hat{\beta}_M + 2\hat{\beta}_{M^2}m_{it} + \hat{\beta}_{KL}k_{it} + \hat{\beta}_{LM}m_{it} \quad (6)$$

$$\hat{\theta}_{it}^L = \hat{\beta}_L + 2\hat{\beta}_{L^2}l_{it} + \hat{\beta}_{KM}k_{it} + \hat{\beta}_{LM}l_{it} \quad (7)$$

$$\hat{\theta}_{it}^K = \hat{\beta}_K + 2\hat{\beta}_{K^2}k_{it} + \hat{\beta}_{KL}l_{it} + \hat{\beta}_{KM}m_{it} \quad (8)$$

where $\hat{\theta}_{it}^M$ is the estimated output elasticity of materials, $\hat{\theta}_{it}^L$ is the estimated output elasticity of labor, and $\hat{\theta}_{it}^K$ is the estimated output elasticity of capital.

4.3. Labor Market Regimes

Classification of firms in different regimes is based on previous work by [Dobbelaere and Mairesse \(2013\)](#). Once the relevant input elasticities are obtained from the production function, I use equation (2) to derive firm-level time-varying estimates of labor market power ϕ_{it} .

However, the input shares α_M and α_L are not used directly as observed in the data, but corrected *à la* [De Loecker and Warzynski \(2012\)](#). Specifically, a correction is needed because data on deflated revenues include an error unobservable to both the econometrician and the firm. I thus use equation (3) to obtain estimates of the error term and correct the revenue shares multiplying them by the exponential of the estimated error term.⁸ As explained by [Caselli et al. \(2023\)](#), this adjustment cleans the revenue shares from any variations in output that are not related to variables affecting input demand.

Firm-year observations are classified into three different labor market regimes, according to the value of ϕ_{it} :

- Efficient Bargaining (EB) if $\phi_{it} > 1$. In this case the average available wage is greater than marginal productivity (as inframarginal gains are distributed across workers) and employees hold some degree of market power *vis à vis* the employer.
- Perfect Competition (PC) if $\phi_{it} = 1$. In this case the average available wage equals marginal productivity.
- Monopsony (MO) if $\phi_{it} < 1$. In this case the average available wage is lower than marginal productivity, and the firm holds some degree of labor market power towards the employees.

More precisely, a confidence interval is constructed to operate the firm classification. I start by defining ψ , a measure of labor market power that is conceptually equivalent to ϕ :⁹

$$\psi = \frac{\theta_M}{\alpha_M} - \frac{\theta_L}{\alpha_L} \quad (9)$$

where positive values of ψ correspond to values of ϕ which are > 1 , and vice versa.

Then, I define a 95% confidence interval for ψ_{it} :

$$\text{C.I.} = \hat{\psi}_{it} \pm 1.96 \cdot \text{Var}(\psi_{it}) \quad (10)$$

⁶See Appendix A.1 for a more detailed description of the production function.

⁷Estimation was carried out by Stata/SE 18.0 with the user-contributed module *ivreg2* ([Baum et al., 2002](#)).

⁸Mathematically: $\alpha_X^{corr} = \alpha_X \cdot \exp(\hat{\varepsilon})$, where α_X is the output elasticity of input variable X .

⁹This choice follows [Caselli et al. \(2021\)](#) and permits a simpler characterisation of the confidence interval.

and classify each observation accordingly:

- Efficient Bargaining if $\hat{\psi}_{it} > 0$ and $0 \notin \text{C.I.}$
- Perfect Competition if $0 \in \text{C.I.}$ Here, $\hat{\psi}_{it}$ is not significantly different from zero.
- Monopsony if $\hat{\psi}_{it} < 0$ and $0 \notin \text{C.I.}$

See Appendix A.2 for details on the computation of $\text{Var}(\psi_{it})$.

4.4. Optimal Minimum Wage

Based on the degree of labor market imperfections ϕ_{it} , firm-specific average yearly available wages ($w_{it} = P_{it}^L$), the marginal revenue product of labor MRP_{it}^L , and a hypothetical minimum wage MW , firms can be classified into four different categories:

- Category 1: if $w_{it} < MW$, $MRP_{it}^L < MW$ and $\phi_{it} \geq 1$
- Category 2: if $w_{it} < MW$, $MRP_{it}^L < MW$ and $\phi_{it} < 1$
- Category 3: if $w_{it} < MW$, $MRP_{it}^L > MW$ and $\phi_{it} < 1$
- Category 4: if $w_{it} \geq MW$

Given a hypothetical yearly minimum wage MW , its introduction might cause heterogeneous effects on the employment levels of single firms, depending on which category that firm belongs to.

Firms in cat. 1 are characterized by wages and productivity which are low with respect to the hypothesized minimum wage and a labor market regime of perfect competition (PC) or efficient bargaining (EB). A minimum wage introduction is likely to reduce the labor demand of these firms, possibly increasing layoffs and thus reducing total welfare.

Firms in cat. 3 are characterized by marginal productivity levels that are higher than the hypothesized minimum wage, which in turn is higher than average wages, and operate in a regime of monopsony (MO). A minimum wage introduction is likely to increase labor supply without affecting labor demand, possibly increasing both employment and total welfare.¹⁰ Evidently, the introduction of a minimum wage would be efficient for these firms.

Firms in cat. 2 are characterized by wages and productivity that are low with respect to the hypothesized minimum wage and a labor market regime of monopsony (MO). While a minimum wage introduction is likely to reduce the labor demand of these firms, with negative welfare effects, as it was the case for firms in cat. 1, it also has the potential of reducing monopsony power, generating positive welfare effects. The net welfare effect of a minimum wage introduction on these firms is then ambiguous, and for this reason they are excluded from the analysis carried out below.

Finally, firms in cat. 4 are characterized by average available wages that are already equal or higher than the hypothesized minimum wage. The net welfare effect of a minimum wage introduction on these firms is likely to be both small and unrelated to productivity. For this reason, also these firms are excluded from the main analysis.

4.4.1. Yearly Minimum Wage For every year t in the sample, the optimal (national) minimum wage MW_t^* is then defined as the value minimizing the share of firms in category 1 and maximizing the share of firms in category 3.

Analytically,

$$MW_t^* = \min_{MW} \%_{1,t} - \%_{3,t} \quad (11)$$

where $\%_{1,t}$ and $\%_{3,t}$ are, respectively, the shares of firms in cat. 1 and in cat. 3 at time t .

¹⁰Note that, for this to happen, a redistribution of welfare away from firms and toward workers is implied, with the latter gaining more than the former lose.

Both here and for the regional case (see below), I compute two values for the optimal minimum wage: one based on the above formula using firms shares, and another one using employment shares in the same formula.¹¹

Due to heterogeneity concerns and based on previous results by Caselli et al. (2023), it can be well hypothesized that the introduction of a national minimum wage in Italy would lead to mixed results, with the areas of the country characterized by lower productivity experiencing a decline in labor demand, and more productive areas not feeling the bite of the new minimum. This is the main rationale for the pursuit of distinct optimal minimum wage levels for each Italian region, which largely guided the realization of this paper.

Thus, the optimal minimum wage $MW_{j,t}^*$ in region j at time t is defined as follows:

$$MW_{j,t}^* = \min_{MW} \%_{1,j,t} - \%_{3,j,t} \quad (12)$$

where $\%_{1,j,t}$ and $\%_{3,j,t}$ are, respectively, the shares of firms in cat. 1 and in cat. 3 in region j at time t .

4.4.2. Hourly Minimum Wage The equations above yield yearly values for the optimal minimum wage, also including social security contributions. As minimum wages are generally computed as gross of income tax but net of social security contributions, a conversion formula is applied to obtain the hourly minimum wage HMW :

$$HMW = \frac{MW \times (1 - SSC)}{168 \times 12} \quad (13)$$

where SSC is the share of social security contributions in the total wage bill, and the yearly minimum wage MW is divided by the average number of hours worked per month (168), times 12 months.¹²

5. RESULTS

5.1. Italian Optimal Minimum Wage

Based on the above methodology, the optimal yearly minimum wage in Italy was determined to be €39,000 in 2022. This amount corresponds to €13.85 per hour according to equation (13).¹³ As shown in Figure 1, this is the value that minimizes the difference between the share of firms in cat. 1 and the share of firms in cat. 3 in 2022, with around 15% of firms that would be negatively affected by the minimum wage introduction, and more than 23% of firms on which the impact of the new minimum wage would be positive.¹⁴

In Table 1, estimates of output elasticities are reported, together with results for the labor market power parameter ϕ , for each of the 18 sectors considered. All of these results are to be interpreted as averages of the 2015–2022 period. The only sector characterized by monopsony is the one of electricity, gas, steam, and air conditioning supply (D), which has the lowest value of ϕ . All other sectors were either in a perfect competition or efficient bargaining regime during the 2015–2022 time span (on average), with the sector of education (P) showing the highest level of market power on the side of employees.

¹¹In the second case, the shares of employees working in firms belonging to cat. 1 and to cat. 3 at time t are considered.

¹²As suggested by Caselli et al. (2023), SSC is computed for firms with labor costs around the average $\pm 10\%$. As an approximation, I thus use a value of $SSC = 0.284$, which is the one found by Caselli et al. (2023) and relative to their 2011–2018 data.

¹³As the optimization problem is solved through an iterative process, the error margin is €250 per year, or €0.089 per hour.

¹⁴The result based on the weighted firm shares was found to be €63,500, or €22.55 per hour. Further analyses of this result are needed in order to explain the sharp wedge between this value and the median wage in Italy in 2022 (€13.84 per hour).

FIGURE 1: Optimal National Minimum Wage in 2022.

