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Essays on Alternative Work Arrangements

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Chapter 1

Introduction to the Essays

The Covid-19 pandemic reveals the side effects of alternative work arrangements as if magnified through a burning glass. Slaughterhouses and meat processing and packing plants evolved to hot spots of virus outbreaks worldwide. Besides the cold air in the plants which may facilitate the spread of the virus (Matson et al., 2020), especially the poor working and living conditions of the workers were highlighted as reasons for the development. Meat processing is an industry heavily relying on alternative work arrangements. In the United States, the employment services sector is the second largest employer of slaughterers and meat packers (BLS, 2018). In Europe, labor supply is dominated by subcontracting systems and temporary agency work, often involving migrant workers. Frequently, their accommodation and transportation is arranged by the subcontractors or temporary work agencies, but mostly not to the workers' advantage (EFFAT, 2020). The pandemic initiated public and political discussions about alternative work arrangements and the related working conditions.

Labor market research increasingly turns to investigate working and employment forms outside the norm of the so-called "standard" work, too. The last decades have seen developments indicating that the traditional employee-employer relationships is receding in importance. Alternative work arrangements such as temporary agency work, contract work, and independent contractors have increased by five percentage points since 2005 and accounted for 15.8% of the U.S. workforce in 2015 (Katz and Krueger, 2019a). The share of workers reporting income through self-employment (Schedule C) has nearly doubled in the last 35 years (Katz and Krueger, 2017). Between 2000 and 2017 solo self-employment

relative to self-employment with employees has risen in most of the OECD countries (Boeri et al., 2020).

In contrast to "nonstandard employment", alternative work arrangements are typically market mediated. Nonstandard employees, such as part time workers, employees on a fixed-term contract or on-call workers have a direct employment contract with their employer and are therefore subject to social security contributions, applicable minimum wage laws, collective bargaining agreements and other labor standards in the firms. For alternative work arrangements, this is not necessarily the case, albeit they are not considered precarious per se (Bernhard et al., 2016). Employees of a service contractor or temporary work agency may have a permanent contract and be subject to social security contributions as well. Independent contractors, gig and platform workers, however, are typically self-employed. They are working on their own account and also have to arrange health care, pension, and unemployment insurance themselves. Hence, firms utilize staff external to their organization when they rely on alternative work arrangements. Weil (2014) frames this setting as "fissured" workplace. By shifting work outwards, firms also shift from wage to price setting. Moreover, markets providing these services are often subject to fierce competition.

> "This creates downward pressure on wages and benefits, murkiness about who bears responsibility for work conditions, and increased likelihood that basic labor standards will be violated. In many cases, fissuring leads simultaneously to a rise in profitability for the lead companies who operate at the top of industries and increasingly precarious working conditions for workers at lower levels." (Weil, 2014, p.8)

Findings of various studies provide evidence for the negative effects on workers: Workers experience wage losses when being outsourced (Goldschmidt and Schmieder, 2017; Dube and Kaplan, 2010), temporary agency workers have lower wages than direct employees (Boeheim and Cardoso, 2009; Forde and Slater, 2005) and are less likely to obtain a permanent contract (Amuedo-Dorantes et al., 2008), self-employment is often dependent rather than independent (Boeheim and Mühlberger, 2009).

Many explanations have been put forward for the increasing relevance of alternative

work arrangements. From the worker's perspective, weak labor market situations with high unemployment rates provide few alternatives for standard employment (Katz and Krueger, 2017). From the employer's perspective, digitization and the increasing adoption of technological innovations in firms have standardized work and facilitated outsourcing (Abramovsky and Griffith, 2006; Acemoglu et al., 2010; Bartel et al., 2014). Moreover, employers outsource to avoid rent sharing with low wage occupations (Goldschmidt and Schmieder, 2017) and reduce regulatory burdens such as labor standards or other liabilities (Weil, 2014).

Yet, the literature on alternative work arrangements faces major limitations deriving from data issues. Due to the nature of those work arrangements, administrative data is scarce and most research is relying on survey data. A variety of measurement problems arise with respect to alternative work. Individuals have problems accurately reporting their work status (Katz and Krueger, 2019b), which leads to underreporting – especially of multiple job holdings – and other employment misclassification (Abraham et al., 2021), not only in the US but also in the UK and Italy (Boeri et al., 2020). Hence, Katz and Krueger (2019b) conclude that it is difficult to identify workers engaged in alternative work arrangements in our standard data sources.

We, therefore, lack research on various fronts, especially for alternative work arrangements which are not covered by standard data products. We know little about their prevalence and their patterns across and within industries, the reasons why firms decide to use alternative work arrangements, and the resulting job quality (Bernhard et al., 2016).

This dissertation consists of three essays which study alternative work arrangements in various forms and different contexts. The essays cover a range of alternative work arrangements, namely contracting out, temporary agency work, and solo self-employment. In addition, the essays discuss different drivers, side-effects, and compliance issues related to the use of alternative work arrangements.

First, utilizing alternative work arrangements is basically a firm decision. It is therefore important to better understand the factors determining this fissuring of the workforce as we are increasingly able to observe the often negative outcomes for workers. Second, when implementing alternative work arrangements, firms face various regulatory settings. While regulators aim at protecting the affected workers, compliance by the firms is not always

ensured. And third, labor market institutions may have unintended effects. Improving the situation of some employees may adversely affect other worker groups and shift them to alternative work arrangements. The chapters are described in more detail below.

Outsourcing of Business Processes - Firm Level Evidence on Contracting Out

Chapter 2, which is joint work with Melanie Arntz and Stephan L. Thomsen investigates the drivers of outsourcing decisions in German firms. Despite the remarkable increase of contracting out and the relocation of occupations across industries, we still know little about the underlying drivers of outsourcing decisions. The lack of data is the main impediment in research on contracting out, as this phenomenon is not registered in official data and hardly any survey data. Previous studies, therefore, typically focus on small and homogeneous sets of predominantly low wage processes (Dube and Kaplan, 2010; Goldschmidt and Schmieder, 2017) and use proxies for contracting out rather than observing true outsourcing decisions. By introducing new data on outsourcing decisions on 15 different business processes in German firms, we complement the existing literature with a more comprehensive picture. The data covers the entire spectrum of business processes from low wage processes such as cleaning and logistics to high wage business functions such as R&D and management. We find that outsourcing probabilities vary substantially across business functions. Moreover, firm characteristics are able to explain some of the differences in outsourcing probabilities across firms. The use of other flexible work arrangements is positively correlated with outsourcing probabilities, suggesting that those forms of alternative staffing are complements rather than substituting for each other.

In addition, we develop an innovative measure of the relevant contract market, such that it reflects both the specialization of an industry in providing a process and the inter-industry linkages of industries. This enables us to investigate the within-firm heterogeneity in contracting out decisions for different business processes. We find that market conditions can only explain a small part of these differences. A one percent increase of wages paid to contract workers relative to internal workers reduces the outsourcing probability by 0.096 percentage points on average. Nevertheless, the wage differential is significantly

reducing outsourcing probabilities for low wage processes, supporting the view of a cost saving strategy by outsourcing firms for those support business functions. In contrast, high wage processes – if at all – are more likely to be outsourced, the higher the wages on the contract market are. Hence, the need to make use of task-specific experts and related scale effects seems to be relevant only for high wage processes. The results are robust to focusing on domestic outsourcing and especially for low wage processed the relevant perspective is the regional rather than the nationwide domestic contract market. Furthermore, we simulate that if wages on the contract market and the internal market were harmonized, outsourcing probabilities of low-wage processes such as cleaning and logistics would be 10 to 35 percent lower. Hence, contracting out likely increases the pressure on contract markets providing low wage and mostly low skilled processes.

Noncompliance with Temporary Agency Work Regulations: Don't They Know Better or Do They Abuse?

In Chapter 3, I analyze whether firms knowingly non-comply with temporary agency work regulations when outsourcing to service contractors or whether they simply do not know better. Temporary agency work and outsourcing to a service contractor are two forms of alternative work arrangements firms often use for external staffing. However, temporary agency work is highly regulated and the regulatory complexity can lead to intended or unintended non-compliance with its regulations when firms outsource to a service contractor. Moreover, due to the lack of enforcement in Germany, firms have incentives to make use of the advantages of both forms of alternative work arrangements and discard their respective disadvantages, which, however, results in non-compliant behavior.

In this chapter, I provide evidence for non-compliance with temporary agency work regulations when firms contract out. A novel dataset on contracting out in German firms additionally provides information on defacto implementation practices of outsourcing to service contractors. Using the organizational design of defacto implementation strategies, I find that seven percent of outsourcing firms implement the cooperation with their service contractors like temporary agency work and hence do not comply with temporary

agency work regulations. Therefore, possibly up to 400,000 contract workers are defacto conducting temporary agency work and are misclassified in official statistics.

Furthermore, as an add-on to the survey, firms participated in a choice experiment. The respondents are confronted with hypothetical implementation situations and have to decide upon which contracting form they would choose. The choice experiment aims at assessing the legal literacy of firms in distinguishing temporary agency work from outsourcing to service contractors. I find that firms are able to understand the regulatory baseline of temporary agency work. However, detailed knowledge is missing and it is therefore not surprising that the unregulated outsourcing to service contractors is considered as the default option for external staffing. Firms using temporary agency work have a better knowledge of distinguishing the two forms of external staffing than firms which do not use temporary agency work. Moreover, I show that legal literacy differs between compliers and non-compliers. Non-compliers reveal a lower legal literacy, hence their non-compliance with regulations can therefore be considered as ignorant rather than fraudulent. This and the overall rather limited legal literacy of a majority of the firms indicates that temporary agency regulations are too complex and the related legal gray zones and non-compliance issues are not fully understood.

Minimum Wages and Solo Self-Employment

Chapter 4 of this thesis, coauthored with Terry Gregory, Simona Murmann, and Ulrich Zierahn estimates the effect of a minimum wage introduction on solo self-employment. Self-employment in general is increasing in the U.S. (Katz and Krueger, 2017) as well as the share of self-employed individuals who operate on their own account without any employees, the so-called solo self-employed. Solo self-employed have lower earnings and working hours when compared to standard employment or self-employment with employees and are often depending on just one client. Solo self-employment represents between 4 and 22 percent of total employment among OECD countries and is rising in almost half of them (Boeri et al., 2020).

In this chapter, my coauthors and I study the role of minimum wages for the rising trend of solo self-employment. We exploit four industry-specific minimum wage introductions in

Germany during the late 1990s and early 2000s to show how a minimum wage affects solo self-employment of skilled workers. Relying on a Synthetic Control Method, we find the minimum wages to raise the share of solo self-employed individuals in all four investigated industries. The effects range from 4.8 to 10.5 percentage point increases six years after the introduction, thereby implying that solo self-employment at least doubled due to the minimum wage introduction. Moreover, we demonstrate that the magnitude of our effects significantly increases with the degree of the minimum wage bite.

We develop a theoretical framework to study the underlying mechanisms and to guide our empirical analysis. Our proposed explanation for an increase in solo self-employment of skilled workers is that the minimum wage induces a cost shock to the industry, reducing demand even for skilled workers. The declining labor market and earnings prospects increase the attractiveness of solo self-employment for skilled workers. In line with our proposed explanation, we find the effects to be more pronounced when skilled employment is affected the most. Moreover, revenues of solo self-employed after the introduction of a minimum wage are lower, thereby casting doubt on the hypothesis that solo self-employment is a purely voluntary decision.

Chapter 2

Outsourcing of Business Processes – Firm Level Evidence on Contracting Out [1]

2.1 Introduction

In the last decades, contracting out measured as the related relocation of occupations across industries has been on a rise (Abraham, 1990; Dey et al., 2010, 2012), likely supported by growing (international) trade flows and the increased use of digital technologies (Abramovsky and Griffith, 2006; Bartel et al., 2014).[2] While this form of firm cooperation arguably leads to an overall higher productivity in the economy (Dustmann et al., 2014) as firms focus on their core competencies and outsource inefficient functions to other sectors, it might also contribute to rising wage inequalities if firms contract out to make use of the lower wage costs on contract markets that are less unionized and where workers have lower bargaining powers (Dorn et al., 2018). In line with this, Dube and Kaplan (2010) and Goldschmidt and Schmieder (2017) find a wage penalty for outsourced workers in low-wage occupations in the US and Germany, respectively. Hence, there are increasing

[1]This chaper is joint work with Melanie Arntz and Stephan L. Thomsen. We thank Christina Gathmann and Thomas Zwick as well as conference and seminar participants at VfS Jahrestagung 2019, the 3rd IZA Labor Statistics Workshop: Contract Work, and ZEW for valuable comments and Christian Dietrich and Johannes Trunzer for excellent research assistance.

[2]The idea of comparative advantage and trade (domestic or international) of the specialized good is not new, as dates back to Smith, Marx, and Ricardo.

concerns also in the public that contracting out could lead to a polarization of the labor market, such that contract workers are systematically worse off than when employed directly by the outsourcing firm.

Against this background, the aim of this paper is to provide an in-depth and comprehensive analysis on the potential drivers of outsourcing across the entire spectrum of business functions from high-skilled business processes such as R&D and management to low-wage as well as low-skilled processes such as cleaning and logistics. We describe the heterogeneity of outsourcing across these business functions and examine the role of wage and other market conditions on the contract market compared to the conditions in case of providing the process in-house. For this exploratory analysis, we make use of survey data on contracting out decisions in German firms that provides unique insights into firms' outsourcing behavior at the level of business processes. The paper thus makes three contributions.

First, previous studies on the determinants of contracting out decisions typically focus on a small, rather homogeneous set of mainly low-wage processes and use proxies rather than direct measures of contracting out. In fact, the major limitation in this field of research is the lack of data. Contracting out is not clearly defined and therefore also not registered in official data. In some cases, outsourcing is approximated by sector reallocation of workers (rise of the service sector, Berlingieri (2013)) or by accounting numbers such as intermediate input and value added (Addison et al., 2011). Other papers analyze outsourcing events in administrative data. They do so at the firm level (Abramovsky and Griffith, 2006) or business process level. The latter is usually approximated by identifying few specific occupations (Dube and Kaplan, 2010) and using very narrow definitions of outsourcing, such as onsite outsourcing (Goldschmidt and Schmieder, 2017). As proper administrative data are lacking, survey data are used as well to identify outsourcing at the worker (Katz and Krueger, 2017) or firm level (Addison et al., 2011; Kircher, 2015) or for some business functions (Abraham and Taylor, 1996). In order to get a more comprehensive picture, we use unique survey data which are representative for the German economy containing outsourcing decisions on almost 90,000 processes by more than 7,000 firms. The data thus cover the entire spectrum of business processes and also allow for exploiting the within-firm heterogeneity in contracting out decisions for different business

processes.

Second, we develop an innovative way how to determine the relevant market conditions underlying the outsourcing decision. In particular, our measure of the contract market reflects how specialized a sector is in providing a particular process and how strong the inter-industry linkages are between industries. Combining corresponding weights with administrative data on worker and wage characteristics in each regional labor market, we derive the wage and worker characteristics of the average process-specific worker in sectors that are most likely to be sub-contractors to the outsourcing firm's industry. We exploit variation at the level of regional labor markets but conduct robustness checks with nationwide contract markets. Compared to the average process-specific worker in the firm's industry and region, we are thus able to examine the role of differences in the conditions on the contract and the internal market that may affect outsourcing decisions. We do so while controlling for process-specific differences as well as firm and regional characteristics that may confound our estimates. Moreover, firm characteristics such as the existence of collective wage agreements and works councils are interesting in itself as they imply restrictions on management behavior and proxy for different firm cultures.

Furthermore, we contribute to several strands of the literature. In particular, we add to the scarce quantitative literature on the determinants of contracting out decisions. A notable exception is Abraham and Taylor (1996) who find higher propensities for high-paying firms to outsource low wage janitorial services, while low-paying firms are more likely to outsource high skilled accounting services. The authors discuss this unexpected result in the light of internal wage compression, as norms for pay equity may work in both directions. We complement this analysis by not only looking at the wage of the outsourcing firm, but also taking into account the wage on the respective contract market in order to capture the relevant wage differential that affects outsourcing decisions. Other factors that promote outsourcing may be the need for specialized workers or specific skills (Abraham and Taylor, 1996), a fluctuating demand for these tasks as well as recruitment and monitoring costs for the in-house provision compared to the transactions costs of contracting out. As Weil (2014) discusses, outsourcing allows firms to exploit the economies of scale of the sub-contractors, while at the same time also shifting entrepreneurial risk and responsibility for compliance with labor standards outside the firm's boundary. Our

analysis contributes to the debate on the determinants of contracting out by empirically examining a whole set of potential drivers of outsourcing that have been put forward by theoretical considerations (see Section 2.2 for a discussion).

In addition, we contribute to the discussion revolving around contracting out as a driver of wage inequality (Dorn et al., 2018). Recent literature argues that a large part of rising wage inequality can be attributed to increasing wage dispersion across firms due to assortative matching of workers to firms, segregation (Song et al., 2018) or occupational concentration (Handwerker and Spletzer, 2016). As contracting out tends to increase the homogeneity within a firm's remaining workforce, it is a main candidate for causing these inter-firm and inter-industry sorting processes. Lower wages of outsourced workers in low-wage occupations (Goldschmidt and Schmieder, 2017; Dube and Kaplan, 2010) on the one hand, and the finding that outsourcing increases productivity (Amiti and Wei, 2009) thereby enabling firms to potentially increase rent sharing with remaining workers on the other hand, support this view. Moreover, the debate on wage inequality is closely linked to a debate on job polarization in general with lousy jobs being on the rise.

We find that outsourcing of business processes is widespread among German firms, with large heterogeneity across different types of business processes. Larger firms with works councils are more likely to contract out, while a collective wage agreement decreases this probability. Yet, firm characteristics as well as characteristics of the contract markets are able to explain outsourcing probabilities only to a limited extent. On average, an increase of contract workers' wages relative to internal wages by one percent would reduce the outsourcing probability by 0.096 percentage points. Nonetheless, harmonizing wages for contract workers in cleaning and logistics with the wages paid to internal workers would reduce outsourcing probabilities by 27 and 35 percent respectively. Also, a higher level of firm concentration on the contract market, raises outsourcing probabilities. We find that the relevant domestic contract market is rather regional than nationwide, especially for low wage processes.

The remainder of the paper is structured as follows. We first give a brief overview of the literature on domestic outsourcing and discuss potential determinants of contracting out. In Section 2.3 we present the survey data and discuss how we define the contract market and the internal market for each process in order to proxy for the conditions

on both markets. In Section 2.4 we present descriptive evidence on the incidence and intensity of outsourcing at the firm level, show outsourcing rates by business function, and discuss process-specific differences between the internal and the contract market. Section 2.5 looks at both the firm-level as well as market-specific determinants of the outsourcing decisions and also investigates heterogeneity across different types of processes. A back-of-the-envelope calculation shows the impact of harmonizing conditions on both markets on outsourcing probabilities. In Section 2.6 we present results robust to domestic outsourcing and nationwide contract markets before Section 2.7 concludes.

2.2 Domestic Outsourcing and its Determinants

Domestic outsourcing or contracting out is the buy result of a firm's "make-or-buy" decision. Although outsourcing has increased over the last decades, we lack granular empirical analyses on the reasons why *"outsourcing varies across specific industries, occupations or business functions"* (Bernhard et al., 2016, p. 11).

To derive some hypotheses to guide our variable selection in the empirical analysis, we consider theoretical arguments brought forward by different theories. Starting by neoclassical theory we will discuss arguments from resource based theory and transaction cost theory.[3]

According to the rationale of neoclassical economic theory, firms are rational utility or profit maximizers in perfect markets with complete information on prices. Following that reasoning, the price of a good or service contains the relevant information to be taken as the determinant of a make-or-buy decision. Outsourcing will be implemented if the costs for the external provision of the good are lower than in the case of internal production. Such cost differentials may stem from differences in wage levels between a worker in the outsourcing firm and a worker in contracting firms. Other, more indirect cost differences can derive from differences in workforce characteristics, dismissal protection, and social security benefits. The larger the direct and indirect cost differential, the more likely a firm will outsource to an external contractor. As different workers are specialized on conducting

[3]For an extensive current review of the literature on domestic outsourcing and description of available data for the US we refer to Bernhard et al. (2016).

a certain process, this line of argument is able to explain variation in outsourcing of individual business functions within firms.

According to resource based theory (RBT), however, outsourcing decisions will also depend on firm-specific factors as firms differ in endowments of resources and capabilities. In particular, they differ in their productivity, which is the basis for comparative advantage. The larger the firm, the more it can gain from economies of scale in in-house production (Poppo and Zenger, 1998). On the other hand, larger firms have a different bargaining power than small firms. This can be inferred from rising power on the buyer side (Weil, 2014) and the findings that suppliers with concentrated buyers have lower returns on sales and assets (Gosman and Kohlbeck, 2009; Kim, 2017). Hence, the expected effect of firm size in explaining outsourcing probability is ambiguous a priory.

In addition, overhead labor costs may play a role in highly regulated labor markets with strict employment protection legislation. Some labor market institutions are affecting the cost structure of firms, such as works councils or whether a firm is subject to collective agreement (mandatory and imitating). Works councils increase the non-wage costs of workers, such as investments in training (Kriechel et al., 2014). We therefore expect firms with a works council to have higher internal non-wage costs and therefore to be more likely to outsource. On the other hand, firms subject to collective agreements are found to have lower recruitment costs due to the absence of wage negotiations (Muehlemann and Pfeifer, 2016). Conditional on the wage differential between the contract ad the internal market, firms subject to collective agreements might therefore be less likely to outsource.

As another deviation from the neoclassical model with perfect markets, transaction cost economics (TCE) assumes that any transaction between agents induces costs deriving from negotiating, executing, and enforcing contracts. In addition, possible information asymmetries create a hazard of opportunism. Hence, we expect that the more competition among contractors exists, the more likely is outsourcing as uncertainty and dependence is decreasing (Nam et al., 1996; Ang and Straub, 2006). At the same time, the more specific the skill set (knowledge, experience) needed to produce the service, the less likely is outsourcing, as specificity is a source of imperfect mobility (Aubert et al., 2004). Hence, we expect processes with low skill requirements to show higher outsourcing probabilities than more complex, specialized tasks.

To sum up, outsourcing is a firm level decision (Bernhard et al., 2016) that depends on firm-specific resources for in-house provision, the specifics of any business function and its related transaction costs when contracted out as well as on the wage on the process-specific contract market compared to the wages paid in case of in-house provision. These factors likely affect both a firm's general propensity to contract out as well as the within-firm variation of contracting out across different business processes. Evidence on within-firm variation of outsourcing decisions for different business functions, however, is scant. The subsequent analysis of outsourcing decisions at the sub-firm level thus allows for examining the role of process-specific market conditions in more depth.

2.3 Data

We make use of unique survey data with information on firm level outsourcing decisions for a variety of business processes. In order to analyze the potential drivers of outsourcing a particular process, we use administrative data combined with input-output statistics to define process-specific contract markets for each outsourcing industry. This allows us to complement the survey data with wage and workforce characteristics of the process-specific contract markets.

2.3.1 COOP-Database

At the core of our paper is COOP (Contracting Out Operational Processes), a unique and representative CATI-survey that was conducted among 8,457 German firms in 2016 with the aim to get comprehensive insights into outsourcing behavior. Hence, interviewees were either managers, or heads of personnel or purchasing departments. The sample of firms with at least one dependent employee was drawn from the Mannheim Enterprise Panel (MUP). The MUP basically contains the universe of German firms[4]. We stratified the MUP by twelve industries (excluding agriculture and public sector) and four firm size categories and drew a random gross sample. The sample of realized interviews is representative for the underlying stratified gross sample with respect to the stratification

[4]The MUP serves as sampling base for several other firm surveys. See (Bersch et al., 2014) for a description of the MUP and its uses.

variables (see Table 2.C.1 in the Appendix) and sampling weights are provided.

COOP contains firm characteristics as well as information on the prevalence of contracting out. In particular, the questionnaire covers whether a firm uses any of 15 predefined business processes and asks whether each of them is outsourced completely, partially or not at all. Hence, conditional on the process existing in the firm, we observe a total of 90,335 outsourcing decisions for each business process separately in 7,688 firms. This allows for analyzing outsourcing decisions on a process-firm-level rather than the firm level only. We are thus able to address the heterogeneity across processes and to actually exploit the variation across processes within firms to contribute to an in-depth understanding of the outsourcing decision. The processes that are included in the survey cover a broad spectrum from low-skilled processes such production, technical services, logistics, canteen (food) and cleaning to high-skilled processes such as research and development (R&D), management, accounting and controlling, and marketing.

2.3.2 Defining Process-Specific Internal and Contract Markets

As discussed in Section 2.2, a firm needs to decide whether to produce a service or good itself, i.e. internally, or whether to buy the service or good from another firm. Ideally, for each process, we would like to compare the costs and quality of an internal provision with the costs and quality of the provision in case of contracting out. Yet, this information is not available in the survey and needs to be added from other data sources. More specifically, we construct a respective internal market as well as contract market for each process.

For this purpose, we first identify occupations which are specialized to conduct the tasks within each process. Similar approaches have been used to identify outsourcing trends (Abraham, 1990) and events (Goldschmidt and Schmieder, 2017; Dube and Kaplan, 2010). Table 2.C.2 in the Appendix lists the business process and related occupational titles from the classification of occupations 2010 (KldB 2010).[5] Of the 15 processes

[5]The link between processes and occupations was made by five distinct researchers, based on the questions: "Is this occupation likely to conduct one of the processes? Which one?" The list of occupations alongside the process which was most likely to be sampled for each occupation (mode) was then cross-validated by two other researchers.

indicated in the Section 2.3.1 we are able to identify related occupations for 12 processes.[6] While there are only few occupational titles for some processes such as cleaning, other processes such as production are associated with a longer list of specialized occupations.

In order to approximate the internal provision of a process p within a firm i, we calculate the average characteristics of the specialized workers in the firm's industry j and location r using the Sample of Integrated Labor Market Biographies (SIAB), see Appendix 2.A for details. The internal cleaning market, for instance, then reflects the characteristics of the average cleaner in the same industry and region as the firm i whose outsourcing decision we observe. Hence, X_{pjr} is a vector of averages for different characteristics of the process-specific workers in firm i's industry j and location r.

In order to approximate the alternative provision of the process on the contract market, our starting point are the workers specialized in the provision of a certain process. Not all specialized workers outside firm i's industry j, however, are equally likely to provide the good or service to the firm. First of all, it is very unlikely that firms contract out a process to an industry that is not specialized in that process. Whenever firms outsource cleaning services, for instance, it is likely that the contractor comes from the cleaning sector. Moreover, the contractor that an outsourcing firm i chooses will also depend on inter-industry linkages that are specific to firm i's industry j. Our definition of the contract market takes account of both aspects. In particular, the characteristics of the process-specific workers in industry k providing a good or service to industry j in region r, C_{pjr}, is a weighted average of the process-specific workers from industry k and region r, $\bar{X}_{pkr}$:

$$C_{pjr} = \sum_{k=1}^{K} \frac{\gamma_{pk}\pi_{jk}}{\sum_{k=1}^{K} \gamma_{pk}\pi_{jk}} \bar{X}_{pkr} = \sum_{k=1}^{K} \omega_{pjk} \bar{X}_{pkr}$$

The weight ω_{pjk} reflects both the degree of specialization of industry k in providing process p and the strength of the linkage between industry j and k. The degree of specialization is reflected in γ_{pk}, the share of all process-specific workers that are employed in industry k. We calculate this indicator based on information regarding the number of

[6] Two processes are titled "other" core or support businesses and we do not attempt to identify related occupations as the content is quite heterogeneous and matching occupations is therefore not straightforward. For the process "reception / front desk" we are not able to identify related occupations.

workers in each occupation-industry cell in 2016 that was provided to us by the Statistical Service of the Federal Employment Agency. The strength of the inter-industry-link between industry j and k is reflected in π_{jk}. It measures the share of goods and services bought by industry j that stem from industry k as recorded by the input-output table of the Federal Statistical Office (destatis) as part of the national accounting in 2016.

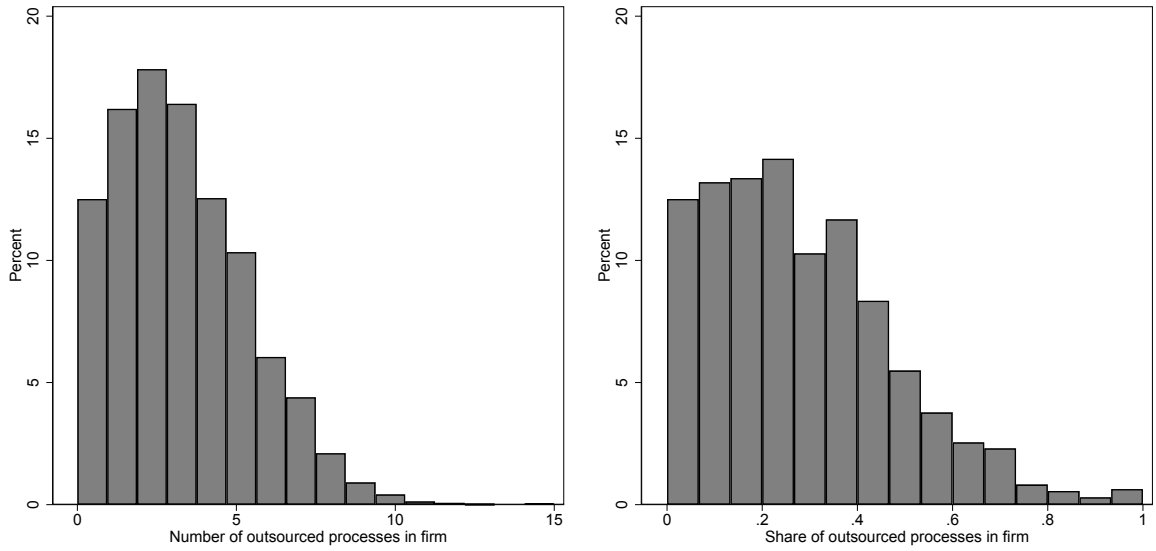
Hence, the weighting factor ω_{pjk} is larger, the more specialized industry k in providing process p and the stronger the link between industry k and j. If a firm outsources cleaning services, for example, this cleaning service is most likely to come from an industry with a high share of cleaners, but among several such industries the cleaning service is more likely to come from an industry that is a more important sub-contractor to this industry in general as reflected by π_{jk}.

For the internal provision, X_{pjr}, and the provision on the contract market, C_{pjr}, we use the SIAB data to measure worker characteristics such as age, gender, skill level, part time, nationality, job type, and also calculate the average wage for a fulltime process-specific worker in both markets.[7] We hence assume that these characteristics proxy for the costs and quality in case firm i had to provide the good or service internally or buy them on the contract market. In addition, we use the firm and revenue structure of the year 2016 in the Mannheim Enterprise Panel (MUP) to construct regional Herfindahl-Indices as proxy for firm concentration on the contract market. Note that process-specific internal and contract markets vary across 12 industries and 133 labor market regions[8]. We merge this information to the COOP based on the firm's regional and industry identifier. As a robustness check, we also construct the internal and contract markets characteristics on a national level, discarding the regional variation (see Section 2.6).

[7]Note that we exclude region-industry cells if there are less than five process-specific workers in the data.

[8]We use the 141 Labor Market Regions (LMR) identified by Kosfeld and Werner (2012). The SIAB contains county identifiers which are aggregated in some cases due to data protection issues. In 8 of those aggregations, the respective LMR is not uniquely identified. We therefore merge LMR until unique identification is possible. This results in 133 labor market regions.

Figure 2.1: Distribution of Number and Share (τ) of Outsourced Processes in Firm



Notes: The graph on the left hand side displays the share of firms outsourcing a certain absolute number of their processes. The graph on the right hand side displays the distribution of the firms' share of outsourced processes among process existing in the firm, τ. 90,335 processes in 7,688 firms.

2.4 Outsourcing in Germany

We find that 92% of all German firms used contracting out for at least one business process in 2016. Hence outsourcing is a very pervasive part of modern firm organization in Germany. However, there is a pronounced heterogeneity across firms in the share of business processes that are contracted out, see Figure 2.1. Approximately 15% of all firms buy more than 50% of their business processes at least partially from other firms. The median firm outsources 33% of its business processes. This is equivalent to outsourcing two business processes, reflecting that not all business processes exist in all firms.[9]

The overall pattern is quite robust irrespective of whether the firm is a service provider or manufacturer (see Figure 2.B.2 in the Appendix), but differs markedly by firm size (see Figure 2.B.3 in the Appendix). In particular, not only the number of business processes that are relevant for a firm increases in firm size, reflecting an increasing complexity in larger scaled organizations. In addition, the share of processes that firms outsource also

[9]Depending on the process, 4 to 48 percent of all firms report the different business functions as non existing (see Figure 2.B.1 in the Appendix).

increases in firm size. For firms with more than 250 employees, it is very unlikely to use outsourcing for less than 20 percent of the business process compared to firms with less than 20 employees.

Table 2.1 provides further characteristics of firms with above and below median outsourcing intensities and for non outsourcing firms. On average, a firm utilizes almost 12 of the 15 business processes of which three are outsourced at least partially. The mean outsourcing rate across all types of processes is 26 percent.[10] As already discussed, the larger firms tend to concentrate in the group that use outsourcing more intensely than the median firm, while firms using no outsourcing at all tend to be dominated by very small firms. Moreover, firms with a higher outsourcing intensity at the extensive margin, as measured by τ, also have a higher outsourcing intensity at the intensive margin, i.e. a higher share of the processes are contracted out fully rather than partially.

Furthermore, firms with different outsourcing intensities also differ significantly in other aspects. The high-intensity outsourcers are more likely to have a works council and rely more frequently on other forms of flexible staffing such as fixed term contracts, temporary agency work and freelancers. Also, high-intensity firms are no more likely to apply collective wage agreements than firms with no outsourcing and actually have a lower incidence of such agreements than low intensity outsources. Finally, high-intensity outsourcers have a higher share of high-skilled and female workers than firms with lower outsourcing intensities suggesting that the three groups also differ by sector.

