Heterogeneous Labour Market Concentration and Minimum Wage Policy in Portugal

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Abstract

This paper tests the monopsonist hypothesis in minimum wage theory, by analysing whether minimum wage increases may have positive employment effects when diverging from a perfect competition framework. I use data from 2002 to 2013 to segment Portugal into several local labour markets, and construct Herfindahl–Hirschman Indices (HHI) to measure concentration levels in each market. I find that minimum wage increases have significant direct disemployment effects but - consistent with the monopsonist hypothesis - they also have a counteracting indirect positive effect on employment by offsetting labour market power. Estimated employment elasticities range from -1.01 to 1.86 depending on the concentration level of each market. I further estimate that, in markets with high minimum wage coverage, the threshold for overall positive employment effects occurs whenever a labour market has a HHI based on hires of at least 0.35. These cases are rare, since most markets are not highly concentrated. My results are robust to changes in concentration measures and alternative samples, although evidence for the monopsonist hypothesis is weaker for some subgroups.

JEL Classification: J2, J3, J38, J42

Keywords— Local labour markets, labour market concentration, monopsony power, minimum wage

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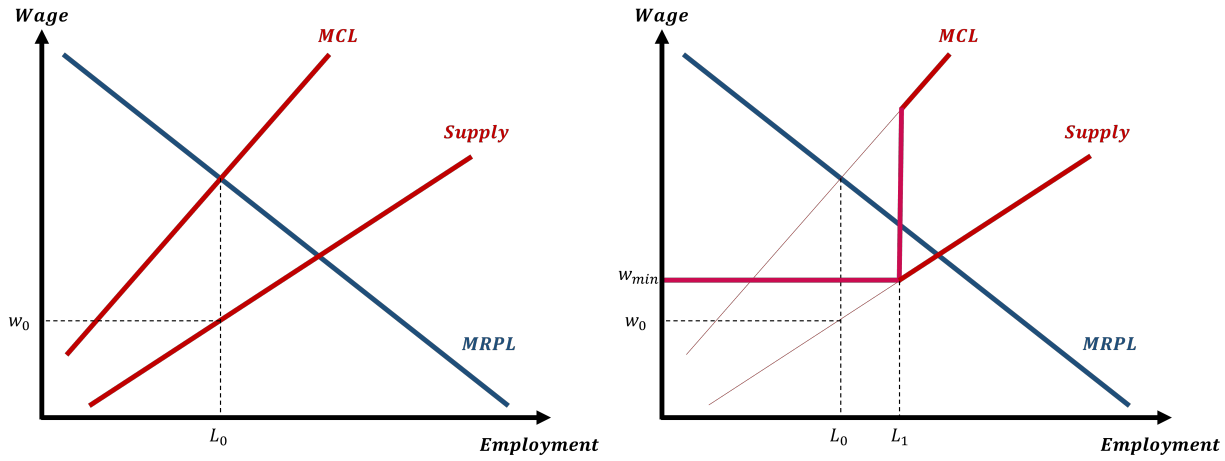
1 Introduction

After decades of research, employment effects of minimum wage increases remain one of the most contentious debates in labour economics literature. In the US, Card and Krueger's 1993 case-study of minimum wage differences in New Jersey and Pennsylvania, followed by their 1995 book *Myth and Measurement*, challenged the established idea in economic theory that minimum wage increases necessarily lead to disemployment effects. Other local (Dube et al., 2007) and national (Dube et al., 2010) studies also find no negative employment effects, while some authors find significant disemployment effects following minimum wage increases, often affecting particular groups (Neumark and Wascher, 1992, 2007).

A common argument for why findings are often at odds with the disemployment effects classical economic theory would expect is that labour markets do not behave competitively. In fact, in the presence of labour market power, minimum wages can theoretically correct a market failure and have a positive impact on both wages and employment (Figure 1). Manning (2011) has indeed argued that labour markets are best characterised by an oligopsonistic or monopsonistic competition framework, allowing firms to exert market power and put downward pressure on wages and employment. Bhaskar et al. (2002) also argue that less competitive markets will have at least milder disemployment effects.

Figure 1: Monopsonistic labour market, with and without binding minimum wage



(a) No binding minimum wage

(b) Binding minimum wage

Given that imperfect competition may provide a potential explanation to the conflicting results, it is almost puzzling to find that the monopsony hypothesis has not been subject to wider empirical testing, as labour markets may not all have the same degree of competition.

This paper tests the monopsony hypothesis using a rich data set from Portugal between 2002 and 2013 that covers the universe of private sector workers to segment the country into several local labour markets. Portugal's high minimum wage bite, one of the highest in Europe, implies that there exists a substantial number of local labour markets in which minimum wage changes have high impact.

Theoretically speaking, and unlike employment effects, the effects of minimum wage on earnings are unambiguously positive regardless of whether the market is perfectly competitive or not. For this reason, this paper focuses solely on how heterogeneous market concentration may affect the minimum wage's employment effects, and not its effects on earnings. The results of this paper confirm the monopsony hypothesis: disemployment effects are less severe in less competitive markets and, in the most extreme cases, the minimum wage may even have positive employment effects.

The remainder of this paper proceeds as follows. Section 2 reviews the Portuguese literature regarding minimum wages and labour market power. Section 3 summarises minimum wage policy in Portugal. In Section 4, I describe the data set used and the design of my observational units and some measurement variables. Section 5 specifies the econometric model and presents the main empirical results, while Section 6 performs robustness checks. Section 7 concludes.

2 Literature Review

Minimum wage literature in Portugal gathers more consensus around its employment effects than in the US, despite there existing some conflicting results too. Four different studies focus on the employment effects when in 1987 (most) and in 1998 (all) teenagers were guaranteed the same national minimum wage as the remainder of the work force. Pereira (2003), Cerejeira (2008) and Cerejeira et al. (2012) all find negative employment effects for the affected population. Portugal and Cardoso (2006) find that this policy change had a

negative impact on hires, but it also had a more than offsetting effect of reduced separations.

Studies of more recent time periods also generally point towards negative employment effects. This includes Carneiro et al. (2011) and Centeno et al. (2011), both of which had an interest in the effects of the ambitious minimum wage increases in Portugal starting in 2007. Alexandre et al. (2022) were interested in the effects of the minimum wage increases after 2014 (when it was unfrozen following the 'Troika' period) and found them to deteriorate employment growth, despite a positive impact on aggregate productivity.

In terms of literature on labour market competition in Portugal, Martins (2018) uses market concentration as a measure for market power and, as expected, finds that wages are negatively affected by market concentration. Bassanini et al. (2022) reiterate this result for Portugal and find similar effects in European comparisons. Félix and Portugal (2016) measure market power using instead estimates of labour supply elasticity, and also find negative effects on workers' earnings.

As far as I am aware, Azar et al. (2019a) are the first and only to try to empirically relate minimum wages and market power. They found that, in the US, increases in the minimum wage had a negative direct effect on employment, but they also annulled part of the negative employment effects arising from high market concentration, implying overall employment effects could be null in highly concentrated labour markets. They have, however, the limitation of focusing on the labour market for solely three different occupations. My contribution is to provide further testing of the concentration heterogeneity explanation in the minimum wage literature, which I consider to be a severely untapped segment. By diverging from Azar et al.'s definition of a local labour market, I am able to include labour markets that cover a much broader range of sectors and occupations.

3 Institutional Background

The national minimum wage (NMW) was first introduced in Portugal in 1974. It initially discriminated against certain occupations and age groups, but it has been universally

applicable to everyone since 1998[1]. The national minimum wage is determined by a monthly value, and thus part-time workers are entitled to a minimum salary proportional to their monthly hours of work. The autonomous archipelagos of Azores and Madeira have their own minimum wage legislation.

The Portuguese government sets a monthly statutory national minimum wage, which is typically revised and updated every year in January. However, due to extensions of collective bargaining agreements, there exists a very large number of *de facto* minimum wages in Portugal, based on sector and occupation (Martins, 2021). Nevertheless, these are typically indexed to the national minimum wage, and so the statutory wage floor impacts wage minima across the entire Portuguese economy.

This paper focuses on the years between 2002 and 2013. This time-period is characterised by three distinct sub-periods in minimum wage evolution. Between 2002 and 2006, the nominal minimum wage increases, but at a pace which is not enough to compensate for inflation, leading to its real value[2] to remain rather constant during this period (Figures 2 and 3)[3]. Following a social concertation agreement, between 2007 and 2011 the real value of the NMW sees a significant increase for the first time in many years. In 2011 this evolution is brought to an abrupt halt. Due to the sovereign debt crisis and under the Economic Adjustment Programme agreed with the 'Troika', the Portuguese government is forbidden from increasing the national minimum wage. It remains frozen until October 2014, causing a stagnation in its nominal value and even a decline in real terms.