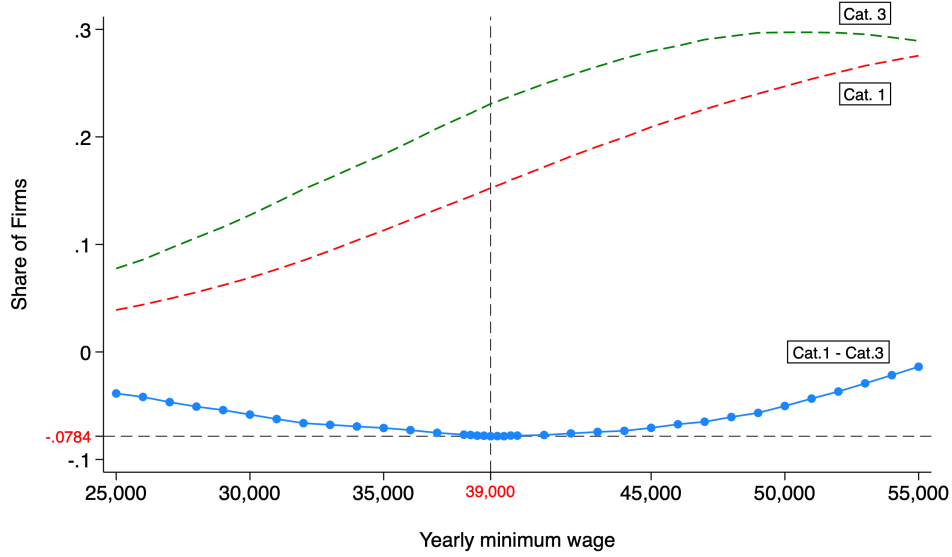


TABLE 1: Output Elasticities and Labor Market Power by NACE sectors.

Sector	N	θ_L	θ_M	θ_K	ϕ
A (Agriculture)	35,930 (2.0%)	0.265 (0.091)	0.584 (0.086)	0.123 (0.033)	2.024 (1.622)
B (Mining)	5,058 (0.3%)	0.425 (0.090)	0.483 (0.061)	0.113 (0.021)	1.224 (0.841)
C (Manufacturing)	564,090 (31.5%)	0.372 (0.108)	0.572 (0.115)	0.068 (0.026)	1.014 (0.596)
D (Electricity)	2,093 (0.1%)	0.355 (0.106)	0.444 (0.118)	0.193 (0.075)	0.775 (0.646)
E (Water and Waste)	15,938 (0.9%)	0.448 (0.024)	0.421 (0.031)	0.157 (0.044)	1.942 (2.034)
F (Construction)	287,130 (16.1%)	0.366 (0.102)	0.578 (0.076)	0.071 (0.022)	1.597 (1.056)
G (Trade)	424,089 (23.7%)	0.221 (0.096)	0.708 (0.122)	0.049 (0.028)	1.002 (0.601)
H (Transportation)	71,075 (4.0%)	0.375 (0.017)	0.513 (0.030)	0.114 (0.042)	2.576 (2.517)
I (Accommodation)	179,292 (10.0%)	0.257 (0.055)	0.623 (0.069)	0.141 (0.071)	2.427 (1.649)
J (Communications)	26,563 (1.5%)	0.459 (0.113)	0.484 (0.073)	0.086 (0.037)	1.516 (1.098)
K (Finance)	4,172 (0.2%)	0.271 (0.107)	0.530 (0.102)	0.218 (0.061)	1.064 (0.559)
L (Real Estate)	14,034 (0.8%)	0.313 (0.089)	0.554 (0.087)	0.114 (0.053)	1.565 (1.220)
M (Professional Act.)	28,179 (1.6%)	0.387 (0.092)	0.493 (0.083)	0.095 (0.033)	1.609 (1.440)
N (Administration)	38,102 (2.1%)	0.360 (0.014)	0.505 (0.019)	0.128 (0.037)	3.786 (3.823)
P (Education)	4,694 (0.3%)	0.286 (0.058)	0.613 (0.083)	0.096 (0.030)	10.227 (9.304)
Q (Human Health)	43,214 (2.4%)	0.313 (0.047)	0.582 (0.053)	0.096 (0.025)	6.270 (6.142)
R (Entertainment)	16,045 (0.9%)	0.211 (0.072)	0.631 (0.009)	0.112 (0.050)	5.759 (6.331)
S (Other Services)	28,862 (1.6%)	0.324 (0.089)	0.590 (0.040)	0.103 (0.034)	3.361 (2.605)
Total	1,788,560 (100.0%)	0.319 (0.116)	0.603 (0.119)	0.080 (0.047)	1.649 (2.076)

NOTES. Sectors O (Public administration and defense; Compulsory social security), T (Activities of households as employers), and U (Activities of extraterritorial organizations and bodies) were excluded from the analysis due to the small number of observations. Standard errors in parentheses.

Following the procedure detailed in section 4.4 and based on employment shares, the optimal yearly minimum wage is estimated for 2022, using both the simple firms shares and then weighting observations on employment. However, the results obtained when considering all sectors are considerably higher than the median wage in 2022 (€13.84 per hour), regardless of the weighting strategy (firms' shares or employment shares).

A solution can be found by restricting the analysis to a single industrial sector of interest, instead of considering all firms in the dataset. Looking at the values of ϕ from Table 1, I identify the sectors characterized, on average, by either monopsony or perfect competition. These are Manufacturing (C), Trade (G), Electricity (D), and Finance (K). Excluding the latter two because of the limited number of available observations, I choose to focus the analysis on the Manufacturing (C) sector. This is both the sector representing the relative majority of firms in Italy and a consolidated choice for labor economics studies in the past literature.

A new production function is thus estimated, considering the sub-sectors of manufacturing in equation (5). The resulting elasticities are displayed in Table 2, together with sub-sector-level estimates of labor market power ϕ .

TABLE 2: Output Elasticities and Labor Market Power by Manufacturing Sub-Sector.

Sub-sector	N	θ_L	θ_M	θ_K	ϕ
10 (Food Products)	47,290 (8.4%)	0.215 (0.049)	0.687 (0.059)	0.100 (0.037)	1.416 (1.062)
11 (Beverages)	6,282 (1.1%)	0.261 (0.030)	0.635 (0.051)	0.101 (0.039)	0.989 (1.043)
13 (Textiles)	16,883 (3.0%)	0.391 (0.129)	0.547 (0.156)	0.066 (0.038)	1.017 (0.491)
14 (Wearing Apparel)	16,858 (3.0%)	0.324 (0.070)	0.629 (0.081)	0.065 (0.027)	1.459 (1.440)
15 (Leather)	15,122 (2.7%)	0.345 (0.149)	0.590 (0.162)	0.077 (0.035)	1.108 (0.530)
16 (Wood and Cork)	19,442 (3.5%)	0.350 (0.120)	0.630 (0.103)	0.046 (0.014)	0.957 (0.524)
17 (Paper Products)	10,578 (1.9%)	0.322 (0.105)	0.632 (0.130)	0.056 (0.020)	0.741 (0.323)
18 (Printing)	17,912 (3.2%)	0.398 (0.100)	0.534 (0.070)	0.070 (0.020)	1.257 (0.786)
19 (Coke and Petroleum)	714 (0.1%)	0.356 (0.141)	0.635 (0.132)	0.064 (0.037)	0.481 (0.168)
20 (Chemical Products)	15,826 (2.8%)	0.312 (0.105)	0.641 (0.116)	0.073 (0.034)	0.793 (0.359)
21 (Pharmaceuticals)	2,022 (0.4%)	0.383 (0.157)	0.523 (0.140)	0.074 (0.032)	0.925 (0.375)
22 (Rubber and Plastic)	31,502 (5.6%)	0.325 (0.100)	0.602 (0.101)	0.063 (0.011)	0.943 (0.425)
23 (Other Mineral Products)	27,368 (4.9%)	0.385 (0.120)	0.588 (0.112)	0.075 (0.028)	0.988 (0.489)
24 (Basic Metals)	9,197 (1.6%)	0.362 (0.087)	0.566 (0.101)	0.067 (0.030)	0.796 (0.550)
25 (Fabricated Metal Products)	135,392 (24.2%)	0.430 (0.105)	0.493 (0.116)	0.083 (0.027)	0.993 (0.504)
26 (Electronic Products)	15,281 (2.7%)	0.383 (0.115)	0.558 (0.108)	0.053 (0.021)	1.052 (0.608)
27 (Electrical Equipment)	20,802 (3.7%)	0.309 (0.102)	0.637 (0.104)	0.047 (0.017)	1.178 (0.561)
28 (Machinery and Equipment)	69,359 (12.4%)	0.347 (0.082)	0.605 (0.107)	0.045 (0.021)	1.014 (0.489)
29 (Motor Vehicles)	7,238 (1.3%)	0.350 (0.127)	0.597 (0.138)	0.067 (0.029)	0.925 (0.404)
30 (Other Transport)	4,999 (0.9%)	0.412 (0.131)	0.557 (0.110)	0.065 (0.029)	1.115 (0.643)
31 (Furniture)	21,667 (3.9%)	0.325 (0.119)	0.641 (0.107)	0.048 (0.012)	1.257 (0.550)
32 (Other Manufacturing)	18,414 (3.3%)	0.378 (0.100)	0.547 (0.087)	0.070 (0.018)	1.144 (0.857)
33 (Repairs and Installations)	30,034 (5.4%)	0.429 (0.129)	0.517 (0.105)	0.064 (0.024)	1.141 (0.763)
Total	560,182 (100.0%)	0.361 (0.121)	0.576 (0.125)	0.069 (0.031)	1.071 (0.678)

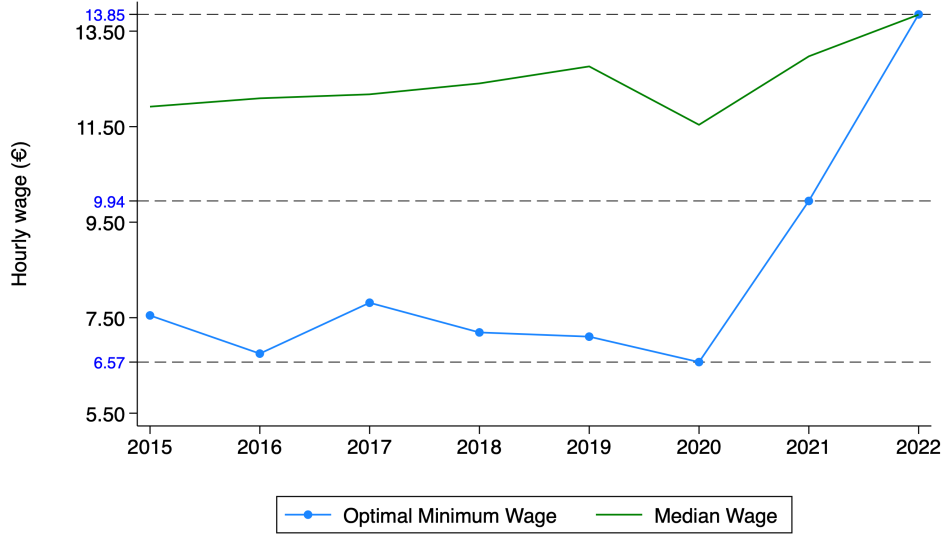
NOTES. Sector 12 (Manufacture of Tobacco Products) was excluded from the analysis due to the small number of observations. Standard errors in parentheses.