Also note that there are some regional differences across firms of different outsourcing intensity. Firms with high outsourcing intensities are more likely to be located in urban, high-income regions that have a higher unemployment rate while firms with below median outsourcing intensity are more rural, less wealthy, but also have a lower unemployment rate. Such characteristics might to some extent be related to the regional contract market. In order to avoid corresponding biases, the subsequent multivariate analysis controls for these regional characteristics. The pronounced variation in outsourcing rates at the level of labor market regions as shown in Figure 2.B.4 in the Appendix, however, does not show any clear urban-rural pattern or the like. This points to the role of other regional drivers

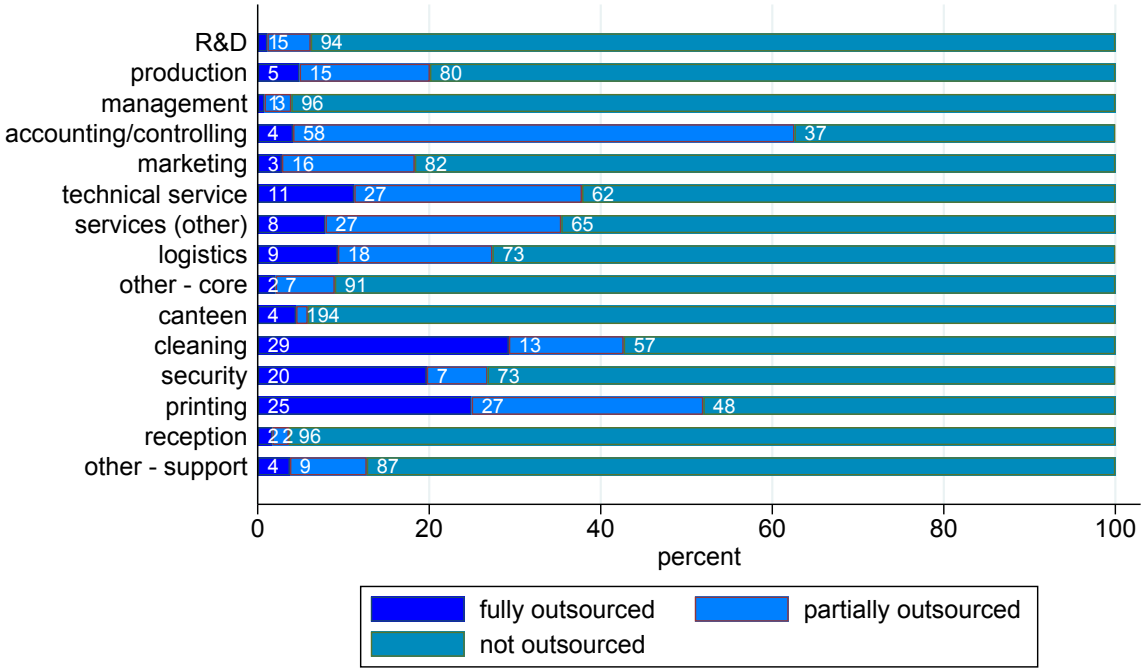
[10]These figures are in line with the European Company Survey (ECS) 2013 which reports that 22% of all firms outsource the production of goods and services in Germany (Kircher, 2015).

Table 2.1: Firm Characteristics: Mean Descriptive Statistics for all Firms by Outsourcing Intensity

	All	by outsourcing intensity τ		
		τ>p(50)	τ<p(50)	τ=0
Firm characteristics				
# of processes at firm	11.780	11.203***	13.138***	8.825***
# of processes outsourced	3.024	4.934***	2.076***	0***
Share of outsourced processes τ	0.264	0.454***	0.160***	0***
thereof fully outsourced	0.329	0.363***	0.298***	
Firmsize				
<20 employees	0.624	0.547***	0.671***	0.715***
20 to 49 employees	0.213	0.250***	0.189***	0.176**
50 to 249 employees	0.138	0.169***	0.119***	0.100***
>250 employees	0.026	0.035***	0.022*	0.009***
Firm has works council	0.094	0.131***	0.073***	0.043***
Firm is subject to collective agreement	0.337	0.321**	0.353***	0.330
Firm uses fixed term contracts	0.332	0.400***	0.291***	0.251***
Firm uses temporary agency work	0.088	0.104***	0.084	0.048***
Firms has freelancers working for it	0.211	0.234***	0.184***	0.233*
Share of low skilled workers	0.198	0.186***	0.208***	0.202
Share of skilled workers	0.633	0.616***	0.643**	0.655**
Share of high skilled workers	0.182	0.205***	0.165***	0.163**
Share of female workers	0.442	0.456***	0.429***	0.443
Manufacturing sector	0.281	0.258***	0.308***	0.263
Regional characteristics				
Urban	0.686	0.711***	0.663***	0.682
GDP per capita (in 1,000 Euro)	37.922	39.095***	36.902***	37.648
Unemployment rate	6.558	6.730***	6.419***	6.480
Open positions per unemployed person	23.859	23.609	24.185**	23.524
Sample size (Firms)	7,688	3,250	3,476	962

Notes: Median outsourcing intensity is .333. Significant differences from the full sample statistics are indicated by * Pr(|T|>|t|<0.10, ** Pr(|T|>|t|<0.05, *** Pr(|T|>|t|<0.01.

Figure 2.2: Outsourcing Rate for Different Processes



Notes: Relative Frequency of answers to the question "Do you outsource process X to another firm? Fully, partially or not at all?" conditional on having the process in the firm. 90,335 processes in 7,688 firms.

such as the conditions on the regional contract market which we will discuss below.

When we take a closer look at what firms tend to outsource, we find strong differences across processes. While management is fully outsourced only in one percent and partially in three percent of the cases, accounting and controlling is outsourced by 62 percent of firms at least partially[11]. 20 percent of firms indicate to outsource production tasks to a contractor.

In order to get insights into how the corresponding internal and contract markets differ, Table 2.2 shows respective market differentials for average wage and worker characteristics that should be major determinants of the outsourcing decision of the firm.[12] Note that these descriptive statistics are unconditional, i.e. they compare all regional contract markets and internal markets regardless of whether firms actually decide to outsource a

[11] Abraham and Taylor (1996) also describe the outsourcing of accounting. In the late 1980's, 16.5 percent of US establishments indicated to contract out accounting services, 18 percent thereof outsourced it fully.

[12] The average wage and workforce characteristics of the internal market and the contract market are displayed in Table 2.C.3 and Table 2.C.4 in the Appendix.

business function.

For all processes, mean daily gross wages of full time workers are on average lower in the contract market than in the case of an in-house provision. The absolute difference is lowest for production and technical services and largest for marketing, cleaning and printing. For technical services, firms, on average, hence pay 96.5 percent on the contract market of what they would have to pay in-house. For production, the corresponding share of the in-house wage costs is 97.9 percent. At the other end of the range, marketing on the contract market pays only 84 percent of the wages on the internal market and for cleaning services, the contract market wage only amounts to 64.4 percent of the wage paid in the internal market. Also note that for management tasks, which range in the middle in terms of the absolute wage difference, firms still have to pay almost 94 percent of what they would have to pay internally. We hence find a markdown in all contract markets compared to the internal market whose scale varies substantially by business process.

When it comes to the workforce characteristics, we distinguish between high-wage and mostly high-skilled processes such as R&D, management, accounting/controlling and marketing and low wage and usually low-skilled processes such as cleaning, canteen services, printing, logistics and production (see Table 2.C.3 and 2.C.4 in the Appendix). While the share of high-skilled workers with a tertiary degree among the former business processes is above 30 percent, the respective share for the latter group of processes is way below 10 percent and even less than 2 percent in case of cleaning. When comparing the skill structure on the internal and the contract market, the differences for most business processes are rather small. However, there is a skill markup of around 2 percent, i.e. a higher share of high-skilled workers on the contract than the internal market, for most high-wage processes. The only exception is R&D whose workers are more often medium skilled. Among the low wage processes, only production and printing have a skill markup of 6 to 8 percent, while for most other processes, we observe small skill markdowns.

For the remaining workforce characteristics, there does not seem to be any clear patterns across business functions. In fact, the workforce on the contract markets is older for all processes. Moreover, the share of female workers is notably higher on the contract market for R&D, cleaning, canteen services and security and lower for printing and marketing. Also, we find a higher share of part time jobs and a lower share of foreign

Table 2.2: Descriptives Δ (Contract Market - Internal Market)

	R&D	Production	Management	Accounting / Controlling	Marketing	Technical Services	Services (other)	Logistics	Canteen	Cleaning	Security	Printing
Wage Structure, Δ in Euro												
Mean daily wage of process specific worker	-2.26	-0.19	-2.66	-3.12	-8.82	-0.36	-1.54	-4.44	2.93	1.23	2.81	-11.3
Mean daily wage of process specific full time worker	-12.89	-2.02	-11.13	-18.15	-25.01	-3.76	-7.15	-8.84	-11.95	-23.48	-7.27	-20.6
Full time contract market wages relative to internal market	0.926	0.979	0.94	0.891	0.84	0.965	0.955	0.922	0.837	0.644	0.944	0.792
Education Structure, Δ in percentage points												
Share of low educated workers	-0.74	-0.22	0	-0.19	-0.23	-0.17	-0.18	0.17	-0.03	-0.36	0.18	-0.38
Share of medium educated workers	1.71	-0.16	-1.65	-1.31	-1.95	0.51	-0.96	-0.1	-0.03	0.48	0.25	-0.04
Share of high educated workers	-0.98	0.37	1.66	1.5	2.18	-0.34	1.14	-0.07	0.06	-0.13	-0.43	0.42
Share of high educated workers contract market / internal market	0.977	1.062	1.052	1.046	1.066	0.959	1.033	0.993	1.021	0.938	0.966	1.08
Age Structure, Δ in percentage points												
Share of young workers	-0.67	-0.68	-0.71	-0.9	-0.27	-0.89	-0.44	-0.3	-1.21	-0.82	-0.53	-0.32
Share of middle aged workers	-0.66	-0.69	-0.33	0.07	0.09	-0.56	-0.33	-0.89	-1.17	-1.03	0.23	0.09
Share of old aged workers	1.33	1.37	1.05	0.83	0.18	1.46	0.77	1.19	2.37	1.86	0.29	0.23
Other characteristics, Δ in percentage points												
Share of female workers	4.88	0.54	0.9	-0.62	-2.51	0.41	-0.08	-0.38	5.42	5.33	6.03	-2.36
Share of part time workers	3.61	0.69	1.14	0.68	-0.54	1.49	0.64	0.52	3.83	3.81	4.27	-1.99
Share of foreign workers	-0.32	-1.41	-0.25	-0.25	-0.41	-0.65	-0.3	-1.07	-1.12	-1.24	0.29	-1.59
Share of minijobs	-0.73	-0.65	-0.48	-0.72	-0.21	-0.65	-0.19	0.69	-1.95	-2.32	-0.90	-2.62
Share of fixed term workers	0.64	0.05	0.73	0.92	1.22	1.12	0.62	0.55	0.46	0.29	1.17	0.06
Share of temporary agency workers	-0.20	-1.55	-0.08	-0.02	-0.14	-0.29	-0.12	-0.89	-0.48	-0.01	-0.09	-0.58
High / low wage process	high	low	high	high	high	low	high	low	low	low	high	low
High / low skilled process	high	low	high	high	high	low	high	low	low	low	low	low

Notes: Differences or ratios between mean characteristics of the generic contract markets and the generic internal markets in percentage points.

workers on the contract market than on the internal market for most business processes. Temporary agency work and marginal employment via minijobs are less common on the contract market, potentially reflecting lower need for adapting to workload fluctuations as compared to an internal provision of the process. The contract market, however, draws its flexibility from employing more workers on fixed term contracts in all processes. In the subsequent analysis, we will analyze to what extent these market conditions are related to the outsourcing decision.

2.5 The Drivers of Outsourcing Decisions

2.5.1 Estimation Approach

To enable a better understanding of the interdependencies between the various aspects discussed theoretically and descriptively, we will consider multivariate models in the following. In a first analysis, we will concentrate on firm-level determinants of the buying/outsourcing firms with particular weight on the 15 business processes (see Section 2.5.2). We start the analysis by specifying the following model:

$$Y_{pi} = \alpha + \mathbf{P_i}\delta \ [+\mathbf{X_i}\beta] \ [+\theta_j] \ [+\mu_i] \ + \varepsilon_{pi}, \tag{2.1}$$

where Y_i denotes the outsourcing decision (0,1) of firm i for process p. $\mathbf{P_i}$ is the matrix containing dummies for the 15 business processes in firm i (with management services as the omitted reference category). $\mathbf{X_i}$ contains observable firm characteristics (collective agreement (dummy); works council (dummy); temporary workers (dummy); fixed-term contracts (dummy); freelance workers (dummy); firm size (categorical); shares of different workers' groups). α (intercept), δ and β denote the corresponding coefficient (vectors).

While we start our estimation considering the effects of $\mathbf{P_i}$ only, we augment and vary the model in equation (2.1) by including the firm characteristics and sector fixed effects (θ_j) in alternative specifications. In addition, we will try to consider firm-specific factors that are unobserved and affect the firm's overall outsourcing probability by including firm fixed effects, μ_i, rather than firm characteristics $\mathbf{X_i}$. We estimate all specifications as linear probability models by OLS. Hence, coefficients can be interpreted as marginal

effects on the outsourcing probability.[13]

Besides analyzing the overall outsourcing probability, our main focus is on the relative importance of the different drivers of the process-specific outsourcing decisions. In a second analysis, we therefore specify the following empirical model:

$$Y_{pi} = \alpha + (\mathbf{C_{pjr}} - \mathbf{X_{pjr}})\lambda + \mathbf{X_i}\beta + \mathbf{X_r}\gamma + \delta_p + \varepsilon_{pi}, \tag{2.2}$$

where Y_{pi} is again the (binary) outsourcing decision $(0, 1)$ of firm i for process p. $\mathbf{X_i}$ are firm-specific covariates of the outsourcing firm. In addition to the first step, they also contain the economic sector (manufacturing dummy). $\mathbf{X_{pjr}}$ comprise characteristics of the process-specific internal market, whereas $\mathbf{C_{pjr}}$ refers to the contract market (log wages; worker shares (various groups); firm concentration on contract market; size of firms (avg. number of employees)) in region r and industry j. These are calculated as described in Section 2.3.2. δ_p captures the fixed effects of the 12 different processes considered for which we are able to construct contract market workforce characteristics. $\mathbf{X_r}$ are regional control variables of the outsourcing firms' labor market regions r. We control for GDP per capita, the unemployment rate as well as vacancies per unemployed and allow for differences in urban as well as West German regions. These variables take major interregional differences – that might otherwise confound our estimates – into account.[14]

We approximate the relevant internal and contract market conditions as described in Section 2.3.2. These should sufficiently map the average working conditions in both markets. However, they are limited in a number of respects: Our measures are likely to be imprecise and may be affected by measurement error, potentially inducing an attenuation bias. The identification in the equation comes from differences in the state of the process-specific contract and internal markets across regions, while taking account of general unobservable differences across processes that are common across regions r.

Note that the data structure allows for including both process-specific fixed effects as well as firm fixed effects. By exploiting only the within-firm variation in outsourcing decisions we can ensure that unobservable firm characteristics that drive outsourcing

[13] Estimation results obtained by application of non-linear models, e.g. probit or logit, are comparable and do not differ with regard to economic interpretation.

[14] Alternatively including dummies for each labor market region is infeasible due to the loss of degrees of freedom.

decisions and might be related to observable covariates cannot bias our estimations. The estimates contain causal reasoning, if we assume that the average working conditions in the internal and contract market conditional on regions and processes are exact proxies of firms' individual circumstances. Given the cross-sectional nature of our data, however, we are cautious and do no consider the subsequent analysis as causal.[15]

As in the first analysis, we estimate all specifications as linear probability models by OLS and interpret the coefficients as marginal effects on the process-specific outsourcing probability. To check the robustness of the coefficient patterns, we vary specifications by including and excluding certain parts on the right-hand side of equation (2.2) in the empirical analysis. Descriptive statistics of the variables in the regressions are presented in Table 2.C.5 in the Appendix.

2.5.2 Firm-level Determinants of Contracting Out

We begin with focusing on the process-specific outsourcing rates and the role of firm characteristics for the outsourcing decision. Hence, we do not include characteristics of the process-specific markets at that stage. Column (1) of Table 2.3 tells us that the outsourcing probability varies substantially across processes. In comparison to management tasks – serving as the reference process – all processes have a significantly higher outsourcing probability (the only exception are reception services). Accounting and controlling is the process with the highest outsourcing probability of 59 percent, followed by Printing and Cleaning with 48 and 39 percent respectively. The products behind those processes are usually highly standardized, enabling outsourcing firms to profit from the contractor's specialization which is reflected in the observed high outsourcing probabilities. On the contrary, Management, R&D, and Canteen services have rather low outsourcing probabilities. Those tasks are often specific in their content or location and outsourcing involves high transaction, information and communication costs due to the complexity of the product. The further columns of Table 2.3 report estimation results from extended model specifications. Across models presented, the findings on the point estimates of the processes are very robust, independently whether firm characteristics (Column 2), firm

[15]In addition there may be unobservable factors, e.g. managers' habits, networks etc., that induce outsourcing and are related to other characteristics as well.

fixed effects (Column 4), and/or additional sector fixed effects are considered (Column 3). Firm characteristics, therefore, do not determine differences in process-specific outsourcing rates.

Nevertheless, they affect the overall outsourcing probability of a firm. In particular, we find that having a works council increases the outsourcing probability by five percentage points. This is in line with the idea that works councils increase the non-wage costs of workers and, therefore, increase incentives for outsourcing. If the wage setting in a firm is subject to a collective agreement, the firm has lower recruitment costs. The empirical estimate is in line with the theoretical prediction and the outsourcing probability is 1 pp lower. Yet, this effect turns insignificant when including sector fixed effects (Column 3), which reflects the different industry coverage of agreements to a large extent. A rather clear and stable pattern is, however, that firms which use other forms of flexible work such as freelancers, temporary workers as well as fixed term contracts are more likely to contract out processes. Thus, outsourcing and other forms of alternative or nonstandard work arrangements are complements rather than substitutes. Firms with a higher outsourcing probability thus have a higher demand for other forms of flexible staffing.

Regarding the other firms characteristics, we find that small firms are less likely to outsource, but that there is no scale effect beyond that. Firms with more than 20 employees have outsourcing probabilities that are 3 pp higher compared to smaller firms and this magnitude is similar for larger firm sizes as well. This suggests that the mere size of a firm is not necessarily an advantage for providing the business process in-house, but that in fact larger scaled firms might have an advantage when contracting out due to being able to negotiate more favorable contracts. In line with this, the firm survey also indicates that contracting out comes with high legal and monitoring demands which larger firms may be able to provide at lower costs.[16] A higher share of unskilled workers comes with a lower outsourcing intensity, while the opposite holds for high-skilled workers. Also firms with a higher share of female employees are slightly more likely to outsource some processes. However, these workforce characteristics are considered for purpose of precise estimation of the process-specific effects. They should not be interpreted for strong

[16] 27 percent of the small firms reports that negotiating, concluding, managing and monitoring of contracting out results in a lot of effort and costs. Of the large firms with more than 250 employees only 18 percent agree to this statement.

Table 2.3: Firm Level Determinants of Outsourcing Decisions

Dep Var: Process outsourced yes/no (1/0)	(1)	(2)	(3)	(4)
Processes				
R&D	0.023***	0.020***	0.019***	0.035***
production	0.163***	0.162***	0.162***	0.176***
accounting/controlling	0.588***	0.587***	0.587***	0.588***
marketing	0.145***	0.144***	0.144***	0.144***
technical service	0.341***	0.342***	0.342***	0.342***
services (other)	0.316***	0.316***	0.315***	0.322***
logistics	0.235***	0.235***	0.235***	0.239***
other - core	0.052***	0.051***	0.051***	0.066***
canteen	0.019***	0.017***	0.017***	0.054***
cleaning	0.388***	0.387***	0.387***	0.386***
security	0.229***	0.227***	0.227***	0.246***
printing	0.482***	0.480***	0.480***	0.480***
reception	-0.002	-0.004	-0.004	0.014***
other - support	0.089***	0.088***	0.088***	0.112***
Firm characteristics				
firm is subject to collective agreement		-0.011**	-0.004	
firm has works council		0.051***	0.050***	
firm uses temporary work		0.021***	0.020***	
firm uses fixed term contracts		0.039***	0.038***	
firm has freelancers working for it		0.018***	0.019***	
Firm size:				
20 to 49 employees		0.033***	0.032***	
50 to 249 employees		0.024***	0.025***	
>250 employees		0.029*	0.027*	
Share of unskilled employees		-0.019***	-0.022***	
Share of highly skilled employees		0.052***	0.054***	
Share of female employees		0.023***	0.013*	
Constant	0.039***	-0.008*	0.005	0.031***
	(0.002)	(0.005)	(0.006)	(0.003)
Sector FE	No	No	Yes	No
Firm FE	No	No	No	Yes
R-Squared	0.1755	0.186	0.1885	0.1979
Adjusted R-Squared	0.1754	0.1858	0.1881	0.1977
N processes	89055	89055	89055	89055
N firms	7363	7363	7363	7363

Notes: Linear Probability Model. Omitted categories are Process: Management; Firm size: <20 employees; Share of skilled employees. Standard Errors are clustered at the firm level. * p<0.10, ** p<0.05, *** p<0.01.

implications.

In column (4), we include firm fixed effects rather than firm characteristics in order to examine whether unobservable characteristics at the firm level are potentially confounding the process-specific outsourcing probabilities. However, the coefficients for the different types of processes as well as the proportion of total variation in the outcome explained by the model are quite similar compared to the previous specifications, with the only notable exceptions being canteen and reception services. We conclude that the firm and sector covariates used in (2) and (3) sufficiently control for firm heterogeneity in outsourcing propensities. For the subsequent analysis of market-specific determinants of contracting out, we therefore use firm characteristics rather than firm fixed effects in order to use a more parsimonious model specification.

2.5.3 Market-Specific Determinants of Contracting Out

We now turn to estimating the full model as shown in equation (2.2) and include the characteristics of the process-specific internal market relative to the corresponding characteristics of the contract market.[17] We again add firm and regional characteristics as well as process dummies. The corresponding results in Table 2.4 exploit the fact that firms depending on their location and industry face different process-specific market conditions such as wage levels and workforce structure.

Column 1 only includes wages paid to process-specific workers on the contract relative to the internal market and abstracts from other market differences. A one percent increase of wages paid to contract market workers relative to internal workers reduces the outsourcing probability by 0.03 percentage points. Also note that by including the wage differential between contract and internal market the point estimates of the other firm characteristics changes as compared to the previous specifications, thereby indicating that the wage differential is related to features such as collective agreements and works councils that are also relevant for other important non-wage staffing costs. The point estimate of the wage differential is only slightly reduced to 0.022 pp if process fixed effects are

[17] Workforce characteristics of internal and contract markets can only be calculated for 12 out of 15 processes and sample size is therefore reduced. The results in Table 2.3 are robust to the exclusion of these processes.

included. Hence, our measure of the wage differential is able to capture process specific differences.

As the aggregate wage differential might be subject to differences in the compositions of the workers in the internal market and the contract market, we include further characteristics of the workforce in specification (3). Outsourcing is more likely when the contract market has a higher educated and younger workforce as compared to the internal market. Hence, firms' probability to outsource any given process increases by 0.3 or 0.4 percentage points if the share of highly educated or young workers increases by one percent in the respective contract market relative to the internal market. This is in line with the argument that outsourcing is a means of having experts and specialized workers to conduct a certain task. Yet, if we consider the educational level as a proxy for the specificity of a good, this result is not supporting the rationale of transaction cost economics which would predict that specificity reduces the probability of outsourcing. Interestingly, a higher share of female and old age workers in the contract market reduce the outsourcing probability. It can also derive from relatively low shares of female and old age workers in the internal market. Thinking about the demographic change, this can then be considered a strategy to retain the own young workforce and not outsource their tasks to an older contract market.

Including additional workforce characteristics markedly increases the point estimates of the log wage differential. Hence, the compositional structure of the workforce not only plays a direct role, but it additionally amplifies the effect that wages have on the outsourcing decision. This result reinforces in magnitude and significance if we include process fixed effects again in Specification 4.[18] In addition, the firm concentration on the contract market positively affects the outsourcing decision. Increasing firm concentration by one standard deviation raises the outsourcing probability by one percentage point. Hence, the more competition among contractors, the lower is the outsourcing probability. TCE would predict that higher concentration leads to less outsourcing because in concentrated markets dependence on the contractors is higher. Yet, empirically firms prefer outsourcing to more concentrated contract markets. This might be due to higher reputation or reliability

[18]The results are also robust to using all workers wages (not only full time workers) and when estimating a probit model, see Table 2.C.6 in the Appendix.

Table 2.4: Drivers of Outsourcing Decisions - Looking Behind the Processes

Dep Var: Process outsourced yes/no (1/0)	(1)	(2)	(3)	(4)
Market Characteristics $\mathbf{C_{pjr} - X_{pjr}}$				
Log wages	-0.030***	-0.022**	-0.048	-0.096***
	(0.009)	(0.009)	(0.039)	(0.037)
Share of low educated workers			-0.001*	-0.001
			(0.001)	(0.001)
Share of high educated workers			0.003***	0.002***
			(0.000)	(0.000)
Share of female workers			-0.002***	-0.001***
			(0.000)	(0.000)
Share of part time workers			-0.003***	0.002***
			(0.000)	(0.000)
Share of foreign workers			-0.001*	-0.000
			(0.001)	(0.001)
Share of young workers			0.004***	0.002***
			(0.001)	(0.001)
Share of old age workers			-0.001	-0.000
			(0.000)	(0.000)
Share of minijobs			0.003***	0.000
			(0.000)	(0.000)
Share of workers on fixed term contract			0.002***	-0.001*
			(0.001)	(0.001)
Share of temporary agency workers			0.005***	0.003***
			(0.001)	(0.001)
Firm concentration on the Contract Market			0.054***	0.076***
			(0.020)	(0.020)
log(average number of employees) Contract Market			0.012***	0.008*
			(0.004)	(0.004)
Firm characteristics				
log(number of employees) outsourcing firm	0.012***	0.012***	0.013***	0.012***
	(0.003)	(0.002)	(0.003)	(0.002)
firm is subject to collective agreement	-0.018***	-0.021***	-0.020***	-0.020***
	(0.006)	(0.005)	(0.006)	(0.005)
firms has works council	0.031***	0.036***	0.030***	0.032***
	(0.010)	(0.010)	(0.010)	(0.010)
firm uses temporary work	0.007	0.011	0.008	0.012
	(0.010)	(0.009)	(0.010)	(0.009)
firm uses fixed term contracts	0.026***	0.026***	0.023***	0.023***
	(0.006)	(0.006)	(0.006)	(0.006)
firm has freelancers working for it	0.020***	0.017***	0.024***	0.019***
	(0.006)	(0.006)	(0.006)	(0.006)
manufacturing	-0.002	-0.005	-0.027***	-0.023***
	(0.006)	(0.006)	(0.007)	(0.007)
Regional characteristics				
west	-0.028***	-0.029***	-0.027***	-0.027***
	(0.008)	(0.008)	(0.008)	(0.008)
urban region	0.021***	0.018***	0.022***	0.019***
	(0.006)	(0.006)	(0.006)	(0.006)
GDP per capita	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
unemployment rate	0.001	0.000	0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.002)
open positions per unemployed	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.225***	-0.017	0.186***	-0.065***
	(0.019)	(0.018)	(0.022)	(0.022)
Process dummies	No	Yes	No	Yes
R-Square	0.0072	0.1610	0.0186	0.1630
N processes	51595	51595	51595	51595
N firms	7177	7177	7177	7177

Notes: Linear Probability Model; Standard Errors are clustered at the firm level; * p<0.10, ** p<0.05, *** p<0.01, Omitted variable Process Management.

of big players and it might also reduce the costs when searching for contractor. This is also supported by the positive relation of average firm size in the contract market and outsourcing probability, suggesting that contractors are larger companies.

The literature suggests that outsourcing relies on a local market sufficiently large such that it allows firms to cooperate. Indeed, we find that firms in urban regions are more likely to outsource than in rural regions. Economically thriving regions as measured by GDP per capita increase the outsourcing probability of firms. However, West German firms are 2.7 percentage points less likely to outsource than their East German counterparts. This could reflect structural differences in firm organization, such that more East German firms were founded after reunification in the 1990s. This coincides with the beginning rise of outsourcing and may have affected the choice of the firms' boundaries right from the foundation.

For specifications without process dummies the constant is high and the explanatory power of the model is low as compared to the specifications including the set of dummies. Hence, while the included characteristics of the contract market do marginally explain outsourcing probabilities, they are not fully able to capture the extent of process specific outsourcing. Given the vast literature on potential determinants of outsourcing this is not unexpected. In future versions of this paper we will try to add information on the economic situation of the outsourcing firm such as revenues and (import) competition. By using linked-employer employee data we can also approximate the specialization grade of the contract market and the underlying task structure of processes.

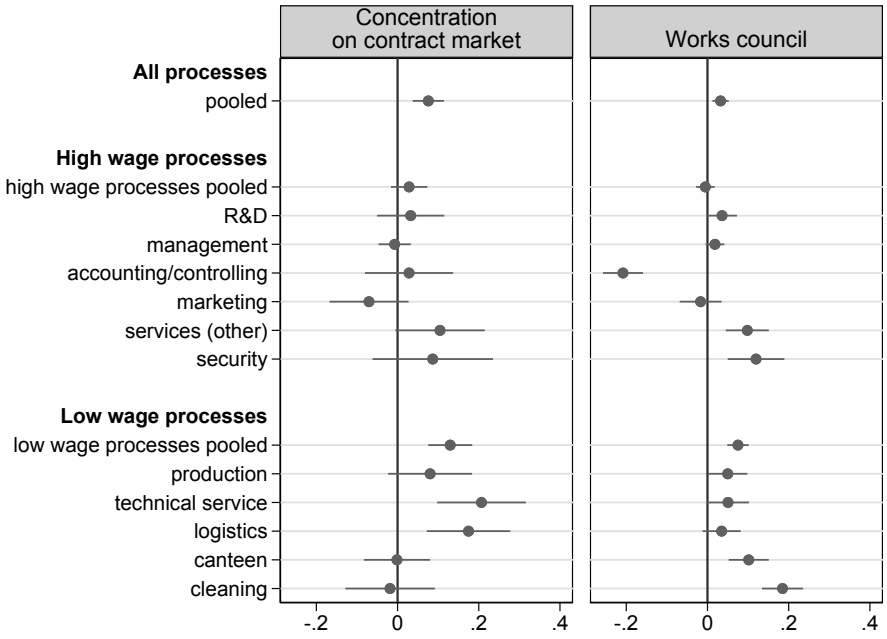
Summarizing the results so far, we find that the wage differential between the internal market and the contract market increases the outsourcing probability, indicating a cost saving strategy of outsourcing firms. Furthermore, processes are more likely to be outsourced the higher educated and the younger the workforce on the contract market is. The older and the more female the workforce is on the contract market relative to the internal market, the less likely a process is outsourced. Firms in urban and thriving regions are more likely to outsource, yet prefer contract markets with larger firms and less competition among the contractors. However, the characteristics of the contract market are not able explain substantial variation in outsourcing probabilities suggesting that further important factors are not yet captured by our analysis.

2.5.4 Heterogeneity in Outsourcing High and Low Wage Processes

Given that we find a negative relation of the log wage differential between contract and internal market on average, we are interested in whether this holds for individual processes, too. As to better understand the heterogeneity of the outsourcing decisions we separately estimate specification 4 of Table 2.4 for the various processes or pooled sub-groups thereof. We group the processes by the median average log wages into high and low wage processes. In addition, we also estimate the processes individually, which however yields less precisely estimated coefficients as sample size decreases considerably.

Figure 2.3 shows the resulting coefficients of firm concentration on the contract market and whether a firm has a works council. The subgroups used to run the regression are indicated on the left hand side. For comparison we also display the coefficient for the pooled overall estimation in the first row. The overall results indicate that both a

Figure 2.3: Coefficients of the Firm Concentration on the Contract Market and Works Council for Different Subsets of Processes



Notes: Estimated coefficients of running specification 4 in Table 2.4 for all processes (overall) or separately for high and low wage processes and for each process individually. Points represent point estimates, bars represent 95% confidence intervals.

higher firm concentration and the existence of a works council increase the outsourcing probability. Outsourcing to concentrated contract markets is especially pronounced for low wage processes such as logistics and technical services. Firms with works council are more likely to outsource some low wage as well as high wage processes. Noticeable different is the point estimate for the process accounting / controlling, which is outsourced less often if the firm has a works council.

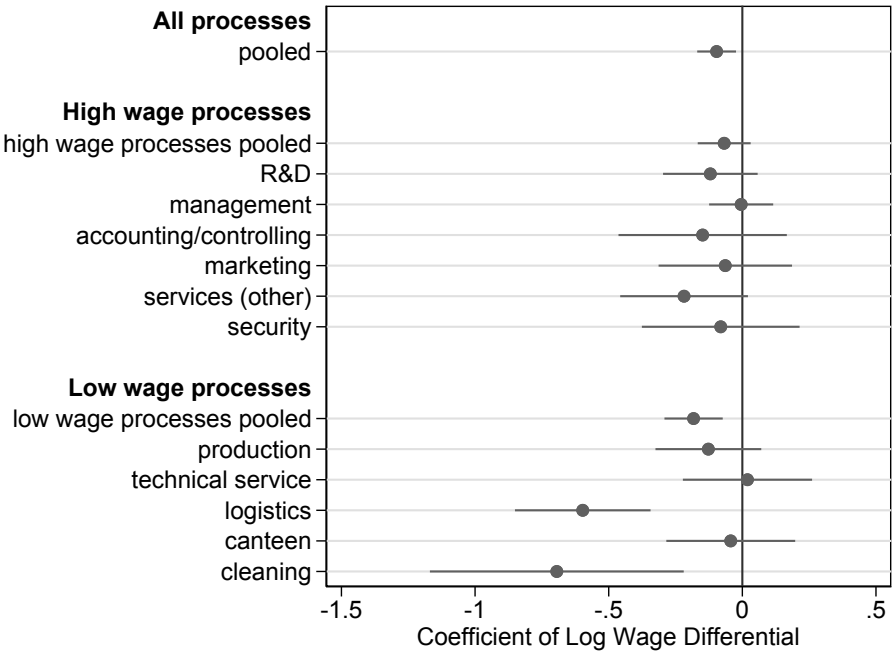
Figure 2.4 shows the resulting coefficients for the log wage differential between contract and internal market.[19] The overall results which indicate outsourcing to be a cost saving strategy are especially pronounced for low wage processes. Scrutinizing the individual processes, cost saving seems to be a statistically significant factor for outsourcing processes such as logistics, cleaning and other services. This is reflecting the results by Goldschmidt and Schmieder (2017) who find that outsourced workers in cleaning, logistics and food services face wage losses. For high wage processes the picture is different. None of the point estimates for high wage processes is significantly different from zero. This is in contrast to the idea of outsourcing as means to reduce costs and rather suggests an upgrading strategy. Firms outsource high wage and mostly high-skilled processes if the contract market ensures a certain expertise and quality regardless of potential wages differences.

We find that larger wage differentials between the contract market and the internal market are significant factors for firms' outsourcing probabilities. The principle of equal-pay is an aim of labor unions and frequently raised when it comes to flexible staffing arrangements.[20] So what would happen to the outsourcing intensity if wages on the contract market were raised or even equalized? We use specification (4) from Table 2.4 in order to predict outsourcing probabilities on various counterfactual wage levels on the contract market. We focus on processes with significant ($p<0.10$) point estimates only. We assume that wages of the outsourcing industry are not reduced (no decrease in nominal wages) and only wages of the contract market would be increased. We hold other covariates constant, hence we do not consider any compositional changes of the workforce which most likely would be induced by a substantial wage increase. We use our prediction

[19] The coefficients of further variables are displayed in Figure 2.B.5 in the Appendix.

[20] Due to the unions' support, equal-pay is one feature in the German regulations of Temporary Agency Work. Yet, outsourcing to non-temp agency firms is not subject to those regulations and wage-setting is unregulated.

Figure 2.4: Coefficients of the Log Wage Differential for Different Subsets of Processes



Notes: Estimated coefficients of running specification 4 in Table 2.4 for all processes (overall) or separately for high and low wage processes and for each process individually. Points represent point estimates, bars represent 95% confidence intervals.

to estimate the changes in the outsourcing rate if average wages on the regional contract market are increased by 3 percent and 5 percent – a typical range of results in collective wage bargaining – or are set such that there is no wage differential remaining.

