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Occupational Deregulation, Skill Scarcity, and Incumbent Wage Premia^{*}

Abstract

We examine the effect of occupational deregulation on incumbent master craft workers' wages by exploiting a 2004 reform in the German crafts sector that removed the requirement to hold a master certificate for business entry in roughly half of all craft occupations. Using administrative, employee-level data and a triple-difference design, we find that the reform increased the wage premium of incumbent masters by 3% in deregulated relative to regulated occupations. The results are consistent with a scarcity mechanism whereby the decline in the inflow of newly certified masters increased the relative market value of incumbent masters. The wage premium increase is most pronounced in small firms and in East Germany, where pre-existing shortages of high-skilled labor amplified the scarcity effect. These findings suggest that deregulation may have unintended distributional consequences by reducing the private return to obtaining advanced occupational certification, thereby raising incumbent wage premia and widening skill-based wage gaps.

JEL classification

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Keywords

occupational licensing, deregulation, skill investment, skill scarcity, wage premium

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1 Introduction

Occupational regulation—and occupational licensing in particular—has expanded substantially over the past three decades and covers nearly a quarter of all workers in both the United States and the European Union (Cunningham 2019; Koumenta and Pagliero 2019). Licensing is commonly justified as a way to set minimum quality standards and mitigate information asymmetries between consumers and service providers (Leland 1979; Shapiro 1986). These regulations typically require individuals to obtain formal credentials, pass standardized exams, complete mandatory training, or acquire special permits before they may legally practice in a given field (Kleiner 2000).

The labor-market effects of occupational regulation are theoretically ambiguous. Entry requirements may screen out low-quality providers and strengthen incentives for occupation-specific human capital investment. Yet they may also induce inefficiently high standards, excessive investment in credentials, and rents for incumbents (Shapiro 1986; Kleiner 2000). This ambiguity is particularly relevant in the context of deregulation. While removing legal entry restrictions should increase competition and reduce regulatory rents (Kleiner 2000; Koumenta et al. 2022), it may also reduce the private return to obtaining occupational credentials. If this discourages workers from acquiring these credentials, the resulting scarcity of credentialed workers may increase the relative market value of their qualifications. Whether deregulation lowers or raises the wages of credentialed workers is therefore an empirical question.

In this paper, we examine how occupational deregulation affects the wages and wage premia of credentialed workers. Existing evidence on the labor-market consequences of occupational deregulation is limited and yields mixed results, with studies documenting both wage declines and wage gains (e.g., Kleiner et al. 2016; Pizzola and Tabarrok 2017). We contribute to this literature by showing that deregulation can increase the relative scarcity of credentialed workers and thereby raise their wage premia.

We study this question in the context of the German crafts sector. Our empirical setting is the 2004 amendment to the German Trade and Crafts Code, which abolished

the master certificate requirement for starting a business in approximately half of all craft occupations. The reform substantially increased entrepreneurial activity in deregulated occupations ([Rostam-Afschar 2014](#)). Its implications for dependent employment (i.e., employment as an employee rather than self-employment), however, were more subtle. Workers without a master certificate could legally perform craft tasks as employees both before and after the reform. Among employees, the master certificate thus served as a voluntary credential signaling advanced skills and productivity. The reform removed the certificate’s role as a legal requirement for business entry in deregulated occupations but left its role as a voluntary labor-market credential unchanged. This institutional setting allows us to estimate how the wage premium associated with the master certificate changes once the certificate is no longer required to start a business.

We argue that occupational deregulation may affect the wage premium of incumbent master craft workers through two opposing channels. On the one hand, lower entry barriers may reduce the relative demand for master labor. This channel puts downward pressure on the incumbent master wage premium. On the other hand, deregulation can reduce incentives to obtain the master certificate. A lower inflow of newly certified workers can gradually reduce the stock of masters relative to non-masters. This relative scarcity can raise the wage premium of incumbent masters. The net effect is theoretically ambiguous and depends on whether the relative-scarcity effect dominates the relative-demand effect. We formalize these channels in a stylized partial-equilibrium framework.

We estimate the reform effect using two complementary difference-in-differences (DiD) designs. First, we compare wage changes of incumbent master craft workers in deregulated occupations with those in regulated occupations before and after the 2004 reform. Second, because our main outcome of interest is the master wage premium, we use a triple-difference (DDD) design that adds non-master craft workers as an additional comparison group. This specification compares the change in the master–non-master wage gap in deregulated occupations with the corresponding change in regulated occupations, thereby netting out differential wage changes between deregulated and regulated occupations that are common to masters and non-masters. Our analysis uses longitudinal administrative data from the

German Sample of Integrated Labour Market Biographies (SIAB), which represents a 2% random sample of workers covered by the German social security system.

2 Institutional Background and Related Literature

2.1 Occupational Regulation

Occupational regulation refers to the rules and requirements that govern entry into occupations or specific activities within an occupation. These regulations differ in how strongly they restrict who may provide a service, perform a task, or operate a business.

Occupational licensing is the most stringent form of occupational regulation. It typically requires individuals to meet prerequisites such as obtaining a specific educational qualification, passing standardized examinations, completing mandatory training, or acquiring a special permit before they may legally operate a business or practice in a given field (Kleiner 2000). In licensed occupations, it is illegal to perform the regulated activity without holding the appropriate license.

Certification is less restrictive. It does not restrict the right to practice but allows individuals to voluntarily obtain certification from a regulatory body. Certification attests to a worker's competence and helps consumers or employers distinguish between certified and non-certified providers. Unlike licensing, certification does not legally bar non-certified individuals from engaging in the occupation (Kleiner 2000).

This distinction matters for expected wage effects. Both licensing and certification may generate wage premia by signaling worker quality or screening workers with higher productivity. Licensing is generally expected to generate a larger premium because it combines screening with legal entry restrictions and the resulting wage-setting power (Koumenta et al. 2022).

The main rationale for occupational regulation is to improve service quality by setting skill requirements and reducing information asymmetries between consumers and providers (Shapiro 1986; Leland 1979). Compared with licensing, certification provides weaker direct

incentives for skill development because, in the absence of mandatory entry barriers, its effectiveness in promoting human capital investment depends largely on labor-market demand for certified workers (Forth et al. 2011).

Licensing may also have unintended economic consequences. By restricting entry, it can reduce competition, increase prices and firm profits, limit the supply of qualified workers, and raise the wages of licensed incumbents (Kleiner 2000; Pagliero 2011). The quantitative importance of occupational regulation is substantial. In the EU, approximately 22% of workers are subject to licensing requirements, and a similar share holds a professional certification related to their main job (Koumenta and Pagliero 2019).¹ In the US, estimates range from 20% to 29% for licensing and from 6% to 8% for certification, depending on the data source and definition (Kleiner and Krueger 2013; Gittleman et al. 2018). Both licensing and certification are therefore quantitatively important labor-market institutions.

2.2 The 2004 Deregulation Policy in Germany

Occupational regulation in Germany has historically been stringent, especially in the crafts sector. These regulations date back to the Middle Ages, when guilds controlled entry into craft occupations and maintained quality standards (Ogilvie 2004, 2014). Until 2004, holding a master certificate (*Meisterbrief*) was a central requirement for establishing a business in the German crafts sector. The master certificate is the highest vocational credential in the crafts sector and is administered by regional craft chambers. It builds on the apprenticeship qualification (*Gesellenprüfung*) and typically requires one to three years of coursework and successful completion of the master examination, with costs ranging from four to ten thousand euros (Rostam-Afschar 2014).²

The master certificate had two economic roles in the German crafts sector. First,

¹Coverage also varies by employment status. In the EU, self-employed workers account for 15% of licensed workers and 15% of certified workers. Employees therefore constitute the large majority of both groups (Koumenta and Pagliero 2016).

²The examination covers four areas: practical occupation-specific skills, theoretical occupation-specific knowledge, business and commercial knowledge including law, and pedagogical competence related to apprentice training. Passing the master examination grants eligibility to train apprentices. The alternative route to obtaining this eligibility is to pass a trainer qualification examination (*Ausbildereignungsprüfung*) (Rostam-Afschar 2015).

before the reform, it served as a legal prerequisite for business entry in crafts subject to the master requirement: individuals generally needed the certificate, or a comparable qualification, to establish or operate a craft business. Second, the same certificate served as a credential in dependent employment. Employees without a master certificate could legally perform craft tasks, but holding the certificate could signal higher productivity, advanced occupation-specific skills, business knowledge, supervisory capacity, and the ability to train apprentices. From an employer’s perspective, the certificate could therefore indicate higher firm-level competence, while also implying higher wage costs or a stronger outside option in wage bargaining, including the possibility of future self-employment.

This institutional distinction is central to our analysis. We study employees, not the self-employed. For employees, the master certificate was not a license to practice; it functioned as a voluntary credential and skill signal both before and after the reform. The reform changed the institutional environment of this credential by removing its licensing role for business entry in deregulated occupations. Thus, our empirical analysis does not estimate the full licensing premium associated with access to self-employment. Instead, it estimates how the wage premium of employed masters changed after the master certificate ceased to be a legal requirement for business entry in deregulated crafts.

In January 2004, the German government implemented a major reform of the Trade and Crafts Code (*Handwerksordnung, HwO*) in response to concerns about declining numbers of craft workers and apprentices. The reform, part of the broader “Agenda 2010” labor market and economic policy package, aimed to facilitate entrepreneurship, stimulate employment growth, and enhance economic competitiveness. It removed the master-certificate requirement for business entry in 53 of 94 craft occupations. The remaining 41 occupations continued to require the master certificate or a comparable qualification for business entry (see Appendix Table [A.1](#)). The official justification for maintaining the master requirement in regulated occupations was to reduce health and safety risks and mitigate information asymmetries. At the same time, the final classification of regulated and deregulated crafts reflected political negotiations among employer associations, labor unions, and political parties, which produced inconsistencies in the allocation of occupations

(Rostam-Afschar 2014). These inconsistencies support the use of the reform as a source of quasi-experimental variation.

The reform transformed the affected occupations from a licensing regime for business entry into a regime in which the master certificate remained a voluntary credential. Although the certificate was no longer legally required to operate a business in deregulated occupations, it continued to signal quality, productivity, and firm-level competence (Rotenberg 1980; Albert et al. 2019). For employees, the certificate remained a voluntary credential both before and after the reform.

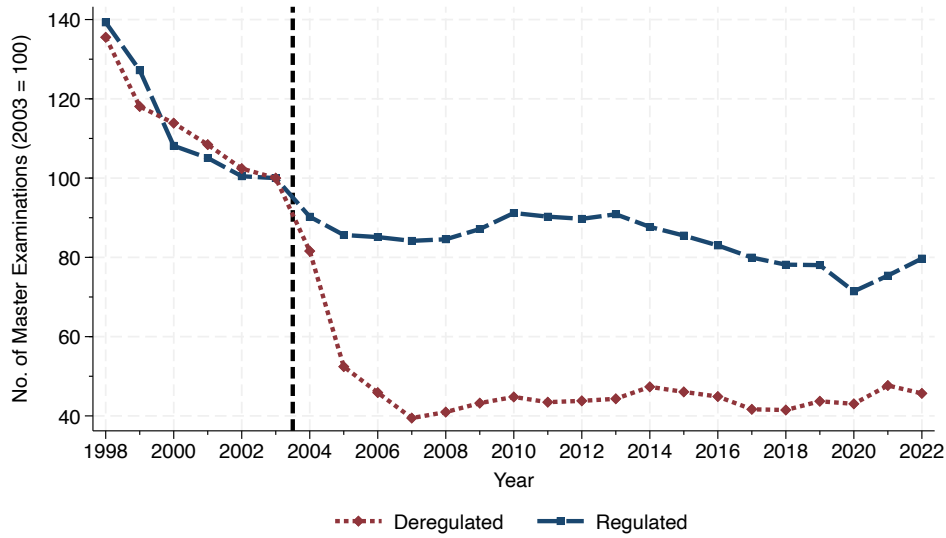


Figure 1: Number of Master Examinations in Regulated and Deregulated Craft Occupations

Notes: The figure shows the number of successfully completed master examinations relative to 2003 for regulated and deregulated occupations. Data source: German Confederation of Skilled Crafts, 1998–2022.

The reform sharply reduced the incentive to obtain the master certificate in deregulated occupations. Figure 1 shows that regulated and deregulated occupations followed similar downward trends in master examinations before the reform. This common decline likely reflected broader developments in the crafts sector, including demographic change and the weak economic environment in the early 2000s (Müller 2018). After 2004, the decline intensified in deregulated occupations, whereas the number of master examinations in regulated occupations stabilized.³ By 2007, completed master examinations in deregulated

³This stabilization is consistent with the fact that the master certificate retained its legal and institutional value in regulated crafts as the main route to establishing a business. In addition, improved

occupations had fallen to approximately 40% of the 2003 level, compared with around 85% in regulated occupations. The number of examinations nevertheless did not fall to zero, suggesting that the certificate retained value as a voluntary credential, either because of the skills acquired during training or because it continued to signal quality to employers and consumers even after it was no longer required for business entry.⁴

2.3 Related Literature

Our paper relates primarily to the literature on the labor-market effects of occupational regulation, particularly the growing literature on occupational licensing. Most studies in this area examine wages and earnings and generally document a wage premium associated with occupational licensing.⁵ For example, [Koumenta and Pagliero \(2019\)](#) show that entry regulation is associated with 4% higher hourly wages in the EU. [Kleiner and Krueger \(2013\)](#) and [Gittleman and Kleiner \(2016\)](#) find somewhat larger effects in the US, ranging from 7% to 11%.

