Institutional variation in occupational licensing and its consequences for wages.

A distributional analysis for the USA and Germany.

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Abstract: Licensing is a central institution in labor markets worldwide. Using the example of the USA and Germany, this study shows strong institutional differences between licensing systems that are of great importance for wage distribution but are not yet part of the debate about the economic consequences of licensing. The two countries differ significantly in terms of the rules of entry into occupational labor markets, the competencies of occupational boards, and the combination of licensing with price regulation. I claim that licensing systems change the bargaining power and bargaining scope for wages, which leads to different wage premiums across the distribution and different consequences for wage inequality. Using novel license data, I empirically show that licensing is associated with the largest relative wage premium for German low-wage and American middle-wage workers. In addition, the USA system leads to greater dispersion among licensed workers and to higher wage inequality overall. In contrast, the German system compresses wages for licensed workers, thereby reducing overall wage inequality.

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1 Introduction

In 2015, the White House (2015) stated that occupational licensing – the permission given by a state authority to work within an occupation (e.g., physicians) – can benefit consumers "when designed and implemented carefully" (White House 2015, 1), especially for health and safety standards. However, the report also expressed strong worries that occupational licensing would cost "millions of jobs nationwide and raise consumer expenses by over one hundred billion dollars" (White House 2015, 5), thereby fueling a heated debate about the growing economic inequality and exploding health care expenditures in the USA. Many policy makers, sociologists, and economists alike view occupational licensing with skepticism. They describe it as a means for economic rents (Weeden 2002), an artificial market restriction to the benefit of powerful groups (Kleiner and Krueger 2010), or some kind of market failure that increases inequality (Weeden and Grusky 2014a). Occupational licensing speaks to the general debate about the effectiveness of labor market regulation in national markets, which are crucial for wage-setting processes and overall wage inequality.

Occupational licensing appears in many countries (Humphris, Kleiner, and Koumenta 2011; Koumenta et al. 2014), but its manifold consequences for the economy and the distribution of wages have been most heavily debated in the United States (Potts 2009). In other countries, including Germany, occupational licensing is not subject to criticism in policy debates (Haupt 2016b). Cross-country differences in the institutional implementation of licensing are a likely reason, although they have received little attention among social scientists so far.

This article attempts to set the agenda for social scientists to start paying attention to cross-country differences in licensing systems as a major institutional factor shaping economic inequality.

By doing so, this paper complements previous research on licensing in several ways. First, I analyze the *institutional variation of occupational licensing*, based on differences in the countries' constitutions and rules typically established by the U.S. Supreme Court and the German Federal Constitutional Court, respectively. Both countries offer an excellent starting point for an in-depth cross-country comparison of different licensing rules. In the available cross-country comparisons, occupational licensing appears as a unitary phenomenon, which creates barriers to entry into labor markets. Here, I discuss whether these barriers are quantitatively and qualitatively the same across countries. To understand the differences, I describe the legal frameworks in which these regulations operate. The analysis of the legal structures embedding occupational licensing helps understand why the scope of licensing in the USA is much broader than that in Germany, what roles

occupational boards are allowed to play, and why price regulation is an important part of occupational licensing in Germany but not in the USA.

Second, I combine the information of institutional variation with bargaining theory to infer about the wage advantage associated with occupational licensing. Institutional variation alone does not explain the corresponding differences in wage premiums, as such variation only creates structural differences with the potential to alter labor market processes. By connecting the institutional variation of licensing with bargaining theory, I offer a novel line of reasoning of how licensing influences wages at the microlevel. I argue that occupational licensing is one of many means that allows employees to increase their bargaining power. This increase can differ across countries but also within a country because entry regulation can be more or less severe for different licensed occupations within a country. In addition, I show that occupational licensing changes the bargaining range of wages. Differences in the bargaining range lead to different minimum and maximum wage offers. Both aspects result in *differences in the wage advantage gained by licensing across the wage distribution.*

Third, using this detailed distributional lens, I derive expectations concerning the consequences of occupational licensing for between-occupation and overall wage inequality. I argue how the difference in the wage advantage translates into different distributions of wages *between* licensed and unlicensed employees in Germany and the USA. I conclude that licensing increases the wage dispersion for licensed employees relative to nonlicensed employees in the USA but decreases the wage dispersion in Germany. Whether occupational licensing is, in addition, a driver of wage inequality or a counter against it depends on the kind of wage advantage associated with it in a given country, the share of licensed employees, and the composition of licensed occupations. If licensing primarily reduces the risk of earning low wages for many employees, it is likely to be a counter against wage inequality. If licensing instead represents an (additional) advantage for a minority of high-earning employees, it is likely a driver of wage inequality – but only to a very limited extent. I expect that the combination of different wage advantages of licensing with the different occupational composition between countries results in licensing as a driver of overall wage inequality in the USA but a counter against it in Germany.

Analyzing the economic consequences of licensing is challenging because we lack high-quality licensing data. To change this situation, the Current Population Survey (CPS) introduced questions about licensing information in 2015. For waves prior to 2015, scholars typically needed to combine “official” licensing data from websites with surveys. It is not

clear whether scholars can fruitfully compare both kinds of data. This paper offers a proposal on how to harmonize both kinds of licensing data for the USA over time.

I argue in this paper that the crucial differences in licensing's economic consequences go beyond the mean. To grasp them, we need a fine-grained, distributional lens. Thus, this study offers an application of different quantile models using the relation of licensing to wages as central information. The appropriateness of different quantile models for different empirical questions is an ongoing debate (England et al. 2016; Killewald and Bearak, Jonathan 2014; Wenz 2018). The paper offers an empirical case that shows what kind of questions the different models can answer.

2 What we know and what we do not know about occupational licensing

2.1 The common reasoning about licensing and wages

The common reasoning about occupational licensing and wages is at its core a variation of Max Weber's social closure theory (Weber 1922): if an occupation becomes politically strong enough, some actors will seek to reduce competition in favor of that occupation. Market actors can achieve reduced competition by controlling entry into an occupation and/or by controlling the market supply for occupation-specific demands. The first establishes a closed group, and the second establishes a closed market. Closing the market is only possible if an occupation is the only legitimate supplier of a specific good or task. Occupational licensing serves both goals. A license is the permission granted by the state to work in an occupation and to perform occupation-specific tasks. Only persons with a license have the authorization to be in the group and to be a supplier for the occupation-specific task.[1] Occupational licensing is the result of successful lobbying that aims to obtain and secure power. However, this does not support public legitimacy. Instead, occupational representatives claim that licensing serves consumer protection. Occupational boards, chambers, or associations serve as collective actors to organize entry regulation. They use that power to manipulate the demand-supply curve in their favor. By reducing supply as well as channeling the demand for services to their occupation, licensed workers in that market are able to demand higher prices and wages than we would expect given full competition. The difference between the wage under full competition and the wage under market restriction is an *economic rent.* Wage inequality is only possible if markets are not fully competitive and some market actors earn rents. Therefore, rents based on occupational licensing increase wage inequality.

[1] This is different from educational credentials, which are only a means to close groups but not the market (Cardona 2013).

Many scholars use that line of argumentation. The motivation behind occupational licensing is typically seen as a power struggle, most prominently formulated in Stigler's *capture hypothesis*: "every industry or occupation that has enough political power to utilize the state will seek to control entry" (Stigler 1971, 5). Scholars of this strand doubt that legislators intend to protect consumers and see the regulation of occupations merely as an act of unnecessary government intervention (Angrist and Guryan 2008; Arias and Scafidi 2009; Kleiner and Krueger 2010). The asserted arbitrariness of licensing within the U.S. labor market across states is taken as evidence for that view (Carpenter et al. 2015). Some occupations are regulated in some states but not in others. Entry requirements vary across states. If consumer protection were the motivation for occupational licensing, we should expect similar entry regulations across states due to equal consumer hazards. Since that is not the case for some occupations, licensing is seen as the extreme along a continuum with certification, accreditation, and registration as less successful forms of capturing market power (Koumenta et al. 2014).

Some scholars regard licensing as a state-regulated labor market monopoly, assuming homologous mechanisms across labor markets. In their comparison between the UK and Germany, Bol and Weeden (2015, 357) state that "[t]he standards for licensure are often set by occupational agents or an organization that directly represents the occupation (e.g., a lawyer's bar association); as with occupational control over apprenticeships, this gives occupational representatives indirect control over the number and qualities of licensees. [Thus,] occupational licenses affect wages by restricting opportunities to apply skills." The interpretation of the licensing wage premium as a consequence of (intentional) supply manipulation by collective actors is the common view in empirical studies of occupational licensing in particular and social closure in general (Bol and Drange 2017; Weeden 2002; Albert 2016; Gittleman and Kleiner 2016; Kleiner and Krueger 2013; Bol 2014; Redbird 2017; Blair and Chung 2017; Timmons et al. 2018; Zhang 2018b).

Other scholars claim that occupational licensing contributes to an increase in wage inequality (Haupt 2012; Weeden and Grusky 2014a; Bol and Weeden 2015), which is often considered harmful for the economy (Cingano 2014; Persson and Tabellini 1994). Weeden and Grusky (2014a, 474) assume that increased inequality in Western societies "occurred not only because of competition-increasing change at the bottom (e.g., declining union power, globalization) but also because of competition-reducing processes at the top." A major reason is economic rents, which are "wage premiums that accrue to licensing and related types of occupational closure" (Weeden and Grusky 2014a, 475).

Despite its frequent use in the literature, scholars rarely discuss the validity of this common reasoning. How sure can we truly be that the common reasoning is useful and applicable to different contexts?

2.2 Is the common reasoning valid?

Many scholars claim to show evidence for at least certain aspects of the common reasoning. I am in line with Zhou (1993, 536) in the overall assessment that the literature still tends to be one-sided and treats "occupational licensing as evidence that occupational groups are pursuing their own interests when they pressure the state to restrict entry into their professions at the expense of the public interest". This is a very restricted interpretation of the institutional basis of licensing. It is not clear whether it applies to European countries, such as Germany, or even the USA in a correct manner.

The first part of the licensing theory sketched above concerns reasons why occupations are licensed. The empirical historical work is not in line with a strict interpretation of the capture hypothesis. Zhou (1993) finds that the age and prestige of an occupation were important for the diffusion of occupational licensing in the early 1990s in the USA, which can serve as evidence that licensing indicates the success of politically important occupations and their lobbies. He also finds strong evidence for state government effects independent of occupational properties: the higher the revenue of a state is (which is a measure of its organizational capability), the more occupations are licensed in the person sector but the fewer occupations are licensed in the business sector. This should not be the case if licensing is just the winners' price of a lobby tournament. Governmental decisions across U.S. states about the need to license specific occupations are thus a major part of this policy.

Law and Kim, S. (2005) argue that occupational licensing resulted from a growing information asymmetry between more advanced practitioners and consumers. As urbanization increased, more consumers interacted with more suppliers of services, which enabled consumers to choose alternatives. Consumers needed licenses as a strong and trustworthy signal of quality of service to solve an increasing "lemon market problem" (Akerlof 1970): the inflow of market actors with very low quality hiding within a group of actors with high quality. Law and Kim, S. (2005, 754) empirically show that occupations' "licensing legislations were adopted earlier and were more likely to restrict entry into professions where informational asymmetries were most likely to be problematic."

While studies of quality enhancements are scarce, many investigate the relationship between licensing and wages and find positive associations. Weeden (2002) shows that U.S. licensed occupations have 9% higher wages, on average - independent of individual

or other occupational characteristics. Various other studies also find higher average wages of licensed employees, ranging from 10% to 18% for the USA (Kleiner and Krueger 2013; Gittleman and Kleiner 2016; Pagliero 2011; Cooney 2013; Timmons, Hockenberry, and Durrance 2016). This positive association also holds for other countries. Koumenta et al. (2014) provide an overview of licensing in the EU-27. Accountants, dentists, pharmacists, and architects enjoy wage premiums of 9 to 19%, while the wages of security guards, plumbers, social workers, and teachers seem to remain unaffected. In their study comparing Germany and the UK, Bol and Weeden (2015) find the wage premium attributable to occupational licensing to be approximately 10% in both countries. Bryson and Kleiner (2010) compare the situation of licensed occupations in the U.S. and the UK. They estimate a wage premium of licensed occupations of 13% in the UK and 18% in the USA.

There are some noteworthy exceptions to the overall picture. Law and Marks (2013) compare the wages of registered and practical nurses between 1950 and 1970 in the USA. During this time, these occupations changed from certification to licensing in some states but remained certified in others. The authors estimate no changes in wages attributable to changed licensing status (see also Law and Marks 2009, 2017). The study by Redbird (2017) uses the variation of licensing across states over time to study wage effects. She, too, does not estimate an increase in the occupational mean wage after the licensure of an occupation within a state. If wages increase as a direct consequence of licensing *and* the mechanism works the same for all licensed occupations, we should expect a positive increase.

However, the aforementioned, important null results may be a consequence of the selective samples of these studies (Deyo, Kleiner, and Timmons 2018). For instance, nursing is a medium-wage occupation, and its status is not comparable with that of classic professions, such as lawyers or physicians. The newly licensed occupations studied by Redbird (2017) are most likely to be low- and medium-wage occupations with lower status and power resources than classic professions (Timmons et al. 2018). Habinek and Haveman (2019) show for the U.S. medical market how important occupational power is to maintain monopolies against rival occupations.

We lack detailed information about power differences across licensed occupations. However, I assume within this paper that licensed occupations are heterogeneous in this regard and that we need to include such differences to fully grasp the economic consequences of licensing. An indirect test of the power differences across licensed occupations is to analyze whether licensing has different wage advantages across the distribution, where the more powerful and prestigious occupations should be found in higher parts of the wage or income distribution with even higher premiums. However,

empirical work about differences in the licensing premium across occupations or the wage structure is scarce. Weeden (2002) finds the highest wage premiums for licensed employees in professions. Bol and Weeden (2015) estimate higher coefficients for lower parts of the German wage structure, which does not hold for the UK. Gittleman, Klee, and Kleiner (2015) analyze different premiums for four different parts of the wage distribution based on self-reported licensure in the U.S.. Wages are higher in all quartiles due to licenses, but the advantage seems more pronounced in the bottom quartile. In a follow-up study, Gittleman and Kleiner (2016) report the largest wage advantages of licensing in the bottom and top quartiles. This is not an overall clear pattern, but it suggests that the licensing wage advantage is not uniform across the distribution but rests on differences within licensed occupations that we need to understand better.

The last stream of the general literature concerns the relation of licensing to overall wage inequality. Mouw and Kalleberg (2010), Kim, C. and Sakamoto (2008), and Weeden and Grusky (2014a) assume that occupational licensing is a factor behind increased wage inequality in the USA, but they do not test this claim. Bol and Weeden (2015, 354) stress that their results about occupational licensing in Germany and the UK have "important implications for understanding between-occupation wage inequality and cross-national differences in aggregate levels of wage inequality. […] [R]ents in the United Kingdom exacerbate wage inequality (by driving up top-end wages) more than in Germany, where rent-generating institutions are more likely to also protect low-wage or low-skill workers". However, they cannot provide a formal test of that assumption and call for research "that focuses on institutionalized rents and their distribution across the occupational structure which may help us understand cross-national differences in aggregate levels of wage inequality" (Bol and Weeden 2015, 366). As of yet, the empirical analysis of licenses and wage inequality is only conceptual. There is no rigorous empirical study testing the claim (Zhang 2018a).

2.3 What do we not know about occupational licensing and the distribution of wages?

Despite the growing body of studies analyzing both the incidence and influence of occupational licensing on wages, there remain at least three points worth further investigation.

First, we know hardly anything about institutional variations in occupational licensing across countries. There are some comparative studies about licensing, but they assume that labor market institutions work similarly in all countries (Koumenta et al. 2014; Humphris, Kleiner, and Koumenta 2011; Bol and Weeden 2015). In contrast, I claim that there is

considerable institutional variation of licensing across countries. Licensing is a particular labor market institution deeply embedded within a country's legal system. Past accounts neglect both the different legal systems and the embedding of licensing into the system. I offer such an analysis comparing the sets of legal rules governing occupational licensing in the USA and Germany.

Second, we can be confident about the positive association between licensing and wages, but we do not know whether this advantage is the same for all licensed employees. Does licensing help licensed employees avoid low wages, does it push high earners even higher within the wage structure, or does it affect both subgroups? The traditional closure story cannot answer such questions because it does not make arguments about the heterogeneous effects of licensing at different points of the wage structure or, more generally, an argument about differences in wage setting situations. I believe the reason for the absence of such arguments is that the general literature fundamentally relies on a one-sided concept of labor markets. Licenses, so the story goes, disturb the equilibrium of a fully competitive market, which forces employers to buy licensed labor at a higher price and is the reason wages are higher *for all licensed employees*. The perspective in the literature on the wage setting of licensed employees is a one-dimensional supply-and demand-driven perspective.

In contrast, I will obtain a clear picture of the heterogeneous influences on wages at different points of the wage distribution combining elements of closure theory with bargaining theory. Using such a bargaining approach, we can analyze why licensing increases the bargaining power of employees and show that different legal frameworks change the scope of bargaining. If the bargaining range of licensed employees is systematically narrower than that of nonlicensed employees, the wages of the former should be more homogeneous, and the resulting wage distribution should be more compressed. I thus propose a new lens to study the nature of the licensing wage premium.

Third, the literature does not answer whether licensing increases wage inequality. If institutional variation matters for the scope of licensing across all occupations within a country and the amount of the licensing wage premium across the distribution, the answer to this question is not trivial. A licensing premium across the distribution only tells us the following: if we observe a licensed employee with a given rank within a distribution, we expect X% higher wages. Even if countries are similar in the structure of the premium across the distribution, they can differ in how many employees are able to add such a premium at different points of the distribution. A large licensing premium in the top ranks of the distribution may not matter much for the level of overall inequality if there are very few licensed employees at the top. Most licensed employees within a country may crowd in the upper middle of the distribution, where the premium is lower. However, the

cumulative influence of many employees with moderate advantages in the upper middle of the distribution can have larger consequences on wage inequality than a few elite employees with a large premium. This is why the composition of licensed occupations matters strongly for such an analysis. We need to know which occupations are licensed within a country, where they are located within the distribution, and how the licensing premium varies across the distribution to estimate the influences of licensing on wage inequality.

3 The institutional variation of occupational licensing in Germany and the USA

I describe institutional variation in licensing in three steps. First, I ask which principles guide the governmental decision to license an occupation. For many scholars and politicians, occupational licensing represents a strong interference with free labor market processes because licensing is in conflict with other norms, such as anti-trust regulations or the freedom of occupational choice (Edlin and Haw 2014; Bona 2011; Hall, J. and Hurley 2012). The institutional variation of occupational licensing materializes in the legal settlements of these conflicts.

Second, I analyze the kind of power occupational boards typically have. Occupational licensing is not limited to the governmental decree of entry regulations. It needs some institutional control of the adherence to the rules of the occupation stated by the government. Governments typically assign this task to occupational boards (Jost et al. 1993; Hogan 1983; Pagliero 2019). Occupational boards potentially serve as powerful institutions that execute and maintain the power of occupations within the labor market. Thus, to understand the power of and power differences between licensed occupations, we need to understand the role of occupational boards. Furthermore, if the common reasoning is correct and licensing is a means of market control, we should be able to observe at least some kind of gate keeping from boards as strong occupational collective actors.

My third focus refers to price regulations for particular services provided by licensed occupations. The regulation of labor and the regulation of prices can fall under very different legal norms and can therefore be part of the licensing system or not. Previous research suggests that price regulation is strongly correlated with wage setting (Guadalupe 2007; Nicoletti and Jean 2002). It is therefore imperative to study whether such price regulations exist for licensed occupations and, if so, how rigid they are.

3.1 Occupational licensing in Germany

3.1.1 The licensing rule: Securing the supply and quality of basic public goods

The German government can license an occupation only if it is necessary to produce and maintain a basic public good. This restricts the number of licensed occupations a great deal in comparison to other countries, such as the USA. The restriction is a result of balancing two German constitutional cornerstones by the German Federal Constitutional Court (GFCC): the right of free occupational choice according to article 12 and the postulate that Germany is a democratic and social state according to articles 20 and 28 of the German constitution. A direct consequence of that postulate is that the government has the right to control and regulate business processes if they have the potential to be in conflict with democratic and social affairs (Schwark 1997).

Occupational licensing is a restriction of the right to choose an occupation freely. It must therefore be justified by higher interests of the state, and it is limited by the range of these interests. Germany has a historically established heritage of occupational regulation dating back to craft guilds and powerful professions. Many occupation-specific regulations of the 1950s and 1960s dated back to the early 20th century. During the late 1950s, it turned out that the new constitution after World War II and the old occupational heritage were not always compatible. The precedent case for this conflict was a pharmacist poised to open a new pharmacy. Contemporary legislation prohibited new stores if they were in competition with other pharmacies in the area. The pharmacist sued the government and brought his case to the GFCC, which ruled in his favor in 1958 and established the right of free occupational choice as paramount to interests associated with market regulation. The only exception refers to market regulations concerning basic public goods.

In the wake of the rule in favor of the pharmacist, the GFCC established the *three-stage theory,* ruling out which kind of regulation is appropriate with respect to these basic public goods. It has been the basis of any formal or informal regulation of German occupations ever since (Schulte zu Sodingen 2000). Occupational licensing is only one kind of such regulation, and governments need to justify why occupational licensing, as a strong kind of regulation, is appropriate but a weaker regulation is not.

The court distinguished three stages of occupational regulation with increasing strength. The *first stage* defines whether specific actions or tasks are occupation specific and whether occupations are allowed to perform specific actions. That includes, for example, regulations of nurses' occupational activities in contrast to the activities of medical doctors.

In this case, the first stage defines sets of occupation-specific actions, but this is not licensing.[2]

The *second stage* defines whether formal entry regulations into occupations are permissible. These regulations are the foundation of all licensing laws in Germany. Occupational licensing laws are only justified "if they are a necessary precondition […] for the protection of a basic public good (that is superior to the individual freedom)" (Bundesverfassungsgericht 1958; own translation). The court claimed that governments could only legally restrict labor market access for occupations if the status of Germany as a social state would be in danger without those restrictions. This status rests on the ability of the state to assure the provision of basic public goods ("Gemeinschaftsgüter"). There is by intention no exhaustive list of these basic public goods (Herweck-Behnsen 1997). Governments have the right (within the boundaries of the constitution) to declare a good a basic public good. So far, governments have claimed and courts accepted four different basic public goods: education, public health, public security, and rule of law ("*Rechtsstaatlichkeit*") (Lücke 1994). Any regulation of occupations in Germany must serve the quality or allocation of at least one of these goods.