The optimal yearly minimum wage in Italy was thus found to be €39,000 in 2022.

Figure 2 illustrates the evolution of the optimal national minimum wage, as computed based on unweighted firm shares, from 2015 to 2022. Here, a rather surprising picture arises, as optimal minimum wages are relatively low and stable between 2015 and 2020, before showing a steep increase of 51% in 2021 and 39% in 2022.¹⁵ In 2022, the estimated optimal minimum wage is €0.01 higher than the median wage. While this result might seem counterintuitive, the analysis of productivity and labor market regimes below will try to assess if it can be justified by monopsony power growth.

¹⁵This behavior might be partly explained by the "rebound" effect experienced by worldwide economies in the aftermath of the Sars-CoV2 pandemic. However, the reasons behind such a steep increase might be investigated by further research, also employing more recent data from 2023 to 2024.

FIGURE 2: Optimal National Minimum Wage from 2015 to 2022.



To explain such behavior, in Figure 3 I present evidence on the evolution of average labor productivity (as measured by the marginal revenue product of labor) by firm sizes.¹⁶ Following the standard EU definition for small and medium enterprises (SME), microfirms are the ones employing fewer than 10 people and having a turnover below €2 million; small firms have fewer than 50 employees and a turnover below €10 million; medium-sized firms employ fewer than 250 people and do not exceed €250 million in yearly turnover. All remaining firms with values above these thresholds are classified as big firms (European Commission, 2003). Not surprisingly, there is a positive and stable correlation between firm size and labor productivity. From 2020 onwards, we observe a sizeable increase in productivity, with the marginal revenue product of labor increasing on average by 16.7% from 2020 to 2021 and by 17.6% between 2021 and 2022.¹⁷ During both periods, this increase is more pronounced for medium-sized and big firms, while it is less important for microfirms and small firms.

As documented in Figure 4, the average firm size increased between 2020 and 2022.¹⁸ This is due to a 5 percentage-points (pp) reduction in the share of microfirms, contemporaneous to a 3pp increase in the share of medium-sized firms and an increase of 1.5pp for small firms. Big firms also experienced a 1pp increase in their share over the period.

What is the overall relationship between all of these trends and labor market regimes? From Figure 5 we can see that the gap between the shares of firms operating under monopsony (MO) and the ones operating in an efficient bargaining (EB) regime significantly widens from 2019 onward. Between 2021 and 2022 the share of firms in the EB regime declined by 6.25 pp, at the expense of a 6.24pp increase in the share of firms operating under monopsony. In 2022, roughly two-thirds of manufacturing firms were classified in the MO regime, as opposed to less than one-third operating under EB.

¹⁶See appendix C for a similar graph showing the evolution of labor productivity by macroregion.

¹⁷Note that, over the 2020–2022 period, the average productivity increased by 37.3%, and the estimated optimal minimum wage increased by 110.8%.

¹⁸The average firm employed 38.06 people in 2020, 38.78 in 2021, and 40.83 in 2022. The median firm employed 11 people in 2020, 12 in 2021, and 12 in 2022.

FIGURE 3: Labor Productivity by Firm Size.

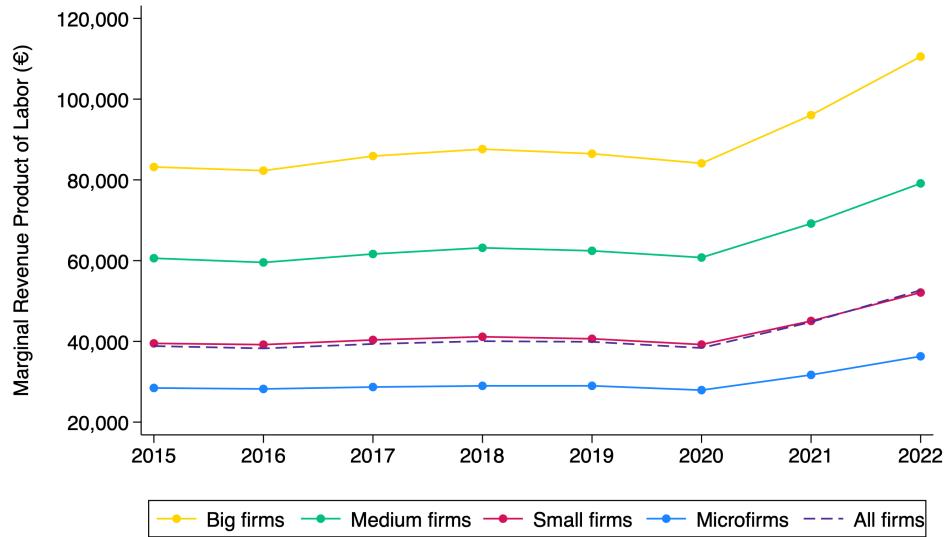


FIGURE 4: Share of Firms by Size Class.

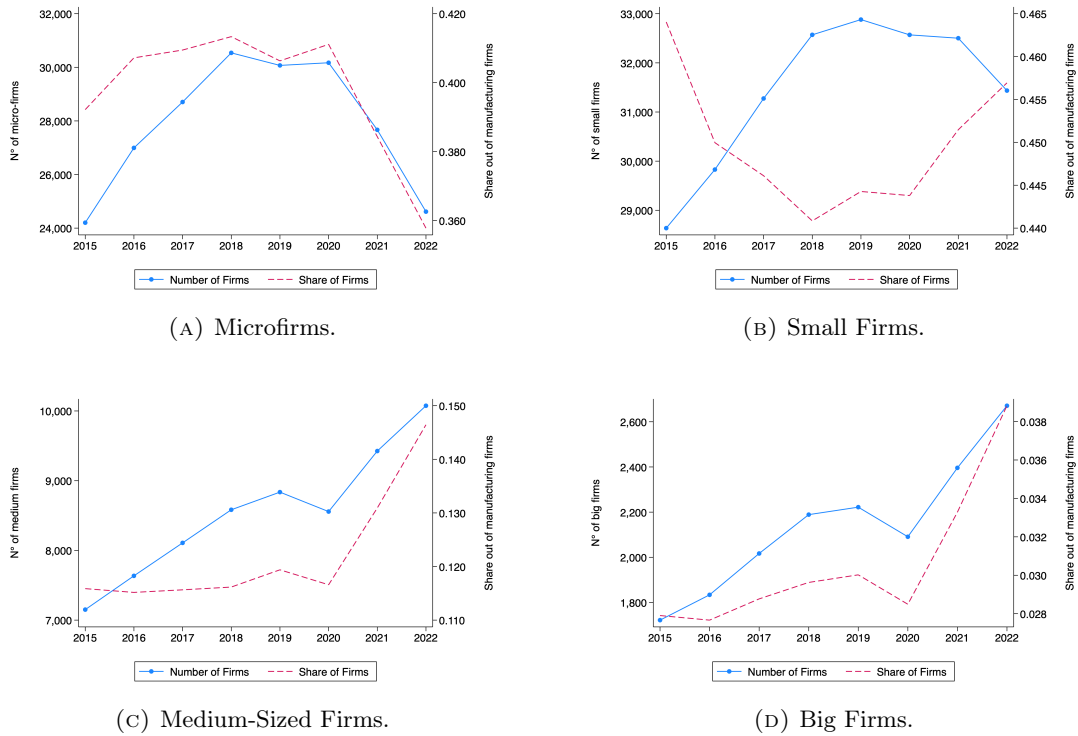
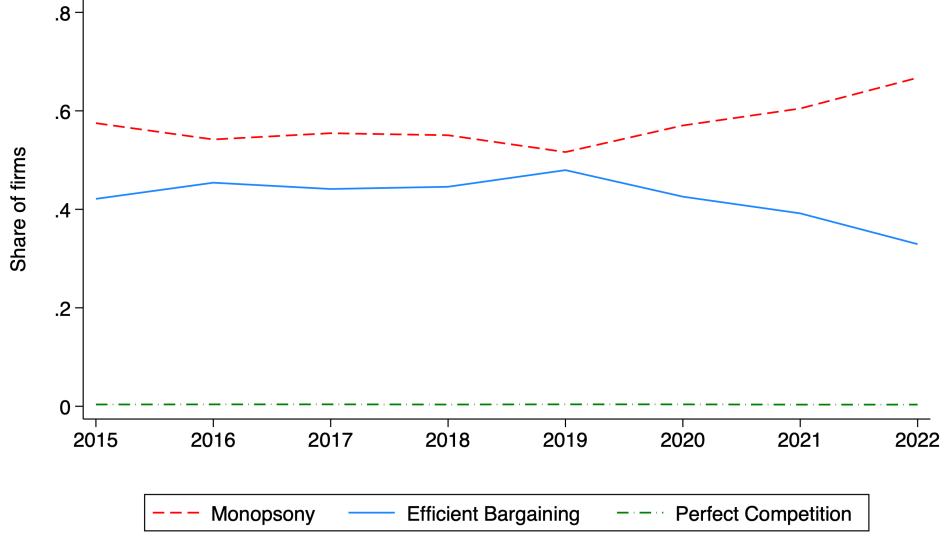


FIGURE 5: Share of Firms by Labor Market Regimes.