Recent theoretical work emphasizes that occupational licensing affects labor-market outcomes through multiple channels. [Koumenta et al. \(2022\)](#) distinguish between screening and wage-setting power, arguing that licensing combines both features, whereas certification operates mainly through screening. Consistent with this distinction, they estimate wage premia of 4% for licensing and 1.6% for certification among native workers in the EU. [Siegel \(2020\)](#) shows that licensing standards can shape incentives for skill acquisition and may therefore be welfare-relevant beyond their role in ex post sorting. [Kleiner and Soltas \(2023\)](#) develop a structural welfare framework in which licensing is modeled as a mandatory upfront investment in occupation-specific human capital that can restrict labor

financial support through the Meister-BAföG and marketing campaigns for master training may have supported demand for master training during this period ([Müller 2018](#)).

⁴For context on the career paths of prospective masters, survey evidence indicates that self-employment was an important, but far from universal, option. Among master-course participants surveyed in 2010, about 39% were either already self-employed or intended to become self-employed after obtaining the master certificate ([Lehmann and Müller 2012](#)).

⁵For example, studies by [Kleiner and Kudrle \(2000\)](#), [Weeden \(2002\)](#), [Timmons and Thornton \(2008\)](#), [Kleiner and Krueger \(2010\)](#), [Thornton and Timmons \(2013\)](#), [Chi et al. \(2017\)](#), [Kleiner and Vorotnikov \(2017\)](#), [Ingram \(2019\)](#), [Zhang \(2019\)](#), [Dodini \(2023\)](#), [Lyu et al. \(2023\)](#), [Blair and Chung \(2025\)](#), [Carollo \(2025\)](#), and [Kleiner and Xu \(2025\)](#) find positive effects of occupational licensing on wages and earnings. In contrast, [Redbird \(2017\)](#) finds no positive wage effect.

supply while affecting worker quality, selection, and consumers' willingness to pay. These approaches imply that licensing may affect wages not only by restricting entry but also by changing incentives to acquire skills and altering the composition and scarcity of qualified workers. Our study speaks to this broader perspective by showing how deregulation can reduce incentives to obtain the master certificate and increase the market value of incumbent masters.

A related literature examines the effects of occupational licensing on wage dispersion. By restricting market entry and limiting competition, licensing can generate economic rents. If these rents accrue disproportionately to high-wage workers, licensing may increase wage dispersion ([Koumenta and Pagliero 2019](#)). While studies for the US find no significant effects of licensing on wage dispersion ([Kleiner and Krueger 2013](#); [Gittleman and Kleiner 2016](#)), evidence from the European Union and Canada suggests that occupational licensing increases wage dispersion by disproportionately benefiting workers in the upper part of the wage distribution ([Koumenta and Pagliero 2019](#); [Zhang and Gunderson 2020](#)). We contribute to this literature by showing that deregulation can widen skill-specific wage differentials within occupations. By increasing the scarcity of certified workers, deregulation may raise the wage premium earned by incumbent masters.

Because deregulation reforms are rare, evidence on their labor-market effects remains scarce. Notable exceptions include [Kleiner et al. \(2016\)](#), who find that relaxing scope-of-practice restrictions increased nurses' wages; [Pizzola and Tabarrok \(2017\)](#), who find that the 1983 de-licensing of funeral services in Colorado reduced funeral-service wages by about 11%; and [Timmons and Thornton \(2019\)](#), who find that de-licensing barbers in Alabama in the early 1980s reduced their relative earnings by about 8%. We contribute to this literature by analyzing a German deregulation policy and showing that incumbent wage premia can rise when deregulation weakens incentives to obtain the master certificate and increases the scarcity of certified masters.

Our paper is most closely related to studies of occupational regulation in the German crafts sector.⁶ This literature examines how regulation affects wages (e.g., [Damelang et al.](#)

⁶In 2024, approximately 4.7 million people were employed in the crafts sector, representing about 10%

2018; Lergetporer et al. 2018; Fredriksen 2020; Haupt 2023; Lukesch and Zwick 2024), self-employment (Prantl and Spitz-Oener 2009; Prantl 2012; Rostam-Afschar 2014; Runst et al. 2019), and business dynamism (Bredtmann et al. 2025). Previous studies show that the 2004 reform substantially increased self-employment and business formation in deregulated crafts. Using repeated cross-sections from the German Microcensus, Rostam-Afschar (2014) finds that the reform increased both the likelihood of being self-employed and the probability of entering self-employment among craft workers without a master certificate. Evidence on the income effects for self-employed workers is more limited and generally points to small or statistically insignificant effects (Lergetporer et al. 2018; Fredriksen 2020). While these studies provide evidence on the reform’s effects on entrepreneurship and wages, they do not examine how deregulation affected the returns to a master certificate among employees. We contribute to this literature by showing that deregulation can reshape skill-based wage differentials within occupations and increase the wage premium of incumbent masters.

3 Data and Descriptive Evidence

Our empirical analysis uses the Sample of Integrated Labor Market Biographies (SIAB), provided by the Institute for Employment Research (IAB) at the German Federal Employment Agency. We use the weakly anonymous version covering 1975–2021 (Graf et al. 2023; Schmucker et al. 2023).⁷ The SIAB is a 2% random sample of individuals with at least one entry in the Integrated Employment Biographies (IEB). The IEB combines administrative records on employment subject to social security contributions, receipt of unemployment benefits or basic income support, registered job search, and participation in active labor market programs. The SIAB is representative of individuals covered by the German social security system, which accounts for approximately 80% of the workforce.

of total employment in Germany (Federal Statistical Office 2026).

⁷Access to the data was provided via on-site use at the Research Data Centre of the German Federal Employment Agency at IAB, followed by remote data access.

It does not cover the self-employed, civil servants, or military personnel.⁸ For covered workers, the data provide longitudinal spell records with detailed information on daily wages, occupations, industries, firm size, and sociodemographic characteristics such as age, gender, and educational attainment.

We construct the estimation sample from workers’ main employment spells observed on June 30 of each year from 2000 to 2008. This window covers four pre-reform years and five post-reform years. We end the sample in 2008 to avoid potential confounding from the late-2000s recession and subsequent policy changes. Because we study incumbent workers in dependent employment, we restrict the baseline sample to workers observed at least once before and after the reform. We exclude individuals younger than 18 or older than 65. The SIAB does not report exact hours worked but identifies whether employees are classified as working full-time or part-time. Because we cannot construct hourly wages, we restrict the analysis to employees classified as full-time. To mitigate the influence of implausible earnings values and outliers, we exclude observations with daily earnings below 40 euros and censor the top 1% of the earnings distribution at the 99th percentile.

We classify occupations as regulated or deregulated following the procedure in [Rostam-Afschar \(2014\)](#) and [Lergetporer et al. \(2018\)](#). Specifically, we map occupations from the official Trade and Crafts Code—where regulated occupations are listed in Annex A and deregulated occupations in Annex B1—to the 3-digit German Classification of Occupations 1988 (KldB88) used in the SIAB. This procedure maps all but four small craft occupations to KldB88 codes.⁹

The SIAB identifies workers’ occupations and employers’ industries, but it does not indicate whether a firm is registered in the crafts sector rather than, for example, the industrial or public sector. Our sample may therefore include workers employed by firms not directly affected by the craft-sector deregulation. Because craft firms are typically

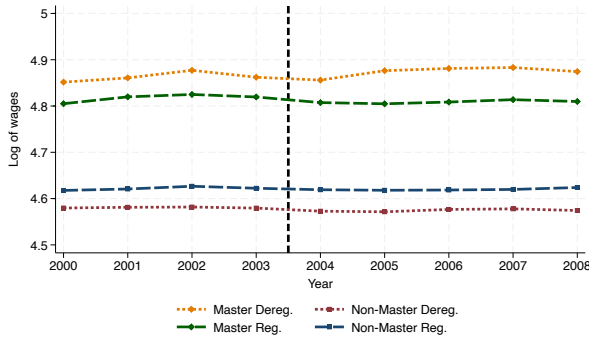
⁸To place our employee sample in the broader context of the German crafts sector at the time of the reform, about 12% of craft workers were self-employed and therefore not covered by the SIAB. Among these self-employed craft workers, 78% held a master certificate ([Koumenta and Pagliero 2016](#); [Müller 2018](#)).

⁹See Appendix Tables [A.2](#) and [A.3](#) for an overview of the occupation matching. [Lergetporer et al. \(2018\)](#) provide a detailed description of the procedure. [Runst et al. \(2019\)](#) propose a more restrictive classification for the German Microcensus.

small or medium-sized, we address this limitation in a heterogeneity analysis by firm size, with smaller firms representing the group most likely to be directly exposed to the reform.

We assign workers to the treatment and control groups based on their pre-reform occupation in 2003. If a worker is not observed in 2003, we use the last available pre-reform observation from 2000 to 2002.¹⁰ The treatment group consists of workers employed in one of the 53 occupations deregulated by the reform, while the control group consists of workers employed in the 41 regulated craft occupations. All control variables, including age, educational attainment, occupation, industry, and firm size, are measured in the pre-reform base period. Appendix Table A.4 defines the key variables, and Appendix Table A.5 reports detailed sample statistics for workers in regulated and deregulated occupations.

Panel A: Wages of Masters and Non-Masters



Panel B: Wage Premia

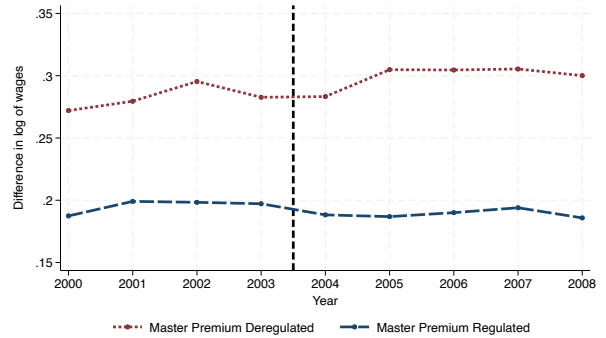


Figure 2: Wages of Master and Non-Master Craft Workers and the Master Wage Premium

Notes: Panel A shows the average log daily wages for regulated and deregulated master and non-master craft workers from 2000 to 2008. Panel B shows the average master–non-master wage gap in regulated and deregulated occupations from 2000 to 2008. Data source: SIAB, 2000–2008.

Figure 2 provides descriptive evidence on wages and wage premia. Panel A plots average log daily wages for master and non-master craft workers from 2000 to 2008, separately by regulatory status. Wage trends are relatively flat for most groups, but wages of masters in deregulated occupations begin to rise in 2005, one year after the reform. Panel B shows the corresponding master wage premia. The premium increases markedly

¹⁰This applies to 9.6% of all workers in our sample. The main reason occupational information is missing for these workers in 2003 is temporary unemployment. In addition, individuals may temporarily move outside the coverage of German social security because of inactivity, self-employment, emigration, or periods of civil service.

in deregulated occupations after the reform, whereas no comparable change is visible in regulated occupations.

4 Empirical Strategy

The 2004 deregulation of the German crafts sector provides quasi-experimental variation that allows us to estimate how removing the master-certificate requirement for business entry affected the wages and wage premia of incumbent master craft workers. We use DiD-based research designs in which treatment status is determined by workers' occupation in the pre-reform base period. Workers whose base-period occupation was subsequently deregulated form the treatment group, while those whose base-period occupation remained regulated form the control group. We begin with a DiD model comparing wage changes of masters in deregulated and regulated occupations before and after the reform:

$$\log(\text{wage}_{ijt}) = \alpha_0 + \alpha_1 \text{deregulated}_j \times \text{post}_t + X_i' \alpha_2 + \mu_j + \kappa_t + \varepsilon_{ijt}, \quad (1)$$

where $\log(\text{wage}_{ijt})$ denotes the log real average daily wage of individual i in occupation j and year t . deregulated_j is an indicator equal to one if the worker's base-period occupation was deregulated by the reform. post_t is an indicator variable that takes the value one in the post-reform period, from 2004 onward. μ_j denotes occupation fixed effects, which control for time-invariant differences across occupations, and κ_t represents year fixed effects, which control for common economic shocks. X_i' includes individual characteristics (e.g., gender, age, education), firm characteristics (e.g., firm size), and regional characteristics (East vs. West Germany), all measured in the pre-reform base period. We hold these control variables fixed at their pre-reform values to ensure that they are predetermined with respect to the reform and to avoid conditioning on characteristics that may themselves respond to deregulation. We restrict the baseline sample to incumbent workers observed at least once before and after the reform, ensuring that each baseline sample member is observed on both sides of the reform. While our main interest is the wage effect for masters, we also estimate Eq. (1) for all craft workers to benchmark our results against

the average effect for incumbent workers.

In Eq. (1), α_1 estimates the average change in log wages in deregulated occupations relative to regulated occupations between the pre- and post-reform periods, conditional on covariates. A causal interpretation requires that, absent the reform, wages in deregulated and regulated occupations would have followed parallel trends.¹¹ It also requires that compositional changes do not differentially alter the treated and control groups in ways correlated with potential wage outcomes.¹²

To examine the dynamic effects of the reform and assess the plausibility of the parallel trends assumption, we estimate an event-study version of Eq. (1). This involves interacting the treatment indicator, deregulated_j , with year indicators, year_t , yielding the following specification:

$$\log(\text{wage}_{ijt}) = \beta_0 + \sum_{\substack{t=2000 \\ t \neq 2003}}^{2008} \eta_t \times \text{deregulated}_j \times \text{year}_t + X'_i \beta_2 + \mu_j + \kappa_t + \varepsilon_{ijt}. \quad (2)$$

The last pre-treatment year, 2003, is omitted and serves as the reference category. The coefficients η_t capture the differential wage change between deregulated and regulated occupations in each year relative to 2003.

Even if pre-reform wage trends are parallel, the identifying assumption could be violated if contemporaneous shocks affected regulated and deregulated occupations differently. For example, demand shocks or other policy changes affecting services provided by deregulated crafts could generate differential wage changes unrelated to the master-certificate requirement.

¹¹Violations of the parallel trends assumption could occur if firms and workers had anticipated the reform and adjusted their behavior in advance. However, given the rapid passage and implementation of the policy within a year, such anticipation effects are unlikely.