Table 2.5 lists the average wage on the contract market relative to the internal market in Column 1 and the predicted outsourcing rate $\hat{Y}$ for the processes in Column 2. The remaining columns present the predicted changes in outsourcing rates in percent for the three counterfactual situations. Increasing the contract market wages by 3 percent would reduce the overall outsourcing rate by 0.5 percent. There is however substantial heterogeneity with respect to the wage level of processes. While high wage processes would be more likely to be outsourced when the wage gap is closed, outsourcing of low wage processes would be reduced by an even larger extent. Hence, increasing wages of contract workers would have an opposing effect for outsourcing low and high wage processes. When looking at the changes in reduction of individual processes' outsourcing rates heterogeneity is large. The largest reductions of outsourcing would be experienced for logistics, which has already a relatively low wage-markdown of 92 percent. An increase of the contract market wages by three percent would reduce outsourcing by more than six percent and equalized wages would imply a reduction by 35 percent. Outsourcing of cleaning would be reduced by 27 percent in the case of wage equalization even though the cleaning contract market is currently paid at only 64 percent of the internal wage level.

Table 2.5: Predicted Change in Outsourcing Probability if Wages on the Contract Market are Set at Different Thresholds

	Average Wage contract market / Wage internal	$\hat{Y}$	Predicted change in outsourcing rate (in percent) if wages on the contract market are increased by		
			3%	5%	equalized
Overall	88.63	29.12	-0.51	-0.85	-2.71
High wage processes	91.60	26.84	1.02	1.69	6.02
Low wage processes	85.65	31.59	-3.03	-5.01	-15.43
Services (other)	95.51	35.82	-1.92	-3.16	-10.38
Logistics	92.15	28.08	-6.38	-10.53	-35.51
Cleaning	64.42	44.69	-5.56	-9.18	-27.32

Notes: Predicted changes of outsourcing probabilities if wages on the contract market are increased by 3 percent, 5 percent, or wages on the contract market are equalized to internal market wages. Predictions use estimated coefficients of running specification 4 in Table 2.4 for all processes (overall) or separately for high and low wage processes and for each process individually.

2.6 Regional and Nationwide Contract Markets

The analysis so far exploits the regional variation of the internal and contract markets for each process. We therefore assume outsourcing to be related to regional characteristics while the measured outsourcing decisions are not regionally constrained and include outsourcing to other German regions or foreign destinations.

Domestic outsourcing has been shown to rely partially on geographical proximity (Abraham and Taylor, 1996; Essletzbichler, 2003). Furthermore, a majority of outsourcing firms in the COOP state spatial proximity to the contractor to be relevant to a certain degree when choosing their contracting partner and only 11% indicate outsourcing to foreign firms. Hence, a large part of outsourcing is therefore domestic and regional on average. However, the tasks behind some processes, such as R&D, may be more tradeable than for other processes, as cleaning for example. Respondents of the COOP, therefore, are asked to asses the importance of spatial proximity to the contractor on a 5-point likert scale from very unimportant to very important. Table 2.C.7 in the Appendix shows the responses to the question whether spatial proximity is an important factor when choosing a contractor. On average 48 percent of firms indicate that spatial proximity is very important or rather important, while for only 28 percent of firms it is rather or very unimportant. There is heterogeneity among the processes such that especially for high wage processes firms are less focused on spatial proximity to the contractors. For other processes such as canteen, technical services, and reception 54 to 73 percent of the firms indicate the importance of outsourcing to a local contractor.

Hence, as a robustness check we investigate the relevance of domestic outsourcing and regional and nationwide contract markets. Table 2.6 displays estimations repeating specification (4) from Table 2.4. In addition to the regional log wage differential, we include the wage differential between the national contract market and the regional internal market of the outsourcing firm in column 1. The point estimate of the regional wage differential is -0.092 and therefore similar to the -0.096 estimated before. The national wage differential is not significantly different from zero. In column 2, we restrict the sample to firms that only conduct domestic outsourcing such that they do not outsource any of their processes to foreign contractors. The coefficient of the regional wage differential is reduced to

-0.067. Hence, our main results are robust to focusing on domestic outsourcing only, even though the magnitude is slightly reduced. The significant coefficients on the regional wage differential and the insignificant ones on the national wage differential indicate that outsourcing is indeed related to characteristics of the regional contract markets rather than nationwide domestic markets.

Table 2.6: Drivers of Outsourcing Decisions, Focus on Domestic Outsourcing

	(1) both national & regional	(2) restricted to domestic outsourcing	(3) restricted to high wage processes	(4) restricted to low wage processes
Market Characteristics $\mathbf{C_{pj(r)} - X_{pjr}}$				
Log wages - regional	-0.092**	-0.067*	-0.066	-0.118**
	(0.038)	(0.039)	(0.054)	(0.058)
Log wages - national	-0.004	-0.002	0.009	-0.019*
	(0.006)	(0.006)	(0.008)	(0.011)
Constant	-0.063***	-0.048**	-0.009	0.395***
	(0.022)	(0.023)	(0.026)	(0.033)
Workforce characteristics	Yes	Yes	Yes	Yes
Firm characteristics	Yes	Yes	Yes	Yes
Process Dummies	Yes	Yes	Yes	Yes
Regional Characteristics	Yes	Yes	Yes	Yes
R-Square	0.1630	0.1664	0.2363	0.1028
Adjusted R-Square	0.1624	0.1657	0.2352	0.1015
N processes	51595	44090	22826	21264
N firms	7177	6201	5832	6016

Notes: Linear Probability Model; Standard Errors are clustered at the firm level; * p<0.10, ** p<0.05, *** p<0.01, Covariates are included as indicated. Column 1 reruns estimation 4 of Table 2.4 including the national log wage differential in addition. Column 2 restricts the estimation to firms that conduct domestic outsourcing only. Columns 3 and 4, splits the sample by high and low wage processes, while still restricting the sample to domestic outsourcing only.

In addition to restricting to domestic outsourcing, we split the sample by high and low wage processes in columns 3 and 4 as to investigate whether the regional perspective is equally relevant for both types of processes. For high wage processes the coefficients of both the national and the regional wage differential are insignificant, supporting our results in Figure 2.4. Hence, neither the regional nor the nationwide wage differentials explain domestic outsourcing of high wage processes. Domestic outsourcing of low wage processes is mainly driven by the regional wage differential with a coefficient of -0.118, while the point estimate of the wage differential to the national contract market is at -0.019. Low wage and low skilled processes are therefore more likely to be outsourced

the lower the wages on the regional contract market. Those processes such as production and cleaning are presumably less tradeable and the relevant domestic contract market is therefore regional rather than nationwide.

2.7 Conclusion

During the last decades, contracting out and the related relocation of occupations across industries have seen a remarkable increase. We still know little about the drivers for this development, partly because of a lack of data.

In this paper, we make use of a unique dataset on firm level outsourcing decisions for 15 different business processes. We combine this survey data with information on both the internal market and contract market conditions as to explore the drivers of contracting out. We develop an innovative measure of the relevant contract market reflecting both the specialization of an industry in providing a process as well as inter-industry linkages. The contract market for all business processes turns out to pay less to a process-specific workers, on average, than to workers providing the task in-house. While this wage differential is small for high-wage processes such as management tasks and R&D, wages paid for cleaning staff on the contract market amount only two thirds of the wages paid on average when employed in the outsourcing industry.

As a major advantage of the data, we can explore the within firm variation in outsourcing decisions across various business processes. Outsourcing probabilities vary substantially across business functions. Accounting and Controlling is the process most likely to be outsourced with 59 percentage points, while management functions or front desk tasks show quite moderate outsourcing probabilities. Firm characteristics are able to explain some of the differences in outsourcing probabilities across firms. The use of other flexible work arrangements is positively correlated with outsourcing probabilities, suggesting that these forms of flexible staffing are complements rather than substitutes and that firms with higher outsourcing probabilities have some general need for flexible staffing.

The conditions of workers on the contract market relative to the internal market are partially able to explain within firm variation of outsourcing decisions across business

functions. A one percent increase of wages paid to contract workers relative to internal workers reduces the outsourcing probability by 0.096 percentage points. Increasing the share of high skilled and young workers on the contract market by one percentage point is related to increases in outsourcing probabilities by 0.3 and 0.4 percentage points respectively.

Higher wages on the contract market relative to the internal market considerably reduce outsourcing probabilities for low wage processes, supporting the view of a cost saving strategy by outsourcing firms for those ancillary business functions. In fact, if wages on the contract market and the internal market were harmonized, low-wage processes such as cleaning and logistics would have lower outsourcing probabilities by 10 to 35 percent. Hence, contracting out likely increases the pressure on contract markets providing low wage and mostly low skilled processes. Moreover, high wage processes – if at all – are more likely to be outsourced, the higher are the wages on the contract market, pointing to the subordinate role of prices for more complex and high-skilled tasks. The results are robust to focusing on domestic outsourcing only and the relevant perspective are regional rather than nationwide domestic contract markets, especially for low wage processes. Although we cannot fully answer the question to what extent outsourcing contributes to rising wage inequality, our findings suggest that contracting out in some occupations may be a driver of wage inequality.

Finally, market conditions such as market concentration, wage differentials and compositional differences between the internal process-specific workers and their counterparts on the contract market have limited explanatory power for the within-firm variation in outsourcing decisions, pointing to the need for further research in this direction.

Appendix

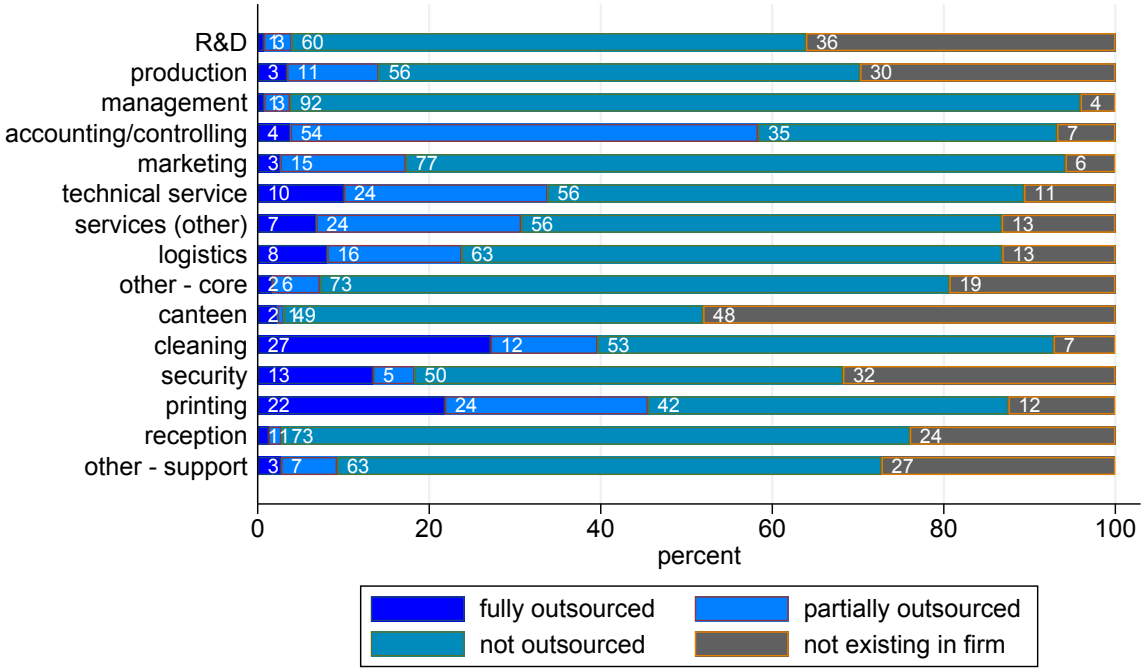
2.A SIAB

For deriving characteristics of the workforce on the internal market and the contract market, we use the Sample of Integrated Labor Market Biographies (SIAB)[21] which is a representative 2% sample of social security records in Germany, excluding only civil servants and self-employed. Those records contain longitudinal information on pay, type of employment, occupation, demographic variables of the workers and industry as well as regional information of the employer. We impute top coded wages following Gartner (2005) as well as inconsistent or missing educational information using the procedure by Fitzenberger et al. (2006). By using the occupation, industry and labor market region (LMR) included in the data for each employment spell, we can allocate workers to a process-specific contract market or the process-specific internal market in order to compute characteristics for these sub-groups regarding the workforce composition (e.g. education, age, gender) and the wages paid. We derive these statistics for the year 2016, the year in which the COOP is conducted.

[21]This study uses the factually anonymous Sample of Integrated Labour Market Biographies (version 1975 - 2017). Data access was provided via a Scientific Use File supplied by the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB). DOI 10.5164/IAB.FDZD.1904.en.v1. Project Number 102352.

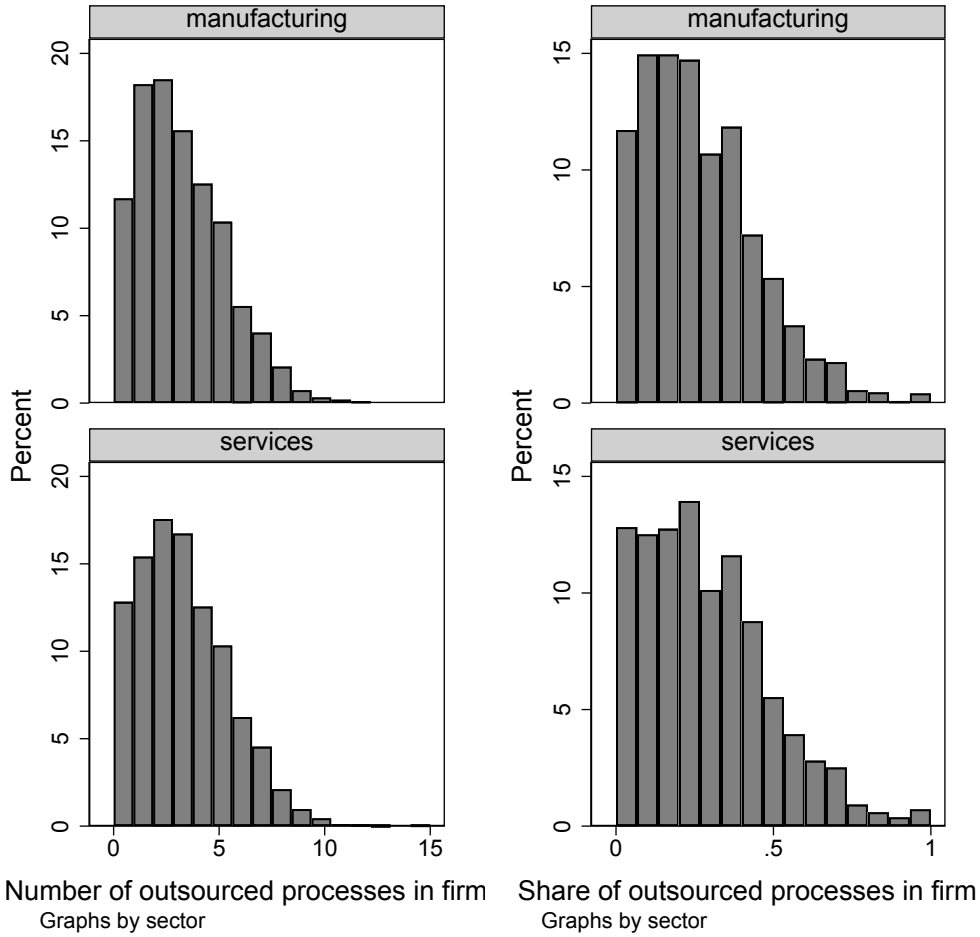
2.B Additional Graphs

Figure 2.B.1: Outsourcing Rate and Non-Existence of Different Processes



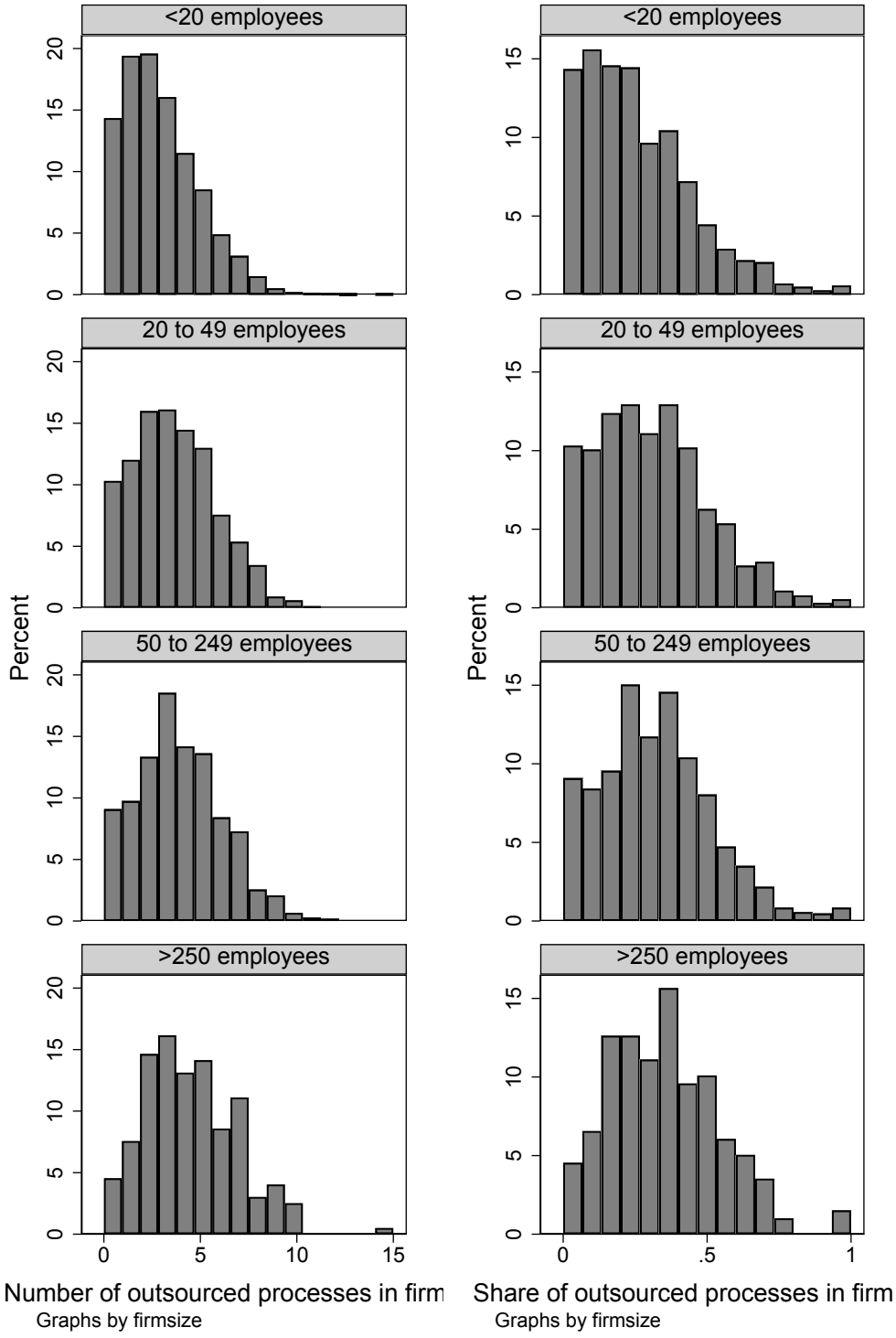
Notes: Relative Frequency of answers to the question "Do you outsource process X to another firm? Fully, partially, not at all, this process is not existing in your firm?". 111,943 processes in 7,514 firms.

Figure 2.B.2: Distribution of Number and Share of Outsourced Processes in Firm, by Sector



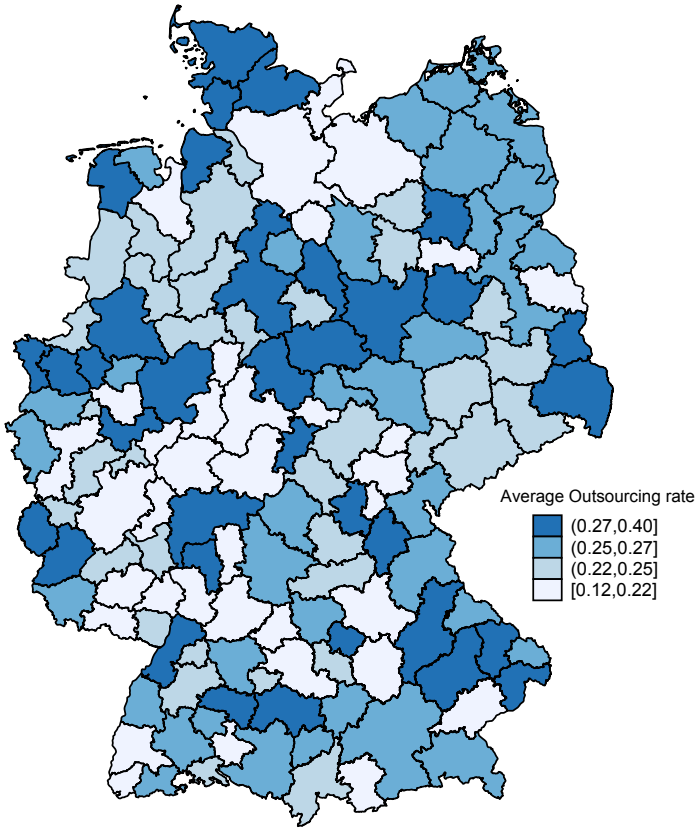
Notes: The graph on the left hand side displays the share of firms outsourcing a certain absolute number of their processes by manufacturing and service sector. The graph on the right hand side displays the distribution of the firms's share of outsourced processes among process existing in the firm by manufacturing and service sector. 90,335 processes in 7,688 firms.

Figure 2.B.3: Distribution of Number and Share of Outsourced Processes in Firm, by Firm Size



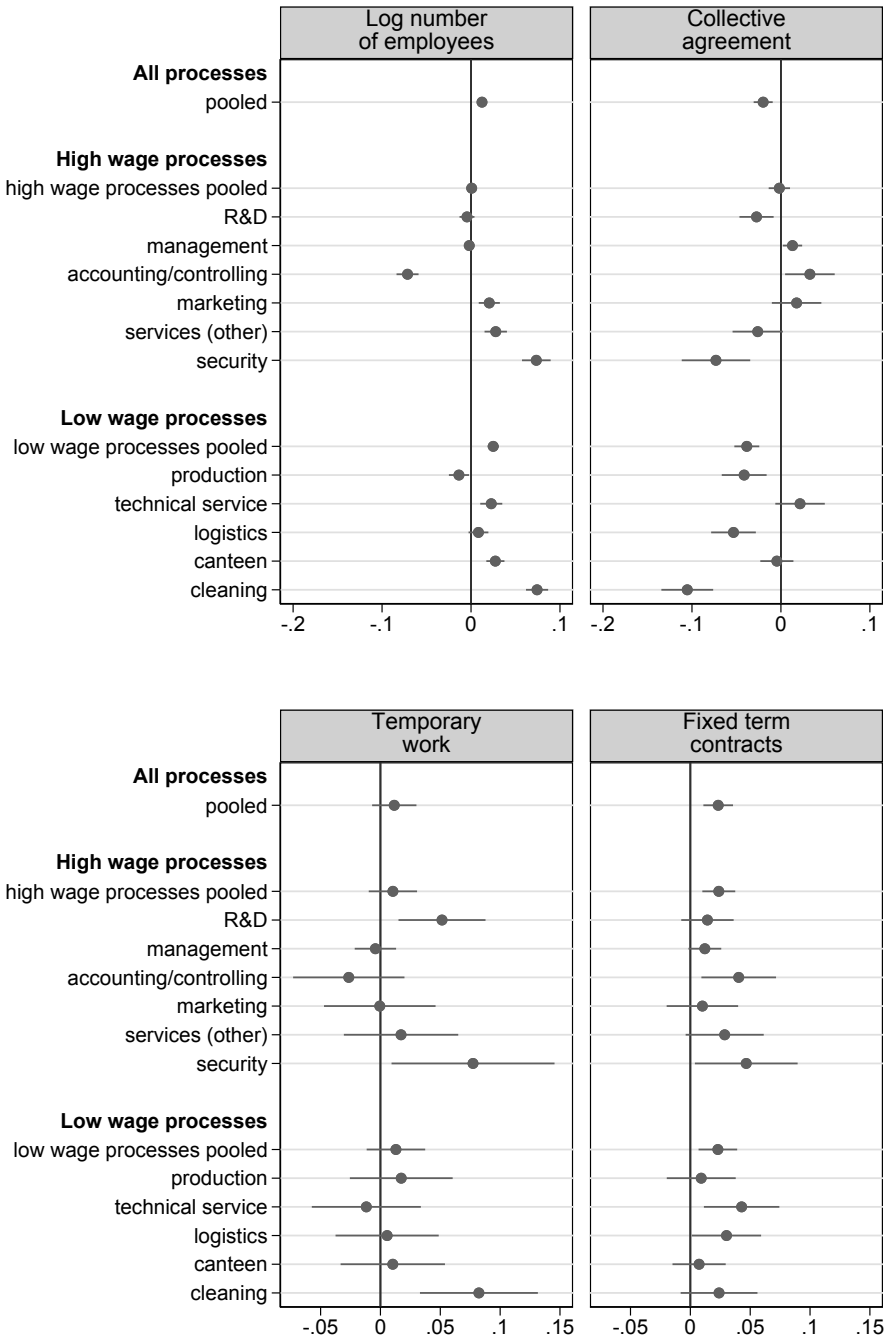
Notes: The graph on the left hand side displays the share of firms outsourcing a certain absolute number of their processes by firm size categories. The graph on the right hand side displays the distribution of the firms's share of outsourced processes among process existing in the firm by firm size categories. 90,335 processes in 7,688 firms.

Figure 2.B.4: Share of Outsourced Processes, by Labor Market Regions



Notes: Displayed is the share of outsourced processes within 133 labor market regions. Coloring refers to quartiles of the distribution of regional outsourcing rates. 90,335 processes in 7,688 firms.

Figure 2.B.5: Coefficients of Further Covariates for Different Subsets of Processes



Notes: Estimated coefficients of running specification 4 in Table 2.4 for all processes (overall) or separately for high and low wage processes and for each process individually. Points represent point estimates, bars represent 95% confidence intervals.

2.C Additional Tables

Table 2.C.1: Relative Frequencies of the Gross sample and Realized Sample of the COOP

	Gross Sample	Realized Sample
	Relative Frequency in percent	
Industry		
Manufacturing	10,8	12,6
Construction	17,4	12,2
Trade/Maintenance of motor vehicles	11,4	11,4
Transportation and warehousing	8,3	9,1
Catering and hospitality	6,7	6,5
Information and Communication	7,4	8,1
Finance and insurance	6,8	5,0
Scientific and technical services	9,1	11,5
Other commercial services	5,2	6,1
Health and social services	4,6	6,8
Arts, entertainment and recreation	6,0	4,7
Other services	6,3	6,3
Firm size		
<20 employees	56,1	56,4
20 to 49 employees	18,3	24,2
50 to 249 employees	9,5	12,0
>250 employees	1,7	1,4
All	100,0	100,0

Notes: Relative Frequencies of firms' Industry and Firm size in the randomly drawn gross sample and the realized sample of interviews.

Table 2.C.2: Identifying Occupations Specialized for each Process, KldB2010 Number and Name of Occupation

R&D
25 Occupations in technical research and development
44 Occupations in mathematics and statistics
45 Occupations in biology
46 Occupations in chemistry
47 Occupations in physics
48 Occupations in geology, geography and meteorology
49 Occupations in environmental protection engineering
54 Occupations in software development
92 Laboratory occupations in medicine

Production
5 Conditioning and processing of natural stone and minerals, production of building materials
6 Occupations in industrial glass-making and -processing
7 Occupations in industrial ceramic-making and -processing
8 Occupations in plastic- and rubber-making and -processing
10 Occupations in wood-working and -processing
11 Technical occupations in paper-making and -processing and packaging
15 Occupations in metal-making
16 Occupations in metalworking
17 Occupations in treatment of metal surfaces
18 Occupations in metal constructing and welding
19 Occupations in precision mechanics and tool making
20 Occupations in machine-building and -operating
21 Technical occupations in the automotive, aeronautic, aerospace and ship building industries
22 Occupations in mechatronics, automation and control technology
28 Occupations in textile making
29 Occupations in the production of clothing and other textile products
30 Occupations in leather- and fur-making and -processing
31 Occupations in beverage production
32 Occupations in the production of foodstuffs, confectionery and tobacco products
102 Technical occupations in medicine, orthopaedic and rehabilitation

Management
50 Occupations in environmental protection management and environmental protection consulting
80 Managing directors and executive board members
82 Occupations in business organisation and strategy
113 Occupations in economics
125 Technical and management occupations in museums and exhibitions

Accounting / Controlling
84 Occupations in human resources management and personnel service
85 Occupations in insurance and financial services
86 Occupations in accounting, controlling and auditing
87 Occupations in tax consultancy

Marketing
12 Occupations in technical media design
114 Occupations in advertising and marketing
115 Occupations in public relations

Technical Services
2 Occupations in gardening
24 Occupations in electrical engineering
39 Painters and varnishers, plasterers, occupations in the waterproofing of buildings, preservation of structures and wooden building components
41 Occupations in building services engineering
42 Occupations in plumping, sanitation, heating, ventilating, and air conditioning

Services (other)
26 Draftspersons, technical designers, and model makers
27 Technical occupations in production planning and scheduling
34 Occupations in construction scheduling and supervision, and architecture
35 Occupations in surveying and cartography
51 Occupations in computer science
52 Occupations in IT-system-analysis, IT-application-consulting and IT-sales
53 Occupations in IT-network engineering, IT-coordination, IT-administration and IT-organisation
70 Occupations in real estate and facility management
79 Occupations in event organisation and management
88 Occupations in legal services, jurisdiction, and other officers of the court
117 Occupations in editorial work and journalism
118 Occupations in product design, artisan craftwork, fine arts and the making of musical instruments

Logistics
57 Occupations in warehousing and logistics, in postal and other delivery services, and in cargo handling
60 Management assistants in transport and logistics
61 Driver of vehicles in road traffic
68 Occupations in purchasing and sales

Canteen
33 Cooking occupations

Cleaning
67 Occupations in cleaning services

Security
66 Occupations in physical security, personal protection, fire protection and workplace safety

Printing
14 Occupations in printing technology, print finishing, and book binding

Note: We did not attempt to match the category of other core and support business functions, as the content of those processes is quite heterogeneous and identifying related occupations is therefore not straightforward.

Table 2.C.3: Mean Descriptives of an Internal Provision of the Processes – The Internal Market

	R&D	Production	Management	Accounting / Controlling	Marketing	Technical Services	Services (other)	Logistics	Canteen	Cleaning	Security	Printing
Wage Structure in Euro												
Mean daily wage of												
process specific worker	158.06	91.20	162.38	140.08	138.37	99.65	149.09	102.84	57.42	45.88	116.70	92.40
process specific full time worker	173.22	95.07	185.14	166.00	155.92	106.54	159.19	112.69	73.14	66.00	128.68	99.03
Education Structure												
Share of low educated workers	0.0577	0.1381	0.0600	0.0235	0.0575	0.0953	0.0639	0.1031	0.1339	0.2365	0.0776	0.1186
Share of medium educated workers	0.5180	0.8011	0.6197	0.6527	0.6106	0.8221	0.5921	0.8003	0.8350	0.7429	0.7946	0.8287
Share of high educated workers	0.4243	0.0607	0.3203	0.3237	0.3319	0.0826	0.3440	0.0966	0.0311	0.0205	0.1278	0.0527
Age Structure												
Share of young workers	0.1807	0.2585	0.1672	0.1232	0.2329	0.1784	0.1817	0.1601	0.1784	0.0781	0.1367	0.1427
Share of middle aged workers	0.4111	0.3554	0.3929	0.4366	0.4540	0.3410	0.4114	0.3594	0.3701	0.3266	0.3338	0.3441
Share of old aged workers	0.4081	0.3861	0.4399	0.4402	0.3131	0.4806	0.4069	0.4805	0.4515	0.5953	0.5294	0.5133
Other characteristics												
Share of female workers	0.3869	0.1402	0.4994	0.7041	0.5360	0.1160	0.2797	0.2462	0.7140	0.7944	0.3020	0.2980
Share of part time workers	0.1921	0.1005	0.2123	0.2926	0.2317	0.1469	0.1292	0.1739	0.5180	0.6778	0.2181	0.1560
Share of foreign workers	0.0553	0.1156	0.0313	0.0294	0.0435	0.0857	0.0375	0.0987	0.1670	0.2110	0.0726	0.0709
Share of minijobs	0.0466	0.0868	0.0597	0.0856	0.0606	0.1888	0.0672	0.1942	0.3436	0.5569	0.2110	0.1435
Share of fixed term employees	0.1283	0.1292	0.1053	0.0858	0.1456	0.1396	0.1052	0.1453	0.2040	0.1248	0.1826	0.1067
Share of temporary agency workers	0.0107	0.0596	0.0060	0.0062	0.0065	0.0157	0.0079	0.0395	0.0218	0.0063	0.0050	0.0282
High / low wage process	high	low	high	high	high	low	high	low	low	low	high	low
High / low skilled process	high	low	high	high	high	low	high	low	low	low	low	low

Notes: Mean characteristics of the generic internal markets, that is the average over (LMR x outsourcing industry x process) cells by processes.

Table 2.C.4: Mean Descriptives of the Contract Markets for the Processes

	R&D	Production	Management	Accounting / Controlling	Marketing	Technical Services	Services (other)	Logistics	Canteen	Cleaning	Security	Printing
Wage Structure in Euro												
Mean daily wage of												
process specific worker	155.8	91.01	159.72	136.96	129.55	99.29	147.54	98.39	60.34	47.11	119.51	81.1
process specific full time worker	160.33	93.05	174.01	147.85	130.91	102.78	152.03	103.84	61.19	42.52	121.41	78.43
Education Structure												
Share of low educated workers	0.0504	0.136	0.06	0.0216	0.0553	0.0936	0.0621	0.1048	0.1336	0.233	0.0794	0.1148
Share of medium educated workers	0.5351	0.7996	0.6031	0.6397	0.591	0.8272	0.5825	0.7993	0.8347	0.7478	0.7971	0.8283
Share of high educated workers	0.4145	0.0645	0.3369	0.3387	0.3537	0.0792	0.3554	0.0959	0.0317	0.0193	0.1236	0.0569
Age Structure												
Share of young workers	0.1741	0.2516	0.1601	0.1142	0.2301	0.1695	0.1773	0.1572	0.1663	0.0699	0.1315	0.1395
Share of middle aged workers	0.4045	0.3485	0.3896	0.4373	0.4549	0.3354	0.408	0.3505	0.3584	0.3163	0.3362	0.3449
Share of old aged workers	0.4214	0.3998	0.4503	0.4485	0.3149	0.4952	0.4146	0.4923	0.4752	0.6138	0.5324	0.5156
Other characteristics												
Share of female workers	0.4357	0.1456	0.5083	0.6979	0.5108	0.1201	0.2789	0.2424	0.7682	0.8477	0.3622	0.2744
Share of part time workers	0.2282	0.1074	0.2237	0.2994	0.2263	0.1618	0.1356	0.1791	0.5563	0.716	0.2608	0.1362
Share of foreign workers	0.0521	0.1015	0.0289	0.0269	0.0394	0.0792	0.0345	0.0879	0.1558	0.1986	0.0756	0.055
Share of minijobs	0.0393	0.0803	0.0549	0.0784	0.0584	0.1823	0.0653	0.2011	0.3241	0.5337	0.2020	0.1173
Share of fixed term employees	0.1348	0.1297	0.1126	0.0950	0.1578	0.1508	0.1115	0.1508	0.2086	0.1277	0.1943	0.1073
Share of temporary agency workers	0.0087	0.0441	0.0053	0.0060	0.0051	0.0128	0.0066	0.0306	0.0169	0.0062	0.0041	0.0224
High / low wage process	high	low	high	high	high	low	high	low	low	low	high	low
High / low skilled process	high	low	high	high	high	low	high	low	low	low	low	low

Notes: Mean characteristics of the generic contract markets, that is the average over (LMR x outsourcing industry x process) cells by processes. The characteristics of the contract market are based on a weighted average of process-specific workers which is calculated as described in Section 2.3.2. To settle potential rounding differences, for categorical variables the shares are scaled to sum up to one.

