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Labor Demand Response to Labor Supply Incentives: Lessons from the German Mini-Job Reform

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Abstract

This paper analyzes how firms respond to changes in tax benefits for low-earning workers and how, through equilibrium effects, such policies also affect non-targeted, high-earning workers. I explore establishment-level outcomes around Germany's 2003 Mini-Job Reform, which entailed a significant expansion of tax benefits for low-earning workers. Firms' responses are decomposed in terms of the scale effects that arise from lower labor costs and the substitution effects that are due to changes in the relative prices of low- and high-earning employment post-reform. Using a differences-in-differences approach, I document that highly exposed establishments—those with a high proportion of low-earning workers pre-reform—expand their number of employees relative to non-exposed establishments–those with a low proportion of such workers. Importantly, this relative expansion is tilted towards high-earning workers, a group that is not the target of the tax benefits. In addition, non-exposed establishments substitute employment towards low-earning workers without expanding at the same pace. My findings are consistent with a model of the labor market that features tax sharing between workers and firms and simultaneous shifts in labor supply and demand after changes in tax benefits for low-earning workers. In this setting I illustrate that the employment growth the policy intended is accompanied by a reallocation of employment and production between highly exposed firms and non-exposed firms, and this may result in an efficiency loss.

Topics: Labour markets; Firm dynamics; Economic models
JEL codes: H20, H24, H32, E24, E64, I38, J23, J38

1 Introduction

Since early 1990s, providing tax benefits for workers with low earnings has become a popular policy in many developed countries. These so-called *in-work benefits* aim to provide incentives to work for, and promote the self-sufficiency of, individuals with low earning capacity. Numerous studies show the effectiveness of such policies for expanding the labor supply of targeted groups.[1] This paper contributes to a much scarcer literature on the demand-side and equilibrium effects of tax benefits for low-earning workers. These are workers who are generally unskilled or who work part-time.

A series of recent studies for the UK (Azmat 2019), US (Leigh 2010 and Rothstein 2010) and Germany (Galassi 2018) document that when tax benefits for low-earning workers are expanded, firms appropriate at least part of the increase in these benefits through a decline in before-tax wages. Tax-benefit sharing between workers and employers is a natural consequence of the intended labor supply expansion (Eissa and Nichols 2005). For firms, this represents a reduction of the cost of one input, namely the low-earning employment targeted by the benefit. Understanding what firms do with respect to this cost reduction in low-earning employment is particularly important, not only in relation to in-work benefits, but also in the context of increasing employment in nonstandard work arrangements and part-time work (see, e.g., Katz and Krueger 2019 and Borowczyk-Martins and Lalé 2019), typically concentrated in the low-earning segment.

In this paper, I provide empirical evidence on firms' responses to in-work benefits by exploiting Germany's Mini-Job Reform of 2003, which led to a significant expansion of tax benefits for low-earning workers. Since the reform, workers in so-called *mini-jobs*, with gross monthly earnings below €400, have been exempt from social security contributions (SSC) and income tax, and workers in *midi-jobs*, those that pay between €400 and €800, incur a subsidized SSC rate. Mini- and midi-jobbers are known both in the literature and in policy discourse as *marginal workers*. Workers whose earnings are above this threshold are considered to be in *regular* employment and are subject to full taxation. The Mini-Job Reform led to a large increase in the number of mini-jobs, from ap-

[1] The literature that mainly focuses on the US and the UK has extensively documented a substantial positive effect of in-work benefits on labor participation, particularly of single mothers, and a small negative effect on hours worked (see, e.g., Eissa and Liebman 1996, Meyer and Rosenbaum 2001, Saez 2002, Eissa and Hoynes 2004, Saez 2010 and Chetty, Friedman, and Saez 2013, Blundell, Costa Dias, Meghir, and Shaw 2016, Blundell and Shephard 2011, Blundell 2006, Blundell 2000 and Blundell, Duncan, McCrae, and Meghir 2000, Blundell and Hoynes 2004). In addition, these policies have also proven effective for redistribution (see, e.g., Hoynes and Patel 2017).

proximately 4 million in 2002 to 7 million in 2004.[2] Germany's Mini-Job program has a coverage that is comparable to the well-known Earned Income Tax Credit (EITC) in the US.

The goal of this paper is to answer the following questions regarding the expansion of in-work benefits: Do firms create new employment at all, and if so, what type of employment? Do firms replace high-earning employment–the input that becomes relatively more expensive–with low-earning employment–the input that becomes relatively cheaper? Replying to these questions requires studying firms' responses not only in terms of low-earning labor (targeted by the policy) but also high-earning labor (not targeted). These two types of labor differ along dimensions that are relevant for production, such as the number of hours worked or skill levels. Firms combine low- and high-earning workers for production because these workers are complementary. A change in the pre-tax wage for workers in low-earning jobs, induced by the expansion of in-work benefits, provides incentives for firms to react by changing their demand for all types of labor. The change in relative costs favors the use of low-earning labor, and the savings in labor costs translates to a higher demand for both low- and high-earning workers (Hamermesh 1986).

Using a panel of German establishments for the period between 2000 and 2007, matched to administrative data on workers, I apply a differences-in-differences (DiD) strategy that exploits the variation in the pre-reform fraction of low-earning workers across establishments. In line with the literature that studies firm-side responses to labor market policies, I use this variation to capture the different establishments' respective degree of *exposure* to the policy.[3] The main identifying assumption is that in the absence of the reform and, hence without any changes in the relative prices of the different types of employment, firm-level employment would have evolved at the same pace within both highly exposed and non-exposed establishments (the so-called *parallel trends* assumption).[4] I

[2]The papers analyzing the effects of the reform have documented a labor supply expansion that was driven by secondary workers (e.g., married women) and regular workers who took up marginal employment as a second job, a feature encouraged by the reform (Tazhitdinova 2019, Carrillo-Tudela, Launov, and Robin 2019, Caliendo and Wrohlich 2010, Bargain, Caliendo, Haan, and Orsini 2010, Fertig and Kluve 2006, Freier and Steiner 2008 and Steiner and Wrohlich 2005).

[3]The literature studying firm responses to labor market policies includes, e.g., Harasztosi and Lindner (2019), Cahuc, Carcillo, and Le Barbanchon (2019), Deslauriers, Dostie, Gagné, and Paré (2018), Draca, Machin, and Van Reenen (2011), Machin, Manning, and Rahman (2003). The concept of exposure is analogous to the intensity of treatment common in the development literature (see, e.g., Duflo 2001, Bleakley 2007).

[4]Throughout the remainder of the paper, I will use the expression *highly exposed establishments* for establishments with a relatively high proportion of low-earning workers prior to the reform (mostly, above the median proportion), and *non-exposed establishments* for establishments with a relatively low (or below median) proportion of low-earning workers prior to the reform.

verify that this is indeed the case for the years preceding the reform.

My estimates show that after the reform, (i) highly exposed establishments experience a larger increase in the use of high-earning workers than non-exposed establishments, (ii) the increase in the employment of low-earning workers is smaller in highly exposed establishments than in non-exposed ones, and (iii) total employment grows more in highly exposed establishments than in non-exposed establishments.

I show that these results are consistent with the standard theory of labor demand. When the price of low-earning labor drops because of an expansion of in-work benefits, the reaction of a firm that combines both low- and high-earning workers can be decomposed in terms of a *scale effect*–resulting from lower labor costs–and a *substitution effect*–from changes in the relative cost of different types of jobs. While the scale effect yields an increase in the demand for both low- and high-earning labor, the substitution effect results in firms leaning towards low-earning and away from high-earning employment. Furthermore, the strength of the scale and substitution effects depends on the ex-ante importance of low-earning workers–those targeted by the policy–in the total workforce. Intuitively, on the one hand, firms with more low-earning workers experience larger reductions in labor costs and, thus, increase their demand for and employment of both low- and high-earning workers. On the other hand, firms with few low-earning workers have a stronger incentive to increase these workers' participation, aiming to decrease the cost of their workforce, which is now relatively expensive. The pattern in the DiD analysis is consistent with the scale effect that drives employment behavior in highly exposed establishments and the substitution effect in non-exposed establishments.

Wages and hours determine earnings, which in turn determine the eligibility for the policy. I show that employment changes occur in terms of both the number of hours worked (changes in the part- and full-time mix in jobs) and wages (changes in the skills composition of the workforce). This is key to understanding how firms change their demand for labor in a way that is consistent with the previous observations. The relative expansion of high-earning workers in highly exposed establishments is driven by an increase in the number of hours of work per employee (i.e., there are more full- and fewer part-time workers), and by a change in workers' education level (i.e., there are more medium-educated workers to the detriment of low-educated workers). The change in the educational composition of the workforce takes place in parallel with a larger increase in investment

in physical capital in highly exposed establishments than in non-exposed establishments. Physical capital has a higher level of complementarity to skilled than to unskilled labor. The evidence also suggests that establishments change their task composition: highly exposed establishments tend to shift towards more-complex tasks, whereas non-exposed establishments lean towards using more tasks that are lower in complexity. Finally, incumbents' earnings upgrade more frequently (and downgrade less frequently) in highly exposed establishments than in non-exposed ones, and the former also hire disproportionately more workers that are above the earnings limit for tax exemptions. The results are robust to a multiplicity of alternative specifications.

Finally, I use a parameterized version of the model that is consistent with my empirical results to illustrate the effects of the reform on overall employment and output. The main insights from this exercise are that the policy potentially leads to: (i) an increase in total employment that is driven by an expansion in low-earning employment that does not fully displace high-earning employment, given the complementarity between these two inputs, and (ii) a decline in total output due to a reallocation of production (and employment) from non-exposed establishments (highly productive) to highly exposed ones (with low productivity).

This paper contributes to the scarce literature on the demand-side effects of in-work benefits. The previous literature differs from this paper in that firms' responses were analyzed mainly in relation to how labor market frictions drove their employment decisions. When tax benefits are expanded, in the presence of labor market frictions, firms will change not only their demand for eligible workers but also for non-eligible workers, as long as eligible and non-eligible workers are perfect substitutes for each other. Along these lines, Shephard (2017) studies the Working Families Tax Credit in the UK, which allows some workers who compete in the same labor market to be entitled to the policy, depending on their demographic traits.[5] Along a similar vein, Tazhitdinova (2019) argues that firms that are motivated by labor market frictions will disproportionately create mini-jobs, thereby replacing jobs that would pay slightly more than the earnings threshold, to profit from the tax exemption.[6] My paper focuses on a different type of firms' responses, due to the complementarity between targeted and non-targeted workers who differ along productivity dimensions–hours and skills. In this

[5] Similar mechanisms are studied for in-work benefits in Kolm and Tonin 2011 and for job search assistance programs in Crepon, Duflo, Gurgand, Rathelot, and Zamora 2013.

[6] Gudgeon and Trenkle 2019 also study how frictions motivate firm responses, focusing on earnings adjustments below the mini-job threshold.

sense, I complement the literature on the demand-side effects of in-work benefits as I add to firm responses that are motivated by labor market frictions.[7]

The work of Collischon, Cygan-Rehm, and Riphahn (2018) is closely related to this study as it tackles the same question and also uses the Mini-Job design. The main departure is that their study focuses on the statutory incidence of the tax benefit, whereas I consider the economic incidence. In their paper, the Mini-Job Reform represents an increase in cost for firms; in my paper I interpret this as having the opposite result.[8] I furthermore consider the firm decision on both mini-jobs and regular jobs as being made jointly and not sequentially as these authors do to motivate their instrumental variable approach. As a result, I document not only a displacement of regular workers with tax-advantaged workers, as is the interpretation given in Collischon, Cygan-Rehm, and Riphahn (2018), but also an increase in the demand for non-tax-advantaged employment in establishments for which the expansion in tax benefits represents strong labor costs savings.

The ongoing political controversy over the Mini-Job Reform, which has remained under scrutiny within Germany and other countries considering similar reforms for promoting employment, illustrates the policy relevance of my paper. Several pundits and policy makers in Germany have attributed observed increases in labor precariousness to the Mini-Job Reform. It is argued that the program mainly favored firms that substituted high-earning occupations with low-paid workers. At the same time, the strength of the German labor market over the last decade has led others to stress that the program may have resulted in beneficial job creation.[9] I provide evidence for both effects, in particular for an unexpected effect on the employment of high-earning workers, as these were not targeted by the policy. More generally, my results show that the design of policies, or the emergence of alternative work arrangements, that are concentrated on low-earning workers should take into ac-

[7] Less related studies that also tackle the demand-side responses to the Mini-Job Reform include Jacobi and Schaffner 2008 and Bradley and Kuegler 2019. They both rely on analyzing changes in structural parameters with the reform. Instead, I study the employment effects when structural parameters are stable.

[8] As will be explained later, the employer-paid contribution increased slightly with the reform. However, the total tax wedge decreased substantially.

[9] Different from the EITC which has been consistently praised by the academic and political spheres for its success in increasing employment and decreasing inequality (see, e.g., "Building on the success of the Earned Income Tax Credit" by Hilary Hoynes), there is no apparent consensus about the employment effects of the Mini-Job program. Negative opinions concentrate on firms that are appropriating the benefits (see, e.g., "Fur eine hand voll euro" by Spiegel, or "The dark side of Germany's job miracle" by Reuters), while other countries suffering from high and persistent unemployment have acclaimed its effectiveness in reducing unemployment (see, e.g., "Putting Germany's mini-jobs in their context" by El País, or "Our jobs market is broken - and Germany may have the answer" by The Telegraph). Apart from concerns about the employment effects, political economy arguments generally fuel the negative opinions about the Mini-Job Reform (e.g., "German labour reforms: Unpopular success").

count the labor demand response to such interventions, including the spillovers on the high-earning segment of the labor market.

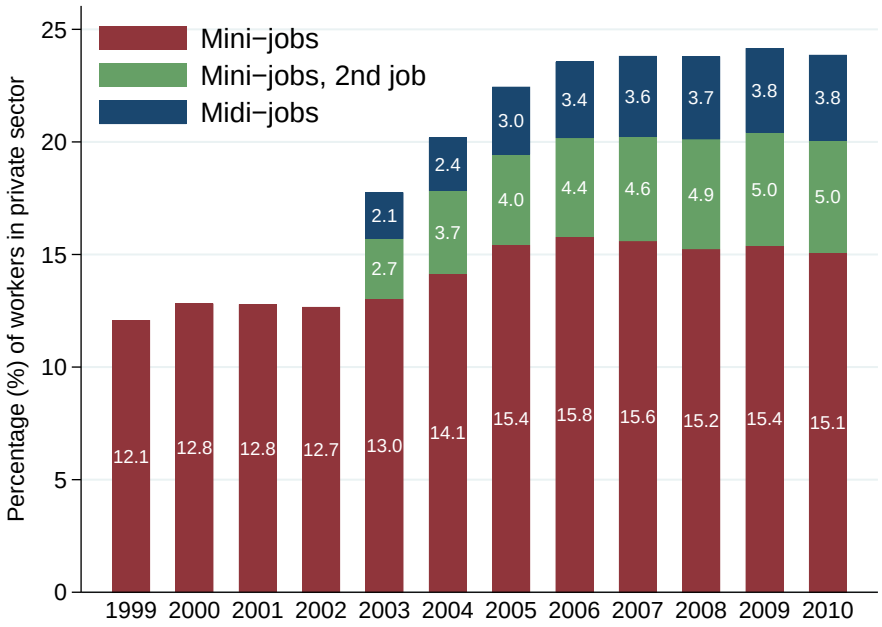
The remainder of this paper is organized as follows. Section 2 provides details on the institutional background of the Mini-Job Reform. Section 3 describes the data. Section 4 presents the empirical analysis by outlining the strategy and the results. Section 5 presents a theoretical framework that illustrates the macroeconomic implications of the empirical results shown in section 4. Finally, section 6 concludes.

2 Institutional Context of the Mini-Job Reform

The Mini-Job Reform was part of a wider set of policies, the so-called Hartz Reforms, which were gradually implemented between 2003 and 2005. The Hartz Reforms' explicitly stated objective was to simultaneously reduce unemployment and increase competitiveness, by boosting labor supply, labor demand and matching efficiency. In this paper I focus on Hartz II or Mini-Job Reform, one of the most controversial components of the Hartz reforms. The Mini-Job Reform was introduced in April 2003, and it expanded the exemptions from social security contributions (SSC) and income tax for workers with low earnings. The so-called *marginal* employment–tax-advantaged, low-earning employment–already existed in Germany before the reform. Mini-jobs were subject to several restrictions, not only in terms of earnings but also in hours of work and total earnings from all jobs. The Mini-Job Reform extended the earnings limit for mini-jobs to €400 per month and eliminated the limit on the number of hours worked. Employers' SSC rate increased to 25% for mini-jobbers, slightly above the 21% paid in contributions for regular jobs. A phase-out, or transition, category was introduced for monthly gross earnings of between €400 and €800, for the so-called *midi-jobs*, for which the SSC increased linearly for the worker while employers were subject to the regular 21% rate and for which the regular income tax rate applied. Secondary jobs, those with a different employer than in the main job, qualified as mini- or midi-jobs and workers received the tax advantages irrespective of their total earnings in all jobs.

Figure 1 shows the evolution of the proportion of salaried workers in the private sector with tax-advantaged jobs; i.e., mini- and midi-jobs. The red bar in the figure corresponds to workers who were holding a mini-job as their main job during the period under review, while the green bar

Figure 1: Importance of mini- and midi-jobbers in total employment

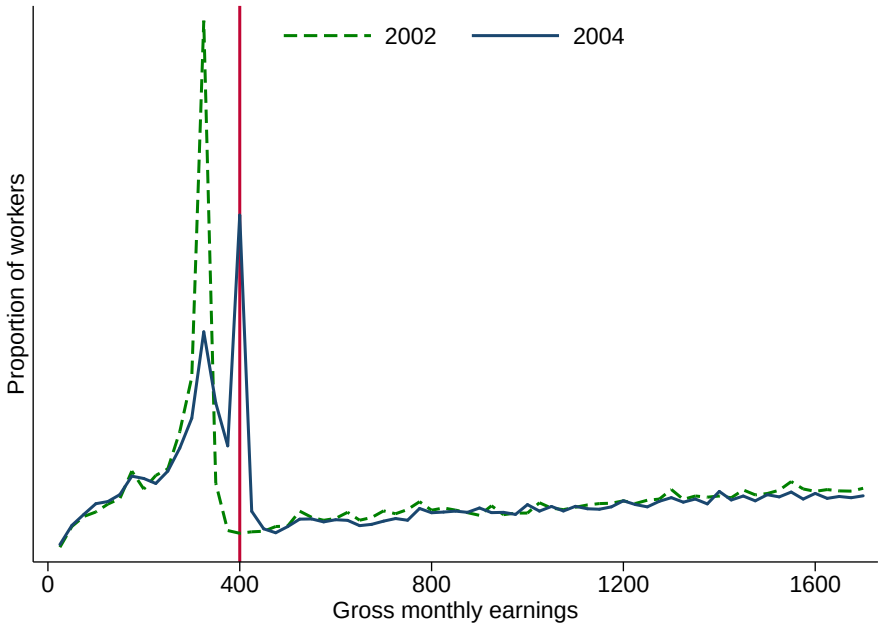


Source: SIAB, annual data, main job.

represents those workers who held a regular job as their main employment and a mini-job as a secondary source of employment, and the blue bar represents workers with midi-jobs. The number of workers who held mini-jobs surged after the 2003 reform, from approximately 13% of private wage employment in the years before the reform, to 19% after. The increase was more modest for workers with a mini-job as their main source of income (15.5%). The graph shows that employment with tax benefits, including midi-jobs, affects more than 20% of workers in the private sector. This proportion is comparable to the numbers of the EITC in the US and doubles the number of workers with temporary contracts in Germany.

The relevance of the mini-job design is also apparent in the earnings distribution plotted in Figure 2. The dotted line presents the distribution before the reform (in 2002), and the solid line, after the reform (2004). There is a strong spike at the mini-job threshold, at gross monthly earnings of €325 before the reform and €400 after the reform. The additional spike at €165 reflects the earnings disregard–income that is not counted–for the unemployment insurance, a feature that did not change with the reform. The change in the location of the spike is observed the year of the reform, 2003, and is consistent with a lack of anticipation for the reform (see Figure B.1 in the appendix).

Figure 2: Gross monthly earnings in 2002 (pre-reform) and 2004 (post-reform)



Source: SIAB, annual data, main spell, gross monthly earnings computed from daily wages.

Mini- and midi-jobbers are entitled to most of the benefits regular employees enjoy in Germany, including holidays, paid sick days, employment protection against dismissal, and parental leave. The main difference is that these employees are not entitled to full pensions. They can opt to contribute voluntarily, but very few mini-jobbers do so.

Although several other institutional reforms were taking place around the time of the Mini-Job Reform, these programs were not likely to generate the results we present in this paper. The Mini-Job Reform acted as the main activation measure for low-earning workers, particularly in the time close to when the reform was implemented. Hence, it is possible to use this setting to understand the effects of the expansion in tax benefits for low-earning workers on the demand for different types of labor. Appendix C presents further details of the institutional context.

3 Data and Descriptives

3.1 Data

The empirical analysis is based on administrative data gathered by the Institute for Employment Research of the German Federal Employment Agency (IAB). These data are available via on-site

and remote access that is provided by the Research Data Centre (FDZ) of the IAB. The firm-level analysis draws on the cross-sectional model 1993-2010 of the German linked employer-employee (LIAB) data. Assembled by the FDZ / IAB, the dataset combines administrative social security data on individuals obtained from the Integrated Employment Biographies (IEB) with establishment data from both the Establishment History Panel (BHP) and the IAB Establishment Panel through a unique establishment identifier. The main advantage of the linked employer-employee data is that it allows us to follow establishments over time and it provides individual information about their employees.[10] Further details are available in Heining, Scholz, and Seth (2013) and Heining, Klosterhuber, and Seth (2014).

The IAB Establishment Panel is an annual survey, corresponding to June 30th each year, on a stratified sample of establishments. It consists of different longitudinal sections that require using weights to accommodate for the stratification of the sample and also for attrition. I use the longitudinal section for the period 2000-2007, as the first year in which mini-jobs are included in the social security system is 1999, and the analysis stops before the onset of the international financial crisis of 2008. The information on establishments includes a wide range of subjects related to employment and some elements of firms' balance sheets, for example, physical capital investment.

Social security records of all workers employed in the sampled establishments on June 30th each year (between 1.6 million and 2.5 million workers per year) are included in the cross-sectional model of the LIAB. Social security records in the IEB contain spells of employment, the receipt of unemployment benefits and job searches. Information about workers includes basic demographics (age, gender and education), daily earnings and benefits, and occupation, including job type and whether it is part-time or full-time. Additional workplace information, such as industry branch and geographic location, is available from social security records that are aggregated at the establishment level and are found in the BHP and correspond to June 30th of each year.

Most descriptives discussed in this section draw upon the Sample of Integrated Labor Market Biographies (SIAB) 1975-2010, which is a 2% random sample obtained from the IEB (1.6 million

[10]The unit of observation in the data is the establishment (local economic unit) and not the firm, which may comprise several establishments in different locations or carrying out different activities. I consider the establishment as the relevant unit for employment decisions. I use the words *firms* and *establishments* interchangeably throughout the text, to refer to the latter.

workers). The SIAB allows us to perform a longitudinal analysis of the workers as it contains all the spells of the labor history for each worker in the sample. More details can be found in Vom Berge, König, and Seth (2013).

Two important limitations of the data are the lack of information on the hours worked and the fact that earnings are censored at the maximum level of earnings for which social security contributions are made (approximately €61,000 in annual gross earnings). My analysis relies on measures of employment; hence, the lack of information on hours worked is relevant. To circumvent this issue, I generate a measure of *full-time equivalent* (FTE) employment, which consists in attributing a lower weight to part-time workers than to those working full-time. Regarding the censoring of earnings (which affects approximately 5% of the observations), I apply an imputation procedure wherein I model log daily earnings using Tobit models, splitting workers by education and age group (see; e.g, Card, Heining, and Kline 2013, Dustmann, Ludsteck, and Schonberg 2009, Gartner 2005). It is worth noting that the censoring of earnings is not crucial for my analysis; the upper limit for social security contributions is beyond the earnings limit for tax-advantaged jobs. I provide more details about the data and these adjustments in section D of the appendix.

3.2 Who are the mini-jobbers?

Table 1 shows the characteristics of mini- and midi-jobbers compared to regular workers and the unemployed (according to the main job or the spell with the highest earnings), for the year after the reform. Most rows show the characteristics in percentages, such as gender, age and education composition, the distribution of tasks performed and the proportion of part-time and second-job holders. The last block of rows shows averages. I focus on the contrast between mini-jobbers and regular workers, as midi-jobbers typically display characteristics that are in between the other two types.

As expected from the eligibility test on earnings (hours $\times$ wages), mini-jobbers work fewer hours (90% work part-time compared to 16.4% of regular workers), and they earn lower wages as they have low education levels: one-third have not completed their *Abitur* (higher secondary school certificate) compared to 13% of regular workers. Mini-jobbers represent about half of the total number of part-time workers in the economy, the remaining half being highly educated, part-time

workers.

There are also large differences in the types of jobs that marginal and regular workers perform. Mini-jobbers carry out more tasks that are interactive, manual and non-routine (15% and 49% of mini-jobs respectively, compared to 10% and 26% of regular workers); they also do jobs with less cognitive tasks (6% are in analytical non-routine tasks and 22% in cognitive routine tasks, compared to 18% and 33% of regular workers). Mini-jobbers work disproportionately in the service sector and less in manufacturing. They also have a higher representation in establishments that are younger and smaller.

Some demographic groups stick out among mini-jobbers and this is associated to their sensitivity to the incentives created by the tax design. The high proportion of women (three out of four mini-jobbers) is in line with the well-documented fact that tax benefits are particularly relevant for secondary workers within households, especially in Germany due to the income tax exemptions and the possibility for couples in Germany to file a joint income tax return. Previous non-participation in the labor market seems a relevant trait among mini-jobbers, as suggested by the lesser amount of work experience and employment tenure, combined with the similar average age and duration receiving unemployment benefits among mini-jobbers as compared to regular workers. The long-term unemployed does not represent a substantial group within mini-jobbers (the history of receiving unemployment benefits is shorter for mini-jobbers than for the unemployed). Younger (those below 30 years of age) and older (those above 55 years) workers constitute more than half of all mini-jobbers, and they represent only one-third of all regular workers. This is not surprising as students and adults in partial retirement usually work part-time. Furthermore, these groups are often entitled to particular benefits (the so-called BaföG for students and disability insurance or stipends for older workers who are partially retired) for which the means tests overlap with the €400 limit for tax benefits.

The previous description highlights that there are systematic differences in characteristics between mini- (and midi-) jobbers and regular workers. They are different types of workers that compete in different labor markets. This segmentation in the German labor market, between *regular* and *atypical* employment (mainly mini- and midi-jobs), has already been discussed in the academic and policy circles (see, e.g., Eichhorst and Tobsch 2013, Keller and Seifert 2012).