¹²This assumption would be violated if workers systematically switched between deregulated and regulated occupations, thereby contaminating both the treatment and the control group. As a robustness check, we estimate our model for a sample that excludes workers who switched between regulated and deregulated occupations or from non-master to master status after the reform. Because our estimand concerns wages in dependent employment, transitions to self-employment are not themselves part of the wage outcome. However, reform-induced transitions out of dependent employment could affect the composition of the observed sample if workers who leave differ systematically from those who remain. We therefore assess whether the reform affected the likelihood of dropping out of the sample and whether including those who dropped out of the data after the reform changes our estimated wage effects (see Section 5.2).

To mitigate this concern and strengthen the identification strategy, we employ a triple-difference (DDD) design (Olden and Møen 2022), using non-masters as an additional comparison group. The DDD approach exploits wage differences along three dimensions: (i) between masters and non-masters, (ii) between deregulated (“treated”) and regulated (“control”) occupations, and (iii) before and after the reform. Specifically, it compares the change in the master–non-master wage gap in deregulated occupations with the corresponding change in regulated occupations. More generally, the DDD specification nets out any differential wage change between deregulated and regulated occupations that is common to masters and non-masters. It therefore helps to account for contemporaneous occupation-group-specific shocks or trends that affect masters and non-masters similarly. The identifying assumption is that, absent the reform, the master–non-master wage gap in deregulated occupations would have followed the same trend as the corresponding wage gap in regulated occupations. Accordingly, we interpret the DiD estimates as informative about the wage change of masters in deregulated relative to regulated occupations, while the DDD estimates provide our preferred estimate of the reform effect on the master wage premium. Formally, the DDD model is specified as follows:

$$\begin{aligned} \log(\text{wage}_{ijt}) = & \gamma_0 + \gamma_1 \text{master}_i + \gamma_2 \text{deregulated}_j \times \text{master}_i + \gamma_3 \text{deregulated}_j \times \text{post}_t \\ & + \gamma_4 \text{master}_i \times \text{post}_t + \gamma_5 \text{deregulated}_j \times \text{master}_i \times \text{post}_t \\ & + X_i' \gamma_6 + \mu_j + \kappa_t + \varepsilon_{ijt}. \end{aligned} \quad (3)$$

As before, $\log(\text{wage}_{ijt})$ denotes the log real average daily wage of individual i in occupation j in year t . The variable master_i is an indicator equal to one if individual i held a master certificate before the reform. The coefficient of interest is γ_5 , which captures the post-reform change in the master–non-master wage gap in deregulated occupations relative to the corresponding change in regulated occupations.¹³ In other words, γ_5 identifies the causal effect of the deregulation policy on the master wage premium among dependently employed workers. To assess the extent to which γ_5 is affected by pre-treatment firm

¹³The DiD and DDD estimates coincide if non-masters in deregulated and regulated occupations experienced the same wage growth, that is, if the DiD estimate for non-masters equals zero.

sorting or individual-specific heterogeneity, we estimate alternative specifications of Eq. (3) that include firm or individual fixed effects, which absorb time-invariant unobserved characteristics at the firm and worker level, respectively. We also estimate event-study versions of Eq. (3) analogous to Eq. (2).¹⁴

5 Results

5.1 Baseline Results

Table 1 reports estimates of the effect of the deregulation policy on the wages of master craft workers. Column (1) presents DiD estimates for the sample of masters (Eq. (1)). Following the reform, wages of masters in deregulated occupations increased by 2% relative to those of masters in regulated occupations. The effect is statistically significant at the 10% level. This positive effect contrasts with the average effect for all incumbent craft workers. As shown in column (2), which presents the results from estimating Eq. (1) for all incumbent craft workers, deregulation led to a modest relative wage decline of 0.7% among workers in affected occupations.¹⁵ One possible explanation for this modest effect is that the deregulated trades were already relatively competitive before the reform. Fredriksen (2020) notes that approximately 75,000 firms operated across the 53 subsequently deregulated trades at the end of 2003 and argues that this large number of firms may have kept prices relatively close to marginal costs even before deregulation. If pre-reform regulatory rents were already limited, there would have been little scope for deregulation to reduce employee wages through lower rent sharing.

Panel A of Figure 3 presents the dynamic effects from the DiD specification in Eq. (2), comparing the evolution of wages of incumbent masters in deregulated occupations with those in regulated occupations. The estimates show no evidence of a differential pre-trend

¹⁴In all models, standard errors are clustered at the individual level to account for serial correlation within individuals. Our substantive conclusions remain unchanged when standard errors are clustered at the occupation level (see Figure A.1 in the Appendix).

¹⁵This result is qualitatively consistent with Lergetporer et al. (2018), who find a slightly larger effect (−2.3%), primarily due to their inclusion of post-2008 data, which we exclude from our analysis. It is also in line with Damelang et al. (2018), who report a similar effect of −0.65%.

Table 1: Effect of Deregulation on Wages – DiD and Triple-Difference Results

	DiD		Triple Difference		
	(1) Master	(2) All	(3) Occ. FE	(4) Firm FE	(5) Ind. FE
Master	–	0.212 [†]	0.216 [†]	0.228 [†]	–
Deregulated × Post	0.020*	–0.007 [†]	–0.008 [†]	–0.009 [†]	–0.010 [†]
	(0.011)	(0.002)	(0.002)	(0.002)	(0.001)
Master × Post	–	–	–0.014 [†]	–0.010***	–0.011 [†]
			(0.004)	(0.003)	(0.003)
Deregulated × Master	–	–	0.010	0.041*	–
			(0.017)	(0.023)	
Deregulated × Master × Post	–	–	0.030***	0.020*	0.020**
			(0.011)	(0.011)	(0.010)
Year FE	Yes	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes	No
Firm FE	No	No	No	Yes	No
Individual FE	No	No	No	No	Yes
Adjusted R^2	0.461	0.585	0.585	0.845	0.901
Observations	20,696	474,929	474,929	474,929	474,929

Notes: The table shows estimated average effects of the reform on log daily wages between 2000 and 2008. Columns (1) and (2) show coefficient estimates derived from Eq. (1). Results in column (1) are based on a sample including only master craft workers and results in column (2) are based on a sample including all craft workers. Columns (3)–(5) show coefficient estimates derived from Eq. (3) using a sample of all craft workers in the regulated and deregulated occupations. In all specifications, individual and firm characteristics, measured in the base period, are controlled for (see Appendix Table A.6 for full results). Standard errors (in parentheses) are clustered at the individual level. Significance levels: [†] 0.1%, *** 1%, ** 5%, * 10%. Data source: SIAB, 2000–2008.

before the reform. After the reform, however, the relative wages of incumbent masters in deregulated occupations increased, with the effect reaching 3.7% in 2006 and remaining relatively stable thereafter.

Column (3) of Table 1 presents the DDD estimates from Eq. (3), comparing the wages of masters and non-masters in regulated and deregulated occupations before and after the reform. Compared to the DiD model, the DDD estimator additionally accounts for contemporaneous occupation-specific shocks that affect masters and non-masters symmetrically. The coefficient on Master indicates a sizable conditional pre-reform wage differential of about 24% between masters and non-masters in regulated occupations.¹⁶ This differential should not be interpreted causally, as it may reflect both the value associated with the master certificate and pre-existing differences between masters and non-masters in unobserved productivity, ability, or job responsibilities. Following the

¹⁶For reference, non-masters in regulated occupations earned an average of 3,283 euros per month before the reform.

reform, non-masters in deregulated occupations experienced a relative wage decline of 0.8% compared to non-masters in regulated occupations, while the master–non-master wage gap in regulated occupations narrowed by 1.4%. Conversely, the master–non-master wage premium in deregulated occupations increased relative to that in regulated occupations. In our preferred specification with occupation fixed effects, the reform led to a statistically significant 3% increase in the master wage premium in deregulated occupations relative to regulated occupations.¹⁷ Given average pre-reform monthly earnings of 4,116 euros for masters, this corresponds to an increase of approximately 124 euros in monthly earnings. This 3% increase in the wage premium represents almost one-tenth of the overall 33% wage premium of masters compared to non-masters in deregulated occupations in 2003. The estimated reform effect declines to 2% when firm fixed effects are added to the model (column (4) of Table 1), suggesting some role for pre-treatment firm sorting. Replacing occupation and firm fixed effects with individual fixed effects (column (5) of Table 1) leaves the treatment effect unchanged at 2%, providing little evidence that time-invariant individual heterogeneity drives the estimated effect. Overall, the stability of the estimated reform effect across these specifications suggests that the baseline result is unlikely to be driven by time-invariant firm characteristics or unobserved worker heterogeneity.¹⁸

Panel B of Figure 3 presents the corresponding dynamic effects from the DDD specification in Eq. (3). The pattern is similar to that shown in Panel A. The master wage premium in regulated and deregulated occupations followed similar trends before the reform. Beginning one year after the reform, however, the master wage premium in deregulated occupations increased significantly relative to that in regulated occupations, with estimated effects ranging from 3.7% to 4.3%.

Our finding that occupational deregulation increased the wages of masters in dependent

¹⁷Re-estimating Eq. (3) with a full set of occupation-year fixed effects, instead of separate occupation and year effects, leaves the DDD coefficient essentially unchanged: $\gamma_5 = 0.021$ (s.e. = 0.011). The point estimate thus falls by less than one baseline standard error and remains statistically significant, confirming that the main result is not driven by time-varying occupation-specific shocks.

¹⁸We retain the occupation-fixed-effects specification as our preferred model because the reform was assigned at the occupation level, and our main parameter of interest is the change in the master wage premium among workers in dependent employment who were exposed to it through their pre-reform occupation.

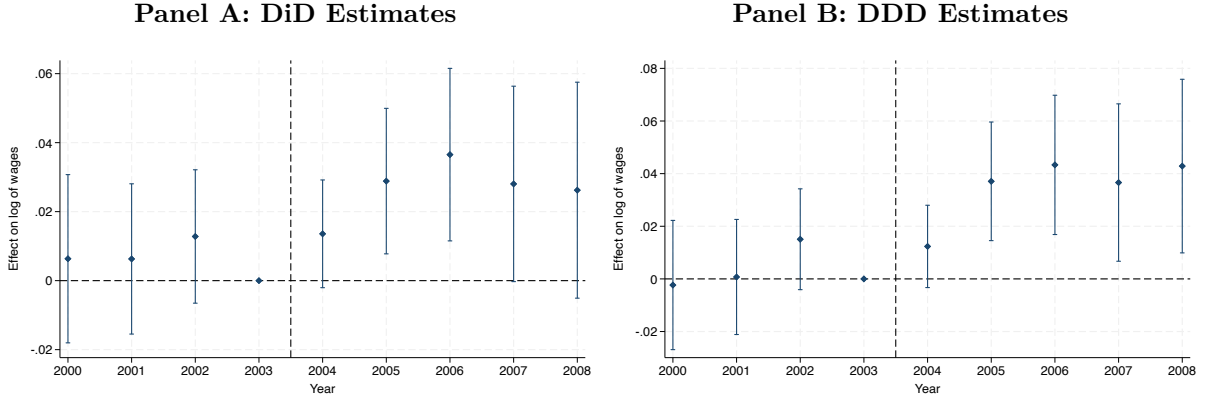


Figure 3: Yearly Effects of Occupational Deregulation on the Relative Wages of Master Craft Workers: DiD and DDD Estimates

Notes: The figure shows coefficient estimates and 95% confidence intervals of the yearly effects of occupational deregulation. Panel A reports DiD estimates from Eq. (2), comparing the log wages of incumbent master craft workers in deregulated occupations with those in regulated occupations. Panel B reports DDD estimates from the event-study version of Eq. (3), comparing the master–non-master wage gap in deregulated occupations with the corresponding gap in regulated occupations. Data source: SIAB, 2000–2008.

employment, both relative to masters in regulated occupations and to non-masters, appears counterintuitive from the perspective of the conventional licensing-rent mechanism. Under this mechanism, occupational deregulation should increase product-market competition by lowering entry barriers, thereby reducing prices and firm profits. This channel would tend to lower the wages of workers whose compensation partly reflects regulatory rents (Kleiner 2000). However, our estimates do not capture the full licensing premium associated with the legal right to establish or operate a craft business. Instead, they capture the reform-induced change in the wage premium associated with holding the master certificate among workers in dependent employment. This distinction also reconciles our findings with the broader literature on occupational licensing and certification. Prior evidence typically finds larger wage premia for licensing than for certification, consistent with the idea that licensing combines a skill signal with legally enforced entry restrictions (Koumenta et al. 2022). Our results show that the master-certificate wage premium among dependently employed craft workers can increase when deregulation reduces incentives to obtain certification, thereby reducing the supply of certified workers.

The increase in the wage premium can be explained by the dual role of the master certificate. As formalized in Appendix B, deregulation reduces the self-employment-related value of the master certificate by removing its licensing role for business entry. Provided

that any offsetting increase in the certificate’s employment-related value is not large enough to compensate for this loss, the overall private return to certification declines for new cohorts. This lower return reduces the inflow of newly certified masters. Under the maintained conditions formalized in Appendix B, the lower certification inflow gradually reduces the stock of active master labor relative to the continued-licensing counterfactual. If master labor consequently becomes scarcer relative to non-master labor, this generates the relative-scarcity channel that raises the incumbent master wage premium.

At the same time, the model shows that the net effect on the wage premium of incumbent masters is theoretically ambiguous. We decompose this effect into a relative-demand channel, which may lower the premium, and a relative-scarcity channel, which increases the premium when master labor becomes scarce relative to non-master labor. Our positive estimates, together with the sharp decline in master examinations, suggest that the relative-scarcity channel dominates the relative-demand channel. These findings point to an unintended consequence of the reform. By weakening incentives to obtain a master certificate and thereby reducing the supply of certified workers, deregulation can increase the market value of incumbent masters and widen wage differentials between masters and non-masters within deregulated occupations.