Table 2.C.5: Descriptive Statistics for Variables in Regression

Variable	all		outsourced		not outsourced	
	mean	sd	mean	sd	mean	sd
Dependent variable						
Process outsourced	0.290	0.454	1	0	0	0
Market Characteristics $\mathbf{C_{pjr} - X_{pjr}}$						
Log wages	-0.170	0.283	-0.175	0.285	-0.168	0.283
Share of low educated workers	-1.526	5.009	-1.701	5.351	-1.454	4.861
Share of high educated workers	-2.845	9.856	-2.547	9.277	-2.966	10.081
Share of female workers	-3.410	16.241	-4.112	17.027	-3.123	15.901
Share of part time workers	-2.003	10.186	-2.641	10.769	-1.743	9.926
Share of foreign workers	-1.850	5.431	-2.005	5.810	-1.786	5.268
Share of young workers	-3.180	6.026	-3.032	5.623	-3.240	6.181
Share of old age workers	-3.331	13.930	-3.798	14.482	-3.141	13.694
Firm concentration on the contract m.	0.287	0.158	0.288	0.159	0.287	0.157
log (average number of employees) contract m.	3.030	0.733	3.059	0.741	3.018	0.730
Firm characteristics						
log (number of employees) outsourcing firm	2.648	1.337	2.760	1.352	2.602	1.328
firm is subject to collective agreement	0.311	0.463	0.301	0.459	0.316	0.465
firm has works council	0.100	0.300	0.118	0.323	0.092	0.289
firm uses temporary work	0.096	0.295	0.106	0.308	0.092	0.289
firm uses fixed term contracts	0.342	0.474	0.379	0.485	0.326	0.469
firm has freelancers working for it	0.226	0.418	0.245	0.430	0.218	0.413
Manufacturing sector	1.730	0.444	1.741	0.438	1.725	0.446
Regional characteristics						
West	0.783	0.412	0.771	0.420	0.788	0.409
Urban region	0.744	0.437	0.762	0.426	0.736	0.441
GDP per capita	39.332	16.390	40.013	16.906	39.055	16.166
Unemployment rate	6.636	2.695	6.747	2.706	6.590	2.690
Open positions per unemployed	23.583	11.656	23.315	11.567	23.693	11.690
Processes						
R&D	0.062	0.240	0.015	0.120	0.081	0.273
Production	0.092	0.289	0.066	0.249	0.102	0.303
Management	0.125	0.331	0.017	0.129	0.169	0.375
Accounting / Controlling	0.106	0.308	0.228	0.420	0.057	0.231
Marketing	0.083	0.275	0.053	0.224	0.095	0.293
Technical services	0.107	0.309	0.136	0.343	0.095	0.294
Services (other)	0.104	0.306	0.130	0.336	0.094	0.292
Logistics	0.114	0.317	0.111	0.314	0.115	0.319
Canteen (food)	0.045	0.208	0.009	0.097	0.060	0.238
Cleaning	0.089	0.284	0.137	0.344	0.069	0.253
Security	0.047	0.211	0.046	0.210	0.047	0.212
Printing	0.026	0.160	0.051	0.221	0.016	0.126
N	51959		15025		36570	

Notes: Mean and standard deviation for variables used in Regressions in Table 2.4.

Table 2.C.6: Robustness: All Workers Wages and Probit estimation

	(1) LPM - any (also not FT) workers wages	(2) Probit - regional variation in X	(2') maginal effects at mean
Market Characteristics $\mathbf{C_{pjr} - X_{pjr}}$			
Log wages - regional	-0.096***	-0.372***	-0.108***
	(0.037)	(0.126)	(0.037)
Share of low educated workers	-0.001	-0.002	-0.001
	(0.001)	(0.003)	(0.001)
Share of high educated workers	0.002***	0.006***	0.002***
	(0.000)	(0.001)	(0.000)
Share of female workers	-0.001***	-0.003***	-0.001***
	(0.000)	(0.001)	(0.000)
Share of part time workers	0.002***	0.006***	0.002***
	(0.000)	(0.001)	(0.000)
Share of foreign workers	-0.000	-0.001	-0.000
	(0.001)	(0.002)	(0.001)
Share of young workers	0.002***	0.005**	0.002**
	(0.001)	(0.002)	(0.001)
Share of old age workers	-0.000	-0.001	-0.000
	(0.000)	(0.002)	(0.000)
Share of minijob workers	0.000	0.001	0.000
	(0.000)	(0.001)	(0.000)
Share of workers on fixed term contract	-0.001*	-0.003	-0.001
	(0.001)	(0.002)	(0.001)
Share of temporary agency workers	0.003***	0.009***	0.003***
	(0.001)	(0.002)	(0.001)
Firm concentration on the Contract Market	0.076***	0.251***	0.073***
	(0.020)	(0.067)	(0.019)
log (average number of employees) Contract Market	0.008*	0.028**	0.008**
	(0.004)	(0.014)	(0.004)
Firm Characteristics - outsourcing firm			
log (number of employees)	0.012***	0.042***	0.012***
	(0.002)	(0.008)	(0.002)
subject to collective agreement	-0.020***	-0.068***	-0.020***
	(0.005)	(0.019)	(0.006)
has works council	0.032***	0.108***	0.031***
	(0.010)	(0.033)	(0.010)
uses temporary work	0.012	0.038	0.011
	(0.009)	(0.031)	(0.009)
uses fixed term contracts	0.023***	0.080***	0.023***
	(0.006)	(0.021)	(0.006)
has freelancers working for it	0.019***	0.067***	0.020***
	(0.006)	(0.021)	(0.006)
manufacturing sector	-0.023***	-0.073***	-0.021***
	(0.007)	(0.022)	(0.006)
Regional Characteristics			
west	-0.027***	-0.088***	-0.025***
	(0.008)	(0.026)	(0.008)
urban region	0.019***	0.065***	0.019***
	(0.006)	(0.022)	(0.006)
GDP per capita	0.001***	0.002***	0.001***
	(0.000)	(0.001)	(0.000)
unemployment rate	0.000	0.001	0.000
	(0.002)	(0.005)	(0.002)
open positions per unemployed	-0.000	-0.001	-0.000
	(0.000)	(0.001)	(0.000)
Constant	-0.065***	-2.146***	
	(0.022)	(0.081)	
Process dummies	Yes	Yes	
R-Squared	0.1630		
Adjusted R-Squared	0.1624		
N processes	51595	51595	
N firms	7177	7177	

Notes: Specifications 1 is a Linear Probability Model, Specifications 2 is a probit estimation with the corresponding marginal effects (dydx) at the mean. Standard Errors are clustered at the firm level; * p<0.10, ** p<0.05, *** p<0.01, Omitted variable: Process Management.

Table 2.C.7: Importance of Spatial Proximity: Share of Firms Indicating Importance or Unimportance, by Process

Process	Spatial proximity is important	Spatial proximity is unimportant
R&D	37.76	37.76
production	43.77	29.26
management	41.67	29.17
accounting	51.78	22.45
marketing	47.58	30.65
technical services	60.78	15.83
services other	44.83	27.90
logistics	38.62	37.40
core other	45.25	35.71
canteen	72.73	6.06
cleaning	44.58	30.62
security	53.01	26.32
printing	42.55	34.45
reception	53.57	32.14
other support	44.05	28.57
Total	47.69	27.81

Notes: The table refers to the following question in the COOP: "When outsourcing process <p>, different criteria can play a role in the choice of a contractor. How important is spatial proximity to the contractor on a scale from 1: very unimportant to 5: very important?" Column 2 shows the share of firms indicating that spatial proximity is very important or rather important; Column 3 shows the share of firms indicating that spatial proximity is rather unimportant or very unimportant.

Chapter 3

Noncompliance with Temporary Agency Work Regulations: Don't They Know Better or Do They Abuse? [1]

3.1 Introduction

Recent developments indicate that the traditional model of employee-employer relationships is on the decline. Alternative work arrangements such as temporary agency work, contract work and independent contractors have increased by five percentage points since 2005 and accounted for possibly 15.8% of the US workforce in 2015 (Katz and Krueger, 2019a). Many explanations are put forward for the rise of those new forms of work: Pronounced use of ICT (Abramovsky and Griffith, 2006), weak labor markets with high unemployment and therefore little opportunity for standard employment relationships (Katz and Krueger, 2017), firms seeking to reduce rent sharing with their employees (Goldschmidt and Schmieder, 2017) and the desire to reduce regulatory burden (Weil, 2014). Firms therefore increasingly draw towards more flexible forms of work such as temporary agency work or contract work and reduce their own workforce.

[1] I thank Christina Gathmann and Boris Ivanov as well as seminar participants at University of Heidelberg and ZEW for valuable comments.

The firm can decide between different forms of work arrangements: Employment, Temporary Agency Work, and Outsourcing to a service contractor[2]. All forms have their advantages and drawbacks. Employing a worker is subject to standard employment protection and, depending on the firm or industry, wage regulation such as collective agreements and minimum wages. Yet, the firm can exert full managerial authority over the employee. The latter is true also for the temporary agency worker, but temp work is subject to certain employment regulations to avoid precarious working conditions. Payment is subject to temporary agency work specific minimum wage for the first six months. After that period, however, the temp worker is entitled to equal pay with respect to the core workforce. This is not the case when outsourcing to a service contractor. The contract worker receives wages set by the contractor firm and are not subject to a time limit. Yet, the firm has to give up any influence and control over the worker, as she is employee of another firm. Given that a firm already decided against employing a worker on its own, the choice between temporary agency work and outsourcing to a contractor is a trade-off: exerting managerial power over the worker or cost savings by exploiting potential wage differentials for a flexible duration.

I argue that there exist incentives for firms to reap the benefits of both forms of alternative work arrangements. This however, may result in non-compliance with temporary agency work regulations, especially if the contractor sends workers on the firm's premises. If the firm integrates those workers in its organizational structure - as it is typical for temp workers - contract work as the official contracting form is not appropriate and the situation constitutes non-compliance with temporary agency work regulations. For a profit-maximizing firm, compliance is never an optimal choice in the absence of enforcement. Even if regulations are enforced, firms will still choose not to comply if the probability of being caught and the penalty to be paid are small compared to the loss of profit deriving from compliant behavior (Ashenfelter and Smith, 1979). Temporary agency work and contract work are valid and legal forms of alternative work arrangements if properly realized. However, given the vast body of regulations for temporary agency work, differentiation between the two is often blurred and implementation of contract

[2]I will use the terms outsourcing, contracting out and contract work interchangeably throughout this paper as they all refer to work conducted by a third party.

work - be it intended or unintended - happens within a legal gray zone or is illegal. Firms' non-compliant behavior implies that workers are misclassified and may experience wage losses. While temp workers are entitled to payment of equal wages with respect to the core workforce, contract workers are withhold from firm's rent sharing.

While the literature is vast on temporary agency work, we lack reliable research on the effects of contract work. Both alternative work arrangements are associated with wage penalties for workers (see Boeheim and Cardoso (2009); Forde and Slater (2005) for temporary agency work and Dube and Kaplan (2010); Goldschmidt and Schmieder (2017) for contract work). Furthermore, temporary agency workers are less likely to receive a permanent contract (Amuedo-Dorantes et al., 2008) or find themselves in repeated spells of temp work (Antoni and Jahn, 2009) as compared to standard employment. Nevertheless, future employment spells of temp workers are found to be stable (de Graaf-Zijl et al., 2011; Ichino et al., 2008). However, empirical research is based on registered temporary agency work, and it is unclear if the effects hold for unregistered temporary agency work, too. In addition, legislators' intentions to protect vulnerable temporary agency workers miss the target if the group is not fully captured.

This paper aims at investigating non-compliance with Temporary Agency Work regulations when firms use service contractors as alternative work arrangements. I make three main contributions. First, I address the issue of whether firms are able to differentiate the two forms of external staffing in principle. Given that temporary agency work is highly regulated, agents might not be fully aware of the legal details. In order to understand whether firms have the knowledge of legal aspects, I use a choice experiment. Respondents are confronted with hypothetical staffing situations and are asked to choose the appropriate legal contract. In this experimental part of the paper I find that firms show a basic knowledge of the differentiation between temporary agency work and contract work. However, on average they do not exhibit a detailed legal literacy and have a bias towards choosing the unregulated contract work.

Second, I provide indicative evidence for non-compliance with Temporary Agency Work Regulations in Germany. I do so by investigating whether the way how alternative work arrangements are implemented in firms show features of temporary agency work but are labeled to be contract work. I make use of a novel data set on contract work and its

implementation in German firms. I find that there are firms which officially outsource to service contractors but implement it like temporary agency work and hence represent a group of non-compliers. Given that there is indication of non-compliance, defacto temporary agency work is probably under-reported in official statistics. Furthermore, investigators sent out to temp agencies are probably able to find some partial non-compliance with temporary agency work regulations, but would not find the fully non-complying firms.

After having established the level of legal knowledge and the compliance situation, thirdly, I address the question whether non-compliance is an informed choice and therefore might be considered as fraud or if non-compliance is simply deriving from ignorance. By linking the experimental part of the paper with the defacto implementation practices, I investigate whether firms comply with the regulations, given that they are able to understand them. I find that complying firms reveal an average basic legal knowledge. They are not fully able to discriminate between the two forms of work arrangements and their compliant behavior is not based on substantial knowledge. In addition, I find that non-complying firms show lower legal literacy in differentiating contract work and temporary agency work. Hence, their non-compliant behavior is not an informed choice but rather derives from a lack of detailed knowledge.

The limited legal literacy of most of the firms indicates that temporary agency work regulations are too complex and the legal proximity of contract work is not fully understood. Many firms outsourcing to a service contractor are not aware of the problematic legal grayzone with respect to temporary agency work. Policy makers should therefore expand efforts in educational work by providing reliable information on the distinction of the two staffing arrangements, if the aim is to reduce non-compliance with temporary agency work regulations.

The paper is structured as follows. In Section 3.2, I review the economic literature on compliance and describe the two forms of work arrangements and their legal relation which constitutes the baseline for compliance and non-compliance. In Section 3.3, I describe the data and provide descriptive statistics on the compliance situation in Germany. I shortly present the empirical strategy before turning to the results in Section 3.4. Section 3.5 concludes.

3.2 Compliance and Institutional Background

3.2.1 Compliance in Economics

There exists an extensive body of literature on non-compliance with labor market regulations in general, which is especially prominent in developing countries. In those countries non-compliance is represented by large informal labor markets such that firms or workers conduct economic activity which is not reported to regulatory or tax authorities. This includes social security contributions (Almeida and Carneiro, 2012) but also compliance with minimum wage laws. In contrast to many other labor market institutions, enforcement of minimum wages is not only a problem in developing countries (Rani et al., 2013; Squire and Suthiwart-Narueput, 1997) but also in industrialized economies. For the first US - minimum wages in the 1970s compliance is calculated to be around 70% (Ashenfelter and Smith, 1979). Non-compliance continues to serve as answer to statistic puzzles in current minimum wage evaluation (Caliendo et al., 2018).

Based on the economics-of-crime model by Becker (1968) especially the field of public finance has developed models to explain individuals' choices of non-compliance (see Alm (2019) for a current review). Ashenfelter and Smith (1979) model compliance with labor market regulations as a firm decision depending on wages. For a profit-maximizing employer compliance with a minimum wage law is never an optimal choice in the absence of enforcement. Even in the case of enforcement, employers will still choose not to comply if the probability of being caught and the amount of the penalty to be paid are small relative to the forgone profit of compliance. Their economic theory of firms' non-compliance focuses on minimum wage law, but can be applied to any regulatory setting where the known costs of compliance are higher than the probable costs of non-compliance.

Early models are based on expected utility theory and therefore define compliance as rational choice or a willingness to comply. Yet, individuals are not always rational and deviate from classical economic decision models: They have a limited computing ability (bounded rationality), they asymmetrically asses their perspectives depending on a reference point (prospect theory), and they are subject to various other cognitive biases. Behavioral economics discusses how those biases affect decision making and therefore the ability to comply with regulations (Congdon et al., 2011). Decisions are formed within

a set of social norms, such that an individual's choice is affected by how others behave (Cialdini et al., 1990; Goldstein et al., 2008). Agents prefer choices which are simple and convenient in addition to being likely to adopt default options (Lunn, 2014). This is in contrast to what regulatory designers often do. Many labor market regulations are very detailed in trying to cover as many situations as possible. Thereby, they are hard to comprehend for agents in the market on the one hand. Smart agents on the other hand, are able to find shortcomings in the law and alternatives circumventing the regulation. Empirically, higher compliance is not only observed in countries with credible enforcement, but also where policies are comprehensible and aim at raising awareness (Rani et al., 2013).

Non-compliance with governmental regulations is important for many reasons. Speaking in broad terms, it induces a re-allocation of public or private resources and creates unintended distortions or welfare losses (Congdon et al., 2011). Non-compliance with temporary agency work regulations distorts firm competition and increases firm polarization. Firstly, agencies who compliantly provide temporary workers compete not only with other agencies but in addition with unregulated contractors. Secondly, service contractors conducting non-compliant activities may have a cost advantage over their compliant competitors thereby gaining higher profits or market shares. This in turn may affect wages and increase wage polarization between core workforce and the external workers.

Empirical analysis of non-compliance is challenging:

> "As with most analyses of undetected illegal behavior, noncompliance can rarely be established without ambiguity." (Ashenfelter and Smith, 1979, p.334)

Compliance or noncompliance are per se ambiguous concepts. Laws can be respected to varying degrees, ranging from full, over partial to no compliance at all. In addition, illegal behavior is mostly not reported in official statistics and data is therefore scarce.

3.2.2 Definitions

Temporary Agency Work (TAW, *"Arbeitnehmerüberlassung"*) is a flexible staffing instrument which allows firms to adopt their labor input to business cycles and demand fluctuations. Figure 3.2.1 displays the interaction of the parties engaged in TAW on the

left hand side. The temp worker is employed by the temporary work agency with the intention to be hired out to a user firm which in turn assigns tasks and supervises his or her work. A temporary work agency fulfills the contractual obligations by providing adequate staff without any further responsibility. The client firm then has full managerial authority over the temp worker and is free to include him in its production process similar to own employees. TAW provides labor input to the production of the client firm.

Temporary Agency Work has grown in most OECD countries (OECD, 2019). In 2016 there were more than 990,000 temporary agency workers in Germany, representing 2.7% of total employment (Bundesagentur für Arbeit, 2018).

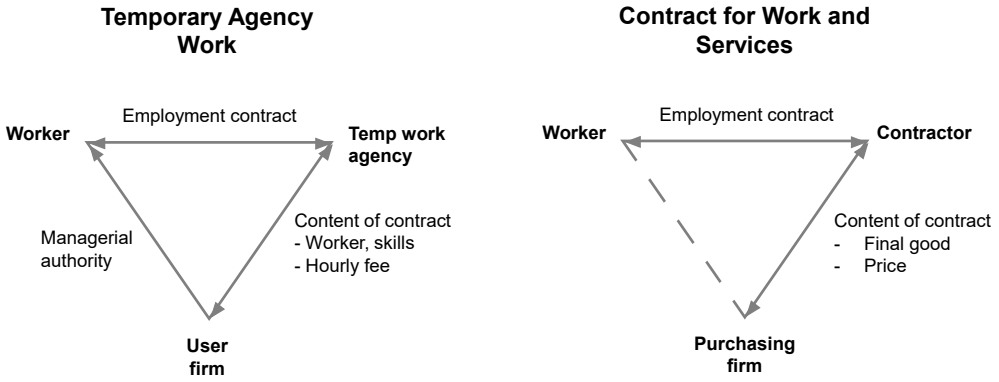
Due to the often precarious working conditions TAW is regulated in the European Union since 2011 (European Parliament, 2008)[3]. In order to rent out workers, temporary work agencies need a license issued by the Federal Employment Agency. The duration of a worker's assignment is limited to a maximum number of months. In 2016 the maximum duration was 18 months. According to firms, the limitation of assignment duration is the largest drawback of TAW regulations (Hamann, 2003). Furthermore, since 2013 temporary agency workers are subject to a sector specific minimum wage. This wage level is higher than the statutory minimum wage that was introduced in 2015, yet below other collective agreements. Additionally, after 6 months of assignment workers have the right to equal pay with respect to the core workforce. These regulations reduce the attractiveness of TAW especially when flexibility and wage savings are the reason for its use.

Contracts for Work and Services (CWS, *"Werkverträge"*) are the contractual basis for German firms when undertaking outsourcing activities. Those contracts define the purchase of a work or service by a buyer from a seller for an agreed price and are subject to contract law.[4] The right hand side of Figure 3.2.1 displays the schematics of contracts for work and services. While the contracting parties are relatively free to choose the details of their agreement, there are two integral parts of a contract for work and service. One is the timing and definition of the material result or service which is to be provided by the contractor. The other one is the agreed price that has to be paid by the

[3]Germany adopted the directive earlier and the TAW sector was highly regulated by labor law already before the Directive 2008/104/EC became effective officially.

[4]In contrast to the similar contract for sale the contracted work or service is very specific to the buyer and can hardly be resold to another party.

Figure 3.2.1: Temporary Agency Work and Contracts for Work and Services - Legal Distinction



Notes: Own illustration based on Hamann (2003), p20.

customer in exchange. Any further agreements to be included are additional and not obligatory. The "work or service" subject to the contract is characterized by a final result and not by the effort needed to provide it. The worker itself is therefore not part of the contract. The purchasing firm can specify detailed characteristics of the final good but has no right to interfere with either the realization process in general or the selection of personnel in specific. It is the contractor's full responsibility to realize the agreed output while bearing the full entrepreneurial risk in doing so. Contract work is therefore an intermediate input, partially substituting for own production of the purchasing firm.

Contracts for work and services between firms are a vital part of advanced economies, showing up in intermediate consumption in national accounting.[5] Due to growing international trade driven by globalization and increasing importance of digital technologies, contracting out has become increasingly important (Abramovsky and Griffith, 2006). Contracting out serves as explanation for various labor market developments. It can explain wage polarization by increasing dispersion in wage premia across firms and assortative matching (Card et al., 2013) as well as task specialization by firms as they increasingly outsource cognitive tasks (Cortes and Salvatori, 2019). In an economic downturn, Germany's manufacturing sector profited from outsourcing services to other domestic sectors

[5]In 2018 intermediate consumption amounted to 51 % of gross output in Germany (Volkswirtschaftliche Gesamtrechnung, destatis).

with low wage growth (Dustmann et al., 2014).

Most activities or tasks can be realized by using either of the external work arrangements. Filling of shelves should serve as an example here. In both cases the shelving worker has an employment contract[6] with her employer, a temporary work agency or a service contractor. If the employer is a temporary work agency it concludes a hiring contract with the user firm, specifying that a named worker with shelving skills is rented out to the user firm. The user firm then assumes full managerial authority and has to instruct the worker on which shelves to fill, how to stack products and coordinates working times, absences and job site. In the case of contract work, the contracting partner is probably a logistics firm or a firm offering services for retailers. The contract specifies the result, hence that the contractor is obliged to have shelves filled by a certain date or time of the day. It is the contractors decision how this result is achieved. It is at his choice to send one worker to each store or a group of workers covering more than one store. Instructing the workers and planning of their working hours is core task of the contractor.

3.2.3 Compliance with Temporary Agency Work Regulations

Contracts for work and services and temporary agency work are two different methods of deploying external staff. Their distinction is obvious when the final good is delivered to the client firm without further interaction. However, a contract for work and services can define a work that needs to be conducted on the premises of client firm. In this case, the contractor sends workers to produce the good or provide the service on-site. If the client firm integrates those workers in its organizational structure or interferes in another way with the realization of the output it may constitute a situation of non-compliance with temporary agency work regulations.

The current legal situation causes some uncertainty for firms, as there do not exist clear criteria or a cutoff point to distinguish temporary agency work from contracts for work and services. Starting point in determining compliance or non-compliance is the definition of temporary agency work with its regulations (Deich, 2009). Not the naming of the contractual agreement is relevant, but only the defacto way of implementation. Based

[6]This employment contract can be open-ended, part-time, fixed-term or any other form of full or marginal employment.

on the TAW regulations, legal scholars have identified various implementation features that allow for a distinction of TAW and CWS (Deich, 2009; Hamann, 2003, 2017). I will group them to primary and secondary aspects, taking into account that some features are considered more relevant than others in defining the defacto implementation (Greiner, 2013).

The **Primary Aspects** to distinguish TAW from CWS refer to the entrepreneurial risk and managerial authority. In the case of a contract for work and services the entrepreneurial risk lies with the contractor. As the labor or capital inputs needed to produce the work or service are not explicitly part of the contract, the contractor has full authority on how the work is done. This implies that any risk associated with providing the service has to be borne by the contractor, too. First, I consider as primary aspect who is giving the instructions to the workers, whether it is the contractor or a supervisor thereof, or employees of the purchasing firm. Second, in the case of contract work the final good is checked and accepted while with a TAW the firm has to actively control the work process. Finally, the most conclusive primary aspect is the fact who pays for rework in case the final good is defect. With a contract for work and services the contractor has to remedy or newly produce the contracted good. With TAW the responsibility lies only with user firm which hence has to cover any further costs. The primary aspects are not directly visible for a casual observer at any point in time.

The **Secondary Aspects** in distinguishing TAW from CWS are permanently observable characteristics. Judges and laywers adduce them as evidence if the primary aspects do not allow for a clear distinction. These aspects refer to the extent of external workers' integration into the firm's organizational structure. Contract workers are not to be integrated into the company organization of the client firm, while the labor supplied by temp workers is by definition a direct input to the production function. Hence, workers bringing their own tools, having a different working space or performing different tasks than the core workforce of the client firm are features I consider as secondary aspects of CWS.

Each of the individual aspects is considered an indicator for the distinction of temporary agency work from contract work. They are used to describe the accuracy in implementing both forms. However, there is no legally defined threshold for what is considered to be

on the legal side and what constitutes noncompliance. Judges individually assess each potential non-compliant situation by taking into account all implementation features. This lack of legal clarity spans a grayzone between TAW and CWS and renders differentiation difficult in practice. The federal employment agency provides little help for firms. Their leaflet which should provide information and help firms to understand the differences is not helpful. Its concluding remark on engaging the services of legal advisers or lawyers to obtain precise information was criticized as insufficient by legal scholars (Hamann 2017, p. 41).

Only few cases of noncompliance with TAW regulations are taken to the courts, even less are convicted. Inspections by the financial control of illicit employment (Finanzkontrolle Schwarzarbeit) only take place if there are indications for non-compliance (denouncing). In 2010, 868 cases were fined with an average fine of 100 Euro and only 64 cases were convicted as a crime (Bundesregierung, 2011). Enforcement is therefore low. Given that temporary agency work is regulated and subject to a higher minimum wage, and misuse has rarely legal consequences, there exist incentives to conclude a contract for work and services instead.

I argue that agreements declared as contract for work and services are the relevant form to investigate. If the two parties conclude a contract for work and services but the defacto implementation shows features of TAW this is considered illegal. This form of noncompliance is known as illegal supply of temporary agency workers or pseudo contract work (Scheinwerkvertrag). If, on the other hand, two firms use the highly regulated temporary agency work as the official declaration for their staffing agreement, they are most probably aware of the underlying regulations. Hence, investigating TAW would only reveal small acts of non-compliance. This is similar to the situation in countries with informal labor markets as described by Almeida and Carneiro (2012): Formal firms are easier to find and hence easier to control by labor inspectors. By doing so, the main source of informal employment - informal firms - is ignored. In order to find the main source of non-compliance with TAW regulations, I will therefore focus on contracts for work and services.

3.3 Data and Descriptive Statistics

For the analysis I use two cohesive surveys conducted among German firms in 2016.

The first survey (survey #1) is the COOP - Contracting Out Operational Processes, a questionnaire investigating the prevalence and intensity of contracts for work and services. The computer-assisted telephone interviews with managers, personnel managers or heads of purchasing departments were conducted in 8.457 German firms with at least one dependent employee.[7] Participants were chosen by stratified random sampling, such that firms are representative with respect to firm size and industry. I apply the provided weights for analyses related to the prevalence of contracts for work and services and non-compliance.

The questionnaire addresses issues of outsourcing to other firms,[8] especially the use of contracts for work and services. In addition to unveiling the prevalence of contracting out, the data allows to investigate the reasons, organizational procedures and working conditions associated with contracts for work and services. The survey includes questions on the reasons why CWS are used and also why CWS rather than TAW is implemented. If firms use contracts for work and services they are interviewed in detail on the features and legal aspects of the contract's implementation. Using this information I present descriptive evidence for non-compliance[9] with TAW regulations when firms use CWS in section 3.3.1.

The data captures contracting out in its various forms, be it either work which has been done previously in-house or new or temporary activities which have never been performed by the firm itself but always or once by contractors. In addition to representing the user side (by outsourcing business functions), firms can also be suppliers and perform the contracted tasks. In some cases both features apply, since each firm can potentially be both a user firm by employing external staff for its own processes and a contractor providing other firms with special works or services. Table 3.3.1 shows how the possible

[7] More information on the data, such as questionnaire and sampling design, weights and a discussion of representativeness and response behavior can be found in Arntz et al. (2017).

[8] Outsourcing to solo self-employed workers like freelancers is not integral part of the questionnaire and captured only if a firm reports to have no B2B cooperation.

[9] Due to the lack of a legally defined threshold, the data used in this paper does not allow for establishing proper juridical non-compliance. For a verdict, judges take an overall assessment which is subject to a more extensive investigation than a survey can achieve. However, the survey gathers the same basic information as it would be done for a juridical review.

Table 3.3.1: Prevalence of Contracts for Work and Services and Reasons for Outsourcing

	Percentage of firms
Use of Outsourcing	
Neither user firm, nor contractor	7.3
User firm, but not contractor	39.7
No user firm, only contractor	1.5
Both user firm and contractor	51.4
Outsourcing because of... (multiple answers possible)	
Wage savings	36.1
Specialized staff	75.9
Better alternative to temporary agency work	27.7
Flexible labor input	40.3

Relative frequencies of indicating outsourcing and reasons for its use. Sampling weights applied. First panel N=8,457; second panel N=3,734

constellations are distributed in the German economy. It is particularly noticeable that there are only few firms (7 percent) that do not engage in outsourcing activities and hence are neither user nor contractor of contracts for work and services. In addition, 91 percent of all firms are users of contracts for work and services and half of the firms indicate that they act as contractors as well. The use of contracts for work and services is therefore a common form of external staffing in Germany. The main reason for its use is the need for specialized staff. Flexibility and wage savings are less important but still are indicated by more than a third of the firms. 28 percent of the outsourcing firms also state that contract work is a better alternative to temporary agency work.

On the other hand, the provision of contracts for work and services is concentrated on considerably fewer firms than the user side. Based on the data, I approximate that possibly 16.3m employees work in firms that operate as contractors, 9.2m are in some way performing contract work and 5.7m employees are only performing contract work[10]. This implies that possibly 13 percent of employees in Germany are dedicated to provide services and goods to other firms via contract work.

The second data in my analysis is a choice experiment (survey #2). The participants for this vignette study are recruited from the COOP (survey #1) by asking for their

[10]This is a back-of-the-envelope calculation, using the information of firms reporting the share of their revenues by providing contract work to other firms, the share of their employees dedicated to do this contract work, and the number of employees in the firm.

willingness to participate in an additional personal computer assisted interview (CAPI). A face to face interview allows for more complicated questions and thus contains the choice experiment I describe in Section 3.3.2. The aim of the experimental survey is to understand the extent of respondent's knowledge on the legal differentiation between TAW and CWS. Firms taking part in survey #2 are not representative by sampling design, but show similar characteristics with respect to using contracts for work and services as I discuss later.

Besides the problematic nature of the topic, the data has limitations which are due to the survey design. Our respondent can be a different individual than the person deciding about the use of TAW or CWS. Furthermore, the respondents might not be the same individuals in survey #1 and #2.[11] However, the interviews were conducted with managing directors or other executive staff who can therefore be assumed to be involved in or near to the decision process. In addition, they are both managerial employees of the same firm. It is therefore plausible to assume they have the possibility to share their legal knowledge with the rest of the firm.

3.3.1 Defacto Implementation

In order to understand the features of the organizational structure and the way how contracts for work and services are implemented in the firm, the COOP includes a variety of related questions. Some of those questions are strong in identifying compliance or non-compliance as they refer to legal primary aspects, others do only give small indications given that they are referring to aspects of secondary legal relevance. As these questions are only relevant in the case of onsite outsourcing, information on defacto implementation is available for a respective subset of 2,832 firms.

Panel A of Table 3.3.2 lists the questions related to both primary and secondary aspects and whether a Yes or No is the answer associated with compliant behavior. 69% of all firms state that their employees are not guiding and instructing external workers and

[11]The two interviews were conducted over the course of six months. The implementation situation (survey #1) might not concur with the legal knowledge (survey #2). I will use a question from survey #2 addressing this issue. Respondents were asked whether they are aware of the legal grayzones when using CWS and TAW. Firms reporting a general awareness of the topic do not show a different legal knowledge than firms without.

are therefore showing compliant behavior for the aspect referring to instructions. About 68% of firms do not control the workflow of the external workers but instead check only the final product and 56% have the contractor pay for reworks and remedy. Hence, the majority of firms report individual details of their external staffing such that they suggest compliance with TAW regulations.

For all individual aspects more than half of the firms report their implementation behavior to be compliant with TAW regulations. However, this implies that the remaining firms are showing indications for non-compliance. This is especially pronounced when it comes to the question of who pays for rework or remedy. Legal scholars consider this aspect to be the most conclusive in determining non-compliance. If CWS are properly implemented, it is the contractor's obligation to cover any costs for rework. The 44% of firms reporting to pay for rework are therefore clearly not complying with TAW regulations. Panel B of Table 3.3.2 sums up the individual aspects to provide a more comprehensive compliance picture. 29% of firms report compliant behavior for all three primary aspects. The contracts for work and services of 7% of the firms show features which are clearly not compliant with TAW regulations by violating all three primary aspects. As 5.7m employees are dedicated to conduct contract work, probably around 400.000 of them are misclassified in official statistics and should be considered as temporary agency workers.

For the analyses in the paper, I will mostly use indicators related to the implementation of the primary legal aspects, due to their higher relevance in determining non-compliant behavior.

To better understand which firms are compliers or non-compliers, Table 3.A.1 in the Appendix provides descriptive statistics by the compliance status of firms. Compliers are smaller firms, who use temporary agency work less often and also do not as much consider contract work to be a better alternative. For compliers, wage savings are less often the reason for outsourcing. A significantly larger share of non-compliers outsource for reasons of wage savings and flexible labor input. Non-compliers also consider contract work a better alternative to temporary agency work. This is in line with the rationale that firms have incentives to reap the advantages of both forms of alternative work arrangements, which however may result in non-compliant behavior.