The time-period 2002-2013 is thus an interesting one to study the effects of minimum wage in the economy, since we witness stagnation, expansion, and decline in its real value. Figures 7 and 8 in the Appendix.A demonstrate the impact of these variations on the wage structure in Portugal, namely the Kaitz Index (ratio between the NMW and the median wage), and the coverage of the NMW.

[1]Domestic workers only became entitled to the full value of the national minimum wage in 2004, but they are often considered to belong to the informal economy.

[2]Base prices used is the GDP deflator for 2011Q3.

[3]In Portugal, wage earners receive a total of 14 months of monthly salary per annum (12 regular months plus a Christmas and a holidays subsidy). Analogously, even though the national minimum wage is set at a monthly figure, a minimum wage earner will receive 14 monthly minimum wages in a given year. For most international comparisons, one would need to multiply the monthly value by a factor of 14/12.

Figure 2: NMW in Portugal (€)

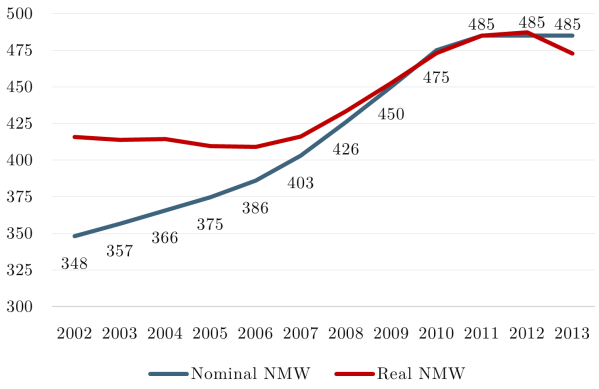
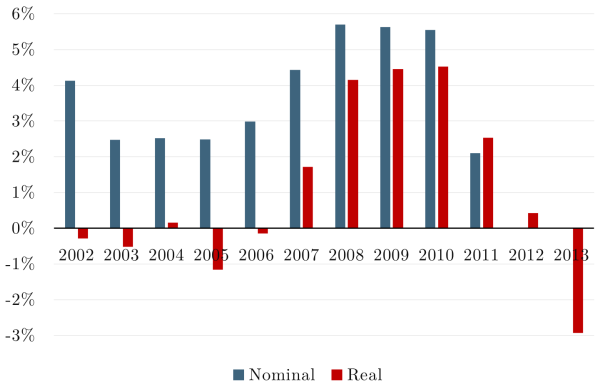
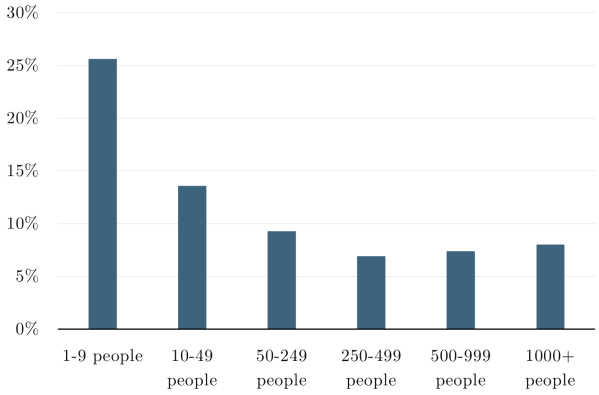


Figure 3: NMW change y.o.y.

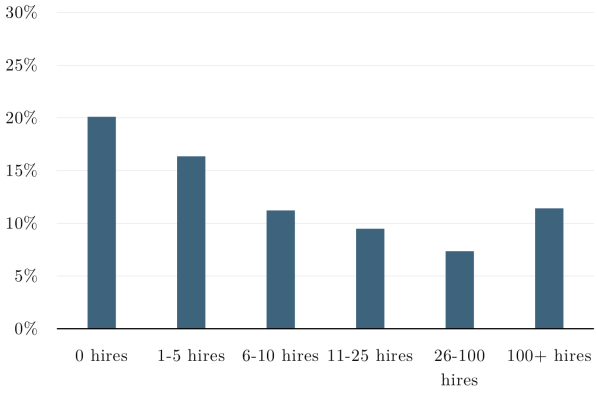


Perhaps most interesting for the purpose of this paper is Figure 4. This decomposes minimum wage coverage by firm size over the analysed time-period. Initially, minimum wage coverage decreases with firm size, as larger firms tend to be more productive and able to pay higher wages. However, this trend is inverted for the largest of employers, with the percentage of workers earning the bare minimum increasing again.

Figure 4: Percentage of workers earning NMW by firm size (2002-2013)



(a) By number of workers in firm



(b) By number of firm hires in a given year

These firms are likely to be dominant in their respective labour markets and yield considerate market power. If so, then the higher NMW coverage in these firms is in accordance with the monopsony hypothesis, in which the minimum wage becomes binding again (Figure 1). This initial analysis provides further motivation to analyse the heterogeneity of minimum wage impact according to labour market concentration.

4 Data and Design

4.1 Data

The data set used for this analysis is the *Quadros de Pessoal* (Personnel Records), which consists of a matched employer-employee panel. Being an annual mandatory survey collected by the Portuguese Ministry of Labour for all private sector firms employing at least one worker, it covers the near universe of private sector workers in Portugal for the period ranging from 1986 to 2013. It contains characteristic information on each worker and the firm plus establishment employing them, with time-invariant identifiers for each.

The data set suffers from a discontinuity in 1990 and 2001, while it didn't collect some information regarding workers' contracts prior to 2000. For these reasons, I focus solely on the time period between 2002 and 2013. This, however, implies that I get no cross-sectional variation in the NMW, as the national minimum wage has been the same for everyone since 1998.

The data set has one main drawback: it does not include public employees, which can potentially affect estimation results if we consider public and private enterprises to compete in the same labour markets. I tackle this issue in the way I construct my samples.

4.2 Design

4.2.1 Local Labour Markets

There is a discernible split in Portuguese minimum wage literature as to at what level they measure employment effects. For instance, Pereira (2003), and Portugal and Cardoso (2006) look at firm levels of employment, while Carneiro et al. (2011) and Cerejeira (2008) use the local labour market as their unit of analysis.

My analysis is done on a local labour market level. Carneiro et al. (2011) point out the advantages of this approach, as it reduces problems in estimation since firm exits from the labour market may be at least partially caused by minimum wage changes. It is much less likely for an entire labour market to disappear as a result of minimum wage changes. Furthermore, in terms of policy, it is much more interesting to understand the effects of

minimum wage increases on an aggregated labour market than on an individual firm.

Unlike Azar et al. (2019a), who define local labour markets as a location-occupation pair, I define my local labour markets similarly to Carneiro et al. (2011), who do so on a basis of location, sector of activity and worker characteristics. More specifically, I denote by a local labour market any triad of location - sector - age group. I use sectors based on the Portuguese Classification of Economic Activity (CAE-Rev.2) at the 1-letter level.

A common challenge in the literature is defining the geographic boundaries of Portuguese local labour markets. Administratively, mainland Portugal is split into 18 districts, which are further sub-sectioned into 278 municipalities, neither of which are adequate definitions of a commuting zone. Most districts are far too large to be considered effective commuting zones, while there exist significant inter-municipal flows (particularly surrounding major urban areas) that make municipalities too granular of a division.

What is novel about my approach within the related Portuguese literature is the use of Afonso and Venâncio (2016), who use 2011 census data in order to analyse commuting flows in mainland Portugal and aggregate municipalities into 52 commuting zones. Although not an official administrative division of Portuguese national territory, I use their definition of commuting zones as I believe that it allows me to geographically define local labour markets with improved precision.

Overall, I consider 52 commuting zones (c), 17 sectors of activity (s), and 6 age groups (a) for each year (t), which allows for the potential existence of a total of 5,304 local labour markets in every year, or 63,648 cells[4] between 2002 and 2013.[5]

4.2.2 Labour Market Power

Azar et al. (2019b) suggest measuring labour market power by using either labour market concentration or labour supply elasticity faced by firms, showing the two to be correlated. Since my unit of observation is the local labour market (LLM) rather than the

[4]I denote by labour market any triad *csa*, and by labour market cell my units of observation, i.e. a labour market at a particular point in time (*csa,t*).