The empirical evidence supports the scarcity channel described above. The first key implication—a reduction in the inflow of newly certified masters—is clearly visible in Figure 4. Panel A shows the effect of deregulation on the log number of successfully completed master examinations. While there is no immediate estimated effect on completed master examinations, a large negative effect emerges beginning in 2005.¹⁹ This effect grows over time, from a reduction of about 36% in 2005 to 44% in 2008. As shown in Panel B of Figure 4, this sharp decline in the inflow of newly certified masters is accompanied by a negative estimated effect on the stock of masters in dependent employment.²⁰ Although the

¹⁹The delayed effect reflects the fact that obtaining a master certificate requires one to three years of coursework (Rostam-Afschar 2014). Effects on completed master examinations are therefore unlikely to emerge until at least one year after the reform.

²⁰The results depicted in Panels A and B of Figure 4 are based on dynamic DiD models estimated at the occupation level, analogous to the model in Eq. (2). These models regress the log number of successfully completed master examinations and the log number of employed masters on a set of interaction terms between year dummies and a dummy for deregulated occupations, controlling for year and occupation

estimated effects of deregulation on master employment are imprecise, they are consistently negative and economically sizable, ranging from a reduction of around 5% in 2004 to almost 11% in 2008. This pattern is consistent with a gradual decline in the number of masters employed in the affected occupations.

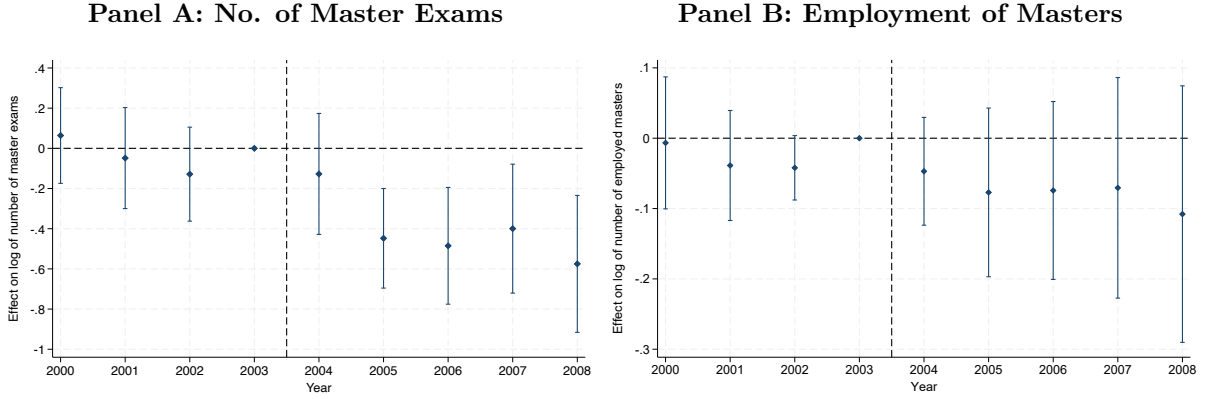


Figure 4: Yearly Effects of Occupational Deregulation on Master Examinations and Master Employment

Notes: The figure shows coefficient estimates and 95% confidence intervals of the yearly effects of occupational deregulation on the log number of successfully completed master examinations (Panel A) and the log number of employed master craft workers (Panel B). Data sources: German Confederation of Skilled Crafts, 2000–2008; SIAB, 2000–2008.

A second empirical condition for the scarcity channel is that the master certificate retained economic value after deregulation. Evidence suggests that it did. The certificate may have remained salient as a signal of skill, experience, and productivity (Spence 1973; Albert et al. 2019). In a newly deregulated market open to all entrants, the master certificate may help consumers identify more qualified and experienced providers within an increasingly heterogeneous pool of firms. This signaling function helps explain why firms continued to value masters even after the removal of the legal requirement for business entry. Consistent with this signaling interpretation, Fredriksen et al. (2019) find that firms led by master craft workers receive higher consumer ratings in the deregulated market segment, which they interpret as evidence that the certificate can reduce consumer search costs.²¹ The sharp reduction in the inflow of newly certified masters, combined with continued demand

fixed effects.

²¹However, broader evidence on professional regulation and service quality is mixed. For home-improvement services, Farronato et al. (2024) show that US consumers respond more strongly to online reviews than to verified licensing status. More generally, Koumenta et al. (2018) argue that quality effects are difficult to measure and may vary across markets and quality dimensions.

for their expertise in a newly deregulated market with rising firm entry (see Appendix Figure A.3), is consistent with the positive wage-premium effect documented above.

5.2 Robustness Checks and Heterogeneity Analysis

We next examine whether our baseline results are robust to alternative sample definitions, selective attrition, placebo timing, and reweighting. We then analyze heterogeneity by firm size, region, and gender.

First, we address the concern that our results may be driven by compositional changes due to occupational mobility or post-reform changes in master status. Workers may switch between regulated and deregulated occupations, or some non-master craft workers may transition to master status after the reform. To assess whether such changes drive our estimates, we re-estimate the model on a restricted sample that excludes workers who switched between regulated and deregulated occupations or transitioned from non-master to master status after the reform. As column (1) of Table 2 shows, the estimated reform effect remains robust under this restriction, with a 3.2% increase in the wage premium of incumbent masters.²²

Second, we address the concern that deregulation may have encouraged non-master craft workers to become self-employed, causing them to drop out of our data. If workers leaving dependent employment differ systematically from those who remain, our sample of incumbent craft workers may no longer be representative of all craft workers in dependent employment before the reform. Although the SIAB does not allow us to identify transitions into self-employment directly, we can examine whether the reform affected sample attrition and whether our wage estimates are sensitive to including workers who leave the sample after the reform. To do so, we relax the requirement that workers must have been employed at least once during the post-reform period. Using this extended sample, we first estimate our DDD model with an indicator for sample attrition as the outcome variable. As

²²This aligns with Damelang et al.'s (2018) finding that occupational mobility in the German labor market is relatively limited, with only a small share of workers changing occupations. Such mobility is particularly uncommon in craft occupations because of their distinct occupational structure and highly specialized task profiles.

column (2) of Table 2 shows, deregulation increased the probability of sample attrition among non-masters by 0.8 percentage points. For masters in deregulated occupations, however, the corresponding effect is negative and marginally statistically significant. While we can only assess reform effects on attrition rather than self-employment itself, this pattern is consistent with theoretical expectations and aligns with the evidence in Rostam-Afschar (2014).²³

Table 2: Effect of Deregulation on the Wage Premium of Masters – Robustness Checks

Dependent variable	(1) Exclude Switchers Log wage	(2) Attrition Att. ind.	(3) Extended Sample Log wage	(4) Placebo Regression Log wage	(5) Entropy Balancing Log wage
Master	0.233 [†] (0.006)	−0.000 (0.003)	0.216 [†] (0.005)	0.227 [†] (0.005)	0.200 [†] (0.008)
Deregulated × Post	−0.008*** (0.002)	0.008*** (0.002)	−0.007 [†] (0.002)	0.011 (0.015)	−0.010 [†] (0.002)
Master × Post	−0.016*** (0.004)	0.010** (0.005)	−0.013*** (0.004)	−0.012*** (0.004)	−0.008* (0.005)
Deregulated × Master	0.002 (0.018)	0.001 (0.009)	0.006 (0.015)	0.011 (0.015)	0.024 (0.019)
Deregulated × Master × Post	0.032** (0.013)	−0.020* (0.012)	0.034*** (0.013)	0.003 (0.010)	0.028** (0.012)
Year FE	Yes	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes	Yes
Adjusted R ²	0.602	0.061	0.587	0.578	0.542
Observations	408,917	456,597	506,288	526,360	373,218

Notes: The table reports alternative specifications assessing the robustness of the estimated reform effect on the master wage premium. The dependent variable is log daily wage in columns (1) and (3)–(5) and an indicator for sample attrition in column (2). Coefficient estimates are derived from estimating Eq. (3), controlling for individual and firm characteristics. Standard errors (in parentheses) are clustered at the individual level. The placebo regression in column (4) uses data from 1995 to 2003, while all other specifications use data from 2000 to 2008. Significance levels: [†] 0.1%, *** 1%, ** 5%, * 10%. Data source: SIAB, 1995–2008.

Using the extended sample that does not condition on observing workers in dependent employment after the reform, we further re-estimate our DDD wage regressions. If workers who leave dependent employment after the reform, potentially because they switch to self-employment, differ systematically from those who remain, the estimated wage premium based on this extended sample should differ from our baseline estimate. Column (3) of Table 2 shows that including craft workers who leave the sample after the reform leaves

²³Based on the German Microcensus, Rostam-Afschar (2014) shows that following deregulation, non-master craft workers had a 0.8 percentage point higher probability of entering self-employment, while the corresponding effect for master craft workers is negative but not statistically significant.

the estimated reform effect largely unchanged. The estimated increase in the master wage premium is 3.4%, compared with 3.0% in the baseline specification. This similarity suggests that selective attrition does not substantially affect our baseline estimate.

Third, we conduct a falsification test using a placebo reform date. Specifically, we estimate our model for the pre-reform period 1995–2003 and define 1999 as the placebo reform year. As column (4) of Table 2 shows, the estimated placebo effect is close to zero and statistically insignificant. This finding provides additional evidence that the baseline results are not driven by differential pre-reform trends in the master wage premium.

Finally, to address differences in observable characteristics between workers in regulated and deregulated occupations, we reweight the sample using entropy balancing to achieve covariate balance (Hainmueller 2012). The balancing variables include the pre-reform covariates used in our baseline specification (see Table A.6), supplemented by the pre-reform wage. Column (5) of Table 2 shows that the estimated reform effect remains positive, statistically significant, and similar in magnitude to the baseline estimate.

We next explore heterogeneity in the effect of deregulation across firms and regions. First, we examine whether the reform effect varies by firm size. This distinction is important because smaller firms are more likely to operate in the crafts sector and may therefore be more directly exposed to the reform, whereas larger firms are more likely to be industrial firms for which craft-specific licensing rules are less binding. Smaller firms may also be more vulnerable to a decline in the supply of master craft workers because they typically employ fewer masters and have less flexibility to substitute across workers. Columns (1)–(3) of Table 3 present DDD estimates separately for small, medium-sized, and large firms.²⁴ The estimated reform effect is largest in small firms, where the master wage premium increased by about 5%. The corresponding increase is about 3% in medium-sized firms. In contrast, the estimated effect in large firms is close to zero and statistically insignificant.

This pattern is consistent with stronger scarcity pressures in small and medium-sized

²⁴According to European Commission (2003), we define small firms as those with less than 50 employees, medium-sized firms as those with 50 to less than 250 employees, and large firms as those with 250 or more employees.

Table 3: Heterogeneous Effects of Deregulation by Firm Size and Region

	Firm Size			Region	
	(1) Small	(2) Medium	(3) Large	(4) East	(5) West
Master	0.200 [†] (0.007)	0.259 [†] (0.012)	0.189 [†] (0.013)	0.216 [†] (0.015)	0.214 [†] (0.006)
Deregulated $\times$ Post	-0.010 [†] (0.003)	-0.009*** (0.003)	0.019*** (0.003)	-0.005 (0.004)	-0.009 [†] (0.002)
Master $\times$ Post	-0.011** (0.005)	-0.014* (0.007)	0.002 (0.008)	-0.027*** (0.010)	-0.012** (0.004)
Deregulated $\times$ Master	-0.009 (0.026)	-0.010 (0.026)	-0.009 (0.026)	-0.053 (0.071)	0.013 (0.017)
Deregulated $\times$ Master $\times$ Post	0.049*** (0.018)	0.029* (0.016)	-0.004 (0.027)	0.119*** (0.041)	0.022* (0.012)
Year FE	Yes	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes	Yes
Adjusted R ²	0.473	0.514	0.514	0.461	0.546
Observations	220,327	118,644	135,958	94,961	379,968

Notes: The table shows estimated average effects of the reform on log daily wages between 2000 and 2008 by firm size (columns (1)–(3)) and by region (columns (4) and (5)). Coefficient estimates are derived from estimating Eq. (3), controlling for individual and firm characteristics. Standard errors (in parentheses) are clustered at the individual level. Significance levels: [†] 0.1%, *** 1%, ** 5%, * 10%. Data source: SIAB, 2000–2008.

firms. Because small firms face higher vacancy costs and generally pay lower wages (Oi and Idson 1999), they may need to raise wages more strongly to attract and retain masters when the inflow of newly certified masters declines. Large firms, in contrast, are more likely to employ multiple master craft workers and may therefore be less vulnerable to the departure of any individual master. In such firms, the signaling value of employing at least one master craft worker may remain intact even if one master leaves, which may give large firms greater bargaining power in wage negotiations. Moreover, large firms are less likely to be craft firms and more likely to be industrial firms, making them less directly exposed to craft-specific deregulation. These factors may help explain why the estimated reform effect is concentrated in small and medium-sized firms.

Second, we examine whether the reform had differential effects in East and West Germany. Columns (4) and (5) of Table 3 show that the reform increased the wage premium of master craft workers in affected occupations in both parts of Germany. However, the effect is much stronger in East Germany (12%) than in West Germany (2%). This pattern is also visible in Appendix Figure A.2. In East Germany, the wage premium

of masters increased sharply one year after the reform, peaked at approximately 20% in 2005, and subsequently declined. In West Germany, the effect is smaller and more stable, ranging from 2.1% to 3.7% after 2005.

The substantially larger effect in East Germany is consistent with pre-existing labor-market conditions that may have amplified the scarcity channel. Several indicators suggest that high-skilled craft labor was relatively scarcer in East Germany before the reform. First, the pre-reform wage premium for master craft workers was larger in East Germany (0.24 log points in 2003) than in West Germany (0.18 log points).²⁵ Second, masters accounted for a smaller share of the crafts workforce in East Germany (3.4% vs. 4.7% in West Germany). These conditions were reinforced by persistent out-migration of skilled workers from East to West Germany following reunification, which contributed to shortages of high-skilled labor (Hunt 2006; Fuchs-Schündeln and Schündeln 2009). Third, the smaller and less competitive market structure in East Germany, which was dominated by small firms (Burda and Hunt 2001), may have amplified the signaling value of the master certificate. In markets characterized by non-standardized services and information asymmetries, firms may rely more strongly on certified workers to signal quality and firm-level competence.