Answering questions related to features of non-compliance may be subject to social

Table 3.3.2: Defacto Implementation Features of CWS Indicating Compliance with TAW Regulations

	compliant if	share of firms
Panel A: Defacto implementation of individual aspects	answered with	
Primary Aspects		
Instructions: Are external workers regularly instructed by own employees?	No	69.15
Check: Do you control and interfere with the workflow of external workers?	No	68.47
Rework: Do you pay in case of rework?	No	56.09
Secondary Aspects		
Workspace: Do external workers have a separate work space?	Yes	50.07
Tools: Do external workers bring their own tools?	Yes	55.48
Tasks: Do external workers conduct the same tasks as your core workforce?	No	76.51
Panel B: Aggregating the non-compliant implementation practices		
Non-compliers primary aspects		6.64
Full compliers primary aspects		28.92
Full compliers all aspects		8.83

Notes: Firms are asked about the implementation practices of their CWS. Column 2 indicates the answer which is in line with CWS implementation and therefore compliant with TAW regulations. Column 3 lists the share of firms reporting the respective compliant implementation behavior. In Panel B, full compliers' implementation behavior respects primary/all aspects, non-compliers' implementation behavior violates TAW regulations in primary/all aspects. N=2,832 for primary aspects in Panel A and B. N=691 for secondary aspects in Panel A and all aspects in Panel B.

desirability bias. Firms may be reluctant to report illegal behavior and hence the reported non-compliance has to be considered a lower bound information. However, given the observed extent to which firms report indications for non-compliance, social desirability bias seems to be small. This may be due to different reasons. First, firms may not be aware that their behavior possibly violates TAW regulations and their non-compliance is deriving from ignorance. Second, firms might be aware of the legal setting but do not mind breaking TAW regulations given that sanctions are small and unlikely. If the latter is the case, firms' non-compliance has to be considered as fraudulent behavior. I therefore need to assess the legal literacy of firms and understand whether firms can differentiate between contracts for work and services and temporary agency work in principle.

3.3.2 Assessment of Knowledge by a Choice Experiment

In order to investigate the extent of firms' knowledge about the two forms of external staffing, I make use of a choice experiment in the survey. In such experiments respondents are asked to choose from or rate multiple hypothetical descriptions (vignettes) that vary

along different dimensions. The dimensions included in the vignette are presumed to be relevant determinants of the overall situation. One of the first applications of vignette studies was by Rossi et al. (1974) in order to investigate how various characteristics of household members add to the social standing of their common household. The seminal paper was followed by applications in various social sciences, especially sociology, covering fields like crime, law, sex and gender (see Wallander (2009) for a systematic review of factorial surveys in sociology). In economics, choice experiments are increasingly applied to answer questions of racial discrimination in the labor market (Bertrand and Mullainathan, 2004), naturalization (Hainmueller and Hangartner, 2013) and attitudes towards migration (Hainmueller and Hopkins, 2015).

In the study at hand, a vignette is a hypothetical but specific implementation situation describing external staffing to which the respondent has to assign the label "temporary agency work" or "contract for work and services". Each vignette is composed of six dimensions which represent the primary and secondary aspects relevant for the legal distinction of TAW and CWS as discussed in Section 3.2.3. Each dimension describes either the feature of temporary agency work or contract for work and services. Hence, the respondent is asked to evaluate fictitious settings where the overall situations vary from clear cut temporary agency work to clear cut contract work, and the grayzone in-between.

Table 3.A.2 in the Appendix lists all dimensions with their respective attributes and indicates whether they represent a situation legally associated with a contract for work and services or temporary agency work.

The vignettes used in the survey are constructed by combining the six dimensions, randomly choosing one level of each dimension. Beyond the varying vignette dimensions, one characteristic is held constant. The respondents are informed that the work or service is performed on their premises[12]. This situation is the necessary condition which allows the client firm to exert any form of managerial authority over the external workers. It initiates the legal distinction between temporary agency work and contract work.

[12]This includes also situations in which the user firm specifies any job site other than the contracting firm's.

An exemplary vignette including the introductory comments reads as follows:

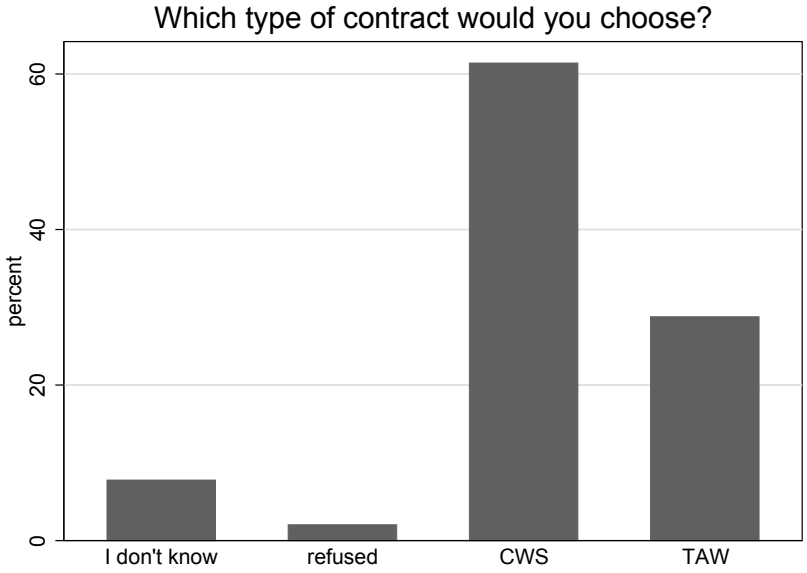
> Imagine a situation where you want a task to be performed by a third party firm. The contracting partner is another firm with employees. I will present you different variants of the general implementation and how the tasks are realized. For each variant, please evaluate whether you would choose a contract for work and services or a temporary agency work agreement as contracting form. In a next step please indicate, whether the scenario at hand is prevalent in your firm.
>
> *The work or service is performed on your firm's premises or a job site determined by your firm. The external workers conduct different tasks than your core workforce. The external workers work in a separate work space and bring and use their own tools. The external workers are instructed by an external supervisor. Your firm checks and accepts the final product. In case of a defect work, the external firm pays it to be remedied or newly produced.*

Each respondent has to evaluate 5 randomly selected situations out of 64 possible combinations and indicate which type of contract they would choose for the specific situation - a contract for work and services (CWS) or temporary agency work (TAW).

Figure 3.3.1 shows the resulting choices for all 3,200 vignettes. 61 percent of the vignettes were answered such that respondents would choose a contract for work and services, compared to 29 percent temporary agency work as contracting form. In 8 percent of the vignettes, respondents do not know which contracting form to choose and in 2 percent respondents refused to answer.

Respondents are twice as likely to choose CWS than TAW for any given hypothetical situation. This may be due to various reasons, which I can not investigate but only speculate. First, CWS is the seemingly unregulated form of external staffing and may be therefore preferred over TAW, also in cases where the aspects are not clear. Second, TAW can only be arranged with a limited number of licensed firms while CWS can be concluded with any firm and, as shown before, is therefore more common. Third, the survey that escorted the vignette study is focussed on CWS and hence participants might have been more inclined to choose this contracting form. However, none of the above discussed reasons is a threat to identification as I will use the variation over a set of vignettes for each respondent, regardless of the respondent's baseline bias for one of the two contracting forms.

Figure 3.3.1: Dependent variable - Chosen Contracting Form in the Choice Experiment



Notes: Relative Frequency of answers to the question "Please evaluate whether you would choose a contract for work and services or a temporary agency work agreement as contracting form.", N=3200.

It is however important that the attributes are orthogonal over all dimensions. Orthogonality is ensured by including all possible combinations in the survey and randomizing the vignettes. Table 3.A.3 in the Appendix shows the sample statistics at the vignette level. The first six rows show how often each dimension's attribute took the description of a setting in line with CWS characteristics. For all six dimensions this value is around 50%, indicating that the randomization is conducted properly. This is also true for the linked sample, where the experimental data is combinded with defacto implementation practices. Furthermore, for about 10 percent of all vignettes, the three primary aspects congruently represent CWS or respectively TAW. For 40 percent of the vignettes the respondents indicate that this hypothetical situation is also prevalent at the firm.

By randomizing each dimension's content (attributes) independently, the vignette universe has the feature of factor orthogonality. This allows to estimate the relative importance of each attribute for the resulting choice and results in high internal validity by experimental design. As the respondents are unlikely to be fully aware of the controlled variation, their answers are supposed to be less affected by social desirability bias than

in conventional surveys (Alexander and Becker, 1978). In addition to internal validity, Hainmueller et al. (2015) show a relatively high external validity of vignette analyses if targeted at the appropriate sample.

Table 3.3.3: Sample Statistics - Firm Level

	Full Sample	Vignette Sample	Linked Sample
Firm characteristics	N=8,457	N=593	N=222
Share of firms using CWS for external staffing	0.9297	0.9293	1***
Share of firms being contractor	0.5732	0.5552	0.5270*
Share of firms using TAW for external staffing	0.1201	0.1366	0.0807**
Share of firms beeing aware of legal grayzones	N/A	0.3502	0.3767
Share of firms inclined to use CWS in unclear situation	N/A	0.3491	0.3649
Average number of employees	85.68	144.27*	49.80***
Compliance characteristics	N=2,832	N=234	N=222
Instructions: compliant behavior	0.6915	0.6910	0.6847
Check: compliant behavior	0.6847	0.6496	0.6441*
Rework: compliant behavior	0.5609	0.6395**	0.6351***
Share of firms being full complier (primary)	0.2892	0.3291*	0.3243
Share of firms being non-complier (primary)	0.0664	0.0556	0.0586

Notes: Firm characteristics are available for all firms, compliance characteristics for a subsample thereof. Sample sizes are indicated respectively. Significant differences from the full sample statistics are indicated by * p<0.10, ** p<0.05, *** p<0.01. N/A indicates that variable is not available for this sample.

Table 3.3.3 shows the sample statistics for the full set of firms in the COOP, for the firms participating in the vignette survey (survey #2 used in Section 3.4.1) and for the linked sample used for the defacto-comparison in Section 3.4.2. The samples are relatively similar in their characteristics with regards to being a client firm (more than 90%) and contractor (around 55%) of contracts for work and services. About one third of the firms indicate to be aware of legal grey areas of TAW regulations when dealing with CWS and also one third reports to be more inclined to use CWS rather than TAW agreements in any setting of external staffing. The vignette sample has a higher share of firms using also TAW and has a larger number of employees. The share of full compliers is slightly larger in the vignette sample than in the full survey sample. Hence, the firms in the vignette sample are similar to the overall sample with respect to the CWS characteristics, but are more likely to comply, use TAW as well and are larger. The average firm in the vignette

sample might therefore be more aware of TAW regulations than an average firm overall.

3.4 What Do Firms Know and Do They Abuse?

To analyze the legal literacy of firms based on the choice experiment, I will estimate

$$CWS_i = \alpha_d Dimension_{di} + \gamma_f + u_i$$

where CWS_i is a binary variable indicating that CWS was the choice for a given vignette i. $Dimension_{di}$ is the vector of the six dimensions consisting of binary variables which take the value of 1 if the respective dimension takes up the attribute of a contract for work and services, ($Dimension_{di}$=1|$attribute_{di}$=CWS). In order to find the marginal effect of each dimension regardless of individual baseline preference for CWS or TAW the estimation is run with a firm fixed effect γ_f. This estimation allows to identify the marginal effect that individual dimensions have on the choice for the appropriate contracting form. To analyze if firms' non-compliant behavior has to be considered as ignorant or rather fraudulent, some specifications will restrict the sample to various firm level information, such as the defacto implementation situation[13]

3.4.1 Basic but no Detailed Knowledge

Based on the features described in Section 3.2.3 of the legal distinction between temporary agency work and contracts for work and services, I derive some hypothesis on how the knowledge of respondents should be shaped.

Given the relative importance of primary to secondary aspects in determining the legal form, the primary dimensions should be especially important in determining the choice of the appropriate contracting form.

Only if the set of primary aspects is indecisive, the set of secondary aspects plays a role in the juridical assessment. Hence, if firms are informed, secondary aspects should

[13]Note, that due to fixed effects any firm level information would have to be interacted with the variables of the hypothetical situation, resulting in long output tables which are hard to read. For simplicity I refrain from displaying interaction terms and instead provide the results of sample split estimates. The results for estimations with interaction term are similar in their interpretation to the presented sample split results and are available from the author upon request.

only be a determining factor for the decision if the set of primary dimensions presents an unclear picture and does not help in determining the correct contracting form in the first place. However, the law is relatively complex and also the federal employment agency provides little help for firms. Hence, I furthermore expect that some firms do not know how to distinguish the two contracting forms.

Table 3.4.1 shows the results on the question whether firms have knowledge about the legal aspects in differentiating between TAW and CWS. The estimations in column 1 and 2 compare OLS and Fixed Effects estimators. Given that the estimations yield similar results, there seems to be no large respondent fixed effect of a baseline preference for one of the two contracting forms. Table 3.A.4 in the Appendix also includes a Probit estimation in order to account for the dichotomous dependent variable. Predicted marginal effects are similar to the fixed effects specification, which will be used throughout the paper.

Table 3.4.1: Results - Hypothetical Knowledge

Dep.Var: CWS chosen for hypothetical setting	(1) OLS	(2) FE	(3) firm uses TAW	(4) primary = CWS	(5) primary = TAW
instructed by ext. supervisor	0.115***	0.116***	0.194***		
	(0.015)	(0.015)	(0.041)		
final product is checked	0.049***	0.051***	0.125***		
	(0.015)	(0.015)	(0.039)		
rework paid by ext. firm	0.108***	0.111***	0.155***		
	(0.016)	(0.017)	(0.046)		
separate work space	0.057***	0.060***	0.021	0.211***	0.161***
	(0.015)	(0.016)	(0.042)	(0.078)	(0.06)
own tools	0.027**	0.028**	0.039	-0.075	-0.019
	(0.013)	(0.014)	(0.033)	(0.087)	(0.066)
different tasks	0.044***	0.043***	0.076*	-0.016	-0.003
	(0.015)	(0.015)	(0.042)	(0.082)	(0.062)
Constant	0.428***	0.425***	0.269***	0.674***	0.436***
	(0.025)	(0.02)	(0.048)	(0.064)	(0.053)
OLS/FE	OLS	FE	FE	FE	FE
R^2	0.0668	0.067	0.142	0.129	0.088
N	3013	3013	470	358	376

Notes: * p<0.10, ** p<0.05, *** p<0.01, standard errors clustered at the firm level presented in parenthesis. OLS estimation includes controls at the firm level: multicooperation, collective bargaining, competition, workers council, tenure of respondent. Specifications (2)-(5) include firm fixed effects. Specification (3) restricts the sample to firms using TAW. Specifications (4) and (5) restrict the sample to vignettes where all three primary dimension unambiguously indicate a setting under TAW or CWS respectively.

In all specifications the vignette dimensions have a significant positive marginal effect on explaining the choice for the appropriate contracting form. If the specific vignette description included the information that external workers have a separate work space, the responded was 6% more likely to choose CWS as the resulting contract. The magnitude of the point estimate varies with the dimensions. Especially two primary aspects which are highly relevant for a legal distinction show the largest coefficients. Vignettes which stated that the workers are instructed by an external supervisor increase the choice of CWS by 11.6%. Hypothetical situations where rework is paid by the external firm show an increase of 11.1% in the probability of CWS being chosen. All dimensions describing a situation in line with CWS have a significant positive effect on the choice of CWS as contracting form. The coefficients of the primary aspects together are significantly[14] larger than those for the secondary aspects in sum. This indicates that firms have a baseline knowledge of the aspects and also their relative importance in differentiating TAW and CWS.

Firms that employ TAW might have a better knowledge of the regulations related to its usage. Column 3 restricts the sample to firms using TAW. They have larger point estimates for the primary aspects and secondary aspects are less significant. Firms which are using temporary agency work have therefore a higher legal literacy in differentiating it from contract work.

The random composition of vignettes creates heterogeneous situations which are distributed over the full scale of the legal grayzone. Hence, some of the vignettes do not allow for a proper distinction between TAW and CWS. Yet, a subset of vignettes clearly identifies either TAW or CWS. This is the case if all primary aspects take on the characteristics of one contracting form, i.e. all primary aspects indicate either CWS or TAW. Columns 4 and 5 restrict the sample to vignettes where the legal distinction of CWS and TAW is clear. In those specifications the coefficients of the secondary aspects are insignificant apart from the information that workers are using a separate workspace[15]. Given that the primary aspect unambiguously indicate one of the two contracting forms, none of the secondary aspects should have an effect on the choice. In the case of all primary aspects indicating TAW, the constant is expected to be lower than in the pooled

[14]Wald test for coefficients Instructions + Check + Rework = Workspace + Tools + Tasks: $\chi^2(1) = 16.09$; Prob $> \chi^2 = 0.0001$.

[15]The three primary aspects are not included due to multicollinearity.

estimations if respondents were able to differentiate the two forms. Hence, even in the case of unambiguous hypothetical situations, the respondents make their choices on a low level of legal knowledge, similar to the previous specifications. Therefore, they are partially aware of secondary aspects not being relevant in the case of unambiguous primary aspects, yet have a high baseline preference for CWS. Additional specifications do not change this assessment of a basic but limited knowledge of the legal aspects (Table 3.A.4 in the Appendix). Firms that report to be more inclined to use CWS rather than TAW in any staffing situation do not show a different response behavior. This is true also for firms stating that they are aware of the legal grayzone.

Over all specifications the constant keeps a relatively high level. Hence, the respondents still choose CWS with a chance of approximately 40% even if all dimensions point towards TAW rather than CWS. This is not unexpected considering that more than 60% of the vignettes led to the choice of CWS already in the descriptive statistics (see Figure 3.3.1). Summarizing the results, I can infer that agents have basic knowledge of the regulations. Yet, the regulatory details are too complex to be fully applicable. The unregulated contract work seems to be the default option for users of external staffing arrangements. Firms using TAW as well show a slightly higher legal literacy.

3.4.2 Negligently Ignorant Behavior

So far I have shown that firms have a basic knowledge of the legal aspects related to the differentiation of CWS and TAW. Now I analyze whether firms' non-compliant behavior from the descriptive part of the paper has to be considered as ignorant or rather fraudulent. To this end, I combine the hypothetical legal knowledge from the vignettes with information on how the respective firm defacto implements their contracts for work and services.

On the one hand, I can investigate firms whose defacto use is consistent with CWS and therefore fully compliant with TAW regulations. On the other hand I can also identify if firms' defacto use of CWS shows all features of TAW and therefore violates TAW regulations. I will furthermore include information on whether the hypothetical setting is known at the firm as they reported to implement such a form of external staffing. If the

situation is known at the firm the choice of the respondent can be considered to be more informed.

As the information about defacto implementation is available only for the linked subset, sample size decreases. Table 3.4.2 shows the respective estimation results. Column 1 reruns the baseline specification from the previous section on the smaller sample. Comparing the results with those of the full sample (Table 3.4.1, (2)) reveals that the linked sample shows a higher legal literacy. The choice of CWS as contracting form is predominantly determined by the primary aspects, while the secondary aspects are less or not significant.

The next specification includes information on whether the hypothetical setting is known and implemented as such. In firms where the situation is known, we can expect the choice of the contracting form to be more informed. The coefficients are at best marginally significant. The pure existence of such an implementation at the firm level has therefore no effect on determining the correct form of contract.

Specification 3 to 6 exploit information on the defacto implementation of CWS at the firm. Firms' defacto use of CWS can be non-compliant or compliant with respect to the three primary aspects and all six aspects. Specification (3) analyses firms where all three primary aspects are implemented such that they are non-compliant with TAW regulations, showing interesting results. The coefficients are insignificant on all vignette dimensions, indicating that non-complying firms do not even show a baseline knowledge of the legal differentiation. Coefficients of some aspects are even negative, yet not distinguishable from zero, indicating a perverted impression of how contract work should be implemented. Fully complying firms on the other hand, are better able to discriminate temporary agency work from contract work. If vignettes indicated that instructions are given by an external supervisor and the other firm pays for rework, they are more likely to chose CWS as the correct contracting form (Specification 4). A similar picture can also be observed for compliance or non-compliance with respect to all six legal aspects (Specifications 5 and 6). However, even for complying firms the constant is at 0.544. Hence, they marginally react to the individual legal aspects but are choosing CWS as contracting form in 50 percent of cases which indicate that temporary agency work is the appropriate form. Compliers therefore show a similar baseline legal literacy as demonstrated before, while non-compliers cannot discriminate between the two forms of external staffing at all or

Table 3.4.2: Results - Fraud or Ignorance

Dep.Var: CWS chosen for hypothetical setting	(1) base FE	(2) vignette sit. known	(3) Non-complier primary aspects	(4) Full complier primary aspects	(5) Non-complier all aspects	(6) Full complier all aspects
instructed by ext. supervisor	0.132***	0.049*	-0.036	0.138***	0.028	0.282**
	(0.025)	(0.029)	(0.055)	(0.042)	(0.094)	(0.115)
final product is checked	0.063***	0.075**	0.178	0.034	0.206	-0.022
	(0.024)	(0.033)	(0.115)	(0.045)	(0.12)	(0.094)
rework paid by ext. firm	0.106***	0.001	0.02	0.095**	-0.029	0.137
	(0.027)	(0.035)	(0.091)	(0.044)	(0.106)	(0.113)
separate work space	0.056**	0.037	-0.124	0.013	-0.236*	-0.033
	(0.025)	(0.032)	(0.076)	(0.038)	(0.121)	(0.072)
own tools	0.013	0.004	0.057	-0.028	0.075	0.034
	(0.021)	(0.024)	(0.063)	(0.039)	(0.1)	(0.048)
different tasks	0.031	0.039	0.038	0.038	0.114	0.122
	(0.024)	(0.037)	(0.054)	(0.043)	(0.09)	(0.08)
Constant	0.457***	0.693***	0.530***	0.544***	0.749***	0.567***
	(0.031)	(0.041)	(0.072)	(0.061)	(0.046)	(0.105)
FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.073	0.033	0.15	0.072	0.228	0.272
N	1235	536	75	377	55	52

Notes: * p<0.10, ** p<0.05, *** p<0.01, standard errors clustered at the firm level presented in parenthesis. All specifications include firm fixed effects. Specification (1) reruns Specification (2) from Table 3.4.1 on the smaller sample. Specifications (2)-(6) restrict the sample to firms: (2) reporting that the hypothecial situation is known at the firm; (3) noncomplying with all three primary aspects; (4) fully complying with all three primary aspects; (5) noncomlying with all six aspects(6) fully complying with all six aspects.

might even confuse them.

Whether firms comply or non-comply knowingly can also be analyzed on the firm level. I therefore calculate an indicator for the share of "correct" choices in the survey experiment. An answer is considered correct if the choice in the experiment corresponds with the appropriate type of contract. As this is feasible only in cases where vignettes describe unambiguous situations[16], approximately 20% of the vignette sample can be used. The correctness indicator reports the share of correct choices among unambiguous vignettes at the firm level and ranges from 0 to 1, where the upper end indicates that for all hypothetical legal unambiguous situations the appropriate contracting form was chosen.

Table 3.4.3 shows the correlation of different non-compliance indicators with the share of correct choices in the experiment. In column 1 and 2 non-compliant behavior in the primary and respectively secondary aspects at the firm level is counted. In column 3 all six aspects are taken into account. Column 4 and 5 use dummy variables indicating if a firm is a full complier or non-complier with the primary aspects. All correlations are negative but insignificant. The negative sign would indicate that firms with higher legal literacy - measured by correct choices - show less non-compliant behavior, implying that legal literacy comes along with compliance. However, based on a smaller subset of firms and vignettes, there is no significant indication for either fraudulent or negligent behavior.

In summary, it can be said that if the hypothetical situation is known at the firm it does not change the respondents' ability to better discriminate between CWS and TAW. For compliant firms, the choice of type of contract is determined by a basic but not detailed knowledge of the legal aspects. Firms that show a high level of defacto non-compliant behavior lack any legal literacy when it comes to discriminating between CWS and TAW. This implies that they are not fully aware of the TAW regulations and their non-compliant behavior is due to ignorance rather than fraudulence.

At this point, I want to stress that the analysis of this paper is limited such that it cannot identify juridical non-compliance. Even if I classify some firms' implementation practices as non-compliant, it does not imply that their behaviour would be considered

[16]Vignettes are considered unambiguous if the set of the three primary aspects congruently indicates either CWS or TAW

Table 3.4.3: Results - Fraud or Ignorance - Firm Level

	(1)	(2)	(3)	(4)	(5)
	counting defacto non-compliant aspects			full	non-
Dep.var.:	primary [0-3]	secondary [0-3]	all [0-6]	complier primary	complier primary
Share of correct choices in experiment [0-1]	-0.068	-0.466	-0.968	-0.107	-0.060
	(0.164)	(0.413)	(0.628)	(0.088)	(0.041)
Constant	1.986***	2.606***	4.790***	0.405***	0.099*
	(0.219)	(0.602)	(0.916)	(0.118)	(0.055)
All controls included	Yes	Yes	Yes	Yes	Yes
R^2	0.066	0.254	0.292	0.063	0.090
N (firms)	172	48	48	172	172

Notes: OLS estimations, standard errors displayed in parenthesis, * p<0.10, ** p<0.05, *** p<0.01. Dependent variable is a count variable for specifications (1)-(3), counting the number of defacto non-compliant implementation practices at the firm; dependent variable is a dummy variable for specifications (4) and (5), indicating whether a firm defacto fully complies with all three primary aspects or none.

illegal in a trial at court. The survey uses questions which are underlying the investigations by labor inspectors and judges as well. Yet the survey is simplifying ambiguous situations and misses out the details an in-depth inspection would probably find. Nonetheless, non-compliant firms as defined in my analysis can be considered suspected cases where labor inspectors start a thorough investigation.

The results of my analyses are in line with the economic literature and theories on compliance. In Germany the probability of being caught and the amount of the fine to be paid are both small. In the absence of a credible threat, non-compliance is the optimal choice for firms. It is therefore not surprising that there are indications for a considerable size of non-compliance with TAW regulations. Behavioral economics provides insights into how regulations should be designed. On the one hand, it has been shown that agents prefer default options. When implementing external staffing CWS seems to be the default option. This is a reasonable choice considering that this is the seemingly unregulated contracting form. On the other hand, regulations should be simple and convenient in order to allow agents to understand and willingly comply with them. The more detailed regulations are, the more likely they are to be misunderstood. The fairly complex regulatory setting in Germany comes at the cost of legal literacy of the affected firms. Overall, firms are equipped with basic knowledge at best.

3.5 Conclusion

In this paper I investigate compliance or non-compliance with Temporary Agency Work Regulations when firms implement external staffing by contracts for work and services. Due to the lack of enforcement in Germany, firms have incentives for non-compliance as this enables them to make use of the advantages of both alternative work arrangements by discarding their respective disadvantages.

I find indications for non-compliance with temporary agency work regulations when firms outsource to service contractors: seven percent of outsourcing firms officially use a Contract for Work and Services as contracting form but implement it like temporary agency work and hence consist a group of non-compliers. The workers are officially labelled as contract workers while in fact they conduct work which should be subject to temporary agency work regulations and registration. Official statistics hence under-report the defacto extent of TAW in Germany. Officially registered temporary agency work amounts to 990.000 workers in 2016. Possibly up to 400.000 contract workers are misclassified, hence about 28 percent of defacto temporary agency work may not be reported as such in official statistics. By outsourcing to service contractors, firms can avoid paying minimum wages of the temporary agency sector and exclude the workers from firm wage premia, which may cause substantial earnings losses for the affected workers.

Furthermore, I find that firms have a basic knowledge of the differentiation between the two forms of alternative work arrangements. On average they do not exhibit a detailed legal literacy and have a bias towards the unregulated outsourcing to service contractors. Firms using temporary agency work as well, are better able to differentiate the two staffing arrangements than firms not employing temporary agency workers. Moreover, I find that non-complying firms show basically no legal literacy in differentiating contract work from temp work. Hence, they do not know better when non-complying with temporary agency work regulations. The limited legal literacy of most of the firms indicates that regulations are too complex and the legal aspects are not fully understood. Many firms implementing contract work are not aware of the problematic legal grayzone with respect to temporary agency work. The analysis of legal literacy is based on a sample not fully representative for German firms, hence I might miss the fraudulent misclassifications. Nevertheless,

this work provides evidence for non-compliance with the regulations of temporary agency work. While firms presumably profit from their actions, the effects for affected workers are unclear and a question for further research.

The intention of legislators to protect the vulnerable temporary agency workers misses its target if the group is not fully captured. As I do not find indications for informed non-compliance, increasing the ability to comply would be the first course of action in order to increase compliance with temporary agency work regulations. Providing helpful information and reducing the complexity of regulations would help agents to better understand and classify their external staffing arrangements. Another credible way to ensure enforcement of the regulations is to increase the incentives to comply with them. In order to make compliance the optimal choice in the German setting, the costs and probability of being caught could be increased. This in turn may reinforce also the incentives for firms to be informed, thereby having an effect on both the ability and the willingness to comply. There are various methods to incentivize compliance, starting with increasing fines for non-compliers or establishing a unit of labor investigators dedicated to this issue. Collecting data on the use of contracting out on an administrative level would support enforcement by improving labor investigators' chances of finding non-complying firms. Moreover, it would improve the data base for further research on the effects of outsourcing to a service contractor.

Appendix

3.A Additional Tables

Table 3.A.1: Statistics on Compliers and Non-Compliers

	sample	full complier	non-complier
Outsourcing because of...			
Wage savings	36.1	31.8*	42.5***
Specialized staff	75.9	81.3	82.2
Better alternative to temporary agency work	27.7	23.5***	37.2***
Flexible labor input	40.3	32.9***	60.0***
Firm characteristics			
Average number of employees	37.8	26.6*	37.4
Firm uses TAW in %	12.0	6.5***	12.2
N	2,832	819	188

Notes: Sample in Column 1 includes firm for which compliance or non-compliance can be investigated. Significant differences from this sample are indicated by * p<0.10, ** p<0.05, *** p<0.01.

Table 3.A.2: Dimensions and Attributes of the Vignettes

Dimensions	**Attributes**	**Type of Contract**
Primary Aspects		
Instructions	1. The external workers are instructed by an external supervisor.	CWS
	2. The external workers are instructed by (one of) your employees.	TAW
Check	1. Your firm checks and accepts the final product.	CWS
	2. Your firm or one of your employees controls the work process.	TAW
Rework	1. In case of a defect work, the external firm pays it to be remedied or newly produced.	CWS
	2. In case of a defect work, your firm pays it to be remedied or newly produced.	TAW
Secondary Aspects		
Work space	1. The external workers work in a separate work space.	CWS
	2. The external workers work in the work space of the own core workforce.	TAW
Tools	1. The external workers bring and use their own tools.	CWS
	2. The external workers use the tools provided by your firm.	TAW
Tasks	1. The external workers conduct different tasks than your core workforce.	CWS
	2. The external workers conduct similar tasks as the core workforce.	TAW

Table 3.A.3: Sample Statistics - Vignette Level

	Full vignette sample	Linked vignette sample
Panel A: Individual vignette dimension takes the value of...		
work space representing CWS	0.5025	0.5008
work tools representing CWS	0.4946	0.5114
tasks representing CWS	0.5442	0.5081
instructions representing CWS	0.4775	0.4770
check representing CWS	0.4937	0.4819
rework representing CWS	0.5125	0.5065
Panel B: Aggregated vignette information		
all primary dimensions represent CWS	0.0975	0.1155
all primary dimensions represent TAW	0.1019	0.1229
vignette situation is known at firm	0.4040	0.4336
N	3200	1220

Notes: Panel A shows the share of how often the listed attribute of the six individual vignette dimensions were realized. Panel B shows the share of vignettes where all primary dimensions represent CWS or TAW respectively and how often firms indicated that the hypothetical situation is known at the firm.

Table 3.A.4: Results - Hypothetical Knowledge Part 2

Dep.Var: CWS chosen for hypothetical setting	(1) Probit	(2) marginal effects	(3) firms enclined to use CWS	(4) aware of legal grayzones
instructed by ext. supervisor	0.297***	0.110***	0.123***	0.140***
	(0.047)		(0.024)	(0.021)
final product is checked	0.110***	0.040***	0.063***	0.070***
	(0.47)		(0.023)	(0.023)
rework paid by ext. firm	0.269***	0.100***	0.144***	0.105***
	(0.047)		(0.024)	(0.023)
separate work space	0.135***	0.050***	0.054**	0.093***
	(0.047)		(0.024)	(0.022)
own tools	0.068	0.025	0.027	0.041**
	(0.047)		(0.02)	(0.02)
different tasks	0.123***	0.045***	0.073***	0.035
	(0.047)		(0.023)	(0.022)
Constant	-0.161***		0.420***	0.425***
	(0.062)		(0.029)	(0.029)
FE	No		FE	FE
N	3013		1343	1508

Notes: * p<0.10, ** p<0.05, *** p<0.01, standard errors clustered at the firm level presented in parenthesis. Specification (1) is a probit estimation, the corresponding marginal effects (dydx) are indicated in Column (2). Specification (3) restricts the sample to firms who are inclined to use CWS in unclear settings. Specification (4) restricts the sample to firms who are aware of legal grayzones.

Chapter 4

Minimum Wages and Solo Self-Employment [1]

4.1 Introduction

The share of self-employed individuals who operate on their own account without any employees – solo self-employed – is on the rise in most developed countries. According to Boeri et al. (2020), solo self-employment accounts for between 4 and 22 percent of total employment among OECD countries and is rising in almost half of them. Yet, little is known about the nature of these jobs. Boeri et al. (2020) argue that solo self-employed workers appear to be an intermediate category between employment and unemployment, supported by the fact that they share important characteristics with underemployed workers. Compared to traditional jobs and self-employed with employees, solo self-employed have lower earnings and working hours, a higher incidence of part-time and are often dependent on just one client (Boeri et al., 2020). Understanding the reasons for the surge in solo self-employment among developed countries has thus become an important research question to answer.

One potential reason for the rise in solo self-employment lies in its interaction with

[1]This chapter is joint work with Terry Gregory, Simona Murmann, and Ulrich Zierahn. An earlier version of this chapter is part of the dissertation by Simona Murmann (Murmann née Wagner, 2019). We gratefully acknowledge helpful comments by Christina Gathmann, Katrin Hussinger and Konrad Stahl as well as from conference and seminar participants at ESPE, EALE, EEA, IZA, University of Heidelberg, KIT and ZEW. We remain solely responsible for any remaining errors and imprecisions.

wage setting institutions such as minimum wage policies.[2] Despite lacking research, the existing literature suggests two potential links[3]. First, as a reaction to a minimum wage (or rising wages), employers adjust their workforce towards independent employment (e.g. contracting out) in order to save labor costs or avoid minimum wage regulations (Abraham and Taylor, 1996; Parker, 2010). Second, workers, who are laid off by employers in reaction to the minimum wage decide to become solo self-employed in search for alternative sources of income (Blau, 1987)[4]. So far, empirical evidence on the impact of a minimum wage on solo self-employment, and its mechanisms, is missing. Existing studies either provide only suggestive evidence in favour of a positive relationship between minimum wages and solo self-employment (Medrano-Adán et al., 2015), focus more general on self-employment without distinguishing between self-employed workers with and without employees (such as Blau, 1987; Bruce and Mohsin, 2006) or look at other forms of alternative work besides solo self-employment (Datta et al., 2019).

To close this gap, we provide new insights into the link between minimum wages and solo self-employment by making at least three main contributions. First, we investigate the long-run causal impact of a first-time minimum wage adoption on solo self-employment in a unique quasi-experimental setting. The assessment of a first-time adoption is possible for Germany because it introduced its first minimum wages on an industry level starting with main construction, roofing, electrical trade, and painting in the late 1990s. For institutional reasons, no other industries within and beyond the broader construction sector in Germany conducted such a policy intervention, thus providing us the opportunity to compare treated with uncovered, yet comparable, industries, within a control group approach. Note that most studies in the US are only able to look at minimum wage increases rather than a first-time adoption (Neumark, 2019). As a further advantage, the setting allows us to study the long-run consequences of the policy change due to the availability of long time series for both treated and control industries. More recent

[2]Other studies discuss more general reasons for an increase in alternative work forms without focusing on minimum wages. Reasons put forward include firm's rent-sharing with workers, new technologies that contract-out work, workforce aging, or a worsening of workers' bargaining position due to a depressed labor market (Katz and Krueger, 2017).