Table 1 gives an overview of those goods and their related occupations. We briefly discuss each good and the corresponding occupations.

Public health is a major concern of the welfare state (Augsberg 2015). Hence, the majority of health-related professions in Germany are licensed. That includes physicians, pharmacists, podiatrists, nonmedical practitioners, nurses, physiotherapists, psychiatrists, psychologists, midwives, and veterinarians. No license is required for those who use the title of "healer", "health advisor", or "nutritionist" and perform actions within the boundaries of these occupations. A mere relation of an occupation to a basic public good

[2] A second kind of regulation refers to exclusion criteria defined as rules forbidding occupations to perform specific actions. In a series of current rules, for example, the courts consider the prohibition of fracking techniques justified, even if this reduces engineers' amount of occupational freedom (Frenz 2016). Rules of both kinds are justified under the condition that "they serve reasonable purposes of the public good and do not impose excessive or unacceptable burdens on the citizen" (Bundesverfassungsgericht 1958; own translation). The codes of professional conduct for lawyers, tax consultants, and physicians are complex regulations of exercising professional activities. They can be relevant for the analysis of economic consequences of licensing because they restrict the set of protected activities within the labor market. The Administrative Court of Minden, for example, decided that plastic surgeons have no right to perform the operations of dentists, even if they are maxillofacial surgeons. A dual license is required for such a case (Verwaltungsgericht Minden 2007). It is important to note that rules of the first stage represent no immediate obstacle to market entrance since they may relate to single activities and leave others unregulated.

is not sufficient to license the occupation. Nutritionists perform actions that aim to restore or maintain health, but the current political opinion seems to be that low-quality nutritionists would not endanger public health. A low-quality service of physicians, food chemists, or physiotherapists would be a threat to public health. These occupations are therefore licensed in Germany, but nutritionists are not.

Table 1: Licensed occupations and the related public goods in Germany

Public Health	Academic health professions Health care professions Assistant health professions Food chemists	**Rule of law**	Judicial officers Tax consultants & personnel Accountants
Education	Teachers at public schools Driving teachers Preschool teachers	**Public Safety**	Military, police Aviation and shipping occ. Chimney sweeps Architects, construction engineers, consulting engineers Pyro technicians, blasters

Education is under state supervision according to article 7 of the German Constitution. Hence, teachers in public elementary and secondary schools (including teachers of vocational schools) need a license to practice their occupation. The German state has no "education monopoly" and therefore allows private schools, for which the strict entry requirements do not apply. Article 7 of the Federal Constitution states, "Private schools as replacement for public schools require state permission and are subject to federal state law (*Landesgesetze*). Permission must be granted whenever private schools are not inferior to public schools with respect to their curricula, equipment, and the academic education of their teachers." The German federal states are autonomous in their educational policies, which results in state-specific regulations concerning private teachers. Some states require that at least 2/3 of the personnel be licensed. Others require comparable qualifications, mostly university degrees. The legal situation is similar for social workers and preschool teachers. Licenses are required to work in public organizations, but comparable qualifications are sufficient to work for private organizations.

The German constitution rules that Germany is a democratic state. The rule of law is thus one of its cornerstones. Every citizen has the right to constitutional state action, realized prominently in the separation of powers. Jurisdiction, administration of justice, tax consultancy, and audit must therefore be independent from state interests. German citizens

have the right to obtain services from these occupations with minimum standards defined by entry regulations.

Public security is the last of the four basic public goods. Since force can be necessary to sustain that good and since the state has the monopoly of the use of force, there is a strong case for the regulation of market access in this realm. It is in the interest of public security that the state restrict the market access for professions such as police, chimney sweeps, pilots, air traffic controllers, pyro technicians, or architects. It is noteworthy that licenses are *not* required for most engineers in Germany. Laws only protect the title of various engineers, which is a much weaker kind of regulation than entry regulation. In line with the claims of the GFCC, the only exceptions apply to consulting and construction engineers. The regulations regarding these occupations can be strong because the construction and planning of buildings have a strong relation to the basic public good of public security, while the construction of other objects lacks this strict relation.

While the second stage justifies regulations regarding entry requirements, the additional regulation of the *number* of market actors is an even stronger kind of regulation. This would fall under the third stage of the three-stage theory. A control of the amount or a quota of practitioners is "only permissive where it is imperative for the containment of proven or highly likely threats to an extraordinarily important public good" (Bundesverfassungsgericht 1958; own translation). Such rules can ban persons from market access, even if they fulfill all necessary entry requirements of a licensing law. The standards for such restrictions are extraordinarily high (Bundesverfassungsgericht 1987) and are only applied to very few cases, such as regulations for casinos to reduce compulsive gaming (which relates to the basic public good of public health) or regulations to sell guns (which relates to public safety).

3.1.2 The competencies of German occupational boards

In Germany, occupational boards take the form of occupational chambers. As such, they are part of the executive branch of the state. Technically, they are an occupation-specific public corporation ("Berufsständische Körperschaft") implemented and supervised by the state to regulate occupation-specific affairs. Any incumbent of an occupation with a chamber must be a member of the chamber. Chambers have the right to *counsel* the government in matters of qualification standards for the occupation. They examine the qualifications of those who are interested in obtaining a license and issue the license. Chambers create codes of conduct and report misbehavior of its members to the judicative (typically to the attorney general or a special part of the state court). They can also manage occupation-specific pension funds.

As members of the executive branch, German chambers have a limited set of actions. They have no legal ground for setting or changing the qualification standards. If they identify misbehavior or hold the opinion that someone should not practice within the occupation-specific labor market, they may send cease and desist letters, but a court needs to decide whether there is indeed a violation of a norm or law and, if so, what sanctions are appropriate. They also lack the power to issue quotas of practitioners because that would fall under the third stage of the three-stage theory, which refers to the control of the number of market actors.[3]

Last, German chambers are not unions and therefore have no right to bargain collective pay schemes or work conditions and may not organize strikes. Their ability to increase the wages of employees within the occupation-specific labor market is thus extremely limited. Chambers can pledge for increased qualification standards and hope to increase earnings because of this improvement. They can also sue unlicensed competitors, who may increase market pressure and thus decrease prices. German chambers have won a considerable number of such cases. According to the respective court decisions, teeth-whitening or dental cleaning is illegal without a dental license (OLG Frankfurt am Main 2012), the treatment of wrinkles is illegal without a medical license (OVG Nordrhein-Westfalen 2006), and counseling for patent application is illegal without a lawyer's license, even if engineers have the proper technological knowledge about the innovation (Bundesgerichtshof 2016). It may, of course, be the case that members of the chambers only sue competitors to protect the public from harm, but their behavior may also result from perceived threats to their economic position.

The general literature about licensing suggests that occupational agents have the power to control or regulate entry into occupations and thus increase earnings. This assumption seems to overstate the competencies of chambers as the relevant agents for occupation-specific matters in Germany. It is not possible for them to control the number of entrants

[3] Such controls do exist for medical professions, but only for the medical practices associated with public insurance companies. These regulations may seem like market closure in favor of these professions. However, the main purpose of this regulation is to avoid increasing health care insurance contributions to keep health care affordable. Any new medical practice has the right to spend a defined budged on patients. Therefore, each new medical practice is a new weight on the public insurance fund. Keeping health care affordable is a goal that relates strongly to the supply of public health and is therefore not an internal affair of the medical professions itself but of the society as a whole. Consequently, chambers do not have a say in the matter of this particular market closure. A committee consistent of members of the government, care providers, and insurances decide whether there is an oversupply of medical practices in their area and if so, they can decide to close the area to new practices. For the government and the insurance members of this committee, we can hardly allege an interest creating economic rents for the medical profession. Their interest is in keeping costs low and trying to avoid oversupply by closing the market for new self-employed public-insurance related employers. However, this rule only applies to the contract situation with the public insurances. Any medical professional has the right to open a private practice.

into the occupation or to increase the difficulty of entrance autonomously to achieve this aim directly. They must rely on defending the scope of their market against unlicensed practitioners.

In sum, we can only attribute gatekeeping behavior to German boards in matters of controlling active market members due to codes of conduct, reporting misbehavior, and suing market members perceived to be illegitimate.

3.1.3 Keeping the service of basic public goods affordable by regulating prices

The provision of basic public goods alone does not satisfy constitutional requirements. In addition, every citizen must be able to afford standard legal, educational, health, and (construction) safety services. It would be a violation of the welfare principle if citizens were not able to afford standard medical services or if the prices of these services strongly increased the social security contribution.[4] Because of that, licensing in Germany is in most cases combined with economic regulations that define price ranges for occupational tasks. These regulations cover statutory fees, statutory contracts with insurance, and collective wage agreements with public servants. An account of these economic regulations is indispensable for understanding the economic situation of licensed occupations in Germany.

Governments regulate prices on the grounds of fee structures and scales of charges for the respective occupations. The fee schedule for dentists, for instance, determines that the "resection of a root tip of an anterior tooth" costs at least 25.87 Euro but not more than 90.55 Euro (German Dental Association 2011, Nr. 3110). Chimney sweeps may charge 12.28 Euro for the basic services for each house and have fixed prices for every additional task associated with their duties. The pay of lawyers, judges, or accountants should be independent from the results of their cases. Architects, construction engineers, chimney sweeps, tax consultants, and most health-related professions also face price regulations. Although some health-related professions, such as physiotherapists and nurses, are unregulated by fee structures, they are subject to §125 of the Code of Social Law V (*Sozialgesetzbuch V*). According to that paragraph, health insurance is bound to enter into statutory contracts defining maximum prices for services with providers. The contract for logopedia fixed the costs for each standard logopedic treatment of 30 minutes at 23.66 Euro in 2015 (Verband der Ersatzkassen 2014). Price regulations for educational services do not exist, but mandatory collective agreements regulate the remuneration of employees in the

[4] For instance, §71, 3 of the Code of Social Law V defines the principle of contribution stability for the public health insurance contributions ("Beitragsstabilität der Grundlohnsumme"). The share of these contributions of all taxpayers in relation to their gross earnings should not increase over time.

educational system. Similar arrangements exist for the military, police, and air traffic control.

Price fixing is not a necessary – but a very likely – implication of licensing in Germany. For some licensed occupations, the prices for a service itself are not fixed, but the wages for the service suppliers are. This applies to civil servants in particular but also to occupations directly associated with a basic public good (such as air traffic controllers or teachers). Civil servants can sue the German state if they consider their wages substandard. In 2015, German judges and federal prosecutors won such a case, and governments have had to pay them a higher wage since (Bundesverfassungsgericht 2015b).

A notable exception to the price regulation of licensed occupations concerns practices that do not belong to the state-defined activity of the occupation. In such a case, it is possible for incumbents of particular licensed occupations to set prices freely. For example, it is rather common practice among lawyers to offer consulting services. Since these services are not considered specialized to lawyers, the remuneration for them is unregulated by the government. The same is possible for health care services that are not part of the standard catalog of the respective occupation. Physicians can offer services such as esthetic interventions or practices outside traditional medicine to clients and freely bargain over the prices for these services.

In summary, the provision of basic public goods is the main purpose of the German system of occupational licensing. This is a high priority state goal embedded in the German constitution. This – and only this – higher interest justifies a restriction of the right to free occupational choice. Chambers have the duty of helping fulfill the goal of high-quality basic public goods provision. They have very limited power to close the market and act more as an extended arm of the state to govern the internal affairs of the occupation. With some minor exceptions, licensing comes with strong economic regulations to keep basic public goods affordable for German citizens.

3.2 Occupational Licensing in the USA

3.2.1 The licensing rule: protection of the public from harmful market actors

The share of licensed employees has greatly increased over the past decades, and some scholars refer to licensing as currently one of the most important labor market institutions of the U.S. (Pagliero 2013; Gittleman and Kleiner 2016). The increase in this strong kind of labor market regulation seems to be at odds with the rhetoric of the USA as a liberal and free market society. There are indeed many formal norms that are clearly in favor of free market transactions, such as the Sherman Antitrust Act from 1890, which prohibits any restraint of free market competition from market actors. Since occupational licensing

establishes monopolies on the provision of certain services, it seems to be in conflict with the Sherman Act, and some scholars argue that this is the case (Monaghan 1961; Edlin and Haw 2014).

As in Germany, the justification of occupational licensing boils down to a conflict between the individual freedom of occupational choice and the collective interest in social welfare. Any U.S. licensing law rests on the argumentation that it serves the public by weeding out potentially harmful market actors (Leland 1979; Larkin Jr 2016). U.S. states can restrict the freedom of occupational choice as part of a social policy because the American constitution does not guarantee the right of free occupational choice as clearly as the German constitution does (Klein 2016). In addition, there is no legal obligation to focus on basic public goods to limit the scope of state licensing policies. In theory, any U.S. state could license any occupation. Governments only need to be convinced that the licensure of an occupation serves the public by preventing harm. In stark contrast to the case in Germany, a government does not need to legally justify its licensing of an occupation. It holds the power to do so as social policy.

The initiative to license an occupation may come from states themselves, but it may also stem from occupational associations. Every occupation may pledge the state for regulation in general and for licensing in particular. This is not the case for firms. Lobbying for regulations that reduce competition is in principle in conflict with the Sherman Act. Occupational lobbying is an exception to that rule. Pledging for *occupational regulation* is legitimate in the USA because *political petitioning* is not subjected to antitrust laws. This so-called petitioning immunity stems from the Noerr-Pennington doctrine and has its roots in two Supreme Court cases, which stated that pledging for regulations is a political activity and therefore not subject to anti-trust laws (U.S. Supreme Court 1961, 1965).[5] This enables occupational associations in the U.S. to lobby for licensing. This is also the case in Germany, but there, the prerequisite of licensing rests on a clearly defined *occupational property*: the direct relation to a basic public good. The U.S. law does not articulate such a necessity. The decision to license an occupation is therefore subject to state government considerations, and occupational associations can use their lobbying power to pledge in favor of licensing. This binds occupational licensing much more to *properties of local occupational associations* (their prestige, influence, or importance) than is the case in Germany, where it rests solely on the properties of the occupation itself. Consequently,

[5] It is still heavily debated in the USA what kind of petitioning by occupational associations is or is not in line with the Noerr-Pennington doctrine (Thimke 1978; Lee 2010; Lao 2002).

there is considerable heterogeneity across U.S. states regarding which occupations are licensed (Hemphill and Carpenter 2016).

3.2.2 The competencies of U.S. boards

If occupational associations' pledge for regulation is successful, the governments establish occupational boards and give them the power to regulate occupational affairs under their supervision. In all states, boards have the authority to counsel the government about requirements of market entry, examine and license the candidates, define codes of conduct, and sanction undue behavior (Svorny and Scholar 1997; Svorny 2000).

The competence to examine candidates is a crucial difference in the power of boards between both countries. If candidates apply for a license, they need to pass an exam. In contrast to the case in Germany, occupational boards have the authority to create and oversee the exam.[6] This includes the definition of cut scores, which are set to measure the minimum competency needed to exercise the occupation without harm to the public (Mehrens 1995). Both exam difficulty and cut scores have increased for a number of occupations over time. Typically, officials claim that the quality of new candidates dropped compared to that of older cohorts, and the more severe quality standards solve the (potential) problem of low-quality service providers. However, studies for lawyers (Merritt, Hargens, and Reskin 2000) and teachers (Goldhaber 2011) find no evidence for that claim. In contrast, Merritt, Hargens, and Reskin (2000, 933) argue that "states have raised bar passing scores without evidence that prevailing standards were inadequate, and despite evidence that examinees' average performance was increasing". Along these lines, Pagliero (2013) finds a strong correlation between an increased number of law students and the level of the cut score, implying its respective adjustment.[7] In the past, boards were successfully sued because judges considered requirements to be high (U.S. District Court for the Middle District of Alabama 1989; Mills 1995). However, the courts did not question the board's authority to set the scores or exam questions.

The empirical pattern is thus very suggestive in favor of the claim that U.S. boards try to control the number of market entrants and thus set prices for their services. There is also evidence of subtle means boards adopt to do so. As in Germany, boards counsel the government about formal entry requirements but have no power to set or change them autonomously. However, the extent of the right to counsel the government seems to depend

[6] German boards do have their own exams for Meister diplomas or specialized occupational tasks (e.g., "Facharztprüfung"). However, these cases do not represent licensing itself. The Meister diploma is a requirement for self-employment. Candidates for the examination of a specialized occupational task first need to obtain a license, which is not issued by the chamber/board itself.

[7] After Japan lowered the exam difficulty of attorneys, the quality of successful attorneys increased because self-selection into the exam decreased (Ramseyer and Rasmusen 2015).

on the structure of the boards within U.S. states. Broscheid and Teske (2003) report a strong positive correlation between the share of public members within U.S. medical boards and the choice for educational-based entry requirements. The more independent a board is (in terms of the requirements of public members on the board and the strength of public budgetary control), the more likely it is that candidates need letters of recommendation, personal interviews, finger printing, and high fees for the examination. In line with these results, Svorny (2000) claims adjustments of entry requirements, for example, additional years of experience or an additional area of expertise, to be the main subjects of regulation by occupational boards. Differences in the influence of the boards over entry requirements across states are thus correlated with the heterogeneous entry rules for the respective occupations (Carpenter et al. 2012; Meehan, B. and Benson 2015).

We lack comprehensive knowledge about the role of boards in policymaking (Pagliero 2019). Here, I assume in line with Allensworth (2017) that as their influence on occupational policies increases, the more outsiders attribute special knowledge to board members or any occupational insiders. Such perceived asymmetry can lead to information cascades from a small fraction of actors within a network throughout the network. I further assume that high-status occupations are able to create and contain such asymmetries over long periods, making them more influential.

I thus conclude that, compared with German boards, U.S. occupational boards have a much larger potential for gatekeeping activities because they are legally able to regulate the means of entry and the affairs of active market members. Their influence on policies and the scope of their gatekeeping might be a function of their power or status. However, I have to concede that the current research about their role is rather scarce, and this conclusion rests strongly on the assumptions laid out here.

3.2.3 The ban of price regulations in the US

Price regulations, especially for licensed services, did exist in the United States until the Supreme Court disapproved of them in 1975. In *Goldfarb v. Virginia State Bar,* the U.S. Supreme Court (1975) ruled that price setting for law services was not immune to antitrust policy because law services are part of trade and commerce. They introduced a crucial differentiation. The regulation of market entry by occupational boards is a part of a social policy.[8] The setting of price floors for services, however, is a business act and therefore not

[8] A comparable position of firms would fall under the Sherman Act and be illegal. Occupational boards, however, enjoy state action immunity *with respect to their state-given duties*. As long as they act as members of the public administration, they are not considered market actors but state actors. In this case, they fall under the Parker immunity doctrine, which exempts any state action from federal antitrust laws (Parker vs. Brown; U.S. Supreme Court 1943).

exempted from antitrust laws. Consequently, schedules of fees issued by state bar associations are illegal under the Sherman Act. The plaintiff's motivation in *Goldfarb v. Virginia State Bar* was to find cheaper attorneys than was possible under minimum fee schedules that effectively created a price floor. The Supreme Court stated that minimum fees result in a kind of price fixing, which is illegal under the Sherman Act. Furthermore, the court made any "learned profession" subject to this rule. It also banned maximum fees a few years later (U.S. Supreme Court 1981). Since then, any occupation-specific fee schedule in the U.S. has been illegal.

The judges of the Supreme Court in these days were strongly influenced by the ideas of the Chicago School (Gerhart 1982). A core idea of this free market reasoning is that without market regulation, prices will fall towards the equilibrium price because anti-competitive price regulations hinder new members from entry (Arnould and Friedland 1977). However, some scholars voted in favor of fee schedules to contain costs for the public (Kallstrom 1978) and held that the U.S. constitution did allow price fixing if it would benefit the public (Easterbrook 1981). However, the USA did not reinstall price schedules and instead made prices a matter of the market. According to Noah (2009), the result for medicine was a paradigm shift: "Where once government had sought to police the health care sector mainly to protect patients, now it sought to police it mainly to protect a competitive health care marketplace. A thriving health care bazaar, it was assumed, would serve patients' interests" (see also: Relman 1991). In contrast, prices typically did not fall for licensed work. In particular, highly qualified professionals in health care and law increased their prices on average and for top practitioners.

Longitudinal information about prices for licensed and not licensed work in the U.S. is limited but points in the same direction. Dieleman et al. (2017) estimate that 50% of the increase in healthcare spending between 1995 and 2015 is due to increased service prices. The prices for legal services have strongly increased since the 1990s and even more so since the normalization of the billable hour for lawyers (Hitt, Bierman, and Collins 2007). A more indirect piece of information is income trends for occupations. Incomes for physicians, nurses, dentists, teachers, lawyers and judges have increased much more than average incomes since the 1970s (Helland and Tabarrok 2019). These data are not consistent with falling prices due to deregulation of price settings. In contrast, prices for professional services are at an all-time high in the USA (Helland and Tabarrok 2019).

3.3 What can and cannot be done with occupational licensing in the USA and Germany

The comparison of the institutional structures of the licensing regime between the USA and Germany reveals some similarities but also crucial differences. In both countries, governments justify licensing with arguments about public safety and delegate a wide range of duties to collective actors, which ought to have special knowledge about occupation-specific affairs and thus be well suited to regulate them. The discussion about the licensing systems reveals at least three major differences between the countries.

The first difference concerns the rules on which licensing rests: in Germany, the Federal Constitutional Court reduced the scope of licensing to occupations with a direct relation to basic public goods. The USA does not have such a reduction of scope. The justification of licensing laws rests on the much broader concept of *protection of the public.* Consequently, some states of the USA license occupations that would not be licensed in Germany.

The second difference refers to how boards are able to regulate market entry. German boards are not allowed to regulate entry and have no power to change entry rules directly. U.S. boards are much more powerful and are able to increase barriers to entry.

The third crucial difference is the combination of occupational licensing and price fixing. For most German licensed occupations, there are minimum and maximum prices. Fee schedules were a part of the U.S. licensing system, too, but the U.S. Supreme Court declared them illegal in the late 1970s.

A brief comparison of the regulations for dentists, athletic trainers, and waiters illustrates these crucial differences. Dentists face licensing in both countries. Since the service provided by dentists affects the public good of health, dentistry falls within the allowed licensing scope. Both countries have boards for dentists. German boards only regulate dentists, as part of the dentistry market, but they do not oversee the dentistry exams. That is the duty of universities and state examination offices. The prices for the services of German dentists are fixed according to the most recent fee schedule. In contrast to the case for German dentists, U.S. boards for dental examiners issue the exam to candidates. Furthermore, there is no price fixing for dentists in the U.S.