The 2004 EU enlargement may have reinforced these forces. Freedom of establishment enabled EU citizens to enter self-employment and provide craft services in Germany, thereby increasing competitive pressure on incumbent firms, particularly in East Germany. If incumbent firms responded by differentiating themselves more strongly in terms of quality, their demand for masters may have increased. Moreover, deregulation took place in a labor market characterized by a relatively limited supply of highly skilled craft workers, which may have intensified competition for the existing pool of masters. Together, these mechanisms may help explain why the estimated increase in the master wage premium is substantially larger in East Germany than in West Germany.

Finally, we examine heterogeneity by gender (see Appendix Table A.7). For male

²⁵Despite the larger pre-reform wage premium in East Germany, absolute wage levels remained considerably lower: notably, the pre-reform average log wage for masters in East Germany (4.57) was even below the average log wage of non-masters in West Germany (4.68). This further underscores the stark regional economic disparities existing prior to deregulation.

masters, we estimate a statistically significant increase in the wage premium of 3.3%. For female masters, the point estimate is smaller and statistically insignificant. However, because female masters account for only about 5% of all masters in our sample, the estimate for women is relatively imprecise and does not rule out economically meaningful effects.

6 Conclusion

This paper examines how occupational deregulation affects the wages and wage premia of incumbent master craft workers in dependent employment. We exploit the 2004 reform of the German crafts sector, which abolished the master-certificate requirement for business entry in roughly half of all craft occupations. Using administrative social security data and a triple-difference design, we show that occupational deregulation can increase the wage premium earned by incumbent masters.

The reform increased the wage premium of incumbent masters in deregulated occupations by approximately 3% relative to regulated occupations, thereby widening within-occupation wage differentials. This effect reflects a relative wage increase for masters in deregulated occupations, despite a slightly negative average wage trend in deregulated occupations relative to regulated occupations. Event-study estimates indicate no immediate effect of the reform but reveal a persistent increase in the wages and wage premia of masters in deregulated occupations beginning in 2005, one year after the reform. These findings are consistent with a scarcity effect that dominates any negative relative-demand effect. By reducing the incentives to obtain a master certificate, deregulation led to a sharp decline in master examinations. At the same time, the certificate retained its value as a signal of advanced skills and quality in dependent employment, increasing the relative market value of incumbent masters. The results are robust to alternative sample definitions, controls for attrition, entropy balancing, and a placebo test based on the pre-reform period.

The effects vary substantially across firms and regions. The reform increased the master wage premium in small and medium-sized firms but had no statistically significant effect

in large firms. This pattern is consistent with stronger scarcity pressures in firms that are more likely to operate in the crafts sector and have less scope to substitute between workers with different skill levels. The effect was also substantially larger in East Germany than in West Germany. Pre-existing shortages of high-skilled labor in East Germany may have amplified the scarcity channel and intensified competition for the limited pool of incumbent masters.

Our findings contribute to the policy debate on occupational licensing by showing that lowering barriers to business entry can have unintended distributional consequences for incumbent employees. By weakening the incentives to obtain a master certificate, deregulation increased the scarcity value of incumbent masters and widened the wage differential between masters and non-masters. These results should not, however, be interpreted as evidence that stricter licensing or higher skill requirements are necessarily welfare-enhancing. Such requirements may increase entry costs, restrict access to regulated occupations, particularly for disadvantaged workers, reduce competition, and raise consumer prices. The policy implications are therefore more nuanced. Reforms that lower entry barriers should be evaluated not only in terms of their effects on competition and firm entry but also in terms of their effects on skill investment, worker sorting, and skill-based wage differentials.

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Appendix

A Additional Tables and Figures

Table A.1: List of Regulated and Deregulated Occupations

Regulated	Deregulated
1. Bricklayer and concretor	1. Tile, slab and mosaic layer
2. Stove and air heating mechanic	2. Cast stone and terrazzo maker
3. Carpenter	3. Screed layer
4. Roofer	4. Vessel and equipment constructor
5. Road construction worker	5. Clockmaker
6. Thermal and acoustic insulation fitter	6. Engraver
7. Well sinker	7. Metal former
8. Stonemason	8. Galvaniser
9. Plasterer	9. Metal and bell founder
10. Painter and lacquerer	10. Cutting tool mechanic
11. Scaffolder	11. Goldsmith and silversmith
12. Chimney sweep	12. Parquet layer
13. Metal worker	13. Shutter and sunshade mechatronics
14. Surgical instrument maker	14. Model builder
15. Coachbuilder	15. Turner (ivory carver) and wooden toy maker
16. Precision engineer	16. Wood carver
17. Motorbike and bicycle mechanic	17. Cooper
18. Refrigeration mechanic	18. Basket maker
19. Communication technician	19. Costume tailor
20. Automotive mechatronics technician	20. Embroiderer
21. Mechanic for agricultural machinery	21. Milliner
22. Gunsmith	22. Weaver
23. Plumber	23. Sailmaker
24. Installer and heating fitter	24. Furrier
25. Electrics technician	25. Shoemaker
26. Electrical machine engineer	26. Saddler
27. Joiner	27. Interior decorator
28. Boat builder	28. Miller
29. Rope maker	29. Brewer and maltster
30. Baker	30. Wine cellarperson
31. Pastry-cook	31. Textile cleaner
32. Butcher	32. Wax-chandler
33. Dispensing optician	33. Building cleaner
34. Hearing aid acoustician	34. Glass finisher
35. Orthotic technician	35. Precision optician
36. Orthopaedic shoemaker	36. Glass and china painter
37. Dental technician	37. Precious stone engraver and cutter
38. Hairdresser	38. Photographer
39. Glazier	39. Bookbinder
40. Glass blower and glass apparatus maker	40. Typesetter and printer
41. Mechanic for tyres and vulcanization	41. Screen printer
	42. Flexographer
	43. Ceramist
	44. Organ and harmonium maker
	45. Piano and harpsichord maker
	46. Reed-organ musical instrument maker
	47. Violin maker
	48. Bow maker
	49. Metal wind instrument maker
	50. Wooden wind instrument maker
	51. Plucked instrument maker
	52. Gilder
	53. Sign and illuminated advertisement maker

Source: *Bundesministerium der Justiz (2004)*.

Table A.2: Mapping of Occupations from Trade and Crafts Code to Classification of Occupations 1988: Deregulated Occupations

Trade and Crafts Code – Annex B1		Classification of Occupations 1988 (KldB88)	
No.	Name	No.	Name
1	Fliesen-, Platten- und Mosaikleger	483	Fliesenleger
2	Betonstein- und Terrazzohersteller	112	Formstein-, Betonhersteller
3	Estrichleger	486	Estrich-, Terrazzoleger
4	Behälter- und Apparatebauer	252	Behälterbauer, Kupferschmiede und verwandte Berufe
5	Uhrmacher	286	Uhrmacher
6	Graveure	232	Graveure, Ziseleure
7	Metallbildner	193	Metallzieher
7	Metallbildner	213	Sonstige Metallverformer (spanlose Verformung)
7	Metallbildner	225	Metallschleifer
7	Metallbildner	233	Metallvergüter
7	Metallbildner	244	Metallkleber und übrige Metallverbinder
8	Galvaniseure	234	Galvaniseure, Metallfärber
9	Metall- und Glockengießer	202	Formgießer
10	Schneidwerkzeugmacher	291	Werkzeugmacher
11	Gold- und Silberschmiede	302	Edelmetallschmiede
12	Parkettleger	–	n/a
13	Rollladen- und Jalousiebauer	627	Übrige Fertigungstechniker
14	Modellbauer	306	Puppenmacher, Modellbauer, Präparatoren
15	Drechsler (Elfenbeinschnitzer) und Holzspielzeugmacher	183	Holzwarenmacher
16	Holzbildhauer	182	Holzverformer und zugehörige Berufe
17	Böttcher	503	Stellmacher, Böttcher
18	Korbmacher	184	Korb-, Flechtwarenmacher
19	Damen- und Herrenschnneider	351	Schneider
20	Textilgestalter (Sticker, Weber, Klöppler, Posamentierer, Stricker)	342	Weber
20	Textilgestalter (Sticker, Weber, Klöppler, Posamentierer, Stricker)	346	Textilverflechter
20	Textilgestalter (Sticker, Weber, Klöppler, Posamentierer, Stricker)	354	Sticker
20	Textilgestalter (Sticker, Weber, Klöppler, Posamentierer, Stricker)	352	Oberbekleidungsnäher
20	Textilgestalter (Sticker, Weber, Klöppler, Posamentierer, Stricker)	356	Näher, a.n.g.
20	Textilgestalter (Sticker, Weber, Klöppler, Posamentierer, Stricker)	357	Sonstige Textilverarbeiter
21	Modisten	355	Hut-, Mützenmacher
22	Segelmacher	362	Textilausrüster
23	Kürschner	378	Fellverarbeiter

To be continued on the next page.

Table A.2: Mapping of Occupations from Trade and Crafts Code to Classification of Occupations 1988: Deregulated Occupations (Continued)

Trade and Crafts Code – Annex B1		Classification of Occupations 1988 (KldB88)	
No.	Name	No.	Name
24	Schuhmacher	372	Schuhmacher
25	Sattler und Feintäschner	374	Groblederwarenhersteller, Bandagisten
25	Sattler und Feintäschner	375	Feinlederwarenhersteller
25	Sattler und Feintäschner	376	Lederbekleidungshersteller und sonstige Lederverarbeiter
26	Raumausstatter	491	Raumausstatter
27	Müller	432	Mehl-, N�hrmittelhersteller
28	Brauer und M�lzer	422	Brauer, M�lzer
29	Weink�fer	421	Weink�fer
30	Textilreiniger	932	Textilreiniger, F�rber und Chemischreiniger
31	Wachszieher	–	n/a
32	Geb�udereiniger	934	Glas-, Geb�udereiniger
33	Glasveredler	135	Glasbearbeiter, Glasveredler
34	Feinoptiker	135	Glasbearbeiter, Glasveredler
35	Glas- und Porzellanmaler	514	Keramiker, Glasmaler
36	Edelsteinschleifer und -graveure	102	Edelsteinbearbeiter
37	Fotografen	837	Photographen
38	Buchbinder	163	Buchbinderberufe
39	Buchdrucker: Schriftsetzer; Drucker	173	Buchdrucker (Hochdruck)
39	Buchdrucker: Schriftsetzer; Drucker	174	Flach-, Tiefdrucker
40	Siebdrucker	175	Spezialdrucker, Siebdrucker
41	Flexografen	172	Druckstockhersteller
42	Keramiker	121	Keramiker
43	Orgel- und Harmoniumbauer	305	Musikinstrumentenbauer
44	Klavier- und Cembalobauer	305	Musikinstrumentenbauer
45	Handzuginstrumentenmacher	305	Musikinstrumentenbauer
46	Geigenbauer	305	Musikinstrumentenbauer
47	Bogenmacher	305	Musikinstrumentenbauer
48	Metallblasinstrumentenmacher	305	Musikinstrumentenbauer
49	Holzblasinstrumentenmacher	305	Musikinstrumentenbauer
50	Zupfinstrumentenmacher	305	Musikinstrumentenbauer
51	Vergolder	235	Emaillierer, Feuerverzinker und andere Metalloberfl�chenveredler
52	Schilder- und Lichtreklamehersteller	834	Dekorationen-, Schildermaler

Notes: Occupations are classified as deregulated based on the occupation-based mapping procedure used by [Rostam-Afschar \(2014\)](#) and [Lergetporer et al. \(2018\)](#). The occupations Embroiderer and Weaver are combined into the occupation Textile Designer (Textilgestalter). [Runst et al. \(2019\)](#) propose a more restrictive classification for the German Microcensus that excludes occupational codes in which less than 60% of apprentices are trained in craft firms. We do not apply this restriction because apprenticeship intensity would alter the composition of the legally affected treatment and control groups and is closely linked to the master requirement itself. Since training activity may respond to deregulation, it is not an exogenous assignment variable in our setting. We therefore rely on the occupation-based classification and address the possible inclusion of non-craft firms through heterogeneity analyses by firm size (see [Table 3](#)).