[5]The autonomous archipelagos of the Azores and Madeira have been excluded since they have different laws governing minimum wage policy and they do not have defined commuting zones. A more detailed description of how local labour markets were defined is included in the Appendix.B.

individual firm, I will be using the Herfindahl-Hirschman Index to measure labour market concentration.

Both Azar et al. (2019a) and Azar et al. (2022) calculate HHI using the shares of online job postings. I will diverge from this, since some of the labour markets I consider may not advertise job vacancies online, and instead calculate HHI using the share of new hires by a firm (f) in a local labour market (csa) for each year (t), as done by Martins (2018) and Marinescu et al. (2021). The formula used for measuring local labour market concentration is thus given by:

$$HHI^{flow}_{csa,t} = \sum_{f=1}^{F} \left(\frac{NewHires_{f,csa,t}}{\sum_{f=1}^{F} NewHires_{f,csa,t}} \right)^2, \quad \forall f \in LLM_{csa,t} \tag{1}$$

This implicitly defines labour market concentration as a flow concept, by using shares of new hires rather than shares of employment[6]. In some alternative specifications, I will take a stock interpretation of labour market concentration,[7] measuring HHI as:

$$HHI^{stock}_{csa,t} = \sum_{f=1}^{F} \left(\frac{Employment_{f,csa,t}}{\sum_{f=1}^{F} Employment_{f,csa,t}} \right)^2, \quad \forall f \in LLM_{csa,t} \tag{2}$$

HHI, by construction, can vary between 0 and 1. The higher its value, the more concentrated is the labour market. If a labour market exists (is hiring), then HHI for employment (hires) must be strictly greater than 0.

If the HHI for employment (for hires) tends to 0, then the labour market is perfectly competitive and has many employers (many recruiters). If the HHI for employment (for hires) equals 1, then the labour market is a monopsony, i.e. it has a single employer (single recruiter). By definition, if a labour market has a single employer it will also have a single recruiter, meaning that a HHI for employment of 1 is a stronger condition than a HHI for hires of 1.

[6]The data set includes information on the firm and establishment level. While local labour markets were defined using establishment information, HHI was calculated using firm shares. A more detailed explanation is included in the Appendix.C.

[7]Throughout the rest of this paper, I will often refer to the HHI measure defined by shares of hires in equation (1) as HHI flow, and to the HHI measure defined by shares of employment stock in equation (2) as HHI stock.

5 Empirical Analysis

5.1 Sample Description

My definition of local labour market generates 4,318 labour markets existing at some point during the analysis period, and 47,014 cells observable in the data.

My analysis, however, is not done on the universe of local labour markets. I make four additional restrictions in order to select my sample of analysis.

Firstly, I exclude all sectors which are likely to have a high government presence, such as education, health services, transport, etc. This is done for essentially three reasons. My data set, *Quadros de Pessoal*, consists solely of private sector workers. This implies that, if for instance a teacher moves from a private school to a public school, they would disappear from the data set and I would wrongly count this as a reduction in labour market employment rather than a change in employer. Furthermore, the government might be a significant employer in these sectors, but since those hired or employed by the government do not appear on the data set, I could severely miscalculate local labour market concentration. Additionally, even in sectors in which the government is a major employer, they might not behave as profit-maximising firms, and thus higher market concentration need not imply higher market power in setting sub-optimal employment levels. Overall, this leads me to only keep eight of the 17 sectors of activity.[8]

Secondly, I further restrict my sample by only including local labour markets which have at least one new hire in every of the twelve years of analysis. This simplifies the analysis, since I am only considering local labour markets that continuously exist over the twelve years, and it ensures HHI for hires is always defined. It also excludes some cells that may be far too small to be realistically considered a market.

Thirdly, I only consider labour markets in which the NMW covers a considerable amount of workers, in order to only include markets where minimum wage changes may actually have some real impact. As a cut-off rule, I only consider labour markets in which, on average over the twelve years, at least 20% of workers earned the NMW.

[8] A detailed description of excluded sectors is included in the Appendix.D.

Finally, since some of the labour markets defined are still too small, I exclude outliers by removing from my sample the smallest 5% of labour markets in terms of employment over the twelve years. This also greatly reduces concerns of endogeneity in my HHI measure, since in small labour markets the level of employment creates heavy restrictions on the value HHI can take.[9]

These restrictions generate a sample of 1,069 local labour markets per year, or 12,828 cells over the entire period. Summary statistics for the universe and selected sample of local labour market cells are presented below.

Table 1: Summary statistics for universe and selected sample of local labour market cells

	All labour markets cells	Selected sample
Age (years)	37.61	30.54
Female workers	44.92%	48.46%
Years of schooling	8.79	8.06
Mean regular real wage	€ 905.22	€ 605.84
Mean monthly normal hours per worker	159.90	158.08
Workers earning NMW	13.93%	27.48%
Number of firms	149.92	158.66
Employment	586.29	424.96
Total hires in given year	127.00	131.42
HHI for new hires	0.25	0.11
HHI for employment	0.09	0.02
Observations	47,014	12,828

Worker statistics (top half) are averaged across workers
Labour market statistics (bottom half) are averaged across local labour market cells
Base prices used is GDP deflator for 2011Q3

Workers in the selected sample are younger, slightly less educated and with a higher proportion of female participants vis-a-vis the universe of local labour markets. These can be argued to be groups we expect to be more prone to earning the NMW. Indeed, in my sample (by construction), a higher percentage of workers earns the minimum wage, and mean real wages are lower, although monthly hours worked are not that different.

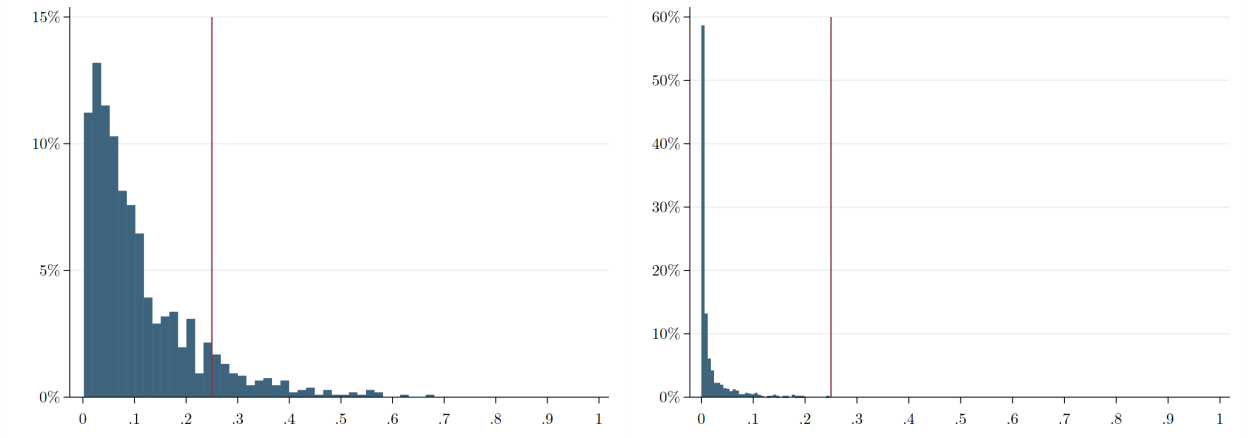
Labour markets cells in my sample are similar in size in terms of number of firms and yearly hires with respect to the universe, although they are smaller in terms of employment.

[9] A market with one employee forcefully implies a HHI of 1. Similarly, a market with two employees forcefully creates a lower bound of 0.5 in HHI. Without removing excessively small labour markets, my empirical model could suffer from reverse causality.

My selected sample is less concentrated regardless of HHI measure used. This is to be expected, since the universe of labour market cells includes sectors with high government presence, but since government market shares don't appear in the data, HHI values may be misleadingly high.

Figure 5 shows the distribution of local labour markets in the selected sample by their average concentration level. The majority of local labours markets present low concentration levels. Tables 10 and 11 in the Appendix.E show that the majority of markets would be considered highly competitive or unconcentrated under US Department of Justice/Federal Trade Commission horizontal merger guidelines, and that the two measures of HHI are highly correlated.

Figure 5: Distribution of concentration in selected sample



(a) HHI flow (average 2002-13) **(b)** HHI stock (average 2002-13)

Note: Vertical line at HHI value of 0.25 indicates the threshold above which the US Department of Justice/Federal Trade Commission considers a market to be highly concentrated.

Figure 9 in the Appendix.F decomposes concentration by subgroups showing younger workers to be more exposed to high concentration than older cohorts, and demographically denser regions to have lower concentration levels.