The second example refers to athletic trainers, who are not licensed in Germany and are licensed only in some states of the U.S. The service of athletic trainers relates to public health and may thus qualify as a licensing candidate in Germany. However, their role in public health is not substantial enough to justify licensing according to German legislation. There is also no board for athletic trainers in Germany. Forty-five states in the USA license

athletic trainers to prevent public harm (Morin 1992). These states have athletic trainer boards, which oversee both entry into the market and the market actors themselves.

Waiters and waitresses, the third example, seem to affect no public good whatsoever. Hence, they are licensed neither in Germany nor in a single U.S. state. This occupation does not seem to be in a position to pledge for labor market regulation as a tool for social policy.

In the following section, I will use the information about institutional variation as a condition for wage bargaining in licensed and not licensed occupations.

4 Occupational licensing, bargaining power, and wages

4.1 A bargaining model for wages

A key finding of the literature on occupational licensing is that licensing is associated with higher wages. The literature relies heavily on the assumption that occupational licensing reduces competition and concludes that this increases wages because it generates an economic rent. The underlying model is a very simple one in which wages are a direct consequence of the relation between the supply and demand of labor. This model of wage setting certainly has appeal as a simple heuristic, but I believe that it fails to capture some crucial aspects.

I assume that wage setting is at its core a power struggle concerning the distribution of revenues between employers and employees (Kalleberg, Wallace, and Althauser 1981; Stainback, Tomaskovic-Devey, and Skaggs 2010). Therefore, I will analyze the consequences of occupational licensing for employees in light of how they alter this power struggle.

In accordance with Manning (2003), I model the process of wage setting as a bargaining game with three elements: the bargaining power (α) of each side, the maximum contribution of revenue attributable to the employee within the firm (p), and the lowest wage offer acceptable to the employee (b). The maximum contribution and the minimal offer define two ends of a continuum in which the wage can be set. The distribution of bargaining power between employee and employer determines on which point of the continuum the resulting wage is located. The following equation expresses the wage setting (w) in light of this relation between the two bargaining parties:

$$w = \alpha \cdot p + (1 - \alpha) \cdot b.$$

The model rests on some necessary assumptions. First, no firm or organization pays more than the contribution the employee yields the firm in terms of revenue.[9] Second, potential employees have a minimum threshold regarding their pay (called a reservation wage) and are able to turn down bad offers. Third, there is only one continuum of bargaining power, and the two sides are split along this continuum. Every advantage to one side is a loss to the other. Thus, the bargaining power of the employers is per definition $1 - \alpha$ with $0 < \alpha < 1$. The model is not restricted to direct wage bargaining between two individuals. Collective actors can also be part of the model.

An objection may be that in some cases, wages are not the result of direct bargaining but a "take it or leave it" proposal. Such a situation is likely for jobs in the public sector (Brenzel, Gartner, and Schnabel 2014). Manning (2011) shows that in such cases, the model still works well because this situation can be framed as *anticipated wage bargaining*.[10] If the offer for such positions is too low, people will choose better-paid options over time. Thus, employers are in competition with each other and could be outcompeted by others paying better. If employers anticipate this behavior, they can adjust their offers. Within the model, scholars can interpret this adjustment as a result of bargaining power in favor of employees. The crucial difference of this situation compared to direct bargaining is that the amount of bargaining power is a result of a (anticipated) collective self-selection into alternative jobs.

The advantage of this model lies in its ability to theorize about heterogeneous influences for employees with different characteristics, such as licensing status. If groups differ regarding the first part of the equation $\alpha \cdot p$, we expect them to have different chances for high wages. Likewise, differences regarding the second part $(1 - \alpha) \cdot b$ are associated with different risks of low pay.

4.2 Occupational licensing and the distribution of wages

I claim that occupational licensing changes the bargaining situation considerably in both countries, and I associate these changes with every element of the bargaining model. I argue that licensing increases employees' bargaining power, especially in prestigious professions. Furthermore, it reduces the risk of low pay in Germany but not substantially in the USA and increases the chances of high pay in the USA but not substantially in Germany.

[9] There could be situations in which firms pay employees more than their maximum contribution to the firm. Some scholars argue that this might be the case for employees at the top of the distribution. A highlighted case concerns CEOs; scholars assume that CEOs are not paid for what they contribute to the firm but that their wages (with bonuses) are a product of tournaments and culture independent of their individual achievements for the firm (Tosi Jr and Gomez-Mejia 1989; Haynes, Campbell, J., and Hitt 2014).

[10] Manning (2011) refers to this situation as *ex ante* bargaining and the alternative as *ex post* bargaining.

4.2.1 Occupational licensing and bargaining power

The amount of bargaining power of (potential) employees correlates strongly with the availability of equivalent or better alternatives. The better the alternative options are, the higher the bargaining power (Barnhizer 2005; Lachowska 2016). The more replaceable employees are, the lower their bargaining power.

Occupational licensing typically increases the bargaining power of employees. Barriers to market entry ban those without a license from competition for vacancies. That is, licensed workers represent the only legitimate alternatives within the market, who are only replaceable with licensed competitors. In addition, their education is not specific to the firm but to the entire occupation. An occupational license is a signal that its holder has the competencies to solve occupation-specific problems, such as landing an airplane or performing a heart surgery. These problems are not strongly correlated with firm- or organization-specific problems. Thus, actors in labor markets for licensed occupations are able to change their employer with lower transaction costs than employees with firm-specific human capital. Transaction costs are all costs connected with job turnover: search costs, training costs, and costs for mobility (Williamson 1981). When licensed employees can change their employer without losing a considerable amount of their knowledge but firms are not able to replace the employee as quickly as they could without licensing, then licensed employees face a bargaining advantage.

This advantage is higher when the employees are less replaceable. The substitutability of an employee depends on the supply for the kind of labor offered by the employee. The higher the entry requirements are, the lower the *additional* potential labor supply. For licensed occupations in the USA, entry requirements differ between and within occupations across states. Licensed labor markets for professionals, such as physicians or attorneys, have very high entry requirements (Vaney Olvey, Hogg, and Counts 2002). However, there are also many occupations, such as crane operators or horse trainer assistants (in Arkansas), with much lower entry requirements (Carpenter et al. 2012). I assume that higher entry requirements reduce the substitutability within the occupation-specific labor market, shifting the bargaining power towards the employee's side.

Furthermore, if my assumption is correct that boards increase the barriers to market entry more strongly the more status the occupation has, then occupations with higher status increase the bargaining power of employees to a higher magnitude. In this case, occupational licensing creates a Matthew effect: high-status, high-paid occupations have more powerful boards, which enables them to control market entry, resulting in higher bargaining power and therefore higher wages for otherwise already well-paid employees.

Our model does not contradict the broad literature about the consequences of licensing for wages but captures it as a special case in which, compared to nonlicensed employees, all licensed employees share the same amount of *additional* bargaining power. It might be worthwhile to reflect on this assumption given the strong heterogeneity of licensed occupations within and between countries in terms of power and entry requirements (Weeden 2002; Bol and Weeden 2015). If entry requirements of licensed occupations differ more strongly in the USA than in Germany, we should expect a more heterogeneous distribution of additional bargaining power for incumbents of licensed occupations in the USA.

4.2.2 Occupational licensing and low wage offers

Occupational licensing is associated with higher minimum wage offers in Germany but not in the USA. Higher occupation-specific minimum wage offers are a result of either a mandatory wage floor or some other social norm to pay a minimum wage for a particular occupation.

Licensed occupations in Germany can have occupation-specific wage floors independently of a general minimum wage. The German state is not only obliged to supervise entry into licensed occupations, ensuring a high quality of service, but also to secure a steady supply of these public goods for citizens. If the supply falls below a publicly or politically acceptable threshold, the wage floor for these occupations rises, very likely due to public pressure, increased competition between states or organizations, or court decisions.

The German Federal Employment Agency stated that in 2015, jobs for licensed geriatric nurses were vacant for 138 days, on average (Bundesagentur für Arbeit 2015). This value is 62% larger than the average across all occupations. There has been a broad public debate about the shortage of qualified health care personnel, as well as teachers, child care workers, and physicians (Bellmann et al. 2013; Deutscher Lehrerverband 2001; Wissdorf 2014). The reactions to these shortages differed during the past decade. In the case of teachers, German states increased their competitiveness and promised higher entry salaries or higher pensions than other states (Seifert and Fertmann, 2009). This was also true for police, fire fighters, and judges (Hausner, Heinrich, and Huelgas 2015). For health care occupations, especially low-paid occupations such as geriatric nurses, the German government established a new law to restrict wage dumping (*Erstes Pflegestärkungsgesetz*). Furthermore, judges and state attorneys sued the German state because of their low wage floor and won their case in 2015 (Bundesverfassungsgericht 2015a). Since then, the German state has had to pay higher entry salaries for both occupations. The judges explicitly stated that low entry salaries could lead to negative

selection into these occupations, which is harmful for the state duty of providing high-quality service of judges and state attorneys.

Court decisions do not only concern public servants, such as judges. According to a court decision in 2007, a fully employed private attorney must earn at least €2,300 a month, which is approximately $2,560 (Anwaltsgerichtshof NRW 2007). The judges argued that such a low wage as apparent in the case does not permit the accuracy and diligence necessary for this kind of work (Gaier 2015). In addition, they stated that every occupation with a chamber had its own code of occupational rules (based on the first step of the three-stage theory), stating that every member of the chamber had the right to be properly employed. Since every employee of a licensed occupation with a chamber in Germany must be a chamber member, these employees have the right to be adequately paid.

Therefore, the distinctive feature of licensed occupations in Germany is that a (perceived) growing number of vacancies can create political or jurisdictional pressure to set a higher wage floor.

We do not expect this to apply for the USA. The institutional architecture in the U.S. does not create a comparable link between occupational licensing and a state duty to guarantee the provision of basic public goods. Thus, specific wage floors for licensed occupations are not part of social policies, and the government cannot be sued because of a low wage within a licensed occupation.

In sum, occupational licensing should lead to reduced risk of earning low wages in Germany, resulting in a strong licensing premium for low-wage employees. For the U.S., I expect the contrary. Licensed employees in low-wage occupations have the weakest institutions and entry regulations. Thus, wage premiums should be the weakest for them.

4.2.3 Occupational licensing and high wage offers

The model predicts high wage offers if employees have high bargaining power *and* are able to attribute a high amount of the firm's revenues to their work. The second point is a result not of the labor market but of product market structures. It is a consequence of the value of services or products, which in turn increases the value of an employee for a firm.

I assume that there is a strong association of that value with occupational characteristics in general and licensing in particular. Weeden (2002) emphasized the role of consumer channeling for licensed occupations (Timmons, Hockenberry, and Durrance 2016; Kleiner and Park 2010). Licensed occupations can achieve the status of regulatory instance for product markets in two ways. First, they can be the only legitimate source of supply for a set of services or products. Second, they can be relevant actors in the process of determining

the prices of these products. The higher the prices for the products whose only legitimate suppliers are licensed occupations are, the higher the contribution of licensed employees to the revenue of their firm.

Statutory price schemes for German licensed occupations are a double-edged sword in this regard. On the one hand, such schemes enable occupations to push prices for their services, setting a higher wage floor. On the other hand, they set maximum prices and thus create very strong glass-ceiling effects. Employers typically have no incentive to pay their employees more than the part of the firms' revenues attributable to them as defined by price schedules. Employees can have a very strong bargaining position – if their contribution to the organization's revenue is small due to price fixing, the model predicts only a moderate wage. In addition, statutory pay schemes not only narrow the bargaining range but also make it much easier to attribute the part of the firm's revenue to a single employee. As long as it is clear which occupational tasks are or should be done by the employee, employers can pretty much calculate the additional (economic) benefit the employee contributes to the firm's revenue.

High-wage offers for licensed employees in the USA are, in absence of any policy regulation for their prices, solely based on market power. Firms can pay very high wages if they can sell the labor of the licensed employee for a very high price. There is – theoretically – no upper bound for such prices, which may result in very high wage offers for licensed employees, who can combine sufficient bargaining power with selection into firms or organizations with high product market power. Firms with high product market power can use their high revenues to outcompete other firms by offering higher wages (Card, Devicienti, and Maida 2014; Sakamoto and Wang 2016; Galanter and Henderson 2008). Typically, large U.S. law firms, accountancy firms, or medical organizations have high market power because they offer strongly regulated services, and prices for their services and products face no regulation. They can sell specialized products or services at very high prices (Krishnan 2001; O'Neill 2015; Lancaster 2016).

I thus expect that statutory price schemes set wage ceilings for German licensed employees who would earn a high wage even without licensing, which strongly reduces the wage premium of licensing. For the U.S., I do not expect such a ceiling effect. The combination of high-status occupations with unregulated product market prices can lead to high bargaining power and the attribution of high amounts of revenue to the employee, resulting in large wage premiums.

Here, I argued prototypically for low- and high-wage offers. Real-world wage setting is, of course, much more complex. However, if the institutional differences between countries

have the proposed effect on wage setting, I should be able to estimate different patterns of the licensing wage premium across the distribution for both countries. I *expect that the licensing advantage increases across the distribution for the USA but decreases across the distribution for Germany*.

4.2.4 The consequences of licensing for the distribution of wages

My previous discussion concerned the distribution of the *wage advantage* due to licensing. To assess the consequences of licensing for between-occupation and overall wage inequality, we need to take into account how the composition of licensed employees within each country places them in a more or less favorable position to *receive the different amounts of the wage premium*.

Consider a country in which most licensed employees are medium-skilled and only a few are high-skilled and licensing itself is not very common. Using the conventional relation of skill level and wages, we place highly skilled employees in the upper parts of the distribution and moderately skilled employees in the middle. If the licensing advantage increases across the distribution, only a few high-skilled licensed employees profit from the larger advantages in the upper parts of the distribution, and most of the licensed employees receive a moderate licensing premium. For such a country, licensing would not necessarily increase the overall wage inequality. The licensed employees with the largest premiums influence the overall distribution at the top only to a very small extent, but their influence in the middle of the distribution is considerable. Even if the wage premium on the individual level is smaller for medium-skilled than for high-skilled employees, the higher number of medium-skilled employees accumulates to a much larger impact on the overall distribution of wages.

It would therefore be erroneous to infer about the consequences for between-group and overall wage inequality based solely on the structure of licensing's wage advantage across the distribution. We thus need to take compositional differences between licensed and not-licensed occupations within each country into account to form expectations about the role of licensing in wage inequality.

Typically, the most important entry requirement defined by licensing laws is educational credentials. Licensed employees in both countries should thus have vocational training or university degrees to a higher extent than nonlicensed employees. I also expect licensed employees in both countries to have greater work experience due to shorter unemployment periods (Damelang, Schulz, and Vicari 2015).

Occupational licensing has a strong association with gender in Germany, where licensed occupations are limited to services for health care, education, public safety, and the rule of law (see table 1). German women are more likely to work in the service sector in general and in health care and education in particular (Aisenbrey and Brückner 2008). For instance, approximately 90% of geriatric nurses and preschool teachers in Germany are women (Bundesagentur für Arbeit 2016). Additionally, the share of women in law occupations dramatically increased over the past 30 years (Michelson 2013). The narrow scope of licensing in Germany over the four aforementioned fields in combination with the strong tendency of women to choose occupations within these fields leads to an overrepresentation of women in licensed occupations (Witte and Haupt 2019). The strong link of German licensed occupations to basic public goods could also associate them more strongly with public employment because organizations in the public sector typically provide these goods. Furthermore, women's employment in general and their employment in the public sector in particular is related to a high propensity towards part-time work (Simonson, Gordo, and Titova 2011).

In sum, I can characterize German licensed employees by a mix of properties known to be wage enhancing (higher education, more experience) and wage decreasing (part-time, service sector work, women's wage penalty). I assume the wage-enhancing properties to be more influential for wages and thus expect licensed employees to distribute across the distribution with their largest shares between the middle and upper middle parts – even without the additional influence of occupational licensing. However, the combination of female-dominated, nonprofessional, service sector work (like geriatric nurses) has a strong risk of low wages. Occupational licensing reduces that risk in Germany, acting as an additional wage source for medium-wage earners, but due to price fixing, it has a limited effect for top-wage earners. *This should scale up to a more compressed wage distribution for licensed employees in comparison to nonlicensed employees. Furthermore, the compression of the licensed employee wage distribution should reduce overall wage inequality.*

Licensed occupations in the USA do not have such a strong inherent connection to occupational fields as those in Germany. Historically, this may have been the case because the first licensed occupations were in the fields of public health and law (Zhou 1993). Licensing as special occupational regulation has diffused since then into many other occupational fields. I do not expect licensed occupations in the USA to be as strongly gendered as those in Germany because of the weaker gender role expectations than in Germany. First, the occupational choice of U.S. women is not as strongly gendered as that of German women (Mósesdóttir 2019). Second, licensed occupations in the USA form a

more diverse set regarding their gender composition because their scope is not as limited. Furthermore, part-time work is not very common for U.S. women compared to German women (Grunow and Aisenbrey 2016). However, I also expect. more women to work in licensed occupations in the U.S, given their overrepresentation in health care.

In sum, I expect that licensed employees in the USA are typically characterized by wage-enhancing properties, locating them more likely in the upper half of the wage distribution. The additional influence of licensing, which we expect to increase across the distribution, locates these employees even higher in the distribution by serving as a wage premium, especially for highly educated, full-time working employees. *If licensed high-wage earners receive the highest premiums and outweigh low- and medium-wage earners, then licensing disperses wages for licensed employees. Consequently, this increased wage inequality between licensed and not-licensed employees increases the overall level of wage inequality in the USA.*

5 Data and Methods

5.1 Data

I use data from the German BIBB/BAuA Employment Survey 2012 and 2018 and the Merged Outgoing Rotation Groups (MORG) of the Current Population Survey (CPS) of 2012 and 2018 (version 2.5) provided by the Center for Economic and Policy Research (2020). The BIBB/BAuA Employment Surveys are representative samples of the German working population, sampling persons above the age of 15 and with a minimum of 10 hours weekly working time every six years (Hall, A., Hünefeld, and Rohrbach-Schmidt 2020; Hall, A. et al. 2015). It yields detailed information on working conditions, worker qualifications, and socioeconomic background. The CPS is a monthly survey of approximately 60,000 households. All interviews within a year are put together into the Merged Outgoing Rotation Groups. The sample is therefore very large, but the information is not as detailed as that in the German data. However, it includes demographic information on schooling and age and information on the worker's main job held, such as industry, occupation, and the sector of employment.

The analytic sample for each country and time point is limited to noninstitutionalized civilian employees between 18 and 64 years of age, working at least 10 hours. I exclude persons with missing occupation information.

Changes over time are not the focus of this paper, but the use of two time points can address important questions in addition to the robustness test as the main purpose. Using the 2012 and 2018 waves of the CPS allows me to examine the consequences of using two kinds of licensing information, as I discuss below in detail. For the German case, it allows me to

study the influence of the statutory minimum wage introduced in 2015, which may reduce the effects of licensing for low-wage employees.

5.2 Variables

5.2.1 Gross hourly wages

The dependent variable is the natural logarithm of the gross hourly wages in 2018 dollars. To facilitate comparisons between the two countries, I convert German wages into 2018 dollars, using the average exchange rate per year.

For the U.S. case, I use the hourly wage information provided by the Center for Economic and Policy Research (2020), which includes tips, commissions, and bonuses.

The German data offer working hours per week and monthly labor earnings but no direct information about the hourly wage. Thus, I divide the monthly earnings by the average number of workdays per month and the weekly hours by five. The relation of both offers an estimate for a gross hourly wage. A substantial share of the German workforce, for example, teachers, holds service contracts without any working hour specification. I use self-reported typical working hours instead of working hours for these cases. Since some respondents reported illegally high typical working hours, I top-coded them to 70 hours per week.

5.2.2 Licensing information

Since 2015, the CPS has included subjective information about occupational licensing (Cunningham 2019). Research prior to 2015 for the U.S. needed to combine "objective" licensing information from administrations or associations to surveys (Weeden 2002; Redbird 2017). It is not clear how subjective and objective licensing data relate and whether we can thus compare results. Here, I offer an analysis using both data gathering strategies for the U.S. I claim that we cannot take subjective and objective licensing information as error-free measures. Instead, I argue that we need to construct *plausible license* information for occupations, building on as much research and data as possible but correcting for possible sources of error.

The inclusion of objective licensing information in surveys entails two severe challenges. First, data about licensing is difficult to collect in the U.S. because the licensing regulations for occupations differ across states, over time, and sometimes across districts. This makes a single collection of licensing information prone to underreporting. Second, the occupational categories within the surveys are in many cases not identical to the occupations falling under licensing rules. This problem is twofold. A) In many cases, even detailed occupational codes include licensed as well as not licensed occupations. For

example, the category "accountants and auditors" includes *certified public accountants*, who are licensed in many U.S. states. However, all other kinds of accountants or auditors are not licensed. B) Most occupational classification systems include residual categories, which are used for the coding of very small occupations as well as unclear or insufficient occupational information of some respondents. The SOC2010 lists "Other healthcare practitioners and technical occupations" as category 29-9000, which could include a wide range of licensed and not licensed health care occupations. The licensing information used here is a dummy variable, distinguishing two possible *legal states of an occupation* – either an occupation is licensed within a state or not. However, the relation of occupations to heterogeneous occupational categories blurs this distinction and leads to a number of false positives and false negatives. If I assign all employees in the category "13-2011 Accountants and auditors" licensing status, I create a large number of false positive licensed employees because certified public accountants are a small group within the larger category of accountants and auditors. If I assign all employees in the category "Other healthcare practitioners and technical occupations" the status of not licensed, I very likely create false negatives because at least some employees in this category are licensed.

My aim was to construct a plausible licensing value for each occupational category for the U.S. to deal with both challenges. Thus, I constructed plausible licensing information for the 2012 data following four steps.

The first step was to compare previous licensing data offered by Summers (2007), Gittleman and Kleiner (2016), Redbird (2017), and the *licensing finder* of the platform carreeronestop, which uses information from the U.S. Department of Labor.[11] I created a list for each occupation mentioned at least once in each source for every U.S. state. If all sources were in line about the occupation's licensing, I assigned this occupation to the list of licensed occupations.

However, the sources offered conflicting information about a substantial number of occupations. In this case, the second step was to search for licensing laws regarding the occupation in a state. If I found a licensing law, I counted the occupation within the state as licensed. This step should reduce the number of missing occupations per state on the licensing list. This list together with all syntax files for the analysis offered here is openly accessible on my GitHub account.

The third step was to connect the data about single occupations to the Standard Classification of Occupations of 2010 (SOC2010). The CPS-MORG 2012 offers 2010

[11] https://www.careeronestop.org/Toolkit/Training/find-licenses.aspx

Census codes (OCC2010) for occupational classification, but many sources about licensing offered only information about the SOC2010. Thus, I used a crosswalk from OCC2010 to SOC2010 offered by the Bureau of Labor Statistics.[12] In cases where official sources offered information about the SOC2010 code of licensed occupations, I used these codes. If I did not have such information, I searched for the occupational title in O*NET and decided about the most plausible SOC2010 code if O*NET offered more than one.