Table A.3: Mapping of Occupations from Trade and Crafts Code to Classification of Occupations 1988: Regulated Occupations

Trade and Crafts Code – Annex A		Classification of Occupations 1988 (KldB88)	
Code	Name	Code	Name
1	Maurer und Betonbauer	441	Maurer
1	Maurer und Betonbauer	442	Betonbauer
2	Ofen- und Luftheizungsbauer	484	Ofensetzer, Luftheizungsbauer
3	Zimmerer	451	Zimmerer
4	Dachdecker	452	Dachdecker
5	Straßenbauer	462	Straßenbauer
6	Wärme-, Kälte- und Schallschutzisolierer	482	Isolierer, Abdichter
7	Brunnenbauer	465	Kultur-, Wasserbauwerker
8	Steinmetzen und Steinbildhauer	101	Steinbearbeiter
9	Stukkateure	481	Stukkateure, Gipser, Verputzer
10	Maler und Lackierer	511	Maler, Lackierer (Ausbau)
10	Maler und Lackierer	512	Warenmaler, -lackierer
11	Gerüstbauer	453	Gerüstbauer
12	Schornsteinfeger	804	Schornsteinfeger
13	Metallbauer	301	Metallfeinbauer, a.n.g.
14	Chirurgiemechaniker	285	Sonstige Mechaniker
15	Karosserie- und Fahrzeugbauer	285	Sonstige Mechaniker
16	Feinwerkmechaniker	284	Feinmechaniker
17	Zweiradmechaniker	285	Sonstige Mechaniker
18	Kälteanlagenbauer	285	Sonstige Mechaniker
19	Informationstechniker	628	Sonstige Techniker
20	Kraftfahrzeugtechniker	621	Maschinenbautechniker
21	Landmaschinenmechaniker	621	Maschinenbautechniker
22	Büchsenmacher	211	Blechpresser, -zieher, -stanzer
23	Klempner	211	Blechpresser, -zieher, -stanzer
23	Klempner	261	Feinblechner
24	Installateur und Heizungsbauer	262	Rohrinstallateure
25	Elektrotechniker	311	Elektroinstallateure, -monteure
25	Elektrotechniker	622	Techniker des Elektrofaches
26	Elektromaschinenbauer	314	Elektrogerätebauer
27	Tischler	501	Tischler
28	Boots- und Schiffbauer	275	Stahlbauschlosser, Eisenschiffbauer
29	Seiler	332	Spuler, Zwirner, Seiler
30	Bäcker	391	Backwarenhersteller
31	Konditoren	392	Konditoren
32	Fleischer	401	Fleischer
33	Augenoptiker	304	Augenoptiker
34	Hörgeräteakustiker	—	n/a
35	Orthopädietechniker	628	Sonstige Techniker
36	Orthopädieschuhmacher	—	n/a
37	Zahntechniker	303	Zahntechniker
38	Friseure	901	Friseure
39	Glaser	485	Glaser
40	Glasbläser und Glasapparatebauer	132	Hohlglasmacher
40	Glasbläser und Glasapparatebauer	133	Flachglasmacher
40	Glasbläser und Glasapparatebauer	134	Glasbläser (vor der Lampe)
41	Vulkaniseure und Reifenmechaniker	144	Vulkaniseure

Notes: Occupations are classified as regulated based on the occupation-based mapping procedure used by Rostam-Afschar (2014) and Lergetporer et al. (2018). Runst et al. (2019) propose a more restrictive classification for the German Microcensus that excludes occupational codes in which less than 60% of apprentices are trained in craft firms. We do not apply this restriction because apprenticeship intensity would alter the composition of the legally affected treatment and control groups and is closely linked to the master requirement itself. Since training activity may respond to deregulation, it is not an exogenous assignment variable in our setting. We therefore rely on the occupation-based classification and address the possible inclusion of non-craft firms through heterogeneity analyses by firm size (see Table 3).

Table A.4: Definition of Key Variables

Variable	Definition
Daily Wage	Gross daily wage in euros, imputed to account for right-censoring.
Post	Dummy variable indicating the post-reform period, i.e., the years from 2004 onwards (0 – Years 2000–2003, 1 – Years 2004–2008).
Occupation	Occupational title of the job performed by the employee, encoded according to the 3-digit “Classification of Occupations” (KldB 1988).
Deregulated	Dummy variable indicating whether the occupation belongs to the group of deregulated crafts (0 – Regulated, 1 – Deregulated). See Appendix Tables A.2 and A.3 for an overview of the occupation matching.
Master	Dummy variable indicating master status based on occupational status (Stellung im Beruf) (0 – Other, 1 – Master craft workers and foremen). This category serves as a proxy for master status.
Age	Age of the individual as of the reference date of 30 June, in years.
Female	Dummy variable indicating the employee’s gender (0 – Man, 1 – Woman).
Foreigner	Dummy variable indicating the employee’s nationality (0 – German, 1 – Other).
East Germany	Dummy variable indicating the region of the workplace (0 – West Germany, 1 – East Germany).
University entrance qualification	Dummy variable indicating the educational degree based on the formal school leaving qualification (0 – Lower secondary schooling or lower, 1 – Upper secondary schooling/University entrance qualification).
Job tenure	Categorical variable based on the days in employment on the current job (1 – Below 4 years, 2 – Between 4 and 8 years, 3 – Between 8 and 14 years, 4 – Over 14 years).
Industry	Categorical variable based on a mapping of the 1-digit industry code (NACE Rev. 1) according to the classification by the Federal Statistical Office (1 – Manufacturing, 2 – Construction, 3 – Wholesale and retail, 4 – Real estate and others).
Number of employees	Total number of an establishment’s employees as of the reference date of 30 June.

Notes: The table shows the key variables used in the analysis and how they are defined.

Table A.5: Descriptive Statistics

	Regulated		Deregulated	
	Mean	SD	Mean	SD
Daily wage, absolute	107.712	44.655	102.066	36.283
Log of daily wage	4.605	0.380	4.567	0.344
Master craft workers	0.045	0.208	0.030	0.170
Age	38.693	10.107	39.903	10.217
Female	0.074	0.261	0.171	0.377
Foreigner	0.049	0.215	0.096	0.295
East Germany	0.217	0.413	0.166	0.372
University entrance qualification	0.069	0.253	0.033	0.180
<i>Job tenure</i>				
Below 4 years	0.496	0.500	0.405	0.491
Between 4 and 8 years	0.181	0.385	0.192	0.394
Between 8 and 14 years	0.178	0.383	0.208	0.406
Over 14 years	0.145	0.352	0.196	0.397
<i>Industry</i>				
Manufacturing	0.393	0.488	0.749	0.434
Construction	0.335	0.472	0.094	0.292
Wholesale and retail	0.080	0.271	0.056	0.229
Real estate and others	0.192	0.394	0.101	0.302
No. of employees (in 1,000)	1.225	5.359	0.779	3.709
<i>Firm size</i>				
Micro and small	0.510	0.500	0.365	0.482
Medium	0.231	0.421	0.310	0.462
Large	0.260	0.438	0.325	0.468
Observations	50,647		10,868	

Notes: The table shows the means and standard deviations of the variables included in the analysis sample, based on 2003 or the last pre-reform observation.

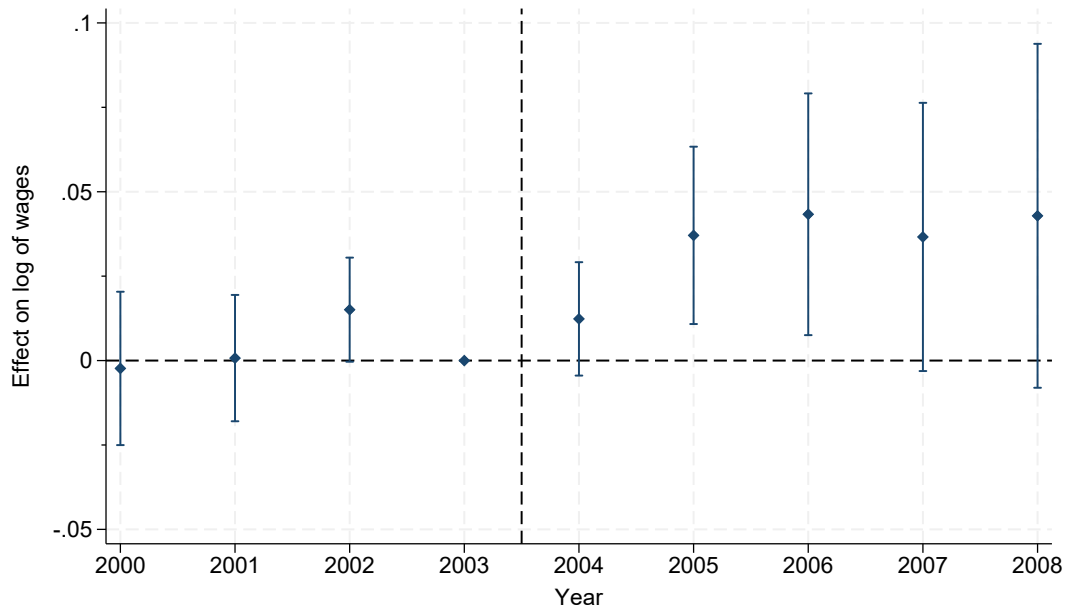


Figure A.1: Yearly Effects of Occupational Deregulation on the Relative Wages of Master Craft Workers, Standard Errors Clustered at the Occupation Level

Notes: The figure shows coefficient estimates and 95% confidence intervals of the yearly effects of occupational deregulation from the event-study version of the DDD approach depicted in Eq. (3). Standard errors are clustered at the occupation level. Data source: SIAB, 2000–2008.

Table A.6: Effect of Deregulation on Wages – Full Results

	DiD		Triple Difference		
	(1) Master	(2) All	(3) Occ. FE	(4) Firm FE	(5) Ind. FE
Master	–	0.212 [†] (0.005)	0.216 [†] (0.006)	0.228 [†] (0.009)	–
Deregulated × Post	0.020* (0.011)	–0.007 [†] (0.002)	–0.008 [†] (0.002)	–0.009 [†] (0.002)	–0.010 [†] (0.001)
Master × Post	–	–	–0.014 [†] (0.004)	–0.010*** (0.003)	–0.011 [†] (0.003)
Deregulated × Master	–	–	0.010 (0.017)	0.041* (0.023)	–
Deregulated × Master × Post	–	–	0.030*** (0.011)	0.020* (0.011)	0.020** (0.010)
Female	–0.163 [†] (0.033)	–0.200 [†] (0.005)	–0.200 [†] (0.005)	–0.163 [†] (0.006)	–
Foreigner	–0.074* (0.039)	–0.033 [†] (0.004)	–0.033 [†] (0.004)	–0.023 [†] (0.005)	–
East Germany	–0.274 [†] (0.016)	–0.275 [†] (0.003)	–0.275 [†] (0.003)	–	–
Age	0.032 [†] (0.005)	0.019 [†] (0.001)	0.019 [†] (0.001)	0.013 [†] (0.001)	–
Age × Age	–0.000 [†] (0.000)	–0.000 [†] (0.000)	–0.000 [†] (0.000)	–0.000 [†] (0.000)	–
<i>Job tenure (Ref.: Below 4 years)</i>					
Between 4 and 8 years	0.050 [†] (0.014)	0.044 [†] (0.003)	0.044 [†] (0.003)	0.065 [†] (0.004)	–
Between 8 and 14 years	0.073 [†] (0.014)	0.059 [†] (0.003)	0.059 [†] (0.003)	0.094 [†] (0.004)	–
Over 14 years	0.110 [†] (0.015)	0.088 [†] (0.003)	0.088 [†] (0.003)	0.111 [†] (0.005)	–
University entrance qualification	0.016 (0.020)	0.167 [†] (0.005)	0.167 [†] (0.005)	0.158 [†] (0.006)	–
<i>Industry (Ref.: Manufacturing)</i>					
Construction	–0.042** (0.019)	–0.035 [†] (0.003)	–0.035 [†] (0.003)	–	–
Wholesale and retail	–0.121 [†] (0.020)	–0.034 [†] (0.004)	–0.034 [†] (0.004)	–	–
Real estate and other industries	0.004 (0.017)	–0.032 [†] (0.003)	–0.032 [†] (0.003)	–	–
Log of no. of employees	0.057 [†] (0.003)	0.050 [†] (0.001)	0.050 [†] (0.001)	–	–
Constant	3.892 [†] (0.095)	4.030 [†] (0.013)	4.020 [†] (0.013)	4.253 [†] (0.017)	4.627 [†] (0.000)
Year FE	Yes	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes	No
Firm FE	No	No	No	Yes	No
Individual FE	No	No	No	No	Yes
Adjusted R ²	0.461	0.585	0.585	0.845	0.901
Observations	20,696	474,929	474,929	474,929	474,929

Notes: The table shows estimated average effects of the reform on log daily wages between 2000 and 2008. Columns (1) and (2) show coefficient estimates derived from Eq. (1). Results in column (1) are based on a sample including only master craft workers and results in column (2) are based on a sample including all craft workers. Columns (3)–(5) show coefficient estimates derived from Eq. (3) using a sample of all craft workers in the regulated and deregulated occupations. In all specifications, individual and firm characteristics, measured in the base period, are controlled for. Standard errors (in parentheses) are clustered at the individual level. Significance levels: [†] 0.1%, *** 1%, ** 5%, * 10%. Data source: SIAB, 2000–2008.