[3]More links have been discussed for general self-employment (see e.g. Bruce and Mohsin, 2006), which, however is not the focus of this study.

[4]Although Blau (1987) do not distinguish between self-employment with and without employees, their theory might also hold for solo self-employed.

studies have shown that long-run effects are likely to differ from short-run effects (Meer and West, 2016; Sorkin, 2015). Also, Germany's first industry-specific minimum wages are characterized by partly generous minimum wage levels (relative to the median wage) that were introduced during a phase of an economic downturn which is more likely to trigger potentially unfavorable adjustment including a shift from traditional to alternative work forms. All this makes our case an interesting object of study, especially against the background of rising minimum wage levels and a Covid-19 induced economic recession observed worldwide.

Second, to estimate the impact of a first-time minimum wage adoption on solo self-employment, we combine innovative data and methods. In particular, we exploit a relatively unexplored micro-level firm data set that comprises the universe of active firms in Germany and that allows, among others, to identify self-employed persons without any employees – solo self-employed – on a 3-digit industry level, which demarcate the first minimum wage regulations in Germany. We combine this data with industry-level statistics on the workforce prepared from a two percent random sample of all workers in Germany that are subject to social security contributions (i.e. excluding self-employed and public servants). Based on the combined data, we estimate the effect of a minimum wage introduction on the share of solo self-employed individuals across several industries using the synthetic control method proposed by Abadie and Gardeazabal (2003) and Abadie et al. (2010, 2015). As a major advantage compared to traditional Difference-in-Differences designs, the more recently developed method uses systematically more attractive comparisons (Athey and Imbens, 2017; Abadie, 2020). To apply the method, we are able to draw on a rich set of variables from our firm- and worker-level micro data. Several robustness checks further ensure that our constructed synthetic control industries mimic the counterfactual situation of the treated industries well. To our knowledge, we are the first to estimate the introductory effect of a minimum wage on solo self-employment. By doing so, we contribute to the literature on minimum wages and atypical work discussed above as well as literature trying to asses the determinants and consequences of alternative work arrangements more generally (e.g. Katz and Krueger, 2017, 2019a).

Third, we develop a substitution-scale model to explain a minimum wage-induced shift from dependent employment to solo self-employment. Building on Gregory and Zierahn

(2020), we model the minimum wage as an increase in wages for low-skilled workers that induces firms to substitute low- by high-skilled workers as a reaction to the change in relative input prices. At the same time, all workers suffer from a negative scale effect in reaction to the overall increase in firm's labour costs. The net effect for high-skilled workers then depends on the relative size of the scale relative to the substitution effect. In a context of an economic downturn with a rising minimum wage bite, the scale effect is likely to exceed the substitution effect, so that a minimum wage leads to a net decline in labor demand and wages for high-skilled workers. As an extension to Gregory and Zierahn (2020) who focus on spillover effects of minimum wages, we further show how deteriorating earnings perspectives of high-skilled workers in traditional jobs induce as shift towards solo self-employment. Up to the authors knowledge, our model is thus the first to provide a comprehensive framework that allows to study the link between minimum wages and solo self-employment. Our model complements not only the few existing studies on minimum wages and solo self-employment mentioned above, but also adds to the literature on minimum wage spillovers (Gopalan et al., 2020; Phelan, 2019).

Fourth, we test our models' predictions related to the mechanisms through which a minimum wage impacts solo self-employment. For this, we assess the effect of a minimum wage introduction on overall employment and total industry size (scale effect), the share of high-skilled workers (substitution effect) as well as on absolute employment of high-skilled workers (net effect). Given the large variation of minimum wage levels relative to the median wage (the minimum wage bite) across industries and parts of Germany at the time of the policy introduction and thereafter, we further investigate whether the size of the minimum wage bite plays a role in determining the magnitude of our estimated effects. Finally, we investigate the minimum wage effect on solo self-employed revenues in order to shed light on the earnings perspectives of these new alternative work relationships. By doing all this, we provide empirical evidence for our proposed substitution-scale model as well as for the economic conditions that enforce these adjustments, such as a rising minimum wage bite in poor economic times. Moreover, our estimates for employment and revenues contribute to the existing minimum wage literature focusing on more traditional outcomes by, among others, adding evidence for different skill groups as well as providing alternative estimates using the newer synthetic control method.

Overall, we find that the minimum wage introduction led to an accumulated increase in the share of solo self-employed workers six years after the policy reform between 2.4 and 10.5 percentage points, depending on the industry and region. In line with our substitution-scale model, we find a negative impact of the minimum wage on labor demand and wages for high-skilled workers. These deteriorating earnings perspectives of high-skilled workers suggest a shift from dependent employment towards solo self-employment in response to the minimum wage. Moreover, our results indicate that the revenues of new solo self-employed have declined or stagnated in the aftermath of the policy reform, suggesting that the minimum wage pushes workers with worse entrepreneurial ability into solo self-employment. Finally, we demonstrate that the magnitude of our effects significantly increases with the minimum wage bite, indicating that generous minimum wage levels in economic downturns trigger such adjustments.

The paper is structured as follows. In Section 4.2, we develop a theoretical framework to explain how a minimum wage introduction affects solo self-employment and derive testable hypotheses from our theory. In Section 4.3, we briefly describe the institutional background in Germany. Section 4.4 introduces the data and provides descriptive statistics, before Section 4.5 then describes our synthetic control approach. The main results are then discussed in Section 4.6 with robustness checks in Section 4.7. Section 4.8 concludes.

4.2 Theoretical Framework

In this section, we develop a stylized framework to explain how minimum wages affect workers' decision to become solo self-employed. The framework serves to illustrate the mechanisms through which minimum wages affect solo self-employment and to derive under which conditions the effect of minimum wages on solo self-employment is positive or negative. By shedding light on these mechanisms and conditions, we aim to guide the empirical analyses. We do not aim to provide a structural model of the industries. Our model builds on the minimum wage spillover model by Gregory and Zierahn (2020), but extends the model to allow high-skilled individuals to choose solo self-employment

as an alternative to dependent employment.[5] We first briefly describe the main set-up before discussing the consequences of minimum wages for the labor market and solo self-employment. The details of the model are in Appendix 4.A.

4.2.1 Main Set-Up

Assume that firms produce varieties of a final output. The price elasticity of demand for the aggregate output of the firms Q_f is ϵ. Each firm produces a single variety of the output and consumers have Constant Elasticity of Substitution (CES) preferences over these varieties with elasticity of substitution σ between the varieties. We assume an analogous structure for the demand for the varieties and aggregate output produced by solo self-employed, using index s instead of f. The focus of our framework lies on interactions between the industries via the labor market. Accordingly, we abstract from interactions between firms and entrepreneurs on the product market to keep the analysis simple and traceable.

Firms i require a fixed non-artisan input f and a variable artisan labor input $n_i = q_i/\varphi_i$ with average wage costs $\bar{w}$. We assume Melitz (2003) type firm heterogeneity. There exists a large mass of potential entrepreneurs M_e who face fixed costs f_e of entering the industry and who randomly draw productivity φ_i from a Pareto distribution with minimum productivity φ_{min} and shape parameter k. We focus on artisan employment and do not further consider non-artisan employment (who are not covered by the minimum wage and who are no substitutes to artisan labor). Assuming free entry, industry demand for labor is $N = \bar{w}^{-\tilde{\epsilon}} Q_0 K$, where $\tilde{\epsilon} \equiv \epsilon + \frac{\epsilon-1}{1-\sigma} + \frac{\epsilon-1}{k}$ is the wage elasticity of industry labor demand and Q_0 and K are constants. Industry labor demand declines in average wages.

The industry labor input N is an aggregate of high-skilled H and low- and medium-skilled L labor inputs with constant elasticity of substitution η between these two types of labor. We do not further distinguish between low- and medium-skilled workers, because the focus of our study lies on the high-skilled workers and to keep the model simple

[5] While the underlying idea of how the minimum wage affects heterogeneous workers is similar in both models, the model differs in several ways. Most importantly, we allow high-skilled workers to become solo self-employed. In addition, there can be a positive substitution effect on high-skilled workers in our model whereas there is no substitution to high-skilled workers in Gregory and Zierahn (2020). Moreover, our model covers firm heterogeneity.

and focused.[6] The wage cost index $\bar{w}$ depends on the wages of high-skilled w_H and low- and medium-skilled w_L workers. Industry demand for high-skilled workers then is $H = w_H^{-\eta}\bar{w}^{\eta-\tilde{\epsilon}}Q_0K$. It declines in high-skilled workers' wages while either in- or decrasing in the average wage costs, depending on the relative sizes of the elasticity of substitution between worker types η and the wage elasticity of industry labor demand $\tilde{\epsilon}$.

There is a large mass of low- and medium-skilled workers L^S who work if their wage is at least as large as their reservation wage, $w_L \geq \underline{w}$. We assume that low- and medium-skilled labor supply exceeds labor demand $L^S > L$, so that these workers earn their reservation wage, unless there is a minimum wage w_{min} which exceeds their reservation wages $w_L = \min(\underline{w}, w_{min})$. This assumption is motivated by the empirically large unemployment rate among low-skilled workers and it ensures that they earn the minimum wage (if it exceeds reservation wages). We study the case of a minimum wage which is larger than low- and medium-skilled workers' reservation wage but lower than high-skilled workers' equilibrium wage, $\underline{w} < w_{min} < w_H$.

Assume that there exists a finite mass of high-skilled individuals $\bar{H}$ who can choose between dependent employment as high-skilled workers, earning wages w_H, or solo self-employment in the same industry. We do not consider an outside option for them, since labor mobility among high-skilled workers is extraordinary low due to the specificity of their skills. In the German crafts industry, high-skilled workers hardly ever switch between industries, as the skills which they learned in their apprenticeship training are so specific to the industries that they are not easily applicable in other industries.

Self-employed produce with technology $z = q_s$ where z are intermediate inputs and q_s is output. Profit maximization implies that prices are a constant mark-up over the marginal costs, which are defined by the exogenous costs of the intermediate inputs p_z. Free entry implies that new self-employed enter the market until profits correspond to high-skilled workers' wages w_H. We assume that high-skilled individuals differ in their entrepreneurial ability ϕ, indicated by the size (or quality) of the projects that they can

[6] We could alternatively assume that L is a CES aggregate of low- and medium-skilled workers, as in Gregory and Zierahn (2020). This would imply substitution between these two type of workers – the minimum wage raises employment and wages of medium-skilled workers at the expense of low-skilled workers. However, the effects on high-skilled workers would still depend only on the increase in average wage costs and wages of high-skilled relative to the other workers. Our results for high-skilled workers would thus remain qualitatively unchanged.

handle $q_s(\phi) = \phi$. Assume that high-skilled individuals randomly draw their ability ϕ from distribution $\phi = (1-s)^{\kappa}\phi_{max}$, where $0 \leq s \leq 1$ is the share of high-skilled individuals who are self-employed, ϕ_{max} is the maximum ability and κ is a distributional parameter. This distribution approximates a Pareto distribution for $\kappa \ll 1$ and contains the uniform distribution for $\kappa = 1$. We choose it because it allows for analytically tracable results. With these assumptions, high-skilled labor supply is $H = \bar{H} w_H^{1/\kappa} \phi_{max}^{-1/\kappa}$. This implies that high-skilled labor supply increases in their wages – and analogously solo self-employment declines in high-skilled workers' wages.

With these assumptions, we derive high-skilled workers' equilibrium wages

$$w_H = \left(\bar{w}^{\eta-\tilde{\epsilon}} Q_0 K \phi_{min}^{1/\kappa} \bar{H}^{-1}\right)^{\frac{\kappa}{1+\kappa\eta}} \tag{4.1}$$

Jointly with the CES wage cost index $\bar{w}$, this equation describes the equilibrium on our industry labor market.

4.2.2 Effects of a Minimum Wage

We study the effects of an introduction or a rise of a minimum wage on the industry.

Proposition 1 (Scale Effect)**.** *The introduction or rise of a minimum wage*

1. *raises average wage costs,* $\frac{\partial \ln \bar{w}}{\partial \ln w_{min}} > 0$,
2. *reduces industry employment* $\frac{\partial \ln N}{\partial \ln w_{min}} < 0$,
3. *raises the cut-off productivity level for firms* $\frac{\partial \ln \psi^*}{\partial \ln w_{min}} > 0$,

Proof. Changes in average wages are $\frac{\partial \ln \bar{w}}{\partial \ln w_{min}} = \alpha + (1-\alpha)\frac{\partial \ln w_H}{\partial \ln w_{min}}$, where α is the steady state share of high-skilled workers. Using this jointly with equilibrium high skilled wages (Equation 4.1) provides $\frac{\partial \ln \bar{w}}{\partial \ln w_{min}} = \frac{\alpha/\kappa+\eta}{1/\kappa+\alpha\eta+(1-\alpha)\tilde{\epsilon}} > 0$.

This implies a decline in industry labor demand, $\frac{\partial \ln N}{\partial \ln w_{min}} = -\tilde{\epsilon}\frac{\partial \ln \bar{w}}{\partial \ln w_{min}} < 0$.

Increasing wages imply an increase in the cut-off productivity level for firms, $\frac{\partial \ln \psi^*}{\partial \ln w_L} = \frac{1}{\kappa}\frac{\partial \ln \bar{w}}{\partial \ln w_L} > 0$.

□

The minimum wage implies a cost shock to the industry. Average labor costs increase, leading to rising prices, declining product demand, and thus a shrinkage of the industry that implies a decline in industry employment N. The shrinkage of the industry is associated with stricter firm selection – the least productive firms are forced out of the market as the cut-off productivity level increases and the number of firms declines. This effect is our scale effect. It implies a scaling-down of overall employment N. The size of the effect increases in the industry labor demand elasticity $\tilde{\epsilon}$ and in the size of the minimum wage. The effects on high-skilled and low- and medium-skilled workers differ because their relative prices change due to the minimum wage:

Proposition 2 (Substitution Effect)**.** *The introduction or rise of a minimum wage*

1. *reduces high-skilled workers' wages relative to low- and medium-skilled workers' wages,* $\frac{\partial \ln w_H/w_L}{\partial \ln w_{min}} < 0$

2. *raises the ratio of high-skilled to low- and medium-skilled employment,* $\frac{\partial \ln H/L}{\partial \ln w_{min}} > 0$

Proof. Using the results from Proposition 1 on the response of average wages, we derive $\frac{\partial \ln w_H/w_L}{\partial \ln w_{min}} = -\frac{1/\kappa+\tilde{\epsilon}}{1/\kappa+\alpha\eta+(1-\alpha)\tilde{\epsilon}} < 0$.

Using this in relative labor demand, we get $\frac{\partial \ln H/L}{\partial \ln w_{min}} = \eta\frac{1/\kappa+\tilde{\epsilon}}{1/\kappa+\alpha\eta+(1-\alpha)\tilde{\epsilon}} > 0$. □

The minimum wage implies a rise of high-skilled workers' wages relative to low- and medium-skilled workers' wages, inducing firms to substitute low- and medium-skilled for high-skilled workers. The ratio of high-skilled workers to low- and medium-skilled workers increases. This is our substitution effect. The size of the effect depends on the elasticity of substitution between worker types η and on the bite of the minimum wage. The net effect on high-skilled workers' wages, employment, and solo self-employment then depends on the relative size of these two effects.

Proposition 3 (Net Effect on High-Skilled Workers)**.** *The introduction or rise of a minimum wage*

1. *raises (reduces) high-skilled workers' wages,*

2. *raises (reduces) high-skilled employment,*

3. raises (reduces) the cut-off ability level,

if the elasticity of substitution between the worker types η exceeds (is lower than) the wage elasticity of aggregate labor demand $\tilde{\epsilon}$,

Proof. From the equilibrium wage level (eq. 4.1) and the effect the minimum wage on the average wage from Proposition 1, we derive $\frac{\partial \ln w_H}{\partial \ln w_{min}} = \frac{\alpha(\eta-\tilde{\epsilon})}{1/\kappa+\alpha\eta+(1-\alpha)\tilde{\epsilon}}$ with $0 < \alpha < 1$, $\kappa > 0$, $\eta > 0$ and $\tilde{\epsilon} > 0$.

Using this result in high-skilled labor supply provides $\frac{\partial \ln H}{\partial \ln w_{min}} = \frac{1}{\kappa}\frac{\partial \ln w_H}{\partial \ln w_L}$, which implies that the high-skilled employment response has the same sign as the high-skilled wage response to the minimum wage shock.

Further using the result on high-skilled wages in the cut-off condition provides $\frac{\partial \ln \phi^*}{\partial \ln w_{min}} = \frac{\partial \ln w_H}{\partial \ln w_{min}}$, which implies that the cut-off ability's response also has the same sign. □

If the elasticity of industry labor demand ϵ exceeds the elasticity of substitution between worker types η, the scale effect dominates. In this case, there is insufficient substitution between the worker types to compensate for the decline in industry labor demand, so that labor demand even for high-skilled workers declines and their wages shrink. This pushes them into solo self-employment as an alternative source of income and high-skilled employment declines whereas solo self-employment increases. The increase in solo self-employment, however, is driven by a weaker selection into solo self-employment: high-skilled individuals with lower ability now enter solo self-employment, which also implies that their revenues are lower than those of incumbent solo self-employed.

The results (and arguments) are reversed if the elasticity of substitution between worker types η exceeds the elasticity of industry labor demand. If it is sufficiently easy for firms to replace the more expensive low- and medium-skilled workers with high-skilled workers, then we expect demand for high-skilled workers to increase, their wages and employment to increase, and solo self-employment to decrease as the cut-off ability for solo self-employed increases.

4.3 Institutional Background and Market Environment

Minimum Wage Regulations. The first minimum wages in Germany were introduced on an industry-level in the construction sector, starting with main construction (January 1997), electrical trade (June 1997), roofing (October 1997) and painting and varnishing (December 2003). See Table 4.B in the Appendix for a delimitation of industries by WZ-73 industry coding. The main reason for the policy introduction was the increasing cost pressure from Eastern Europe as a result of the European agreement on the free movement of labor. To protect their firms against relatively cheap foreign labor and distortions to competition, the employers' associations and trade unions in these industries independently decided to introduce a minimum wage for their workers. Since the decisions related to such a policy introduction depend very much on the industry-specific negotiations between employer and employee representatives, not all industries were able to agree on such a policy reform, at least not immediately. Only from 2007 onwards, several further industries agreed on introducing a minimum wage for their workers as well. Given the partly very different industry-specific debates, the introduction of these first minimum wages was thus hard to anticipate for firms and workers. In 2015, Germany finally introduced a general cross-sector national minimum wage, although industry-specific regulations still apply if their minimum wage level is higher than the general one. In our study, we focus on the four minimum wages in Germany mentioned above, as these industries allow us to study long-run adjustments to the minimum wage, which is at the center of our study. Another reason is that our four selected minimum wage industries are very different from industries that introduced a minimum wage only later, due to some special regulations, as discussed below.

Minimum wages in our four selected industries vary between industry and East/West. Within our observation period, only the construction industry additionally implemented a minimum wage for skilled workers. We abstract from this additional skill differentiation, although we conduct robustness checks without main construction. Judged by the real minimum wage, the differences in the minimum wage level between industries and East/West are quite substantial (see Figure 4.B.1 in the Appendix), which largely explains

the corresponding variation in the minimum wage bite that we find (see Section 4.4.2). Regarding minimum wage coverage, the regulations apply to all firms whose main activities lie in the respective industry. The 3-digit industry coding, which is available in our data, is therefore a good approximation for the minimum wage coverage on the firm side. On the worker side, all blue-collar workers are covered, with the exception of apprentices, trainees and students. These workers can be identified by our micro data.

Market Environment. All minimum wage industries are part of the construction sector and share several peculiarities regarding production conditions, competition, employment structure and other regulations. To demonstrate this, Table 4.3.1 shows some industry characteristics (for details on the data, see Section 4.4). All industries are quite skill intensive and very male-dominated. Average daily wages are relatively low, especially for high-skilled workers. Due to high physical demands, the age structure of these industries is particularly low. All industries are part of the construction sector, which experienced a long-lasting downward trend starting in the late 1990s and which rested until the mid 2000s. Results of this study should therefore be interpreted in the context of an economic downturn.

Self-Employment Regulations. All minimum wage industries are highly regulated by the German Trade and Crafts Code. The first professional degree that can be achieved is the journeyman ("Geselle"), which requires the completion of an apprenticeship training (duration approximately 3 years). The highest professional degree is the master craftsmen ("Meister"), which takes approximately another 1-3 years, depending on whether it is done in part- or fulltime. Running a business in these industries requires a master craftsmen degree or, since 2004, a journeyman certificate together with at least six years of industry working experience (certified by a master craftsman and including management tasks such as supervising apprentices). We define these workers as high-skilled workers (see also Section 4.4). Industry-specific knowledge is generally not transferable, so that qualification degrees can not simply be used across industries. Note that we conduct robustness checks showing that our main results are robust to these craft-specific regulations (see Section 4.7).

Table 4.3.1: Pre-Reform Industry Characteristics

	All industries	Main Construction	Electrical Trade	Roofing	Painting and Varnishing
Share of high-skilled workers	67.5	79.3	85.4	80.3	84.7
Share of female workers	35.5	9.6	13.4	8.6	11.3
Share of workers by age:					
age 18 to 35	39.2	37.4	44.8	49.3	42.1
age 35 to 50	42.2	43.0	39.6	37.8	40.7
age above 50	18.6	19.6	15.6	12.8	17.2
Average daily wage	80.9	71.0	63.5	64.9	63.4
Average daily wage of potential self-employed	90.5	74.6	65.2	66.2	64.9
Number of workers	168,211	300,827	84,884	36,477	68,893
Share of solo self-employed among workforce	4.2	9.7	7.4	3.5	6.9
Number of firms	64,496	75,759	22,123	6,801	17,012
Share of firms with					
1 to 9 employees	18.5	19.0	20.9	7.8	17.4

Notes: Numbers are averages over the years 1992-1996 for average industry, main construction, electrical trade and roofing; and the years 1992-2002 for painting and varnishing. Values for the average industry are weighted by number of firms for MUP data and by number of employees for SIAB data in each industry. High-skilled workers are defined as workers with either master craftsmen or journeymen with at least 6 years of industry working experience. Share of solo self-employed workers as well as number of workers are based on SIAB data (2 % random sample) projected to total employment figures.

Further worth mentioning is a parallel policy reform set out in Germany during our observed time period. As part of the German Hartz reforms, a start-up subsidy ("Ich-AG") was introduced in 2003, which aimed at encouraging start-up activity among unemployed individuals. Since the start-up subsidy applies to both treated and untreated industries, it should not contaminate our approach in general. We can not rule out though, that the subsidy enforced the effects. Note that this would only affect our point estimates of main construction, roofing and electrical trade seven years after the policy change, whereas those of painting and varnishing from post-reform year one on. We therefore always display results three and six years after the minimum wage introduction, as they are unaffected by the policy for three of our treated industries.

4.4 Data and Descriptives

4.4.1 Data

Mannheim Enterprise Panel. Our data source on absolute numbers of solo self-employed individuals in an industry is the relatively unexplored Mannheim Enterprise Panel (MUP) provided by the Leibniz Centre for European Economic Research (ZEW). The data includes basic firm information (location, number of employees, date of foundation and closure), information on its owners (number of owners, age) as well as some financial information (credit rating score, payments, revenues). The data is collected by Creditreform for credit rating purposes and comprises information for the universe of all economically active firms in Germany. A firm is registered by Creditreform as active, if it is recorded in official registers (commercial register, register of associations, state register), mentioned in the media or if at least one client asks for the credit rating of the firm. A firm in this data set is defined as an enterprise rather than an establishment. At the end of 2013, the MUP contained information on 7.7 million firms, of which about 3.2 million were still active. Detailed information about the data and comparisons with official registers can be found in Bersch et al. (2014).

Most important, the data allows to identify firm owners without employees, which we define as solo self-employed individuals. This includes sole and multiple ownership as long as there are no dependent employees. In total, we have 9.8 million yearly observations for 785,000 solo self-employed workers across the time period 1992-2010. As an advantage, the data contains the 3-digit industry coding of the firm, which is necessary to identify the minimum wage industries. On this detailed industry-level, we then calculate the number of solo self-employment individuals together with their average revenues. For some analyses, we also restrict these numbers to "young" solo self-employed, i.e. those whose business is less than three years old.

Sample of Integrated Employment Biographies. Data on total industry employment as well as on the structure of the workforce come from the Sample of Integrated Employment Biographies (SIAB) provided by the Institute for Employment Research

(IAB).[7] The data includes all workers subject to social security contributions, thus excluding civil servants and self-employed individuals. We use a 2-percent random sample of the weakly anonymous version that includes all individuals' employment histories together with several worker characteristics including age, education, experience, gender, daily wage, workplace location and the occupation of a worker. The data is generally available since 1975 for West Germany. Since East German workers are only covered reliably from 1992 onwards and since the MUP data is not available earlier either, we restrict our sample to the years 1992-2010. Similar to the MUP, the data contains the 3-digit industry coding of the workers' employer. We focus on annual spells that overlap June 30th and exclude minor employment as this is only recorded from 1999 onwards. We further restrict the sample to the main employment spell and drop observations with missing industry identifiers. As daily wages are top-coded, we apply the imputation procedure proposed by Gartner (2005). Missing and inconsistent values in the education variable are imputed based on the method proposed by Fitzenberger et al. (2006).

We use this micro data to calculate several indicators on employment and wages on a 3-digit industry level. Among others, we calculate the industry share of high-skilled workers among dependent employees within an industry. We thereby define high-skilled workers as those eligible for running a business, that is either master craftsmen or journeymen with at least 6 years of industry working experience (see Section 4.3). We further calculate the share of middle-aged workers (between the age of 35 and 50). As wage indicators, we calculate the average daily wage for all workers as well as for high-skilled workers. Finally, we calculate hourly wages by dividing weekly wages by weekly hours worked. Weekly hours worked are generally not available in administrative data. We thus impute hours worked from the Microzensus data, which includes information on a one percent random sample of all households in Germany, but which lacks detailed information on wages. In particular, we calculate average weekly hours worked within fine demographic cells in the Microzensus data. We do this using variables that equally exist in the SIAB data. Within the defined cells, we then transfer the cell averages from the Microzensus into the SIAB

[7] This study uses the weakly anonymous Sample of Integrated Labour Market Biographies (Years 1975 - 2010). Data access was provided via on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) and subsequently remote data Access. Project Number 731. DOI: 10.5164/IAB.SIAB7517.de.en.v1

data in order to construct hourly wages (for details, see Appendix 4.B).

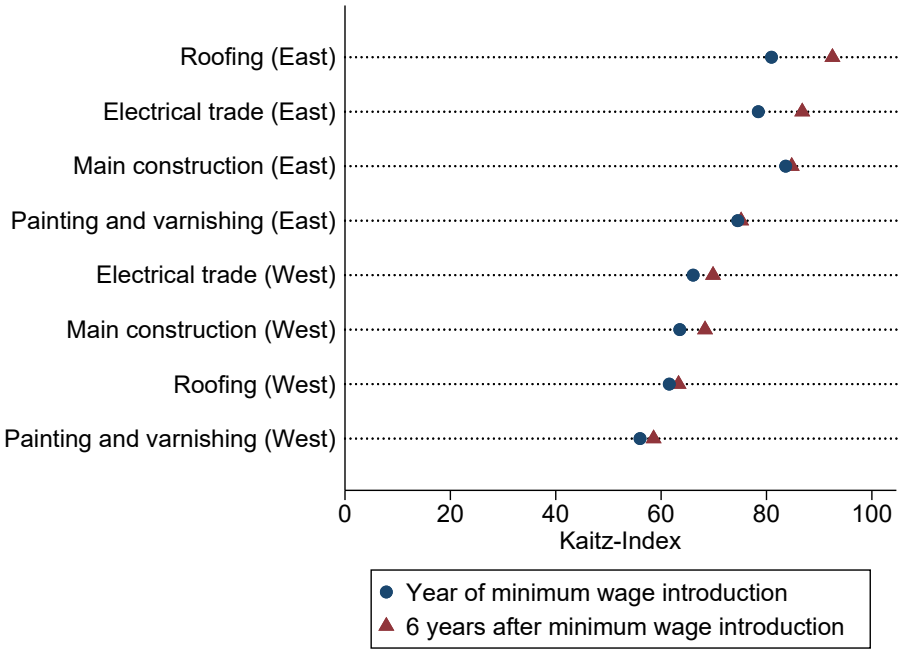
Industry-Region Panel. The aggregate industry statistics from both the MUP and SIAB data are combined to an industry-region panel covering 138 industries, two regions (East and West Germany) and all years between 1992-2010. Note that since industry coding changed during the observation period, we re-calculate all industry codes to the 1973 industry coding (WZ 73) using the procedure proposed by Eberle et al. (2014). We exclude 31 industries in which there exist fewer than 50 firms in the MUP data or fewer than 20 employment observations in the SIAB data in any of the years during the observation period. We exclude two industries which implemented a minimum wage later in the observational period. Furthermore, we exclude 20 industries that are not profit-oriented, so that we are left with 104 industries in West Germany for the 19 year period. For East Germany, the final data comprises 73 industries for the same time period. Based on that final MUP-SIAB industry-year panel, we additionally calculate the share of self-employed individuals among the workforce.[8].

4.4.2 Minimum Wage Bite

Figure 4.4.1 shows the Kaitz-Index, as defined by the ratio of the minimum wage level relative to the median wage, by industry, region (East/West) and time. The graph reveals large differences in the minimum wage bite across these dimensions. In particular, East Germany shows much higher Kaitz-Index values compared to West Germany, for all industries. Given that wage levels in East Germany amount to about 75% of West German levels during our time period (Burda, 2006), this is not surprising. However, there are also substantial differences across industries within both parts of the country. Whereas the East German Kaitz-Index in painting and varnishing was 74% in its year of introduction, it was almost 84% in main construction. The bite of the minimum wage grew even stronger over time. For instance, six years after the minimum wage introduction, the Kaitz-Index in East-German roofing reached almost 93%. The figures are in line with Gregory and Zierahn (2020), who show evidence in favor of a particularly strong bite in

[8]Note that the number of workers (denominator) is based on a two percent random sample of all workers. We thus multiply the figures with 50 to reflect total employment figures.

Figure 4.4.1: Minimum Wage Bite by Industry, Region and Time

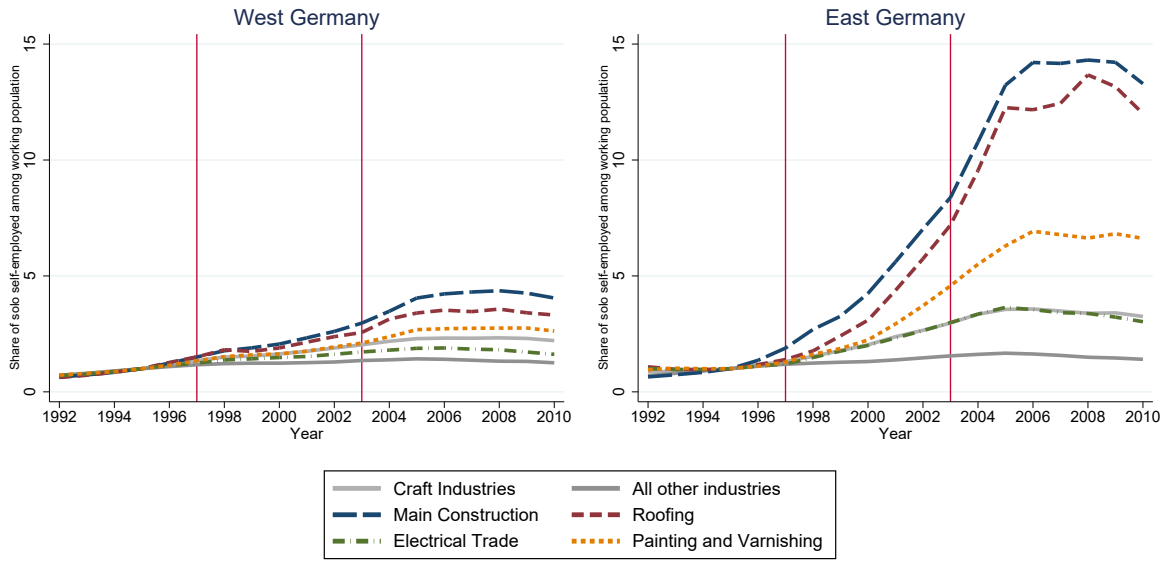


roofing, compared to international standards.

4.4.3 Trends in Solo Self-Employment

As documented by Boeri et al. (2020), solo self-employment is generally on the rise in all OECD countries. For Germany, we find that the share of self-employed individuals among the workforce increased from 2.3% to 4.9% during the observed time period 1992-2010. Large parts of the increase thereby stem from minimum wage industries, as demonstrated in Figure 4.4.2. The Figure shows the development of the share of self-employed individuals for all four investigated minimum wage industries together with the average value across all non-minimum wage industries and all craft industries, and distinguishes between East and West Germany. Whereas the share of self-employed individuals rose, on average, by 8.8 percentage points in minimum wage industries, it only rose by 2.3 percentage points in all other industries (see Appendix Table 4.C.1 for details). The growth was thereby particularly pronounced in East Germany, as well as in main construction and roofing, which suggests a positive link between solo self-employment and the minimum wage bite (compare Figure 4.4.1). Of course, there may be many other forces determining

Figure 4.4.2: Trends in Solo Self-Employment: Treated Minimum Wage Industries Compared to all other Untreated Industries



Notes: Own calculations based on MUP and SIAB. For comparability, figures are normalized to values in 1995. Vertical lines represent the introduction of minimum wages 1997 and 2003. The panel for all other industries is weighted by the number of employees in each industry.

this descriptive picture, which is the reason why we adopt the Synthetic Control Group Method in our empirical analysis.

4.5 Empirical Approach

4.5.1 Synthetic Control Group Estimator

To identify the causal impact of a minimum wage introduction on solo self-employment, we follow the synthetic control method proposed by Abadie and Gardeazabal (2003) and Abadie et al. (2010, 2015). The method is suited to study a policy change on aggregate-level outcomes such as on the level of countries, regions or, in our case, industries.[9] For a recent overview and discussion of the method, see Abadie (2020). The method has already been applied to study the impact of state minimum wage increases in the US (Sabia et al., 2012; Neumark et al., 2014; Allegretto et al., 2013). We use the method to study the first-time

[9]The method is increasingly used to study multiple treated units and individual outcomes as well, see Chan et al. (2014), Kreif et al. (2016).

adoption of a minimum wage on the industry-level.[10] Applied to our case, the idea is to compare outcomes in the treated industries to a weighted average of untreated industries rather than relying on only one of them. The synthetic control method thereby chooses the weights such that the weighted average best resembles the treated industry before the intervention. Potential control industries which are not comparable to the treated industry receive a weight of zero. The synthetic control method thus uses systematically more attractive comparisons compared to traditional Difference-in-Difference designs (Athey and Imbens, 2017).