Licensing regulations can change over time. Thus, as a fourth step, I needed to backcode the licensing information to 2012 if the licensing status of an occupation within a U.S. state changed between 2012 and the data collection phase (2017-2019). I used the information of the literature about changes in licensing (Timmons and Thornton 2018; Thornton and Timmons 2015) as well as the LegiScan database, offering information about legislative changes in every U.S. state.[13] I searched every occupational title for every state to track changes in licensing legislation. Most of the changes did not concern regulation of entry but rather administrative rules. If I found legislation changing an occupation from licensed to not licensed or vice versa in a state, I changed the information in the database. In sum, these changes were minor (e.g., the licensure of genetic counselors in Idaho in 2015 or of lactation consultants in Georgia in 2016).

I combined the licensing list with the survey data using SOC2010-state cells as the fifth step, leading to "raw licensing" information. I assume that this version includes a share of false positives and false negatives that is too large to ignore, especially regarding the comparability over time. Thus, a last step was to reduce the number of false positives and negatives as much as possible. I used the subjective licensing data of a pooled CPS-MORG of 2017 and 2018 as an additional data source to estimate the possibility of false positive and false negative licensing information.[14] Thus, to describe the construction of the plausible licensing information, we need to understand the nature of the subjective licensing data.

Since 2015, the CPS has included questions about the licenses and certifications of respondents using a filter of three questions (Allard 2016). The first question is, "Do (you/name) have a currently active professional certification or a state or industry license? Do not include business licenses, such as a liquor license or vending license." If respondents said yes, they were asked the second question: "Were any of (your/his/her)

[12] https://www.bls.gov/cps/cenocc2010.htm
[13] https://legiscan.com/
[14] The licensing information of 2015 and 2016 is as yet not comparable with later CPS information. Thus, I pooled only the information for 2017 and 2018.

certifications or licenses issued by the federal, state, or local government?". The third question is, "Was your certification or license required for the job?".[15] If the answer to all three questions was yes, I assume the employee working in a licensed occupation.

However, it is not plausible that this subjective licensing information is an error-free measure. For example, 18% of all employed lawyers, 12% of all dentists, 13% of all physicians and surgeons claimed to work as such but to hold no active license, but all U.S. states license these occupations. The reasons for this underreporting are manifold, as discussed by Furth (2016) and Cunningham (2019). One of the largest obstacles seems to be that many responses refer to the occupation of the spouse and other relatives of the anchorperson during the interview. In many cases, persons know the relative's occupation but have a tendency to underreport the licensing requirements. Thus, we cannot take the individual information at face value.

My strategy here is to combine both types of licensing data, thereby using the strength of each type to reduce errors. The objective licensing data likely create more false positives than false negatives because the licensing list operates on the occupational category level. For example, I list the certified public accountant (CPA) under the SOC2010 Code 13-2011. Merging the licensing list with the CPS data assigns all accountants and auditors with the same code licensing status, but CPAs are a minority among all accountants and auditors. This leads to a large over reporting, which I aim to avoid. The CPS data of 2017/2018 allow me to assess the severity of the problem because I can calculate the shares of licensed employees within each category. By using these shares, I can reduce the number of false positives in the 2012 data. If more than 75% of employees within a state-occupation cell claim to have no license but should have one according to my list, I count this case as a false positive. If more than 75% claim to have one but should not, I count this category as a false negative.

According to the data, 9.1% of cases were false positives and 0.27% false negatives. There are two major reasons for false positives. First, some retail salespersons are licensed (selling drugs or cars), but the large majority are not. Instead of assigning no retail salespersons licensing status, I assigned the status only to those who work as salespersons in the automobile industry or in pharmacies. Second, some occupational categories are very heterogeneous, but it was not clear whether the licensed groups outweighed the nonlicensed groups beforehand. For example, I counted "Truck drivers/Taxi drivers" as licensed in many states, but this produced a large number of false positives. Thus, I overwrote the

[15] The third question is not part of the CPS MORG v2.5 but is available in the Basic Monthly CPS. I merged both data sets using the variables *hrhhid, hrhhid2,* and *lineno*.

original “objective” licensing information in cases with more than 75% false positives. The few false negative cases are due to residual categories, such as “Therapists, all others”, which I did not list as licensed because it is unclear which occupations are included in these categories. I also overwrote the original value if the share of employees within such state-occupation cells exceeded 75%.

To solve the problem of underreporting regarding the subjective licensing data, I used a complimentary strategy, but with a higher bar for overwriting information. If more than 90% of cases within a state-occupation cell either counted as false negative or false positive, I overwrote the original licensing information. A total of 5.8% of all cases were false negative, and 0.4% were false positive.

I refer to the resulting version of the licensing variable as the *plausible licensing value* of an occupational category in a state and year. I assume that this version still includes some false negatives and positives. However, I claim that it is the version with the lowest error yet produced for the USA.

For Germany, I rely on the licensing information provided by Haupt (2016a), who performed an exhaustive analysis of German licensing laws from 1949 to 2015. According to the U.S. case, an occupation is only defined as licensed if the law protects the right to undertake occupation-specific actions. The protection of occupational titles (credentials) or the right to be self-employed in the German crafts (Meister diploma) is not sufficient to qualify as a licensing law because any German citizen can legally work in these occupations. I used the occupational classification of the Federal Labor Agency of 2010 (KldB 2010). Regarding data complexity, the German case is much more straightforward than the USA case because a vast majority of licensing rules are federal. Only for some minor cases do states differ in their licensing laws. In some cases, they also differ in how they apply federal licensing rules, such as the licensing of private school teachers. However, these differences are minor, and I did not include between-state variations in the German data (see Haupt 2016b for a discussion).

5.2.3 Control variables

I use a skill measure differentiating three levels (low, medium, high). For the U.S. case, the low skill category refer to persons without a high school degree; the medium skill category includes those having completed high school or some college education. The high skill category refers to persons with college or graduate school degrees. For Germany, employees without vocational degrees fall into the category of low-skilled employees, those with vocational degrees (including *Meister/Techniker* degrees) are referred to as medium-skilled employees, and highly skilled employees hold degrees from universities

or universities of applied sciences. I measure work time using three categories based on the typical working time reported: part time (10 to 35 hours), full time (36-49 hours), and over work (50 hours and more). The data for work experience differ strongly between data sets. Since there is no direct measure in the CPS, I use the common approximation "age – years of schooling – 6" for work experience. For the German data, I calculate "2012 – year of career start – years of work interruptions". For both countries, I group experience into seven categories (0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30+). I harmonize the information about the industry of employment using 16 categories, which are similar in both countries. As an additional control, I include information on the gender composition in the occupation. Since many jobs in the educational and health care systems are licensed and since these professions typically have high concentrations of women, the wage premiums of licensing could be neutralized by this gender effect (Witte and Haupt 2019). I define occupations as dominated by men or women when 70% or more are of one gender or the other and as mixed when there is no gender domination. The variable is based on the three-digit versions of the respective occupational codes. In cases of small numbers within occupational cells, I carefully merge them with neighboring occupations to achieve as much homogeneity as possible within the newly created occupational categories, without merging licensed and not licensed categories. Age (six categories) and gender are also included as controls.

Some variables have different categories in each country for varying reasons. Since Germany and the USA differ strongly in their ethnic and racial composition, the questionnaires are different in this respect. However, it is very likely that citizens representing the ethnic majority in both countries have a higher propensity to enter licensed occupations due to educational selection. I thus include a measure to control for the ethnic majority and minorities, even if the information is not the same in both countries. For the USA, I include race measured in four categories (non-Hispanic white, non-Hispanic black, Hispanic, and other). The German data allow only a distinction between employees with and without a migration background. Individuals have a migration background if they are German citizens and report not being a native German speaker.

A second crucial difference between the questionnaires is the availability of job tenure information. Employment with short-term contracts has increased strongly in Germany during the last 20 years. Licensed employees face lower risks of fixed-term contracts, which grants them a bargaining advantage (Stuth 2017). Thus, I need to control information on job tenure for German employees. The CPS does not offer information on that account. For Germany, I further include a dummy of whether the person is a civil servant. Last, I include information about the region of employment. I expect that the industrial and therefore occupational composition differ markedly within each country between regions.

For the USA, I distinguish four regions(East, Central, South, and Mountain/Pacific) and for Germany, I denote three large regions (Northeast [ex GDR], Northwest, South).

5.3 Methods

5.3.1 Quantile treatment effects, conditional and unconditional quantile value differences

We need to distinguish three types of questions regarding the relation of licensing and wages.

First, does the wage premium of licensing differ for low-, medium-, and high-wage earners? This is a question about quantile treatment effects. It implies that employees are high- or low-wage earners *independent* of licensing *and* that licensing influences wages differently for these low- and high-wage earners. Thus, it is imperative to distinguish the observed wage distribution, which includes the licensing influence, from a counterfactual wage distribution net of licensing. The licensing premium is heterogeneous conditional on employees' rank within the *counterfactual* but not the *observed* wage distribution because the observed premium is the result of licensing's influence on wages in combination with all other observed and unobserved influences. In this paper, I use the method offered by Powell (2019) to estimate quantile treatment effects.

Second, I ask whether licensed employees have a more dispersed or compressed wage distribution than nonlicensed employees. Methodologically, this is a question about group-specific (conditional) quantile value differences (Koenker and Bassett 1978). If one group has a more compressed wage distribution than another, the differences of high and low quantile values are smaller in the first case than in the latter. The relation between quantile treatment effects and conditional quantile value differences is not trivial. I will discuss this relation in more detail below.

My third question concerns the relation of licensing to the overall level of inequality within a country. Does licensing reduce or increase *overall* wage inequality? This is not a question about group-specific distributional differences but a question about the *contribution* of a group to the shape of the overall distribution (see Bloome and Schrage 2019 for a similar kind of question). If Weeden and Grusky (2014b) are correct in their assumption that wage premiums of licensing are responsible for increased inequality, especially at the top, we should observe strong differences in upper quantile values between the observed wage distribution and a counterfactual distribution without the influence of licensing. I use unconditional quantile regressions introduced by Firpo, Fortin, and Lemieux (2009) to estimate the contributions of licensing in each quantile of the overall wage distribution for each country.

5.3.2 The differences in quantile models using simulated data

Instead of offering a technical review, I introduce the logic of the three kinds of models using a simulation. By doing so, I can show which methods answer which question about the data.

The simulated data consist of 20,000 employees with information about their education, experience, age, part-time work, gender, and licensing status. Education, experience, and age are moderately correlated with each other. Women are 10 percentage points (p.p.) more likely to choose licensed occupations, and they are more likely to work in part-time jobs. The educational variable distinguishes low-, medium-, and high-educated employees. The probability of selecting a licensed occupation increases by 20 p.p. for each increase in the education category. Approximately 30% of all employees are licensed. Because licensing is strongly correlated with gender and education, it is not a randomized treatment, which complicates identification of the treatment effect (Frölich and Melly 2010).

In the simulation, wages increase with education, experience, and age. Women and part-time working employees receive lower wages. This results in a wage distribution independent of licensing, which is the counterfactual distribution I discussed above.

With these wages uninfluenced by licensing, I apply a heterogeneous licensing treatment across the distribution. After predicting wages net of licensing, I rank all employees according to their wage. Afterwards, I construct the influence of licensing on wages conditional on that rank. Here, I apply a U-shaped pattern of licensing. Employees with potentially low and high wages receive higher gains from licensing than employees ranked in the middle of the potential wage distribution. This function is a mix of both cases I discussed in this article. It combines a hypothesized German wage floor with a strong increase in the occupational power over labor and product markets from the middle to the top of the distribution, as I believe to be the case for the U.S.

Figure 1 shows the essential information of the simulation. Prior to the treatment, approximately 7% of all employees in the first percentile were licensed. An employee with a wage equal to the first percentile value of $12.40 receives an additional $9.20 if licensed. The resulting wage of $21.60 locates this employee around the 8th percentile of the *observed* wage distribution. Thus, we no longer observe any licensed employees in the first percentile of the observed wage distribution. Figure 1 also notes that licensed employees are less likely to be located in the lower parts than in the upper parts of the distribution, which is a result of the connection between licensing and education. This has an important consequence. The quantile treatment effect has the same magnitude at the 10th and 90th percentiles of the counterfactual wage distribution. However,there are more licensed

employees at the 90th than at the 10th percentile. Therefore, more high-wage than low-wage employees receive the same licensing premium, which leads to different consequences at the top and bottom of the distribution. Any influence of licensing on conditional or unconditional distributions is based on the combination of at least the quantile treatment effect and the distribution of the treated across the counterfactual distribution. It follows that the asymmetric distribution of licensed employees across the potential wage distribution *in combination* with the U-shaped treatment effect has a larger influence on upper quantile values than lower quantile values.

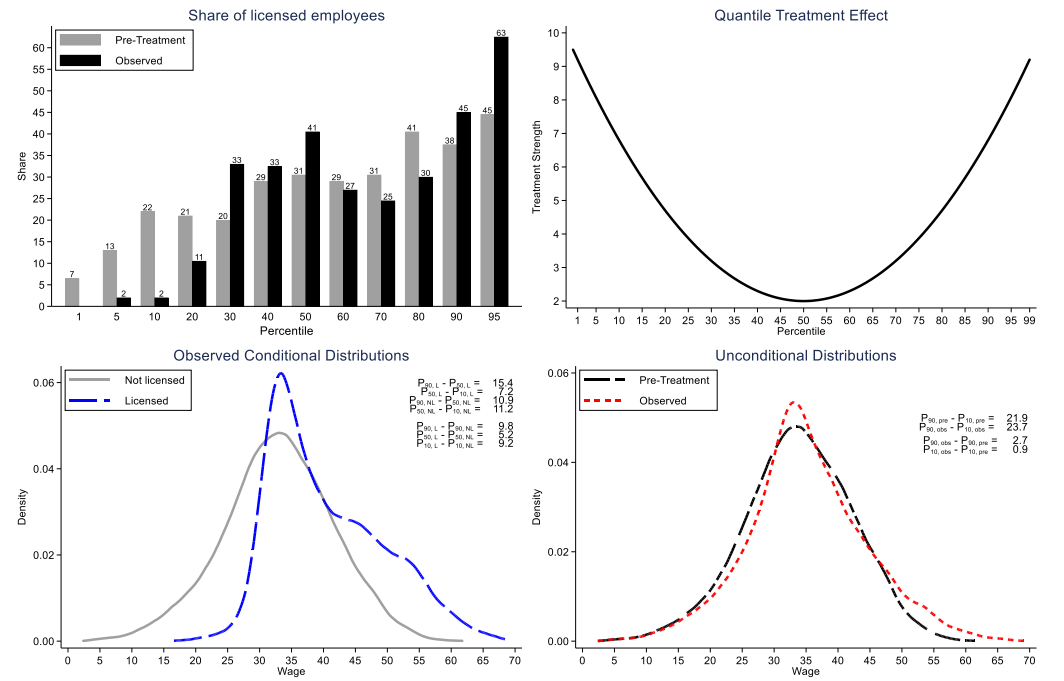

Figure 1: Central settings and results of the simulation. Share of licensed employees across the distribution before and after the inclusion of the treatment, the functional form of the quantile treatment effect, conditional wage distributions with conditional quantile value differences, and unconditional wage distributions before and after the inclusion of the treatment.

The lower panel of figure 1 shows the resulting distributions of the simulation. The left-hand side shows group-specific (conditional) distributions of observed wages. The distribution of licensed employees has a very different shape than that of nonlicensed employees. It is more compressed in the lower half and more dispersed in the upper half. The difference between the 90th percentile value and the median for licensed employees is \$15.40. The median and the 10th percentile differ by \$7.20. For nonlicensed employees, I estimate \$10.90 as the difference between the 90th percentile and the median and \$11.20 between the median and the 10th percentile.

On the right-hand side, I plot the distributions of the counterfactual (no licensing) and observed wages. The latter shows a heavier upper tail, indicating that licensed employees increased higher percentile values stronger than lower ones. The wage premium of licensing increases the 90th percentile value by \$2.70 and the 10th percentile by \$0.90,

indicating an increase in overall wage inequality. However, this cannot be the result of the quantile treatment effect alone because this effect is symmetric for the lower and upper quantiles. It is largely a result of the likelihood of being licensed, which is conditional on education and gender, locating licensed employees more likely in the upper parts of the distribution net of licensing. Employees with a low potential wage are much less likely to be licensed because higher education has a strong positive influence on potential wages and predicts entry into licensed occupations. Thus, licensed employees are more likely to receive a treatment from the middle to the top of the potential wage distribution than to receive a strong positive treatment at the bottom. The strong positive treatment strength of licensing in the top of the potential wage distribution in combination with the higher likelihood that licensed employees are located in the upper parts of the potential wage distribution results in a strong influence of licensed employees on the upper tail in comparison to the lower tail – despite the same treatment strength for both parts.

Figure 2 shows the results of three different quantile models. In the following, I describe the basics of the methods as well as how to interpret the coefficients.

I estimate quantile treatment effects using the generalized quantile regression model (GQRM) proposed by Powell (2019). This method offers a solution to the problem of having to go all the way back from the observed unconditional and conditional distributions to a counterfactual distribution, where the location of treated employees in the distribution may differ from that in the observed distribution. Here, we introduce the logic of the estimation procedure that is exemplary for the case of the treatment at the median. As a starting point, it is essential to note that in the counterfactual distribution, employees with equal characteristics have the same *expected* probability of earning a specific wage higher than the median. Licensing has no influence on wages in this stage. In the observed distribution, the probability of earning wages higher than the median differs between both groups. Thus, we need to model a counterfactual distribution using estimated parameters in which licensed and not licensed employees *with equal covariates* have the same probability of earning above-median wages. If we are able to model such a distribution, we can locate each observation within it. In practice, this means ranking each observation according to counterfactual wages, assigning ranks from 0 to 1. A rank of 0.5 thus means that an observation has a predicted pretreatment wage equal to the pretreatment median. Observations at the pretreatment median have specific covariate combinations. We can use these combinations to search for treated observations with exactly these covariate sets within the observed wage distribution and estimate their average wage. The difference between this average and the pretreatment median is the quantile treatment effect at the median.

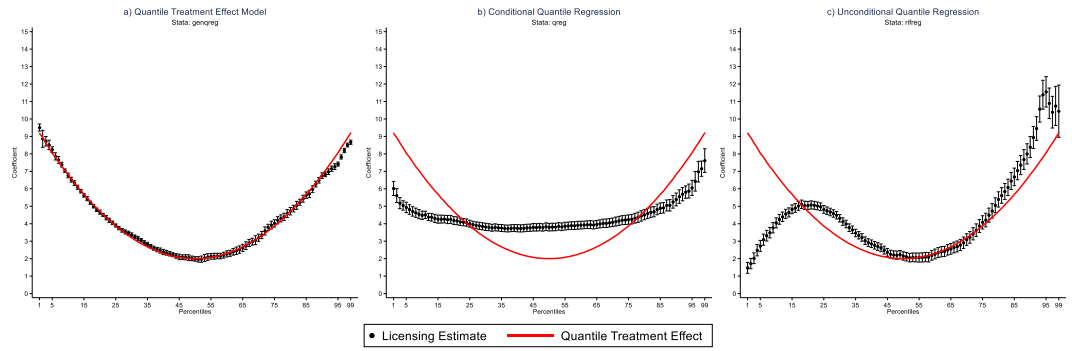

Figure 2: Licensing coefficients of quantile treatment, conditional quantile, and unconditional quantile models.

As figure 2 shows, the model works very well in identifying the quantile treatment effect. It tells us that licensed employees, who we would expect to find at the median of the counterfactual distribution given their characteristics, earn, on average, two dollars higher wages due to licensing.

Conditional quantile regressions (CQRs) model the differences in *observed* quantile values between groups. The observed differences are the result of the quantile treatment effect, the distribution of the treated within the counterfactual distribution, and the influence of characteristics correlated with the treatment. In the simulated data, licensing correlates with all covariates through direct or indirect paths. In our case, the aim of CQR is to separate the influence of characteristics correlated with licensing from the licensed employee distribution. However, the latter is a combination of licensing's quantile treatment effect *and* the distribution of licensed employees prior to the treatment. CQR *cannot* control for the different locations of licensed employees within the distribution net of the treatment (Powell 2019). It controls for the correlation of licensing with observed characteristics of *observed outcomes*. CQR does not consider that compared to employees at the middle of the pretreatment distribution, the group of licensed employees is more likely to be highly educated and thus to be located higher in the counterfactual distribution, which results in a higher likelihood of receiving a larger treatment strength. We can use CQR to estimate the *consequences* of the treatment on the outcome distribution of the treated as one particular result of the data generating process. That is important information, but it is not equal to information about the quantile treatment effect itself.

Figure 2 shows the licensing estimate of multivariate CQRs. If we used them as measures for quantile treatment effects, we would strongly underestimate the effect for the lower and upper quantiles and overestimate it for the middle quantile.[16] The reason for the difference

[16] The particular result might suggest that scholars would at least receive a suggestion of the U-shaped pattern of the QTE with the results of CQR. However, there are many cases in which the functional form of the QTE and the conditional quantile value differences differ strongly.

between the models is the distribution of licensed employees prior to treatment. In the lower tail, for example, the treatment effect is strongest for the first percentile of the potential wage distribution and declines strongly towards the middle. The first percentile of licensed employees spreads across the first four percentiles of the pretreatment distribution. Thus, the first quantile value of licensed employees' wages (net of other influences) is a mix of varying treatment strengths across the first percentiles. Therefore, it does not give us an estimate of the quantile treatment effect *at* the first percentile of the pretreatment distribution, but it gives us an estimate of the treatment's consequence for the first percentile of licensed employees in comparison to the untreated.

A treatment does not only influence the distribution of the treated. The treated are part of the overall distribution. Thus, if the treatment changes the group-specific distribution, it also changes the overall distribution (Bloome and Schrage 2019). We can therefore estimate how much a group-specific treatment influences specific quantile values of the unconditional *observed* distribution as proposed by Firpo, Fortin, and Lemieux (2009) with unconditional quantile regression (UQR). Here, we want to test whether licensing increases or decreases wage inequality in Germany and the USA.