As the reform also allows secondary jobs to be tax advantaged, as long as the income from the

Table 1: Characteristics of unemployed, mini- and midi-jobbers, and regular workers

	Unemployed	Mini-job	Midi-job	Regular
Female	46.8%	71.3%	76.2%	43.0%
	(0.499)	(0.453)	(0.426)	(0.495)
Young (< 30)	22.0%	27.1%	22.2%	20.8%
	(0.414)	(0.444)	(0.416)	(0.406)
Prime age (30-55)	62.7%	43.9%	68.1%	69.7%
	(0.484)	(0.496)	(0.466)	(0.459)
Old (>55)	15.2%	29.0%	9.6%	9.5%
	(0.359)	(0.454)	(0.295)	(0.293)
No *Abitur*	21.7%	31.2%	20.6%	13.3%
	(0.412)	(0.463)	(0.404)	(0.339)
With *Abitur* or apprentices	72.4%	65.4%	75.3%	74.4%
	(0.447)	(0.476)	(0.431)	(0.437)
Professionals	5.9%	3.4%	4.2%	12.4%
	(0.236)	(0.181)	(0.200)	(0.329)
Second-job holder	0.4%	4.6%	8.5%	4.8%
	(0.065)	(0.208)	(0.279)	(0.214)
Part-time		90.0%	61.9%	16.4%
		(0.300)	(0.486)	(0.371)
Analytical non-routine tasks		6.4%	7.7%	18.3%
		(0.245)	(0.267)	(0.387)
Interactive non-routine tasks		15.3%	15.0%	10.1%
		(0.360)	(0.357)	(0.302)
Cognitive routine tasks		22.0%	25.4%	33.2%
		(0.414)	(0.435)	(0.471)
Manual routine tasks		7.1%	4.2%	12.2%
		(0.257)	(0.201)	(0.328)
Manual non-routine tasks		49.2%	47.7%	26.1%
		(0.500)	(0.499)	(0.439)
Daily wage/benefit (euros)	18.8	8.8	19.9	81.0
	(11.97)	(3.74)	(10.07)	(45.54)
Employment experience (years)	8.1	8.4	9.2	13.1
	(7.559)	(7.546)	(6.865)	(8.710)
Tenure (years)		3.1	4.4	7.3
		(3.864)	(5.058)	(7.272)
Duration of benefit receipt (months)	40.9	9.1	12.5	8.0
	(44.845)	(18.678)	(21.902)	(16.187)

Source: SIAB, annual data (2004), main job or spell. Standard errors are in parentheses.

second job complies with the earnings limits, it is also important to understand who the workers with secondary jobs are. Table 2 shows the characteristics of secondary job holders, contrasting secondary mini-jobs with secondary regular jobs (included midi-jobs), and compares them to workers who do not hold a secondary job. The first rows express percentages of each group with a certain characteristic (gender, age groups, education level and part-time status), and the remaining rows show average wage and earnings in the second job. Age and gender differences across the groups are not as pronounced as those between regular workers and workers with a mini-job as a main occupation. Some disparities in the education level still remain, however, with more low and medium-educated workers (workers without and with *Abitur* respectively) in the group holding a mini-job as their secondary job, and more professionals in the group holding a regular job as their secondary job. These workers, with a regular main job and a regular (typically part-time) secondary job are a rather small group (less than 10% of workers with a secondary job). Overall, workers with a regular main job and a mini-job as a secondary job are slightly less educated and with some demographics close to mini-jobbers. However, they are not entirely comparable with workers with a mini-job as their main job. Still their weight on total mini-jobs is not substantial (between one-fifth and one-fourth depending the year).

For firms to respond to a reduced cost of low-earning employment that is induced by an expansion of in-work benefits, the labor supply needs to increase at the bottom of the earnings distribution. Appendix D.1 shows some descriptive statistics that suggest this was indeed the case for the German Mini-Job Reform.[11] In brief, both the changes in the earnings distribution and transitions from non-employment to employment between 2002 and 2004 suggest an inflow of new workers at low-earnings levels at the time of the reform.

Furthermore, for both low- and high-earning workers to be affected by the reduction in the wages of the former, a key premise is that they must be imperfect substitutes; i.e., they must have at least some degree of complementarity and substitutability. The observed differences in the traits of mini-jobbers (or low-earning workers) and regular workers (or high-earning workers), in particular, in

[11] The article in the British newspaper *The Telegraph*, entitled "Our jobs market is broken - and Germany may have the answer" explains in plain words the labor supply incentives the reform aims to provide: "Take a lone mother who works 10 hours a week on the minimum wage. If she works 15 hours, she is not better off, because the extra money she earns is offset by the welfare she loses. [...] If the single mother in question were allowed to work under a mini-job contract, she could keep every penny."

Table 2: Characteristics of workers with a secondary job

		Secondary-job holders	
	No secondary job	Mini-job	Regular job
Female	47.3%	55.5%	55.6%
	(0.499)	(0.497)	(0.497)
Young (<30)	21.8%	22.1%	20.9%
	(0.413)	(0.415)	(0.406)
Prime age (30-55)	65.4%	68.7%	66.5%
	(0.476)	(0.464)	(0.472)
Old (>55)	12.9%	9.2%	12.6%
	(0.335)	(0.289)	(0.332)
No *Abitur*	16.6%	18.3%	13.8%
	(0.372)	(0.387)	(0.345)
With *Abitur* or apprentices	73.0%	75.8%	65.5%
	(0.444)	(0.428)	(0.475)
Professionals	10.4%	5.9%	20.7%
	(0.305)	(0.236)	(0.405)
Part-time, main job	23.3%	32.5%	50.0%
	(0.300)	(0.486)	(0.370)
Daily wage, second job		7.6	40.3
		(4.045)	(51.96)
Monthly earnings, second job		231.6	1,203.7
		(123.4)	(1342.4)

Source: SIAB, annual data (2004). Standard errors are in parentheses.

terms of the characteristics that are linked to productivity (such as hours of work and education), suggest that they can be considered different inputs that firms combine for the production of goods and services. Section D.2 in the appendix further discusses this argument. Certain jobs can be split into shifts, or relabelled, such that they can be performed either by full-time regular workers, or by part-time mini-jobbers, for example. Hence, mini-jobs and regular workers seem to be substitutes in some cases. However, they are complements in many other occasions, as not all jobs have this characteristic. In what follows, I will consider mini-jobs and regular workers as imperfect substitutes.

4 Empirical Analysis: Effects on Labor Demand

4.1 Identification strategy

The empirical analysis follows the literature on the employment effect of policies that change inputs costs for firms (see, e.g., Harasztosi and Lindner 2019, Machin, Manning, and Rahman 2003 and Draca, Machin, and Van Reenen 2011 for the minimum wage). This literature typically exploits the variation in *exposure* to the policy across establishments. Exposure is defined as the pre-reform proportion of workers that would be entitled to tax benefits after the reform; i.e., the proportion of *low-earning workers*. Using the longitudinal section for the linked employer-employee data for the period 2000-2007, I apply a DiD approach comparing across establishments with different levels of exposure. The main specification relates establishment-level outcomes to pre-reform use of low-earning workers as follows:

$$y_{kt} = \alpha_k + \lambda_t + \beta_t Exp_k + \varepsilon_{kt} \tag{1}$$

where y_{kt} stands for the outcome of establishment k in period t (employment, wages, workers' flows, etc.), α_k are the establishment fixed effects that capture time-invariant heterogeneity across establishments (industry, productivity, etc.), λ_t are the year fixed effects that absorb common macro-economic shocks. Exp_k measures the fraction of workers that were below the mini-job post-reform

threshold in 2002 (the year before the reform).[12] Standard errors are clustered at the establishment level to account for autocorrelation. The results in the main body of the paper are based on the specification (1). I provide a series of robustness checks that show the results do not change with less parsimonious specifications.

The coefficient of interest β_t is computed for each year by interacting Exp_k with the year fixed effects. The estimates of β_t capture the differences in the outcome paths between *highly exposed* and *non-exposed establishments*, relative to the year before the reform (2002). β_t measures the effect of the Mini-Job Reform as the difference in the labor demand of establishments with different exposures, after controlling for heterogeneity at the establishment level and for common macroeconomic shocks. The main identification assumption is that, in the absence of the reform, the evolution of the outcomes would follow parallel trends across establishments with different exposures. I show that the assumption for this parallel is not violated for the pre-reform years, for which the estimates of β_t are not statistically different from 0.

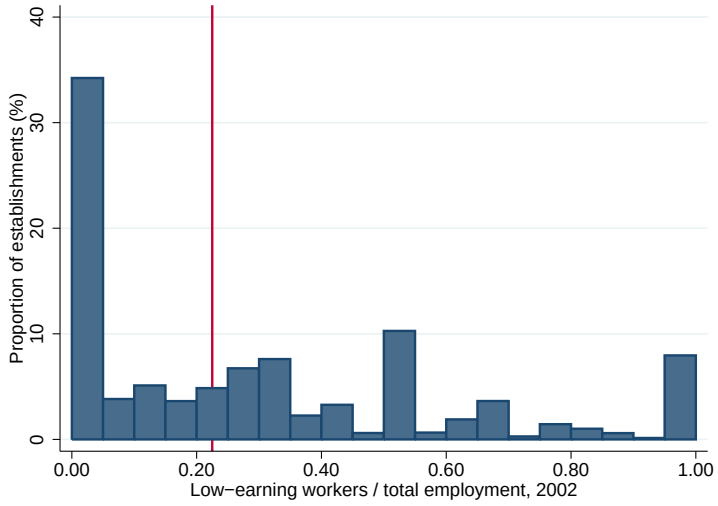
The sample I use to calculate the effects of the Mini-Job Reform comprises 3,770 establishments matched to 1.1 million workers. Here, I present some descriptives using the longitudinal sampling weights constructed by the IAB for the panel of establishments for the period 2000-2007 to account for the disproportionately stratified sampling.[13]

For the empirical strategy to be successful, the variation in the measure of exposure, i.e., the pre-reform proportion of low-earning employment, has to be sufficiently large. Figure 3 shows the distribution of establishments across levels of exposure for the pre-reform year (2002); the red line is the median level of exposure. While close to 35% of the establishments have a very low proportion of low-earning workers in 2002 (0-5%), the remaining 65% are distributed across a wide range of

[12] The threshold effectively used is €400 net-of-SSC earnings, which amounts to €506.33 in gross monthly earnings under pre-reform regulations ($400 = 506.33 \times (1 - 0.21)$, where 21% is the pre-reform SSC rate). The regressions do not include establishment-level controls which, since they are relatively constant over time, are highly collinear with the fixed effects. Since Exp_k is not observable for establishments born after 2002, I exclude establishments born between 2000 and 2002. Establishment death is very low during the observation window. Still, I perform the analysis on the subgroup of establishments that survived until 2007 as a robustness check. In the analysis, I included the 1999 observations for the establishments in the panel for which these observations are available (68%) in order to add one year of data for pre-trend tests. The results do not change when this year is excluded.

[13] Table A.9 in the appendix shows summary statistics for 2002 for both the cross-section and longitudinal section, with and without weights. The characteristics of the cross-section and the panel units are similar. A comparison of characteristics using weights and not using weights is illustrative of the features of the sampling, specifically the over-sampling of large establishments.

Figure 3: Distribution of establishments according to the exposure level, 2002



Note: Panel 2000-2007.

intensities. Half of the establishments have more than 21% of their workforce in the low-earning segment, 15% of the establishments have between 20% and 30% of their workers below the mini-job threshold, while 28% have more than half of their employees below the mini-job threshold.

Table 3 shows summary statistics of the panel of establishments for 2002, according to the weighted quintiles of the proportion of low-earning workers, Q1 to Q5. Although the establishments with varying levels of exposure differ along several dimensions, it is worth highlighting that the proportion of low-earning workers is non-monotonic with respect to some key establishment characteristics, such as size, age, proportion of low-educated workers and median daily wage. For instance, non-exposed establishments (quintiles 1 and 2) include both relatively small and relatively large establishments. The lack of correspondence between the level of exposure and other establishment characteristics permits me to infer that the estimated β_t from equation 1 does indeed capture different trends due to diverse use of low-earning workers. Importantly, the differences in characteristics of firms with different exposures do not invalidate the DiD identification strategy, as it relies on the parallel trends assumption, verified for the years that preceded the reform. The DiD strategy allows me to overcome the confounding effects that arise from macroeconomic shocks, a particularly relevant feature as Germany found itself in a strong economic slump around the years of the reform.

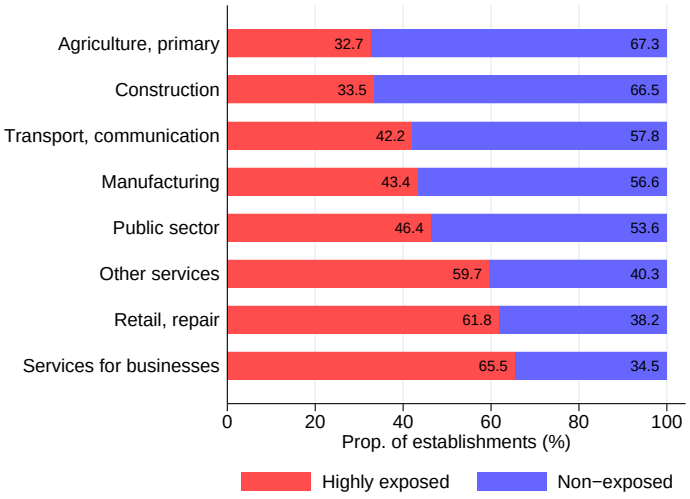
Figure 4 shows the proportion of highly exposed establishments (above the median proportion of low-earning workers) in red, and non-exposed establishments (below the median) in blue, per in-

Table 3: Characteristics of establishments by level of exposure (quintiles), 2002

	Q1	Q2	Q3	Q4	Q5
Proportion of workers below 2003 mini-job threshold	0%	6.2%	24.3%	46.3%	83.2%
	(0)	(0.0337)	(0.0702)	(0.0505)	(0.165)
Proportion of workers below 2003 midi-job threshold	11.8%	11.2%	34.0%	54.6%	85.7%
	(0.274)	(0.0770)	(0.171)	(0.166)	(0.153)
Establishment age (years)	14.7	18.5	14.7	13.0	11.8
	(9.029)	(8.811)	(8.427)	(8.653)	(8.180)
Establishment size (n. workers)	9.1	97.2	14.6	9.2	6.2
	(35.99)	(281.4)	(40.17)	(25.43)	(20.17)
Establishment size (full-time equivalent)	8.4	87.3	11.5	6.3	3.3
	(33.57)	(257.7)	(30.92)	(17.95)	(10.18)
Proportion of part-time workers	13.0%	17.7%	28.7%	42.7%	67.9%
	(0.272)	(0.199)	(0.212)	(0.267)	(0.327)
Proportion of low-educated workers	9.2%	13.2%	12.2%	13.7%	11.6%
	(0.216)	(0.158)	(0.167)	(0.200)	(0.248)
Proportion of medium-educated workers	65.6%	66.2%	60.2%	51.8%	43.2%
	(0.392)	(0.251)	(0.292)	(0.314)	(0.405)
Proportion of highly educated workers	5.6%	9.1%	4.5%	2.9%	0.4%
	(0.181)	(0.167)	(0.112)	(0.125)	(0.0255)
Vacancies-to-employment (workers)	3.0%	1.6%	1.2%	1.6%	0.7%
	(0.106)	(0.0464)	(0.0444)	(0.0642)	(0.0408)
Median daily gross wage (euros)	59.0	72.8	50.8	31.2	9.9
	(24.77)	(23.39)	(23.45)	(14.43)	(3.000)
Median daily gross wage (growth rate)	19.0%	2.9%	9.6%	22.6%	-7.2%
	(1.176)	(0.615)	(0.449)	(0.900)	(0.323)
Median daily gross wage of full-time workers (euros)	64.5	80.2	63.8	56.2	38.8
	(26.54)	(24.07)	(24.22)	(26.40)	(24.56)
Median daily gross wage of full-time workers (growth rate)	4.2%	2.5%	0.7%	5.6%	4.2%
	(0.199)	(0.0835)	(0.141)	(0.358)	(0.316)
Median daily gross wage of part-time workers (euros)	46.2	33.9	16.4	12.4	9.0
	(21.16)	(23.51)	(13.31)	(10.98)	(4.595)
Median daily gross wage of part-time workers (growth rate)	16.6%	22.0%	10.3%	7.1%	14.5%
	(0.511)	(0.892)	(0.588)	(0.478)	(1.559)
Average capita monthly labor cost (euros)	1,548	2,148	1,551	1,068	783
	(1136.4)	(895.7)	(782.2)	(687.6)	(663.7)
Inequality (P75/P25) of full-time workers	1.38	1.39	1.67	2.30	1.61
	(0.543)	(0.286)	(1.168)	(33.01)	(2.011)
Hirings-to-employment (workers)	0.14	0.18	0.19	0.25	0.23
	(0.235)	(0.132)	(0.165)	(0.253)	(0.286)
Separations-to-employment (workers)	0.30	0.19	0.20	0.26	0.33
	(0.596)	(0.182)	(0.204)	(0.493)	(0.791)
Investment (million euros)	0.057	0.777	0.057	0.033	0.037
	(589018.3)	(4760239.4)	(434432.9)	(265893.5)	(190410.8)
Sales (million euros)	1.627	21.291	1.565	0.566	0.448
	(12204560.1)	(138684037.2)	(5046558.0)	(2213170.6)	(931665.0)
Exports as a proportion of revenues	4.2%	11.8%	2.5%	3.4%	3.1%
	(21.41)	(29.24)	(13.98)	(16.97)	(23.44)
Proportion of establishments with a work council	11.2%	37.3%	7.6%	4.5%	1.4%
	(0.316)	(0.484)	(0.266)	(0.207)	(0.116)
Proportion of establishments with a collective agreement	47.3%	58.8%	49.6%	40.5%	28.6%
	(0.500)	(0.492)	(0.500)	(0.492)	(0.453)
Observations	1,041	1,288	852	306	283

Note: Panel 2000-2002. Establishments classified according to the (weighted) quintile of the proportion of low-earning workers. Standard errors are in parentheses.

Figure 4: Proportion of establishments by level of exposure (above/below median proportion of low-earning workers) by industry, 2002



Note: Panel 2000-2007. Highly exposed and non-exposed establishments refer to whether they are above or below the (weighted) median of proportion of low-earning workers.

dustry branch. Even though the proportion of highly exposed establishments is larger in certain industries, such as services, retail trade and repair, there is a significant presence of such establishments across all industries. The proportion of highly exposed establishments fluctuates between one-third and two-thirds. This observation holds for a finer classification of industries (224 categories) as well, and reaffirms that the estimates are also not linked to industry variation, but to a variation in the use of low-earning workers within industries.[14]

4.2 Results

In this section, I present the estimates of the coefficient β_t in equation 1 for a variety of firm-level outcomes. Even though the independent variable Exp_k is continuous (between 0 and 1), I refer to the results as the difference between highly exposed and non-exposed establishments.[15] The results are presented in graphical format in Figures 5 to 11, in which estimates of the coefficient β correspond to the red dots, and the confidence intervals at the 95% confidence level are the vertical blue bars. Table A.11 shows estimates in a compressed format. The appendix further shows the raw trends of

[14]Further confirmation of this claim is discussed in section 4.2, in which I show that the analysis at the industry level, instead of establishment level, does not yield similar results.

[15]In section 4.4, I discuss that changing the continuous variable Exp_k for a binary variable that takes the value 1 for establishments with a pre-reform proportion of low-earning workers above the median, and 0 for establishments below the median, does not change the results.

the outcomes, comparing highly exposed and non-exposed establishments, as defined with respect to the median exposure.

Effects on employment

Figure 5 shows the estimates of β_t for total establishment-level employment as an outcome. The left-hand panel shows the differential paths of the total number of workers across firms with different exposures.[16] Highly exposed establishments exhibit a noticeable expansion (relative to non-exposed establishments) after the reform. The estimated coefficients are statistically significant for 2005 and 2006 and borderline significant for 2004. Economically, the magnitude of the estimated coefficients implies an increase of 4% with respect to the average establishment size in the pre-reform year and 8% with respect to the size of establishments with an above-median proportion of low-earning workers, by the second year after the reform.[17]

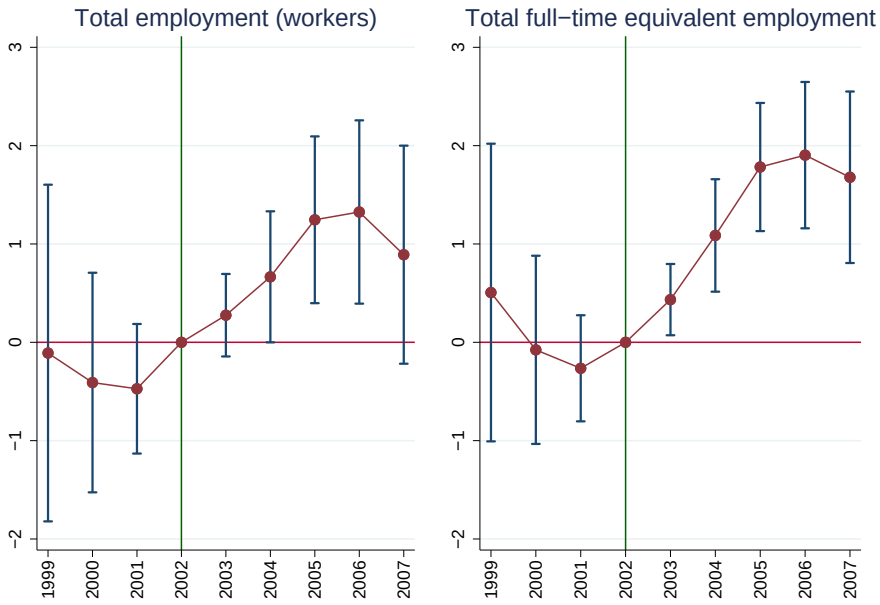
The positive effect on employment is also confirmed by analyzing a proxy for hours worked, i.e., full-time equivalent (FTE) employment, as shown by the right-hand panel of Figure 5. The difference is statistically significant for all of the years following the reform. This represents 7% of the initial FTE employment in the sample and 22% of the initial FTE employment in highly exposed establishments by the second year after the reform.

Figure 6 shows the estimates of β_t for the growth rate of low- and high-earning workers separately. The estimation sample excludes establishments with only one type of worker (i.e., the 1^{st} and 5^{th} quintiles of the exposure distribution). Estimates correspond to the difference in the growth rates in each period with respect to the baseline year 2002. Highly exposed establishments, which exhibit similar changes as non-exposed establishments in the growth rate of both low- and high-earning

[16] I estimate the effect of the Mini-Job Reform on the employment level and not the growth rates because the parallel trends assumption, which requires that employment change in similar magnitudes for establishments with different exposure levels, is verified empirically for the pre-reform period for the level and not for the growth rates. I argue that analyzing the changes in levels is reasonable in this setting. Intuitively, this implies assuming a non-constant elasticity of total employment with respect to the wage of low-earning workers (targeted by the reform). This means that total-employment growth, as a consequence of a fall in the wage of low-earning employment, is higher in highly exposed smaller establishments, which seems plausible. Instead, a constant elasticity would imply that the impact of the change in labor costs increases with firm size, which seems implausible. The specification with respect to employment, hence, assumes an additive effect on total employment, as opposed to a multiplicative effect (see, e.g., Ciani and Fisher 2019). When considering low- and high-earning workers separately, the parallel trends assumption holds for growth rates instead, indicating a constant elasticity within each type of labor.

[17] The fact that the gap closes since 2006 is not surprising, given the reversal in the tax benefits implied by the increase in the SSC rate for the employer to 30% for mini-jobs and the decrease of the SSC rate for both employer and employee to 19.5% for regular jobs (see details in the appendix C).

Figure 5: Effect on total employment



Note: Confidence intervals correspond to the 95% level.

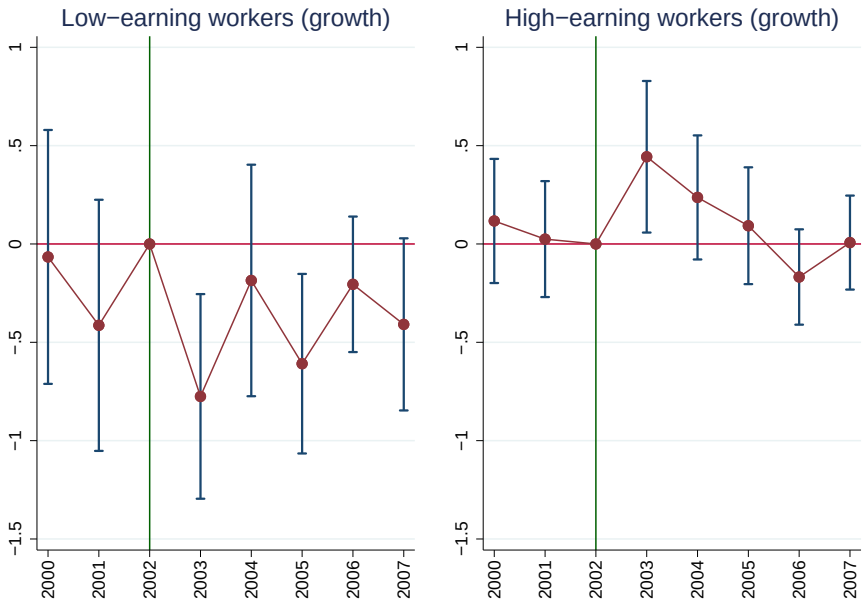
workers before 2003, show a relatively higher growth rate of high-earning workers after the reform (statistically significant for 2003, with point estimates of 44 percentage points [pp.]) and a relatively lower growth of low-earning workers (significant in 2003 and 2005, with point estimates of -78 pp. and -61 pp., respectively). As the total number of low-earning workers is growing, this is only possible if non-exposed establishments increase their lists of such workers, as shown in Figure B.9 in the appendix.

Interpretation of the employment effects

The results analyzed so far suggest that: (i) highly exposed establishments expand total employment relative to non-exposed establishments, (ii) the expansion is tilted towards high-earning employment, and (iii) non-exposed establishments increase the use of low-earning workers more than highly exposed establishments. To rationalize these three findings, I discuss here the well-known Hicks-Marshall decomposition of the changes in the demand for employment when the price of one employment type changes.

Let's denote low-earning employment (part-time and low-educated) as N_1, and high-earning employment (full-time or highly-educated) as N_2. Wage rates for each employment type are denoted

Figure 6: Effect on the growth rate of low- and high-earning workers



Note: Establishments with both low- and high-earning workers in the pre-reform year (quintiles 2-4 of intensity). Confidence intervals correspond to the 95% level.

by w_1 and w_2, respectively. The low-earning segment is characterized by an upper earnings limit and a lower tax rate than the high-earning employment. It is possible to show that the expansion of tax benefits for low-earning employment induces an increase in the labor supply in this segment relative to the high-earning segment. The labor demand adjusts accordingly in equilibrium and does so jointly with a decrease in w_1/w_2, provided the low- and high-earning employment are not perfect substitutes. [18]

Using the Hicks-Marshall rules of derived demand, and assuming without loss of generality that w_1 falls and w_2 remains constant, the following expressions show the marginal changes in the demand for each employment type (derivations are in section E in the appendix and are based on Hamermesh

[18] Section E in the appendix supports these arguments theoretically; section D.1 and Figure B.10 provide empirical support.

1986):[19]

$$\begin{aligned} \frac{dlnN_1}{dlnw_1} &= -[s_1\eta + (1-s_1)\sigma] \\ \frac{dlnN_2}{dlnw_1} &= -[s_1\eta - s_1\sigma] \end{aligned} \tag{2}$$

η is the absolute value of the price-demand elasticity for each good, σ is the elasticity of substitution between low- and high-earning employment (in a constant elasticity of substitution–CES–production function), and s_1 denotes the cost share of low-earning employment.

The common term of both equations, $s_1\eta$, captures the scale effect. The reduction in w_1, induced by the expansion of tax benefits, represents a lower labor cost for the firm. On the one hand, as free entry drives profits to zero, the firm expands the production and increases the demand for both low- and high-earning employment. On the other hand, the substitution effect, reflected in the remaining term in each equation, induces an increase in demand for low-earning employment and a reduction in demand for high-earning employment.

The crucial insight from this expression is that the change in the demand for low- and high-earning employment depends on the share of low-earning employment in total labor costs, s_1. Thus, the scale effect dominates if the cost share of low-earning employment is high; i.e., for highly exposed firms. The substitution effect is strong, in terms of changes in low-earning employment (and weaker in terms of changes in high-earning employment), if the cost share of low-earning employment is low; i.e., for non-exposed firms.