5.2. Local Effects of the National Minimum Wage

What would be the impact of the proposed minimum wage (€13.85 per hour) on employment levels? I investigate this issue in Figure 6, where the share of firms in categories 1 and 3 (see section 4.4 for the classification) is reported for each province, with darker colors indicating higher values of the share of firms in a given category.¹⁹

Negative employment effects (corresponding to firms in category 1) are mainly concentrated in the Center and in the South of Italy, with a partial exception being the North-Western region of Liguria. Positive effects on employment (corresponding to firms in category 3) would also come from the Center-South of the country, which would experience a stark reduction both in monopsony power and (probably) in the number of active firms, if the proposed minimum wage were to be implemented. Moreover, its bite in Northern Italy would probably be very limited, with the majority of active firms in the area belonging to category 4.²⁰

Considering Italy as a whole, this national minimum wage policy would result in around 15% of firms reducing their labor demand and more than 23% of firms increasing wages to their existing workforce and/or employing more workers.

The picture emerging from this analysis suggests that a more fine-tuned approach to the optimal minimum wage definition would both bring gains in terms of efficiency and improve the functioning of local labor markets.²¹

5.3. Optimal Regional Minimum Wages

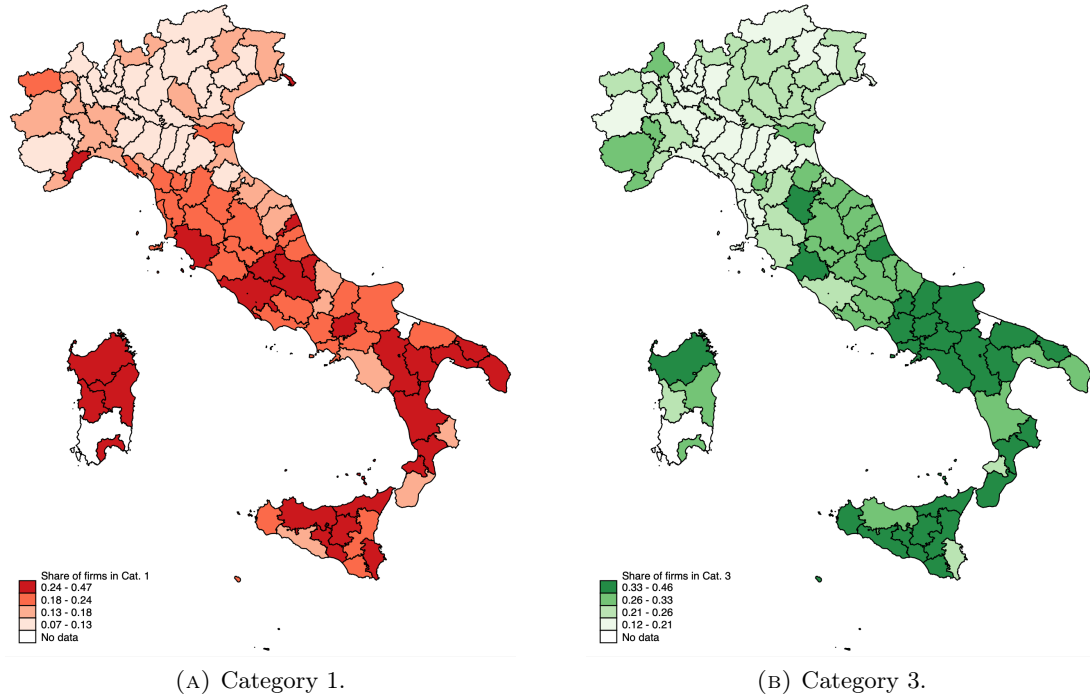
In this light, it seems reasonable to propose a differentiated approach where a different optimal minimum wage is defined at the level of every single Italian region. This endeavor, although very

¹⁹All choropleth maps in this paper are realized in Stata/SE 18.0 with the modules *shp2dta*, *mif2dta*, and *spmap* (Crow, 2006; Pisati, 2005, 2007).

²⁰See Figure 11 in Appendix C for the shares of firms in categories 2 and 4.

²¹Note that the proposed national minimum wage would imply sizeable disemployment effects in certain southern provinces, with more than 25% of firms being negatively affected by its introduction. In these areas, a rather big number of firms could potentially be pushed out of the market.

FIGURE 6: Share of Firms by Minimum Wage Category (National MW).



much theoretical in its nature, can possibly shade light on regional patterns in terms of wages and productivity.

As it was the case when studying the optimal national minimum wage, the regional analysis is again restricted to firms operating in the manufacturing sector.²²

Table 3 displays the results of the optimization procedure,²³ with columns 2 and 3 showing the ranges found for yearly minimum wages, and columns 4 and 5 indicating the hourly minimum wage ranges for every region.²⁴ Considering the results originating from the procedure employing unweighted firm shares (i.e., the lower bounds of every range), there is wide between-regions heterogeneity in the optimal minimum wage values. The three highest minima (which are found in the autonomous province of Bolzano, Veneto, and Lombardy) are more than double the amount of the proposed Sardinian minimum wage, which, at €7.46 per hour, is the lowest value found in Italy.

These results are most likely driven by local productivity, whose geographical distribution in 2022 is plotted for reference in Figure 7. Average values of the marginal revenue product of labor (in manufacturing) range from a low of €36,627 in the province of Nuoro, in Sardinia, to a high of €64,420 for the province of Lecco, in Lombardy. Unsurprisingly, the North-South divide in average firm productivity is very pronounced, with a strong positive association between latitude and average marginal product of labor.²⁵

²²As before, further analyses are needed in order to explain the sharp wedge between the optimal regional MWs computed with data from all sectors and the median wage in Italy in 2022.

²³As the optimization problem is solved through an iterative process, the error margin is €500 per year, or €0.178 per hour.

²⁴As it was the case for the national result, a value of $SSC = 0.284$ was used in equation (13) to convert yearly values into hourly ones.

²⁵The observation that productivity is higher in the North than in the South (with medium values in Central Italy) is a qualitative one, which can be drawn simply by looking at Figure 7.

REGIONAL MINIMUM WAGES AND LABOR MISALLOCATION IN ITALY

TABLE 3: Optimal Regional Minimum Wages in 2022.

Regions	Yearly MW (€)		Hourly MW (€)	
	Unweighted	Weighted	Unweighted	Weighted
Abruzzo	38,500	48,000	13.67	17.05
Basilicata	34,500	55,500	12.25	19.71
Prov. Aut. Bolzano	52,750	65,500	18.73	23.26
Calabria	31,000	45,000	11.01	15.98
Campania	32,000	50,000	11.37	17.76
Emilia-Romagna	45,500	66,500	16.16	23.62
Friuli-Venezia Giulia	46,000	60,500	16.34	21.49
Lazio	27,000	57,000	9.59	20.24
Liguria	32,500	55,000	11.54	19.53
Lombardia	47,000	64,000	16.69	22.73
Marche	40,000	50,500	14.21	17.94
Molise	36,250	42,250	12.87	15.01
Piemonte	39,000	71,000	13.85	25.22
Puglia	36,500	47,500	12.96	16.87
Sardegna	21,000	44,000	7.46	15.63
Sicilia	32,000	40,000	11.37	14.21
Toscana	32,500	56,500	11.54	20.07
Prov. Aut. Trento	45,500	69,000	16.16	24.51
Umbria	38,500	53,000	13.67	18.82
Valle D'Aosta	45,500	60,750	16.16	21.58
Veneto	48,500	58,500	17.23	20.78

NOTES. "Unweighted" indicates that simple shares of firms were used in the computation. "Weighted" indicates that the computation was carried out using employment shares.

While some minimum wage ranges are somewhat narrow, allowing for a precise definition of its optimal level (this is the case, e.g., in Molise, Sicilia, Abruzzo, and Veneto), others are rather wide, giving little information on the actual minimum wage value that would benefit the region in question (this happens, e.g., in Piemonte, Lazio, Toscana, and Trento). I attribute this to different distributions of firm sizes between regions: if all firms had the same number of employees, there would be no difference between the unweighted and the weighted result.²⁶ The share of employees working in big firms is positively correlated (0.44) with the gap between the weighted and unweighted optimal minimum wage at the region level.²⁷

Firms with a number of employees greater than the average increase the weighted share of the category to which they belong and cause the two results (weighted and unweighted MW) to differ, with the direction of this effect depending on the minimum wage categories in which the bigger firms operate. Since bigger firms are more productive (see Figure 3) and pay higher wages,²⁸ I expect them to belong mainly to categories 3 and 4 for most given values of MW . Considering that (i) cat. 2 and cat. 4 are not directly part of the analysis; (ii) for any given value of MW , bigger firms are over-represented in cat. 3 and cat. 4 and under-represented in cat. 1 and cat. 2,²⁹ the

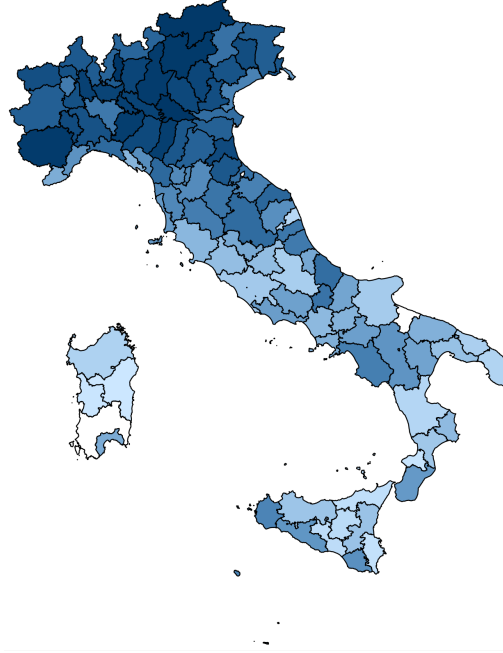
²⁶See Tables 4 and 5 in Appendix C for the distribution of firms and employees in class-sizes across regions.