UQR coefficients express the difference between two counterfactual unconditional distributions: one distribution without the influence of the treated and one in which every unit is treated (see Rios-Avila 2020 for further discussion). The observed distribution is a mix of both *potential* states. Consider the estimates for the tenth and 90th percentiles: $\beta_{UQR,10} = 4.05$; $\beta_{UQR,90} = 8.39$. These are the estimated percentile value differences between a distribution in which every employee influences wages like licensed employees and a distribution in which licensing has no influence. This is, however, not the quantity we are interested in regarding our question about licensing's influence on overall inequality. To obtain the correct information, we need to make use of the fact that the observed distribution is a mix of 30% licensed and 70% not licensed employees. Thus, we can easily calculate the point estimate for the influence on the 90th percentile value as 8.39 * 0.299 = 2.51. Based on the model, our best guess is that licensing increased the 90th percentile by \$2.51 (95% CI: 2.69, 2.32). In relative terms, licensing increases the 90th percentile value by 5.6%. The observed 90th quantile value is 47.5. Canceling out the influence of licensing gives 44.99 and [(47.5 – 44.99)/44.99]*100 = 5.6.

Using these relative quantities, I calculate the influence of licensing on unconditional quantile value ratios. My aim is to study the consequence of licensing for overall *relative* wage inequality. Relative inequality increases if the relation of upper and lower quantiles to the middle increases. Using the same calculation as for the 90th percentile, licensing increases the median by 1.9% and the 10th percentile by 5.3%. We can now use the observed

quantile value ratios and the counterfactual ones to calculate how much licensing influences the overall quantile value ratio. The P90/P50 ratio of the observed wages is 1.374 for the simulation setting. Cancelling out the influence of licensing on both quantiles results in a ratio of 1.326. Thus, licensing increases the P90/P50 ratio by 3.5%. The same calculation for the P50/P10 ratio leads to -3.4%, which means that licensing reduces the distance between the median and the 10th percentile. An overview of percentile ratios with the median as reference thus allows us to assess the overall influence of licensing on relative wage inequality.

Our discussion showed the stark differences between all quantile models. I need each model to test the corresponding country-specific hypothesis regarding licensing's influences on wages, which I will discuss in the next section.

I estimate all models and the descriptive results using cross-sectional weights and report the results for the third up to the 98th percentile. The confidence intervals for the first two and the 99th percentile are very large and obscure the graphical display of the results. I show the results including them in the appendix. The QTE models use adaptive Monte Carlo Markov Chains (MCMC) with 1000 draws and a burn-in of 200 draws. The reported intervals are thus not CIs in a frequentist sense but represent a double standard deviation from the average coefficient over the 800 draws used. I assume for all models that licensing is exogenous conditional on covariates.

7 Results

7.1. Descriptive results

In 2012, approximately 20.8% of all U.S. employees needed a license to work. The share increased by 3.3 p.p. to 24.1% in 2018. In Germany, 17.5% of all employees needed a license in 2012, which increased by 5.3 p.p. to 22.8% in 2018. The small difference between shares across countries may come as a surprise given the larger scope of licensed occupations in the U.S. The reason for the similar shares is the larger size of the health-care and the educational system in Germany compared to the USA. According to data from the World Bank, Germany had 4.2 physicians and 13.2 nurses/midwives per 1000 people in 2016.[17] In the same year, the USA had 2.6 physicians and 8.6 nurses/midwives per 1000 people. For secondary schools, Germany had a student per teacher ratio of 12. This ratio was 15 for the USA. The numbers for the two largest licensed occupational categories in the survey data of 2018 point in the same direction. For the US, the largest occupations are registered nurses and elementary and middle school teachers. The former represent a share

[17] http://wdi.worldbank.org/table/2.12.

of 2.5% of all employees and 8.3% of all licensed employees, the latter a share of 2.6% of all employees and 7.6% of licensed employees. For Germany, health care occupations, such as nursing, have a share of 3.81% of all employees but 19.83% of all licensed employees. Teachers represent a share of 2.7% of all employees but 14% of all licensed employees. This involves, of course, some comparison of apples and oranges because of the different occupational coding systems, but it notes the very different societal structures, which licensing is a part of and which scholars should not ignore.

In both countries, the share of licensed occupations is higher in the upper half than in the lower half. However, this pattern is much more pronounced for the USA (figure 3). In 2012, the share of licensed occupations increased from 11% in the first decile to 29% in the tenth decile. The data for 2018 show a very similar pattern. The share increased from 15.1% in the first decile to 32.9% in the tenth decile. The largest licensed occupational categories are constant across years. In each of the first four deciles, the categories are nursing, psychiatry, and home health aides. The largest categories in the fifth, sixth, and seventh deciles are elementary and middle school teachers. Registered nurses are the largest group of licensed employees in the eighth and ninth deciles. Lawyers are the largest group in the tenth.

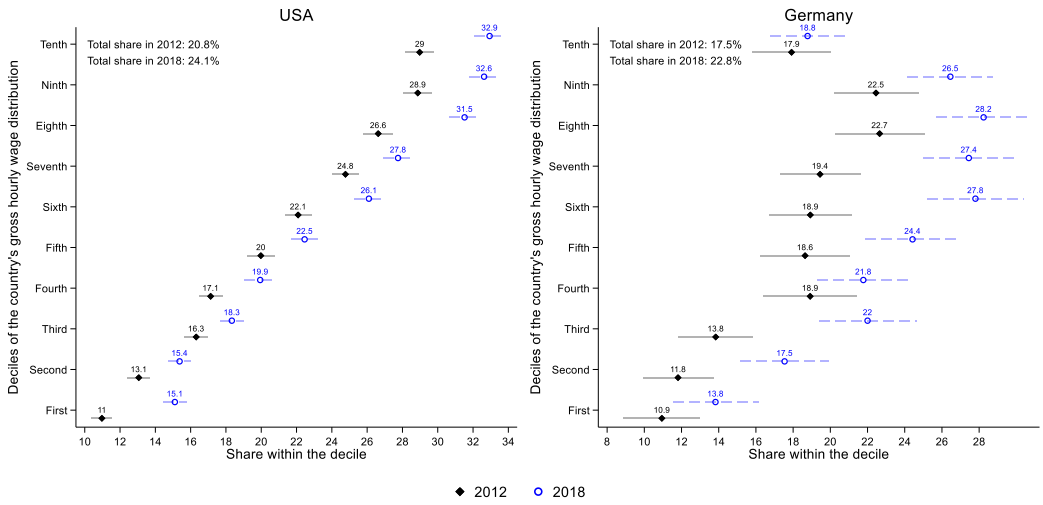

Figure 3: Share of licensed employees in deciles of the gross hourly wage distribution by country. The horizontal lines represent 95% confidence intervals.

In the first two deciles of the German wage distribution, approximately 11% to 14% of all employees are licensed, with geriatric nurses as the largest group. The share increases to approximately 19%-28% for the fourth to seventh deciles, with occupations in nursing and emergency medical services as well as occupations in social work and pedagogic specialists in social care work representing the largest groups. The eighth and ninth deciles contain approximately 23% in 2012 and 28% in 2018. I estimate a share of approximately 18%-

19% for the tenth decile. Teachers in schools of general education are the largest group in each of the three upper deciles.

In the USA, average wages differ by $5.40 between licensed and not licensed employees in 2012 and by $5.50 in 2018, which represent advantages of 24% and 23%, respectively. This difference is much smaller in Germany, with approximately $1.2 in 2012 and $0.7 in 2018 in absolute terms and 9.9% and 6.7% in relative terms.

However, the distributional differences between licensed and not licensed employees are more complex. Figure 4 plots group-specific wage distributions for each country and time point, showing very consistent country differences. For the U.S., the distribution of licensed employees shifts to the right, resulting in large quantile value differences. These differences are more pronounced for the middle quantiles than for the lower and upper quantiles. The relation of wages between a licensed median earner and a licensed low-wage earner (earning a wage at, for example, the fifth percentile value) is larger than the relation between nonlicensed employees (2.7 vs. 2.3 in 2012 and 2.5 vs 2.2 in 2018). However, in 2012, licensed employees at the 95th percentile of the licensed wage distribution earned about three times higher wages than the licensed median earner. The nonlicensed 95th percentile earner made 3.2 times as much as the nonlicensed median earner. The pattern is consistent for 2018, with P95/P05 ratios of 3.4 for not licensed and 3.2 for licensed employees. The U.S. pattern is thus not in line with the expectation of a much-skewed wage distribution for licensed employees, *especially* favoring high-wage earners in relative terms. In contrast, the upper and lower parts of the licensed employees' distribution show smaller differences than the middle for both time points.

The German case shows quite different distributional characteristics. I estimate the largest differences for the lower quantiles. Differences decrease starting with the 20th percentile and become even negative for the upper quantiles. This pattern of quantile value differences leads to a more homogeneous wage distribution of licensed employees in comparison to nonlicensed employees. Both the relations of the 95th percentile value to the median and of the median to the 5th percentile value are lower for licensed employees than for nonlicensed employees in 2012 and 2018.

However, these descriptive results could be driven by compositional differences between licensed and not licensed employees as well as differences between licensed employees across countries. In both countries, licensed employees are more likely than nonlicensed employees to be high skilled. This is unsurprising given the important role the professions with occupational licensing. However, approximately 43% of licensed employees in 2012 and 44% in 2018 in the U.S. are medium skilled (see table 1 in the appendix). These figures

are even larger in Germany, with 54% in 2012 and 49% in 2018. Thus, even if professions are important for the different skill structure of licensed employees, we should not ignore the great number of licensed employees outside high-skilled occupations in both countries. Occupational licensing is not only a matter of an educational elite but is also deeply embedded in both labor markets across skill groups.

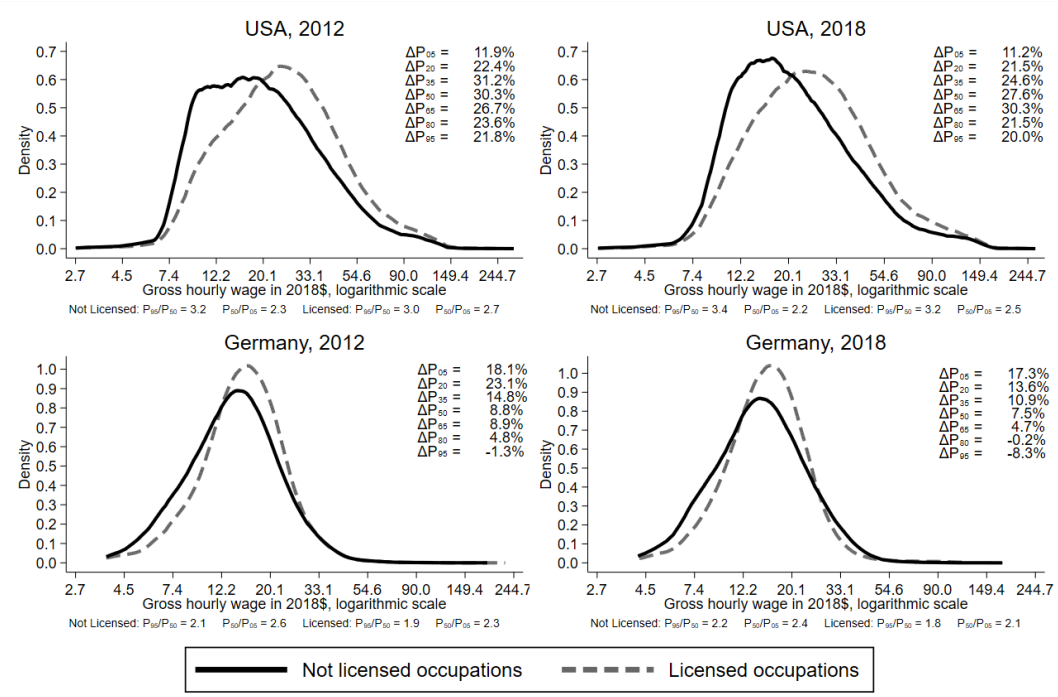

Figure 4: Kernel density and quantile value estimates of licensed and not licensed employees' log. gross hourly wages in the USA and Germany 2012 & 2018.

Women are more likely to work in licensed occupations in both countries. In Germany, 71% and 70% of all licensed employees were women in 2012 and 2018, respectively. There is a much smaller gender crowding of licensed occupations in the U.S., with 58% in 2012 and 54% in 2018. In both countries, female-dominated occupations account for larger shares of the licensed than the unlicensed. In 2012, 48% of all licensed employees in the U.S. and 75% of those in Germany worked in female-dominated occupations. Thus, licensed occupations show a higher level of occupational gender segregation than the overall labor market does.

German licensed employees have a higher propensity to work part-time, which is most likely a result of the close connection between gender and part-time work in Germany (Bick and Fuchs-Schündeln 2017). Licensed employees in the U.S. have a slightly higher share of overworkers (>50 h/week) and a lower share of part-time employed. Furthermore, 5% of U.S. licensed employees but 54% of German licensed employees stated that they worked for the government in 2012 (6% vs 59% in 2018). These differences reflect the much stronger connection of licensed occupations to governmental organizations in Germany but

also rest on the very different public/private institutional structures in each country, for example, in terms of schools.

In sum, the descriptive results strongly suggest stark differences in the distribution of wages and the workforce composition between groups. Furthermore, the results demonstrate the comparability of the licensing information for the U.S. over time – even if we need to take the results with a grain of salt. The patterns are similar over time. There is some change in the data, but that is also the case for Germany, with a constant data collection strategy.

7.2. Multivariate Results

I have argued that institutional variation in licensing alters the wage bargaining situation differently in the two countries, which should result in decreasing wage premiums for German licensed employees and increasing wage premiums for their U.S. counterparts.

Figure 5 plots estimated quantile treatment effects for both countries and time points. In the case of the median, the coefficients for each country and time point express the estimated wage advantage of licensing for an employee we would expect to observe at the median, given that licensing has zero influence. This wage advantage is the economic rent of licensing we can attribute to the median earner.

The results for the USA show an inverse U-shaped pattern of the overall positive influence of licensing across the wage distribution. However, we need to interpret the results for the U.S. with care because the coefficients show considerable variation between neighboring quantiles. One reason for this may be that the licensing premium is very heterogeneous even for employees sharing the same quantile (of the distribution net of licensing's influence). Nevertheless, even given such heterogeneity, the inverse U-shaped pattern of the coefficients is very robust for both time points.[18] I estimate the lowest premiums with approximately 1.5%-4% for employees, which we would expect in the lower tail of the wage distribution. Licensing's influence on wages increases towards the middle. For employees in the middle of the distribution, the coefficients increase to 10%-12%. Around the 65th percentile, the influence declines, and it is, on average, 6% for the upper ten percentiles. The estimates for 2018 show slightly larger QTEs for the upper quantiles, with rents of approximately 8%. Thus, the result does not show a monotonically increasing premium across the distribution. Employees with characteristics of middle earners profit most in relative terms. Licensing pushes them from the center upwards. High-wage earners still profit considerably from licensing, but – in relative terms – not as much as earners with

[18] An OLS regression of licensing coefficients on quantiles as second-order polynomials (quantiles and squared quantiles) is significant given a very low alpha level ($p < 0.0001$) and has an R^2 of 0.56 for 2012 and 0.64 for 2018.

medium-wage characteristics. However, given the large dispersion of U.S. wages, a 6%-8% economic rent for employees located in the upper 10% of the gross hourly wage distribution can still result in larger economic advantages in annual income than a 12% economic rent in the middle.

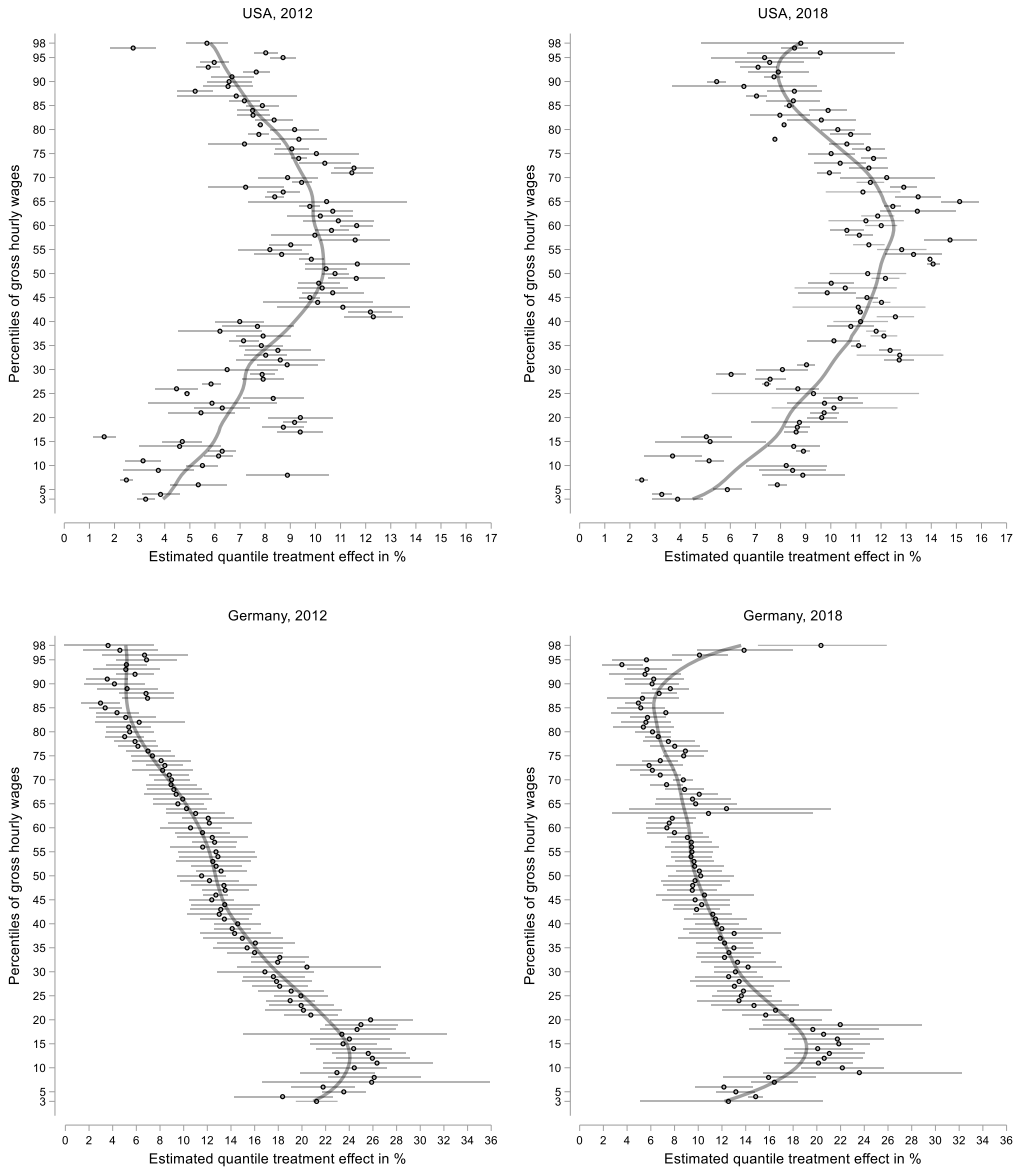

Figure 5: The licensing wage advantage across the distribution. The dots refer to the average licensing coefficient of multivariate quantile treatment effect models on gross hourly wages for Germany and the USA. The horizontal solid lines refer to two standard deviations of the licensing coefficient across 800 MCMC draws. The vertical solid lines represent polynomial smoothers for the relation between the point estimates and percentiles.

The results for Germany are very much in line with the formulated expectations. I estimate the largest premiums of approximately 20%-24% for licensed employees, which we would expect between the fifth and 20th percentiles given their other characteristics. The influence of licensing pushes these employees strongly towards the middle. The premium declines constantly from the 20th percentile towards the top. In 2012, I estimate a typical rent of 5%

between the 85th and 98th percentiles. In 2018, I estimate an increasing rent in the last five percentiles. The estimates for the third to tenth percentiles in 2018 are considerably lower than those in 2012. I interpret this as suggestive evidence for the consequence of the mandatory minimum wage introduced in 2015.

Comparing the results for both countries using both time points shows consistent differences. Typically, advantages are largest in the lower third for Germany and largest in the middle for the U.S. In both countries, the QTEs for upper quantiles are still positive but typically small for Germany, and in the U.S., they are half the size of those in the middle. The results are mostly in line with the expectations of the different wage bargaining effects between the countries. The U.S. shows a more complex pattern than expected. The advantage seems to increase with higher bargaining power only to a point in the middle and then declines.

The results of conditional quantile regressions test my second hypothesis that the consequences of institutional variation in licensing disperse wages for U.S. licensed employees but compress them for German licensed employees. The results are in line with that expectation (figure 6).

The wage distribution of licensed employees in the USA is more unequal than that of nonlicensed employees. In 2012, the fifth percentile values differ by 2.1%, the tenth by 3.8%, the medians by 6.9%, and the 95th percentile values by 13.9%. I estimate a slight decrease in the quantile values from the 95th percentile to the very top. The pattern for 2018 is very similar to that for 2012, but I estimate larger differences for lower quantiles. The differences are 5.2% for the fifth percentiles, 6.4% for the tenth percentiles, 8.6% for the medians, 10.9% for the 90th percentiles, and 10.1% for the 95th percentiles.

Thus, the U-shaped quantile treatment effect does not translate into a U-shaped pattern of group-specific quantile value differences. The descriptive results suggest that licensed employees in the U.S. are much more overrepresented in the upper parts of the distribution than those in Germany. A small number of (potential) low-wage earners thus receive the lowest premiums, and a sizable number of (potential) medium-wage earners receive the highest premiums. However, the largest number of licensed employees, with characteristics marking them above-average and high earners, still receive moderate wage premiums. The combination of a strong asymmetric distribution of licensed employees, even without the influence of licensing, with an inverse U-shaped quantile treatment effect strongly disperses the wages of licensed employees in the U.S.

In Germany, the quantile value differences between the groups decrease over the distribution. In 2012, the fifth percentiles differ by 13.2%, and the wages of German

licensed employees in the tenth percentile are approximately 14.2% larger, with a median of 11.9%. The 90th and 95th percentile values of the licensed employee distribution are 6.5% larger. In 2018, the pattern was very similar. The lower quantile values differ to a smaller extent, resulting in differences of 9.5%, 10.5%, 10.3%, 7.1%, and 5% for the quantiles listed above.

The conditional quantile value differences are not as large as the quantile treatment effects and do not differ as much across quantiles. For the case of the U.S., the number of (potential) low-wage, licensed employees is much smaller than the number of medium and high-wage employees. The former receive the highest premiums, and I locate them much higher in the observed distribution than I would without licensing. Thus, low-wage earners among licensed employees have much higher wages than nonlicensed low-wage earners. Most German licensed employees are potential medium- and high-wage earners, who receive lower premiums than potential low-wage earners. This reduces the distance between low-, middle-, and high-wage licensed employees in Germany, but not as much as we would expect from the strong quantile treatment effect alone. Nevertheless, the wage distribution of German licensed employees is considerably more compressed than that of nonlicensed employees.