The estimated DiD coefficients presented so far do not allow me to separately identify the scale and substitution effects. However, it is possible to analyze whether the estimates are compatible with only one of these effects in place at a time. On the one hand, in the case with only the substitution effect, i.e., $\sigma \to \infty$, expression (2) suggests that high-earning employment (N_2) should decrease more in highly exposed establishments than in non-exposed ones. This would yield a negative coefficient in the DiD analysis, that contradicts the results presented so far. On the other hand, the case with only the scale effect, i.e., $\sigma = 0$, is also counterfactual. Employment of both types of workers should increase more in highly exposed establishments, which would imply a positive coefficient in

[19]These expressions are built under some assumptions, such as profit-maximizing firms (with a constant elasticity of substitution), competitive markets and free entry. The technology assumption is rather general, as it nests other cases such as the Cobb-Douglas, perfect substitutes or perfect complements. Regarding the other assumptions, the nature of the decomposition holds when they are relaxed (see, e.g., Harasztosi and Lindner 2019 for derivations in a non-competitive environment).

the DiD estimates for the growth of both low- and high-earning employment. Hence, the negative coefficient for low-earning employment discards the hypothesis of having only the scale effect in place. Table A.12 in the appendix provides additional intuition regarding this discussion.

Note that this interpretation of the empirical findings does not rely on the presence of labor market frictions, as it is standard in the literature documenting spillovers for similar policies. Moreover, the employment effects would still be in place if there were labor market frictions. On the one hand, more workers in the labor market may increase the difficulties of any worker finding a job (Diamond 1982b). Such a congestion effect should take place in the low-earning segment of the labor market, in which the labor supply shock originates. The implication of such an effect is a mitigation of employment changes as a consequence of the policy. On the other hand, trading externalities (Diamond 1982a, Shimer 2001) may act in the opposite direction, magnifying the effect of the complementarity that exists across different types of workers. These externalities refer to the facilitation of hiring and, hence, to increases in the number of vacancies coming from the increase in the number of the workers in the market. Congestion and trading externalities may either amplify or mitigate the effects on labor demand, but not overturn them. It is also possible that search frictions induce firms to disproportionately create the types of jobs workers are more likely to take up as a response to the policy (Chetty, Friedman, Olsen, and Pistaferri 2011). Although this effect would amplify the rise in low-earning employment on aggregate, it cannot underlie the estimates as there is no apparent relationship with the running variable in the analysis, i.e., the exposure to low-earning workers.

It is worth noting that in the empirical specification, there are, strictly speaking, no treatment or control groups, and hence the assumption that some production units are not affected by the reform should be dispensed; i.e., the stable unit treatment value assumption (SUTVA) does not hold. Non-exposed establishments, which do not reduce labor costs due to the reform, are not affected by the scale effect. However, they are subject to the substitution effect. According to equation 2, non-exposed establishments, in particular, have incentives to increase their use of low-earning workers. As both highly exposed and non-exposed establishments have incentives to increase employment following the expansion of in-work benefits, the post-reform differences in the trends of total employment as measured by β_t offer a conservative estimate of the employment effect.

Figure 7: Effect on employment by part- and full-time status

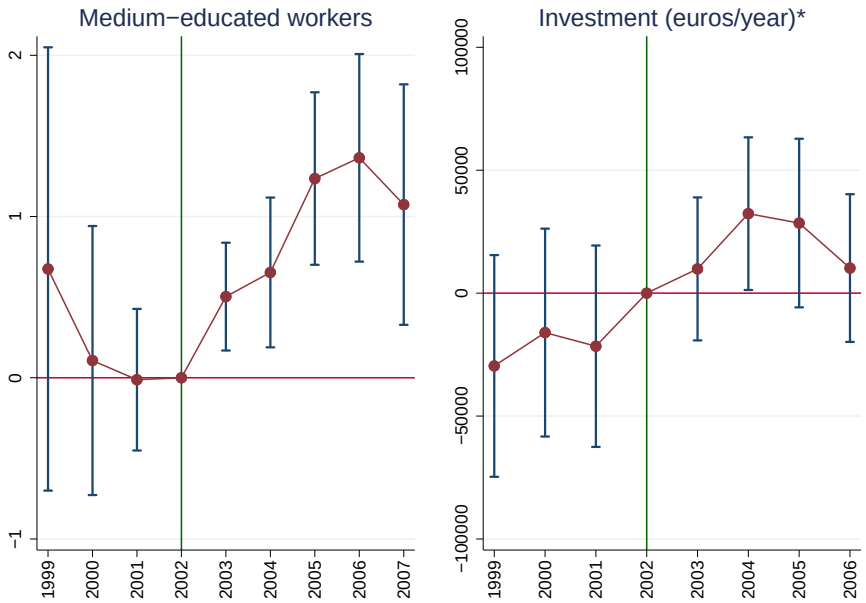
Note: Confidence intervals correspond to the 95% level.

Effects on hours and wages

The relative expansion of highly exposed establishments in terms of high-earning employment may be driven by either a relative increase in wages (*productivity channel*, which can be examined through changes in the education composition of the workforce), or by an increase in the number of hours per worker (*hours channel*, or change in the full-time vs. part-time mix). Here, I show evidence that supports both channels. Figure 7 shows that after the reform the number of full-time workers increases and the number of part-time workers decreases in highly exposed establishments with respect to non-exposed establishments. The coefficients for 2004 show that there are 0.8 fewer workers in part-time jobs in highly exposed than in non-exposed establishments, and 1.6 more full-time workers in highly exposed than in non-exposed establishments (20% and 35%, respectively, with respect to the baseline number of each type of worker). Figure B.11 in the appendix shows, on the one hand, an increase in the trend in part-time employment after the reform led by non-exposed establishments. On the other hand, highly exposed establishments seem to reduce the speed of the downward trend in full-time employment.

The left-hand panel of Figure 8 shows that the number of medium-educated workers (with *Abitur* or

Figure 8: Effect on employment by education level



Note: Confidence intervals correspond to the 95% level. (*) Using a binary variable as the regressor: 1 for above-median and 0 for below-median intensity in low-earning workers.

vocational training) increases in highly exposed establishments relative to non-exposed establishments: 0.6 more workers, 3% increase with respect to the baseline. A similar increase cannot be seen in the number of low-educated workers. As further support regarding the change in the workforce skill composition, the investment in physical capital, that is more complementary with skilled labor, increases more in highly exposed establishments than in non-exposed establishments after the reform (right-hand panel of Figure 8). The DiD coefficient for 2004 (significantly different from 0) is €32 thousand, close to the initial value of investment in physical capital in highly exposed and almost one-third of the average amount in the sample.

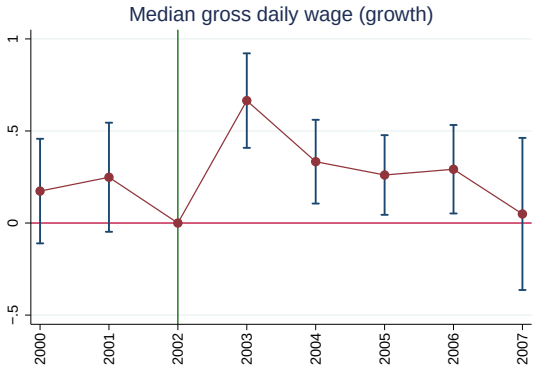
The increase in both hours worked and wages is further supported by a higher growth rate of median daily wages in highly exposed than in non-exposed establishments (Figure 9).[20]

Effects on workers' flows and promotions

The employment expansion in highly exposed establishments that increase the number of high-earning workers more than non-exposed establishments requires that highly exposed establishments

[20]The pattern holds qualitatively when splitting between part- and full-time workers, as shown in Figure B.13 in the appendix.

Figure 9: Effect on median daily wages



Note: Confidence intervals correspond to the 95% level.

either hire high-earning workers or upgrade earnings of incumbent workers. Here, I show that both phenomena seem to underly the previous results.[21]

Figure 10 suggests that, after the reform, highly exposed establishments have a higher rate of vacancy openings and hire more workers with earnings that are above the mini-job threshold than non-exposed establishments (Figure B.16 in the appendix). Separations of high-earning workers seem to be less pronounced in non-exposed establishments than in highly exposed establishments. This suggests that it is not likely that high-earning workers are flowing only from establishments where they are more abundant to those where they are scarcer, but that there is also room for employment creation (Figures B.18 and B.19).

Incumbent workers seem to be taking part in the process of change in the structure of the workforce within the establishments. From Figure 11, a smaller proportion of workers suffers reductions in gross earnings in highly exposed establishments than in non-exposed ones. Wage upgrades also seem more frequent in highly exposed than in non-exposed establishments.

Effects on task composition of the workforce

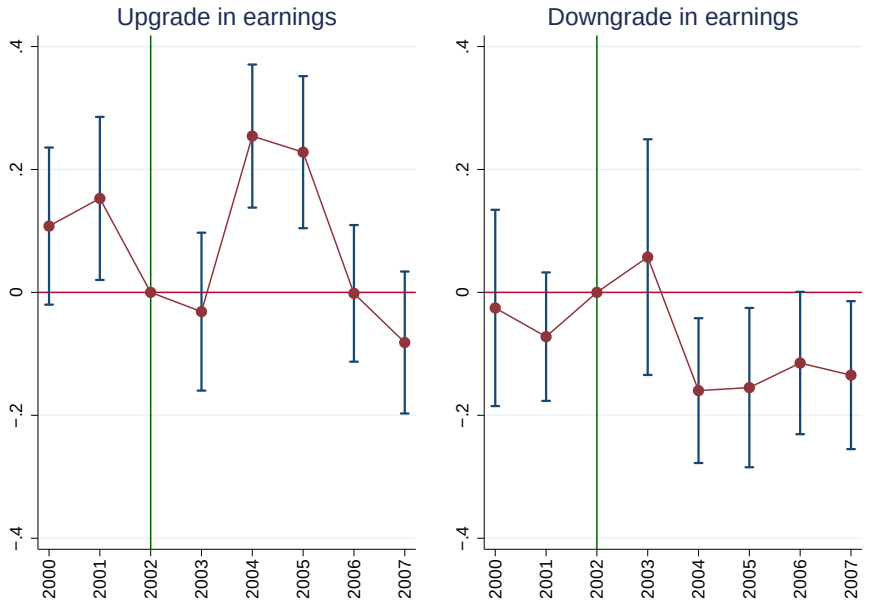
Some trends regarding the task composition of the workforce appear to change after the reform, as Figure 12 shows. It seems that highly exposed establishments are leaning towards tasks of higher complexity, as the relative increase in the proportion of workers carrying out analytical and manual

[21] The DiD estimates in this section become highly imprecise, because workers' flows are particularly small. Hence, in the text, I show those workers' flows for which coefficients are significant and for the rest of the workers' flows I add more discussion based on the descriptive evidence from the raw trends presented in appendix B.

Figure 10: Effect on hirings of workers by gross monthly earnings

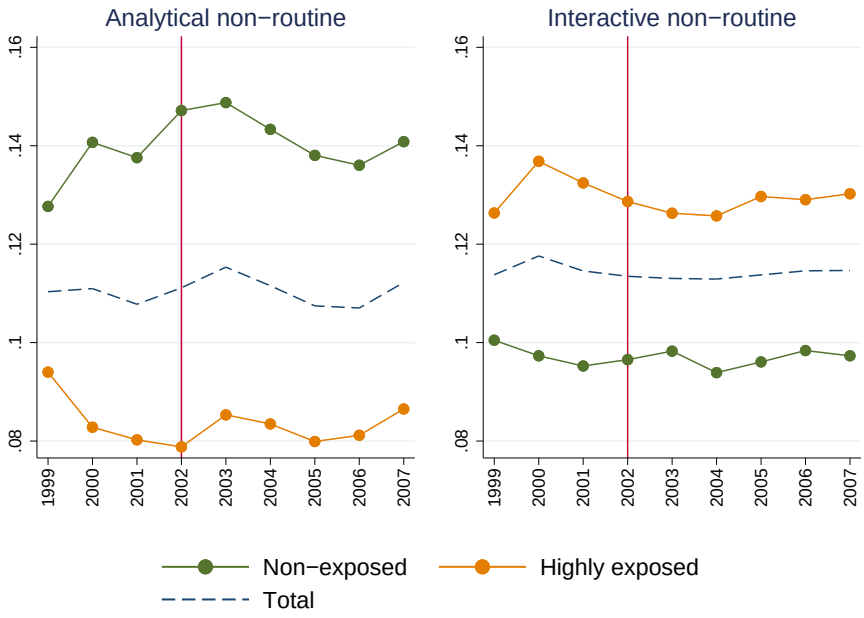
Note: Confidence intervals correspond to the 95% level.

Figure 11: Effect on wage changes for workers within establishments



Note: Confidence intervals correspond to the 95% level.

Figure 12: Evolution of occupational structure (proportion of workers in each task)



non-routine tasks suggests. The proportion of interactive non-routine and cognitive routine tasks in non-exposed establishments increases; these types of tasks can be considered as less complex. No apparent differences in the path of total job titles can be seen after the reform across establishment exposures to low-earning workers. However, the downward trend in the number of occupations within establishments for the years before the reform seems to revert in all types of firms.

4.3 Heterogeneous effects

Having established the presence of significant effects on the demand for employment due to the Mini-Job Reform, in this section I investigate whether the effects vary across industries, across establishment characteristics such as age and size, and with the presence or absence of collective agreements. For reasons of space, I restrict the analysis to some salient outcomes (total employment, part- and full-time employment, and medium-educated employment).[22] The econometric specification is a modification of equation 1, as follows:

$$y_{kt} = \alpha_k + \phi Post_t + \sum_m \beta_m Exp_k \times Post_t \times Heter_{mk} + \sum_m \gamma_m Heter_{mk} + \sum_p \lambda_p t^p Ind_k + \varepsilon_{kt} \qquad (3)$$

where $Post_t$ is a dummy that takes the value 1 after the reform and 0 otherwise, $Heter_{mk}$ is a set of dummies that take the value 1 for the establishments that belong to group m, and $\sum \lambda_p t^p * Ind_k$

[22]These results need to be taken with caution as the stratification of the sample design does not consider all of these dimensions (only industry and size).

controls for a quadratic polynomial on the industry-level (224 categories) trend. Table A.13 in the appendix shows the estimates of coefficients β_m (the baseline in each case is specified, and the coefficients on the remaining categories show the differences with respect to the baseline). I base the discussion here on the size of the point estimates. I discuss the statistical significance of the differences in each case, as estimates are highly imprecise when performing cuts from the data.

The differences across industries are not statistically significant. The point estimates, though, suggest that the relative changes in employment (in highly exposed establishments with respect to non-exposed establishments) are stronger within manufacturing than within services.

The employment effects are larger for more mature establishments and statistically different for full- and part-time employment within establishments that are more than 20 years old. Regarding establishment size, larger establishments seem to experience stronger employment effects. The differences in full-time-equivalent employment are significant for establishments with more than 200 workers. There is also a significant difference in total employment and the number of medium-educated workers for establishments with 20 to 200 workers.

The relative employment expansion of highly exposed establishments, especially in full-time employment, is significantly higher in establishments under industry- or company-level collective agreement. As collective agreements impose limits on wage reductions, this observation is further suggestive of the reform's expansionary effect on labor demand.

4.4 Robustness and validity of the empirical results

In this section, I discuss a series of checks for the robustness of the results. Regarding the definition of the variable of interest Exp_k, I change the specification in several ways: (i) I define low-earning workers as those earning below the midi-job €800 threshold, (ii) I define Exp_k as a binary variable that takes the value 1 for establishments with an exposure level that is above the median in the sample, and 0 otherwise–a useful exercise to rule out whether outliers are driving the results and to confirm the linearity of the effects, (iii) I exclude younger and older workers–those disproportionately affected by the policy–from the definition of the exposure to low-earning workers, and (iv) I use the proportion of part-time and low-educated workers at the firm and industry level. In all of these cases, the results do not change qualitatively. Furthermore, for (i)-(iii), the estimates of

the coefficients and the significance levels are virtually the same as in the benchmark estimations. In the case of (iv), the point estimates are very similar to the main estimates but the precision is much lower, as expected, since low-earning workers do not correspond exactly with the group of low-educated part-time workers. The invariance of the results to these different specifications of the variable Exp_k reinforces its interpretation as capturing a feature of the production function of firms. Estimates from these robustness checks are available upon request.

Although the longitudinal section for the period 2000-2007 is meant to avoid attrition between one wave and the following wave and I exclude establishment birth during the whole observation window in the main estimations, some establishments die during the period (7%). I verify that the analysis does not change if I use the subgroup of establishments that survived until 2007 (3,494). The invariance of the results also suggests that the effects of the reform on establishment death may have been negligible. To maximize the pre-reform period, I use the observation in 1999 when it is available for establishments in the 2000-2007 panel.[23] Even though there is no information from 1999 for one-third of these establishments, estimates for 2000 on do not change when excluding this year. These results are also omitted and available upon request.

I further estimate a variant of equation 1 that controls for specific trends. I perform several exercises, following the specification:

$$y_{kt} = \alpha_k + \lambda_t + \beta_t Exp_k + \sum_p \lambda_p t^p \times Ind_k + \varepsilon_{kt} \tag{4}$$

First, I control for quadratic trends at the industry level, where Ind_k is a set of binary variables that take the value 1 for the industry (224 categories) to which the establishment corresponds. Second, I do a similar exercise but for different levels of pre-reform exposure to low-earning workers (quintiles). A third exercise controls for an establishment-specific linear trend, by taking first differences of (4):

$$\Delta y_{kt} = \Delta\lambda_t + \Delta\beta_t Exp_k + \varepsilon_{kt} \tag{5}$$

Furthermore, I control for variables that are arguably exogenous to the effect of the reform at the establishment level, by estimating the following specification:

$$y_{ktci} = \alpha_k + \lambda_t + \beta_t Exp_k + \phi_0 Int_{i(-c)} + \phi_1 Int_{c(-i)} + \varepsilon_{ktci} \tag{6}$$

[23] The Establishment Panel provides a limited number of longitudinal sections, and there is no section that comprises the reform period and starts in 1999, the first year for which marginal employment is available in the social security records.

where $Int_{i(-c)}$ is the proportion of low-earning workers in industry i in all of the commuting zones except the zone where the establishment is located, and $Int_{c(-i)}$ is the proportion of low-earning workers in the commuting zone c in all industries except the one in which the establishment operates. This exercise aims to control for omitted trends in local labor markets and at the industry level, which can be considered related to labor supply shifts. Tables A.14 to (A.22) in the appendix show the estimates for β_t for all of these specifications, as compared to the benchmark from equation 1. The main lesson from these exercises is that the estimates remain virtually unaffected after controlling for specific trends in a variety of ways. The specification in first differences that controls for firm-specific trends yields lower point estimates and precision levels; this is reasonable because the variations are year-to-year and not with respect to the pre-reform year as in the other estimations.

Finally, I address concerns about the potential biases in the estimators, which would arise if the dependent variables were persistent (Nickell 1981). The specification with the lagged dependent variable is:

$$y_{kt} = \alpha_k + \rho y_{kt-1} + \lambda_t + \beta_t Exp_k + \varepsilon_{kt} \tag{7}$$

Due to the endogeneity introduced by the lagged dependent variable in the fixed effects estimation, I estimate this model using dynamic panel data techniques. The system of equations in levels and in differences is estimated by General Method of Moments (GMM). I instrument differenced lags and lagged levels of the dependent variable with further lags of this variable. I also use lags of other covariates (average gross wages and investment) to improve efficiency, following the approach of Blundell and Bond (1998), and I use the Arellano and Bover (1995) transformation that includes forward orthogonal deviations (the implementation follows Roodman 2009). Estimates of β_t are shown in Figures B.22 to B.24 in the appendix. The results hold qualitatively, as the point estimates generally preserve the signs reported in the main results. However, there is an important loss of precision due to the use of instruments and most estimates are not statistically significant. An important exception is the results regarding the differential evolution of part- and full-time workers, which remain statistically significant.

I further estimate the model both by using ordinary least squares (ignoring the establishment fixed effects) and by directly introducing the lagged dependent variable in the within estimation. According to Angrist and Pischke (2009), these two estimates should provide bounds for the true value of

the parameter, as the former is downward biased and the latter upward biased. Point estimates are also included in Figures B.22 to B.24 in the appendix, and they show that the conclusions hold for the estimates that are within these bounds.

4.5 Discussion of empirical analysis

The empirical findings suggest that the Mini-Job Reform has important consequences for employment, not only for workers who were targeted (low-earning) but also for workers who were outside the scope of the policy (high-earning). Actually, establishments with a higher proportion in one type of worker seem to lean towards employment of the opposite worker type after the reform. Intuitively, this would lead to a convergence, with establishments decreasing the gap in terms of their exposure and becoming more similar to each other. Some pieces of evidence seem to support this intuition.

Figure B.25 in the appendix shows the distribution of establishments by the exposure, for the panel used for estimation for 2002–before the reform–and 2007–last year in the estimation. There is more mass with medium exposure in 2007 than in 2002, and less mass with low exposure. Changes in the earnings distributions of workers across establishment pre-reform exposure to low-earning workers (shown in Figure B.26 in the appendix) also point in the direction of production units becoming more similar in their payroll; establishments with low exposure respond more strongly in terms of bunching at the threshold than highly exposed establishments.

Figure B.27 shows the evolution of the composition of establishments, by industry, according to whether they are highly exposed or non-exposed to low-earning workers. This is restricted to the 2000-2007 panel of establishments. After the reform, the proportion of highly exposed establishments decreases in industries in which they were initially abundant, such as services and retail commerce. At the same time, some originally high-paid activities, such as agriculture or other primary production, experience an increase in the proportion of highly exposed establishments. This does not hold when looking at the whole universe of establishments (in cross-sections of the linked employer-employee data), as shown in Figure B.28. Most industry branches seem to be either keeping or increasing their proportion of highly exposed establishments. This is the case if the lower labor costs in certain industries due to the reform not only induce incumbents to expand but also

encourage entry of new establishments with similar characteristics. Furthermore, the total number of establishments increases in industries with initially abundant highly exposed establishments relative to industries with fewer highly exposed establishments, as shown in Figure B.29 where the evolution of the proportion of establishments by industries is depicted. Establishments in services and retail commerce represent 60.5% of the total number of establishments in 2002, and 62.8% in 2007, whereas the share of production units in manufacturing and construction shrinks from 22.7% in 2002 to 21.6% in 2007.

Complementing the evidence about convergence at the industry level, the proportion of low-earning workers increases more in local labor markets with an initially low presence of these workers. The maps in Figures B.30 and B.31 in the appendix show that whereas the German northwest has a higher presence of low-earning workers in 2002, the increase is stronger in the northeast. Table A.23 in the appendix confirms this result as it shows that the correlation between the initial proportion of low-earning workers and its variation at the local labor market level is negative (-0.33 for 2002-2004, and -0.71 for 2002-2007).

These signs of convergence across establishment types (highly exposed and non-exposed) is consistent with, and supports, the results from both the theoretical and empirical analyses. Furthermore, the apparent increased entry of highly exposed establishments that is encouraged by the expansion of in-work benefits raises questions about the allocation efficiency of such a policy, a point that is discussed in the next section.

5 Implications

The empirical strategy is not sufficient for the evaluation of the total employment effects for firms with different exposures, as it analyzes only how employment of highly exposed establishments changes in relation to non-exposed ones. To discuss the implications of the results in terms of employment levels and to extend the analysis to other macroeconomic variables, such as output, I present a simple model that extends the framework used in the discussion about the employment effects in section 4.2. The goal of the model is not to provide a quantitative evaluation of the Mini-Job Reform, but to act as a *proof-of-concept* of the potential implications for aggregate employment and output. Apart from firm's decisions, I introduce the labor supply decision, following the literature

on labor supply and taxation (see, e.g., Saez 2010, Chetty, Friedman, Olsen, and Pistaferri 2011, Tazhitdinova 2020). I further model the product market and government budget. I compute the general equilibrium of the model and discuss the role of the degree of substitution between different workers. Here, I present a sketch of the model, and the derivations are in the appendix, section E.

5.1 Framework

Labor supply: There is a continuum of workers, who are heterogeneous in a parameter α that reflects the taste for work. α is distributed with a cumulative distribution function $F(\alpha)$ and a density function $f(\alpha)$. Workers choose whether to participate in the labor market, and they also choose the number of hours worked as a function of the take-home wage and their taste for work. Their labor supply decision determines their sorting in two jobs, indexed by $j \in \{1,2\}$. Jobs differ in the before-tax hourly wage w_1 and w_2, and in the tax rate on gross earnings, $\tau_1 < \tau_2$.[24]

The worker's utility maximization problem is:

$$\max_{c,n} U(c,n) = c - \alpha^{-\frac{1}{\varepsilon}} \frac{n^{1+\frac{1}{\varepsilon}}}{1+\frac{1}{\varepsilon}} - \beta I\{n>0\} \tag{8}$$

s.t.

$$c = \begin{cases} b + tr & \text{if } n = 0 \\ (1-\tau_2)w_2 n = \hat{w}_2 n + tr & \text{if } n > 0 \\ (1-\tau_1)w_1 n = \hat{w}_1 n + tr & \text{if } n > 0 \text{ and } w_1 n \leq K, \end{cases} \tag{9}$$

where c is consumption, n is the number of hours of work in efficiency units, β is a fixed cost of working, b is the income in the case of non-employment (unemployment benefit or social assistance), and tr is a lump-sum transfer from the government. I denote the take-home hourly wage as $\hat{w}_j \equiv w_j(1-\tau_j)$. The utility function is quasi-linear and, hence, implies no income effects, and ε is the constant elasticity of labor supply with respect to the wage. This specification is standard in the literature of labor supply and taxation. I extend the model to include the participation decision (see, e.g., Blundell, Bozio, and Laroque 2011 as their approach is relevant for the discussion of in-work benefits).

[24] The tax rates are defined as $\tau_j \equiv \frac{(\tau_j^w + \tau_j^e)}{(1+\tau_j^e)}$, where τ_j^w and τ_j^e are the worker- and employer-paid tax rates, respectively, in type-j job. There is a direct relation between τ_j and τ_w. The purpose of this simplification is to define the take-home (or net) wage of the worker as a linear function of the tax rate and the before-tax wage (labor cost per hour). In this section, I use the terms *before-tax* and *gross* interchangeably for simplification, as they move one-to-one with the labor costs for the employer, for whom taxes barely change with the reform.

As pointed out by Tazhitdinova (2020), the interesting case for the Mini-Job Reform setting is such that $(1-\tau_1)w_1 = \hat{w}_1 > \hat{w}_2 = (1-\tau_2)w_2$. Otherwise, all workers would take up type-2 jobs, which are not subject to the means test on earnings K. There exist α_0^*, α_1^* and α_2^*, such that the individual labor supply is:

$$n = \begin{cases} 0 & \text{if } \alpha \leq \alpha_0^* \\ \alpha \hat{w}_1^{\varepsilon} & \text{if } \alpha_0^* < \alpha \leq \alpha_1^* \\ \hat{K}/\hat{w}_1 & \text{if } \alpha_1^* < \alpha < \alpha_2^* \\ \alpha \hat{w}_2^{\varepsilon} & \text{if } \alpha \geq \alpha_2^* \end{cases} \tag{10}$$

where $\hat{K} = (1-\tau_1)K$. The region between α_1^* and α_2^* corresponds to the bunching in the earnings distribution at the cutoff K of gross earnings. The aggregate labor supply is:

$$\begin{gathered} N_1^S = \int_{\alpha_0^*}^{\alpha_1^*} \alpha \hat{w}_1^{\varepsilon} f(a)da + \int_{\alpha_1^*}^{\alpha_2^*} \frac{\hat{K}}{\hat{w}_1} f(a)da \\ N_2^S = \int_{\alpha_2^*}^{\infty} \alpha \hat{w}_2^{\varepsilon} f(a)da \end{gathered} \tag{11}$$

Formulated this way, the earnings test implies that individuals in type-1 jobs can be understood as being unskilled (low-wage) and part-time (low number of hours), whereas individuals in type-2 jobs can be understood as being highly educated or full-time workers whose earnings surpass the threshold for being eligible for tax benefits. This is in line with the distinction between the workers that are highlighted in the descriptive evidence provided earlier.