5.2 Model Specification

I now turn to estimate the effects of market concentration and real minimum wage changes on labour market employment and hires.

The empirical model used is an adaptation of the two-way panel fixed effects model present in Azar et al. (2019a). For the employment regressions, the model used is:

$$\begin{aligned} ln(Y_{csa,t}) = \alpha + \beta_1 ln(NMW_t) + \beta_2 HHI^{flow}_{csa,t} + \beta_3 ln(NMW_t) \times HHI^{flow}_{csa,t} \\ + X_{csa,t-1}\gamma + \tau_n \times t + \sum_{j=0}^{5} \delta_j \mathbb{1}(2002 + 2j \leq t \leq 2003 + 2j) + \phi_{csa} + \epsilon_{csa,t} \end{aligned} \tag{3}$$

$ln(Y_{csa,t})$ is the employment outcome variable in labour market csa in year t, either the log of number of workers or the log of total normal monthly hours worked. $ln(NMW_t)$ is the log of real national minimum wage in force in year t. $HHI^{flow}_{csa,t}$ is the Herfindahl–Hirschman Index based on hires (as defined in equation (1)) for labour market csa in year t.

$X_{csa,t-1}$ is a vector of variables which control for commuting zone size and other economic and demographic factors that may drive labour demand in a particular labour market. These include the log of total commuting zone population, the log of real sales per worker, fraction of female workers, average age and average years of schooling. One may be concerned about the endogeneity of these covariates, as firms may use them as adjustment mechanisms when changing employment levels (if certain groups have lower reservation wages, for instance). For this reason, I instrument for these variables by using their lag.

Minimum wage legislation in Portugal implies that the NMW does not vary across cross-sectional units. As such, I cannot include time fixed effects due to the issue of multicollinearity, and cannot control for year-specific unobservables. Instead, I use dummies for every two-year periods to control for period-specific idiosyncrasies ($\sum_{j=0}^{5} \delta_j \mathbb{1}_{2002+2j \leq t \leq 2003+2j}$), and a NUTS II[10] specific linear time trend ($\tau_n \times t$). The local labour market fixed effect is represented by ϕ_{csa}, and $\epsilon_{csa,t}$ is the error term. Standard errors are clustered at the commuting zone level.

For the hires regressions, I use an analogous model defined by:

[10]Mainland Portugal is split into five NUTS II regions: North, Centre, Lisbon Metropolitan Area, Alentejo and Algarve. Some commuting zones belong to more than one NUTS II region. These are rare, however, and for those cases I assigned the commuting zone to the NUTS II region to which most constituent municipalities belong.

$$ln(Hires_{csa,t}) = \alpha + \beta_1 ln(NMW_t) + \beta_2 HHI^{stock}_{csa,t} + \beta_3 ln(NMW_t) \times HHI^{stock}_{csa,t} + X_{csa,t-1}\gamma + \tau_n \times t + \sum_{j=0}^{5} \delta_j \mathbb{1}(2002 + 2j \leq t \leq 2003 + 2j) + \phi_{csa} + \epsilon_{csa,t} \quad (4)$$

$ln(Hires_{csa,t})$ is the log of yearly hires in labour market *csa* in year *t*. The only other difference in this model vis-a-vis the one described in equation (3) is that I use the HHI based on employment stocks characterised by equation (2) rather than based on hires. This is done in order to avoid endogeneity problems.[11]

The β coefficients are my main coefficients of interest. β_1 indicates base employment/hires elasticity with respect to the NMW in perfectly competitive labour markets, i.e. when $HHI \approx 0$. β_2 indicates by what percentage employment/hires would change if a labour market hypothetically went from perfectly competitive ($HHI \approx 0$) to a monopsony (*HHI=1*), absent the existence of a minimum wage. Finally, β_3 represents the additional employment/hires elasticity with respect to the NMW (on top of β_1), conditional on the level of labour market concentration $0 < HHI \leq 1$.

Some cells in my sample are much larger in terms of employment than others. Some may even be too small to obey to classic market dynamics. For this reason, for some specifications I weigh my observations according to their employment level in 2002. This ensures time-invariant and exogenous weighing (2002 is dropped from the regressions due to the lagged covariates) and gives less weight to excessively small labour markets.

5.3 Results

Table 2 presents the OLS estimates for the employment regressions. Columns (1)-(4) are unweighted estimates, while columns (5)-(6) weigh each labour market according to their 2002 employment levels. All regressions include market and period fixed effects. The HHI measure used is the flow one as defined by equation (1).

[11] Since the dependent variable in this model is yearly hires, including HHI calculated through share of hires could lead to reverse causality between the regressor and regressand - a market with one hire forcefully implies a HHI^{flow} of 1, but creates no restrictions on the value HHI^{stock} can take.

Columns (1)-(2) present base regressions using solely the log of real NMW and HHI, respectively, with no additional covariates. The estimated β_1 and β_2 coefficients indicate an employment elasticity with respect to the real NMW of around -1.3, and a decrease of -1.2% in employment if a market transitions from perfect competition to monopsony, respectively. Both estimates are significant at the 1% level.

Columns (3)-(4) are unweighted regressions that include both variables of interest plus their interaction, the difference being that column (3) does not include additional covariates nor a NUTS II-specific linear time trend, whereas column (4) does. The estimates for β_1 are negative and significant, with estimated elasticities between -1.3 and -1.5. In both cases, β_2 and β_3 present negative and positive estimated coefficients, respectively, although for column (4) they're not significant at any conventional level.

Columns (5)-(6) are weighted versions of columns (3)-(4). The estimate for β_1 remains negative and significant with an elasticity slightly below -1.0. The estimates for β_2 and β_3 maintain their signs, but gain greater magnitude (in absolute value) and become significant at least at the 5% level.

Table 2: Estimated employment effects of minimum wage and labour market concentration

	Unweighted				Weighted	
ln(Employment)	(1)	(2)	(3)	(4)	(5)	(6)
ln(NMW)	-1.319***		-1.312***	-1.541***	-1.333***	-1.014***
	(0.119)		(0.168)	(0.235)	(0.217)	(0.162)
HHI		-1.152***	-14.98**	-10.03	-35.02***	-19.07**
		(0.197)	(7.168)	(6.765)	(10.39)	(8.218)
ln(NMW) × HHI			2.256*	1.450	5.487***	2.874**
			(1.187)	(1.121)	(1.686)	(1.336)
HHI Measure	Flow	Flow	Flow	Flow	Flow	Flow
Additional Controls	No	No	No	Yes	No	Yes
NUTS II Time Trend	No	No	No	Yes	No	Yes
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Market Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	11,759	11,759	11,759	11,757	11,759	11,757
adj. R^2	0.942	0.947	0.947	0.949	0.985	0.985

Standard errors in parentheses

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

The results from column (6) - my preferred specification - can be interpreted as follows. In a perfectly competitive labour market ($HHI \approx 0$), employment is estimated to drop by -1% (β_1) following a 1% increase in real terms in the NMW. In a monopsonistic labour market ($HHI = 1$), employment is estimated to *increase* by 1.9% ($\beta_1 + \beta_3$) when real NMW increases by 1%. For the average concentration level in my sample ($HHI = 0.11$), the estimated elasticity is -0.70 ($\beta_1 + (0.11 \times \beta_3)$). I also estimate that an increase in the NMW has *positive* employment effects in markets with a concentration level greater than 0.35 ($\frac{-\beta_1}{\beta_3}$). Only 5.2% of labour markets in my sample are above this threshold, covering 0.6% of workers.

The results provide some evidence for the monopsony hypothesis. Both the NMW and labour market concentration have negative direct effects on employment levels. However, the NMW also has an indirect effect of offsetting employment-lowering market power, and thus in highly concentrated markets the overall effect of an increase in the NMW on employment may actually be positive.

The fact that my results are only significant when observations are weighted indicates that some labour markets may be too small for classic market dynamics to function, and that markets may need to achieve a certain size for firms to exert some market power.

Although highly correlated with employment levels, it may also be interesting to look at the compound effect of minimum wage increases and labour market concentration on total hours worked in a labour market. The model used is identical to the previous regression, simply changing the dependent variable to the log of total monthly hours worked. Results for these regressions are presented in Table 3 below.

Results are almost identical to those of Table 2, both qualitatively and quantitatively. Again, interpreting the coefficients from my preferred specification in column (6), hours elasticity with respect to the NMW is estimated at -0.99 for perfectly competitive markets, 1.8 for monopsonistic markets, and -0.68 for the average concentration level. The HHI threshold for positive employment effects is 0.36, which accounts for 4.9% of cells in sample, covering 0.6% of workers.