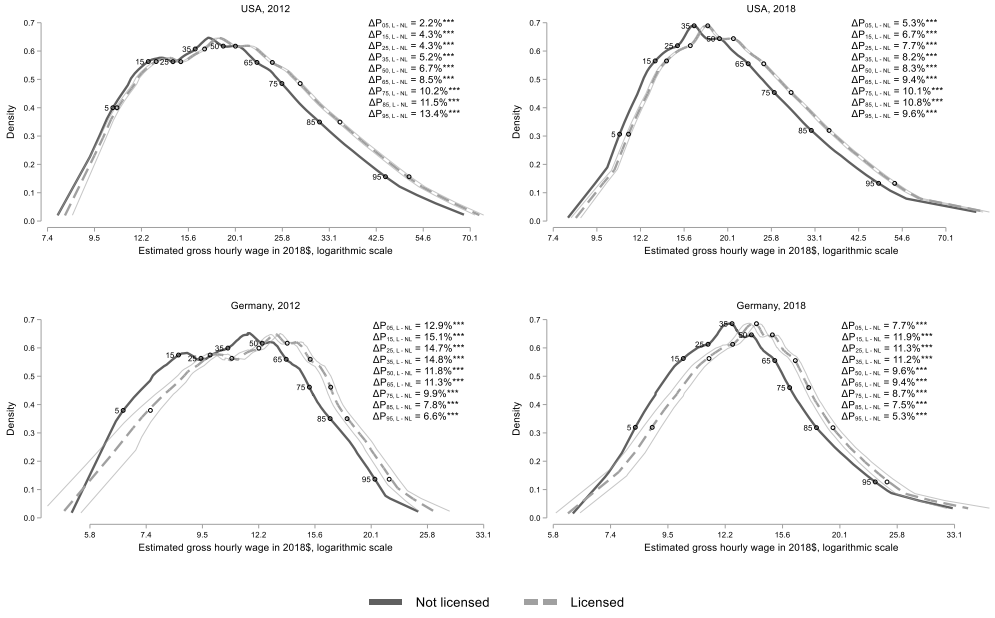

Figure 6: Estimated group-specific wage distributions for licensed and not licensed employees in the USA and Germany based on multivariate conditional quantile models. The solid gray lines refer to the 95% CI of the licensing coefficient. ** p <= 0.01; *** p <= 0.001.

My third question was whether licensing increases or decreases the overall wage inequality in both countries. Overall, it reduces wage inequality in Germany and increases it in the USA, but especially for the U.S. case, the underlying patterns are, again, complex (figure 7, see the appendix for a full overview across quantiles).

The results for the USA follow an inverse U-shaped pattern. Licensing contributes marginally to larger percentile values in the lower quarter, increases the middle percentiles the most, and increases the values in the upper percentiles to a smaller extent than the values in the middle percentiles. This inverse U-shape is more pronounced in 2018. In 2012, licensing increases the fifth percentile value by 0.2%, the tenth by 0.38%, the median by 2.16%, the 90th by 1.56%, and the 95th by 1.8%. In 2018, licensing increases these percentiles by 0.43%, 0.71%, 2.65%, 1.77%, and 1.91%, respectively.

Licensing increases U.S. wage inequality in the lower half and reduces it in the upper half of the wage distribution because it shifts the middle of the distribution father away from the lower tail and moves it closer to the upper tail. For 2012, licensing increases the ratio between the median and the fifth percentile by 1.96% and the ratio between the median and the 15th percentile by 1.68%. It reduces the ratio of the 85th percentile to the median and the ratio of the 95th percentile to the median by 0.36%. In 2018, the distributional consequences are even stronger. Licensing reduces the P85/P50 ratio by 0.30% and the P95/P50 ratio by 0.72% but increases the P50/P05 ratio by 2.2% and the P50/P15 ratio by 1.57%.

In line with expectations, licensing is a counter to wage inequality in Germany. Due to its influence on wages, the fifth percentile is approximately 2.7% larger in 2012 than we would expect without licensing. The tenth percentile is 3.1% larger, as is the median with 2.2%. Licensing has a considerably weaker influence on the upper percentile values, and we cannot distinguish the results of the upper ten percentiles from zero. The point estimates are 0.57% for the 90th percentile and 1.16% for the 95th percentile. For 2018, the results are stronger: licensing increases the fifth percentile by 2.47%, the tenth percentile by 2.97%, the median by 2.32%, the 90th percentile by 1.6%, and the 95th percentile by 1%.

Thus, even if it is unlikely for licensed employees to be in the lower quarter of the German wage distribution, the large wage premium of low-wage earners due to licensing pushes the lower quarter considerably towards the middle. Licensed employees do not push the middle upwards in the same way, which results in a compression of the lower half of the distribution. For 2012, the ratio between the median and the fifth percentile decreases by 0.49%, and the P50/P15-ratio decreases by 1.16. For 2018, the first ratio decreases to 0.15%, but the latter increases to 1.69%. Licensing also compresses the upper half of the German wage distribution because it pushes the medium percentiles up but contributes very little to the high percentile values. In 2012, the 85/50 percentile ratio is 1.3% lower because of licensing's influence on the distribution of wages, as is the P95/P50-ratio with 0.98%. For 2018, I estimate a reduction of the P85/P50 ratio of 1.15% and of the P95/P50 ratio of 1.28%. Overall, the results are clearly compatible with the claim that licensing is a counter to overall wage inequality in Germany.

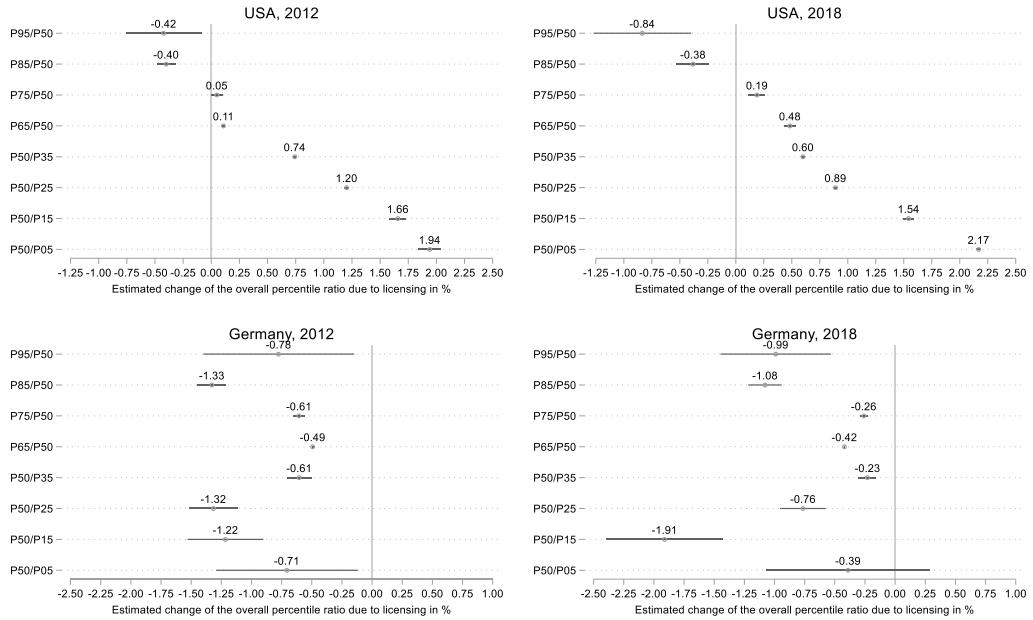

Figure 7: Estimated change in the overall percentile value ratios due to licensing based on multivariate unconditional quantile models with 95% CIs

In sum, the differences across countries are very comparable over time. Low-wage, licensed employees profit the most in Germany, while medium-wage employees profit the most in the U.S. The models do not show clear evidence of large premiums for high-wage employees in Germany but show consistent medium-sized premiums in the upper tail for the USA. This premium in combination with the occupational composition leads to a more compressed wage structure of licensed employees in comparison to nonlicensed employees in Germany but overall a more dispersed wage structure in the USA. That scales up to higher levels of wage inequality in the USA but to a lower level of inequality in Germany.

8 Discussion

This paper provides an in-depth analysis of the heterogeneity of the licensing premium and its consequences for wage inequality in the USA and Germany. Licensed employees enjoy wage advantages in both countries, but the distribution of this advantage differs strongly. It is strongest for low-wage earners in Germany and shows an inverse U-shaped pattern in the USA, with the highest premiums for earners in the upper middle of the distribution. The different distributions of the licensing wage premiums in combination with compositional differences scale up to a decreasing influence of licensing on wage inequality in Germany but to an increasing influence in the USA. It is thus not the case that licensing has similar consequences on wages across countries, apart from a positive influence, *on average.* The patterns behind these average differentials are, however, very heterogeneous. Scholars need to consider them to understand the relation of occupational licensing to wages for a given country.

The institutional variation of occupational licensing between the two countries is key for understanding its distributional consequences. I argued that the legal framework in which licensed occupations operate differs strongly between the countries. Common wisdom suggests that occupational regulation in Germany is stricter because it has a strong history of powerful occupational associations, while regulation in the USA is more relaxed because of its liberal market orientation. This wisdom is both right and wrong. It is right insofar as the German licensing system has strict rules regarding which occupations may be licensed. This applies only to occupations that are closely related to a basic public good. An equivalent principle is absent in the United States. The common wisdom is also correct insofar as the German case regulates more matters of licensing. Occupational chambers have precisely circumscribed competencies, and licensed work is typically accompanied by price schedules. In contrast, U.S. occupational boards enjoy more freedom and competencies in the regulation of their jurisdictions. The U.S. Supreme Court has banned price regulations for being in conflict with antitrust legislation. The stricter regulation on the German side supports the conventional view. However, the common wisdom fails once we account for the range of licensing systems. The U.S. licenses a much larger number of occupations in the absence of a strict rule regarding which occupations may be eligible for licensing.

Institutional variation in occupational licensing alters the labor market positions of employees by changing their wage bargaining situation. I have used a model of wage bargaining in which differences in the licensing systems serve as structural conditions. In this way, these differences systematically change both employees' bargaining power and the bargaining range. Higher entry barriers lead to higher bargaining power and higher wages. The heterogeneous entry requirements of U.S. licensed occupations relate to varying bargaining power. Boards matter strongly here. Moreover, price and wage setting rules, which exist for German but not American licensed occupations, narrow the bargaining range substantially. On the one hand, they create occupation-specific wage floors, which limit firms' ability to bargain substandard wages. On the other hand, strong price regulations set upper limits for wage bargaining because firms cannot sell the respective services at higher prices, thereby restricting the wage scope. In the absence of price regulations, firms selling the services of licensed employees can set very high prices, a point that has stimulated much discussion in the U.S. for health care and law services in particular.

In line with predictions, the German system leads to strong wage premiums for low-wage employees but to smaller premiums across the distribution. I interpret this as the gradual increase in the importance of price setting for wages. In the absence of price setting, I

expected an increasing wage premium for the U.S. case. However, the pattern proved to be more complex, with the largest premiums for the middle but not the top. Licensed occupations in the upper tail might be more competitive, which may reduce wages. A second possible explanation is that I compared licensed professionals with employees who typically work for firms with very strong product market power, such as tech firms, or who have very strong individual bargaining power, such as IT specialists or managers. It is also noteworthy that the dependent variable here is the gross hourly wage. Employees with excessive work hours might have large annual labor incomes but less impressive hourly wages.

In sum, the results warn against simplified interpretations of occupational licensing, as suggested by the general literature. First, institutional variation matters, but the common reasoning about licensing does not account for it. Second, a focus on wage bargaining yields a better understanding of the mechanisms linking licensing and wages than a focus on allegedly 'disturbed' supply-and-demand curves. Employees can have a stronger or weaker labor market position conditional on personal and structural conditions (Kalleberg, Wallace, and Althauser 1981). Both conditions can alter the power relation between employers and employees. Structural conditions, such as the licensing systems studied here, can also change the bargaining situation by setting wage floors or wage caps. I strongly believe that scholars studying consequences of social closure in general or licensing in particular would profit by using such a bargaining perspective. It is helpful to obtain a deeper understanding of what exactly occupational licensing changes in addition to labor market entry. Licensing represents a deep change in labor market processes, influencing the supply itself but also the composition of the workforce, the prices of the products, and the wage setting.

Taking such a broader view also links product market regulations with labor market processes. The regulations associated with occupational licensing are not restricted to labor markets. They eventually involve product markets. Price regulations may also regulate occupations' access to particular product markets. Empirical analyses of occupational licensing's consequences are scarce.[19] The findings offered here indicate that the interrelation of product market regulation with wage setting is crucial for understanding the varying consequences of licensing.

On a methodical level, this paper has shown the benefits of studying distributional differences rather than average differences. Distributional methods have high potential to

[19] Damelang, Haupt, and Abraham (2017) offer such an analysis for the influence of the deregulation of craft markets on employees' wages.

study heterogeneous consequences of labor market regulations within and between countries. The combination of closure theory with a bargaining model is just one example of how to derive hypotheses beyond average differentials.

The study also offers an approach to how scholars could harmonize licensing information over time based on very different data gathering strategies. I have proposed to construct plausible licensing information for occupations using the respective strengths of each data gathering strategy. The results offered here look promising. The data and the syntax files for the analysis are openly available on my GitHub account. These data enrich the current state of licensing information and have the potential to bridge the gap between objective and subjective licensing data.

The central message of this study is that consequences of licensing for inequality strongly differ conditional on the legal implementation. Since the late 1970s, the U.S. has taken the path of stronger entry restrictions without price regulation. I believe that this combination results in a very profitable labor market position for employees, especially when gate keeping is strong. Whether a ban of entry restrictions would reduce their market power stands to reason. The formerly licensed specialists in health care, law, or engineering would still be hardly replaceable specialists. It is therefore unclear to what extent prices would fall if entry requirements for employees were eliminated. I hold that the discussion of reforming the U.S. licensing system would profit by reconsidering the focus on market entry and the behavior of occupational boards. While these are indeed important components, wage inequality may also increase due to occupation-specific product market positions. It is worth discussing whether it truly takes less or more regulation of licensing to solve the challenging inequalities in the USA and other countries. The preservation of consumer protection may well be compatible with the reduction of wage inequality after all.

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A. Descriptive statistics for the U.S. and German samples

Table AB: Descriptive statistics for the USA 2012/2018

	2012					2018				
	All	Not licensed	Licensed	Difference	S.E.	*All*	Not licensed	Licensed	Difference	S.E.
Wage	25.15	24.02	29.44	5.42	0.12	26.91	25.57	31.11	5.54	0.13
Plausibly licensed	20.80					24.11				
Education										
Low skilled	6.98	8.00	3.07	-4.94	0.16	6.34	7.44	2.85	-4.59	0.15
Medium skilled	57.54	61.33	43.08	-18.25	0.31	54.66	57.97	44.23	-13.74	0.31
High skilled	35.49	30.66	53.85	23.18	0.30	39.01	34.59	52.92	18.33	0.30
Experience in years										
0 - 4	13.36	14.28	9.85	-4.43	0.22	14.02	15.26	10.10	-5.16	0.21
5 - 9	12.51	12.35	13.12	0.77	0.21	13.59	13.66	13.35	-0.30	0.21
10 - 14	11.72	11.50	12.53	1.03	0.20	12.59	12.38	13.26	0.88	0.21
15 - 19	11.21	10.99	12.06	1.07	0.20	11.24	10.94	12.18	1.24	0.20
20 - 24	11.49	11.39	11.88	0.49	0.20	10.78	10.32	12.24	1.92	0.19
25 - 29	11.81	11.60	12.59	0.99	0.21	10.58	10.22	11.72	1.50	0.19
30+	27.91	27.89	27.97	0.07	0.29	27.20	27.22	27.15	-0.08	0.28
Work hours										
Part time (<35h)	21.60	22.35	18.73	-3.62	0.26	18.92	19.82	16.10	-3.72	0.24
Full time (35-50h)	66.98	66.99	66.94	-0.04	0.30	69.96	70.12	69.47	-0.65	0.28
Over-workers (>50h)	11.43	10.66	14.33	3.66	0.20	11.12	10.06	14.43	4.36	0.19
Industry										
Ag./Forestry/Fisheries	1.74	2.06	0.50	-1.56	0.08	1.87	2.14	1.04	-1.10	0.08
Mining	0.73	0.81	0.42	-0.39	0.05	0.51	0.53	0.43	-0.11	0.04
Construction	5.34	5.53	4.62	-0.91	0.14	6.27	6.49	5.59	-0.90	0.15
Manu. durables	6.48	7.73	1.74	-5.99	0.16	6.22	7.00	3.77	-3.23	0.15
Manu. non-durables	3.94	4.73	0.92	-3.81	0.12	3.87	4.56	1.71	-2.85	0.12
Transportation	4.07	3.71	5.44	1.73	0.13	4.25	4.14	4.60	0.46	0.12
Communications	1.67	2.05	0.21	-1.84	0.08	1.51	1.86	0.40	-1.46	0.08
Util./Sanitary	1.26	1.29	1.15	-0.14	0.07	1.23	1.27	1.11	-0.16	0.07
Wholesale trade	2.44	2.80	1.06	-1.74	0.10	2.26	2.47	1.60	-0.87	0.09
Retail	17.82	21.41	4.18	-17.22	0.24	17.33	19.13	11.65	-7.48	0.23
FIRE	6.52	6.81	5.40	-1.41	0.16	6.50	6.47	6.61	0.14	0.15
Bus./Repair services	9.82	11.07	5.05	-6.02	0.19	10.44	11.75	6.35	-5.40	0.19
Entertainment/Rec. services	1.92	2.30	0.48	-1.83	0.09	1.98	2.25	1.12	-1.13	0.09
Prof./Other serivices	30.36	21.59	63.74	42.16	0.27	29.88	24.16	47.90	23.73	0.28
Government	5.46	5.58	4.98	-0.60	0.14	5.39	5.21	5.94	0.73	0.14
Occupational composition										
Male dominated (>70%)	25.72	27.17	20.20	-6.97	0.28	29.56	30.85	25.52	-5.33	0.28
Mixed occupation	43.16	46.16	31.74	-14.42	0.31	40.00	41.35	35.76	-5.58	0.30
Female Dominated (>70%)	31.12	26.67	48.06	21.39	0.29	30.44	27.80	38.72	10.92	0.28
Female	49.11	46.71	58.25	11.54	0.32	48.77	47.22	53.65	6.43	0.31
was or is married	55.07	53.24	62.03	8.80	0.32	52.53	50.23	59.79	9.56	0.31
Age										
16 - 23	10.81	12.27	5.27	-7.00	0.20	10.87	12.44	5.90	-6.54	0.19
24 - 31	19.48	19.56	19.20	-0.35	0.25	20.76	21.26	19.18	-2.09	0.25
32 - 39	18.12	17.77	19.43	1.66	0.24	19.15	18.68	20.64	1.96	0.24
40 - 47	18.94	18.58	20.35	1.77	0.25	17.44	16.71	19.74	3.03	0.23
48 - 55	19.16	18.91	20.10	1.19	0.25	17.44	17.08	18.56	1.47	0.23
56+	13.48	12.91	15.65	2.74	0.22	14.34	13.82	15.98	2.17	0.22
Region										
East	18.44	18.14	19.57	1.44	0.25	17.93	18.08	17.45	-0.63	0.24
Central	22.22	22.11	22.65	0.54	0.26	21.47	20.84	23.45	2.61	0.25
South	36.89	36.47	38.45	1.98	0.31	37.05	37.44	35.81	-1.63	0.30
Mountain and Pacific	22.46	23.28	19.33	-3.95	0.27	23.55	23.64	23.29	-0.35	0.26
Race										
White	65.87	64.61	70.66	6.05	0.30	61.19	59.18	67.54	8.36	0.30
White - hispanic	15.39	16.63	10.65	-5.98	0.23	17.65	19.02	13.32	-5.70	0.24
Black	11.51	11.30	12.33	1.03	0.20	12.76	13.16	11.47	-1.69	0.21
Other	7.23	7.45	6.36	-1.09	0.16	8.40	8.63	7.67	-0.97	0.17