When there is an expansion in tax benefits for low-earning workers, given the wages, aggregate supply in type-1 jobs increases, while aggregate supply in type-2 jobs decreases. As a result, N_1^S/N_2^S increases.

Labor demand, product market and government budget: Both the output and the labor market are competitive. There are two firms, indexed by $k \in \{H, L\}$, and they produce two differentiated goods, Y_H and Y_L. H stands for highly exposed to low-earning workers, and L for non-exposed to low-earning workers. The prices in the output market are p_H and p_L, respectively, with $p_L = 1$ as a normalization. The firms' production function is defined as in section 4.2, and I add some firm-level heterogeneity. Output is heterogeneous, Y_k, and total factor productivity is potentially heterogeneous as well, A_k. Importantly, firms differ in the distribution parameter of factor returns, such that $\theta_H > \theta_L$. This means that firm H has a comparative advantage in low-earning workers, while firm L in high-earning workers; this difference in productivity across firms exists despite the

fact that high-earning workers are more productive.[25] The production function that includes these heterogeneities across firms is: $Y_k = F_k(N_{1k}, N_{2k}) = A[\theta_k N_{1k}^{\frac{\sigma-1}{\sigma}} + (1-\theta_k) N_{2k}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}$. From the first-order condition of firms, the ratio of low-earning to high-earning jobs is higher in firm H than in firm L, $N_{1H}/N_{2H} > N_{1L}/N_{2L}$.

Aggregate labor demand is $N_1^D = N_{1H} + N_{1L}$ and $N_2^D = N_{2H} + N_{2L}$. Aggregate output is $Y = Y_H + Y_L$. Aggregate income in the economy, *Inc*, equals consumption. The goods are imperfect substitutes at the aggregate level and each good has an aggregate downward-sloping demand. The government collects revenues from payroll taxes, T, and uses them to finance the benefits that go to non-employed workers, while distributing the remainder in lump-sum transfers.

Equilibrium: The competitive equilibrium of this economy is defined as the set of prices, w_1, w_2 and p_H, such that the labor market for each job type clears, the output market clears, workers and firms optimize, and profits are zero.

5.2 Simulation exercises

The model is solved and parameterized as explained in the appendix, section E.7. I simulate the reform by changing the earnings limit K for workers who receive the lower tax rate τ_1. Table 4 shows that this framework is able to qualitatively generate the results obtained in the DiD analysis when the elasticity of substitution σ is set to 2.5. High-earning and total employment increase more in highly exposed than in non-exposed firms, and low-earning employment decreases in highly exposed relative to non-exposed firms.

Importantly, using the model to simulate the reform allows us to separately identify the changes in employment by type (bottom panel of Table 4), which was not feasible using the DiD strategy. According to the model, total employment in firm H–highly exposed–increases by 9%, with a 46% increase in hours in low-earning jobs, and 5% in hours in high-earning jobs. Total employment in firm L–non-exposed–shrinks by 1%, through a reduction in the number of hours worked in high-earning jobs (-2%), which more than compensates for the increase in the number of hours worked in low-earning jobs (36%) as the latter are less numerous to begin with.

[25] The assumption that different types of jobs, such as part-time vs. full-time, or skilled vs. unskilled, have different productivity levels is standard in the literature (see e.g., Kunn-Nelen, de Grip, and Fourage 2013).

Table 4: Simulation of the Mini-Job Reform in the model vs. DiD estimates

	Model	Data
In terms of baseline averages (2002)		
$DiD_{\text{low-earning employment}}$	-2.8%	-18.5%
$DiD_{\text{high-earning employment}}$	4.3%	12.4%
$DiD_{\text{total employment}}$	4.1%	7.0%
Changes in % of pre-reform levels		
Low-earning in highly exposed firm	46.2%	
Low-earning in non-exposed firm	36.3%	
High-earning in highly exposed firm	5.4%	
High-earning in non-exposed firm	-1.7%	
Total employment in highly exposed firm	8.9%	
Total employment in non-exposed firm	-1.1%	

Note: Mini-Job Reform simulated by setting: $K = 400$, $\tau_1 = 20\%$, $\tau_2 = 35\%$. The DiD estimates in the top panel are the values of the coefficient estimates of regression (1) that correspond to 2004 as a proportion of the pre-reform average across firms, both in the model and the data. I use the estimates that correspond to the number of part- and full-time workers in low- and high-earning employment, respectively, and for full-time equivalent employment for total employment. The bottom panel shows the changes simulated by the model in terms of the pre-reform employment of each firm.

It is worth noting that the key parameters for these results are σ and κ, given that they drive the scale and substitution effects. In this exercise $\sigma = 2.5$ and $\kappa = 10$. Table A.26 in the appendix shows that if the elasticity of substitution is much higher (20 times more), representing a case where the substitution effect is very strong, the model generates counterfactual predictions as the signs of the changes in employment by type, of firm F with respect to firm L, contradict the DiD analysis. Importantly, in this case firm L expands in terms of employment, whereas H contracts its workforce. This point is important, since understanding what is entailed in the elasticity of substitution between different employment types and its role in influencing the outcomes when there are policy changes has generated a substantial amount of interest in labor economics (Hamermesh and Grant 1979, Hamermesh 1982).

Table 5 shows further insights from the theoretical framework. In the first column, I show the benchmark for which the model is computed: the pre-reform period during which tax benefits already exist. The second column contains the values of the simulation of the Mini-Job Reform; i.e., the expansion of tax benefits. The third column shows the counterfactual results in the absence of in-work benefits. In the latter, I still denote N_1 employment delimited by monthly gross earnings of €325, as before the reform, although all of the workers pay the same SSC rate as the regular workers do. The other two columns show the variation in the two simulations with respect to the benchmark.

Table 5: Simulation of the model

	Pre-Reform (benchmark)	Mini-Job Reform (MJR)	No-Policy (counterfactual)	Variation MJR vs. Benchmark	Variation Benchmark vs. Counterfactual
w_1	24.5	21.5	30.5	-12%	-24%
w_2	24.8	24.8	24.8	0%	0%
w_1/w_2	1.0	0.9	1.2	-12%	-24%
$\hat{w}_1$	20.1	17.2	19.8	-14%	1%
$\hat{w}_2$	16.1	16.1	16.1	0%	0%
Employment rate	94.6%	93.3%	94.5%	-1.2pp.	0.1pp.
Workers in mini-jobs (%)	14.9%	16.9%	10.1%	14%	-32%
N_1	1.6	2.3	0.9	40%	43%
N_2	63.6	63.0	64.4	-1%	-1%
$N_1/(N_1+N_2)$	2.5%	3.5%	1.4%	40%	-43%
N_1+N_2	65.2	65.3	65.3	0.1%	0%
N_{1H}	0.7	1.0	0.4	46%	46%
N_{2H}	7.4	7.8	6.8	5%	8%
N_{1L}	0.9	1.3	0.6	36%	40%
N_{2L}	54.7	53.7	56.3	-2%	-3%
N_1/N_2 in H	0.092	0.127	0.054	39%	42%
N_1/N_2 in L	0.017	0.023	0.010	39%	42%
T	558	557	568	-0.1%	-2%
Inc	1,614	1,614	1,623	0%	-1%
Y	1,570	1,567	1,581	-0.1%	-1%
p_H	1.25	1.24	1.27	-1%	-2%
Y_H/Y	10.2%	11.1%	8.9%	9%	13%
Y_L/Y	89.8%	88.9%	91.1%	-1%	-1%

Note: No-Policy: $K = 325$, $\tau_1 = \tau_2 = 35\%$. Pre-reform: $K = 325$, $\tau_1 = 18\%$, $\tau_2 = 35\%$. Mini-Job Reform: $K = 400$, $\tau_1 = 20\%$, $\tau_2 = 35\%$. The comparison is inverted in the last column in order to be comparable to the effects of the previous column.

The simulations corresponding to the Mini-Job Reform and the scenario without policy are particularly interesting, as they illustrate the changes in employment (and output) across different firms for different levels of in-work benefits. Whereas the comparison of the benchmark to the simulated reform shows the effects of expanding in-work benefits, the contrast between the benchmark and the no-policy scenario is illustrative of the introduction of in-work benefits.

Let us focus on the consequences of the Mini-Job Reform as compared to the pre-reform scenario (columns 1 and 2, and 4). This comparison is of particular interest because it allows us to understand the potential general equilibrium effects of the policy, as it was not possible to disentangle them in the empirical analysis. The model predicts that the before-tax wages of low-earning workers drop by 12%, whereas the before-tax wage of high-earning workers remains constant. The drop in w_1 embeds the shift in tax benefit from the workers to the employers and is driven by a stronger increase in the supply of low-earning workers than in the demand for these workers. In equilibrium, both the total number of hours of work and of workers in low-earning jobs increase. The constant w_2 is accompanied by a decrease in the total number of workers in these jobs, particularly due to the receding labor supply. Workers previously in type-2 jobs switch to type-1 jobs due to the redefinition

of the earnings test, K.

An important prediction of the model is that, as a consequence of the labor expansion in firm H and the contraction in L, the configuration of total output shifts towards firm H. This is not trivial, as firms have different productivity levels for different workers, and firm H has a lower total factor productivity in the model. Overall, the model predicts that the total number of hours worked should increase, due to a big expansion in the number of hours worked in low-earning jobs, which more than compensates for a small decline in high-earning jobs; however, total output should decline due to the shift in production from the firm L–more productive–to the firm H–less productive.

Shifting attention to the no-policy scenario (columns 3 and 5) adds an interesting insight with respect to the employment effect of the reform. Even though the before-tax wage for low-earning workers falls as a consequence of the introduction of in-work benefits, the net wage remains above the no-policy level. There is a positive effect on the employment rate as a consequence of the introduction of in-work benefits. However, there is still a negative effect on output due to the reallocation towards the least-productive firm.

To sum up, these exercises provide valuable insights with respect to the labor demand responses when in-work benefits are introduced and expanded. In particular, they show how production and employment reallocate across firms as a consequence of the policy. The wages are depressed for the low-earning segment, without changes occurring for the high-earning workers.

6 Conclusions

This paper analyzes firm responses to an expansion of in-work benefits in the form of lower taxes for low-earning workers. Unlike the existing literature, which focuses mainly on *labor supply* responses to such interventions, I provide an analysis of the *labor demand* responses. The paper shows that in-work benefits not only affect the employment of targeted low-earning workers but also generate *spillovers* on the employment of high-earning workers who are not directly targeted by the policy. The empirical analysis focuses on the German Mini-Job Reform of 2003, which is known to have had a dramatic impact on the German labor market. After the reform, about 20% of all private-sector salaried workers hold so-called marginal jobs that qualify for the tax benefits.

The existing literature documents that employers share part of the tax benefits provided to workers, which results in a change in labor costs when in-work benefits are expanded. In this paper, I show that firm responses are affected by both the implied decrease in total labor costs (and thus a *scale effect*) and the change in the relative costs of tax-advantaged versus non-tax-advantaged workers (and, thus, a *substitution effect*).

I provide empirical evidence of firm responses to the Mini-Job Reform using a panel of establishments matched to administrative data of workers. The identification strategy relies on a differences-in-differences approach that exploits the expansion of in-work benefits with the Mini-Job Reform and the pre-reform exposure to low-earning workers across establishments. I document that, on the one hand, highly exposed establishments expand relative to non-exposed establishments. Importantly, this relative expansion of initially highly exposed establishments is concentrated in high-earning, non-tax-advantaged workers. On the other hand, initially non-exposed establishments seem to substitute employment towards low-earning workers without expanding total employment at the same pace. These changes in firms' workforces are the result of changes within firms in the relative importance of part- and full-time employment, in the skill level of the workforce, and in the type of tasks workers perform.

I discuss the employment results in a very simple theoretical framework that relates the strength of the scale and the substitution effects of a particular firm to its pre-reform exposure to low-earning workers. The theoretical analysis suggests that the scale effect is stronger in firms that are highly exposed to low-earning workers, whereas the substitution effect dominates in firms with a relatively low exposure to low-earning workers.

While the relative responses of initially highly exposed and initially non-exposed firms provide evidence on the presence of both scale and substitution effects, the differences-in-differences approach does not allow us to analyze employment levels and output across firm types. To provide some sense of the implications of the empirical findings in these dimensions, I extend the simple theoretical framework, which focuses on labor demand, to a general equilibrium model by adding the labor supply-side and introducing two types of firms. Simulations of the Mini-Job Reform suggest that the equilibrium wages of low-earning workers decline, whereas the wages of high-earning workers remain constant. In this framework, the differential responses in terms of employment across firms

that are observed in the data are driven by an increase in employment in the low-earning segment across all firms, and by a reallocation of high-earning workers from firms in which they are more abundant to firms in which they are more scarce. There is also reallocation of production from non-exposed (to low-earning workers) firms to highly exposed firms. Since the data seem to suggest that highly exposed firms are less productive, this reallocation has a cost in terms of lower total output.

The effects documented in this paper are inherently important for the design of in-work benefits and, more broadly, for any type of labor market intervention or modification that targets workers that are imperfect substitutes to the rest of the workforce. This includes the recent increase in alternative work arrangements, including the gig economy. My findings suggest that labor supply incentives that target low-earning workers can have non-trivial labor demand effects and can create spillovers to employment that is not targeted by the policy. Finally, the results help to shed light on the ongoing debate regarding the pervasive effects of the German Mini-Job Reform, which is often cited as a major cause of the observed increase in precarious employment in Germany, and which is considered a potential role model by several other countries that are seeking to implement labor market reforms.

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Appendix

A Additional Tables

Table A.1: Social security average tax rates and monthly gross earnings limits in euros in Germany in 1999-2007

	Earnings	Worker rate	Employer rate	Income tax
	Regular Jobs			
1999-30 Mar 2003	€326+	21%	21%	YES
1 Apr 2003-30 Jun 2006	€801+	21%	21%	YES
1 Jul 2006-31 Dec 2007	€801+	19.5%	19.5%	YES
	Mini-Jobs			
1999-30 Mar 2003	€0-€325	0%	22%	NO
1 Apr 2003-30 Jun 2006	€0-€400	0%	25%	NO
1 Jul 2006-31 Dec 2007	€0-€400	0%	30%	NO
	Midi-Jobs			
1999-30 Mar 2003	-			
1 Apr 2003-30 Jun 2006	€401-€800	4.1%-21%	21%	YES
1 Jul 2006-31 Dec 2007	€401-€800	4.1%-19.5%	19.5%	YES

Note: SSC rates are in terms of gross earnings, income tax rates (from which mini-jobs are exempt) are not included.

Table A.2: Hours worked and hourly wages in Germany in 2005

Type of job	Hours a week	Hourly (net) wage
Regular part-time	13	19
	(5.68)	(21.20)
Regular full-time	41	9
	(9.50)	(4.16)
Mini-job (main job)	14	10
	(12.00)	(25.59)
Mini-job (secondary job)	40	9
	(13.97)	(6.59)
Midi-job (main job)	26	8
	(13.86)	(16.41)
Midi-job (secondary job)	36	15
	(16.96)	(12.38)
Total	34	10
	(15.21)	(11.94)

Note: Data from G-SOEP. Standard errors are in parenthesis. Hours worked and hourly net earnings for valid responses. Workers 17-65 years old.

Table A.3: Transitions between labor market states in Germany between 2002 and 2004

Row totals	Inactive	Unemployed	Mini-job	Midi-job	Regular PT	Regular FT	Total
Inactive	20%	21%	23%	2%	6%	27%	100%
Unemployed	1%	64%	7%	2%	5%	21%	100%
Mini-job	6%	4%	79%	2%	4%	5%	100%
Regular PT	1%	9%	4%	6%	72%	8%	100%
Regular FT	0%	9%	1%	1%	3%	86%	100%
Total	4%	16%	12%	2%	12%	54%	100%
Column totals	Inactive	Unemployed	Mini-job	Midi-job	Regular PT	Regular FT	Total
Inactive	81%	23%	34%	21%	9%	9%	17%
Unemployed	3%	40%	6%	9%	4%	4%	10%
Mini-job	11%	2%	52%	9%	3%	1%	8%
Regular PT	2%	6%	4%	36%	70%	2%	11%
Regular FT	3%	29%	5%	25%	14%	85%	54%
Total	100%	100%	100%	100%	100%	100%	100%

Note: SIAB, annual, main job or spell. If there is no observation in a certain year, the individual is considered to be inactive that year.

Table A.4: Proportion of workers with a secondary job before and after Mini-job Reform

	Total	Men	Women	Young (<30)	Prime-age	Old (>55)	Low-educated	Medium-educated	Highly educated
Before (2002)	3.4%	3.0%	3.8%	3.8%	3.3%	3.0%	4.2%	3.4%	2.4%
After (2004)	5.0%	4.3%	5.7%	5.1%	5.1%	4.1%	5.6%	5.0%	3.6%
Var (pp.)	1.6	1.3	1.8	1.3	1.8	1.1	1.4	1.7	1.2
Var (%)	45.5%	42.0%	48.0%	33.1%	53.7%	37.2%	33.3%	49.7%	49.6%

Note: SIAB, spell data.

Table A.5: Mini-jobbers close to the earnings threshold to receive tax benefits in 2004

Status/Earnings in 2002	**Total mini-jobs earning 325-400 in 2004**	**Mini-jobs earning 325-400 in 2004, employed in 2002**	
		Do not change job	**Change job**
out of total employed		73.5%	26.5%
Inactive	30.7%		
Unemployed	5.2%		
(0, 325]	45.6%	76.3%	56.6%
(325, 400]	5.0%	8.3%	6.6%
(400, 800]	5.6%	7.8%	11.5%
more than 800	7.9%	7.7%	25.4%

Note: SIAB, annual data, main job or spell.

Table A.6: Mini-jobbers who were employed in 2002 and close to the earnings threshold to receive tax benefits in 2004

Mini-jobs earning 325-400 in 2004 (changes with respect to 2002)	Full-time to Part-time	Different occupation
Total	11.3%	23.1%
Of those who do not change establishment	7.6%	7.6%
Of those who change establishment	21.8%	62.9%

Note: SIAB, annual data, main job.

Table A.7: Proportion of workers by education level and part-time/full-time status in 2002

Tasks	Low-educated		Medium-educated		Highly educated		Total
	Part-time	Full-time	Part-time	Full-time	Part-time	Full-time	(% workers)
Primary activities and construction							
Analytical non-routine			5.3%	52.9%	1.7%	37.9%	7.6%
Interactive non-routine			29.2%	57.8%			1.1%
Cognitive routine	2.0%	2.7%	16.9%	72.3%	0.8%	5.3%	23.3%
Manual routine	2.9%	12.4%	6.0%	77.3%			9.9%
Manual non-routine	2.0%	8.9%	4.7%	83.8%			58.1%
Manufacturing							
Analytical non-routine	0.5%	2.3%	3.8%	52.5%	1.5%	39.3%	15.5%
Interactive non-routine	5.3%	3.0%	26.8%	57.2%	0.4%	7.2%	4.9%
Cognitive routine	1.2%	5.1%	9.6%	73.0%	0.7%	10.4%	35.0%
Manual routine	2.8%	21.6%	4.6%	70.3%	0.1%	0.5%	33.0%
Manual non-routine	11.6%	15.3%	12.3%	59.9%	0.2%	0.6%	11.6%
Services							
Analytical non-routine	1.4%	2.3%	12.2%	48.2%	7.3%	28.6%	18.6%
Interactive non-routine	7.2%	2.6%	34.9%	42.3%	3.0%	10.0%	14.3%
Cognitive routine	3.0%	2.6%	24.4%	60.8%	1.6%	7.6%	31.3%
Manual routine	10.0%	13.4%	15.9%	59.7%	0.2%	0.8%	3.5%
Manual non-routine	14.8%	8.9%	26.8%	47.2%	0.9%	1.4%	32.3%

Note: SIAB, annual data, main job. Low-educated corresponds to individuals without *Abitur* (upper secondary certificate), medium-educated corresponds to individuals with *Abitur* or apprentices and highly educated corresponds to individuals with a higher-education degree.

Table A.8: Dispersion (inter-quartile range) in low-earning labor/high-earning labor and cost ratios within industries in 2002

	Median	P25	P75	Min	Max
Low-earning / high-earning workers	0.250	0.040	0.60	0.000	9.667
... (in full-time equivalent)	0.077	0.002	0.211	0.000	4.000
Factor cost ratio (in FTE)	0.030	0.004	0.110	0.000	8.959

Note: LIAB, cross-section of establishments. Industries are classified in 224 categories.

Table A.9: Characteristics of establishments, weighted/unweighted, in 2002

	Cross-section		Panel (2000-2007)	
	Unweighed	Weighted	Unweighed	Weighted
Establishment age (years)	15.0	12.9	14.4	14.0
Establishment size (n. of workers)	164.4	15.6	161.6	18.5
Proportion of workers below 2003 mini-job threshold	15.5%	27.8%	16.0%	29.2%
Proportion of workers below 2003 midi-job threshold	21.4%	37.7%	21.4%	37.6%
Proportion of marginal part-time workers	9.9%	18.6%	10.5%	20.4%
Proportion of part-time workers	23.2%	31.2%	23.0%	32.1%
Proportion of temporary workers	5.7%	3.0%	5.3%	3.1%
Proportion of low-educated workers	13.8%	13.0%	12.6%	11.5%
Proportion of medium-educated workers	62.7%	58.6%	65.9%	58.0%
Proportion of highly educated workers	7.5%	3.7%	7.5%	4.3%
Proportion of female workers	46.2%	55.1%	46.4%	56.7%
Proportion of working proprietors	8.4%	20.4%	9.5%	19.8%
Proportion of trainees/apprentices	5.1%	4.6%	5.0%	4.7%
Median daily gross wage (euros)	61.2	44.3	58.3	45.0
Median daily wage full-time (euros)	72.6	59.7	68.9	61.5
Median daily wage part-time (euros)	32.8	20.0	32.8	19.6
Median daily wage low-earning (euros)	9.2	9.1	8.9	9.2
Median daily wage high-earning (euros)	68.0	56.8	65.1	58.8
Monthly per capita labor cost (euros)	1,865.2	1,353.1	1,748.3	1,396.3
Total monthly labor cost (euros)	479,785	33,551	478,390	43,405
Investment (million euros)	2.146	0.116	1.877	0.118
Sales (million euros)	37.483	2.493	29.975	2.967
Exports as a proportion of revenues	10.9%	4.2%	10.5%	4.1%
Hirings/employment (workers)	0.19	0.21	0.17	0.19
Separations/employment (workers)	0.60	0.32	0.25	0.26
Proportion of establishments with a work council	40.4%	10.2%	38.7%	9.9%
Proportion of establishments with a collective agreement	57.8%	43.5%	57.3%	44.6%
Agriculture, primary	4.3%	3.7%	4.4%	4.0%
Manufacturing	26.1%	11.9%	28.6%	12.9%
Construction	8.9%	10.8%	9.7%	10.5%
Retail, repair	13.0%	22.1%	12.5%	21.5%
Transport, communication	3.6%	5.1%	3.1%	4.8%
Financial intermediation	3.0%	2.3%	2.6%	2.3%
Services for businesses	11.4%	15.3%	8.3%	15.7%
Other services	19.4%	23.5%	18.3%	23.2%
Public administration	10.4%	5.3%	12.5%	5.0%
Proportion of workers in analytical non-routine tasks	14.8%	10.6%	13.5%	11.1%
Proportion of workers in interactive non-routine tasks	8.9%	12.0%	8.7%	11.3%
Proportion of workers in cognitive routine tasks	31.5%	34.6%	31.4%	35.9%
Proportion of workers in manual routine tasks	12.8%	8.2%	14.5%	8.7%
Proportion of workers in manual non-routine tasks	28.5%	31.5%	28.2%	30.1%
Proportion of new establishments (Estab. Panel)	1.5%	3.4%		
Proportion of dying establishments	3.1%	5.4%		
Observations	14,591		3,770	

Table A.10: Characteristics of establishments by proportion of low-earning workers (below/above median) in 2002

	Below median	Above median
Proportion of workers below 2003 mini-job threshold	4.6%	53.8%
Proportion of workers below 2003 midi-job threshold	14.5%	60.7%
Establishment age (years)	15.6	12.9
Establishment size (n. of workers)	28.4	8.5
Employment, full-time equivalent (FTE)	25.2	5.8
Proportion of part-time workers	16.5%	47.7%
Proportion of low-educated workers	10.8%	12.2%
Proportion of medium-educated workers	64.6%	51.4%
Proportion of highly educated workers	6.2%	2.4%
Vacancies/employment (workers)	2.5%	1.1%
Median daily gross wage (euros)	61.4	28.5
Median daily gross wage (growth rate)	12.2%	10.0%
Median daily gross wage of full-time (euros)	68.6	53.3
Median daily gross wage of full-time (growth rate)	2.9%	3.7%
Median daily gross wage of part-time (euros)	32.7	11.8
Median daily gross wage part-time (growth rate)	18.5%	9.3%
Median daily gross wage of low-earning workers (euros)	9.3	9.1
Median daily gross wage of low-earning workers (growth rate)	9.5%	7.1%
Median daily gross wage of high-earning workers (euros)	62.9	53.9
Median daily gross wage of high-earning workers (growth rate)	2.0%	4.6%
Average monthly labor cost (euros)	1,720	1,071
Monthly wage bill (euros)	75,929	10,725
Inequality (P75/P25) of full-time workers	1.41	1.93
Hirings/employment (workers)	0.16	0.22
Separations/employment (workers)	0.25	0.27
Investment (million euros)	0.200	0.036
Sales (million euros)	5.328	0.667
Exports as a proportion of revenues	5.2%	3.0%
Proportion of establishments with a work council	16.5%	3.4%
Proportion of establishments with a collective agreement	49.6%	39.5%
Agriculture, primary	5.5%	2.5%
Manufacturing	15.5%	10.3%
Construction	15.4%	5.5%
Retail, repair	18.7%	24.4%
Transport, communication	5.6%	4.0%
Financial intermediation	3.0%	1.7%
Services for businesses	11.7%	19.7%
Other services	19.3%	27.1%
Observations	2,746	1,024

Note: Panel 2000-2007. Establishments classified according to whether they are below or above the (weighted) median of the proportion of low-earning workers (20%).