Table 3: Estimated effects of minimum wage and labour market concentration on hours

	Unweighted				Weighted	
ln(Hours)	(1)	(2)	(3)	(4)	(5)	(6)
ln(NMW)	-1.447***		-1.420***	-1.433***	-1.421***	-0.987***
	(0.117)		(0.166)	(0.226)	(0.202)	(0.169)
HHI		-1.228***	-14.64**	-8.752	-35.27***	-18.61**
		(0.200)	(7.245)	(6.845)	(9.385)	(8.591)
ln(NMW) × HHI			2.189*	1.231	5.504***	2.779*
			(1.201)	(1.135)	(1.524)	(1.399)
HHI Measure	Flow	Flow	Flow	Flow	Flow	Flow
Additional Controls	No	No	No	Yes	No	Yes
NUTS II Time Trend	No	No	No	Yes	No	Yes
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Market Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	11,759	11,759	11,759	11,757	11,759	11,757
adj. R^2	0.942	0.947	0.947	0.949	0.985	0.985

Standard errors in parentheses

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

One may also consider that the theoretical monopsonist problem decides on how many workers to hire each year rather than on its employment level. Table 4 presents results analogous to that of Tables 2 and 3, but with the log of yearly hires as the dependent variable. As explained previously, the HHI measure used is the stock version to avoid endogeneity.

Estimated coefficients are similar to those of Tables 2 and 3 in terms of sign and significance. Base regressions in columns (1)-(2) indicate negative and significant estimates for the effect of NMW and labour market concentration on yearly hires. Unlike in the employment regressions, unweighted regressions in columns (3)-(4) find significance in the estimates for β_2 and β_3 at the 1% level.

Again, the results from column (6) can be interpreted the following way. In a perfectly competitive labour market, yearly hires are estimated to drop by -3.8% following a 1% increase in real NMW. In a monopsonistic labour market, yearly hires are estimated to increase by 18.5% when the NMW increases by 1% in real terms. For the average concentration level in my sample ($HHI^{stock} = 0.02$), the estimated drop is -3.4%. Results are consistent with the monopsony hypothesis, but their magnitude is much larger.

Table 4: Estimated effects of minimum wage and labour market concentration on hires

	Unweighted				Weighted	
ln(Hires)	(1)	(2)	(3)	(4)	(5)	(6)
ln(NMW)	-2.043***		-2.192***	-4.519***	-2.364***	-3.829***
	(0.151)		(0.159)	(0.258)	(0.370)	(0.336)
HHI		-4.688***	-164.9***	-180.1***	-123.9***	-144.3***
		(0.422)	(32.01)	(33.52)	(45.44)	(44.75)
ln(NMW) × HHI			25.98***	28.46***	19.00**	22.33***
			(5.187)	(5.430)	(7.326)	(7.211)
HHI Measure	Stock	Stock	Stock	Stock	Stock	Stock
Additional Controls	No	No	No	Yes	No	Yes
NUTS II Time Trend	No	No	No	Yes	No	Yes
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Market Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	11,759	11,759	11,759	11,757	11,759	11,757
adj. R^2	0.904	0.921	0.924	0.926	0.976	0.977

Standard errors in parentheses

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

The reason for this is that I am now using the stock version of HHI, which has much stronger concentration implications than its flow counterpart. Almost three quarters of market cells are considered highly competitive under this HHI measure, and so the effects of employment concentration aren't as interesting as when using HHI flow, which has higher variability. For this reason, the rest of this paper will focus solely on employment and hours regressions.

5.4 Regressions by Subgroups

Though the previous regressions revealed significant aggregate evidence in favour of the monopsonist hypothesis, I know turn to running regressions on several subgroups, to test whether there exist underlying differences between them that may affect results.

The empirical model used is the one in equation (3), using 2002 employment levels as weights, full set of controls and HHI flow measure, as in column (6) of Tables 2 and 3.

I first run these regressions separately for the time period between 2002-2009 and for 2010-2013. It makes sense to make this distinction as during 2010-2014 Portugal was hit by

a financial crisis, and during 2011-2014 it was under an Economic Adjustment Programme negotiated with 'Troika'. Thus, employment dynamics may differ significantly between these two periods. Table 5 presents the OLS estimates.

Table 5: Separate regressions for pre- and crisis years

	ln(Employment)		ln(Hours)	
	Pre-crisis 2002-09	Crisis 2010-13	Pre-crisis 2002-09	Crisis 2010-13
	(1)	(2)	(3)	(4)
ln(NMW)	-2.947***	-0.737***	-2.964***	-0.706***
	(0.231)	(0.167)	(0.215)	(0.160)
HHI	-52.78***	-28.12*	-49.11***	-28.45*
	(12.66)	(16.11)	(11.74)	(15.61)
ln(NMW) × HHI	8.689***	4.390*	8.071***	4.436*
	(2.095)	(2.609)	(1.944)	(2.528)
HHI Measure	Flow	Flow	Flow	Flow
Additional Controls	Yes	Yes	Yes	Yes
NUTS II Time Trend	Yes	Yes	Yes	Yes
Period Fixed Effects	Yes	Yes	Yes	Yes
Market Fixed Effects	Yes	Yes	Yes	Yes
N	7,482	4,275	7,482	4,275
adj. R^2	0.996	0.995	0.996	0.995

Standard errors in parentheses

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

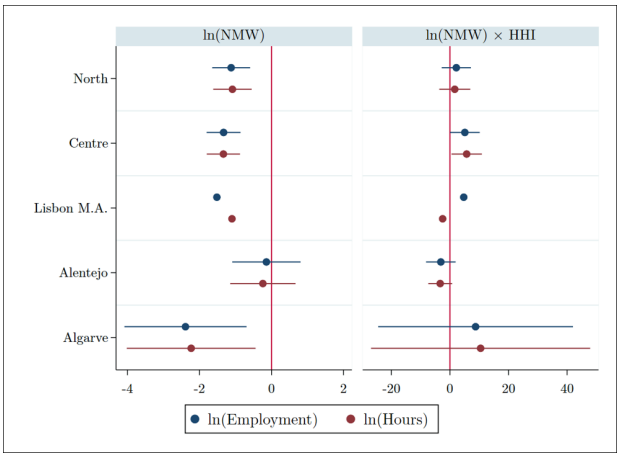
Results are qualitatively similar to previous regressions for both time periods. For average concentration levels in pre-crisis years, estimated employment and hours elasticity are both -2.2. The threshold for positive employment effects are a HHI of 0.34, compared to 0.35 in the original regressions. The results indicate that NMW has a more adverse initial disemployment effect, but it also has a stronger counteracting effect on market power.

During crisis years, estimated elasticities for average concentration levels are -0.11 for employment and -0.07 for hours. Real minimum wage increases are estimated to have positive employment effects in labour markets with a HHI above 0.17, a much lower requirement than in the aggregate regressions. One should, however, be wary of these results. During the Economic Adjustment Programme of 2011-14, Portugal was forbidden from altering its nominal national minimum wage, so all variation in the real NMW regressor

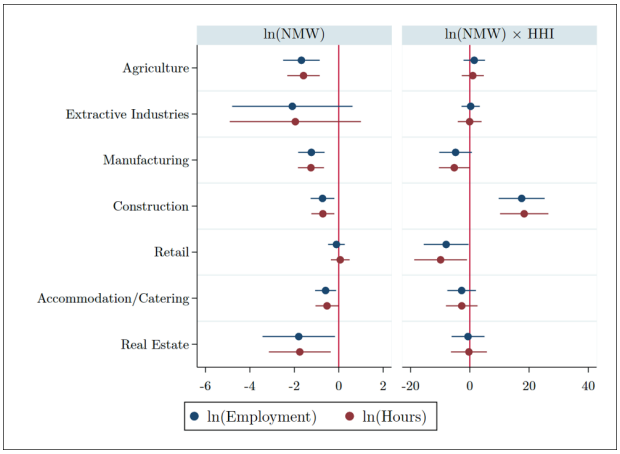
for these years is due to price fluctuations. I may not therefore be capturing the effect of exogenous minimum wage changes, but the effect of price level variations, which is plausible to be endogenous if there exist omitted macroeconomic variables affecting both the price level and employment (such as fiscal/monetary stimulus/contraction or productivity shocks).

Next, Figure 6 shows 95% confidence interval estimations for the direct and indirect effects of NMW on employment and hours, estimated separately for each region, sector, and age group.