Table AC: Descriptive statistics for Germany 2012/2018

	2012					2018				
	All	Not licensed	Licensed	Difference	S.E.	*All*	Not licensed	Licensed	Difference	S.E.
Wage	15.35	15.15	16.32	1.17	0.16	16.19	16.03	16.74	0.72	0.15
Licensed Occupation	17.47					22.81				
Education										
Low skilled	7.97	8.92	3.48	-5.44	0.57	5.78	6.63	2.89	-3.75	0.44
Medium skilled	69.77	73.20	53.57	-19.64	0.96	58.62	61.60	48.53	-13.07	0.92
High skilled	22.25	17.87	42.95	25.08	0.85	35.60	31.76	48.58	16.82	0.89
Experience in years										
0 - 4	8.82	8.42	10.69	2.27	0.60	9.26	9.58	8.18	-1.40	0.54
5 - 9	12.28	11.98	13.72	1.74	0.69	12.53	12.44	12.84	0.40	0.62
10 - 14	12.28	11.91	14.06	2.15	0.69	12.26	12.08	12.85	0.76	0.62
15 - 19	12.07	11.97	12.53	0.56	0.69	11.83	11.50	12.94	1.44	0.61
20 - 24	13.84	13.93	13.43	-0.50	0.73	11.56	11.27	12.55	1.28	0.60
25 - 29	14.57	14.83	13.36	-1.46	0.74	12.85	12.75	13.18	0.44	0.63
30+	26.13	26.96	22.21	-4.76	0.93	29.71	30.38	27.47	-2.91	0.86
Work hours										
Part time (<35h)	26.92	24.50	38.36	13.87	0.93	31.04	28.60	39.28	10.69	0.86
Full time (35-50h)	60.35	62.86	48.49	-14.37	1.02	56.76	59.02	49.12	-9.90	0.93
Over-workers (>50h)	12.73	12.64	13.14	0.50	0.70	12.20	12.38	11.59	-0.79	0.61
Industry										
Ag./Forestry/Fisheries	0.69	0.81	0.12	-0.69	0.17	0.69	0.89	0.02	-0.87	0.16
Mining	0.24	0.27	0.07	-0.20	0.10	0.14	0.17	0.05	-0.12	0.07
Construction	5.53	6.22	2.24	-3.98	0.48	4.32	5.38	0.72	-4.66	0.38
Manu. durables	21.16	25.26	1.80	-23.46	0.84	16.60	20.91	2.01	-18.90	0.68
Manu. non-durables	9.23	11.03	0.71	-10.32	0.60	6.13	7.68	0.90	-6.78	0.45
Transportation	4.58	5.44	0.54	-4.90	0.44	4.61	5.83	0.46	-5.37	0.39
Communications	3.29	3.97	0.11	-3.85	0.37	4.41	5.67	0.15	-5.52	0.38
Util./Sanitary	2.40	2.87	0.15	-2.72	0.32	1.86	2.37	0.16	-2.21	0.25
Wholesale trade	2.16	2.61	-0.00	-2.61	0.31	1.63	2.11	0.01	-2.09	0.24
Retail	7.37	8.46	2.22	-6.23	0.55	6.08	7.39	1.62	-5.77	0.45
FIRE	4.11	4.87	0.54	-4.32	0.42	4.40	5.57	0.42	-5.15	0.38
Bus./Repair services	0.26	0.31	-0.00	-0.31	0.11	0.41	0.51	0.08	-0.43	0.12
Entertainment/Rec. services	3.45	4.13	0.23	-3.90	0.38	3.73	4.75	0.25	-4.50	0.35
Prof./Other serivices	15.81	11.21	37.58	26.37	0.74	19.21	14.70	34.46	19.76	0.72
Government	18.66	11.26	53.64	42.38	0.75	25.03	15.10	58.63	43.53	0.74
Occupational composition										
Male dominated	37.05	42.67	10.52	-32.15	0.99	31.29	37.93	8.81	-29.12	0.84
Mixed occupation	32.39	36.25	14.18	-22.07	0.97	37.29	43.98	14.64	-29.35	0.88
Female dominated	30.55	21.08	75.31	54.23	0.87	31.42	18.08	76.55	58.47	0.74
Women	45.72	40.42	70.73	30.30	1.02	48.92	42.73	69.85	27.12	0.91
was or is married	66.85	66.54	68.35	1.81	0.99	65.87	63.91	72.50	8.58	0.89
Age										
16 - 23	4.33	4.64	2.86	-1.78	0.43	3.53	3.82	2.52	-1.30	0.35
24 - 31	16.67	16.32	18.34	2.02	0.79	13.81	14.51	11.45	-3.06	0.65
32 - 39	17.69	17.66	17.83	0.17	0.80	18.47	18.60	18.03	-0.58	0.73
40 - 47	24.80	25.20	22.87	-2.33	0.91	17.08	16.79	18.08	1.29	0.71
48 - 55	23.80	24.04	22.69	-1.36	0.90	26.09	26.33	25.24	-1.09	0.82
56+	12.71	12.14	15.41	3.27	0.70	21.03	19.95	24.69	4.74	0.76
Region										
South	31.28	31.71	29.28	-2.43	0.98	6.09	5.96	6.53	0.57	0.45
North West	49.51	49.38	50.12	0.74	1.05	61.77	61.53	62.60	1.08	0.91
Nort East (ex GDR)	19.21	18.91	20.60	1.69	0.83	32.14	32.51	30.87	-1.65	0.88
Migration Background	15.66	16.50	11.71	-4.78	0.77	11.54	12.10	9.66	-2.44	0.60
Fixed-term contract	10.79	10.59	11.75	1.17	0.65	10.34	10.73	9.01	-1.72	0.57
Civil Servant	6.33	3.43	20.01	16.63	0.49	5.44	2.98	15.82	12.83	0.44

B. Comparison of the raw with the plausible license information for the U.S.

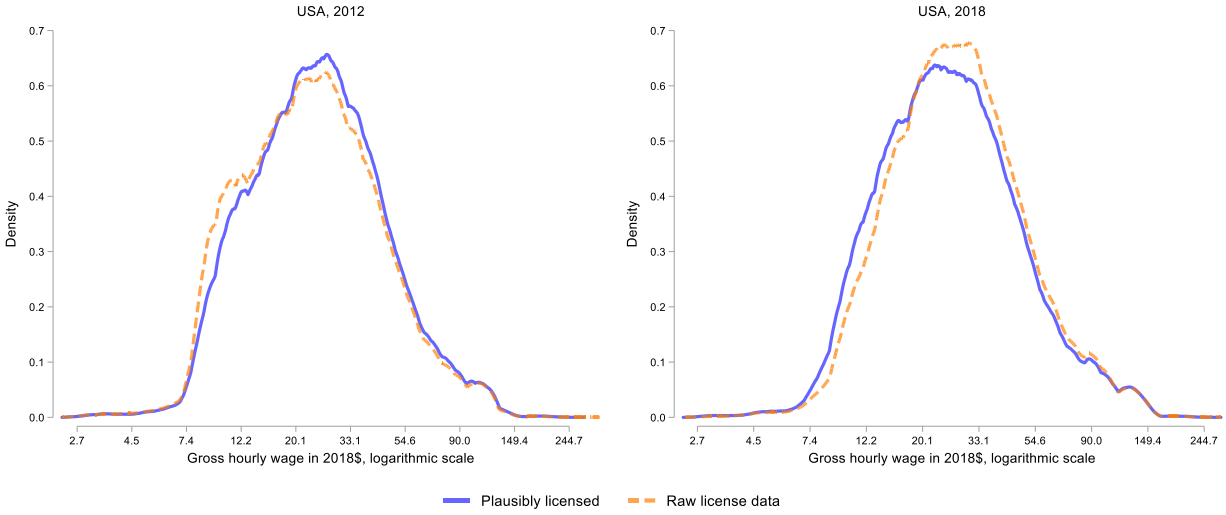

Figure H: Distributions of log. gross hourly wages of licensed employees using raw and plausible license information to construct the licensed group.

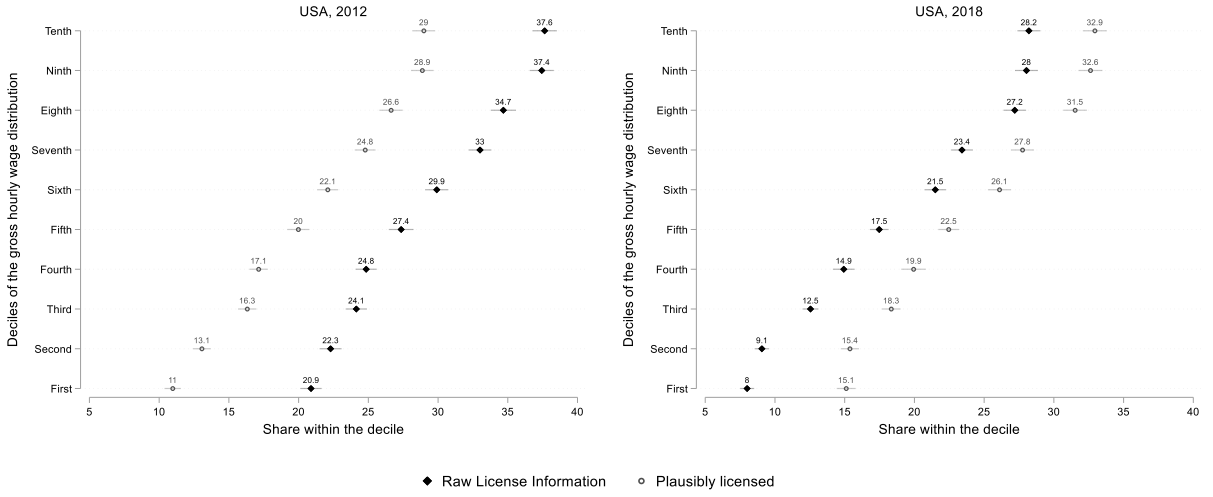

Figure I: Share of licensed employees across the gross hourly wage distribution in 2012 and 2018, conditional on licensing information used.

C. List of licensed occupations for the U.S. and Germany

Table D1: Occupational codes (SOC2010) of plausibly licensed U.S. employees, 2012 & 2018

2012		2018	
Occupational code (SOC2010)	N	Occupational Code (SOC2010)	N
111011. Chief Executives	131	111011. Chief Executives	186
111021. General and Operations Managers	31	111021. General and Operations Managers	159
113061. Purchasing Managers	2	112020. Marketing and Sales Managers	51
119013. Farmers, Ranchers, and Other Agricultural Managers	7	112031. Public Relations and Fundraising Managers	1
119021. Construction Managers	158	113011. Administrative Services Managers	27
119030. Education Administrators	957	113021. Computer and Information Systems Managers	44
119041. Architectural and Engineering Managers	8	113031. Financial Managers	173
119051. Food Service Managers	51	113051. Industrial Production Managers	26
119061. Funeral Service Managers	34	113061. Purchasing Managers	23
119071. Gaming Managers	1	113071. Transportation, Storage, and Distribution Managers	29
119081. Lodging Managers	2	113111. Compensation and Benefits Managers	2
119111. Medical and Health Services Managers	662	113121. Human Resources Managers	22
119141. Property, Real Estate, and Community Association Managers	98	113131. Training and Development Managers	4
119151. Social and Community Service Managers	9	119013. Farmers, Ranchers, and Other Agricultural Managers	47
131011. Agents and Business Managers of Artists, Performers, and Athletes	9	119021. Construction Managers	195
131021. Buyers and Purchasing Agents, Farm Products	1	119030. Education Administrators	388
131041. Compliance Officers	60	119041. Architectural and Engineering Managers	29
131151. Training and Development Specialists	25	119051. Food Service Managers	175
132011. Accountants and Auditors	660	119071. Gaming Managers	8
132021. Appraisers and Assessors of Real Estate	61	119081. Lodging Managers	15
132051. Financial Analysts	1	119111. Medical and Health Services Managers	284
132052. Personal Financial Advisors	152	119121. Natural Sciences Managers	2
132082. Tax Preparers	2	119141. Property, Real Estate, and Community Association Managers	88
151141. Database Administrators	11	119151. Social and Community Service Managers	74
151143. Computer Network Architects	18	119161. Emergency Management Directors	1
171010. Architects, Except Naval	158	119199. Managers, All Other	401
171020. Surveyors, Cartographers, and Photogrammetrists	36	131011. Agents and Business Managers of Artists, Performers, and Athletes	22
172011. Aerospace Engineers	16	131021. Buyers and Purchasing Agents, Farm Products	5
172031. Biomedical Engineers	7	131022. Wholesale and Retail Buyers, Except Farm Products	36
172041. Chemical Engineers	35	131023. Purchasing Agents, Except Wholesale, Retail, and Farm Products	21
172051. Civil Engineers	396	131030. Claims Adjusters, Appraisers, Examiners, and Investigators	86
172061. Computer Hardware Engineers	23	131041. Compliance Officers	78
172070. Electrical and Electronics Engineers	81	131051. Cost Estimators	11
172081. Environmental Engineers	43	131070. Human Resources Workers	34
172110. Industrial Engineers, Including Health and Safety	32	131081. Logisticians	9
172121. Marine Engineers and Naval Architects	11	131111. Management Analysts	68
172131. Materials Engineers	12	131121. Meeting, Convention, and Event Planners	2
172141. Mechanical Engineers	91	131131. Fundraisers	4
172151. Mining and Geological Engineers, Including Mining Safety Engineers	7	131141. Compensation, Benefits, and Job Analysis Specialists	3
172161. Nuclear Engineers	13	131151. Training and Development Specialists	16
172171. Petroleum Engineers	16	131161. Market Research Analysts and Marketing Specialists	10
173031. Surveying and Mapping Technicians	3	131199. Business Operations Specialists, All Other	17
191010. Agricultural and Food Scientists	8	132011. Accountants and Auditors	383
191020. Biological Scientists	4	132021. Appraisers and Assessors of Real Estate	47
191030. Conservation Scientists and Foresters	5	132031. Budget Analysts	2
191040. Medical Scientists	25	132041. Credit Analysts	1

192010. Astronomers and Physicists	1
192040. Environmental Scientists and Geoscientists	2
192099. Physical Scientists, All Other	2
193030. Psychologists	154
194011. Agricultural and Food Science Technicians	1
211010. Counselors	796
211093. Social and Human Service Assistants	133
212011. Clergy	16
231011. Lawyers	1078
252010. Preschool and Kindergarten Teachers	787
252020. Elementary and Middle School Teachers	3607
252030. Secondary School Teachers	1502
252050. Special Education Teachers	504
253000. Other Teachers and Instructors	239
254021. Librarians	52
254031. Library Technicians	1
259041. Teacher Assistants	149
271010. Artists and Related Workers	1
272020. Athletes, Coaches, Umpires, and Related Workers	19
272099. Entertainers and Performers, Sports and Related Workers, All Other	1
273031. Public Relations Specialists	5
273090. Miscellaneous Media and Communication Workers	2
274010. Broadcast and Sound Engineering Technicians and Radio Operators	3
291011. Chiropractors	14
291020. Dentists	80
291031. Dietitians and Nutritionists	97
291041. Optometrists	9
291051. Pharmacists	341
291060. Physicians and Surgeons	867
291071. Physician Assistants	145
291081. Podiatrists	1
291122. Occupational Therapists	154
291123. Physical Therapists	249
291124. Radiation Therapists	7
291125. Recreational Therapists	1
291126. Respiratory Therapists	128
291127. Speech-Language Pathologists	177
291129. Therapists, All Other	26
291131. Veterinarians	69
291141. Registered Nurses	3845
291181. Audiologists	10
291199. Health Diagnosing and Treating Practitioners, All Other	3
292021. Dental Hygienists	210
292030. Diagnostic Related Technologists and Technicians	54
292041. Emergency Medical Technicians and Paramedics	202
292061. Licensed Practical and Licensed Vocational Nurses	631
292071. Medical Records and Health Information Technicians	4
292081. Opticians, Dispensing	26
292090. Miscellaneous Health Technologists and Technicians	68
299000. Other Healthcare Practitioners and Technical Occupations	2
311010. Nursing, Psychiatric, and Home Health Aides	2443
312010. Occupational Therapy Assistants and Aides	22
312020. Physical Therapist Assistants and Aides	21
319011. Massage Therapists	82
319091. Dental Assistants	174
132051. Financial Analysts	27
132052. Personal Financial Advisors	171
132053. Insurance Underwriters	34
132070. Credit Counselors and Loan Officers	97
132081. Tax Examiners and Collectors, and Revenue Agents	6
132082. Tax Preparers	16
132099. Financial Specialists, All Other	4
151111. Computer and Information Research Scientists	1
151121. Computer Systems Analysts	50
151122. Information Security Analysts	9
151131. Computer Programmers	47
151133. Software Developers, Systems Software	70
151134. Web Developers	3
151141. Database Administrators	8
151142. Network and Computer Systems Administrators	15
151143. Computer Network Architects	5
151150. Computer Support Specialists	33
151199. Computer Occupations, All Other	45
152011. Actuaries	4
152031. Operations Research Analysts	8
152090. Miscellaneous Mathematical Science Occupations	7
171010. Architects, Except Naval	91
171020. Surveyors, Cartographers, and Photogrammetrists	36
172011. Aerospace Engineers	96
172031. Biomedical Engineers	12
172041. Chemical Engineers	51
172051. Civil Engineers	172
172061. Computer Hardware Engineers	56
172070. Electrical and Electronics Engineers	213
172081. Environmental Engineers	25
172110. Industrial Engineers, Including Health and Safety	161
172121. Marine Engineers and Naval Architects	16
172131. Materials Engineers	43
172141. Mechanical Engineers	226
172151. Mining and Geological Engineers, Including Mining Safety Engineers	7
172161. Nuclear Engineers	14
172171. Petroleum Engineers	28
172199. Engineers, All Other	97
173010. Drafters	5
173020. Engineering Technicians, Except Drafters	53
173031. Surveying and Mapping Technicians	7
191010. Agricultural and Food Scientists	10
191020. Biological Scientists	14
191030. Conservation Scientists and Foresters	6
191040. Medical Scientists	27
192010. Astronomers and Physicists	2
192030. Chemists and Materials Scientists	13
192040. Environmental Scientists and Geoscientists	19
192099. Physical Scientists, All Other	27
193011. Economists	2
193030. Psychologists	113
193051. Urban and Regional Planners	2
193090. Miscellaneous Social Scientists and Related Workers	4
194011. Agricultural and Food Science Technicians	5
194031. Chemical Technicians	1

331011. First-Line Supervisors of Correctional Officers	5
331012. First-Line Supervisors of Police and Detectives	24
331021. First-Line Supervisors of Fire Fighting and Prevention Workers	37
332011. Firefighters	73
332020. Fire Inspectors	7
333010. Bailiffs, Correctional Officers, and Jailers	45
333021. Detectives and Criminal Investigators	46
333041. Parking Enforcement Workers	2
333051. Police and Sheriff's Patrol Officers	328
339011. Animal Control Workers	4
339021. Private Detectives and Investigators	33
339030. Security Guards and Gaming Surveillance Officers	507
353011. Bartenders	26
353021. Combined Food Preparation and Serving Workers, Including Fast Food	6
371011. First-Line Supervisors of Housekeeping and Janitorial Workers	3
371012. First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers	2
372021. Pest Control Workers	48
391010. First-Line Supervisors of Gaming Workers	5
391021. First-Line Supervisors of Personal Service Workers	20
392011. Animal Trainers	8
393010. Gaming Services Workers	10
394021. Funeral Attendants	1
395011. Barbers	43
395012. Hairdressers, Hairstylists, and Cosmetologists	564
395090. Miscellaneous Personal Appearance Workers	13
397010. Tour and Travel Guides	5
399021. Personal Care Aides	21
412021. Counter and Rental Clerks	2
412031. Retail Salespersons	317
413021. Insurance Sales Agents	472
413031. Securities, Commodities, and Financial Services Sales Agents	164
419020. Real Estate Brokers and Sales Agents	452
419031. Sales Engineers	3
419041. Telemarketers	4
432011. Switchboard Operators, Including Answering Service	1
433011. Bill and Account Collectors	3
433041. Gaming Cage Workers	2
434031. Court, Municipal, and License Clerks	6
434121. Library Assistants, Clerical	4
434131. Loan Interviewers and Clerks	4
434161. Human Resources Assistants, Except Payroll and Timekeeping	5
434181. Reservation and Transportation Ticket Agents and Travel Clerks	3
435030. Dispatchers	5
435041. Meter Readers, Utilities	1
435111. Weighers, Measurers, Checkers, and Samplers, Recordkeeping	12
439041. Insurance Claims and Policy Processing Clerks	8
439111. Statistical Assistants	1
452011. Agricultural Inspectors	3
452041. Graders and Sorters, Agricultural Products	2
452090. Miscellaneous Agricultural Workers	26
453011. Fishers and Related Fishing Workers	6
454011. Forest and Conservation Workers	1
471011. First-Line Supervisors of	96
194090. Miscellaneous Life, Physical, and Social Science Technicians	27
211010. Counselors	357
211092. Probation Officers and Correctional Treatment Specialists	26
211093. Social and Human Service Assistants	344
212011. Clergy	55
212021. Directors, Religious Activities and Education	4
212099. Religious Workers, All Other	1
231011. Lawyers	839
231012. Judicial Law Clerks	1
232011. Paralegals and Legal Assistants	69
232090. Miscellaneous Legal Support Workers	35
251000. Postsecondary Teachers	348
252010. Preschool and Kindergarten Teachers	306
252020. Elementary and Middle School Teachers	2770
252030. Secondary School Teachers	899
252050. Special Education Teachers	327
253000. Other Teachers and Instructors	142
254010. Archivists, Curators, and Museum Technicians	3
254021. Librarians	80
254031. Library Technicians	2
259041. Teacher Assistants	273
259090. Miscellaneous Education, Training, and Library Workers	42
271010. Artists and Related Workers	1
271020. Designers	48
272012. Producers and Directors	2
272020. Athletes, Coaches, Umpires, and Related Workers	124
272030. Dancers and Choreographers	1
272040. Musicians, Singers, and Related Workers	2
272099. Entertainers and Performers, Sports and Related Workers, All Other	3
273010. Announcers	3
273020. News Analysts, Reporters and Correspondents	1
273031. Public Relations Specialists	33
273041. Editors	1
273043. Writers and Authors	5
273090. Miscellaneous Media and Communication Workers	10
274010. Broadcast and Sound Engineering Technicians and Radio Operators	8
274021. Photographers	2
291011. Chiropractors	16
291020. Dentists	75
291031. Dietitians and Nutritionists	59
291041. Optometrists	30
291051. Pharmacists	292
291060. Physicians and Surgeons	783
291071. Physician Assistants	103
291122. Occupational Therapists	102
291123. Physical Therapists	231
291125. Recreational Therapists	4
291126. Respiratory Therapists	89
291127. Speech-Language Pathologists	133
291129. Therapists, All Other	113
291131. Veterinarians	75
291141. Registered Nurses	2908
291151. Nurse Anesthetists	32

Construction Trades and Extraction Workers

472011. Boilermakers	8
472050. Cement Masons, Concrete Finishers, and Terrazzo Workers	1
472073. Operating Engineers and Other Construction Equipment Operators	32
472111. Electricians	698
472121. Glaziers	2
472130. Insulation Workers	1
472150. Pipelayers, Plumbers, Pipefitters, and Steamfitters	410
472211. Sheet Metal Workers	1
472221. Structural Iron and Steel Workers	9
474011. Construction and Building Inspectors	71
474021. Elevator Installers and Repairers	14
474041. Hazardous Materials Removal Workers	20
474071. Septic Tank Servicers and Sewer Pipe Cleaners	1
475021. Earth Drillers, Except Oil and Gas	20
475031. Explosives Workers, Ordnance Handling Experts, and Blasters	7
491011. First-Line Supervisors of Mechanics, Installers, and Repairers	5
492095. Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	4
492097. Electronic Home Entertainment Equipment Installers and Repairers	4
492098. Security and Fire Alarm Systems Installers	10
493011. Aircraft Mechanics and Service Technicians	127
493023. Automotive Service Technicians and Mechanics	53
493090. Miscellaneous Vehicle and Mobile Equipment Mechanics, Installers, and Repairers	1
499021. Heating, Air Conditioning, and Refrigeration Mechanics and Installers	158
499031. Home Appliance Repairers	16
499044. Millwrights	1
499051. Electrical Power-Line Installers and Repairers	11
499071. Maintenance and Repair Workers, General	6
499081. Wind Turbine Service Technicians	2
499091. Coin, Vending, and Amusement Machine Servicers and Repairers	2
499094. Locksmiths and Safe Repairers	5
512011. Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	3
514034. Lathe and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic	1
514120. Welding, Soldering, and Brazing Workers	95
517011. Cabinetmakers and Bench Carpenters	2
517041. Sawing Machine Setters, Operators, and Tenders, Wood	1
517099. Woodworkers, All Other	2
518010. Power Plant Operators, Distributors, and Dispatchers	7
518021. Stationary Engineers and Boiler Operators	30
518031. Water and Wastewater Treatment Plant and System Operators	84
519020. Crushing, Grinding, Polishing, Mixing, and Blending Workers	1
519041. Extruding, Forming, Pressing, and	1
291171. Nurse Practitioners	198
291181. Audiologists	11
292010. Clinical Laboratory Technologists and Technicians	140
292021. Dental Hygienists	162
292030. Diagnostic Related Technologists and Technicians	188
292041. Emergency Medical Technicians and Paramedics	166
292050. Health Practitioner Support Technologists and Technicians	344
292061. Licensed Practical and Licensed Vocational Nurses	418
292071. Medical Records and Health Information Technicians	39
292081. Opticians, Dispensing	28
292090. Miscellaneous Health Technologists and Technicians	43
299000. Other Healthcare Practitioners and Technical Occupations	41
311010. Nursing, Psychiatric, and Home Health Aides	927
312010. Occupational Therapy Assistants and Aides	17
312020. Physical Therapist Assistants and Aides	37
319011. Massage Therapists	70
319091. Dental Assistants	139
319092. Medical Assistants	245
319095. Pharmacy Aides	6
319096. Veterinary Assistants and Laboratory Animal Caretakers	5
319097. Phlebotomists	43
331011. First-Line Supervisors of Correctional Officers	10
331012. First-Line Supervisors of Police and Detectives	41
331021. First-Line Supervisors of Fire Fighting and Prevention Workers	9
331099. First-Line Supervisors of Protective Service Workers, All Other	9
332011. Firefighters	192
332020. Fire Inspectors	4
333010. Bailiffs, Correctional Officers, and Jailers	93
333021. Detectives and Criminal Investigators	71
333051. Police and Sheriff's Patrol Officers	361
339011. Animal Control Workers	2
339021. Private Detectives and Investigators	68
339030. Security Guards and Gaming Surveillance Officers	301
339091. Crossing Guards	5
339093. Transportation Security Screeners	2
351011. Chefs and Head Cooks	52
351012. First-Line Supervisors of Food Preparation and Serving Workers	54
352010. Cooks	79
352021. Food Preparation Workers	24
353011. Bartenders	72
353021. Combined Food Preparation and Serving	18