Table A.11: Coefficient estimates from the DiD analysis, all outcomes

	1999-2002			*2002-2004*	*2002-2007*
	$\hat{\beta}_{1999}$	$\hat{\beta}_{2000}$	$\hat{\beta}_{2001}$	$\hat{\beta}_{Post}$	
Total employment	-0.063	-0.289	-0.344	0.463	0.873*
	(0.8148)	(0.5562)	(0.3313)	(0.2577)	(0.3632)
Total full-time equivalent employment	0.651	0.136	-0.134	0.763***	1.370***
	(0.7153)	(0.4749)	(0.2692)	(0.2238)	(0.2912)
Low-earning workers (growth)		-0.127	-0.488	-0.447*	-0.413**
		(0.3555)	(0.3351)	(0.2149)	(0.1558)
Higher-earning workers (growth)		0.170	0.067	0.300	0.103
		(0.1694)	(0.1449)	(0.1596)	(0.1093)
Part-time workers	-0.178	0.105	-0.069	-0.723***	-0.852***
	(0.3878)	(0.2911)	(0.1825)	(0.1608)	(0.1961)
Full-time workers	0.586	-0.030	-0.118	1.182***	1.873***
	(0.5732)	(0.3638)	(0.2463)	(0.2069)	(0.2711)
Proportion of low-educated workers	-0.014	-0.014	-0.004	-0.038*	-0.042*
	(0.0312)	(0.0164)	(0.0154)	(0.0187)	(0.0204)
Number of medium-educated workers	0.794	0.236	0.052	0.578**	0.963***
	(0.6540)	(0.4179)	(0.2219)	(0.1865)	(0.2453)
Median gross daily wage (growth)		0.175	0.235	0.497***	0.324***
		(0.1756)	(0.1588)	(0.1144)	(0.1084)
Median gross daily wage full-time (growth)		0.057	0.002	0.134	0.093
		(0.1056)	(0.0570)	(0.0730)	(0.0482)
Median gross daily wage of part-time (growth)		0.103	-0.151	0.451***	0.054
		(0.1408)	(0.0982)	(0.1279)	(0.2144)
Total investment (euros)	-61,213	-45,864	-61,997	9,235	6,408
	(40870.5)	(34493.8)	(43756.7)	(32644.1)	(32603.5)
Vacancies (ln)		0.092	0.411	0.395	0.269
		(0.2960)	(0.3240)	(0.2017)	(0.1817)
Hirings of workers earning 800-1200		0.024	-0.045	0.069	0.117***
		(0.0598)	(0.0525)	(0.0402)	(0.0340)
Hirings of workers earning 1600-2000		0.052	-0.107	0.163**	0.189***
		(0.0970)	(0.0919)	(0.0541)	(0.0571)
Wage of part-time hiring		7.121	0.124	1.692	4.524*
		(3.7899)	(3.1635)	(2.2834)	(2.2909)
Wage of full-time hiring		-9.124	5.391	-0.587	-10.362
		(8.3273)	(7.8964)	(5.5420)	(6.6588)
Frequency of wage upgrade		0.148*	0.164*	0.098	0.069
		(0.0673)	(0.0705)	(0.0524)	(0.0440)
Frequency of wage downgrade		-0.037	-0.031	-0.062	-0.098
		(0.0734)	(0.0496)	(0.0690)	(0.0572)
Proportion of workers in analytical non-routine tasks	0.019	0.023	0.010	0.011	0.016
	(0.0250)	(0.0176)	(0.0121)	(0.0089)	(0.0096)
Proportion of workers in interactive non-routine tasks	0.009	0.002	-0.005	-0.006	-0.006
	(0.0165)	(0.0102)	(0.0090)	(0.0086)	(0.0100)

Note: Estimates from equation 1. Different rows correspond to different outcomes. Columns 1-3 show estimates of β over the 1999-2002 period. Column 4 shows estimates of β for the 2002-2004 period (short-run), and column 5, for 2002-2007 (medium-run), both using an indicator variable *Post* that takes the value 1 for 2003 onward. Standard errors are in parentheses. * p<0.05, ** p<0.01, *** p<0.001. Growth rates of low- and high-earning workers are estimated on the subsample of establishments with both types of workers (quintiles 2 to 4 of proportion of low-earning workers).

Table A.12: Schematic analysis of the direction of the employment effects by type in the DiD analysis

Coexistence of scale and substitution effect ($0 < \sigma < \eta$)			
	Highly exposed	Non-exposed	Diff. (HE - NE)
Low-earning employment	$\uparrow$ (scale)	$\uparrow$ (substitution)	$\lesseqgtr 0$
High-earning employment	$\uparrow\uparrow$	$\uparrow$	> 0
Total employment	$\uparrow\uparrow$	$\uparrow$	> 0
Only substitution effect ($\sigma > \eta$)			
	Highly exposed	Non-exposed	Diff. (HE - NE)
Low-earning employment	$\uparrow$	$\uparrow\uparrow$	< 0
High-earning employment	$\downarrow\downarrow$	$\downarrow$	< 0
Total employment	$\downarrow\uparrow$	$\uparrow\downarrow$	$\lesseqgtr 0$
Only scale effect ($\sigma = 0$)			
	Highly exposed	Non-exposed	Diff. (HE - NE)
Low-earning employment	$\uparrow\uparrow$	$\uparrow$	> 0
High-earning employment	$\uparrow\uparrow$	$\uparrow$	> 0
Total employment	$\uparrow\uparrow$	$\uparrow$	> 0

Note: The direction and magnitude of the effects correspond to the expression:

$$\frac{dlnN_1}{dlnw_1} = -[s_1\eta + (1-s_1)\sigma]$$
$$\frac{dlnN_2}{dlnw_1} = -[s_1\eta - s_1\sigma]$$

Total employment is inferred intuitively. The change in total employment should be approximately equal to the change in each employment type, weighted by the respective proportion of each type of worker.

Table A.13: Coefficient estimates from the DiD analysis, heterogeneous effects

	Employment	FTE employment	Part-time	Full-time	Low-educated (proportion)	Medium-educated
			Industry			
IntLE	1.65*	1.68**	0.02	1.64**	-0.09	1.19*
(baseline: Primaries, construction)	(0.688)	(0.583)	(0.434)	(0.522)	(0.110)	(0.480)
IntLE × Manufacturing	0.88	1.65	-1.16	2.43	0.15	1.31
	(1.912)	(1.676)	(0.968)	(1.610)	(0.113)	(1.394)
IntLE × Services	-0.39	-0.25	-0.41	0.03	0.04	0.19
	(0.878)	(0.726)	(0.521)	(0.655)	(0.112)	(0.612)
R^2	0.11	0.12	0.06	0.12	0.07	0.09
			Establishment age			
IntLE	0.90	0.67	0.22	0.54	-0.02	0.91
(baseline: 0-9 y.o.)	(0.730)	(0.588)	(0.370)	(0.528)	(0.022)	(0.515)
IntLE × 10-19 y.o.	0.70	1.45	-0.56	1.79	-0.05	1.33
	(1.237)	(1.015)	(0.514)	(0.956)	(0.059)	(0.869)
IntLE × 20-29 y.o.	0.72	1.54	-1.68**	2.55**	-0.02	0.47
	(1.139)	(0.972)	(0.564)	(0.908)	(0.052)	(0.751)
R^2	0.11	0.12	0.06	0.12	0.07	0.09
			Establishment size			
IntLE	0.35	0.34	-0.25	0.44	-0.05	0.56
(baseline: 1-5 work.)	(0.410)	(0.359)	(0.196)	(0.325)	(0.028)	(0.317)
IntLE × 6-20 work.	1.03	0.55	1.13	-0.09	0.03	0.72
	(0.839)	(0.665)	(0.610)	(0.618)	(0.031)	(0.613)
IntLE × 21-200 work.	5.23	7.18*	2.22	6.04	0.09	7.05*
	(5.217)	(3.483)	(3.381)	(3.115)	(0.051)	(2.980)
IntLE × 201 or more work.	20.21	41.93	-4.72	48.29**	0.07	24.24
	(37.146)	(23.775)	(31.229)	(17.603)	(0.039)	(15.611)
R^2	0.11	0.13	0.09	0.14	0.07	0.09
			Collective agreement (industry or company level)			
IntLE	0.73	0.83	-0.21	0.90*	-0.04	1.07**
(baseline: No agreement)	(0.515)	(0.436)	(0.258)	(0.406)	(0.025)	(0.361)
IntLE × Agreement	1.66	1.92*	-0.51	2.38**	-0.00	0.91
	(0.994)	(0.784)	(0.523)	(0.730)	(0.051)	(0.619)
R^2	0.11	0.12	0.06	0.12	0.07	0.09

Note: Estimates from equation 4.3. Different columns correspond to different outcomes, and different panels correspond to different variables in the heterogeneity analysis. Standard errors are in parentheses. * $p<0.05$, ** $p<0.01$, *** $p<0.001$. Controlling for industry-specific (224 categories) quadratic trends.

Table A.14: Estimates for $\hat{\beta}_t$ for total employment - Specific trends

	Benchmark	*Quadratic trend quintiles LE share*	*Quadratic trend industry*	*Linear trend firm-specific (FD)*	*Controls for pre-trend*
1999	-0.109	2.819	0.114		-0.121
	(0.8734)	(2.1425)	(0.7532)		(0.8745)
2000	-0.409	1.229	-0.522	-0.496	-0.411
	(0.5696)	(1.2483)	(0.5381)	(0.5147)	(0.5692)
2001	-0.472	0.182	-0.491	-0.395	-0.469
	(0.3362)	(0.6493)	(0.3398)	(0.6099)	(0.3362)
2002			*baseline*		
2003	0.276	-0.049	0.406	-0.058	0.286
	(0.2140)	(0.4726)	(0.2302)	(0.3990)	(0.2127)
2004	0.666	0.304	0.914**	0.070	0.677*
	(0.3400)	(0.9055)	(0.3478)	(0.4347)	(0.3398)
2005	1.246**	1.120	1.569***	0.262	1.243**
	(0.4326)	(1.2710)	(0.4602)	(0.4419)	(0.4327)
2006	1.325**	1.748	1.767***	-0.220	1.297**
	(0.4755)	(1.6606)	(0.5366)	(0.4028)	(0.4822)
2007	0.891	2.147	1.374*	-0.760	0.867
	(0.5657)	(2.2076)	(0.6290)	(0.4124)	(0.5692)
LE industry (other commuting zones)					-7.263
					(7.0162)
LE commuting zone (other industries)					-0.480
					(1.9197)

Note: Standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

Table A.15: Coefficient estimates from the DiD analysis for total full-time equivalent employment, adding specific trends

	Benchmark	*Quadratic trend quintiles LE share*	*Quadratic trend industry*	*Linear trend firm-specific (FD)*	*Controls for pre-trend*
1999	0.506	2.145	0.799		0.489
	(0.7722)	(1.8038)	(0.6559)		(0.7739)
2000	-0.077	0.824	-0.141	-0.537	-0.081
	(0.4881)	(1.0433)	(0.4710)	(0.4366)	(0.4884)
2001	-0.264	0.065	-0.241	-0.416	-0.267
	(0.2752)	(0.5404)	(0.2748)	(0.4817)	(0.2756)
2002			*baseline*		
2003	0.434*	0.344	0.529**	0.329	0.441*
	(0.1849)	(0.3896)	(0.1941)	(0.3138)	(0.1836)
2004	1.087***	1.105	1.285***	0.566	1.091***
	(0.2917)	(0.7457)	(0.2945)	(0.3486)	(0.2900)
2005	1.783***	2.105*	2.056***	0.588	1.776***
	(0.3324)	(0.9797)	(0.3512)	(0.3514)	(0.3333)
2006	1.903***	2.748*	2.307***	0.055	1.885***
	(0.3796)	(1.2435)	(0.4080)	(0.3236)	(0.3886)
2007	1.678***	3.251*	2.159***	-0.338	1.659***
	(0.4450)	(1.5847)	(0.4696)	(0.3186)	(0.4507)
LE industry (other commuting zones)					-4.404
					(6.4675)
LE commuting zone (other industries)					0.376
					(1.6108)

Note: Standard errors are in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

Table A.16: Coefficient estimates from the DiD analysis for the growth rate of low-earning employment, adding specific trends

	Benchmark	*Quadratic trend quintiles LE share*	*Quadratic trend industry*	*Linear trend firm-specific (FD)*	*Controls for pre-trend*
2000	-0.066	-1.142	-0.125		-0.075
	(0.3293)	(0.6044)	(0.3278)		(0.3312)
2001	-0.414	-0.869*	-0.451	-1.061	-0.408
	(0.3258)	(0.3612)	(0.3382)	(0.8706)	(0.3250)
2002			*baseline*		
2003	-0.775**	-0.498	-0.776**	-1.065*	-0.782**
	(0.2654)	(0.3013)	(0.2697)	(0.4971)	(0.2660)
2004	-0.186	0.199	-0.200	0.288	-0.187
	(0.3003)	(0.3528)	(0.3005)	(0.5066)	(0.2997)
2005	-0.609**	-0.290	-0.645*	-0.708	-0.605**
	(0.2329)	(0.3433)	(0.2514)	(0.5341)	(0.2322)
2006	-0.205	-0.124	-0.222	-0.059	-0.198
	(0.1758)	(0.4351)	(0.1946)	(0.4197)	(0.1771)
2007	-0.409	-0.737	-0.403	-0.709	-0.396
	(0.2233)	(0.5995)	(0.2423)	(0.4517)	(0.2208)
LE industry (other commuting zones)					2.067
					(1.2267)
LE commuting zone (other industries)					-0.204
					(0.4018)

Note: Standard errors are in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

Table A.17: Coefficient estimates from the DiD analysis for the growth rate of high-earning employment, adding specific trends

	Benchmark	*Quadratic trend quintiles LE share*	*Quadratic trend industry*	*Linear trend firm-specific (FD)*	*Controls for pre-trend*
2000	0.117	0.423*	0.143		0.122
	(0.1610)	(0.2135)	(0.1667)		(0.1580)
2001	0.025	0.140	0.035	-0.069	0.029
	(0.1504)	(0.1695)	(0.1493)	(0.2740)	(0.1502)
2002			*baseline*		
2003	0.443*	0.398	0.453*	0.530	0.444*
	(0.1966)	(0.2091)	(0.1988)	(0.3232)	(0.1961)
2004	0.237	0.219	0.242	-0.302	0.241
	(0.1609)	(0.1862)	(0.1589)	(0.1926)	(0.1610)
2005	0.093	0.174	0.097	-0.203	0.094
	(0.1515)	(0.1798)	(0.1547)	(0.2369)	(0.1510)
2006	-0.168	0.084	-0.163	-0.298	-0.162
	(0.1237)	(0.1633)	(0.1284)	(0.1846)	(0.1220)
2007	0.007	0.499*	-0.023	0.020	0.008
	(0.1219)	(0.2148)	(0.1339)	(0.1949)	(0.1226)
LE industry (other commuting zones)					-0.524
					(0.8959)
LE commuting zone (other industries)					-0.445*
					(0.2204)

Note: Standard errors are in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

Table A.18: Coefficient estimates from the DiD analysis for the number of part-time workers, adding specific trends

	Benchmark	*Quadratic trend quintiles LE share*	*Quadratic trend industry*	*Linear trend firm-specific (FD)*	*Controls for pre-trend*
1999	-0.103	0.639	-0.470		-0.118
	(0.4192)	(1.1710)	(0.3412)		(0.4191)
2000	0.123	0.573	-0.168	0.264	0.119
	(0.3003)	(0.6870)	(0.2588)	(0.2751)	(0.3000)
2001	-0.105	0.131	-0.246	-0.193	-0.108
	(0.1856)	(0.3513)	(0.1951)	(0.3574)	(0.1856)
2002			*baseline*		
2003	-0.635***	-0.878**	-0.526***	-0.669*	-0.630***
	(0.1471)	(0.2738)	(0.1550)	(0.2641)	(0.1471)
2004	-0.811***	-1.306**	-0.618**	-0.233	-0.809***
	(0.2069)	(0.4883)	(0.2087)	(0.2522)	(0.2080)
2005	-0.688**	-1.451	-0.420	0.092	-0.694**
	(0.2561)	(0.7634)	(0.2601)	(0.2604)	(0.2560)
2006	-0.969***	-2.002	-0.649*	-0.332	-0.982***
	(0.2692)	(1.1142)	(0.3029)	(0.2299)	(0.2659)
2007	-1.168***	-2.489	-0.823*	-0.245	-1.182***
	(0.2939)	(1.6077)	(0.3357)	(0.2000)	(0.2911)
LE industry (other commuting zones)					-2.948
					(2.9340)
LE commuting zone (other industries)					0.474
					(1.1140)

Note: Standard errors are in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

Table A.19: Coefficient estimates from the DiD analysis for the number of full-time workers, adding specific trends

	Benchmark	*Quadratic trend quintiles LE share*	*Quadratic trend industry*	*Linear trend firm-specific (FD)*	*Controls for pre-trend*
1999	0.384	1.588	0.963		0.374
	(0.6264)	(1.7176)	(0.5887)		(0.6288)
2000	-0.260	0.379	-0.111	-0.680	-0.262
	(0.3801)	(0.9966)	(0.4205)	(0.4120)	(0.3811)
2001	-0.235	-0.045	-0.110	-0.246	-0.235
	(0.2514)	(0.5083)	(0.2490)	(0.3460)	(0.2521)
2002			*baseline*		
2003	0.786***	0.841*	0.802***	0.675*	0.791***
	(0.1695)	(0.3631)	(0.1745)	(0.2787)	(0.1683)
2004	1.575***	1.889**	1.634***	0.710*	1.579***
	(0.2711)	(0.6959)	(0.2680)	(0.3132)	(0.2691)
2005	2.198***	2.974***	2.281***	0.512	2.194***
	(0.2983)	(0.8853)	(0.3136)	(0.3257)	(0.2998)
2006	2.475***	3.937***	2.654***	0.220	2.462***
	(0.3548)	(1.0831)	(0.3625)	(0.3013)	(0.3645)
2007	2.375***	4.738***	2.616***	-0.209	2.362***
	(0.4122)	(1.2957)	(0.4179)	(0.2904)	(0.4191)
LE industry (other commuting zones)					-3.273
					(6.1716)
LE commuting zone (other industries)					0.135
					(1.5413)

Note: Standard errors are in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

Table A.20: Coefficient estimates from the DiD analysis for the proportion of low-educated workers, adding specific trends

	Benchmark	*Quadratic trend quintiles LE share*	*Quadratic trend industry*	*Linear trend firm-specific (FD)*	*Controls for pre-trend*
1999	-0.018	0.054	-0.029		-0.018
	(0.0313)	(0.0822)	(0.0305)		(0.0314)
2000	-0.008	0.029	-0.011	-0.002	-0.008
	(0.0192)	(0.0492)	(0.0199)	(0.0349)	(0.0192)
2001	-0.002	0.010	-0.003	0.008	-0.003
	(0.0164)	(0.0263)	(0.0166)	(0.0215)	(0.0164)
2002			*baseline*		
2003	-0.039*	-0.042	-0.040*	-0.046	-0.039*
	(0.0179)	(0.0268)	(0.0182)	(0.0243)	(0.0179)
2004	-0.028	-0.023	-0.030	0.008	-0.028
	(0.0212)	(0.0381)	(0.0217)	(0.0192)	(0.0212)
2005	-0.022	-0.000	-0.027	-0.005	-0.022
	(0.0235)	(0.0449)	(0.0242)	(0.0243)	(0.0235)
2006	-0.055*	-0.005	-0.064*	-0.043	-0.055*
	(0.0253)	(0.0541)	(0.0263)	(0.0253)	(0.0251)
2007	-0.062*	0.026	-0.074*	-0.003	-0.062*
	(0.0280)	(0.0704)	(0.0316)	(0.0220)	(0.0278)
LE industry (other commuting zones)					0.056
					(0.1900)
LE commuting zone (other industries)					0.007
					(0.0546)

Note: Standard errors are in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

Table A.21: Coefficient estimates from the DiD analysis for the number of medium-educated workers, adding specific trends

	Benchmark	*Quadratic trend quintiles LE share*	*Quadratic trend industry*	*Linear trend firm-specific (FD)*	*Controls for pre-trend*
1999	0.675	1.664	0.350		0.672
	(0.7014)	(1.5966)	(0.5483)		(0.7049)
2000	0.107	0.707	-0.182	-0.489	0.108
	(0.4257)	(0.9230)	(0.4162)	(0.3802)	(0.4258)
2001	-0.012	0.252	-0.109	-0.112	-0.009
	(0.2240)	(0.4737)	(0.2457)	(0.4476)	(0.2238)
2002			*baseline*		
2003	0.503**	0.332	0.692***	0.559	0.508**
	(0.1706)	(0.3469)	(0.1846)	(0.2861)	(0.1695)
2004	0.653**	0.359	1.013***	0.204	0.659**
	(0.2370)	(0.6522)	(0.2530)	(0.3041)	(0.2350)
2005	1.236***	0.859	1.756***	0.651*	1.236***
	(0.2730)	(0.8547)	(0.3088)	(0.2864)	(0.2732)
2006	1.364***	0.975	2.084***	0.213	1.351***
	(0.3285)	(1.0800)	(0.3637)	(0.2893)	(0.3375)
2007	1.074**	0.722	1.933***	-0.235	1.065**
	(0.3805)	(1.3552)	(0.4112)	(0.2868)	(0.3861)
LE industry (other commuting zones)					-3.414
					(6.0019)
LE commuting zone (other industries)					-0.475
					(1.4333)

Note: Standard errors are in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

Table A.22: Coefficient estimates from the DiD analysis for the growth rate of median daily wage, adding specific trends

	Benchmark	*Quadratic trend quintiles LE share*	*Quadratic trend industry*	*Linear trend firm-specific (FD)*	*Controls for pre-trend*
2000	0.173	0.546	0.126		0.173
	(0.1449)	(0.3644)	(0.1499)		(0.1431)
2001	0.249	0.386*	0.203	0.344	0.248
	(0.1511)	(0.1926)	(0.1546)	(0.2802)	(0.1497)
2002			*baseline*		
2003	0.665***	0.617***	0.690***	0.917***	0.666***
	(0.1309)	(0.1591)	(0.1337)	(0.2669)	(0.1310)
2004	0.333**	0.326*	0.372**	-0.121	0.334**
	(0.1160)	(0.1650)	(0.1189)	(0.2003)	(0.1150)
2005	0.261*	0.388*	0.299**	0.169	0.258*
	(0.1103)	(0.1856)	(0.1126)	(0.1806)	(0.1083)
2006	0.292*	0.646**	0.311*	0.258	0.285*
	(0.1226)	(0.2408)	(0.1281)	(0.1813)	(0.1227)
2007	0.049	0.718**	0.032	-0.026	0.042
	(0.2107)	(0.2677)	(0.1939)	(0.2762)	(0.2067)
LE industry (other commuting zones)					-1.524
					(1.3901)
LE commuting zone (other industries)					0.040
					(0.5315)

Note: Standard errors are in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

Table A.23: Correlation between the proportion of low-earning workers in 2002 and the percentage variation in the proportion of low-earning workers between 2002 and 2004, and 2002 and 2007

	2002-2004	2002-2007
Industry level (41 categories)	0.33*	0.06
	(0.0327)	(0.7130)
Commuting zone of residence (142 categories)	-0.33***	-0.71***
	(0.0001)	(0.0000)

Note: SIAB data. p-values are in parentheses. * p<0.05, ** p<0.01, *** p<0.001.

Table A.24: Parameter values

Parameter	Meaning	Value
σ	Elasticity of substitution N_1 w.r.t. N_2	2.5
θ_H	Productivity N_1 in firm H	0.273
θ_L	Productivity N_1 in firm L	0.159
A_H	TFP firm H	32.00
A_L	TFP firm L	33.57
ε	Elasticity of supply of hours w.r.t. wage	0.2
β	Fixed cost of work	10
μ	Scale parameter in Weibull $F(\alpha)$	40
γ	Shape parameter in Weibull $F(\alpha)$	1.2
b	Non-employment benefit	100
κ	Elasticity of substitution of Y_H w.r.t. Y_L	10

Note: The value of ε is obtained from Tazhitdinova (2020) (middle point of the range of elasticities $[0.07 - 0.32]$). The value of b is set to 100 as a normalization. Values of σ are set such that the model reproduces the sign pattern in the changes in total employment and employment by type (low- and high-earning) presented in the DiD analysis. The rest of the parameters are set such that the moments obtained from the model are (qualitatively) in line with the moments in the data for the years before the reform (average 1999 to 2002).

Table A.25: Comparison of moments obtained from the pre-reform data and the model

Moments	Data (1999-2002)	Model
Employment rate	87.1%	94.6%
Proportion of mini-jobs	12.6%	14.9%
Mini-jobs in bunch/total employment	4.2%	7.8%
Ratio N_1/N_2 in industries H	0.155	0.092
Ratio N_1/N_2 in industries L	0.035	0.017
Gross wage rate for low-earning employment (w_1)	19.2	24.5
Employment in industries H out of total employment	30%	13%
Low-earning employment (N_1) out of total employment	9.0%	2.5%

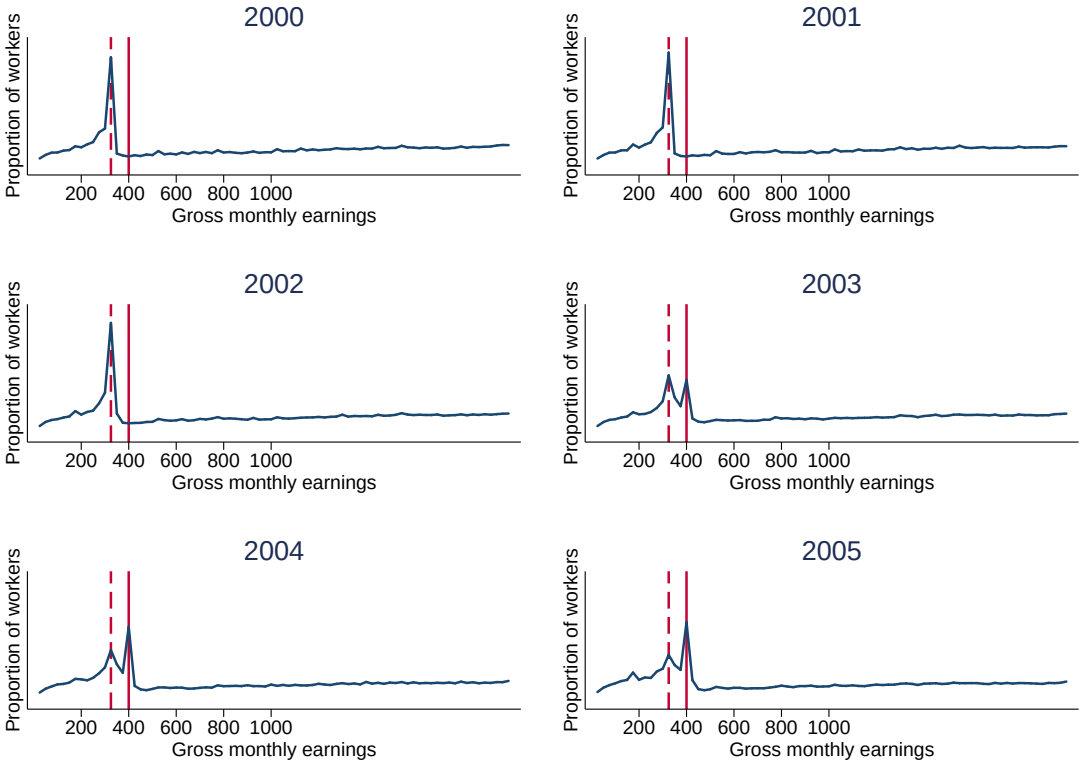
Note: Data from SIAB (1999-2002) is used for the moments. Employment low-earning jobs (N_1), high-earning jobs (N_2) and in industries H correspond to FTE. The gross wage rate for low-earning employment is the daily wage for FTE employment plus the employer-paid rate for mini-jobs (22%). The policy parameters of the model are set to the pre-reform levels: $K = 325$, τ_1 =18%, τ_2 =35%.