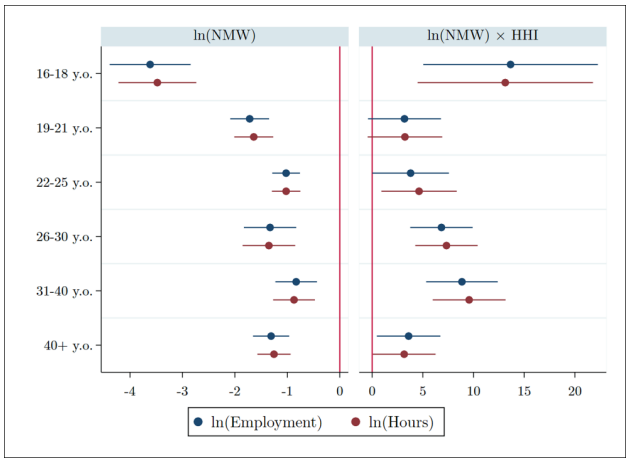
Figure 6: 95% confidence intervals for results of regression by subgroups



(a) Results by NUTS II



(b) Results by sector



(c) Results by age group

While most regions[12] show significant evidence of the direct disemployment effect of NMW, evidence for the counteracting positive effect is not as clear. The same can be said

[12]The Lisbon Metropolitan Area region has no confidence interval estimated. This is because my clustering is done at the commuting zone level, and the entire Lisbon Metropolitan Area region belongs to the same commuting zone. Other NUTS II regions are composed by more than one commuting zone.

for regressions by different sectors of activity[13].

The regressions by separate age groups are the ones most consistent with the monopsonist hypothesis and with the original aggregate regressions. Strong evidence is found for both the negative direct and positive indirect effects of minimum wage increases on employment and hours for all age groups. Consistent with existing literature (Carneiro et al., 2011), teenagers face the most negative employment elasticity, but they are also the group that most benefits from the counteracting effect (the large confidence interval is mostly due to few observations). Nevertheless, the elasticity for the average concentration level they face is -1.8, compared to -0.7 of the aggregate regressions.

6 Robustness Checks

I now perform several robustness checks in order to validate my choice of local labour market definition, and to evaluate the robustness of my aggregate regression results to changes in specifications.

6.1 Validity of Local Labour Market Definition

Although I am confident regarding my geographical boundaries, and my age groups follow directly from Carneiro et al. (2011), the literature is split on whether the most appropriate choice in defining local labour markets is the usage of occupations or sectors. There may obviously exist some inter-market mobility, but if this is too high it might mean that local labour markets aren't properly defined. Therefore, as an exercise, I measure inter-market mobility using three definitions: my definition of sectors at the 1-letter level, occupations at the 1-digit level based on the 2010 Portuguese Professions Classification, and occupations at the 3-digit level. I look at all hires in Portugal between 2002 and 2013, and note the percentage of hires which indicate a change in sector/occupation for the worker from their previous employment. This analysis indicates that 40.3% of changes in employment result in a change in sector of activity, 41.4% result in a change in occupation at the 1-digit level,

[13]Although the fishing sector is also included in my original sample for aggregate regressions, I excluded it from the sector-specific regressions. This is because it is a sector with too few individual observations.

and 60.6% result in a change in occupation at the 3-digit level. Thus, a local labour market defined by sector is the most stable of the three definitions, with the added advantage of being easier to excluded government-heavy sectors.

6.2 Alternative Specifications

I next run employment and hours regressions using alternative specifications. My benchmark specification is the one used for column (6) in Tables 2 and 3, i.e. weighted regressions, with full set of controls, a NUTS II-specific linear time trend, crisis dummies, and labour market fixed effects. Unless stated otherwise, the concentration measure is HHI flow, as specified by equation (1).

My first alteration is precisely to change the concentration measure to another popular measure in competition policy - the C_4 concentration ratio. This simple index sums the shares of hires of the four biggest recruiters in a market. Unlike HHI, it is not affected by different compositions of concentration within the four biggest firms and within remaining firms. More specifically, descendingly ordering firms f by their recruitment share, the C_4 concentration ratio is calculated as:

$$C_{4;csa,t} = \sum_{f=1}^{4} \left(\frac{NewHires_{f,csa,t}}{\sum_{f=1}^{F} NewHires_{f,csa,t}} \right), \quad \forall f \in LLM_{csa,t} \tag{5}$$

The empirical model used is very similar to that of equation (3), being designed as:

$$\begin{aligned} ln(Y_{csa,t}) &= \alpha + \beta_1 ln(NMW_t) + \beta_2 C_{4;csa,t} + \beta_3 ln(NMW_t) \times C_{4;csa,t} \\ &+ X_{csa,t-1}\gamma + \tau_n \times t + \sum_{j=0}^{5} \delta_j \mathbb{1}(2002 + 2j \leq t \leq 2003 + 2j) + \phi_{csa} + \epsilon_{csa,t} \end{aligned} \tag{6}$$

Secondly, I depart from my originally selected sample. I keep my sample restrictions regarding continuous hiring and low government presence, but instead of selecting labour markets with high NMW coverage, I select labour markets with low coverage. More specifically, I only keep local labour markets where less than 10% of workers earn the NMW. Again, I eliminate the bottom 5% of outliers. My prediction is that in labour markets in which the NMW isn't as binding, both its direct (β_1) and indirect (β_3) effects should be

lower in magnitude and/or insignificant.

My final robustness check is to change the definition of local labour markets. Instead of using commuting zone - sector - age group triads, I now define a local labour market by a commuting zone - occupation pair, using occupations at the 3-digit level. This generates 61,553 observations, a moderate increase from the 47,014 previously defined. Although harder to avoid contamination of HHI from high government presence, I exclude all occupations which are likely to have the government as an employer, whilst keeping all other sample restrictions. Estimated regression coefficients are presented below in Table 6.

Table 6: Estimated coefficients for robustness checks

	ln(Employment)			ln(Hours)		
	Conc. Ratio	Low Coverage	Occu-pations	Conc. Ratio	Low Coverage	Occu-pations
	(1)	(2)	(3)	(4)	(5)	(6)
ln(NMW)	-1.063***	-0.357	-1.727***	-0.976***	-0.343	-1.721***
	(0.198)	(0.216)	(0.186)	(0.214)	(0.240)	(0.185)
HHI		-5.896	-64.68***		-7.116	-63.79***
		(12.15)	(13.06)		(12.30)	(12.89)
ln(NMW) × HHI		0.828	10.36***		1.032	10.21***
		(1.982)	(2.131)		(2.008)	(2.103)
C_4	-10.69***			-9.243**		
	(3.862)			(4.016)		
ln(NMW) × C_4	1.594**			1.343**		
	(0.629)			(0.654)		
Concent. Measure	C_4 Flow	HHI Flow	HHI Flow	C_4 Flow	HHI Flow	HHI Flow
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes
NUTS Time Trend	Yes	Yes	Yes	Yes	Yes	Yes
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Market Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Weights	Yes	Yes	Yes	Yes	Yes	Yes
N	11,757	1,451	5,038	11,757	1,451	5,038
adj. R^2	0.986	0.989	0.943	0.986	0.989	0.945

Standard errors in parentheses

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

Starting with the regressions using markets with low NMW coverage (columns (2) and (5)), the estimated coefficients maintain signs consistent with the monopsonist hypothesis, although their values are much lower in magnitude and not statistically significant from zero. That is to say that, in markets with low coverage, there is no evidence of a significant negative direct or a positive indirect effect of minimum wage on employment/hours, as expected.

Qualitatively, the results using the C_4 concentration ratio (columns (1) and (4)) and the ones using labour markets defined by occupations (columns (3) and (6)) are not that different from those of my benchmark regressions (column (6) of Tables 2 and 3). However, the differences in magnitude have different implications as to the strength of the different effects of NMW on employment. Table 7 below compares the main implications from the different regressions.

Table 7: Comparison of estimated results

	ln(Employment)			ln(Hours)		
	Bench-mark (1)	Conc. Ratio (2)	Occu-pations (3)	Bench-mark (4)	Conc. Ratio (5)	Occu-pations (6)
Elasticity w.r.t. NMW						
in perfect competition	-1.014	-1.063	-1.727	-0.987	-0.976	-1.721
in monopsony	1.860		8.633	1.792		8.489
in quadropsony		0.531			0.367	
for average concentration	-0.698	-0.394	-0.173	-0.681	-0.412	-0.190
Threshold for positive effects						
HHI (hires)	0.35		0.17	0.36		0.17
C_4 (hires)		0.67			0.72	
Positive effects in sample						
% labour market cells	5.2%	15.4%	26.8%	4.9%	13.3%	26.8%
% workers	0.6%	2.4%	42.3%	0.6%	1.7%	42.3%

Note: C_4 does not inform when a market is a monopsony, only when it is a quadropsony.