Compacting Machine Setters, Operators, and Tenders	
519051. Furnace, Kiln, Oven, Drier, and Kettle Operators and Tenders	1
519061. Inspectors, Testers, Sorters, Samplers, and Weighers	9
519080. Medical, Dental, and Ophthalmic Laboratory Technicians	5
532010. Aircraft Pilots and Flight Engineers	151
532020. Air Traffic Controllers and Airfield Operations Specialists	40
533011. Ambulance Drivers and Attendants, Except Emergency Medical Technicians	2
533020. Bus Drivers	453
533030. Driver/Sales Workers and Truck Drivers	2347
533041. Taxi Drivers and Chauffeurs	37
533099. Motor Vehicle Operators, All Other	2
534010. Locomotive Engineers and Operators	6
534031. Railroad Conductors and Yardmasters	2
535011. Sailors and Marine Oilers	5
535020. Ship and Boat Captains and Operators	16
536051. Transportation Inspectors	3

Workers, Including Fast Food	
353022. Counter Attendants, Cafeteria, Food Concession, and Coffee Shop	4
353031. Waiters and Waitresses	216
353041. Food Servers, Nonrestaurant	27
359011. Dining Room and Cafeteria Attendants and Bartender Helpers	17
359021. Dishwashers	9
359031. Hosts and Hostesses, Restaurant, Lounge, and Coffee Shop	30
371011. First-Line Supervisors of Housekeeping and Janitorial Workers	24
371012. First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers	24
372012. Maids and Housekeeping Cleaners	47
372019. Building Cleaning Workers, All Other	94
372021. Pest Control Workers	50
373010. Grounds Maintenance Workers	57
391010. First-Line Supervisors of Gaming Workers	21
391021. First-Line Supervisors of Personal Service Workers	24
392011. Animal Trainers	8
392021. Nonfarm Animal Caretakers	50
393010. Gaming Services Workers	33
393031. Ushers, Lobby Attendants, and Ticket Takers	2
393090. Miscellaneous Entertainment Attendants and Related Workers	3
394021. Funeral Attendants	1
394031. Morticians, Undertakers, and Funeral Directors	23
395011. Barbers	43
395012. Hairdressers, Hairstylists, and Cosmetologists	317
395090. Miscellaneous Personal Appearance Workers	137
396010. Baggage Porters, Bellhops, and Concierges	1
397010. Tour and Travel Guides	6
399011. Childcare Workers	149
399021. Personal Care Aides	281
399030. Recreation and Fitness Workers	54
399041. Residential Advisors	5
399099. Personal Care and Service Workers, All Other	11
411011. First-Line Supervisors of Retail Sales Workers	214
411012. First-Line Supervisors of Non-Retail Sales Workers	200
412010. Cashiers	113
412021. Counter and Rental Clerks	19
412022. Parts Salespersons	6
412031. Retail Salespersons	2050
413011. Advertising Sales Agents	9
413021. Insurance Sales Agents	307
413031. Securities, Commodities, and Financial Services Sales Agents	78
413041. Travel Agents	7
413099. Sales Representatives, Services, All Other	21
414010. Sales Representatives, Wholesale and Manufacturing	371
419020. Real Estate Brokers and Sales Agents	362
419041. Telemarketers	1
419091. Door-to-Door Sales Workers, News and Street Vendors, and Related Workers	23
419099. Sales and Related Workers, All Other	16
431011. First-Line Supervisors of Office and Administrative Support Workers	381
432011. Switchboard Operators, Including Answering Service	2
433011. Bill and Account Collectors	40
433021. Billing and Posting Clerks	29
433031. Bookkeeping, Accounting, and Auditing Clerks	55

433041. Gaming Cage Workers	3
433051. Payroll and Timekeeping Clerks	14
433061. Procurement Clerks	2
433099. Financial Clerks, All Other	12
434031. Court, Municipal, and License Clerks	18
434041. Credit Authorizers, Checkers, and Clerks	7
434051. Customer Service Representatives	57
434061. Eligibility Interviewers, Government Programs	3
434071. File Clerks	9
434081. Hotel, Motel, and Resort Desk Clerks	4
434111. Interviewers, Except Eligibility and Loan	11
434121. Library Assistants, Clerical	3
434131. Loan Interviewers and Clerks	13
434151. Order Clerks	1
434161. Human Resources Assistants, Except Payroll and Timekeeping	5
434171. Receptionists and Information Clerks	72
434181. Reservation and Transportation Ticket Agents and Travel Clerks	4
434199. Information and Record Clerks, All Other	10
435011. Cargo and Freight Agents	1
435021. Couriers and Messengers	26
435030. Dispatchers	54
435041. Meter Readers, Utilities	2
435051. Postal Service Clerks	1
435052. Postal Service Mail Carriers	12
435053. Postal Service Mail Sorters, Processors, and Processing Machine Operators	1
435061. Production, Planning, and Expediting Clerks	19
435071. Shipping, Receiving, and Traffic Clerks	92
435081. Stock Clerks and Order Fillers	12
435111. Weighers, Measurers, Checkers, and Samplers, Recordkeeping	13
436010. Secretaries and Administrative Assistants	153
439011. Computer Operators	1
439021. Data Entry Keyers	4
439022. Word Processors and Typists	1
439041. Insurance Claims and Policy Processing Clerks	56
439051. Mail Clerks and Mail Machine Operators, Except Postal Service	1
439061. Office Clerks, General	52
439071. Office Machine Operators, Except Computer	1
439111. Statistical Assistants	1
439199. Office and Administrative Support Workers, All Other	50
451011. First-Line Supervisors of Farming, Fishing, and Forestry Workers	5
452011. Agricultural Inspectors	6
452041. Graders and Sorters, Agricultural Products	28
452090. Miscellaneous Agricultural Workers	62
453011. Fishers and Related Fishing Workers	14
454011. Forest and Conservation Workers	5
454020. Logging Workers	5
471011. First-Line Supervisors of Construction Trades and Extraction Workers	154
472011. Boilermakers	7
472020. Brickmasons, Blockmasons, and Stonemasons	8
472031. Carpenters	242
472040. Carpet, Floor, and Tile Installers and Finishers	3
472050. Cement Masons, Concrete Finishers, and Terrazzo Workers	4
472061. Construction Laborers	268
472071. Paving, Surfacing, and Tamping Equipment Operators	1
472073. Operating Engineers and Other Construction Equipment Operators	84
472080. Drywall Installers, Ceiling Tile Installers, and Tapers	20
472111. Electricians	350
472121. Glaziers	8
472130. Insulation Workers	3
472141. Painters, Construction and Maintenance	23
472150. Pipelayers, Plumbers, Pipefitters, and	211

Steamfitters	
472161. Plasterers and Stucco Masons	2
472181. Roofers	40
472211. Sheet Metal Workers	39
472221. Structural Iron and Steel Workers	9
473010. Helpers, Construction Trades	1
474011. Construction and Building Inspectors	39
474021. Elevator Installers and Repairers	15
474041. Hazardous Materials Removal Workers	15
474051. Highway Maintenance Workers	30
474061. Rail-Track Laying and Maintenance Equipment Operators	1
474090. Miscellaneous Construction and Related Workers	2
475010. Derrick, Rotary Drill, and Service Unit Operators, Oil, Gas, and Mining	6
475021. Earth Drillers, Except Oil and Gas	17
475031. Explosives Workers, Ordnance Handling Experts, and Blasters	8
475040. Mining Machine Operators	11
475071. Roustabouts, Oil and Gas	1
475099. Extraction Workers, All Other	8
491011. First-Line Supervisors of Mechanics, Installers, and Repairers	65
492011. Computer, Automated Teller, and Office Machine Repairers	16
492020. Radio and Telecommunications Equipment Installers and Repairers	11
492091. Avionics Technicians	3
492092. Electric Motor, Power Tool, and Related Repairers	3
492095. Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	1
492097. Electronic Home Entertainment Equipment Installers and Repairers	1
492098. Security and Fire Alarm Systems Installers	29
493011. Aircraft Mechanics and Service Technicians	85
493021. Automotive Body and Related Repairers	18
493022. Automotive Glass Installers and Repairers	1
493023. Automotive Service Technicians and Mechanics	194
493031. Bus and Truck Mechanics and Diesel Engine Specialists	72
493040. Heavy Vehicle and Mobile Equipment Service Technicians and Mechanics	33
493050. Small Engine Mechanics	2
493090. Miscellaneous Vehicle and Mobile Equipment Mechanics, Installers, and Repairers	3
499010. Control and Valve Installers and Repairers	3
499021. Heating, Air Conditioning, and Refrigeration Mechanics and Installers	142
499031. Home Appliance Repairers	1
499043. Maintenance Workers, Machinery	4
499044. Millwrights	6
499045. Refractory Materials Repairers, Except Brickmasons	40
499051. Electrical Power-Line Installers and Repairers	41
499052. Telecommunications Line Installers and Repairers	25
499071. Maintenance and Repair Workers, General	89
499081. Wind Turbine Service Technicians	2
499091. Coin, Vending, and Amusement Machine Servicers and Repairers	2
499094. Locksmiths and Safe Repairers	6
499095. Manufactured Building and Mobile Home Installers	3
499096. Riggers	3
499098. Helpers--Installation, Maintenance, and Repair Workers	1
511011. First-Line Supervisors of Production and Operating Workers	122
512011. Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	2
512020. Electrical, Electronics, and Electromechanical Assemblers	2
512041. Structural Metal Fabricators and Fitters	1
512090. Miscellaneous Assemblers and Fabricators	17

513011. Bakers	10
513020. Butchers and Other Meat, Poultry, and Fish Processing Workers	9
513092. Food Batchmakers	3
513093. Food Cooking Machine Operators and Tenders	2
513099. Food Processing Workers, All Other	2
514010. Computer Control Programmers and Operators	4
514021. Extruding and Drawing Machine Setters, Operators, and Tenders, Metal and Plastic	1
514031. Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	1
514033. Grinding, Lapping, Polishing, and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Plastic	2
514034. Lathe and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic	1
514041. Machinists	12
514070. Molders and Molding Machine Setters, Operators, and Tenders, Metal and Plastic	1
514111. Tool and Die Makers	5
514120. Welding, Soldering, and Brazing Workers	106
514199. Metal Workers and Plastic Workers, All Other	8
515112. Printing Press Operators	4
516011. Laundry and Dry-Cleaning Workers	2
516031. Sewing Machine Operators	1
516041. Shoe and Leather Workers and Repairers	1
516093. Upholsterers	2
516099. Textile, Apparel, and Furnishings Workers, All Other	1
517011. Cabinetmakers and Bench Carpenters	3
517021. Furniture Finishers	1
518010. Power Plant Operators, Distributors, and Dispatchers	9
518021. Stationary Engineers and Boiler Operators	27
518031. Water and Wastewater Treatment Plant and System Operators	69
518090. Miscellaneous Plant and System Operators	4
519010. Chemical Processing Machine Setters, Operators, and Tenders	4
519020. Crushing, Grinding, Polishing, Mixing, and Blending Workers	6
519051. Furnace, Kiln, Oven, Drier, and Kettle Operators and Tenders	1
519061. Inspectors, Testers, Sorters, Samplers, and Weighers	370
519080. Medical, Dental, and Ophthalmic Laboratory Technicians	17
519111. Packaging and Filling Machine Operators and Tenders	1
519120. Painting Workers	9
519195. Molders, Shapers, and Casters, Except Metal and Plastic	1
519198. Helpers--Production Workers	2
519199. Production Workers, All Other	42
531000. Supervisors of Transportation and Material Moving Workers	20
532010. Aircraft Pilots and Flight Engineers	122
532020. Air Traffic Controllers and Airfield Operations Specialists	39
532031. Flight Attendants	59
533011. Ambulance Drivers and Attendants, Except Emergency Medical Technicians	3
533020. Bus Drivers	209
533030. Driver/Sales Workers and Truck Drivers	907
533041. Taxi Drivers and Chauffeurs	363
533099. Motor Vehicle Operators, All Other	2
534010. Locomotive Engineers and Operators	14
534031. Railroad Conductors and Yardmasters	25
534099. Rail Transportation Workers, All Other	2
535011. Sailors and Marine Oilers	10
535020. Ship and Boat Captains and Operators	16
536021. Parking Lot Attendants	1
536031. Automotive and Watercraft Service Attendants	4
536051. Transportation Inspectors	6

536061. Transportation Attendants, Except Flight Attendants	1
536099. Transportation Workers, All Other	1

Table C2: Occupational codes (KldB2010) of licensed German employees, 2012 & 2018

2012		2018	
Occupational Code (KldB2010)	N	Occupational Code (KldB2010)	N
311. Occupations in construction scheduling and supervision, and architecture	137	311. Occupations in construction scheduling and supervision, and architecture	144
312. Occupations in surveying and cartography	30	312. Occupations in surveying and cartography	32
523. Aircraft pilots	9	523. Aircraft pilots	8
532. Occupations in police and criminal investigation, jurisdiction and the penal institution	151	532. Occupations in police and criminal investigation, jurisdiction and the penal institution	177
533. Occupations in occupational health and safety administration, public health authority, and disinfection	13	533. Occupations in occupational health and safety administration, public health authority, and disinfection	18
723. Occupations in tax consultancy	111	723. Occupations in tax consultancy	101
731. Occupations in legal services, jurisdiction, and other officers of the court	111	731. Occupations in legal services, jurisdiction, and other officers of the court	139
812. Laboratory occupations in medicine	72	812. Laboratory occupations in medicine	96
813. Occupations in nursing, emergency medical services and obstetrics	614	813. Occupations in nursing, emergency medical services and obstetrics	634
814. Occupations in human medicine and dentistry	95	814. Occupations in human medicine and dentistry	130
815. Occupations in veterinary medicine and non-medical animal health practitioners	2	815. Occupations in veterinary medicine and non-medical animal health practitioners	11
816. Occupations in psychology and non-medical psychotherapy	27	816. Occupations in psychology and non-medical psychotherapy	43
817. Occupations in non-medical therapy and alternative medicine	104	817. Occupations in non-medical therapy and alternative medicine	126
818. Occupations in pharmacy	73	818. Occupations in pharmacy	83
821. Occupations in geriatric care	281	821. Occupations in geriatric care	245
822. Occupations providing nutritional advice or health counselling, and occupations in wellness	12	822. Occupations providing nutritional advice or health counselling, and occupations in wellness	30
825. Technical occupations in medicine, orthopaedic and rehabilitation	66	825. Technical occupations in medicine, orthopaedic and rehabilitation	79
831. Occupations in education and social work, and pedagogic specialists in social care work	658	831. Occupations in education and social work, and pedagogic specialists in social care work	872
841. Teachers in schools of general education	621	841. Teachers in schools of general education	783
842. Teachers for occupation-specific subjects at vocational schools and in-company instructors in vocational training	189	842. Teachers for occupation-specific subjects at vocational schools and in-company instructors in vocational training	201

D. Licensing coefficients of conditional and unconditional quantile regressions

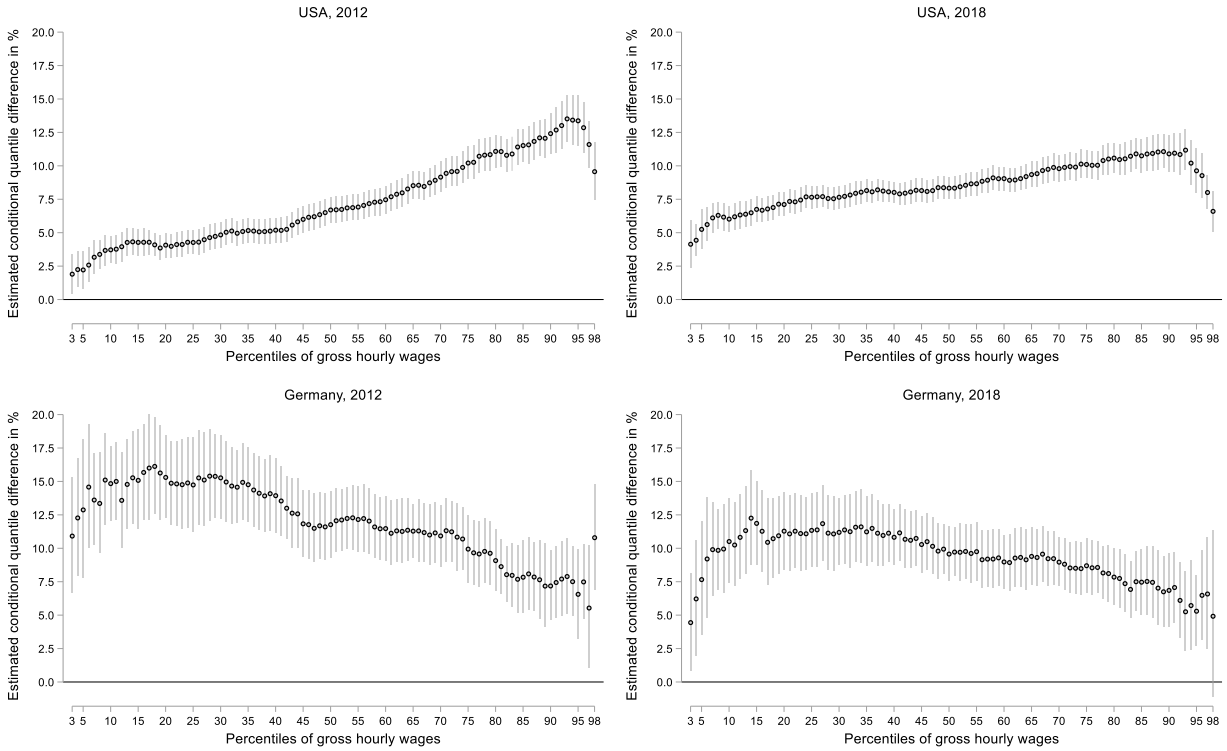

Figure D1: Licensing coefficients of multivariate, conditional quantile regressions for the USA and Germany, 2012 & 2018

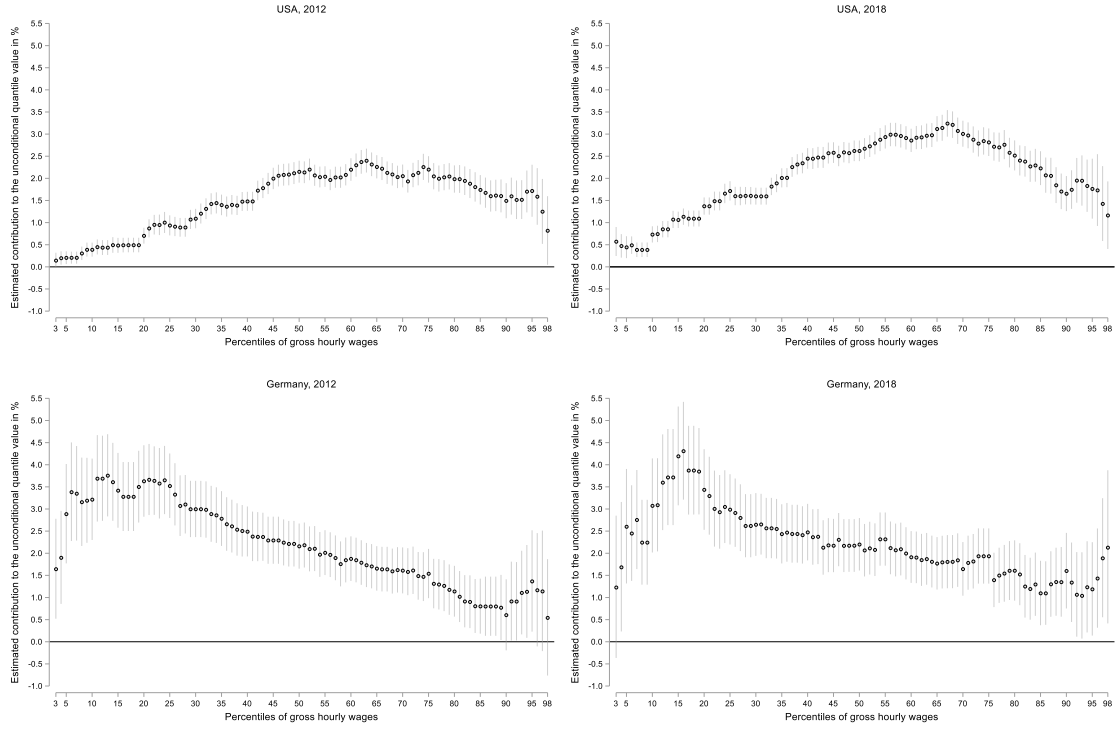

Figure D2: Contributions of licensing on unconditional quantile values based on multivariate, unconditional quantile regressions for the USA and Germany, 2012 & 2018