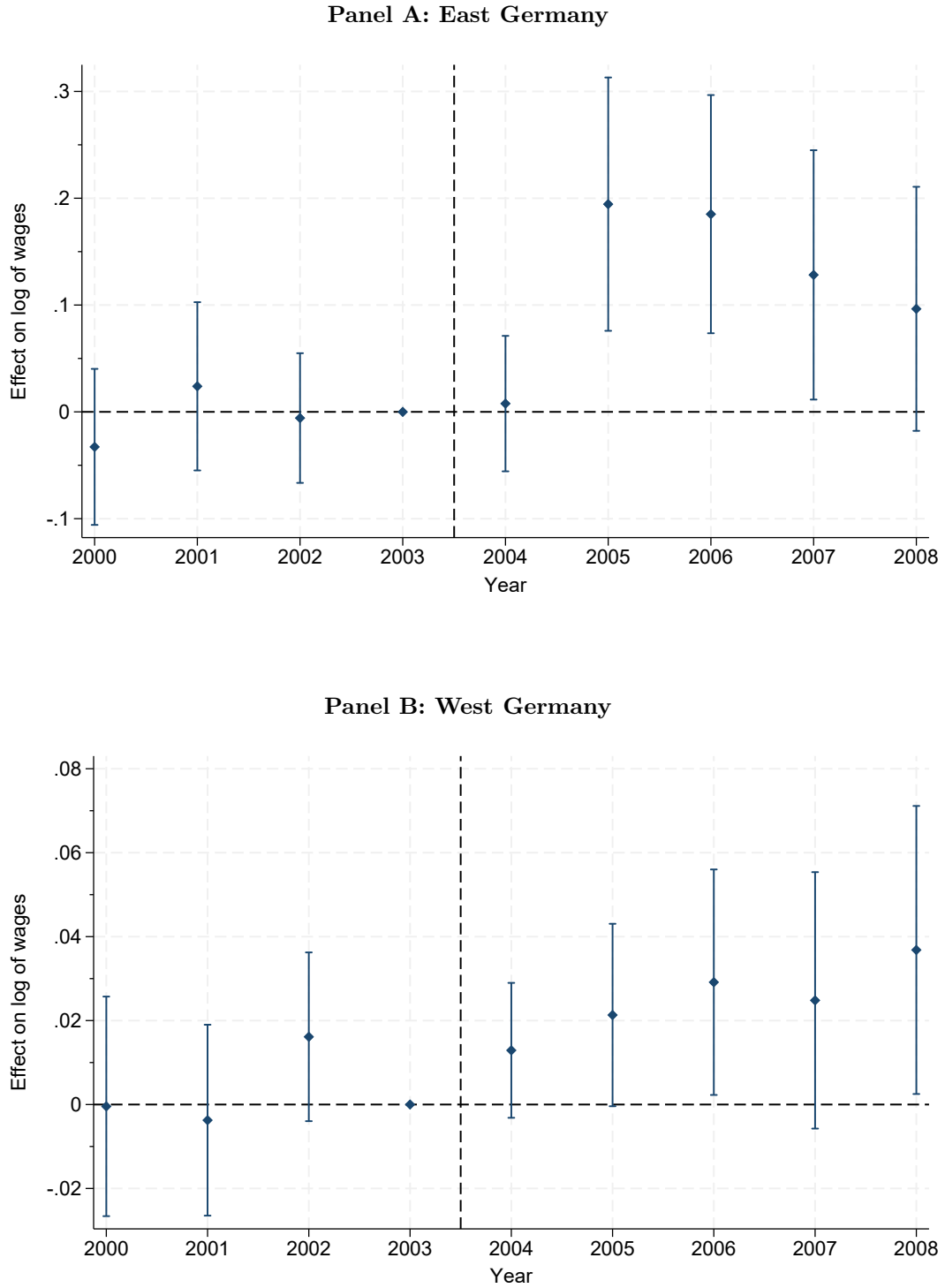


Figure A.2: Yearly Effects of Occupational Deregulation on the Wage Premium of Masters in East and West Germany

Notes: The figure shows coefficient estimates and 95% confidence intervals of the yearly effects of occupational deregulation on the wage premium of master craft workers based on the event-study version of the DDD approach depicted in Eq. (3). Data source: SIAB, 2000–2008.

Table A.7: Heterogeneous Effects of Deregulation by Gender

	Gender	
	(1) Male	(2) Female
Master	0.216 [†] (0.006)	0.164 [†] (0.024)
Deregulated $\times$ Post	-0.008 [†] (0.002)	-0.015*** (0.005)
Master $\times$ Post	-0.012 [†] (0.004)	-0.042** (0.020)
Deregulated $\times$ Master	0.010 (0.017)	0.019 (0.080)
Deregulated $\times$ Master $\times$ Post	0.033*** (0.012)	0.016 (0.047)
Year FE	Yes	Yes
Occupation FE	Yes	Yes
Adjusted R ²	0.571	0.553
Observations	435,243	39,686

Notes: The table shows estimated average effects of the reform on log daily wages between 2000 and 2008 by gender. Coefficient estimates are derived from estimating Eq. (3), controlling for individual and firm characteristics. Standard errors (in parentheses) are clustered at the individual level. Significance levels: [†] 0.1%, *** 1%, ** 5%, * 10%. Data source: SIAB, 2000–2008.

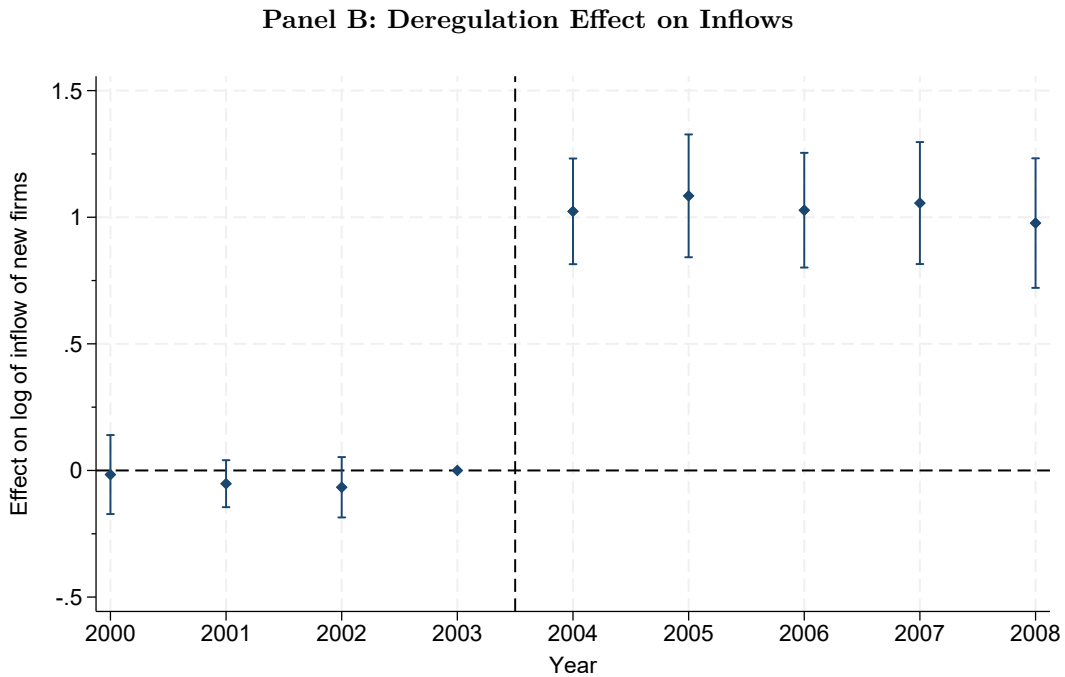
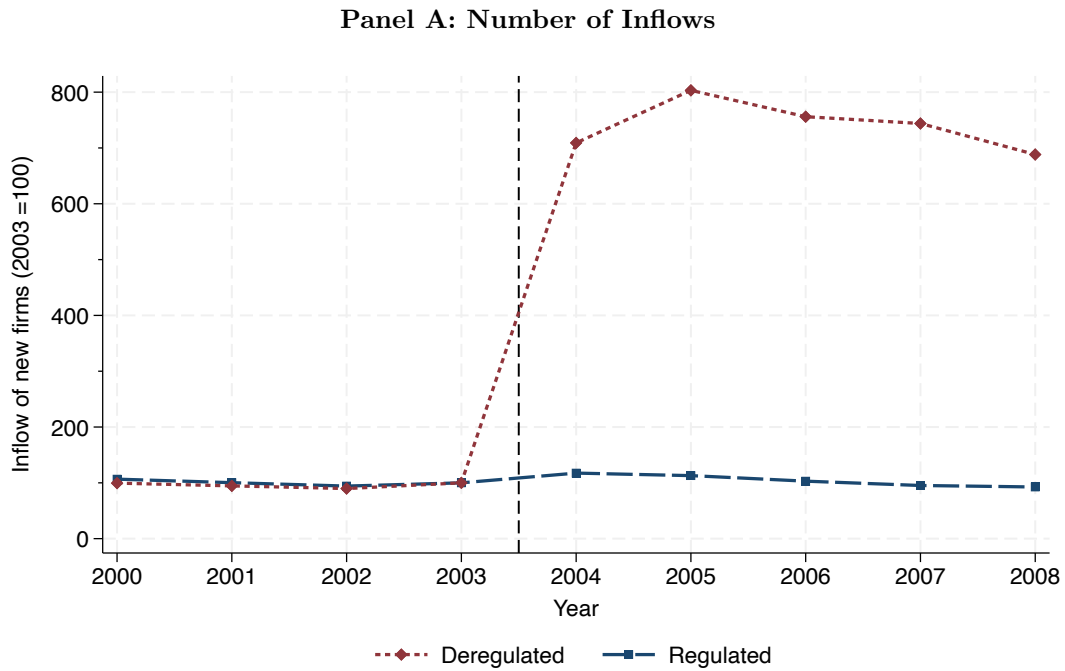


Figure A.3: Firm Inflows and Estimated Effects of Deregulation on Firm Inflows

Notes: Panel A shows the yearly inflows of new firms in regulated and deregulated occupations from 2000 to 2008 relative to 2003. Panel B shows coefficient estimates and 95% confidence intervals of the yearly effects of occupational deregulation on the log number of firm inflows. These results are based on a dynamic DiD model estimated at the occupation level, analogous to the model in Eq. (2). This model regresses the log number of firm inflows on a set of interaction terms between year dummies and a dummy for deregulated occupations, controlling for year and occupation fixed effects. Data source: German Confederation of Skilled Crafts, 2000–2008.

B Conceptual Framework

To clarify the mechanisms through which occupational deregulation can affect the wages of incumbent master craft workers, we develop a stylized partial-equilibrium framework.²⁶ The framework is not intended to characterize the full general-equilibrium adjustment following deregulation. Instead, it isolates two opposing channels that are central to our empirical interpretation. First, under the maintained assumptions formalized below, deregulation reduces the private return to acquiring the master certificate for new cohorts, thereby lowering the inflow of newly certified masters. Over time, these lower inflows can reduce the supply of master labor relative to non-master labor compared with the counterfactual continued-licensing regime and thereby put upward pressure on the relative marginal product and wage premium of incumbent masters. Second, deregulation may reduce the relative demand for master labor, for example if intensified product-market competition lowers the relative value of master-specific tasks, thereby putting downward pressure on the incumbent master wage premium. The net effect on the wage premium is therefore theoretically ambiguous.

Model Setup. In each period, a unit-mass cohort of craft workers who do not yet hold a master certificate decides whether to obtain the certificate. Each worker faces a heterogeneous, one-time training cost $\kappa \geq 0$ to obtain the *master certificate*. Training costs are drawn from a common c.d.f. $F(\kappa)$, with strictly positive density $f(\kappa)$ on $[0, \bar{\kappa}]$. For tractability, we hold this distribution fixed in the model and abstract from common time-varying changes in effective training costs. The relevant restriction for the regime comparison is that the effective training-cost distribution does not shift differentially between the deregulated and continued-licensing regimes.

Firms produce a homogeneous craft good using a constant elasticity of substitution (CES) technology (Hamermesh 1993):

$$Y_t^s = \left[\alpha_t^s (M_t^s)^{\frac{\sigma-1}{\sigma}} + (1 - \alpha_t^s) (N_t^s)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad \sigma > 0, \quad \sigma \neq 1, \quad \alpha_t^s \in (0, 1), \quad (\text{B.1})$$

where $s \in \{L, D\}$ denotes the regulatory regime, t denotes the period, and M_t^s and N_t^s denote the stocks of active master and non-master labor supplied in dependent employment, respectively. For simplicity, we normalize each active worker to supply one unit of the relevant labor type per period. Thus, M_t^s and N_t^s can equivalently be interpreted as measures of active master and non-master workers, respectively. We assume $M_t^s > 0$ and $N_t^s > 0$ throughout. For post-reform comparisons, D denotes the deregulated regime, whereas L denotes the counterfactual continued-licensing regime. We interpret these

²⁶The framework developed here is related to the general model of optimal license acquisition described in Kugler and Sauer (2005).

regimes as alternative post-reform paths originating from the same state at the reform date. Let $t = 0$ denote this common initial state, inherited from the pre-reform economy, and let $t = 1, 2, \dots$ denote subsequent post-reform periods. Accordingly, we impose

$$M_0^D = M_0^L, \quad N_0^D = N_0^L, \quad \alpha_0^D = \alpha_0^L. \quad (\text{B.2})$$

Differences between the two regimes therefore arise only after the reform. The parameter α_t^s is a reduced-form shifter capturing the relative value of master labor in production, and σ is the elasticity of substitution between master and non-master labor, with the Cobb–Douglas case obtained as the limit $\sigma \rightarrow 1$. Allowing α_t^s to vary across regimes and over time captures shifts in the relative demand for master labor. Product-market competition can contribute to this channel insofar as it changes the relative value of master-specific tasks or otherwise shifts labor demand toward or away from master labor. In deriving incumbent wage premia, we use the marginal products implied by Eq. (B.1) for both master and non-master labor. This allows us to express the scarcity channel in terms of the relative wage of masters, which corresponds more closely to our empirical estimand.

Let r^s denote the reduced-form per-period employment-related component of the private value of holding the master certificate under regime $s \in \{L, D\}$, relative to not holding the certificate. This component summarizes wage and career gains associated with productivity, signaling, supervisory responsibilities, or other labor-market advantages of certification. We allow r^s to differ across regimes and thereby incorporate any change in the employment-related value of certification following deregulation. In particular, a scarcity-induced increase in the relative wage of masters may raise r^D relative to r^L . We do not model this feedback structurally; instead, the certification-choice block below requires only that any such change does not fully offset the reform-induced loss in the certificate’s self-employment-related value.

Private Return to Certification under Licensing. Before 2004, establishing a business in regulated crafts generally required a master certificate. Let $\pi^L \geq 0$ denote the reduced-form per-period self-employment-related component of the private value of holding the master certificate under the licensing regime, relative to not holding the certificate. This component includes the regulatory advantage conferred by the certificate’s role as a business-entry requirement, together with any other certificate-related value in self-employment under licensing. Rather than modeling post-certification labor-market allocation explicitly, we treat r^s and π^s as additive reduced-form components of the ex ante private value of certification. They need not represent income flows realized simultaneously; instead, they summarize distinct sources of the expected private value of holding the certificate. The share of newly certified workers who initially enter dependent employment is summarized separately by q^s below. The private return to certification under licensing

is therefore

$$\rho^L = r^L + \pi^L. \quad (\text{B.3})$$

Private Return to Certification after Deregulation. Under the deregulated regime introduced in 2004, the master certificate is no longer generally required for business entry. Deregulation therefore removes the certificate’s mandatory licensing role for business entry in the affected occupations. We allow, however, for the certificate to retain value in self-employment after deregulation. Let $\pi^D \geq 0$ denote the corresponding self-employment-related component of the private value of holding the master certificate under the deregulated regime, relative to not holding the certificate. This component may remain positive because the certificate can continue to signal quality or managerial ability and confer reputational benefits in self-employment.