²⁷See Figure 14 in Appendix C for the scatterplot visualizing this correlation.

²⁸As shown in Table 6, median manufacturing wages in 2022 were €31,734 in microfirms, €39,856 in small firms, €48,968 in medium-sized firms, and €57,001 in big firms.

²⁹This amounts to saying that there are always fewer "big" firms in cat. 1 than in cat. 3, where a "big" firm is defined as one having more than X employees, with X greater than the region-specific average employment level. (This also holds between cat. 2 and cat. 3, but note that cat. 2 is not directly included in the analysis.) To see why this is the case, please refer to Section 4.4 and consider the condition $MRP_{it}^L < MW$, required to be classified in

FIGURE 7: Labor Productivity by Province in 2022.



above causes regions having a higher share of employees working in big firms to display a wider gap between the share of firms in cat. 1 and cat. 3 *vis à vis* other regions. I claim that this differential wedge is concave in MW , the optimal minimum wage level on which we optimize.³⁰ Referring to Figure 1, this amounts to saying that the location of the maximum distance between the cat. 3 and cat. 1 curves will be further to the right on the x -axis for those regions.

In turn, this causes regions featuring a lot of "big" firms to display a higher level of optimal minimum wage when weighting observations using employment shares.³¹

For the reasons above, I always consider the lower bound of every interval (i.e., the unweighted MW) in the analysis that follows to draw a more realistic scenario when describing the potential consequences of the introduction of regional minimum wages.

5.4. Local Effects of Regional Minimum Wages

If the proposed regional minimum wages were in place, the deep North–South divide in employment effects shown in Figure 6 would give way to much more homogeneity in effects when comparing regions.

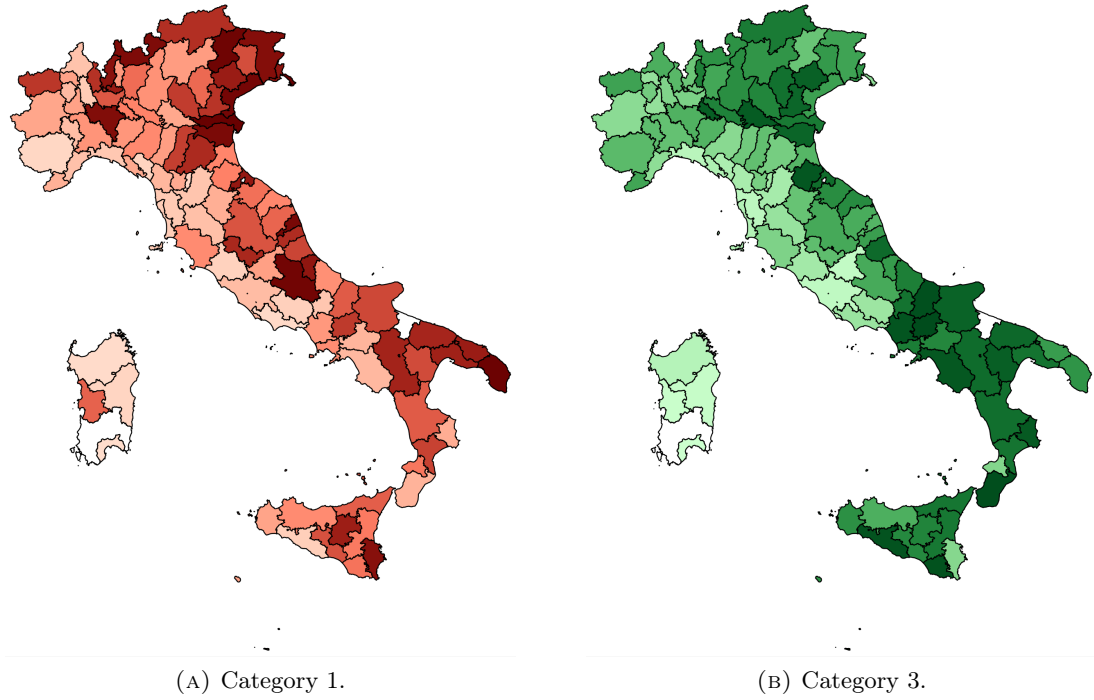
Indeed, Panel (a) of Figure 8 shows a rather homogeneous North–South distribution of provinces with the highest shares of firms in cat. 1. Panel (b) of the same figure shows how shares of firms

cat. 1. For bigger firms, having higher productivity MRP_{it}^L , it is more difficult to satisfy this condition and easier to satisfy $MRP_{it}^L \geq MW$, which is required to be classified in cat. 3, and this holds for any value of MW . Moreover, the condition $\phi_{it} = \frac{w_{it}}{MRP_{it}^L} \geq 1$ follows a similar path, with greater values of MRP_{it}^L making it more likely for a firm to be classified in cat. 3 (if $\phi_{it} < 1$, i.e., "big" firms enjoy monopsonistic power) or cat. 4 (if $w_{it} \geq MW$, i.e., "big" firms' wages are higher than the given MW).

³⁰This claim should be verified by further research, ideally with a formal proof. It is nevertheless sensible to assume a relevant degree of monopsonistic power in the market, which would make it easier for "big" firms to fall into cat. 3 rather than into cat. 1 (please refer to Section 4.4 for the relevant conditions).

³¹Also here, a "big" firm is defined as one having more than X employees, with X greater than the region-specific average employment level.

FIGURE 8: Share of Firms by Minimum Wage Category (Regional MWs).



benefiting from the introduction of regional minimum wages would be rather high across the whole country, with the highest value recorded in Benevento, Campania (46.73% of firms) and the lowest one in Cagliari, Sardinia (5.92% of firms).³²

Within-region heterogeneity dominates the picture, with a weakly positive correlation (0.16) between productivity and the share of firms on which the introduction of a regional minimum wage would be positive (i.e., the ones classified in cat. 3) at the province level.³³

In the whole of Italy, the regional minimum wage policy would induce positive employment effects on 27.16% of firms, while having negative labor demand effects on 17.75% of them. This is a net improvement with respect to the national MW case (where 23% of firms are in cat. 3 and 15% of them are in cat. 1), with the increase in the share of negatively impacted firms being more than compensated for by a larger increase in the share of positively affected ones.

Moreover, the marginal revenue product of labor is found to be weakly correlated (0.19) with net gains from the regional MWs (i.e., with the difference between shares of firms in cat. 3 and in cat. 1) at the province level, suggesting that optimal regional minimum wages likely depend on local productivity.³⁴

6. CONCLUSION

Given the recent discussion about the proposed introduction of a statutory minimum wage in Italy, in this paper I attempted to assess its potential impact through an empirical study employing the latest available data on Italian firms. A measure of individual labor market power was computed from the estimates of input-output elasticities, which were retrieved from a translog production

³²See Figure 12 in Appendix C for the shares of firms in categories 2 and 4.

³³See Figure 13 in Appendix C for the scatterplot visualizing this correlation.

³⁴See Figure 15 in Appendix C for the scatterplot visualizing this correlation.

function via a WLP estimator. This approach allowed to correct for the simultaneity between input choices and unobserved productivity shocks. Following the previous literature, I decided to restrict the analysis to the manufacturing sector, which is characterized by higher average monopsony power (with respect to the value found when considering all sectors) and is representative of the Italian labor market, comprising the relative majority of active firms in the country (more than 31%).

The optimal national minimum wage for 2022 was found to be €39,000 per year, or €13.85 per hour on average. This signals a steep increase with respect to both the optimal MW levels prevailing in Italy until 2020 and to the one found by Caselli et al. (2023) for 2018. I documented noteworthy gains in labor productivity from 2020 onward and a sizeable rise in monopsony power during the 2019-2022 period, and I attributed the increase in optimal minimum wage to both of these factors.

However, this national MW value was found to only be optimal for the country as a whole, featuring highly heterogeneous effects at the local level. Policymakers would thus be faced with both distributional and efficiency issues. In the short run, a national minimum wage in Italy would not only give way to significantly different employment effects between different geographical areas; it would also push a relevant number of firms out of the market.³⁵

Aiming to obtain more homogeneous between-regions employment effects from the potential introduction of a minimum wage, I proposed a regional approach, where optimal MW levels were defined for each of the 21 Italian regions. Results from the spatial analysis based on these optimal values revealed how regional minimum wages would increase positive employment effects at the national level. The proposed regional minima would also have an efficiency-enhancing effect, as the share of firms potentially expanding the workforce would be highest in the most productive provinces. Therefore, regional minimum wages would have a higher bite than the national one, would increase aggregate positive labor supply effects and would reduce negative effects on the labor demand at the local level.

The main limitation of this study lies in the lack of detailed balance-sheet data for many of the smallest Italian firms, which prevents a fully comprehensive analysis of the demand-induced effects of a minimum wage. Moreover, using balance-sheets as a primary data source only allows to observe the mean cost of labor, not the median one. Data on reservation wages would also be useful to identify the pull-effect of the MW at the participation margin. A quantitative estimation of the firm-level employment effect (in terms of the number of employees involved) would allow to capture heterogeneity between firms of different sizes in different locations, leading to a more precise characterization of aggregate employment effects at the national level. Lastly, more recent data from 2023 to 2024 could provide a better understanding of the optimal MW trend in relation to the median wage.