In particular, we estimate the minimum wage impact on the share of solo self-employed individuals among the workforce (and other outcomes, see below) in treated industry $j = 0$ and time t between 1992-2010 as follows:

$$\widehat{\alpha}_{0t} \quad = \quad Y_{0t} - \sum_{j=1}^{J} W_j Y_{jt}$$

that is we take the difference between the outcome of the treated industry (Y_{0t}) and the weighted combination of outcomes of all J untreated industries (donor pool). The vector of weights $\mathbf{W}$ is chosen such that the mean squared error in pre-treatment characteristics between the treated industry ($\mathbf{Z_0}$) and the weighted average of these characteristics among the donor industries ($\mathbf{Z_J W}$), summed over K predictor variables, is minimized, that is:

$$\mathbf{W}^* = \arg min \sum_{k=1}^{K} V_k (Z_{0k} - \mathbf{Z_{Jk}} \mathbf{W})^2 \quad \text{s.t.} \quad \sum_{j=1}^{J} W_j = 1, W_j \geq 0$$

where V_k is a weight measuring the relative importance of the k-th predictor.[11]

As predictors, we choose, if not specified otherwise, the pre-treatment level of the outcome variable. Moreover, since our theoretical model suggests that a minimum introduction leads to adjustments in the demand for skilled labour as well as their wages (see Section 4.2), we include the share of skilled workers as well as their average wage level. Furthermore, since the literature suggests that industries with many small firms

[10] Chung et al. (2016) also apply the method to an industry-level, although they do not study a minimum wage policy.

[11] We choose STATA's default option that searches among all (diagonal) positive semidefinite V-matrices and sets of W-weights for the best fitting convex combination of the control units.

constitute a favorable environment for the market entry of solo self-employed workers, we include the share of small firms. Finally, we include the share of middle-aged workers, as this has been shown to be a further important predictor in driving solo self-employment (Boeri et al., 2020; Parker, 2004). However, we conduct several robustness checks showing that our estimates are robust to either (1) including more pre-treatment data points of the outcome variable, (2) dropping all predictor variables except for the lagged outcome variables, or (3) dropping all lagged versions of the outcome variable (see Section 4.7).

As industry outcomes, we not only use the share of solo self-employed individuals. To test the predictions of the theoretical model, we also estimate the effect of the minimum wage introduction on (skill-specific) employment and revenues of solo self-employed based on the synthetic control group setup.

Due to different minimum wage levels and very different bites of the minimum wage, we conduct our estimates by East and West Germany separately. In total, we have data for 107 industries in West and 76 in East Germany. Depending on the outcome variable, we loose some industries due to missing observations. The resulting number of industries for the different sets of outcomes in the (East/West) donor pools are: share of solo self-employed (103 / 72), employment (85/52) and revenues (43/31). We further test whether our main estimates for solo self-employment are robust to restricting the sample to craft industries, which reduces the donor pool to 19 industries in West Germany and 18 in East Germany. We mention the size of the donor pool for every analysis in the corresponding table notes.

4.5.2 Inference

Due to limitations in applying traditional inference statistics to synthetic control comparisons, we follow Abadie and Gardeazabal (2003), Abadie et al. (2010) and Abadie et al. (2015) and conduct placebo tests to evaluate the statistical significance of our estimates. The falsification exercises are based on the idea that the confidence in the validity of our estimates should decrease if one finds similarly large (or even larger) results whenever the intervention is artificially reassigned to untreated cases. These untreated cases can either be untreated year observations before the intervention (in-time placebo)

or untreated units from the donor pool (in-space placebo[12]). Since we have only few pre-treatment observations, we follow the latter approach. In particular, we estimate the effect of an artificial intervention in each of our control industries from the donor pool. This is done by iteratively reassigning the treatment to each control industry in our data and estimating the intervention effect (placebo runs). This yields the results of placebo effects (permutation distribution) that one can use for display and visual comparison. The effect is significant, if the magnitude is extreme relative to the magnitude of the placebo effects.

A challenge to this approach is, that even if the synthetic control industry is well able to map the trend of the outcome variable in the treated industry before the intervention, this need not be true for all control industries. We therefore follow (Abadie, 2020) and set the effect size in relation to the quality of the fit. For this, we use the ratio of the post-intervention effect relative to the pre-intervention fit for every industry and time period. The fit is measured by the root mean squared prediction error (RMSPE). This yields the permutation distribution of ratios for the placebo effects. Based on this test statistic, we can then calculate p-values as the fraction of ratios greater than or equal to the ratio estimated for the treated unit, down-scaling the effects of placebo runs with a bad fit.[13] In the following analyses, we use these suggested p-values for evaluating the significance of our synthetic control group estimates. Moreover, we also depict the ranking in the permutation distribution of the ratios, as in some cases the low number of placebo runs leads to a low p-value, although the effect size in relation to the quality of the fit is large in comparison to that of the (few) placebo effects.

As an illustration, Figure 4.C.2 in the Appendix depicts the placebo tests of our main regression with share of solo self-employed individuals as the outcome variable, for East and West Germany separately. Each gray line reflects the estimated effects of the artificial interventions in the 103 West German and 72 East German untreated industries, whereas the colored lines denote the estimated effect of the invention on all four minimum wage

[12]In our case, this dimension is industry rather than space (country, state or region).

[13]Formally, the ratio between the post-intervention RMSPE, $R_j(T_0+1,T)$, and pre-intervention RMPSE, $R_j(1,T_0)$, for industry j is $r_j = \frac{R_j(T_0+1,T)}{R_j(1,T_0)}$, where $R_j(t_1,t_2) = (\frac{1}{t_2-t_1+1}\sum_{t=t_1}^{t_2}(\widehat{Y}_{jt} - Y_{jt}^N)^2)^{\frac{1}{2}}$ and where $\widehat{Y}_{jt}$ is the outcome of the synthetic control industry in period t . The p-value is then defined as $p = \frac{1}{J+1}\sum_{j=1}^{J+1} I(r_j \geq r_1)$, where I is an indicator function that returns one if $r_j \geq r_1$ and zero otherwise. For details, see Abadie (2020).

industries. In the visualization it is hard to asses if the effects are among the largest as placebo runs with a bad pre-intervention fit obscure the picture. We therefore produce the distribution of ratios (post-intervention effect relative to pre-intervention fit). In the case of East German roofing, we find that placebo tests for two control industries have ratio larger than that of roofing (judged by the cumulative effect after three years), hence the true effect ranks in the third place. The probability of estimating an effect of similar magnitude with an appropriately fitted control group at random is 3/73. Hence, the effect is statistically significant at the 0.041 level.

4.6 Results

4.6.1 Construction of Synthetic Control Industries

Following the approach described in Section 4.5, we construct our synthetic control industries based on weights chosen such that our synthetic control industries best resemble the predictors of solo self-employment shares (and other outcomes) in the treated industries. Appendix Table 4.C.2 displays the weights larger than 0.01 for each of the four minimum wage industries by East and West Germany. By construction, weights sum up to 1. Table 4.6.1 compares the pre-treatment characteristics that are included in the predictor set between all treated and corresponding synthetic industries. Overall, the results suggest that our synthetic control industries are very comparable to our treated industries. With few exceptions, the synthetic control industries show very similar mean values across all minimum wage industries w.r.t. the share of solo self-employed individuals, share of high-skilled workers, share of small firms, share of workers between 35-50 years of age as well as the wage level for high-skilled workers. Smaller deviations include somewhat higher shares of high-skilled and middle-aged workers for treated compared to synthetic roofers in West Germany as well as a higher wage level among high-skilled roofers in the East. The method thus produces good comparisons to evaluate the minimum wage effect on solo self-employment. Note that we find similar good comparisons for our other outcomes including employment, high-skilled employment and industry revenues.

Table 4.6.1: Pre-Treatment Solo Self-employment Predictor Means (Industry-Level) by Minimum Wage Industry and East/West Germany

	Main Construction		Roofing		Electrical trade		Painting and varnishing	
	treated	synthetic	treated	synthetic	treated	synthetic	treated	synthetic
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
East Germany								
Share of solo self-employed ind.								
in 1993	1.1	1.1	0.6	0.6	2.8	2.8	1.9	1.9
in 1996/1998	2.0	2.0	0.8	0.8	3.2	3.2	3.1	3.2
in 2002							7.0	7.0
Share of high-skilled workers	83.5	83.1	77.1	79.8	83.6	83.7	83.8	84.3
Share of small firms	18.2	18.3	7.2	8.8	19.6	19.6	23.7	20.8
Share of middle-aged								
workers (35-50 yrs.)	36.6	36.6	30.1	32.7	35.6	35.7	40.0	41.3
Mean daily wage of high-skilled								
workers (in Euro)	56.7	56.5	53.9	36.0	48.2	48.2	55.5	58.6
West Germany								
Share of solo self-employed ind.								
in 1993	2.6	2.6	1.0	1.0	4.3	4.3	3.0	3.0
in 1996/1998	4.5	4.4	1.7	1.7	6.5	6.4	5.6	5.6
in 2002							7.2	7.2
Share of high-skilled workers	74.6	74.9	74.7	65.9	77.4	77.4	83.8	81.1
Share of small firms	19.8	19.8	8.4	9.6	22.2	22.2	21.7	21.7
Share of middle-aged								
workers (35-50 yrs.)	31.5	31.6	25.6	31.0	29.2	29.2	35.4	35.4
Mean daily wage of high-skilled								
workers (in Euro)	82.9	83.3	69.9	66.5	67.6	67.6	71.8	72.0

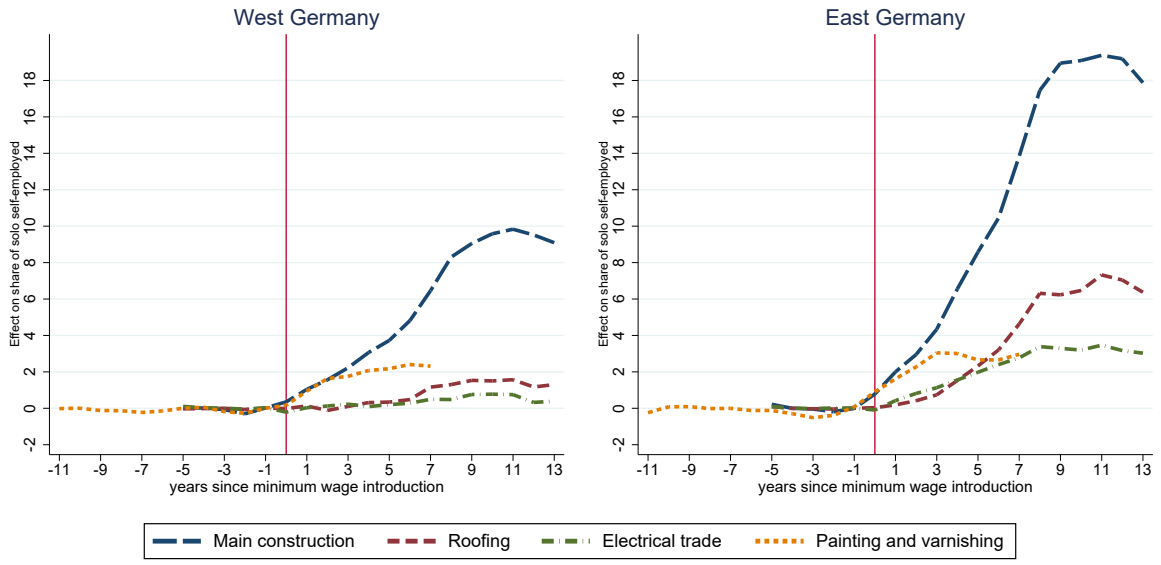
Notes: Predictor variables other than lagged outcomes are averaged over the pre-treatment period. Values for main construction, roofing and electrical trade are averaged over the years 1992-1996. Values for painting and varnishing are averaged over the years 1992-2002.

4.6.2 Minimum Wage Effects on Solo Self-Employment

Figure 4.6.1 shows the estimated effects of the minimum wage introduction on the share of solo self-employed individuals for all our four minimum wage industries by East and West Germany over time. The intervention effects are derived from the difference between the outcomes of the treated compared to the outcomes of the synthetic industries at each time point (see Appendix Figure 4.C.1 for a more detailed graphical representation of both the minuend and subtrahend). Note that different time periods before and after the minimum wage reflect different implementation years of the minimum wage. Table 4.6.2 shows the corresponding accumulated effects 3, 6 and 13 years after the introduction together with its significance levels as discussed in Section 4.5.2.

The results in Figure 4.6.1 show that our synthetic control industries resemble the trajectories of our treated industries very well, indicated by the near-zero gap between the treated and synthetic industries before the minimum wage introduction. As demonstrated

Figure 4.6.1: Effect of the Minimum Wage Introduction on the Share of Solo Self-Employed Individuals by Industry and East/West Germany



Notes: The vertical lines represents the year of minimum wage introduction.

by the increasing differences in post-treatment years, the effect of the minimum wage introduction was positive for almost all industries in both parts of the country. However, we find large heterogeneities w.r.t. the size and significance of the effects. In general, we find the positive effects to be stronger and more significant in East compared to West Germany. Moreover, we find larger effects in construction and roofing as compared to electrical trade and painting and varnishing. And, the effects rise over time until about 10 years after the policy reform, before decreasing slightly again.

In terms of effect size, the minimum wage introduction significantly increased the share of solo self-employed construction workers six years after the reform by 10.5 pp in East and 4.8 pp in West Germany (see Column 2 in Table 4.6.2). Compared to the shares in the pre-treatment year 1996 (see Table 4.6.1), this means that solo self-employment doubled in West Germany and increased sixfold in East Germany. We also find significantly positive accumulated effects six years after the policy change for East German roofing (+3.2%) and electrical trade (+2.4%). All other effects in $t + 6$ are weaker both in terms of size and significance.

Altogether our results show that the minimum wage introduction led to a partly substantial increase in solo self-employment. The size of the effects becomes visible

Table 4.6.2: Accumulated Effects of the Minimum Wage Introduction on the Share of Solo Self-Employed Individuals (in pp.)

Accumulated effect after years (in pp.):	t+3 (1)	t+6 (2)	t+13 (3)
East Germany			
Main construction	4.339*	10.45**	17.88**
	[4]	[2]	[1]
Roofing	0.735**	3.206**	6.375**
	[3]	[1]	[1]
Electrical trade	1.131**	2.400**	3.028**
	[1]	[1]	[1]
Painting and varnishing	3.044*	2.657*	N/A
	[4]	[7]	
West Germany			
Main construction	2.224*	4.815**	9.092**
	[9]	[4]	[5]
Roofing	0.104	0.48	1.300**
	[34]	[17]	[5]
Electrical trade	0.226	0.282	0.388
	[74]	[79]	[63]
Painting and varnishing	1.755**	2.406*	N/A
	[2]	[7]	

Note: p-values indicated by ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$; rank statistics in square brackets; Donor pool size: East 72, West 103. N/A indicates that this industry-year combination lies out of our sample period.

especially in the longer run, in line with recent studies suggesting that the full adjustment to a minimum wage takes time (Meer and West, 2016; Sorkin, 2015). Another general finding here is that the effects are larger for industries and parts of Germany where the bite was particularly strong (compare Figure 4.4.1). Note that our results are robust to restricting the donor pool to craft industries, using alternative predictor sets and donor pools (see Section 4.7). Without distinguishing between solo self-employment and self-employment in general, Blau (1987) reports a decrease of .019 percentage points in the share of self-employment (only male workers) for a one Dollar increase in the minimum wage, using data for the years 1948-82. The simulations by Medrano-Adán et al. (2015) allow for heterogeneity between the two different forms of self-employment. Simulating an introduction of a minimum wage with a Kaitz-Index of 50%, they infer that 21% of formerly employed workers would be induced to become involuntarily solo self-employed or unemployed. Hence, depending on the baseline rate, their simulated increases in solo

self-employment would be up to 21 percentage points. In line with their results, we find an increase by up to 17.9 percentage points in the East German main construction industry. In the following sections, we shed more light on the mechanisms through which a minimum wage sets incentives for solo self-employment and demonstrate the role of the bite in moderating these.

4.6.3 Minimum Wage Effects on Dependent Employment

We have laid out a substitution-scale model in Section 4.2 to demonstrate how a minimum wage impacts solo self-employment. According to our model, a minimum wage-driven increase in the wage of low- and medium-skilled workers raises the relative demand for high-skilled workers due to the change in relative input prices (positive substitution effect, Proposition 2). At the same time, the overall labor cost shock driven by the minimum wage introduction reduces employment among all skill groups (negative scale effect, Proposition 1). The net effect on employment and wages of high-skilled workers then depends on the relative size of these two effects (Proposition 3).

To test these predictions, we follow the procedure of Gregory and Zierahn (2020) and decompose the net effect of the minimum wage on high-skilled workers into a scale and substitution effect as follows:

$$\underbrace{\frac{\partial \ln H}{\partial \ln w_{min}}}_{\text{net effect}} = \underbrace{\frac{\partial \ln H/N}{\partial \ln w_{min}}}_{\text{substitution effect}} + \underbrace{\frac{\partial \ln N}{\partial \ln w_{min}}}_{\text{scale effect}} \tag{4.2}$$

The subsequent effects are estimated again using the synthetic control group approach as described in Section 4.5. For this, we use log total employment (scale effect), log share of high-skilled workers (substitution effect) as well as log number of high-skilled workers (net effect) as outcome variables.

For log total employment and log number of high-skilled workers, we are able to construct synthetic control industries that well resemble the trajectories of our treated industries, again indicated by the near-zero gap between the treated and synthetic industries before the minimum wage introduction in Appenidx Figure 4.C.3. Only for the construction industry, we do find larger pre-treatment deviations between treated and

control industries, at least for the scale and net effect. These effects can thus only be interpreted with caution.

Table 4.6.3 shows the corresponding results three and six years after the minimum wage introduction. Judged by the accumulated effect after six years in Column 2, we find a reduction in log overall employment in almost all industries, generally confirming our prediction of a negative scale effect. However, the negative scale effect differs across industries and parts of Germany in terms of size and significance. The effects are significant only in East Germany. For example, in East German roofing, employment significantly declined by 44% after three and 81% after six years due to the minimum wage. This corresponds to a decline in average employment growth by 4.9pp and by 6.9pp.[14] The negative scale effect is also significantly estimated for electrical trade and painting, although the effects are smaller (-42% and -15% in $t + 6$). For all West German industries, the signs are slightly negative or near zero, but never significant. The results reflect the fact that the minimum wage was introduced in a phase of an economic downturn starting in the early 1990s in these industries and which was particularly severe in East Germany.

The magnitude of the effect appears to be quite strong, possibly reflecting the fact that our synthetic industries do not take sufficient account of certain specifics of the construction industry, so that our coefficients also reflect the general downturn in the construction sector in the post-treatment years. This is indicated by robustness checks, where donor pools are restricted to industries of the construction sector. There, the effect is lowered, although the donor pools are too small to draw reliable conclusions (see Section 4.7). In subsequent versions of this paper, we will further include variables that have stronger power in predicting the downtown.

Regarding the substitution effect after six years (Column 4), we find positive but insignificant effects for all industries and both parts of Germany. The results suggest that the tasks of high-skilled labor do not provide close substitutes for tasks of low-skilled labor. Given the negative scale effect, the net effect for skilled workers is negative (Column 6), although again the magnitude differs across industries and East/West Germany. Whereas the net effect is significantly negative in East Germany, especially in roofing (-70%) and

[14] Gregory and Zierahn (2020) also find a sizable employment decline in East Germany due to the roofing minimum wage by 7% on average for post-minimum wage years until 2008, using a regional Diff-in-Diff approach.

Table 4.6.3: Accumulated Minimum Wage Effects on (Skilled) Workers Three and Six Years after the Introduction

Dependent variable:	Log total employment (scale effect) in %		Log share of skilled employment (substitution effect) in pp.		Log skilled employment (net effect) in %	
Accumulated effect after years:	t+3	t+6	t+3	t+6	t+3	t+6
	(1)	(2)	(3)	(4)	(5)	(6)
East Germany						
Main construction	0.713	0.395	0.031	0.046	0.656	0.353
	[48]	[51]	[32]	[25]	[47]	[50]
Roofing	-0.444**	-0.810**	0.035	0.058	-0.367**	-0.697**
	[1]	[1]	[29]	[18]	[1]	[1]
Electrical trade	-0.189*	-0.424*	0.047	0.095	-0.170*	-0.369**
	[4]	[3]	[17]	[11]	[4]	[2]
Painting and varnishing	-0.191	-0.152**	0.019	0.082	-0.150	-0.121
	[12]	[2]	[51]	[48]	[12]	[32]
West Germany						
Main construction	0.149	-0.099	0.014	0.011	0.018	-0.177
	[50]	[51]	[36]	[43]	[51]	[51]
Roofing	0.017	-0.043	-0.004	-0.015	-0.068	-0.148
	[50]	[48]	[38]	[47]	[41]	[30]
Electrical trade	-0.071	-0.113	0.001*	0.001	-0.094	-0.114
	[41]	[44]	[3]	[10]	[35]	[31]
Painting and varnishing	0.027	0.010	0.020	0.023	-0.032**	-0.034**
	[17]	[35]	[32]	[23]	[1]	[2]

Note: p-values indicated by ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$; rank statistics in square brackets; Donor Pool contains industries with at least N=75 for skilled employment; Donor pool size: East 52, West 85.

electrical trade (-40%), the effects are relatively small and insignificant in West Germany.

Although we cannot directly observe transitions from dependent employment to solo self-employment[15], the institutional regulations (only high-skilled are eligible to become solo self-employed, see Section 4.3) does suggest a link here. To provide further evidence, we correlate the treatment effect on the share of solo self-employed with the net effect on skilled workers in industry-region year cells. Controlling for industry-region fixed effect, we find that a greater negative net effect on high-skilled workers is indeed associated with a statistically significant increase in the treatment effect on solo self-employment (see Appendix Table 4.C.3). The findings suggest that those persons who have left their dependent employment are also those who have become solo self-employed .

[15]The employment biographies only cover dependent employment, whereas the enterprise panel only covers enterprises. We cannot link the two data bases at the micro level due to data protection legislation.

Our evidence suggests that the minimum wage introduction led to a drop in earnings perspectives of high-skilled workers. This was particularly true in industries and parts of Germany, where the minimum wage bite was particularly strong. Here, the negative scale effects were considerable (reflected also in reduced industry sizes, see next Section), which could reflect the combination of a strong minimum wage bite and an economic recession. Again these effects show up already few years after the policy change, but fully unfold only in the long-run. As we propose throughout this paper, the resulting depression of earnings perspectives for traditional high-skilled workers jobs can explain the shift towards solo self-employment as demonstrated in Section 4.6.2. In the following section, we shed light, among others, on the earnings of these new solo self-employed.

4.6.4 Minimum Wage Effects on Revenues

In this section, we provide two additional pieces of evidence. First, we further document the substantial negative scale effect by looking at the minimum wage effect on total firm counts. According to our model, the minimum wage-induced cost shock leads to falling revenues through rising prices, lower product demand and, hence, a shrinking industry where the least productive firms are squeezed out of the market (Proposition 1). We should thus observe a falling number of firms in reaction to the minimum wage introduction. Second, we study the effect on solo self-employed revenues, of both incumbents and entrants, in order to shed light on the earnings perspectives of these new solo self-employed. As proposed by our theoretical model, we expect the incomes of solo self-employed individuals to go down in reaction to the intervention, as only a negative selection among all high-skilled workers becomes solo self-employed, i.e. those that just pass the ability cut-off (Proposition 3).

To test this, we apply the same synthetic control method as before. Figure 4.C.5 shows that our synthetic control industries well resemble the trajectories of our treated industries for our additional outcomes. Table 4.6.4 shows the corresponding effects on the log number of firms (Columns 1-2), log mean revenues of solo self-employed individuals (Columns 3-4) as well as the log mean revenues of new entries to solo self-employment which are defined as solo self-employed individuals who started their business within the last three

Table 4.6.4: Accumulated Minimum Wage Effects on Firms and Revenues of Solo Self-Employed

Dependent variable:	Log Total Number of firms (w/o solo-selfemployed)		Log Mean Revenues Solo-Selfemployed		Log Mean Revenues young Solo-Selfemployed	
	t+3	t+6	t+3	t+6	t+3	t+6
	(1)	(2)	(3)	(4)	(5)	(6)
East Germany						
Main construction	0.091	0.051	-0.260	-0.698	-0.478	-0.558
	[36]	[45]	[17]	[13]	[7]	[8]
Roofing	-0.027	-0.095	-0.443	-1.135	-0.559	-0.771
	[31]	[19]	[10]	[4]	[14]	[17]
Electrical trade	-0.055	-0.113	-0.093	-0.335	-0.144	-0.141
	[17]	[14]	[17]	[13]	[8]	[13]
Painting and varnishing	-0.012	-0.006	-0.335*	-0.021*	0.084	0.078
	[37]	[47]	[2]	[3]	[14]	[15]
West Germany						
Main construction	-0.061	-0.121*	0.025**	-0.010*	-0.018	0.024
	[10]	[6]	[1]	[4]	[34]	[41]
Roofing	-0.006	-0.001	-0.047	-0.188	-0.169	-0.112
	[79]	[85]	[27]	[20]	[15]	[16]
Electrical trade	0.008	-0.046	-0.053	-0.099	-0.064	0.098
	[79]	[83]	[33]	[33]	[32]	[37]
Painting and varnishing	-0.051**	-0.073*	-0.005	0.007	0.059*	-0.026*
	[3]	[6]	[6]	[6]	[4]	[4]

Note: p-values indicated by ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$; rank statistics in square brackets; Donor Pool Column 1: industries with at least 50 firms, size East 52 / West 85. Donor Pool Columns 2 and 3: industries with at least 30 solo self-employed, size East 31 / West 43.

years.[16] The results tentatively suggest a shrinking industry in response to the minimum wage introduction, indicated by the negative coefficients for the accumulated effects of firm counts after six years (Column 2). Although the sign of the effects is in line with our theory, they are mostly insignificant. Only for the West German main construction and painting and varnishing industries we find sizable and statistically significant negative effects of -12.1% and 7.3%.

Regarding the minimum wage effects on average revenues of solo self-employed individuals, we largely find negative effects as suggested by our theory. The effects are particular strong after six years in roofing, followed by main construction and electrical trade, although the precision of these estimates is low. The results hold similarly for solo self-employed entrants, suggesting that the earnings of new solo self-employed have

[16]Note that we choose the three year moving average instead of looking at new cohorts on a yearly basis due to sample size. On average across our four minimum wage industries, 1,139 solo self-employed workers enter the sample per year with non-missing revenues, yet some yearly entrant cohorts consist of only 34 solo self-employed.

deteriorated over time in reaction to the minimum wage introduction. The latter is in line with our models' expectations according to which an increasingly negative selection among all dependent high-skilled workers become solo self-employed. However, all our results here are estimated imprecisely, so that they can only be interpreted as suggestive evidence.

As one potential reason for these imprecise estimations, revenues might be imprecisely measured in our data. Particularly for small firms, the figures on revenues are not updated on a regular basis in our database. The figures further contain peaks in the time series at the firm level, suggesting errors in the coding of these variables. This raises the variance of the revenue indicators, potentially explaining why our results remain largely insignificant despite the correct sign. In subsequent version of this paper, we will thus use winsorizing techniques to correct for these data jumps. Note that these data problems refer to the revenue indicators only, and do not affect our main results.

Despite the uncertainty regarding the estimated coefficients, conclusions can be drawn at least to the extent that the income prospects of an increasing number of solo self-employed individuals do not seem to have improved much. This is in line with Boeri et al. (2020), according to which solo self-employment reflects a state of underemployment characterized by workers with poor outside options who work less than desired and earn less on an hourly basis compared to traditional jobs. They also face more liquidity constraints and are more vulnerable to idiosyncratic shocks compared to self-employed with employees as they often depend on one major client. Boeri et al. (2020) further state that solo self-employment provides ways to undercut wages of workers in traditional jobs. We will return to this point in our overall conclusion. Before, we discuss the role of the bite in driving our findings.

4.6.5 The Role of the Minimum Wage Bite

Although the sign of the effects is in line with theory in almost all analyses, we do find large differences w.r.t. the magnitude of the effects. One hypothesis is that the effect size increases with the minimum wage bite. To test this empirically, we exploit the fact that the level of the minimum wage varies between industries as well as between East

and West Germany. This led to partly substantial differences in the minimum wage bite, which we use for our assessment. In particular, we regress our treatment effects ($\widehat{\alpha}_{irt}$) produced by our synthetic control method on the minimum wage bite for each minimum wage industry i and region r and year t as follows:

$$\widehat{\alpha}_{irt} = \beta_0 + \beta_1 X_{irt} + \gamma_{ir} + \epsilon_{irt} \tag{4.3}$$

where X_{irt} captures the minimum wage bite (Kaitz-Index or share of workers below the next minimum wage) and where γ_{ir} are industry-region fixed effects. As treatment effects on the left hand side, we use the treatment effects related to the share of solo self-employment, the number of skilled workers as well as revenues. We use log-log specifications in all cases, such that the results can be interpreted as elasticities.

Table 4.6.5 shows the results related to a basic model without controlling for industry- or region-specific effects (Column 1), a model with industry and region dummies (Column 2) as well as our preferred model controlling for industry-region fixed effects (Column 3). Regarding the relationship between the treatment effects on the share of solo self-employed individuals and the minimum wage bite (Panel A), we find a statistically significant positive correlation. According to the preferred fixed effects model, a one percent higher Kaitz-Index is associated with a 3% higher minimum wage effect on the share of solo self-employed. Using the share of workers with a wage below the next minimum wage as an alternative measure of the bite confirms our results. Note also that the result remains stable with and without controlling for level differences between industries, regions, and industry-region cells.

Our negative minimum wage effects on labor demand for skilled workers (our net effect), which we presented as one major channel through which a minimum wage affects solo self-employment, also increases with the minimum wage bite (Panel B). Accordingly, a one percent increase in the minimum wage bite, as measured by the Kaitz-Index, amplifies the negative effect on high-skilled workers by 1.6%. In Appendix Table 4.C.4, we show that the subsequent scale and substitution effects are similarly correlated with the bite. This means that not only the main effect on solo self-employment increases with the minimum wage bite, but also the effects on the transmission channels, which again underlines our

Table 4.6.5: Correlations Between the Minimum Wage Bite and Minimum Wage Effects

	OLS (1)	OLS (2)	FE (3)
A. Dependent Variable: minimum wage effect on the share of solo self-employed			
Log Kaitz-Index	2.94**	2.70*	2.96***
	(2.94)	(2.16)	(5.10)
Log share of workers with wage below next minimum wage	0.87***	0.61***	0.54***
	(3.79)	(4.34)	(5.11)
B. Dependent Variable: minimum wage effect on number of skilled workers			
Log Kaitz-Index	-1.56**	-1.88*	-1.63***
	(-3.75)	(-2.12)	(-5.67)
Log Share of workers with wage below next minimum wage	-0.43***	-0.37***	-0.32***
	(-4.27)	(-4.04)	(-7.19)
C. Dependent Variable: minimum wage effect on revenues			
Log Kaitz-Index	-1.59*	-2.00	-1.36***
	(-2.33)	(-1.79)	(-3.55)
Log Share of workers with wage below next minimum wage	-0.42*	-0.38**	-0.27***
	(-2.51)	(-3.52)	(-4.26)
Industry and region dummies	No	Yes	No
Region-industry FE	No	No	Yes
N	92	92	92

Notes: t-statistics in brackets. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$; Columns 1 and 2 are clustered by industry-region; Sample contains industry-region observations for years after minimum wage was introduced; all variables are in logs.

theory.

As a final exercise, we also test whether our effects for revenues correlate with the minimum wage bite (Panel C). Indeed, we find that the decline in revenues is stronger when the bite of the minimum wage is larger. High-bite minimum wages thus have more negative consequences for the revenues of solo self-employed. We show in Appendix Table 4.C.4 that this also holds when focusing on the revenues of solo self-employed entrants.

The results in this section suggest that the size of the bite plays a key role for the (unintended) consequences of minimum wages. The larger the bite, the larger the decline in skilled employment and the more skilled workers are pushed into solo self-employment, with worse outcomes in terms of revenues.

4.7 Robustness

Alternative Donor Pools As discussed in Section 4.3, in December 2003 several craft industries deregulated the requirements to start a business, including becoming solo self-employed. Rostam-Afschar (2014) shows that this deregulation increased the probability to become self-employed in craft industries. Although the author does not distinguish between self-employment with and without employees, which has been shown to be very different (Boeri et al., 2020), the deregulation might have increased solo self-employment more strongly in craft industries compared to non-craft industries. To make sure that this does not affect our results, we restrict our donor pool to craft industries with the same deregulation scheme, leaving us with 19 donor industries in West Germany and 17 in East Germany (see Appendix Table 4.B.2 for an overview of all craft industries). Column 2 in Appendix Table 4.C.5 contains the corresponding synthetic control method estimates related to the minimum wage effect on the share of solo self-employed based on the restricted donor pool. Column 1 shows the base line effects from Section 4.6.2 for comparison. The sign and magnitude of the effects are remarkably similar, despite somewhat less significant West German estimates. Besides these smaller exceptions, the results seem to be robust to these craft-specific regulations.

The magnitude of the effects on dependent employment partly seems very high (see Table 4.6.3 and Figure 4.C.3). One reason could be that our synthetic control industries do not take enough the peculiarities of the broader construction industry into account. We thus conduct robustness checks where we restrict the donor pool to construction industries. Figure 4.C.4 shows the corresponding results. With the smaller donor pool the synthetic controls are not able to fit the pre-treatment trajectories, resulting in insignificantly estimated effects. In subsequent versions of this paper, we will therefore include variables increasing the predictive power as to draw reliable conclusions from our estimates on dependent employment.

Alternative Predictor Sets. To test the sensitivity of our results w.r.t. the predictor set, we conduct several robustness checks. First, we include more pre-treatment data points of the outcome variable (Column 3). In particular, we include lagged outcomes in 1992, 1994, 1996 for the industries that introduced their minimum wage in 1997, and

lagged outcomes in 1992, 1994, 1998, 2000, 2002 for the 2003 minimum wage industry. All other predictor variables remain unchanged. Our results remain robust to these changes. Second, we drop all predictor variables except for the lagged outcome variables (Column 4). Again, the results remain close to our main findings, suggesting that our predictor variables beyond the outcome variable do not change much. Third, we drop all lagged versions of the outcome variable rather than dropping the other predictors (Column 5). The results are similar to our preferred specification. Only the size of the effect changes slightly.

4.8 Conclusion

Solo self-employment is on the rise in almost all OECD countries, despite being associated with less favorable working conditions. We propose that minimum wage policies might be one explanation for the surge in solo self-employment. To demonstrate this, we assess the long-run causal impact of a first-time minimum wage adoption on solo self-employment in a unique quasi-experimental setting. Four conclusions can be drawn from our analysis:

First, a minimum wage can induce a substantial increase in solo self-employment. Across several German industries, we find that the first-time adoption of a minimum wage increased the share of solo self-employed individuals between 4.8 and 10.5 pp, depending on the industry and region. For some industries, this meant a sixfold increase in solo self-employed workers compared to pre-treatment years.

Second, a shift away from dependent employment towards solo self-employment can be explained by a decline in earnings perspectives of high-skilled workers in reaction to a minimum wage. In line with a substitution-scale model, we show that the minimum wage induced only little substitution of high- for low-skilled workers, suggesting that their tasks are not close substitutes. At the same time, all skill groups suffered equally from an overall decrease in labor demand in response to the minimum wage-induced labor cost shock (negative scale effect). As a result, net high-skilled labor demand decreased between 3-70% as judged by the accumulated effect six years after the reform.

Third, such minimum wage responses are more likely to arise in a context of an increasing minimum wage bite in an economic downturn. In some of our investigated

industries, the minimum wage bite, as measured e.g. by the Kaitz-Index, reached values near 100%, where the minimum wage equals the median wage level. We demonstrate that the magnitude of our effects significantly increases with the degree of the bite, suggesting that the height of the minimum wage level plays a major role in triggering the effects, aside with the economic downturn phase that our industries went through. This insight might be of particular interest, given increasing minimum wage levels observed worldwide.