To capture the loss of the certificate’s licensing value for business entry, we assume that this loss is not fully offset by any residual or enhanced certificate-related value in self-employment. Accordingly,

$$\pi^D < \pi^L. \quad (\text{B.4})$$

The private return to certification under deregulation is

$$\rho^D = r^D + \pi^D. \quad (\text{B.5})$$

We allow the employment-related component of certification to respond to deregulation but assume that any increase in this component is not large enough to offset the decline in the self-employment-related component:

$$r^D - r^L < \pi^L - \pi^D. \quad (\text{B.6})$$

Together with Eqs. (B.3) and (B.5), this condition implies

$$\rho^D < \rho^L. \quad (\text{B.7})$$

Thus, deregulation lowers the overall private return to obtaining the master certificate for new cohorts even if the employment-related value of certification rises after the reform.

Training Decision and the Stock of Master Labor. Let $A > 0$ denote a capitalization factor, common across regimes, that maps the per-period private return to certification, ρ^s , into its present value. Its precise value, which may reflect the time horizon and discounting of future returns, is immaterial for the qualitative results below. For tractability, ρ^s summarizes the expected regime-specific return relevant for a representative post-reform certification decision; we abstract from transitional variation in this return across cohorts.

In a richer dynamic setting, a rising scarcity premium could increase the employment-related return to certification for later cohorts and thereby attenuate the initial certification response over time; our constant- ρ^s formulation abstracts from this additional adjustment. A worker invests in certification if and only if

$$A\rho^s \geq \kappa. \quad (\text{B.8})$$

To ensure an interior certification choice in both regimes, we assume

$$0 < A\rho^D < A\rho^L < \bar{\kappa}. \quad (\text{B.9})$$

Hence, the inflow of newly certified masters under regime s is

$$m^s = F(A\rho^s), \quad (\text{B.10})$$

where m^s denotes the measure of workers who acquire the master certificate. Because $A > 0$ and Eq. (B.7) implies $\rho^D < \rho^L$, we have $A\rho^D < A\rho^L$. Strict monotonicity of the c.d.f. therefore gives

$$m^D < m^L. \quad (\text{B.11})$$

Thus, deregulation reduces the inflow of newly certified masters. This prediction is consistent with the sharp post-reform decline in master examinations in deregulated occupations (see Figure 1).²⁷

The certification decision does not by itself determine whether a newly certified master initially supplies labor in dependent employment or instead remains outside the dependent master-labor stock, for example through self-employment. Let $q^s \in [0, 1]$ denote the share of newly certified masters who supply master labor in dependent employment under regime $s \in \{L, D\}$. The inflow into the stock of master labor relevant for our wage analysis is therefore $q^s m^s$. Importantly, $\pi^D < \pi^L$ does not by itself determine the sign of $q^D - q^L$, because π^s captures the incremental value of the master certificate in self-employment rather than the level of the self-employment payoff relative to dependent employment. We therefore leave the allocation share q^s unrestricted across regimes. A central maintained condition for the certification-inflow channel is that the decline in certification is not fully offset by a shift of newly certified masters toward dependent employment:

$$q^D m^D < q^L m^L. \quad (\text{B.12})$$

²⁷For simplicity, the framework abstracts from the time required to complete master training and from transitional cohort composition. With heterogeneous training durations, the effect of a change in certification decisions on completed master examinations can phase in over several years as workers who began training before the reform complete their examinations. These transitional dynamics affect the timing of observed examination flows but not the comparative-static ranking $m^D < m^L$.

This condition allows q^D to differ from q^L and therefore does not require that the allocation of newly certified masters between dependent employment and other labor-market states remain unchanged after deregulation. In particular, the condition can hold even if $q^D > q^L$, provided that the increase in the share of newly certified masters entering dependent employment is not large enough to offset the decline in certification.

To link certification decisions to incumbent wages, we distinguish between the number of newly certified masters, m^s , and the stock of active master labor in dependent employment, M_t^s . As defined above, $q^s m^s$ denotes the inflow of newly certified masters into this labor stock. Let $\lambda \in (0, 1)$ denote the exit rate at which existing masters leave dependent employment because of retirement, occupational mobility, transitions to self-employment, or other forms of exit. For parsimony, we abstract from subsequent entry or re-entry into dependent employment by previously certified workers who are outside the dependent master-labor stock. Allowing for such transitions would affect the path of M_t^s but not the form of the relative-wage decomposition below; their effect would operate through the resulting relative stock of master labor.

We treat the certification inflow m^s and the initial allocation share q^s as constant over time within each post-reform regime and assume that λ is constant over time and common across regimes. Holding the exit rate fixed across regimes isolates the certification-inflow channel. Allowing exit rates to differ across regimes would affect the magnitude of the stock response: higher reform-induced exits from dependent master employment would reinforce the scarcity effect, whereas lower exits would attenuate it. We interpret M_t^s as the beginning-of-period stock of active master labor. Certification decisions made during the interval from t to $t + 1$ generate the inflow $q^s m^s$ into the active master-labor stock at $t + 1$. The stock therefore evolves according to

$$M_{t+1}^s = (1 - \lambda)M_t^s + q^s m^s. \quad (\text{B.13})$$

Given the common initial condition $M_0^D = M_0^L \equiv M_0$ in Eq. (B.2), iterating Eq. (B.13) yields

$$M_t^s = (1 - \lambda)^t M_0 + q^s m^s \frac{1 - (1 - \lambda)^t}{\lambda}. \quad (\text{B.14})$$

It follows that

$$M_t^L - M_t^D = (q^L m^L - q^D m^D) \frac{1 - (1 - \lambda)^t}{\lambda} > 0 \quad \forall t > 0, \quad (\text{B.15})$$

where the inequality follows from Eq. (B.12). Hence,

$$M_t^D < M_t^L \quad \forall t > 0. \quad (\text{B.16})$$

The reform therefore gradually lowers the stock of active master labor in dependent

employment relative to the counterfactual continued-licensing regime as the cumulative effect of lower inflows grows over time. This stock adjustment constitutes the first step of the scarcity channel. The resulting prediction of a lower stock of masters in dependent employment is consistent with the negative post-reform estimates for master employment documented in Figure 4.

We do not impose a separate law of motion for non-master labor, N_t^s , because the wage-premium result below depends on the relative stocks of master and non-master labor. Lower certification tends to increase non-master labor if workers who do not obtain the master certificate remain in dependent employment. At the same time, deregulation may induce non-masters to leave dependent employment, for example through transitions to self-employment, which works in the opposite direction. We therefore do not impose a sign on $N_t^D - N_t^L$. The scarcity channel derived below requires only that deregulation reduce master labor relative to non-master labor,

$$\frac{M_t^D}{N_t^D} < \frac{M_t^L}{N_t^L}. \quad (\text{B.17})$$

Incumbent Workers. Master and non-master labor are imperfect substitutes in production, as captured by the finite elasticity of substitution σ in Eq. (B.1). Within each labor type, however, we assume that incumbent and newly entering workers are perfect substitutes. Incumbency therefore matters because workers who already held the master certificate before the reform have a predetermined certification status, not because incumbent and newly certified masters face different wage schedules. Accordingly, the market wage for master labor also applies to incumbent masters.

To allow for wage-setting components that are common to master and non-master labor, let $\omega_t^s > 0$ denote a regime- and time-specific proportional wage factor. This factor may capture, for example, the output price or wage-setting components that affect both labor types proportionally.²⁸ Wages are given by this common factor times the respective marginal products implied by Eq. (B.1):

$$w_{M,t}^{\text{inc},s} = \omega_t^s \frac{\partial Y_t^s}{\partial M_t^s} = \omega_t^s \alpha_t^s (Y_t^s)^{1/\sigma} (M_t^s)^{-1/\sigma}, \quad (\text{B.18})$$

and

$$w_{N,t}^{\text{inc},s} = \omega_t^s \frac{\partial Y_t^s}{\partial N_t^s} = \omega_t^s (1 - \alpha_t^s) (Y_t^s)^{1/\sigma} (N_t^s)^{-1/\sigma}. \quad (\text{B.19})$$

The framework therefore allows deregulation to affect the overall level of wages through ω_t^s .

²⁸Self-employed providers are not modeled as a separate production input. Reform-induced changes in self-employment can nevertheless affect firms' relative demand for employed master labor through α_t^s and common proportional wage-level components through ω_t^s . The sign of the relative-demand effect is a priori ambiguous because self-employed providers may substitute for or complement employed master labor.

Such common proportional wage effects, however, do not affect the master wage premium because ω_t^s cancels when taking the ratio of master and non-master wages. We abstract from wage-setting effects that differ between master and non-master labor independently of their relative marginal products, including worker-type-specific bargaining responses to reform-induced changes in self-employment outside options. Such responses would constitute an additional channel affecting the master wage premium outside the framework.

Taking the ratio of Eqs. (B.18) and (B.19) yields the relative wage of incumbent masters:

$$\frac{w_{M,t}^{\text{inc},s}}{w_{N,t}^{\text{inc},s}} = \frac{\alpha_t^s}{1 - \alpha_t^s} \left(\frac{N_t^s}{M_t^s} \right)^{1/\sigma}. \quad (\text{B.20})$$

Equivalently, in logs,

$$\log w_{M,t}^{\text{inc},s} - \log w_{N,t}^{\text{inc},s} = \underbrace{\log \left(\frac{\alpha_t^s}{1 - \alpha_t^s} \right)}_{\text{relative demand channel}} + \underbrace{\frac{1}{\sigma} (\log N_t^s - \log M_t^s)}_{\text{relative scarcity channel}}. \quad (\text{B.21})$$

Eq. (B.21) shows that deregulation can affect the wage premium of incumbent masters through two channels. First, deregulation may change the relative demand for master labor, captured by α_t^s . Product-market competition can contribute to this channel if it changes the relative value of master-specific tasks or otherwise shifts labor demand toward or away from master labor. A decline in firm rents or wages that affects master and non-master labor proportionally, by contrast, operates through the common factor ω_t^s and therefore does not affect the relative wage premium. Second, deregulation can affect the premium through the relative supply of master labor. Under the maintained condition in Eq. (B.17), deregulation lowers the stock of master labor relative to non-master labor, which raises the relative scarcity term in Eq. (B.21).

To make these opposing forces explicit, define the deregulation-induced change in the incumbent master wage premium as

$$\begin{aligned} \Delta_t^{\text{prem}} &\equiv \left(\log w_{M,t}^{\text{inc},D} - \log w_{N,t}^{\text{inc},D} \right) - \left(\log w_{M,t}^{\text{inc},L} - \log w_{N,t}^{\text{inc},L} \right) \\ &= \underbrace{\left[\log \left(\frac{\alpha_t^D}{1 - \alpha_t^D} \right) - \log \left(\frac{\alpha_t^L}{1 - \alpha_t^L} \right) \right]}_{\text{relative demand channel}} \\ &\quad + \underbrace{\left[-\frac{1}{\sigma} \left(\log \left(\frac{M_t^D}{N_t^D} \right) - \log \left(\frac{M_t^L}{N_t^L} \right) \right) \right]}_{\text{relative scarcity channel}}. \end{aligned} \quad (\text{B.22})$$

Under the common initial state in Eq. (B.2), $\Delta_0^{\text{prem}} = 0$. Thus, Δ_t^{prem} is the population analog of the deregulation-induced change in the master–non-master wage premium

targeted by our empirical DDD design.²⁹ The relative-demand channel is negative if deregulation lowers the relative demand for master labor, for example if $\alpha_t^D < \alpha_t^L$. The relative-scarcity channel is positive whenever Eq. (B.17) holds, because

$$\frac{M_t^D}{N_t^D} < \frac{M_t^L}{N_t^L}$$

implies

$$\log\left(\frac{M_t^D}{N_t^D}\right) - \log\left(\frac{M_t^L}{N_t^L}\right) < 0.$$

Thus, the net effect of deregulation on the incumbent master wage premium is theoretically ambiguous. If deregulation reduces the relative demand for master labor, the wage premium increases when the positive relative-scarcity effect dominates this negative relative-demand effect. More generally, a positive reform effect on the wage premium, together with evidence that deregulation reduced certification and master employment, is consistent with the scarcity mechanism formalized above.

Intuition. In sum, deregulation removes the master certificate’s licensing role for business entry and thereby reduces its self-employment-related value. Under the maintained condition in Eq. (B.6), any offsetting increase in the employment-related value of certification is insufficient to compensate for this loss, so that the overall private return to obtaining the certificate declines for new cohorts. The resulting decline in certification then lowers the inflow of newly certified masters. Under the additional maintained condition in Eq. (B.12), this lowers the inflow of master labor into dependent employment and gradually reduces the stock of active master labor relative to the counterfactual continued-licensing regime. When the relative-stock condition in Eq. (B.17) also holds, master labor becomes scarcer relative to non-master labor. This relative scarcity raises the marginal product and wage of master labor relative to non-master labor. At the same time, deregulation may lower the relative demand for master labor, for example if intensified product-market competition reduces the relative value of master-specific tasks. Deregulation may also affect overall wage levels through wage-setting components common to both labor types, but such common proportional effects do not affect the master wage premium. The net effect on the incumbent master wage premium is therefore theoretically ambiguous. If the positive relative-scarcity effect dominates any negative relative-demand effect, deregulation increases the wage premium of incumbent masters. Importantly, such an increase in the relative wage premium need not imply an increase in the absolute wage level of masters if

²⁹In the baseline empirical DDD design, master status is measured in the pre-reform base period and kept fixed thereafter. Workers who obtain a master certificate after the reform therefore remain in the baseline non-master group, whereas the model classifies workers according to their current certification status. This distinction disappears when post-reform master-status switchers are excluded. As shown in Section 5.2, excluding such switchers leaves the estimated reform effect virtually unchanged.

deregulation simultaneously puts downward pressure on wages more generally.