Further research should investigate the general equilibrium effects associated with the introduction of national and regional minimum wages in Italy, with a focus on both workers' within-country migration decisions and firms' relocation choices.

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³⁵Please note that firms' and workers' relocation incentives (or other spillover effects) are not taken into account in this paper.

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A. MATHEMATICAL APPENDIX

A.1. Production Function Estimation

In what follows, I give a more detailed description of the production function presented in section 4.2.

Capital is denoted by k , materials are denoted by m and labor is denoted by l . The indexes L_1 and L_2 indicate, respectively, the first and second lags of a variable.

The variables assumed to be exogenous are capital k , its square k^2 , its first lag k_{L_1} , and the first lag of materials m_{L_1} .

The endogenous variables are labor, material, and their interactions: l , m , l^2 , m^2 , lk , lm , mk . Accordingly, they are instrumented with the following lagged variables: l_{L_1} , l_{L_2} , k_{L_2} , m_{L_2} , $l_{L_1}^2$, $l_{L_2}^2$, $m_{L_2}^2$, lk_{L_1} , lk_{L_2} , lm_{L_1} , lm_{L_2} , and mk_{L_2} .

Year fixed-effects are added to control for sector-wide, time-specific shocks that might affect all firms in a given industry.

A.2. Confidence Interval for ψ

I hereby detail the procedure to derive the variance of ψ , used in the computation of the confidence interval presented in section 4.3.

Starting from equation (9) and following Caselli et al. (2021), note that α_M and α_L are observed, but θ_M and θ_L are estimated. As such, they must be considered as random variables. (Note that, in what follows, indexes i and t are left aside for simplicity.)

We can write:

$$\begin{aligned}\text{Var}(\psi) &= \text{Var}\left(\frac{\theta_M}{\alpha_M} - \frac{\theta_L}{\alpha_L}\right) = \\ &= \frac{\text{Var}(\hat{\theta}_M)}{\alpha_M^2} + \frac{\text{Var}(\hat{\theta}_L)}{\alpha_L^2} - \frac{2 \text{Cov}(\hat{\theta}_M, \hat{\theta}_L)}{\alpha_M \cdot \alpha_L}\end{aligned}\quad (14)$$

Given equations (6) and (7), we can derive the variances of $\hat{\theta}_M$ and $\hat{\theta}_L$ as follows:

$$\begin{aligned}\text{Var}(\hat{\theta}_M) &= \text{Var}\left(\hat{\beta}_M + 2\hat{\beta}_{M^2} \cdot m + \hat{\beta}_{KM} \cdot k + \hat{\beta}_{LM} \cdot l\right) = \\ &= \text{Var}(\hat{\beta}_M) + 4m^2 \cdot \text{Var}(\hat{\beta}_{M^2}) + k^2 \cdot \text{Var}(\hat{\beta}_{KM}) + l^2 \cdot \text{Var}(\hat{\beta}_{LM}) + \\ &\quad + 4m \cdot \text{Cov}(\hat{\beta}_M, \hat{\beta}_{M^2}) + k \cdot \text{Cov}(\hat{\beta}_M, \hat{\beta}_{KM}) + l \cdot \text{Cov}(\hat{\beta}_M, \hat{\beta}_{LM}) + \\ &\quad + 4km \cdot \text{Cov}(\hat{\beta}_{M^2}, \hat{\beta}_{KM}) + 4lm \cdot \text{Cov}(\hat{\beta}_{M^2}, \hat{\beta}_{LM}) + 2lk \cdot \text{Cov}(\hat{\beta}_{KM}, \hat{\beta}_{LM})\end{aligned}\quad (15)$$

$$\begin{aligned}\text{Var}(\hat{\theta}_L) &= \text{Var}\left(\hat{\beta}_L + 2\hat{\beta}_{L^2} \cdot l + \hat{\beta}_{KL} \cdot k + \hat{\beta}_{LM} \cdot m\right) = \\ &= \text{Var}(\hat{\beta}_L) + 4l^2 \cdot \text{Var}(\hat{\beta}_{L^2}) + k^2 \cdot \text{Var}(\hat{\beta}_{KL}) + l^2 \cdot \text{Var}(\hat{\beta}_{LM}) + \\ &\quad + 4l \cdot \text{Cov}(\hat{\beta}_L, \hat{\beta}_{L^2}) + k \cdot \text{Cov}(\hat{\beta}_L, \hat{\beta}_{KL}) + m \cdot \text{Cov}(\hat{\beta}_L, \hat{\beta}_{LM}) + \\ &\quad + 4kl \cdot \text{Cov}(\hat{\beta}_{L^2}, \hat{\beta}_{KL}) + 4lm \cdot \text{Cov}(\hat{\beta}_{L^2}, \hat{\beta}_{LM}) + 2mk \cdot \text{Cov}(\hat{\beta}_{KL}, \hat{\beta}_{LM})\end{aligned}\quad (16)$$

Then, the covariance between $\hat{\theta}_M$ and $\hat{\theta}_L$ is computed as follows:

$$\begin{aligned}\text{Cov}(\hat{\theta}_M, \hat{\theta}_L) &= \text{Cov}(\hat{\beta}_M, \hat{\beta}_L) + 2l \cdot \text{Cov}(\hat{\beta}_M, \hat{\beta}_{L^2}) + k \cdot \text{Cov}(\hat{\beta}_M, \hat{\beta}_{KL}) + \\ &\quad + m \cdot \text{Cov}(\hat{\beta}_M, \hat{\beta}_{LM}) + 2m \cdot \text{Cov}(\hat{\beta}_{M^2}, \hat{\beta}_L) + 4lm \cdot \text{Cov}(\hat{\beta}_{M^2}, \hat{\beta}_{L^2}) + \\ &\quad + 2km \cdot \text{Cov}(\hat{\beta}_{M^2}, \hat{\beta}_{KL}) + 2m^2 \cdot \text{Cov}(\hat{\beta}_{M^2}, \hat{\beta}_{LM}) + k \cdot \text{Cov}(\hat{\beta}_{KM}, \hat{\beta}_L) + \\ &\quad + 2kl \cdot \text{Cov}(\hat{\beta}_{KM}, \hat{\beta}_{L^2}) + k^2 \cdot \text{Cov}(\hat{\beta}_{KM}, \hat{\beta}_{KL}) + km \cdot \text{Cov}(\hat{\beta}_{KM}, \hat{\beta}_{LM}) + \\ &\quad + l \cdot \text{Cov}(\hat{\beta}_{LM}, \hat{\beta}_L) + 2l^2 \cdot \text{Cov}(\hat{\beta}_{LM}, \hat{\beta}_{L^2}) + \\ &\quad + kl \cdot \text{Cov}(\hat{\beta}_{LM}, \hat{\beta}_{KL}) + lm \cdot \text{Cov}(\hat{\beta}_{LM}, \hat{\beta}_{LM})\end{aligned}\quad (17)$$

Solving equations (15), (16), and (17) first and then plugging the results into equation (14) allows to find an estimate for the variance of ψ . Finally, it is possible to use such result to compute the confidence interval of ψ presented in equation (10).

B. DATA APPENDIX

B.1. Price Indexes Data

To express all variables in real terms, adequate price indexes are used.³⁶ All publicly available sector-specific Producer Price Indexes (PPIs) are retrieved from the ISTAT website. These include PPIs for sectors A (Agriculture, Forestry and Fishing), B (Mining and Quarrying), C (Manufacturing), D (Electricity, Gas, Steam and Air Conditioning Supply), E (Water Supply; Sewerage, Waste

³⁶The exception being labor, for which the number of employees (already available in the data) is used.

Management and Remediation Activities)³⁷, F (Construction)³⁸, H (Transportation and Storage), J (Information and Communication), M (Professional, Scientific and Technical Activities), and N (Administrative and Support Service Activities). Sub-sector-level PPIs are available in the service industry and are thus used individually. These include sub-sectors from 49 to 53 (H), from 58 to 63 (J), from 69 to 75 (M), and from 77 to 82 (N).³⁹

All indexes have a standard value of 100 in the base year 2015. Although these sectors, for which price data are available, comprise the majority of Italian firms and employed workers, data on the remaining sectors are not publicly available. I thus constructed a national average PPI, based on available price data and using sectoral revenues as weights. Finally, I used this national weighted-average PPI to proxy for the PPI of sectors G (Wholesale and Retail Trade), I (Accommodation and Food Service Activities), K (Financial and Insurance Activities), L (Real Estate Activities), O (Public Administration and Defense; Compulsory Social Security), P (Education), Q (Human Health and Social Work Activities), R (Arts, Entertainment and Recreation), S (Other Service Activities), T (Activities of Households as Employers or for Own Use), and U (Activities of Extraterritorial Organizations and Bodies).

This amounts to assuming that the (weighted) average of PPI in sectors pertaining to agriculture, industry, and services gives a good approximation of producer price dynamics in the field of trade and in all other sectors.

B.2. Revenues Data

The sector-level revenues to be used as weights in the PPI average computation are proxied by the value of production in a given sector and year.⁴⁰ This amounts to assuming that the difference between inventories at the beginning and at the end of a given year is, on average, negligible. Production Value data are retrieved from the Istat website for sectors B, C, D, E, F, H, J, M, and N. Output data from Istat are used for sector A.

B.3. Services Sectors – Approximation Methodology

As PPI data on the services (H, J, M, and N) sectors are often incomplete, a weighted (based on production value) average PPI of the available sub-sectors is constructed and then used as a proxy for the PPI of sub-sectors for which data are missing.