The estimated elasticity for the average concentration level is less negative when using the C_4 concentration ratio vis-a-vis the benchmark regression, and even less so when using occupations-defined labour markets, both for employment and hours worked. The estimated threshold for net positive employment effects from NMW increases is also more optimistic in these alternative specifications, particularly in the occupations-based sample - estimates

indicate that over a quarter of labour market cells have high enough concentration to achieve net gains in terms of employment from NMW increases, covering 42% of workers in the sample.

Nevertheless, I maintain my trust in my benchmark regressions. HHI measures are more informative than the C_4 concentration ratio as they capture relative market shares. Furthermore, as shown, my sector-based sample is a more stable definition of local labour market than a 3-digit level occupation-based sample, as it has lower inter-market mobility.

7 Conclusions

This paper set out to test the monopsonist hypothesis in minimum wage theory, which states that when perfect competition fails, minimum wages may have positive employment effects in the labour market.

Using HHI to estimate competition in labour markets, I find that both real minimum wage increases and labour market concentration have adverse effects on employment and hires. However, consistent with the monopsonist hypothesis, minimum wage increases have a second indirect positive effect of countering labour market power, which in some cases more than offsets the negative direct effect, implying indeed overall positive employment effects from minimum wage increases.

This, however, is a very rare case. Few labour markets have high enough HHI levels for them to be considered highly concentrated, so the cases in which minimum wage increases have overall positive employment effects are still very few, and cover an even smaller proportion of workers.

However, my results imply that nation-wide estimated disemployment effects may not be as severe as when labour market concentration and the indirect offsetting effect from minimum wage increases are not taken into account. They also provide another plausible explanation for the conflicting results in minimum wage literature worldwide. Azar et al. (2019a) are the first to try to use labour market concentration to try to justify conflicting results in the US, but they focus solely on the market for three occupations. It would be interesting in future studies for more countries to take into account these

concentration heterogeneities for better international comparisons. My results for the average concentration level are also consistent with the disemployment effects found by Carneiro et al. (2011) and Centeno et al. (2011), who studied NMW effects in Portugal for a similar time period.

Policy-wise, my results may also have some implications in the Portuguese national debate regarding the nature of the minimum wage. The national minimum wage is seen mostly as a social tool to guarantee a base standard of living. With monopsony power, it may gain a new function as a market failure correcting tool and consequently improve labour market efficiency, particularly given that competition authorities focus mostly on product market concentration rather than labour market concentration.

There exist ongoing discussions and political proposals as to whether a national minimum wage is the most appropriate system for Portugal, in contrast to a more decentralised system with different minimums wages for each sector and/or region. The arguments provided typically invoke heterogeneity in productivity and costs of living across different sectors and regions in Portugal. My findings may provide an additional argument in favour of decentralising minimum wages: heterogeneity in labour market concentration, implying different employment effects from minimum wage changes. My subgroup regressions only found evidence for the monopsonist hypothesis for all age subgroups, failing to do the same for all regions and sectors considered separately. It may therefore be also interesting to consider decentralising minimum wage by creating age-specific minima, such as is done in countries like the United Kingdom.

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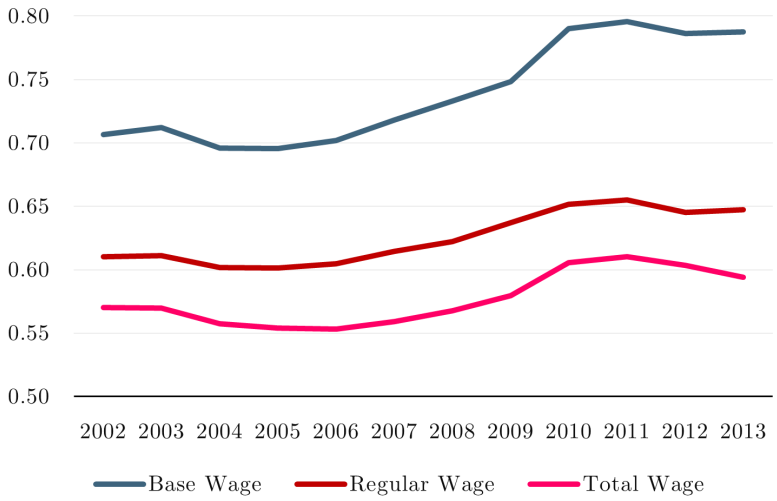
Appendix

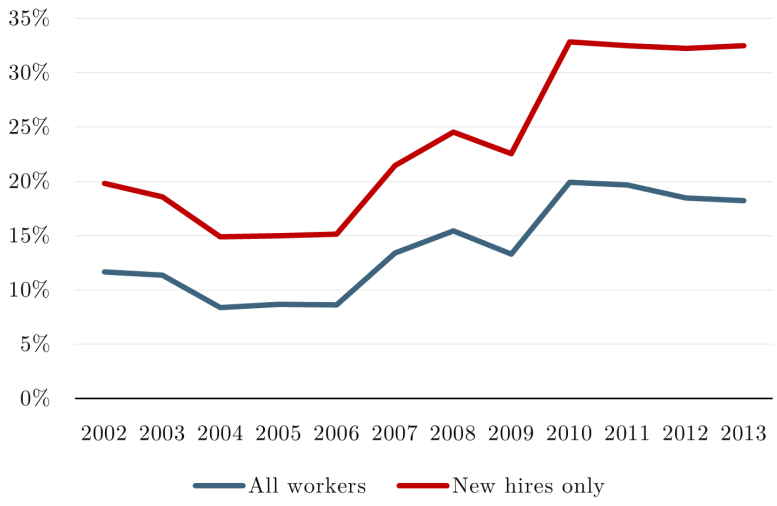
A - Kaitz Index and National Minimum Wage coverage (2002-2013)

Figure 7: Kaitz Index



Three Kaitz Indices are presented: for base wage, since Portuguese minimum wage law establishes a minimum value for base salary, not total; for regular wage, which is the sum of base wage and any other earnings an employee receives regularly, such as meal and commute allowances, risk or nocturnal shift subsidies, and tenure bonuses; for total wage, which includes compensation for extra hours and any other irregular earnings such as productivity bonuses, reparations, or profit participation.

Figure 8: % of workers earning NMW



B - Construction of local labour markets

I consider a local labour market to be any distinct combination of a location - sector - age group triad. I consider a location to be any of the 52 commuting zones defined by Afonso and Venâncio (2016) for mainland Portugal. Regarding sector of activity, I use the Portuguese Classification of Economic Activity (CAE-Rev.2) at the 1-letter level, which consists of 17 different sectors of activity. I further split the workforce into six different age groups: 16-18 years old, 19-21 years old, 22-25 years old, 26-30 years old, 31-40 years old, and 40+ years old.

Afonso and Venâncio define the 52 commuting zones for mainland Portugal based on 2011 census data of inter-municipal commuting flows. I look at local labour markets for the period between 2002 and 2013, meaning that their year of analysis falls within my own temporal range, reinforcing the belief that it is an accurate definition of the geographic boundaries of Portuguese local labour markets. Afonso and Venâncio provide a detailed summary of to which commuting zone they allocated each of mainland Portugal's 278 municipalities.

Table 8: Construction of local labour markets

52 commuting zones	17 sectors of activity (CAE-Rev.2)	6 age groups
Refer to Afonso and Venâncio (2016) for a detailed construction of the 52 commuting zones for mainland Portugal	A- Agriculture, animal production, hunting and forestry	16-18 years old
	B- Fishing	19-21 years old
	C- Extractive industries	22-25 years old
	D- Manufacturing industries	26-30 years old
	E- Production and distribution of electricity, gas and water	31-40 years old
	F- Construction	40+ years old
	G- Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and domestic goods	
	H- Accommodation and catering (restaurants and similar)	
	I- Transport, storage and communications	
	J- Financial activities	
	K- Real estate activities, rentals and services provided to companies	
	L- Public administration, defense and mandatory social security	
	M- Education	
	N- Health and social action	
	O- Other collective, social and personal service activities	
	P- Families with domestic workers	
	Q- International bodies and other extraterritorial institutions	

C - Design using firm versus establishment information

The data set *Quadros de Pessoal* links worker information with the respective firm and the specific establishment, as each firm might have more than one establishment. Establishment data was used to construct local labour markets, whereas for HHI measures I used firm data.