Table A.26: Variation in employment by type calculated from the model simulation of the Mini-Job Reform, and comparison with the estimates from the DiD analysis

	Scale + substitution ($\sigma = 2.5$)	Substitution ($\sigma = 50$)	Data
In terms of baseline averages (2002)			
$DiD_{\text{low-earning employment}}$	-2.8%	123.3%	-18.5%
$DiD_{\text{high-earning employment}}$	4.3%	-19.0%	12.4%
$DiD_{\text{total employment}}$	4.1%	-10.0%	7.0%
Changes in % of pre-reform levels			
Low-earning in highly exposed firm	46%	62%	
Low-earning in non-exposed firm	36%	159%	
High-earning in highly exposed firm	5%	-34%	
High-earning in non-exposed firm	-2%	5%	
Total employment in highly exposed firm	9%	-5%	
Total employment in non-exposed firm	-1%	5%	

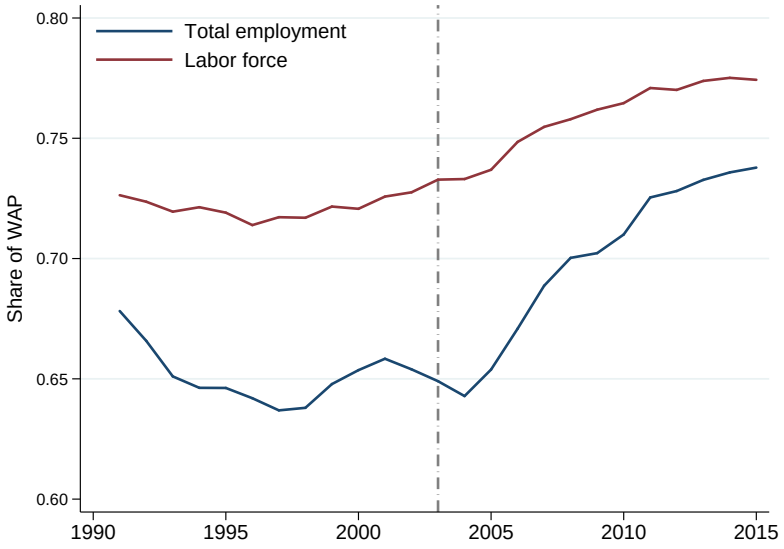
B Additional Figures

Figure B.1: Gross monthly earnings, in Germany, for the period 2000-2005



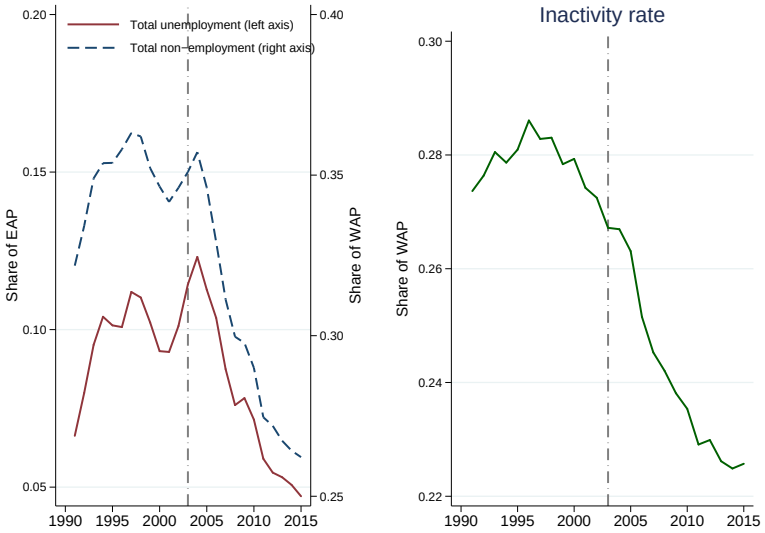
Source: SIAB, annual data, main spell, gross monthly earnings computed from daily wages.

Figure B.2: Employment rate and labor force participation, in Germany, 1990-2015



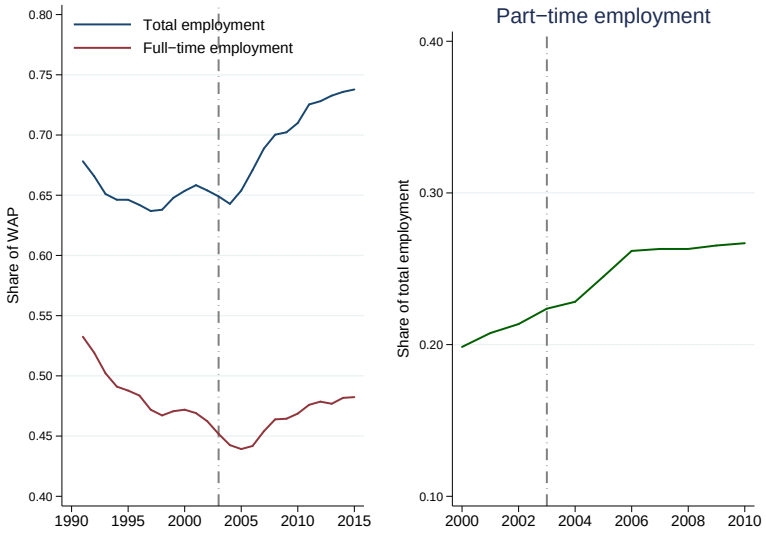
Note: Data from DESTATIS. WAP stands for Working Age Population.

Figure B.3: Unemployment, non-employment and inactivity rate, in Germany, 1990-2015



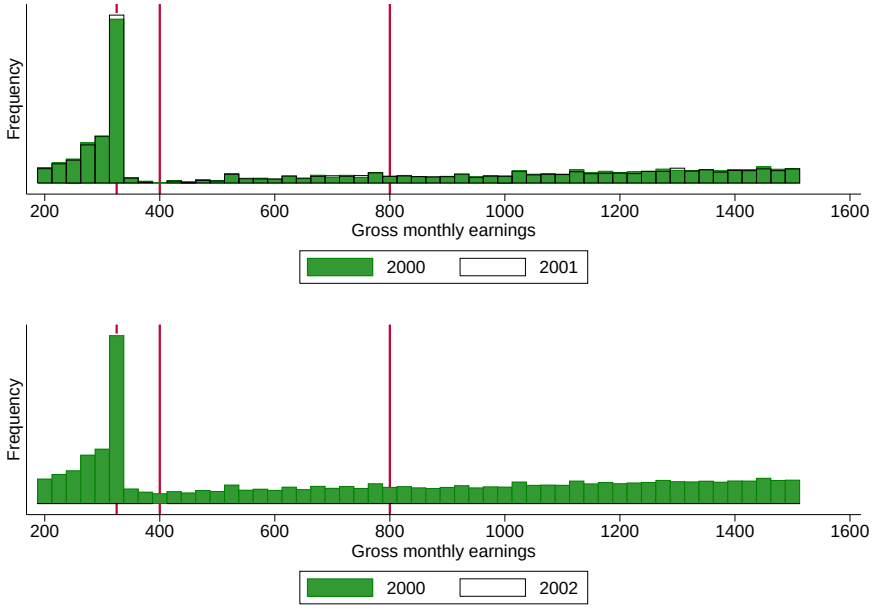
Note: Data from DESTATIS. EAP stands for Economic Age Population, and WAP for Working Age Population.

Figure B.4: Employment, full- and part-time, in Germany, 1990-2015



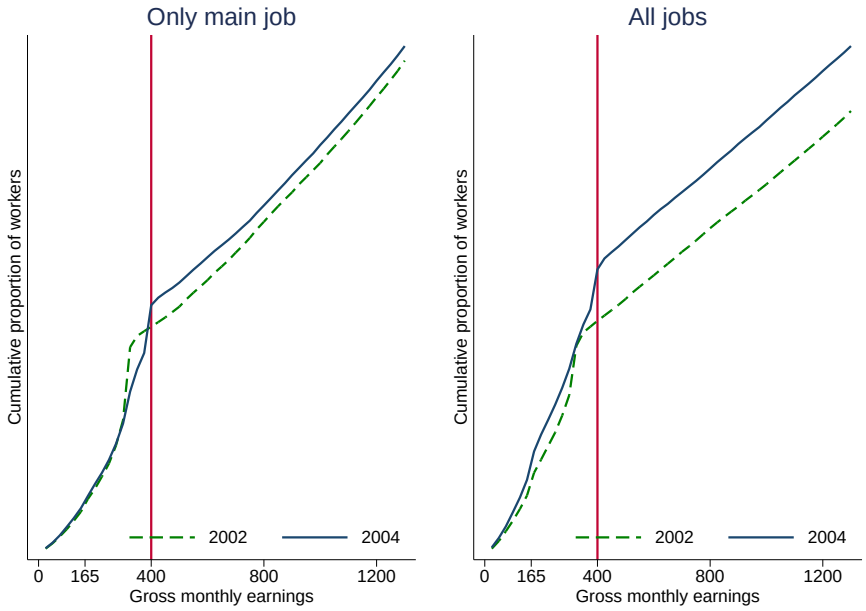
Note: Data from DESTATIS. WAP stands for Working Age Population.

Figure B.5: Distribution of monthly gross earnings, in Germany, pre-Mini-Job Reform



Source: SIAB, annual, main job, gross monthly earnings are computed from daily wages.

Figure B.6: Cumulative distribution of monthly gross earnings, in Germany, 2002 and 2004



Source: SIAB, annual data (left) and spell data (right), gross monthly earnings are computed from daily wages.

Figure B.7: Accounting exercise on the earnings distribution: expansion of in-work benefits

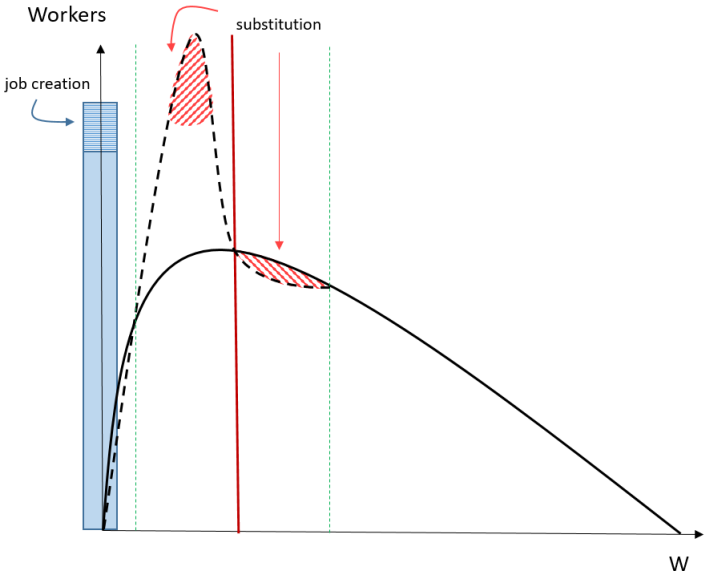


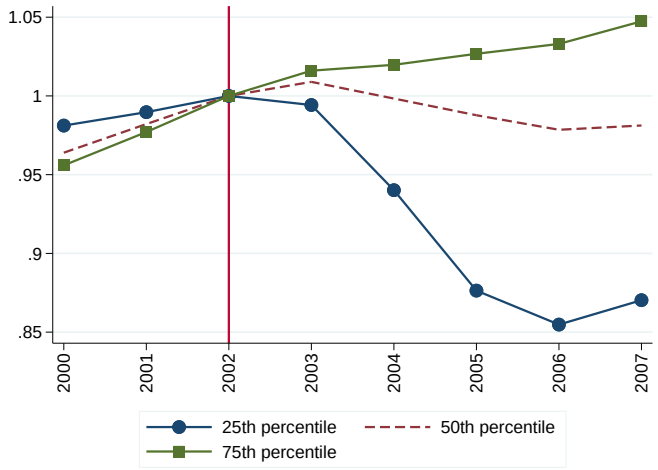
Figure B.8: Evolution of establishment-level employment, in Germany, 1999 to 2007

Note: Panel 2000-2007. Highly exposed and non-exposed establishments refer to whether they are above or below the (weighted) median of the proportion of low-earning workers.

Figure B.9: Evolution of low- and high-earning workers per establishment, in Germany, 1999 to 2007

Note: Panel 2000-2007. Highly exposed and non-exposed establishments refer to whether they are above or below the (weighted) median of the proportion of low-earning workers.

Figure B.10: Evolution of daily wages (all workers), in Germany, 2000 to 2007

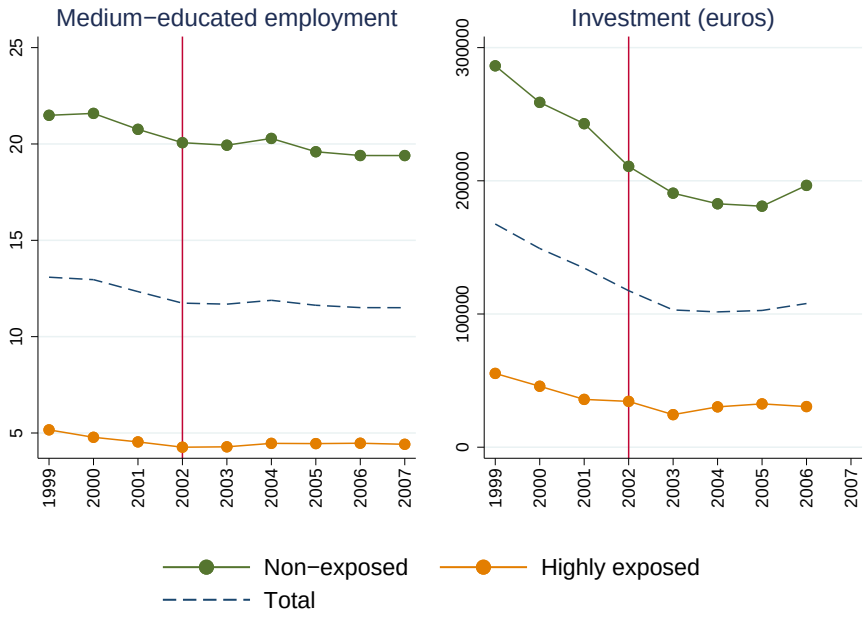


Source: SIAB, annual data, main spell. Daily wages of all workers, including full- and part-time.

Figure B.11: Evolution of part- and full-time workers per establishment, in Germany, 1999 to 2007

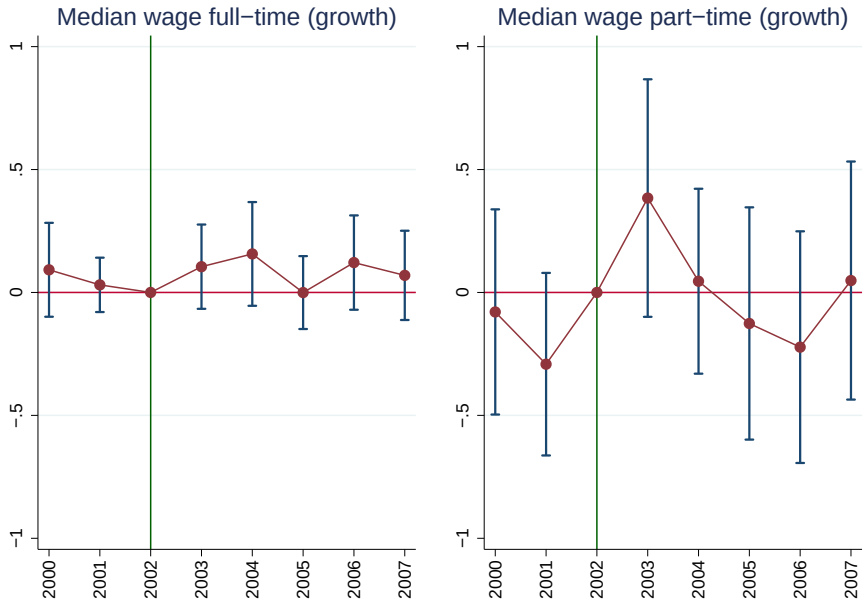
Note: Panel 2000-2007. Highly exposed and non-exposed establishments refer to whether they are above or below the (weighted) median of the proportion of low-earning workers.

Figure B.12: Evolution of medium-educated workers and investment in physical capital, in Germany, 1999 to 2007



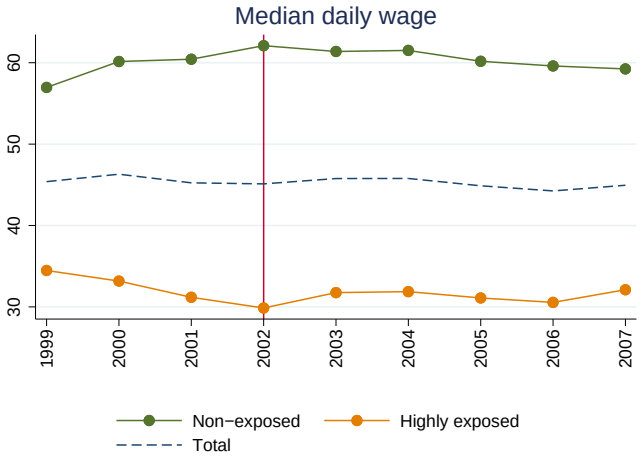
Note: Panel 2000-2007. Highly exposed and non-exposed establishments refer to whether they are above or below the (weighted) median of the proportion of low-earning workers.

Figure B.13: Effect on median daily wages of full- and part-time workers



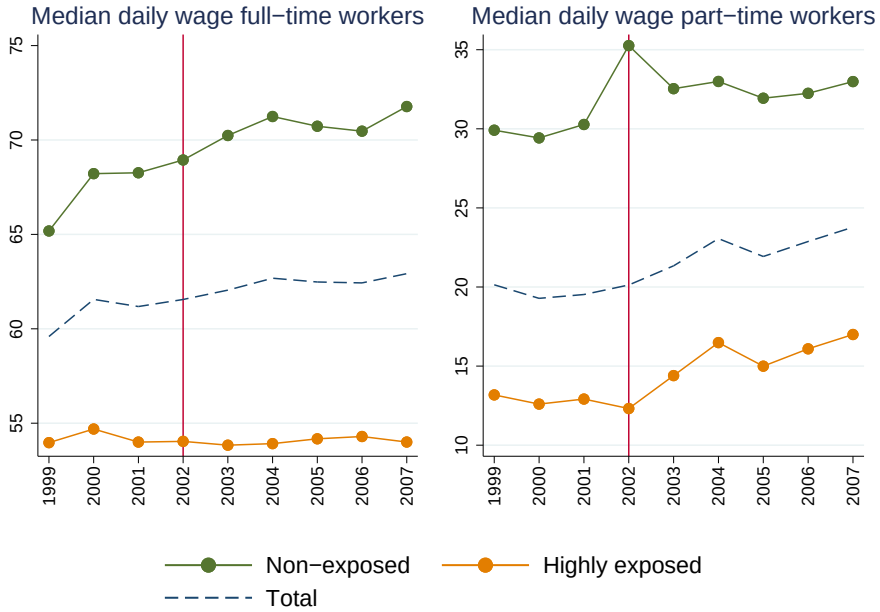
Note: Confidence intervals correspond to the 95% level.

Figure B.14: Evolution of median wages within establishments, in Germany, 1999 to 2007



Note: Panel 2000-2007. Highly exposed and non-exposed establishments refer to whether they are above or below the (weighted) median of the proportion of low-earning workers.

Figure B.15: Evolution of median wages within establishments, for full- and part-time workers, in Germany, 1999 to 2007

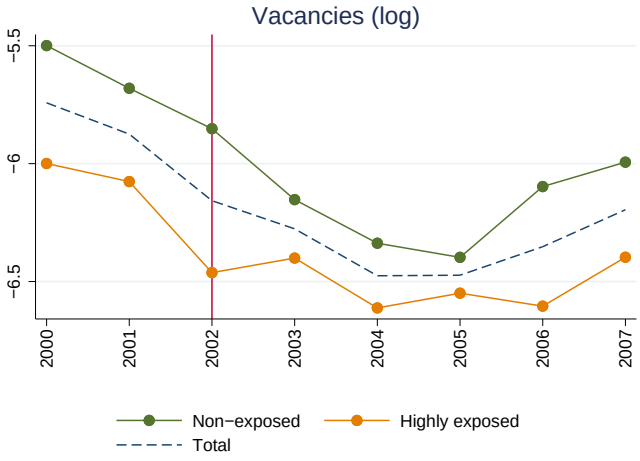


Note: Panel 2000-2007. Highly exposed and non-exposed establishments refer to whether they are above or below the (weighted) median of the proportion of low-earning workers.

Figure B.16: Effect on vacancies

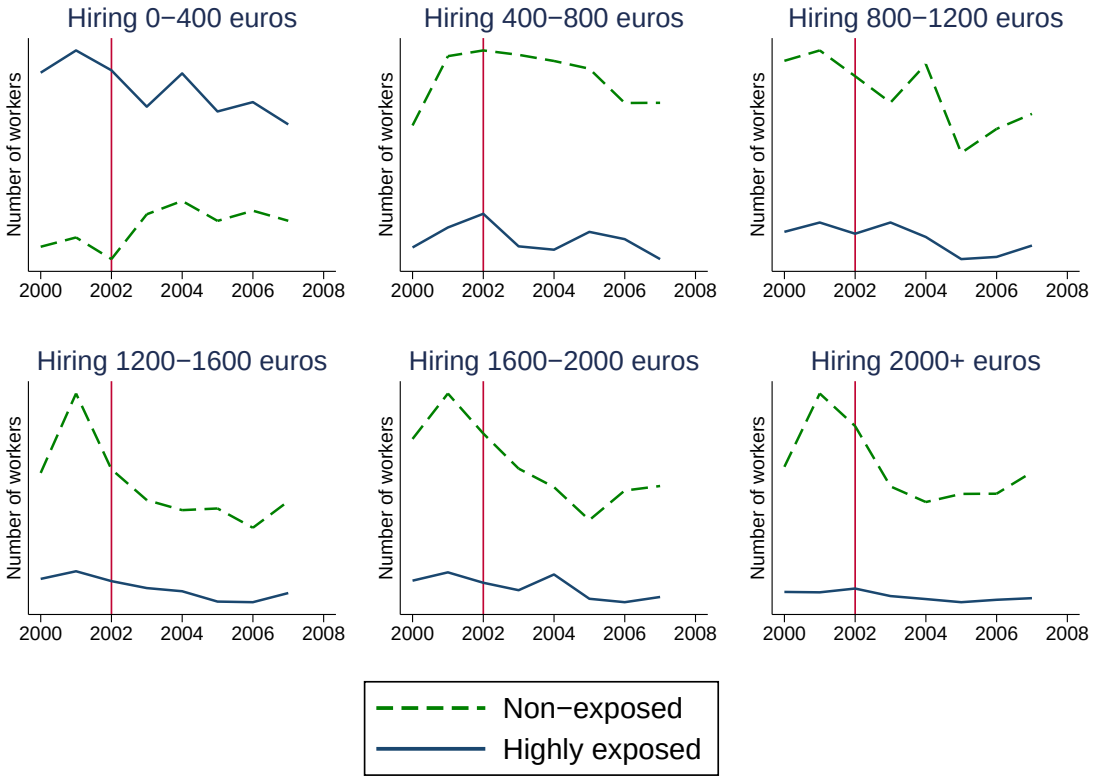
Note: Confidence intervals correspond to the 95% level.

Figure B.17: Evolution of vacancies, in Germany, 1999 to 2007



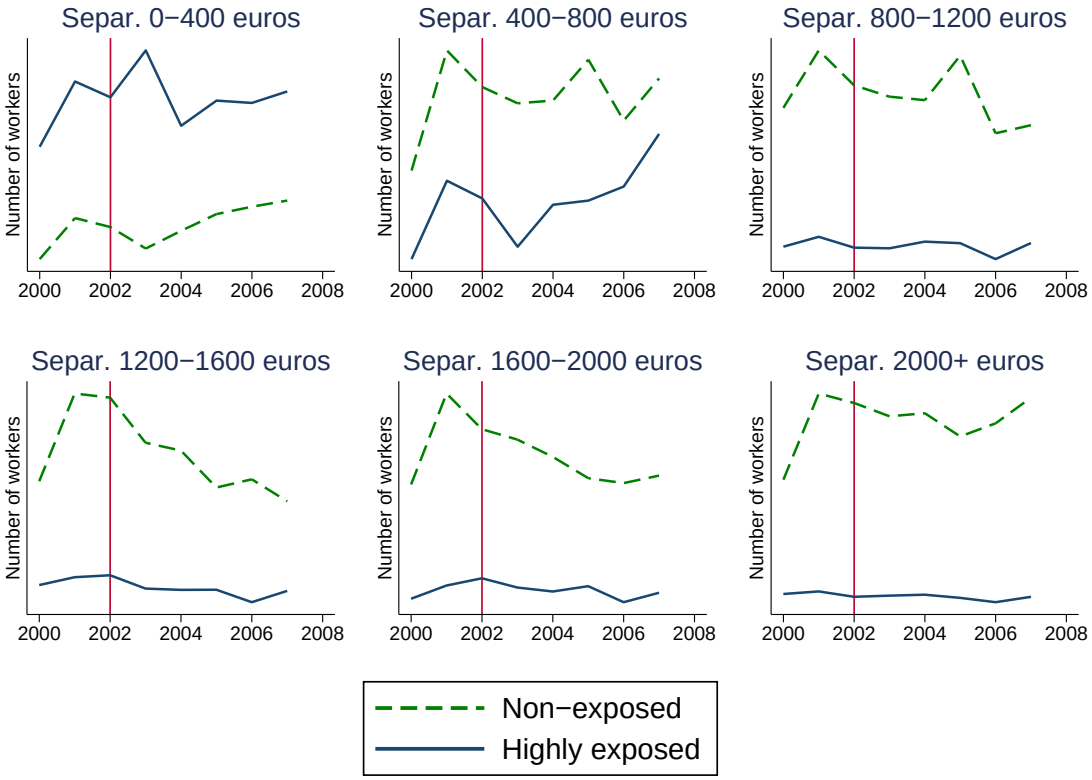
Note: Panel 2000-2007. Highly exposed and non-exposed establishments refer to whether they are above or below the (weighted) median of the proportion of low-earning workers.

Figure B.18: Evolution of hirings by gross monthly earnings, in Germany, 1999 to 2007



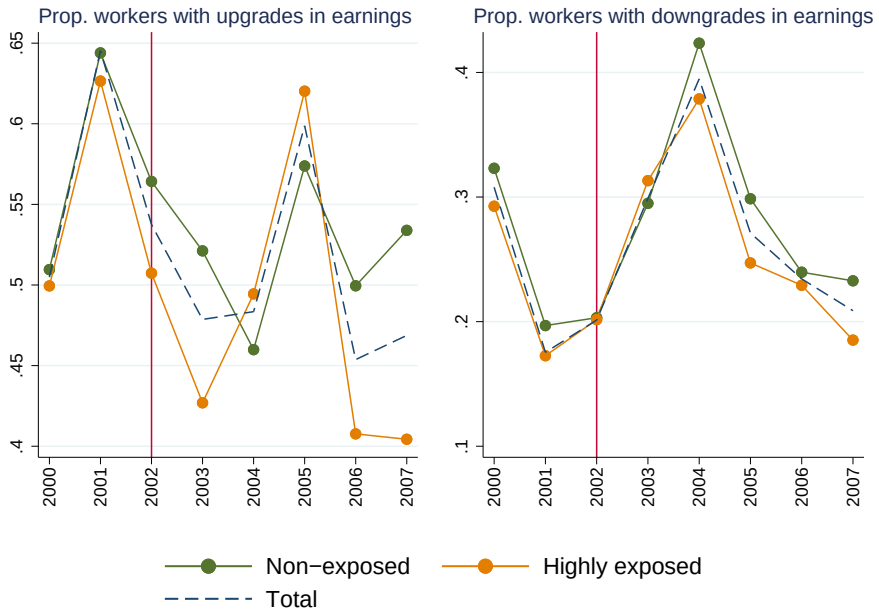
Note: Panel 2000-2007. Highly exposed and non-exposed establishments refer to whether they are above or below the (weighted) median of the proportion of low-earning workers.

Figure B.19: Evolution of separations by gross monthly earnings, in Germany, 1999 to 2007



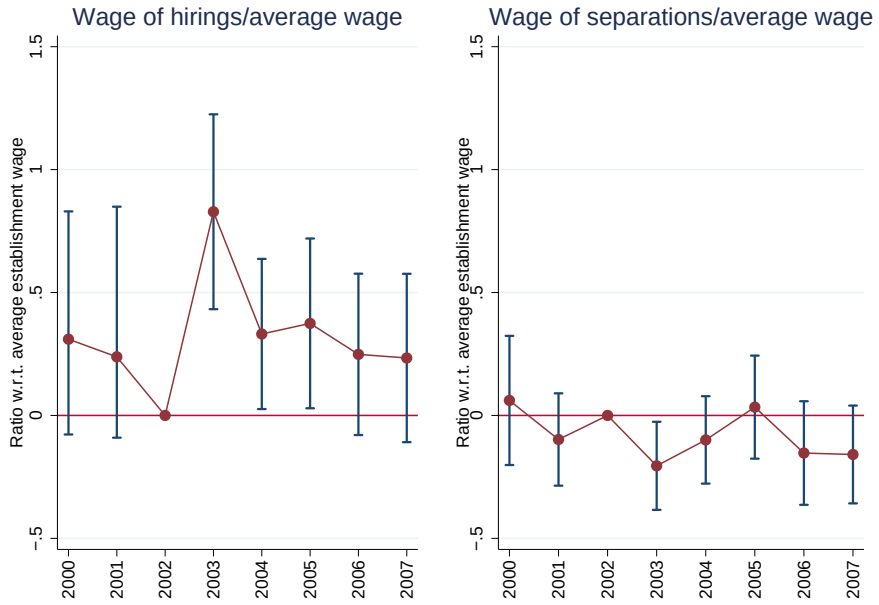
Note: Panel 2000-2007. Highly exposed and non-exposed establishments refer to whether they are above or below the (weighted) median of the proportion of low-earning workers.