Specifically, the weighted averages are constructed as follows: in sector H, the (weighted) average between the PPIs of subdivisions 52.1 (Warehousing and storage) and 52.2 (Support activities for transportation) is used as a proxy for the PPI of sub-sector 52 (Warehousing and support activities for transportation); in sector J, the PPIs of sub-sectors 61 (Telecommunications), 62 (Computer programming, consultancy and related activities), and 63 (Information service activities) are averaged to obtain a proxy PPI for sub-sectors 58 (Publishing activities), 59 (Motion picture, video and television program production, sound recording and music publishing activities), and 60 (Programming and broadcasting activities); in sector M, the average between PPIs of sub-sectors 69 (Legal and accounting activities), 70 (Activities of head offices; management consultancy activities), 71 (Architectural and engineering activities; technical testing and analysis),

³⁷Due to data availability and based on production value considerations, the PPI of sector E is proxied by the one of sub-sector 36 (Water collection, treatment and supply).

³⁸Due to data availability and based on production value considerations, the PPI of sector F is proxied by the one of sub-sector 41.2 (Construction of residential and non-residential buildings).

³⁹Due to both data availability and production value considerations, the following PPI approximations are chosen: division 49 (Land transport and transport via pipelines) is proxied by subdivision 49.4 (Freight transport by road and removal services); subdivision 52.2 (Support activities for transportation) is proxied by sub-subdivision 52.24 (Cargo handling); division 63 (Information service activities) is proxied by subdivision 63.1 (Data processing, hosting and related activities; web portals); division 70 (Activities of head offices; management consultancy activities) is proxied by subdivision 70.2 (Management consultancy activities); division 81 (Services to buildings and landscape activities) is proxied by subdivision 81.2 (Cleaning Activities).

⁴⁰For sector A (Agriculture, Forestry and Fishing) only, revenues are proxied by output.

and 73 (Advertising and market research) proxies for the PPI of sub-sectors 72 (Scientific research and development), 74 (Other professional, scientific and technical activities), and 75 (Veterinary activities); finally, in sector N, the weighted average PPI of sub-sectors 78 (Employment activities), 80 (Security and investigation activities), and 81 (Services to buildings and landscape activities) is used as a proxy PPI for sub-sectors 77 (Rental and leasing activities), 79 (Travel agency, tour operator), and 82 (Office administrative, office support).

C. ADDITIONAL FIGURES AND TABLES

FIGURE 9: Labor Productivity by Macro-Regions.

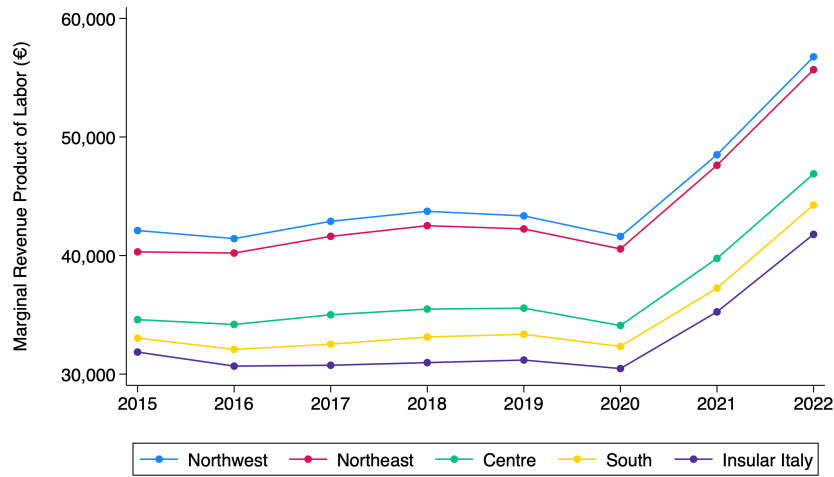


FIGURE 10: Single-Employee Firms.

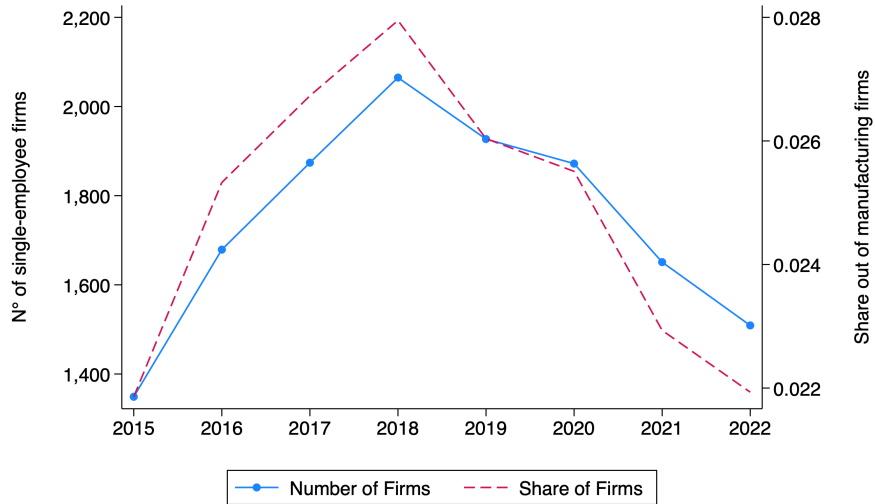


FIGURE 11: Share of Firms by National Minimum Wage Category (2 and 4).

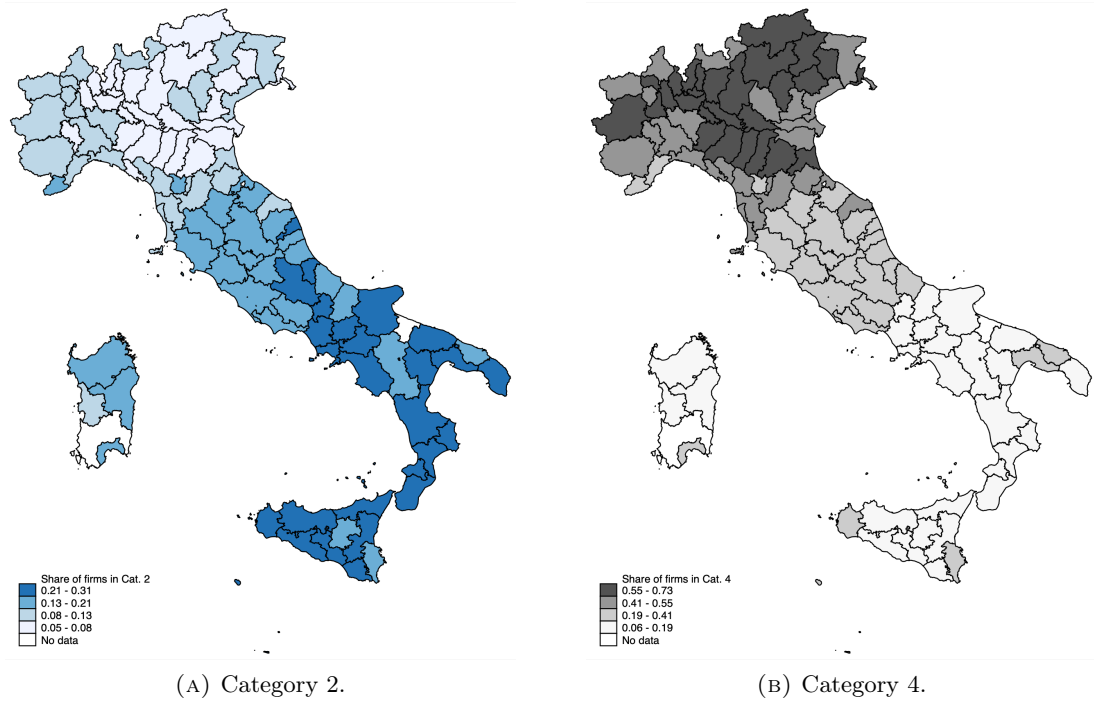
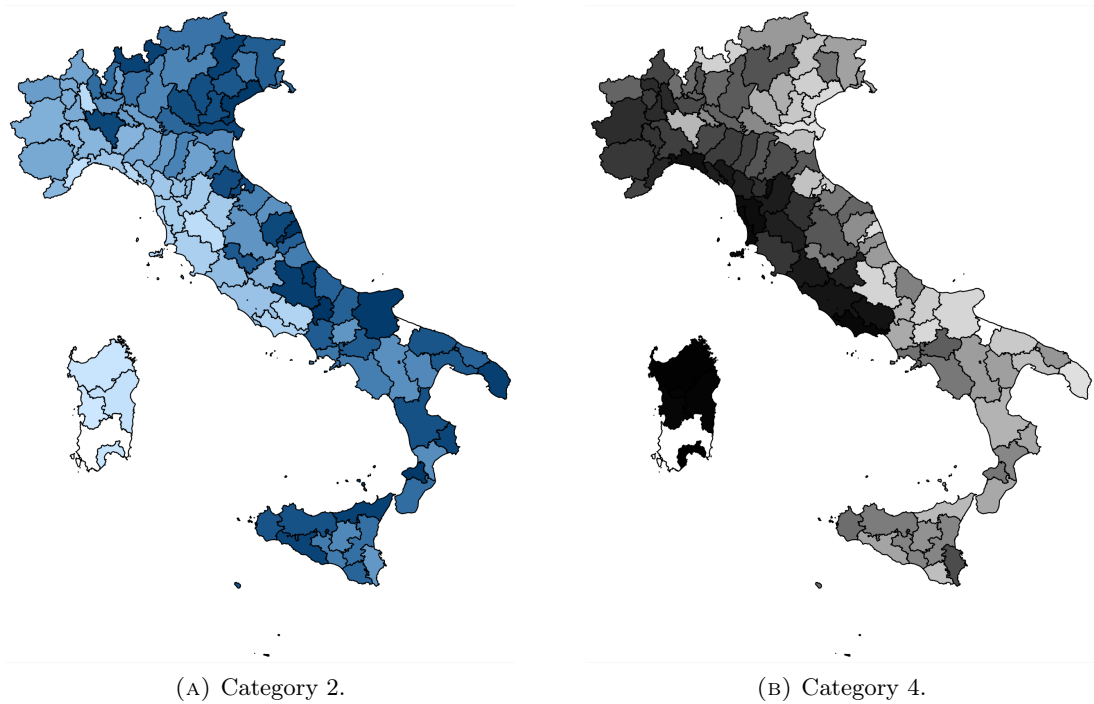


FIGURE 12: Share of Firms by Regional Minimum Wage Category (2 and 4).