I use establishment information for the construction of local labour markets firstly because of the geographic dimension. In the data set, a firm that operates in the entire national territory of Portugal will have its geographical location equal to where it is headquartered. Naturally, I want to know where the worker is actually located, so I use the geographic location of the establishment where each worker is employed in order to know to which local labour market they belong to.

Furthermore, in the data set, the sector of activity assigned to the firm is not always the same as the one assigned to the individual establishment. They may differ if the firm is a holding company or if it operates in multiple businesses. Again, I assume the worker is employed by the establishment and not the firm, and thus labour markets are defined, sector-wise, by the sector of activity of the establishment.

In regards to the construction of labour market concentration indices, I use firm-level data rather than establishment-level. This means that, if a given firm has more than one store hiring within the same labour market, I aggregate all hires belonging to the same firm when calculating market shares. This implicitly assumes that establishments belonging to the same firm do not compete against each other in the labour market, and that there is at least some degree of coordination in hiring policy across the multiple establishments of a firm.

D - Sectors in selected sample

In selecting a sample for analysis, I exclude all sectors which are likely to have a high presence of the government. This is done since the data set *Quadros de Pessoal* only contains information regarding private sector workers and firms.

This means that, if for instance an individual disappears from the data set in a given year, it is impossible to determine whether that individual is no longer employed, or whether they merely switched employer to a state-owned enterprise within the same labour market. I could be wrongly attributing the exit from the data set to a decrease in that local labour market's level of employment. The government might also be a major employer in sectors such as healthcare or education. Since the data set does not contain information about

government employment and hires in these sectors, the concentration indices based on the data set could be severely miscalculated and affect my results. Furthermore, even if the government was included in the data set and I could accurately calculate employment and concentration levels in labour markets where it has a high presence, they may not reflect labour market power. State-owned enterprises may not behave as profit-maximising firms, and thus a market with high concentration due to government presence does not necessarily imply their market power will lead to sub-optimal wages and employment. For all these reasons, for my analysis I only keep sectors which are likely to contain almost purely private agents.

Sectors *L- Public administration, defense and mandatory social security* and *Q- International bodies and extraterritorial institutions* were naturally excluded as their activity is exclusive to the Portuguese state and government. Sector *O- Other collective, social and personal service activities*, despite not being entirely in the state sphere, was excluded due to public interest and sponsorship from the government. Sectors *M- Education* and *N- Health and social action* were also excluded due to the publicly funded nature of the National Health Service and the vast network of state schools.

Sector *E- Production and distribution of electricity, gas and water* was excluded since water distribution in Portugal is state-owned, while the main electric company in Portugal, EDP, only became fully privately-owned in 2011. I excluded sector *I- Transport, storage and communications* since the national railway service is state-owned, while the national airline TAP has been alternating between private and state ownership. The government also owns major Portuguese broadcaster RTP. Sector *J- Financial activities* was excluded since Caixa Geral de Depósitos, one of the largest banks in Portugal, has state participation.

Finally, I also excluded sector *P- Families with domestic workers* as I consider this to be a very informal sector which does not operate as a private labour market, and because only in 2004 did these workers get the right to the same level of minimum wage as the rest of the labour force. Table 9 details all included and excluded sectors.

Table 9: Sectors used for selected sample

Included sectors (CAE-Rev.2)	Excluded sectors (CAE-Rev.2)
A- Agriculture, animal production, hunting and forestry	E- Production and distribution of electricity, gas and water
B- Fishing	I- Transport, storage and communications
C- Extractive industries	J- Financial activities
D- Manufacturing industries	L- Public administration, defense and mandatory social security
F- Construction	M- Education
G- Wholesale and retail trade; repair of motor vehicles motorcycles and personal and domestic goods	N- Health and social action
	O- Other collective, social and personal service activities
H- Accommodation and catering (restaurants and similar)	P- Families with domestic workers
K- Real estate activities, rentals and services provided to companies	Q- International bodies and other extraterritorial institutions

E - Concentration status based on HHI flow and stock

Table 10: Frequency distribution of labour market cells by concentration status

	Flow		Stock	
	Freq.	Percent	Freq.	Percent
Highly Competitive ($HHI < 0.01$)	752	5.86%	9,387	73.18%
Unconcentrated ($0.01 \leq HHI < 0.15$)	9,376	73.09%	3,248	25.32%
Moderately Concentrated ($0.15 \leq HHI < 0.25$)	1,498	11.68%	116	0.90%
Highly Concentrated ($HHI \geq 0.25$)	1,202	9.37%	77	0.60%
Total	12,828	100%	12,828	100%

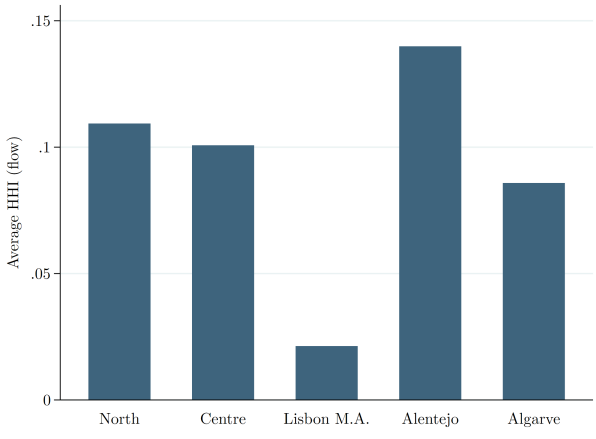
Table 11: Two-way frequency table of HHI flow and stock measures

	Stock				
Flow	Highly Comp.	Un-concentrated	Moderately Concentrated	Highly Concentrated	Total
High. Competitive	752	0	0	0	752
Unconcentrated	7,494	1,882	0	0	9,376
Mod. Concentrated	628	818	52	0	1,498
High. Concentrated	513	548	64	77	1,202
Total	9,387	3,248	116	77	12,828

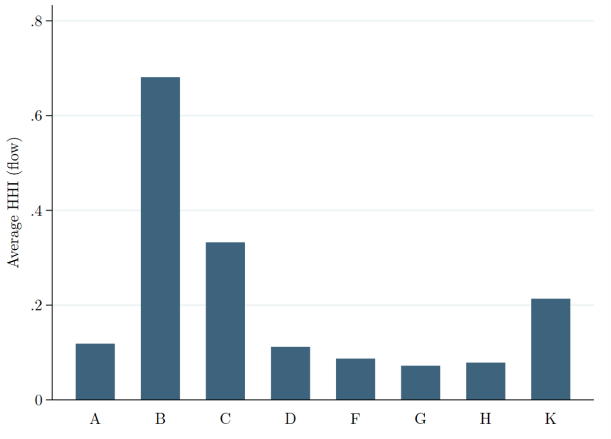
The US Department of Justice/Federal Trade Commission horizontal merger guidelines classifies markets into four categories according to their concentration level. A market with HHI level below 0.01 is considered highly competitive. If HHI is between 0.01 and 0.15 the market is considered unconcentrated. If HHI is in the range of 0.15 and 0.25 the market is moderately concentrated, while if it exceeds 0.25 it is considered highly concentrated.

F - Average concentration by subgroups

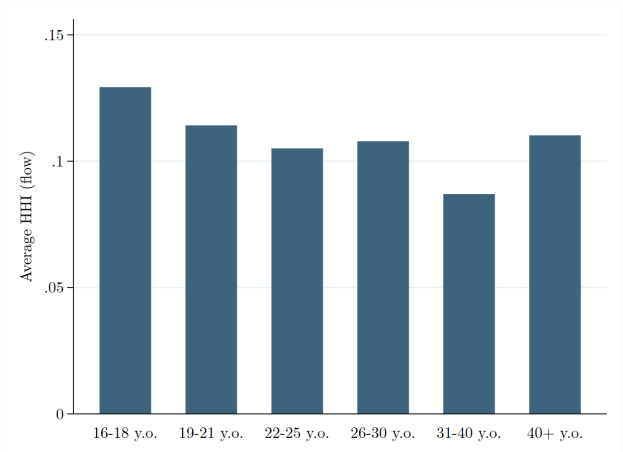
Figure 9: Sample average HHI (flow) by region, sector and age group



(a) HHI by NUTS II



(b) HHI by sector



(c) HHI by age group

A- Agriculture; B- Fishing; C- Extractive Industries; D- Manufacturing; F- Construction; G- Retail; H- Accommodation/Catering; K- Real Estate