Figure B.20: Evolution of wage changes for workers within establishments, in Germany, 1999 to 2007



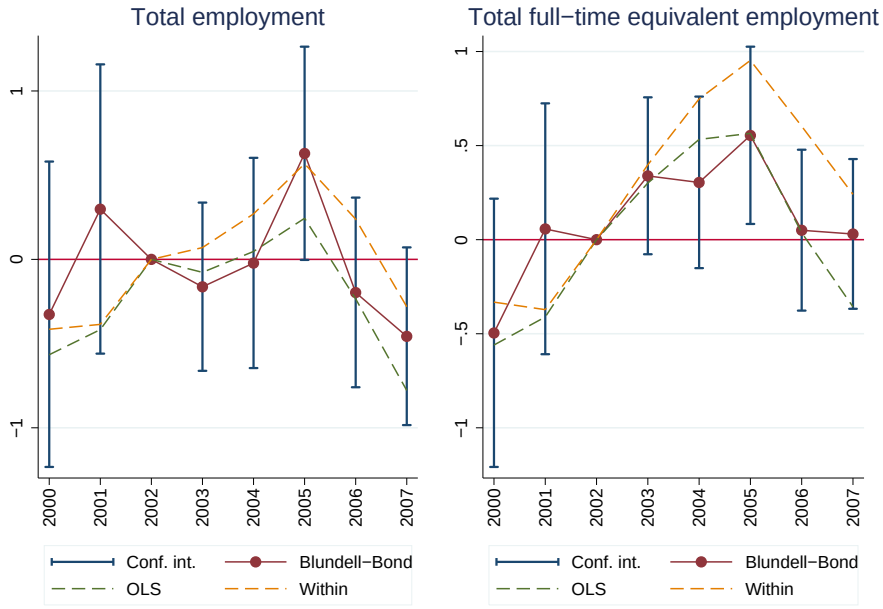
Note: Panel 2000-2007. Highly exposed and non-exposed establishments refer to whether they are above or below the (weighted) median of the proportion of low-earning workers.

Figure B.21: Effect on daily wages of workers' flows with respect to the average wage within the establishment



Note: Confidence intervals correspond to the 95% level.

Figure B.22: Effects on employment, model with lagged dependent variable

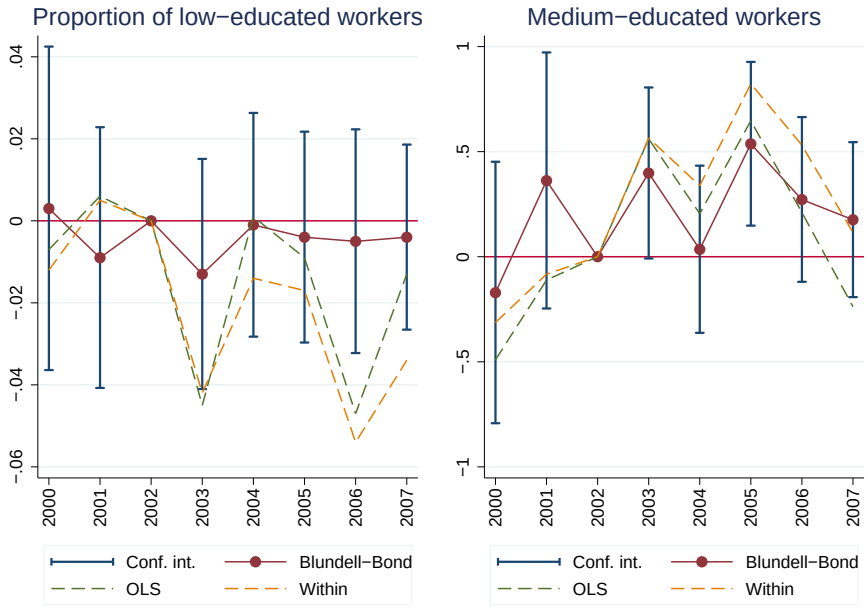


Note: Confidence intervals correspond to the 95% level, and are reported only for Blundell-Bond estimates. The Hansen statistic for the test of overidentifying restrictions is not significant for full-time employment (at the 5% level) but it is for employment. The differences-in-Hansen statistics for the tests of validity of both the GMM and IV instruments are not significant for full-time employment and significant only for the IV instruments for employment. The hypothesis of autocorrelation of residuals for more than one period is rejected (at the 5% level for employment and at any level for full-time equivalent employment).

Figure B.23: Effects on part- and full-time employment, model with lagged dependent variable

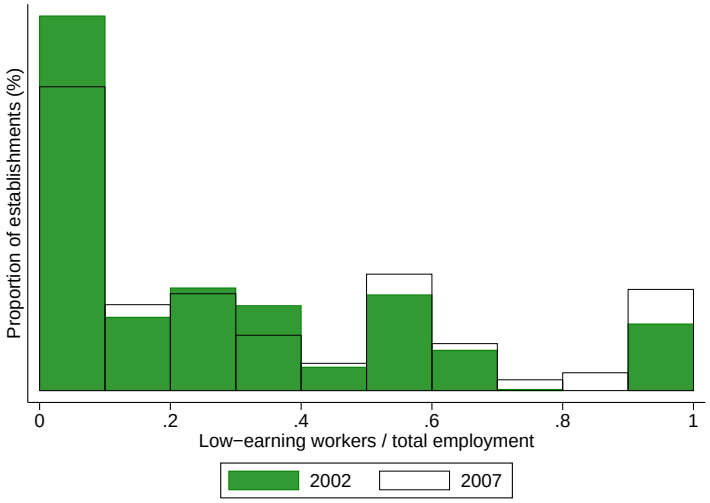
Note: Confidence intervals correspond to the 95% level, and are reported only for Blundell-Bond estimates. The Hansen statistic for the test of overidentifying restrictions is significant, and the differences-in-Hansen statistics for the tests of validity of both the GMM and IV instruments are not significant for full-time employment, and only for the IV instruments for part-time employment. The hypothesis of autocorrelation of residuals for more than one period is rejected.

Figure B.24: Effects on employment by education level, model with lagged dependent variable



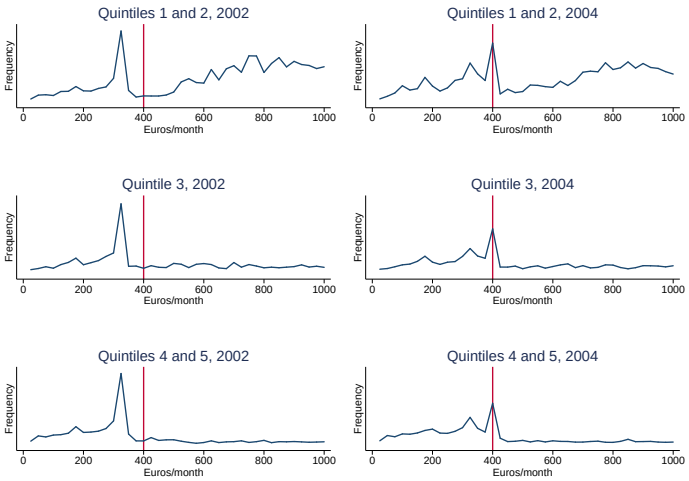
Note: Confidence intervals correspond to the 95% level, and are reported only for Blundell-Bond estimates. The Hansen statistic for the test of overidentifying restrictions is not significant for medium-educated workers, and it is significant for low-educated workers. The differences-in-Hansen statistics for the tests of validity of both the GMM and IV instruments are not significant for either. The hypothesis of autocorrelation of residuals for more than one period is rejected.

Figure B.25: Distribution of establishments according to the proportion of low-earning workers (exposure), in Germany, 2002 and 2007



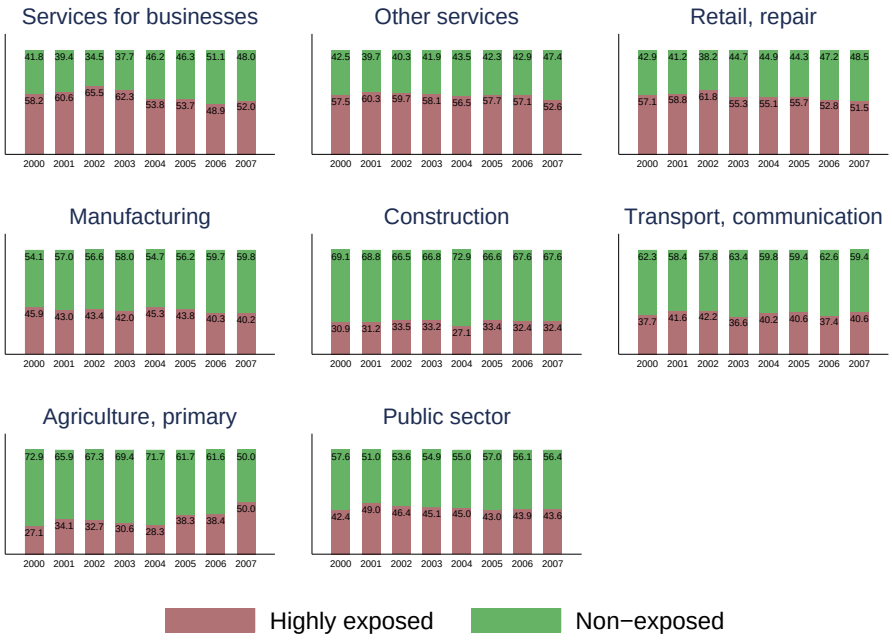
Note: LIAB, panel 2000-2007.

Figure B.26: Earnings distribution by establishment pre-reform exposure to low-earning workers, in Germany, 2002 and 2004



Note: LIAB, panel 2000-2007. Quintiles are defined according to the exposure in 2002, and establishments are followed between 2002 and 2004.

Figure B.27: Proportion of establishments by exposure to low-earning workers, in Germany, panel 2000-2007

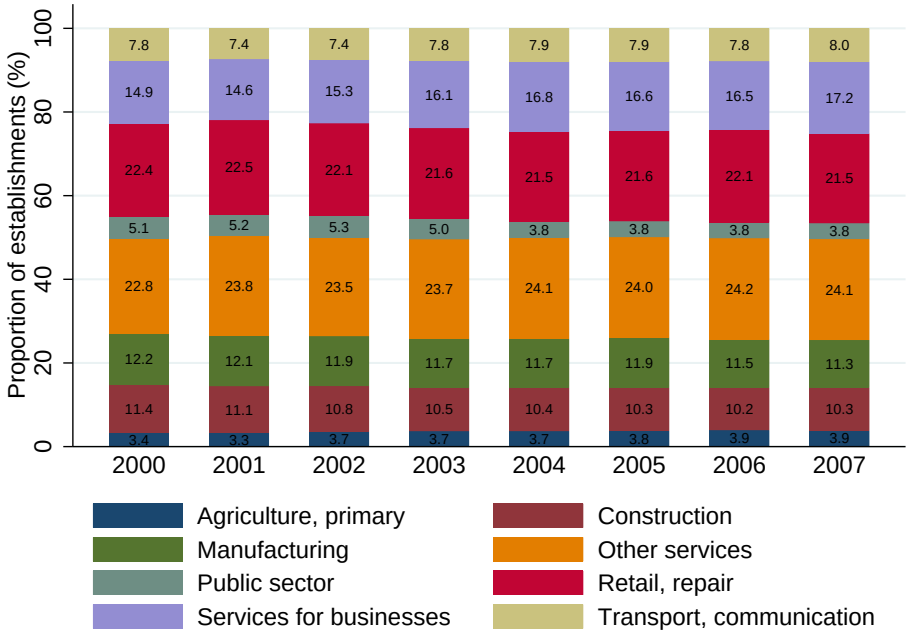


Note: LIAB, panel 2000-2007. Highly exposed establishments are those with a proportion of low-earning workers above the annual median, and non-exposed are those with a proportion of low-earning workers below the annual median. Financial intermediation is excluded due to the insufficient number of observations.

Figure B.28: Proportion of establishments by exposure to low-earning workers, in Germany, all establishments

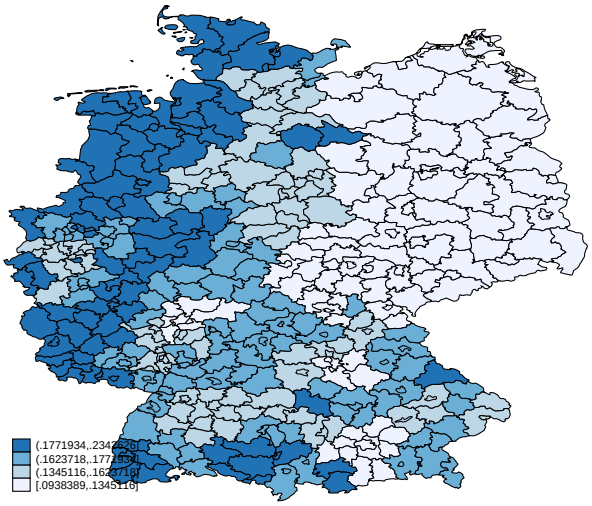
Note: LIAB, cross-sections. Highly exposed establishments are those with a proportion of low-earning workers above the annual median, and non-exposed are those with a proportion of low-earning workers below the annual median. Financial intermediation is excluded due to the insufficient number of observations.

Figure B.29: Industrial composition of establishments, in Germany, all establishments



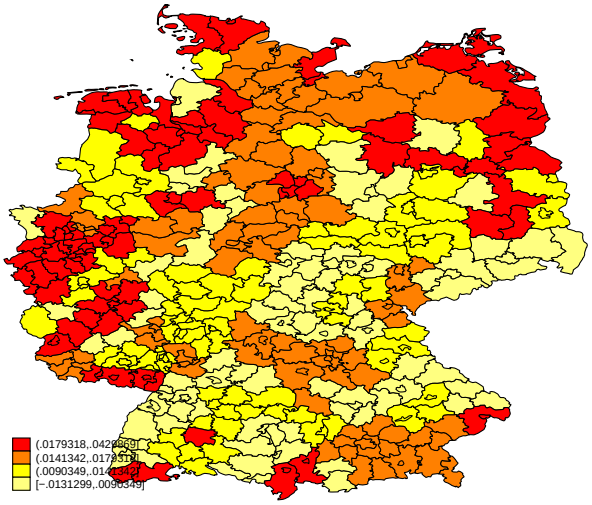
Note: LIAB, cross-sections. Financial intermediation is excluded due to the insufficient number of observations.

Figure B.30: Proportion of low-earning workers by commuting zones, in Germany 2002



Note: SIAB data. Values for commuting zones of residence.

Figure B.31: Proportion of low-earning workers by commuting zones, in Germany Variation (in p.p.) between 2002 and 2004



Note: SIAB data. Values for commuting zones of residence.

C Additional Details on the Institutional Context

Tax advantages for low-earning employment have existed in Germany under different program names since the introduction of the welfare state in the late nineteenth century (Schiller 2016). Before 2003, mini-jobs were restricted to employment that offered a maximum of 15 hours a week and gross monthly earnings of €325, provided this was the only source of income for the worker. In 1999, a reform attempted to bring low-paid jobs into the social security system and limit their scope. A limit in the number of hours of work was introduced, and it was further required that employees' earnings from all jobs were considered before their eligibility was determined. The worker was eligible for the tax benefit only if their total earnings and hours worked were below the cutoffs. Mini-jobbers were exempted from paying income tax and from making the social security contributions, which amounted to 21% of gross earnings for regular employment. Employers paid 22% tax on gross wages for employees in mini-jobs, slightly above the 21% employer rate for workers in regular jobs. If gross monthly earnings surpassed the €325 limit, then the entire amount of earnings was subject to the 21% rate for SSC each for the employer and the employee and these employees also paid income tax.

The Mini-Job or Hartz II Reform increased the earnings limit for mini-jobs to €400 per month and also increased the employers' SSC rate for mini-jobs to 25%. A further 30% increase in employers' SSC rate for mini-jobs was introduced in July 1, 2006, simultaneously with a decrease in the workers' and employers' rate for regular jobs to 19.5%, which mitigated the attractiveness of mini-jobs. See Table A.1 for the evolution of SSC rates related to the Mini-Job design.[26]

The subsidy implicit in the Mini-Job design is substantial: For a worker with €400 gross monthly earnings, the reduction in SSC is slightly more than €1,000 per year, plus the reduced income tax if it applies (a married worker whose family income is above €14,000 approximately). While the €400 threshold might seem low for a worker, this amount is not unusual for mini-jobbers as they usually work around 15 hours a week, which would need to yield an hourly wage of €7 for it to be compatible with the earnings limit of €400 (see Table A.2 for statistics on hours worked and hourly wages). The average gross hourly wage rate of mini-jobbers is thus similar to the after-tax hourly wage rate of full-time regular workers.

Although mini-jobbers are entitled to most of the same benefits as regular employees in Germany, they are not entitled to full pension benefits. They can opt to voluntarily top up their contributions to the pension insurance system. Employers pay 15% on gross earnings to the pension system for mini-jobbers, which implies a difference of 4.9 percentage points compared to the 19.9% contribution for those in regular employment. Only 3% of mini-jobbers voluntarily pay this difference to gain full-pension entitlement (Guardiancich 2010). It is worth noting that employers pay insurance only for work-related accidents for mini-jobbers, and they do not automatically provide health insurance. As an important proportion of mini-jobbers are secondary workers, it is common for them to have access to health insurance through their family members.

The Mini-Job Reform also involved the creation of a centralized office to simplify administrative tasks regarding marginal employment (*Minijob-Zentrale*) and the introduction of subsidies for unemployed workers who want to become entrepreneurs. These additional modifications are relatively small compared to the extension of the tax advantages, and their effect on labor demand and supply is unclear. On the one hand, the establishment of a centralized office for mini-jobbers may have rendered mini-jobs more attractive for firms. On the other hand, the subsidies for entrepreneurs

[26] A special mini-job regime applies to private households but they represent a very small amount of mini-jobbers (1.5% in 2004).

may have mitigated mini-jobs' appeal as self-employment may be an alternative to mini-jobs as a source of income in low-paid occupations.

At the time of the Mini-Job Reform, Germany was undergoing a recession that had started at the beginning of 2000. The turning point in terms of labor market indicators coincides with the Hartz reforms, in particular the Hartz IV, which curtailed unemployment benefits and assistance entitlement for long-term unemployed workers (see Figures B.2, B.3 and B.4 for labor market trends in Germany). As this reform also affected incentives for low-earning workers, a natural concern is that it confounds the effects of the Mini-Job Reform. I argue that it is unlikely that conclusions drawn in this paper about the effects of in-work benefits are driven by this additional reform. First, Hartz IV was introduced in 2005, two years after the Mini-Job Reform, while my empirical results show visible employment changes as having occurred since 2003. Second, to the extent that the introduction of Hartz IV affected labor supply incentives by curtailing unemployment assistance, the reform should be seen as a complementary measure to the expansion of in-work benefits offered by the Mini-Job Reform, as high incentives to work and less-attractive non-employment options are two sides of the same coin (Immervoll and Pearson 2009, Carrillo-Tudela, Launov, and Robin 2019).[27]

The remainder of the Hartz reforms were related to different aspects of the labor market, with little reason to believe that their introduction could confound the effects of the Mini-Job Reform, the focus of this paper. Hartz I (introduced on January 1, 2003) included active labor market policies and obligations for job seekers to remain qualified to receive unemployment insurance and extended the potential for those in temporary employment.[28] Hartz III (January 1, 2004) focused on improving the efficiency of the Public Employment Agency. Intuitively, all of these labor market policies affected the German labor market without a clear focus on the bottom of the earnings distribution, as it is indeed the case with the Mini-Job Reform.

A Tax Reform in 2003-2004 raised the minimum exempt earnings and included progressivity in the income tax, but these changes were substantially small compared with the modifications to the Mini-Job design. Another relevant factor is the incorporation of several Eastern European countries to the European Union in 2004. Given the free movement of people, this may have induced the entry of low-skilled workers into Germany. However, there had already been a change in firm behavior since 2003, whereas the effects of migration might have started to slowly appear only since 2004. Overall, it is safe to conclude that the Mini-Job Reform was the main shock to the low-earning segment in Germany when it was introduced.

[27] Unemployment insurance and assistance were, on average, approximately €700 a month at the time of the reform. Benefits for the long-term unemployed in Germany were much more generous than in the rest of the OECD countries before Hartz IV (see Engbom, Detragiache, and Raei 2015).

[28] Even though temporary workers are probably over-represented in the low-earning segment, the target of the Mini-Job Reform, temporary work has a relatively limited scope in Germany as compared to mini- and midi-jobs (approximately 7.5% of workers on fixed-term contracts and 2.5% in temporary agency work). Importantly, there was no apparent change in the proportion of temporary workers at the time of the Mini-Job Reform (see, e.g., Eichhorst and Tobsch 2014).

D Additional Details on the Data and Descriptives

The Institute for Employment Research of the German Federal Employment Agency (IAB), via the Research Data Centre (FDZ), gathers information on social security, unemployment benefits and workers' job-seeking records combined with establishment-level information. These data permit the characterization of different employment statuses, including employment that is subject to social security (available in the data since 1975), mini-jobs (in the data since 1999), benefit receipt according to the German Social Code III (since 1975) or II (since 2005), registered as job seekers at the Federal Employment Agency or participants in active labor market policies (available in the data since 2000). The Integrated Employment Biographies (IEB) consist of a merge of these data coming from diverse sources.

The employment spells are generated from notifications employers send to the system. In the absence of a major event, these notifications are sent annually. They are also sent in the cases of new hires, terminations, interruptions, changes in the contribution group or the health insurance company of the employee, or changes in the payroll system of the employer. Civil servants, the self-employed, short-term and family workers are not present in these data, since their earnings are not reported via the social security system. The social security records, hence, cover 80% of workers in Germany.

The Sample of Integrated Labour Market Biographies (SIAB) is a 2% random sample drawn from the IEB. It allows us to follow a person's employment status over time. The data shows employment spells, which means that every time there is a notification from an employer, or a change in a worker's status as a recipient of unemployment benefits or as a job seeker, a new observation is added to the dataset. I use spell data, in particular, to compute transitions across states of employment and unemployment. In such cases, I consider all spells of employment and unemployment during each year of the time series. Some of the descriptives are based on a transformation of the data to annual frequencies, following the methodology proposed by the IAB. I keep all the spells that include June 30 each year. I further restrict the data to one spell per worker-year (I eliminate parallel spells) for some of the descriptives, keeping the observation with the highest amount of earnings or benefit received. I explain the version of the data used in each case: *spell data*, *annual data*, or *annual data, main spell–or main job* respectively. Finally, I exclude employment spells with 0 daily earnings.

The linked employer-employee data (LIAB), in turn, combines the IEB records with establishment information from the IAB Establishment Panel and the Establishment History Panel (BHP). The latter contains aggregations of the social security records at the establishment level for June 30th each year. The IAB Establishment Panel is available for West Germany for the period since 1993 and for East Germany since 1996. The sampling design is stratified by establishment size, industry and federal state, over-samples large establishments and excludes unipersonal and informal firms. The response rate in the IAB Establishment Panel has been stable over the years and higher than 80%. For longitudinal analysis, the IAB constructs several longitudinal sections, with the corresponding weights. These sections, besides including new establishments and establishments going out of operation, retain data on the establishments that have continuity in their responses to the survey from one year to the next, being free of survey non-response. I use the longitudinal section 2000-2007, which is the most suitable for the period of the reform. I provide some descriptives by using the cross-section of the Establishment Panel, duely clarified in the text. Even though there is no survey non-response in the longitudinal analysis, the survey is subject to item non-response by certain establishments. However, most of the variables in the analysis, such as employment, wages,

occupations and industries, are drawn from the social security records from the IEB and BHP that are linked to the Establishment Panel.[29] Therefore I consider that measurement error is not a major issue for the analysis in this paper. Workers' information in the LIAB, Cross-Sectional model, comes from social security records for June 30th each year.

I do not impose exclusions of any type on establishments. Typical exclusions in the literature vary according to the topic and consist of excluding small establishments (17% of the establishments in the Establishment Panel have two employees; I verified that excluding them does not change the results), establishments in the agricultural sector (6.7%) and in public administration (9.6%). I avoid restrictions as the sample is meant to be representative of all establishments in Germany.

I perform a set of preparation and cleaning procedures in both the SIAB and the LIAB, according to the recommendations provided by the IAB. First, I correct for the excess missing values and inconsistencies in the education variables. These inconsistences are due to the lack of consequences of the education report–done by the employer–in terms of social security. I follow the criterium number 2B in Fitzenberger, Osikominu, and Volter (2005), which uses all the information for the same individual (forward and backward extrapolation, assignment of the maximum value for parallel spells) and considers the possibility of both under and over reporting. I adapt the code provided by the IAB, by also including information from unemployment or training spells.

Another important adjustment I perform is an imputation of daily earnings when they are right censored (above the social security contribution limit). Right censoring affects fewer than 5% of the observations in my sample and, in particular, it does not affect low-earning workers. The definition of low- and high-earning workers, crucial for the firm-level analysis, is binary and, hence, does not incorporate measurement errors coming from this limitation. However, to have a more appropriate measure of earnings for descriptives and when analyzing earnings dynamics, I impute top coded wages by using a series of Tobit models to fit log daily earnings by education and age groups, based on the methodology of Card, Heining, and Kline (2013) (see also Dustmann, Ludsteck, and Schonberg 2009 and Gartner 2005). The uncensored imputed value is the prediction of the model according to the covariates. I divide education into four groups according to level: no degree or primary/lower secondary or intermediate school-leaving certificate without vocational training, intermediate school-leaving certificate with vocational training (apprentices), upper-secondary school certificate (*Abitur*) with or without vocational certificate, and degree from technical school or university). I divide age into seven groups, each with a 10-year range; in the first group I include all people below 20 years of age and in the last, all above 80. The explanatory variables include age in years, an indicator for firms with more than 10 employees, the average proportion of right-censored observations and the average log daily wage within the establishment, a second-degree polynomial of the number of workers at the establishment, an indicator for unipersonal establishments, the average proportion of workers with a university degree and the average years of schooling by establishment.

Regarding the variables used in the analysis, the data from the IEB contains direct reports of whether the employment spell comes from regular employment, a mini-job (*marginal part-time*) or a midi-job (*in transition zone*), and I use this definition for the descriptives. I use monthly gross earnings to determine whether the workers are in the low-earning or high-earning segment and also for the descriptives that are based on the earnings distributions. As the data only provide daily earnings, using calendar days, I generate a monthly conversion following Tazhitdinova (2019). For workers with a single employment spell covering the whole year, I multiply the daily earnings by the average

[29] One important exception is investment, which is reported by establishments in the survey and it is subject to non-negligible item non-response.

number of days in a month (30.4). For individuals with multiple employment periods in a year, I compute average daily earnings in the year and I multiply this by the average number of days in a month.

Full-time equivalent employment, as a proxy for hours, is constructed by attributing a weight below 1 to part-time workers. In particular, the IEB differentiates between *mini* part-time workers (hours worked below half of full-time, corresponding to 18 hours a week), and *midi* part-time workers (hours worked above half of full-time and below full-time). I assign a weight of 0.5 to *mini* part-time workers and 0.75 to *midi* part-time workers. Even though the weights are somewhat arbitrary, I confirm that the results are the same if I change the weights (e.g., assigning 0.25 to *mini* part-time employment and 0.5 to *midi* part-time employment).