REGIONAL MINIMUM WAGES AND LABOR MISALLOCATION IN ITALY

FIGURE 13: Correlation between Productivity and Share of Firms in Cat. 3.

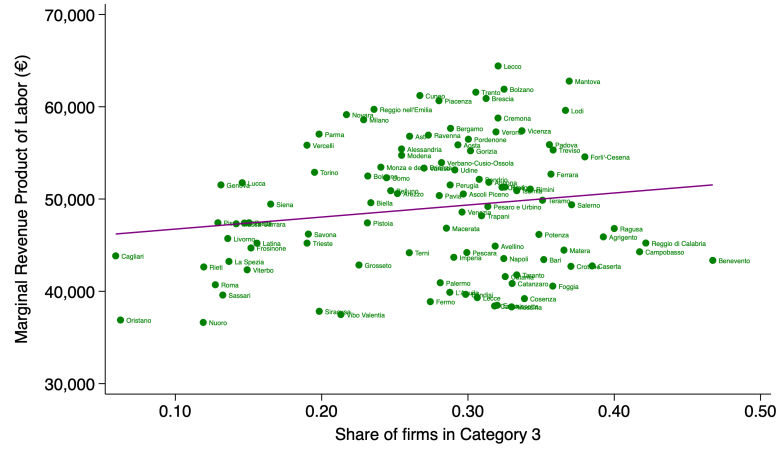


FIGURE 14: Correlation between Share of Employees in Big Firms and MW Gap.

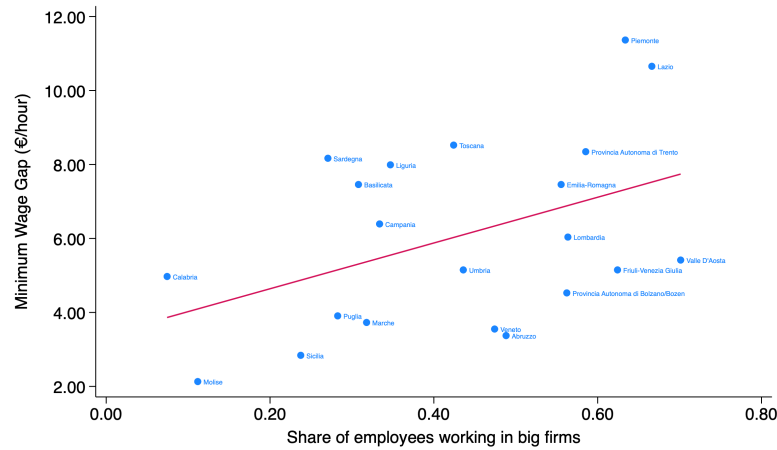


FIGURE 15: Correlation between Productivity and Net Gains from Regional MWs.

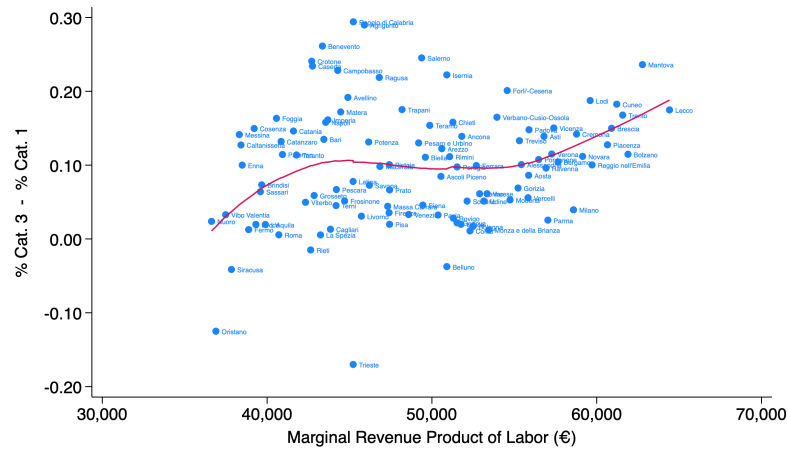


TABLE 4: Share of Firms by Size Class.

Regions	Microfirms	Small Firms	Medium Firms	Big Firms
Abruzzo	0.38	0.47	0.11	0.04
Basilicata	0.46	0.41	0.11	0.02
Prov. Aut. Bolzano	0.30	0.44	0.19	0.07
Calabria	0.56	0.38	0.05	0.00
Campania	0.46	0.41	0.10	0.02
Emilia-Romagna	0.32	0.47	0.16	0.05
Friuli-Venezia Giulia	0.31	0.48	0.16	0.05
Lazio	0.52	0.37	0.09	0.02
Liguria	0.39	0.45	0.13	0.03
Lombardia	0.33	0.46	0.16	0.05
Marche	0.36	0.48	0.14	0.02
Molise	0.46	0.44	0.08	0.01
Piemonte	0.31	0.47	0.17	0.05
Puglia	0.46	0.43	0.10	0.01
Sardegna	0.54	0.38	0.08	0.01
Sicilia	0.52	0.40	0.07	0.01
Toscana	0.38	0.48	0.12	0.03
Prov. Aut. Trento	0.33	0.45	0.16	0.06
Umbria	0.36	0.46	0.14	0.04
Valle D'Aosta	0.40	0.38	0.16	0.07
Veneto	0.30	0.48	0.18	0.04
Italy	0.36	0.46	0.15	0.04

NOTES. The Table displays the distribution of manufacturing firms by size-class in each Italian region in 2022. Microfirms employ fewer than 10 people and have a turnover below €2 million; small firms have fewer than 50 employees and a turnover below €10 million; medium-sized firms employ fewer than 250 people and do not exceed €250 million in yearly turnover. All remaining firms with values above these thresholds are classified as big firms.

TABLE 5: Share of Employees by Size Class of Firm.

Regions	Microfirms	Small Firms	Medium Firms	Big Firms
Abruzzo	0.05	0.25	0.21	0.49
Basilicata	0.09	0.32	0.28	0.31
Prov. Aut. Bolzano	0.03	0.15	0.26	0.56
Calabria	0.19	0.48	0.26	0.07
Campania	0.09	0.30	0.28	0.33
Emilia-Romagna	0.04	0.19	0.22	0.56
Friuli-Venezia Giulia	0.03	0.15	0.20	0.62
Lazio	0.05	0.14	0.14	0.67
Liguria	0.07	0.28	0.30	0.35
Lombardia	0.04	0.18	0.23	0.56
Marche	0.06	0.30	0.32	0.32
Molise	0.12	0.46	0.31	0.11
Piemonte	0.03	0.15	0.19	0.63
Puglia	0.09	0.34	0.28	0.28
Sardegna	0.14	0.35	0.25	0.27
Sicilia	0.14	0.38	0.25	0.24
Toscana	0.06	0.27	0.24	0.42
Prov. Aut. Trento	0.03	0.17	0.22	0.59
Umbria	0.05	0.24	0.28	0.44
Valle D'Aosta	0.03	0.10	0.17	0.70
Veneto	0.04	0.21	0.28	0.47
Italy	0.04	0.20	0.23	0.52

NOTES. The Table displays the distribution of manufacturing employees by firm-size class in each Italian region in 2022. Microfirms employ fewer than 10 people and have a turnover below €2 million; small firms have fewer than 50 employees and a turnover below €10 million; medium-sized firms employ fewer than 250 people and do not exceed €250 million in yearly turnover. All remaining firms with values above these thresholds are classified as big firms.

REGIONAL MINIMUM WAGES AND LABOR MISALLOCATION IN ITALY

TABLE 6: Median Wage by Firm Size.

Regions	Microfirms	Small Firms	Medium Firms	Big Firms
Abruzzo	27,774	34,033	41,758	49,255
Basilicata	26,375	30,641	43,222	48,911
Prov. Aut. Bolzano	39,993	45,900	52,825	61,755
Calabria	22,325	29,085	39,981	40,097
Campania	23,728	29,344	36,538	46,928
Emilia-Romagna	35,199	43,188	52,366	58,967
Friuli-Venezia Giulia	34,027	41,440	48,283	55,768
Lazio	28,200	35,068	46,706	63,317
Liguria	31,050	40,952	50,907	58,810
Lombardia	36,285	43,484	52,385	59,855
Marche	29,324	36,557	43,747	48,910
Molise	25,663	31,339	36,379	71,556
Piemonte	33,808	40,831	49,929	57,433
Puglia	24,684	30,386	37,190	44,084
Sardegna	27,075	32,172	40,026	43,818
Sicilia	22,654	30,260	39,330	44,807
Toscana	31,426	38,117	47,650	57,319
Prov. Aut. Trento	36,384	43,319	50,455	58,418
Umbria	29,766	35,298	43,939	53,452
Valle D'Aosta	32,427	38,197	51,899	58,088
Veneto	33,341	40,862	48,045	53,651
Italy	31,734	39,856	48,968	57,001

NOTES. The Table displays the manufacturing median wage (in Euros) by firm-size class in each Italian region in 2022. Microfirms employ fewer than 10 people and have a turnover below €2 million; small firms have fewer than 50 employees and a turnover below €10 million; medium-sized firms employ fewer than 250 people and do not exceed €250 million in yearly turnover. All remaining firms with values above these thresholds are classified as big firms.