Regarding the classifications used along the analysis, I use the most-recent time-consistent industry classification provided by the IAB, which is the 1993 version of the Classification of Economic Activities, 3-digits, that comprises 224 categories. Some of the analysis uses grouped versions of these classifications. Occupations are categorized according to the German Classification of Occupations (KldB) 1988, comprising 344 categories, and are classified according to complexity and routinization, following Dengler, Matthes, and Paulus (2014). The classification is based on the BERUFENET data collected by IAB; it contains expert knowledge about competencies and skills. For the definition of local labor markets, I use the classification of districts (*kreis*) in commuting zones, according to Kosfeld and Werner (2012).

D.1 Labor supply expansion with the Mini-Job Reform

A simple accounting exercise on the earnings distribution indicates that, with the reform, the proportion of workers increased at the bottom of the distribution. Figure B.7 explains schematically the main ideas behind this exercise. Let's denote the change in the mass of workers below the mini-job threshold as follows:

$$\Delta Emp(MJ) \equiv \frac{Emp_1(MJ) - Emp_0(MJ)}{Emp_0(MJ)}, \tag{12}$$

where $Emp_t(MJ)$ denotes employment below the earnings threshold introduced by the reform (€400), and t is 0 before and 1 after. This mass of employment below the earnings threshold is normalized by the employment level below the threshold in the case of absence of the reform. The mass below the threshold after the reform comprises: (i) workers who retain their jobs (potentially improving earnings), (ii) workers who transit from non-employment to employment, denoted by $Emp_1^+(MJ)$, and (iii) workers pulled from above the earnings distribution, $Emp_1^-(MJ)$. Decomposing $Emp_1(MJ)$ into the sum of $Emp_1^+(MJ)$ and $Emp_1^-(MJ)$

$$\Delta Emp(MJ) = \frac{Emp_1^+(MJ) + Emp_1^-(MJ) - Emp_0(MJ)}{Emp_0(MJ)} \tag{13}$$

The fraction of entrants from non-employment is:

$$\Delta Emp_{MJ}^+ \equiv \frac{Emp_1^+(MJ) - Emp_0(MJ)}{Emp_0(MJ)} = \Delta Emp(MJ) - \frac{Emp_1^-(MJ)}{Emp_0(MJ)}, \tag{14}$$

which is the excess mass of workers below the threshold netted out from the proportion that was pulled down from the upper segment of the earnings distribution. The fraction of workers coming from the upper segment of the earnings distribution is proxied by the missing mass that is close to

the threshold:

$$Emp^{-}(MJ) \equiv emp_0(w > MJ) - emp_1(w > MJ), \tag{15}$$

where $emp_t(w > MJ)$ denotes the number of workers with wages above the mini-job threshold. Using annual data from the SIAB, considering individuals only according to their main job, and €1,200 as the upper limit (where visually the pre- and post-reform distributions of earnings converge), the quantities are: $\Delta Emp(MJ)/Emp_0(MJ)$ =7.8% and $Emp^{-}(MJ)/Emp_0(MJ)$ =-4.1%, which yields ΔEmp^{+}_{MJ} =3.6%. This excess mass is even larger when considering only the prime-age population (9.8%), and more so if all spells (secondary jobs included) are considered (41.7%). There is an ongoing downward trend in employment and an upward trend in unemployment in the period of the reform. However, the distribution of earnings seems relatively stable in the pre-reform years (see Figures B.2 to B.5), which suggests that the error is likely to be small if we ignore time trends in employment when comparing the earnings distribution over a short horizon.

Transitions from non-employment to different employment types, between 2002 and 2004 (Table A.3), corroborate that new workers entered the workforce at the bottom of the earnings distribution. Two-fifths of the workers in mini-jobs in 2004 were not employed in 2002, while only 13% of the workers who are in regular part- or full-time employment in 2004 were not employed in 2002.[30] This indicates an increased influx of new workers into the mini-job segment once the reform is in effect. More than one-third of the transitions out of non-employment between 2002 and 2004 are through mini-jobs, whereas this represents only 15% of workers.[31]

Besides the entry of new workers, the supply of mini-jobs increased due to secondary-job holders. The proportion of workers with secondary jobs increased by around 50%, from 3.4% before the reform to 5% after the reform (Table A.4). This increase was particularly pronounced for women, prime-age and medium-educated workers.[32]

A final source of employment in mini-jobs are workers who were previously earning above the threshold and whose gross earnings decreased after the reform, potentially keeping net earnings. Looking more closely at the workers close to the mini-job earnings threshold in 2004 (between €325 and €400, Tables A.5 and A.6) reveals that whereas 36% were non-employed in 2002, only 13.5% had higher earnings before the reform. This proportion is substantially larger among job movers (37%) than job stayers (15.5%). The numbers suggest that, first, the increase in the employment mass in the bottom of the earnings distribution is not mainly driven by earnings cuts. Second, whenever there is a fall in gross earnings around the threshold, it is more likely to be associated with a job-to-job transition than to occur within the firm. A substantial proportion of workers close to the mini-job threshold seems to have experienced a reduction in hours worked (11% transit from full-time to part-time) or a change in occupation (23%). Both events are strongly associated with a change in employer.

[30] The lack of information on a registered individual in one period is considered a non-participation spell, as this is standard with social security data (see, e.g., Carrillo-Tudela, Launov, and Robin 2019).

[31] Transitions vary by age and gender, not shown in the table. In particular, flows from non-employment to mini-jobs are especially relevant among women, and young and old workers, whereas they are lower for prime-age men. The latter group has higher participation among workers coming from the high-earnings group.

[32] Figure B.6 shows the cumulative distribution of earnings, comparing only main jobs and when all jobs (main or secondary) are included. The cumulative employment mass below the mini-job threshold increases dramatically when second jobs are included.

D.2 Low- and high-earning workers as production inputs

Workers in certain occupations (e.g., cooks, assistants, salespersons, drivers, workers in warehousing and transportation, office specialists and household workers) display frequent transitions between mini-jobs–low-earning workers–and regular employment– high-earning workers. A switch in the type of employment typically responds to changes in full- or part-time status. Hence, one possible hypothesis is that, for some occupations, those characterized by low- or medium-skill requirements, regular employment can be substituted by mini-jobs by splitting a full-time job into two or more part-time jobs. The type of jobs typically carried out by mini-jobbers have a large variability in terms of skills requirements (e.g., around one-half of household cleaners, craftsmen, artists and sportsmen, auxiliary office workers, and teaching and research assistants at universities are mini-jobbers). It is feasible that slight differences in responsibilities or skill requirements for a given occupation lead to a different wage level and, hence, to admit either mini-jobs or regular employment for such occupations.[33] The possibility of substituting between full- and part-time employment has been discussed in other contexts (see, e.g., Goldin and Katz 2016 for the pharmaceutical sector). Substitution is possible due to technological changes and improvements in the information flows within an organization and also to new remuneration schemes that make pay more output dependent and, thus, less directly dependent on the number of hours worked. Another argument in favor of the substitutability of low- and high-earning workers is that similar workers in similar firms can have very different levels of earnings, depending on the hierarchy level, or the degree of control over their own job, as documented by Bayer and Kuhn (2016).

At the same time, this type of substitutability has a limit. Technological constraints may limit the possibility of splitting occupations in shifts, or certain occupations may require particular skill levels. The proportion of workers with different education levels and hours worked (and their share in the labor cost) shows a considerable variability across industry branches even when narrowly defined (see Table A.7). This observation suggests that, for establishments to produce, they need to combine both low- and high-earning workers, as these workers are complementary.[34]

Overall, the discussion in this section supports the premise that mini-jobbers–low-earning workers–are imperfect substitutes of regular–high-earning–workers.

[33] There are references in news articles about this type of substitution, e.g., quoting "The dark side of Germany's job miracle" (Reuters, 2012), "regular full-time jobs are being split up into mini-jobs" and "there is little to stop employers paying mini-jobbers low hourly wages given they know the government will top them up and there is no legal minimum wage." The article also quotes a worker saying, "A lot of my friends work as carpenters, but companies describe them as janitors in their contracts to avoid paying the salary negotiated in the collective wage agreement."

[34] Furthermore, Table A.8 shows that there is an important amount of variability in the use (intensity or cost ratio) of low- and high-earning workers within the same (narrowly defined) industry, a fact that has been shown to indicate that inputs are imperfect substitutes (Raval 2018).

E Additional Derivations in the Theoretical Framework

E.1 Partial equilibrium: Labor supply decision

Given the individual problem of an establishment determining its labor supply, (8), the first-order condition for the solution in the absence of non-linearities is:

$$n = \alpha \hat{w}^{\varepsilon} \tag{16}$$

Note that $\hat{w} = \alpha^{-\frac{1}{\varepsilon}} n^{\frac{1}{\varepsilon}}$ is positively related to the disutility of work. Net earnings, $\alpha^{-\frac{1}{\varepsilon}} n^{\frac{1+\varepsilon}{\varepsilon}}$, are a non-linear function of hours.[35] The take-home wage of the worker is below productivity, $\hat{w} < w$, as a consequence of the tax.

With non-linear taxes, wages, fixed costs of work and non-labor income, there exists α_0^* such that $U(b,0) = U(c,n)$ (for $n > 0$):

$$\alpha_0^* = \frac{(\varepsilon+1)(b+\beta)}{\hat{w}_1^{\varepsilon+1}} \tag{17}$$

Let's define α_1^* as the value of α such that workers choose n, which yields K before-tax earnings ($\hat{K}$ after taxes):

$$\alpha_1^* \equiv \frac{\hat{K}}{\hat{w}_1^{\varepsilon+1}} \tag{18}$$

Finally, there exists α_2^* that solves $U(\hat{K}, \hat{K}/\hat{w}_1) = U(\alpha \hat{w}_2^{\varepsilon+1}, \alpha \hat{w}_2^{\varepsilon})$:

$$(\varepsilon+1)\hat{K} - \varepsilon \alpha_2^{*-\frac{1}{\varepsilon}} \left(\frac{\hat{K}}{\hat{w}_1}\right)^{1+\frac{1}{\varepsilon}} - \alpha_2^* \hat{w}_2^{\varepsilon+1} = 0 \tag{19}$$

Let us consider the relevant case of $\hat{w}_1 > \hat{w}_2$. For individuals with $\alpha \leq \alpha_0^*$, the fixed cost of working and the loss of non-labor income are sufficiently high that the net earnings in a type-1 job cannot compensate for the costs if the workers were to supply their preferred number of hours. As a consequence, they do not work. For $\alpha_0^* < \alpha \leq \alpha_1^*$, individuals optimally choose their number of hours and sort into type-1 jobs, with α_1^* corresponding to the individual for which the optimal n is such that gross earnings are exactly K. Individuals with $\alpha_1^* < \alpha < \alpha_2^*$ would like to work more hours at the take-home wage $\hat{w}_1$, but they cannot do so because their earnings would surpass K and the wage they receive is $\hat{w}_2 < \hat{w}_1$. These agents bunch at the threshold that supplies $n = K/w_1$ at w_1 and subject to τ_1. Individuals with $\alpha \geq \alpha_2^*$ supply their optimal number of hours in type-2 jobs at w_2 and are subject to τ_2.

E.2 Comparative statics: A change in the labor supply when tax benefits change

Given w_1 and w_2, when τ_1 decreases, $(1-\tau_1)$ increases one-to-one. The change in α_0^* is:

$$\frac{\partial \alpha_0^*}{\partial (1-\tau_1)} = -\frac{(\varepsilon+1)^2(b+\beta)}{(1-\tau_1)^{\varepsilon+2} w_1^{\varepsilon+1}}, \tag{20}$$

[35] The formulation with non-linear earnings as a function of hours is typical in the literature that deals with intensive and extensive margins of labor supply (see, e.g., Erosa, Fuster, and Kambourov 2016). Note that earnings are increasing in the disutility for labor, to compensate the individual for the utility cost of supplying more hours of work. The non-linear specification penalizes individuals with a low number of hours, bounding the labor supply decision at the intensive margin away from zero.

which is negative. For α_1^*:

$$\frac{\partial \alpha_1^*}{\partial (1-\tau_1)} = -\frac{\varepsilon K}{\hat{w}_1^{\varepsilon+1}} \tag{21}$$

is also negative. For α_2^*, renaming equation 19 as the implicit function $\tilde{F}(\alpha_2^*, (1-\tau_1))$:

$$\frac{\partial \alpha_2^*}{\partial (1-\tau_1)} = -\frac{\partial \tilde{F}/\partial (1-\tau_1)}{\partial \tilde{F}/\partial \alpha_2^*} \tag{22}$$

where:

$$\frac{\partial \tilde{F}}{\partial (1-\tau_1)} = (\varepsilon+1)K \tag{23}$$

$$\frac{\partial \tilde{F}}{\partial \alpha_2^*} = \alpha_2^{*-\frac{1}{\varepsilon}-1}\left(\frac{K}{w_1}\right)^{1+\frac{1}{\varepsilon}} - \hat{w}_2^{\varepsilon+1} \tag{24}$$

The expression in equation 23 is positive. To derive the sign of the expression in equation 24, note that the first term is lower than the second because:

$$\left(\frac{\hat{K}}{\alpha_2^* \hat{w}_1^{\varepsilon+1}}\right)^{\frac{1}{\varepsilon}} < \frac{\hat{w}_2}{\hat{w}_1} \tag{25}$$

$\alpha_2^* \hat{w}_1^{\varepsilon+1}$ are the net earnings the individual with the initial α_2^* would have incurred if that individual could supply the optimal number of hours at $\hat{w}_1$, which, by construction, are higher than $\hat{K}$. The factor on the left-hand side is, hence, lower than one, as is the factor on the right-hand side as $\hat{w}_2 < \hat{w}_1$. Further, the exponent $1/\varepsilon > 1$ means that the left-hand side is smaller than the right-hand side. Hence, expression (24) is negative and $\partial \alpha_2^*/\partial (1-\tau_1) > 0$. This means that when in-work benefits expand (decrease in τ_1), given the wages, N_1^S increases. The drivers are both the inflow of new entrants into employment (α_0^* decreases) and workers previously in type-2 jobs (α_2^* increases). N_2^S decreases, pushing upwards the ratio N_1^S/N_2^S in the partial equilibrium.

As a cautionary note, I use this parsimonious way of modeling the expansion of an in-work benefit, by a reduction in τ_1. This exercise is particularly insightful about the introduction of in-work benefits. However, this does not match what happened in the case of the Mini-Job Reform. With the reform, K increased. The result of this modification is also an increase in N_1^S/N_2^S in the partial equilibrium, but the channel is different. α_0^* does not change, but α_1^* and α_2^* are affected:

$$\frac{\partial \alpha_1^*}{\partial K} = \frac{1}{w_1^{\varepsilon+1}(1-\tau_1)^{\varepsilon}} \tag{26}$$

is positive, and:

$$\frac{\partial \alpha_2^*}{\partial K} = -\frac{\partial \tilde{F}/\partial K}{\partial \tilde{F}/\partial \alpha_2^*} \tag{27}$$

is also positive. Note that in equation 27 the denominator is the same as in equation 22, and the numerator is:

$$\frac{\partial \tilde{F}}{\partial K} = (\varepsilon+1)(1-\tau_1) - \varepsilon \alpha_2^{*-\frac{1}{\varepsilon}}\left(1+\frac{1}{\varepsilon}\right)\left(\frac{K}{w_1}\right)^{\frac{1}{\varepsilon}} \tag{28}$$

For this expression to be positive, $(1-\tau_1)^{\varepsilon} w_1^{\varepsilon+1} \alpha_2^* > K$. This is indeed the case because the left-hand side is the total before-tax earnings of the individual with α_2^* if that individual were to supply

the preferred hours at the take-home wage $\hat{w}_1$. By construction, this amount is higher than K. Hence, the expression in equation 27 is positive. This means that the change in N_1^S/N_2^S with the Mini-Job Reform under this framework responds exclusively to a reallocation of workers within the low-earning segment (the increase in α_1^* means that workers already in type-1 jobs supply more hours of work), and from the high-earning segment (the increase in α_2^* captures that workers previously in type-2 jobs sort into type-1 jobs by reducing their number of hours worked). Although these effects are not unreasonable for many workers, there is a dimension the model is missing: the entry from secondary workers who may have higher fixed costs of work and would be induced to enter after the reform, given the higher net wage. There are also new low-earning jobs taken up as a secondary job, something also not captured in the model. These caveats are important, as pointed out in section D.1.

E.3 Equilibrium wages

The expansion of in-work benefits induces N_1^S/N_2^S to increase. In equilibrium, the supply of and demand for each job and the relative wages adjust such that the labor market clears. This means that the labor demand ratio, N_1^D/N_2^D, also increases to match the labor supply.

From the first-order condition of the problem of the firms:

$$\left(\frac{\theta_H}{1-\theta_H}\right)^{-\sigma}\frac{N_{1H}}{N_{2H}} = \left(\frac{\theta_L}{1-\theta_L}\right)^{-\sigma}\frac{N_{1L}}{N_{2L}} \tag{29}$$

Taking derivatives on both sides with respect to N_1^D/N_2^D:

$$\left(\frac{\theta_H}{1-\theta_H}\right)^{\sigma}\frac{\partial(N_{1H}/N_{2H})}{\partial(N_1^D/N_2^D)} = \left(\frac{\theta_L}{1-\theta_L}\right)^{\sigma}\frac{\partial N_{1L}/N_{2L}}{\partial N_1^D/N_2^D} \tag{30}$$

As we can see in equation 30, the direction of change in each firm's ratio is the same as in the aggregate because $\theta_k/(1-\theta_k) > 0$. For a higher N_1^D/N_2^D to match the increase N_1^S/N_2^S due to the expansion of the tax benefit, the firm-specific ratios need to increase.

Knowing that the firm-specific ratio moves in the same direction as the aggregate ratio in labor demand, without loss of generality, I can derive the direction of the change in w_1/w_2 in equilibrium. I derive both sides of the first-order condition for the firm H with respect to the change in N_1^S/N_2^S, which in equilibrium is equal to the change in N_1^D/N_2^D:

$$\frac{\partial(w_1/w_2)}{\partial(N_1^D/N_2^D)} = -\frac{1}{\sigma}\left(\frac{\theta_H}{1-\theta_H}\right)\left(\frac{N_{1H}}{N_{2H}}\right)^{-\frac{\sigma+1}{\sigma}}\frac{\partial(N_{1H}/N_{2H})}{\partial(N_1^D/N_2^D)} \tag{31}$$

All the factors in the right-hand side have a positive sign, except for $-1/\sigma < 0$. Hence, for N_1^D/N_2^D to increase to equate the labor supply, w_1/w_2 needs to fall. On the one hand, note that the lower σ (the higher the complementarity between low- and high-earning workers), the bigger the response in the wages due to a change in the relative supply, and the smaller the changes in the relative quantities of labor. On the other hand, the only case in which the change in the relative supply of labor does not exert any effect on the relative wages is when low- and high-earning jobs are perfect substitutes ($\sigma \to \infty$).

E.4 Decomposition in the scale and substitution effects

The Hicks-Marshall rules of derived demand allow us to decompose the change in the labor demand of each employment type when there is a change in the price of one type of employment, in terms of elasticities and cost shares. Let's assume perfect competition and free entry. For simplicity, I skip the index for firm k; all derivations need to hold for both $k \in \{H, L\}$.

Let $s_1 \equiv \frac{w_1 N_1}{pY} = \theta \left(\frac{N_1}{Y}\right)^{\frac{\sigma-1}{\sigma}}$ and $s_2 \equiv \frac{w_2 N_2}{pY} = (1-\theta)\left(\frac{N_2}{Y}\right)^{\frac{\sigma-1}{\sigma}}$ be the cost share of labor in type-1 and type-2 jobs, respectively.

Totally differentiating $Y = F(N_1, N_2)$:

$$\begin{gathered} dY = Y^{\frac{1}{\sigma}} \theta N_1^{-\frac{1}{\sigma}} dN_1 + Y^{\frac{1}{\sigma}} (1-\theta) N_2^{-\frac{1}{\sigma}} dN_2 \\ \frac{dY}{Y} = \frac{Y^{\frac{1}{\sigma}} \theta N_1^{-\frac{1}{\sigma}} N_1}{Y} \frac{dN_1}{N_1} + \frac{Y^{\frac{1}{\sigma}} (1-\theta) N_2^{-\frac{1}{\sigma}} N_2}{Y} \frac{dN_2}{N_2} \\ dlnY = s_1 dlnN_1 + s_2 dlnN_2 \end{gathered} \tag{32}$$

Since the production function has constant returns to scale, $s_1 = 1 - s_2$:

$$\begin{gathered} dlnY = s_1 dlnN_1 + (1-s_1) dlnN_2 \\ dlnN_1 = dlnY + (1-s_1)(dlnN_1 - dlnN_2) \end{gathered} \tag{33}$$

Dividing by $dlnw_1$:

$$\frac{dlnN_1}{dlnw_1} = \frac{dlnY}{dlnw_1} + (1-s_1)\frac{dlnN_1 - dlnN_2}{dlnw_1} \tag{34}$$

A similar expression can be derived for N_2:

$$\frac{dlnN_2}{dlnw_1} = \frac{dlnY}{dlnw_1} - s_1 \frac{dlnN_1 - dlnN_2}{dlnw_1} \tag{35}$$

These expressions decompose the change in the demand for both factors N_1 and N_2 when the price of one of them changes, w_1, in a scale effect (first term) and a substitution effect (second term). Whereas the scale effect is in the same direction in both the demand for N_1 and N_2, the substitution effect acts in the opposite direction.

Next, I express equations 34 and 35 in terms of elasticities. For the scale effect, I use the fact that under perfect competition and free entry, firms make zero profits: $pY = w_1 N_1 + w_2 N_2$. Defining as $\eta \equiv -\frac{dlnY}{dlnp}$ the elasticity of demand for output (in absolute value), and plugging $dlnY = -\eta dlnp$ in equation 34:

$$\frac{dlnN_1}{dlnw_1} = -\eta \frac{dlnp}{dlnw_1} + s_2 \frac{dlnN_1 - dlnN_2}{dlnw_1} \tag{36}$$

Differentiating the zero-profit condition, for the case where only w_1 changes, and using equation 32:

$$dlnp = s_1 dlnw_1 \tag{37}$$

For the substitution effect, using the ratio of first-order condition of the firm's problem:

$$\frac{N_1}{N_2} = \left(\frac{\theta}{1-\theta}\right)^{\sigma} \left(\frac{w_1}{w_2}\right)^{-\sigma} \tag{38}$$

Taking the logs and differentiating:

$$dlnN_1 - dlnN_2 = -\sigma dlnw_1 \tag{39}$$

The elasticities of the demand for labor in each type of job when the price of employment in type-1 jobs changes:

$$\begin{array}{c} \frac{dlnN_1}{dlnw_1} = -[s_1\eta + (1-s_1)\sigma] \\ \frac{dlnN_2}{dlnw_1} = -[s_1\eta - s_1\sigma] \end{array} \tag{40}$$

E.5 Exposure to low-earning employment and cost shares

From the first-order conditions of the firm, $\frac{N_{1H}}{N_{2H}} > \frac{N_{1L}}{N_{2L}}$. From the definition of s_1 omitting the indices k,

$$\begin{aligned} s_1 &= \theta \left(\frac{N_1}{Y}\right)^{\frac{\sigma-1}{\sigma}} \\ &= \theta \left\{ A \left[\theta + (1-\theta) \left(\frac{N_1}{N_2}\right)^{-\frac{(\sigma-1)}{\sigma}} \right] \right\}^{-1} \end{aligned} \tag{41}$$

Deriving with respect to N_1/N_2:

$$\frac{\partial s_1}{\partial (N_1/N_2)} = \theta(1-\theta)\frac{\sigma-1}{\sigma}\left(\frac{N_1}{N_2}\right)^{-\frac{2\sigma-1}{\sigma}} \left\{ \left[\theta + (1-\theta)\left(\frac{N_1}{N_2}\right)^{-\frac{(\sigma-1)}{\sigma}} \right] \right\}^{-2} \tag{42}$$

where the right-hand side is positive.

Let's define $\phi_k \equiv \frac{N_{1k}}{N_{1k}+N_{2k}}$ as the proportion of hours of a firm's low-earning workers out of total number of hours for all the firm's workers. I express N_1/N_2 in terms of ϕ:

$$\frac{N_1}{N_2} = \frac{\phi}{1-\phi} \tag{43}$$

Deriving this expression in terms of ϕ

$$\frac{\partial (N_1/N_2)}{\partial \phi} = \frac{1}{1-\phi}, \tag{44}$$

which is a positive expression, as $\partial s_1/\partial(N_1/N_2)$ showed before. Hence:

$$\frac{\partial s_1}{\partial \phi} = \frac{\partial s_1}{\partial (N_1/N_2)} \frac{\partial N_1/N_2}{\partial \phi} > 0 \tag{45}$$

The insight from this expression is that there is a positive relationship between the cost share, which is the relevant variable when considering the heterogeneous strength of the scale and the substitution effects, and the fraction of the labor in low-earning jobs in each firm, which is a proxy for the exposure variable used in the empirical analysis.

E.6 Consumption and government budget

Aggregate income is:

$$\begin{aligned} Inc &= (b+tr)F(\alpha_0^*) \\ &+ \int_{\alpha_0^*}^{\alpha_1^*}(\alpha\hat{w}_1^{\varepsilon+1}+tr)f(\alpha)d\alpha + \int_{\alpha_1^*}^{\alpha_2^*}(\hat{K}+tr)f(\alpha)d\alpha \\ &+ \int_{\alpha_2^*}^{\infty}(\alpha\hat{w}_2^{\varepsilon+1}+tr)f(\alpha)d\alpha \end{aligned} \tag{46}$$

The total income in the economy is exhausted in the demand for goods: $Inc = p_H Y_H + Y_L$. I model the demand for each good by using a CES aggregation at the economy-wide level:

$$Y_H = \frac{1}{p_H}\frac{Inc}{1+p_H^{\kappa-1}} \qquad Y_L = \frac{Inc}{1+p_H^{\kappa-1}} \tag{47}$$

Balancing the government's budget implies $T = G$, where:

$$\begin{aligned} T &= \int_{\alpha_0^*}^{\alpha_1^*}\alpha w_1^{\varepsilon+1}(1-\tau_1)^{\varepsilon}\tau_1 f(\alpha)d\alpha + \int_{\alpha_1^*}^{\alpha_2^*}K\tau_1 f(\alpha)d\alpha \\ &+ \int_{\alpha_2^*}^{\infty}\alpha w_2^{\varepsilon+1}(1-\tau_2)^{\varepsilon}\tau_2 f(\alpha)d\alpha \end{aligned} \tag{48}$$

and:

$$G = tr + bF(\alpha_0^*) \tag{49}$$

E.7 Parameterizations and solution

To solve the model, I start in partial equilibrium (w_1 and w_2 fixed), and I obtain N_1^S and N_2^S, Inc, Y_H, Y_L, N_{1H}, N_{1L}, N_{2H}, and N_{2L}. Using the zero-profit condition of the firm H, I further obtain p_H. Finally, I iterate on w_1 and w_2 until the excess supply for both types of jobs is zero.

The model is parameterized as follows. I assume $F(\alpha)$ follows a Weibull distribution, characterized by parameters μ and γ. The parameter ε is set to the average of the estimates according to Tazhitdinova (2020). The parameter b is set to 100 as a normalization. The rest of the parameters (θ_H, θ_L, A_H, A_L, β, μ, γ, κ) are selected such that the model provides moments with reasonable values as compared to the pre-reform data (the average for the period 1999 to 2002): the employment rate, the proportion of mini-jobbers with respect to the total number of workers, the proportion of workers in the bunching at €400, the average across highly exposed and non-exposed establishments, the daily (FTE) gross wage rate for low-earning workers, the proportion of low-earning (FTE) employment out of total (FTE) employment, and the total (FTE) employment in highly exposed establishments as a proportion of total (FTE) employment. The key parameter, σ, is set such that the simulation of the Mini-job Reform produces changes in line with the DiD estimates. The parameter values are shown in Table A.24 and the comparison of the moments of the model, in Table A.25.