Fourth, our results cast doubt on the hypothesis that solo self-employment was a purely voluntary decision of former dependent employees. Although we cannot fully test this, our results rather suggest that workers are pushed into solo self-employment. As other studies have argued, this could include firms that outsource work by re-grading their employees as independent self-employed contractors or using other alternative work agreements to buffer the cost shock induced by the minimum wage (Boeri et al., 2020; Datta et al., 2019; Parker, 2010).

Appendix

4.A Theory

In this appendix, we provide more details on the theoretical framework of our paper.

Consumers

Assume that firms produce varieties ω of a final output. The price elasticity of demand for the aggregate output of the firms Q_f is ϵ. We denote the price index for firms aggregate output with P_f. The demand function for firms' aggregate output then is $R_f = P_f^{1-\epsilon} Q_0$, where R are revenues and Q_0 is a constant. Assume that each firm produces a single variety of the output and that consumers have Constant Elasticity of Subsitution (CES) preferences over these varieties with elasticity of substitution σ between the varieties. Utility maximization w.r.t. the budget constraint $P_f Q_f = \int_{\omega \in \Omega} q_f p_f d\omega$ provides

$$q_f(\omega) = \left(\frac{p_f(\omega)}{P_f} \right)^{-\sigma} Q_f = \left(\frac{p_f(\omega)}{P_f} \right)^{-\sigma} P_f^{-\epsilon} Q_0, \tag{4.4}$$

where $P_f = [\int_{\omega \in \Omega} p_f(\omega)^{1-\sigma} d\omega]^{\frac{1}{1-\sigma}}$ is the price index of firms' output.

We assume an analogous structure for the demand for the varieties and aggregate output produced by self-employed, using index s instead of f. Demand for the varieties produced by self-employed thus is identical. The focus of our framework lies on interactions between the two industries on the labor market. We therefore abstract from interactions between firms and entrepreneurs on the product market to keep the analysis simple and traceable.

Firms

We model heterogeneous firms based on Melitz (2003). Assume that firms require a fixed non-artisan labor input of f and a variable artisan-labor input of $n_i(\psi_i) = q_i/\psi_i$, where the wage costs for both are $\bar{w}$. Profit maximization implies that prices are a constant markup over marginal costs, $p_i(\psi_i) = \frac{\bar{w}}{\psi_i}\frac{\sigma}{\sigma-1}$ and profits are $\pi_i(\psi_i) = \frac{r(\psi_i)}{\sigma} - \bar{w}f$, where r are revenues. The price index is $P_f = M^{\frac{1}{1-\sigma}}\frac{\sigma}{\sigma-1}\frac{\bar{w}}{\bar{\psi}}$, where $\bar{\psi}$ is the average productivity of the active firms. Assume that there exists a large mass of potential entrepreneurs M_e who have to bear sunk costs f_e for entering the market. Firms randomly draw their productivity ψ_i from a Pareto distribution $g(\psi_i)$, $G(\psi_i)$ with minimum productivity ψ_{min} and shape parameter k. The mass of surviving firms is $M = (1 - G(\psi_i))M_e$.

The profits of the average firm are $\bar{\pi} = \pi(\tilde{\psi}) = r(\tilde{\psi})/\sigma - \bar{w}f$. Note that the ratio of revenues between two firms is $\frac{r(\tilde{\psi})}{r(\psi^*)} = \left(\frac{\tilde{\psi}}{\psi^*}\right)^{\sigma-1}$ and that profits of the marginal firm with productivity ψ^* are zero, so that $r(\psi^*)/\sigma - f\bar{w} = 0$ or $r(\psi^*) = \sigma\bar{w}f$. Moreover, due to the Pareto Distribution, average productivity is $\tilde{\psi} = \left(\frac{k}{k+1-\sigma}\right)^{1/(\sigma-1)}\psi^*$. The profits of the average firm therefore are $\pi(\tilde{\psi}) = \bar{w}f\frac{\sigma-1}{k+1-\sigma}$

Free entry implies that new entrepreneurs found firms until expected (average) profits correspond to the sunk cost of entry, $v_e = \frac{1-G(\psi^*)}{\delta}\pi(\tilde{\psi}) - f_e \equiv 0$. Hence, the profits of the average firm are

$$\pi(\tilde{\psi}) = f_e\delta\left(\frac{\psi}{\psi_{min}}\right)^k \tag{4.5}$$

where δ is the period-risk of a terminal shock for entrepreneurs and v_e is the expected value of entry. From the profits of the average firm and equation (4.5) we can derive the equilibrium cut-off productivity for firm entry:

$$\psi^* = \left(\frac{\bar{w}f}{\delta f_e}\frac{\sigma-1}{k+1-\sigma}\right)^{1/k}\psi_{min} \tag{4.6}$$

The cut-off productivity rises in the wage cost index – rising wage costs force the least productive firms out of the market. We analyze industry employment of artisans and do

not further consider employment of non-artisans:

$$N = \int_{\psi^*}^{\infty} n(\psi) M \mu(\psi) d\psi = \bar{w}^{-\tilde{\epsilon}} Q_0 K \tag{4.7}$$

$$\text{where } \tilde{\epsilon} \equiv \epsilon + \frac{\epsilon - 1}{1 - \sigma} + \frac{\epsilon - 1}{k}$$

$$\text{and } K = \left(\frac{f}{f_e \delta} \frac{\sigma - 1}{k + 1 - \sigma} \right)^{\frac{\epsilon - 1}{1 - \sigma}} \psi_{min}^{\epsilon - 1} \left(\frac{\sigma}{\sigma - 1} \right)^{-\epsilon} M_e^{\frac{1-\epsilon}{1-\sigma}} \left(\frac{k}{k + 1 - \sigma} \right)^{\frac{1}{\sigma - 1}}$$

where $\mu(\psi)$ is the endogenous productivity density of surviving firms and K is a constant. $\tilde{\epsilon} = \frac{\partial \ln N}{\partial \ln \bar{w}}$ is the wage elasticity of industry labor demand and depends on the price elasticity of demand for firms' output ϵ, the elasticity of substitution between firms varieties σ, and the shape of the productivity distribution of firms k.

Workers

There are two types of workers, high-skilled H and low- and medium-skilled L workers. Their output is combined via a CES technology to the labor input N with elasticity of substitution η between the two types of labor. Firms optimally choose the composition of high-skilled and low-/medium-skilled workers:

$$H = N \left(\frac{w_H}{\bar{w}} \right)^{-\eta} \tag{4.8}$$

where $\bar{w}$ is the CES factor cost index for wages, $\bar{w} = \left(w_H^{1-\eta} + w_L^{1-\eta} \right)^{\frac{1}{1-\eta}}$. We combine equations 4.7 and 4.8 to derive industry demand for skilled workers:

$$H = w_H^{-\eta} \bar{w}^{\eta - \tilde{\epsilon}} Q_0 K \tag{4.9}$$

We combine low- and medium-skilled workers as a single worker type L for simplicity, since our paper focuses on the high-skilled workers. Gregory and Zierahn (2020) instead model L as a CES aggregate of low- and medium-skilled workers. In their model, the minimum wage induces substitution from low- to medium-skilled workers. Note, however, that the effect on high-skilled workers in our case would still solely depend on the change in average wages and in the change of wages of high-skilled workers relative to the other

workers. The qualitative results would thus remain the same and we ignore substitution between low- and medium-skilled workers for simplicity.

There is a large mass of low-/medium-skilled workers L^S who work if their wage is at least as large as their reservation wage, $w_L \geq \underline{w}$. We assume that their labor supply exceeds labor demand $L^S > L$, so that low-/medium-skilled workers earn their reservation wage, $w_L = \underline{w}$. This assumption is motivated by the empirically large unemployment rate among low-skilled workers.

Self-Employment

There exists a finite mass of high-skilled workers $\bar{H}$. High-skilled workers can choose between dependent employment as high-skilled workers in the firms and solo self-employment in the same industry. High-skilled workers never change to the outside sector, as we assume their earnings in the minimum wage industry to always exceed their expected earnings in the outside sector. This assumption is motivated by the empirically extraordinary low mobility rates of high-skilled workers in our minimum wage industries. The mobility rates are low for high-skilled workers due to the German apprenticeship system which provides them with industry-specific skills.

If solo self-employed, high-skilled workers produce using their own labor input and intermediate inputs z at prices p_z with technology $z = q_s$, where q_s is their output. Profits hence are $\pi_s = p_s q_s - p_z z$ and profit maximization implies that their prices are a constant mark up over marginal costs, $p_s = p_z \sigma/(\sigma - 1)$. Free entry implies that new solo self-employed enter the market until profits correspond to the outside earnings, which are high-skilled wages, $\pi_s = w_H$. We normalize $p_z \equiv \sigma - 1$ without loss of generalizability. The entry condition for high-skilled workers into solo self-employment then is $w_H = q_s$. Let us assume that skilled workers exogenously differ in their managerial ability – some can handle more or larger projects than others. We denote their entrepreneurial ability with ϕ and assume that the volume of projects that they can handle is $q_s(\phi) = \phi$. The cut-off managerial ability level for entering solo self-employed then is

$$\phi^* = w_H \tag{4.10}$$

The ability distribution of high-skilled individuals is $\phi = (1-s)^{\kappa}\phi_{max}$, where $0 \leq s \leq 1$ is the share of high-skilled individuals who are solo self-employed, $1-s$ is the share of high-skilled workers, ϕ_{max} is the maximum ability and $\kappa > 0$ is a distributional parameter. The underlying cumulative ability distribution $1 - s = G(\phi) = \left(\frac{\phi}{\phi_{max}}\right)^{1/\kappa}$, with support $0 < \phi < \phi_{max}$ and ability density $g(\phi) = \frac{1}{\kappa}\phi_{max}^{-1/\kappa}\phi^{\frac{1-\kappa}{\kappa}}$, is a flexible distribution which contains the uniform distribution ($\kappa = 1$) and which approximates a Pareto distribution for $\kappa \ll 1$. The main advantage of this distribution is that it allows for analytically traceable results.

Using this ability distribution and the cut-off ability level, we can derive high-skilled labor supply as

$$H = (1-s)\bar{H} = \bar{H}w_H^{1/\kappa}\phi_{max}^{-1/\kappa} \tag{4.11}$$

where $\bar{H}$ is the number of high-skilled individuals.

The aggregate price level in the solo self-employed segment is

$$P_s = \left[\int_{\omega\in\Omega} p_s^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}} = \left[\int_{\phi^*}^{\phi_{max}} p_s^{1-\sigma} d\phi\right]^{\frac{1}{1-\sigma}} = \sigma\left[\phi_{max} - \phi^*\right]^{\frac{1}{1-\sigma}} \tag{4.12}$$

4.B Additional Institutional Background and Data

Industry Coding

Table 4.B.1: Industry Classification 1973 Codes for the Minimum Wage Industries

	WZ 73	description
Main construction	590	General civil engineering activities
	593	Construction of chimneys and furnaces
	594	Plasterers and foundry dressing shops
	600	Carpentry and timber construction
	614	Floor tilers and paviours
Roofing	601	Roof covering
Electrical trade	611	Electric installations
Painting and varnishing	613	Paint shops and wall tilers

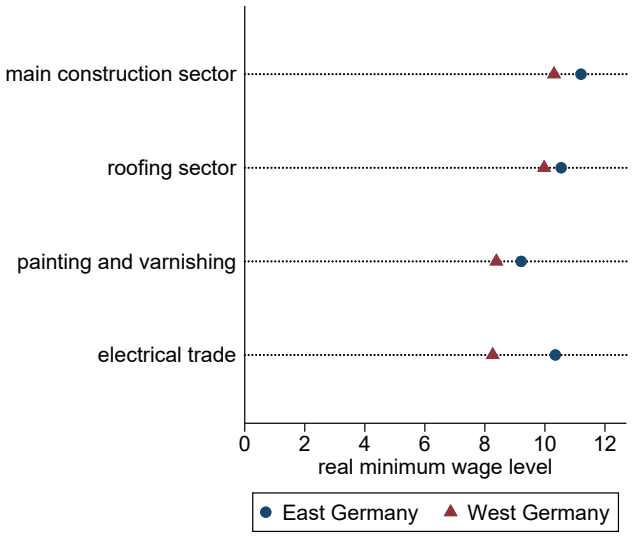
Table 4.B.2: Industries in the Crafts Donor Pool

WZ 73	description
130	Manufacture of rubber products
132	Vulcanization; repair of rubber products
140	Quarrying, cutting, shaping and finishing of stones
162	Manufacture, roughing and smoothing of glass
200	Drawing and cold-rolling of metals
263	Repair shop for agricultural machinery
271	Manufacture of other equipment related to mechanical engineering
300	Service and maintenance of motor vehicles and bicycles
310	Building and repairing of ships
347	Manufacture of television and radio receivers
348	Manufacture of measuring, checking and testing equipment, television and radio transmitters and apparatus for line telephony and line telegraphy
410	Manufacture of builders' carpentry and joinery
412	Cabinet making
545	Bread and pastry shops
562	Butcher's shops (including horse butchery)
610	Plumbing and piping
612	Glazing
615	Stove and furnace fitting
730	Hairdressing

Minimum Wage

Figure 4.B.1 plots the real minimum wage level as well as the date of introduction. The minimum wage levels vary between East and West Germany, captured by the point and triangle markers respectively.

Figure 4.B.1: Industry Specific Real Minimum Wages



Notes: Own illustration based on data from German Federal Statistical Office (Destatis). The numbers of workers refer to all workers subject to social security contributions and are taken from the Confederation of German Trade Unions(DGB).

German Microzensus Data

For the computation of hourly wages, we impute hours worked information from the German Microcensus to the SIAB data. The Microcensus is an annual survey of one percent of all households in Germany, conducted since 1957. A total of about 370,000 households with 810,000 persons take part in the survey. Among others, the data includes information on the employment status, occupation, industry, education and, most important, weekly hours worked. Unfortunately, the data does not include continuous wage information. To impute the hours worked information, we use the micro data of the survey waves 1997-2010, focus on working individuals between 19-65 and identify our minimum wage industries using the 3-digit industry coding (WZ 08): roofing (439), electrical trade (432),

main construction (412, 421,422, 429, 431) and painting and varnishing (433). Note that the 3-digit WZ 08 industry coding does not allow a perfect matching to 3-digit WZ 73, which creates some bias. We then calculate the average weekly hours worked in each of the 5376 cells that are spanned by the following variables shown in Table 4.B.3. The large set of variables thereby ensures that we capture the major part of the variation in hours worked. Note that we ensure that we have about 30-50 observations in each cell. We then transfer these cell-specific hours information to the SIAB data based on the exact same cells. Put differently, for each individual in the SIAB data, we assume the cell-specific weekly hours worked calculated in the Microzensus. Together with the wage information in the SIAB data, we then calculate hourly wages for each worker.

Table 4.B.3: Variables for Imputation of Weekly Working Hours

Variable	Categories	No of categories
Industry	roofing	4
	electrical trade	
	roofing	
	painting and varnishing	
Year	1997-2010	14
Region	East Germany	2
	West Germany	
Education	without vocational training (ISCED 2011, 1.2)	3
	with vocational training (ISCED 2011, 3.4)	
	with university degree (ISCED 2011, 5, 6, 7, 8)	
Gender	female	2
	male	
Age	younger workers (between 19-40)	2
	younger workers (between 41-65)	
Employment status	full-time	
	part-time	2
Type of workers	blue-collar worker	2
	white-collar worker	

4.C Additional Results

Table 4.C.1: Change in Solo Self-Employment Share over Time by Industry

	Average share of solo self-employed individuals among the workforce		
	pre-treatment years	post-treatment years	difference
West Germany			
Main construction	3.2	11.3	+8.1
Roofing	1.2	3.7	+2.5
Electrical trade	5.1	9.2	+4.1
Painting and varnishing	4.8	9.6	+4.8
East Germany			
Main construction	1.4	13.4	+12
Roofing	0.7	5.2	+4.5
Electrical trade	2.9	7.9	+5.0
Painting and varnishing	3.2	11.9	+8.7

Notes: Numbers are average share of solo self-employed among the workforce. Pre-treatment (post-treatment) years include 1992-1996 (1997-2010) for main construction, roofing, and electrical trade; and 1992-2002 (2003-2010) for painting and varnishing.

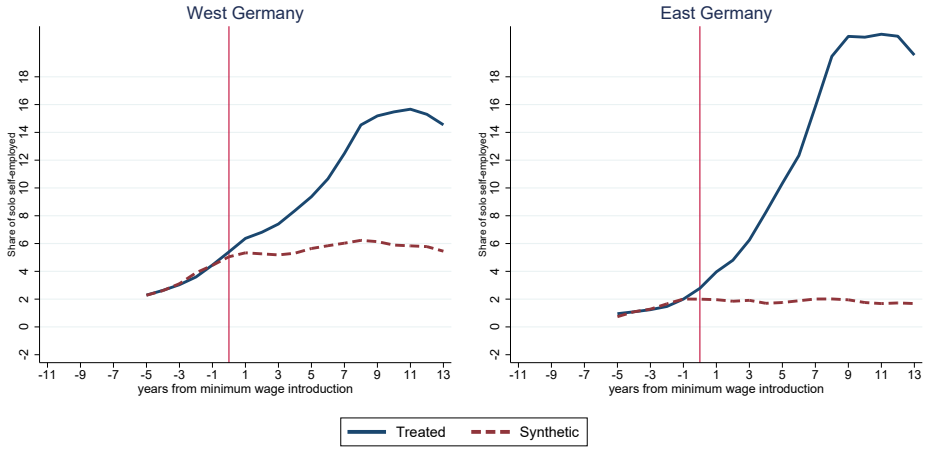
Table 4.C.2: Solo Self-Employment: Industry Weights in the Synthetic Industries (Using the Donor Pool Containing all Industries), by Minimum Wage Industries and East/West Germany

West Germany			East Germany		
Code	Industry	Weights	Code	Industry	Weights
Synthetic main construction industry					
301	Automotive paint shops	0.375	545	Bread and pastry shops	0.295
862	Inquiry office, typing pool, translations service	0.288	862	Inquiry office, typing pool, translations service	0.209
143	Other mining and quarrying n.e.c.	0.177	231	Manufacture of tanks, reservoirs and containers of metal	0.208
410	Manufacture of builders' carpentry and joinery	0.060	300	Service and maintenance of motor vehicles and bicycles	0.174
529	Manufacture of bed articles, manufacture of other textiles n.e.c.	0.011	96	Manufacture of pharmaceuticals, medicinal chemicals and botanical products	0.114
Synthetic roofing industry					
545	Bread and pastry shops	0.548	545	Bread and pastry shops	0.840
143	Other mining and quarrying n.e.c.	0.266	412	Cabinet making	0.094
240	Wagon and lorry building; industrial railway wagon building	0.099	300	Service and maintenance of motor vehicles and bicycles	0.050
529	Manufacture of bed articles, manufacture of other textiles n.e.c.	0.087	862	Inquiry office, typing pool, translations service	0.016
Synthetic Electrical trade					
780	Freelance human health activities	0.297	412	Cabinet making	0.223
410	Manufacture of builders' carpentry and joinery	0.121	220	Locksmithery, welding and grinding	0.164
722	Chimney sweeping services	0.101	231	facture of tanks, reservoirs and containers of metal	0.154
301	Automotive paint shops	0.099	545	Bread and pastry shops	0.075
862	Inquiry office, typing pool, translations service	0.083	562	Butcher's shops (including horse butchery)	0.072
Synthetic Painting and varnishing					
780	Freelance human health activities	0.371	231	Manufacture of tanks, reservoirs and containers of metal	0.371
310	Building and repairing of ships	0.219	610	Plumbing and piping	0.327
410	Manufacture of builders' carpentry and joinery	0.208	865	Labour recruitment and provision of personnel	0.174
790	Solicitor's offices, notary's offices, legal advisory services	0.094	790	Solicitor's offices, notary's offices, legal advisory services	0.128
300	Service and maintenance of motor vehicles and bicycles	0.054			

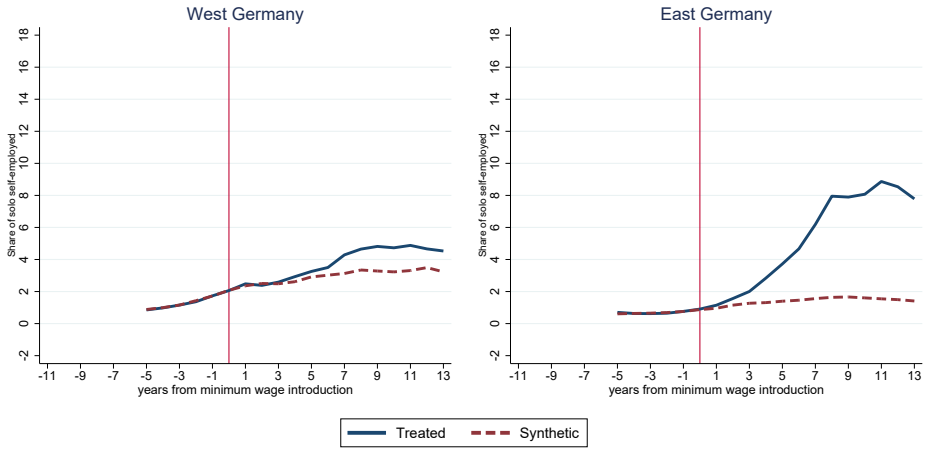
Notes: Only the five largest weights for each synthetic control are displayed. Donor Pool contains all industries.

Figure 4.C.1: Share of Solo Self-Employment in Minimum Wage Industries vs. their Synthetic Counterparts, by East and West Germany

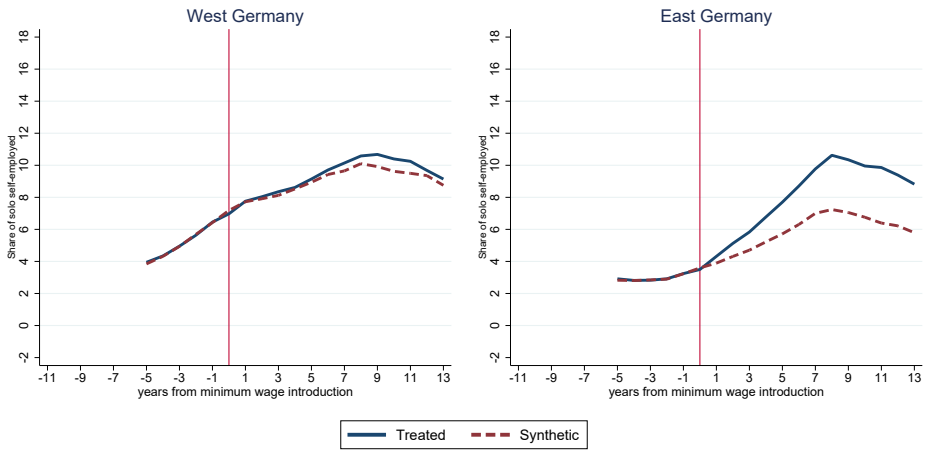
(a) Main construction industry



(b) Roofing industry



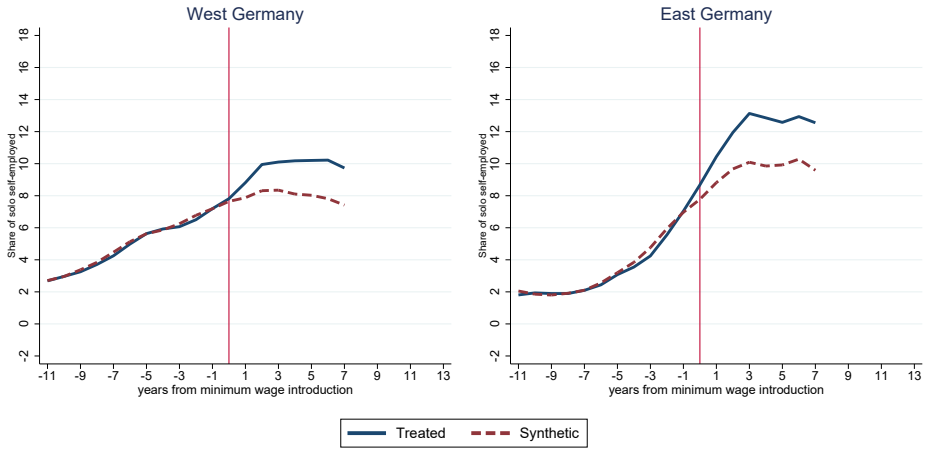
(c) Electrical trade industry



Notes: Donor Pool contains all industries.

Figure 4.C.1: Share of Solo Self-Employment in Minimum Wage Industries vs. their Synthetic Counterparts, by East and West Germany

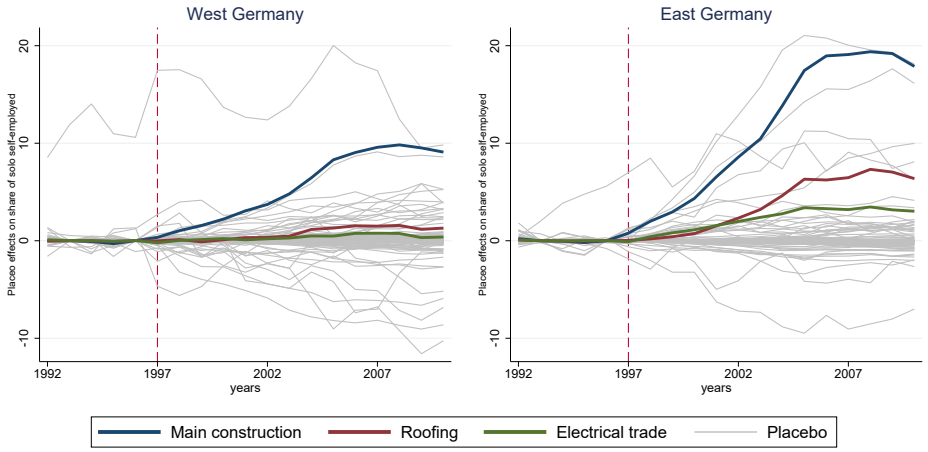
(d) Painting and varnishing



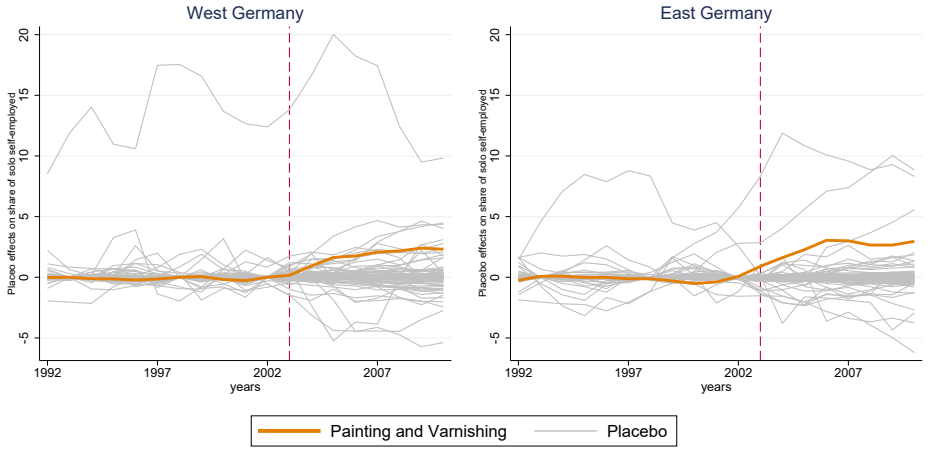
Notes: Donor Pool contains all industries.

Figure 4.C.2: Placebo Effects on the Share of Solo Self-Employment in all Industries vs. their Synthetic Counterparts, by East and West Germany

(a) 1997 minimum wage industries



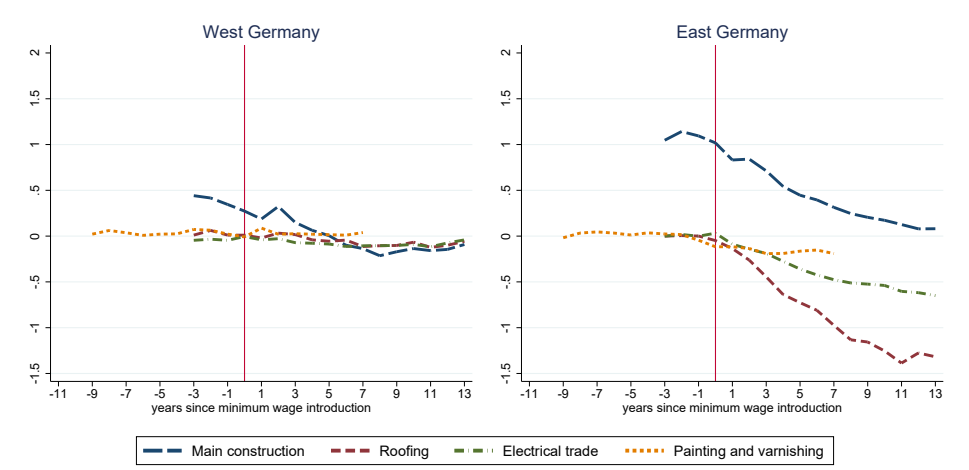
(b) 2003 minimum wage industry



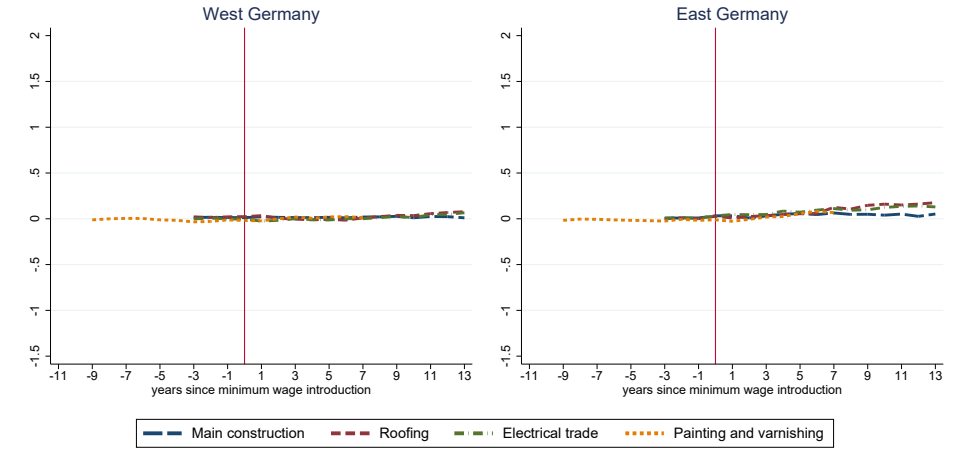
Notes: Individual placebo tests on all available industries. Donor Pool contains all industries without the respective placebo treated industry and the minimum wage industries.

Figure 4.C.3: Substitution and Scale Effects in all Minimum Wage Industries vs. their Synthetic Counterparts, by East and West Germany

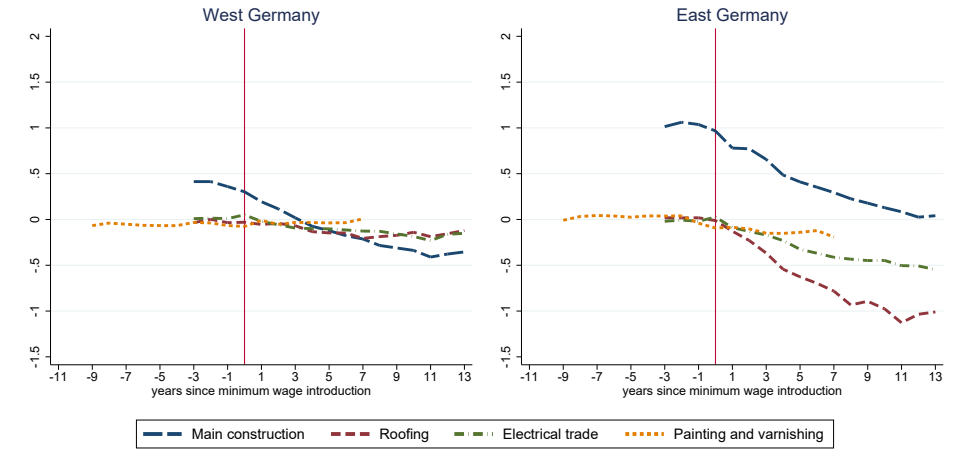
(a) Log total employment (scale effect)



(b) Log share of skilled employment (substitution effect)



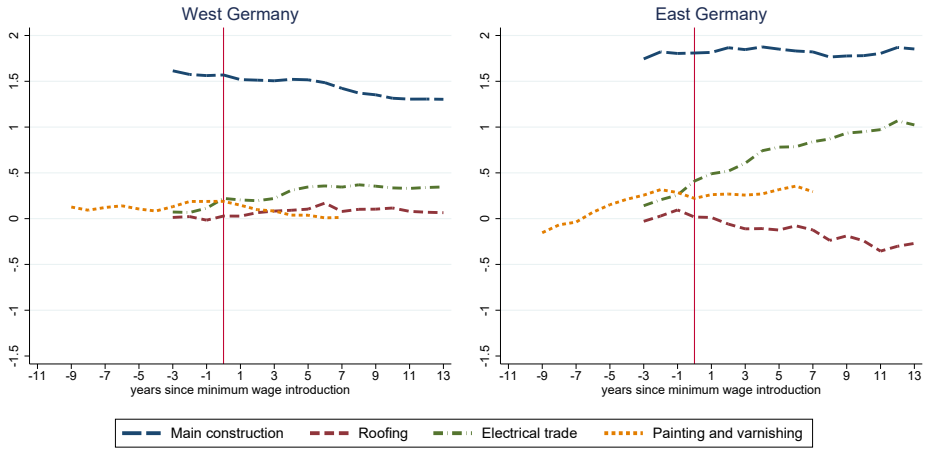
(c) Log skilled employment (net effect)



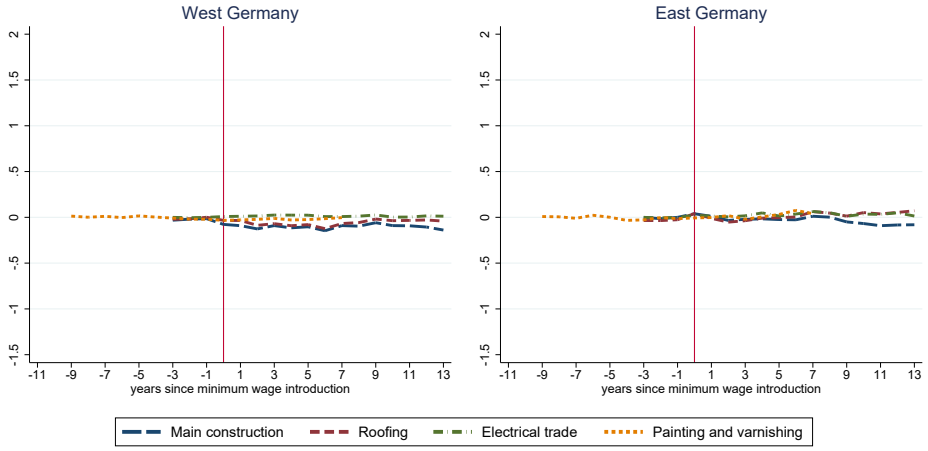
Notes: Estimated effects when applying the synthetic control method to the named variable as outcome variable. Donor pool size 85 / 52 in West / East Germany.

Figure 4.C.4: Substitution and Scale Effects in all Minimum Wage Industries vs. their Synthetic Counterparts, Restricting the Donor Pool to Industries from the Broader Construction Sector, by East and West Germany

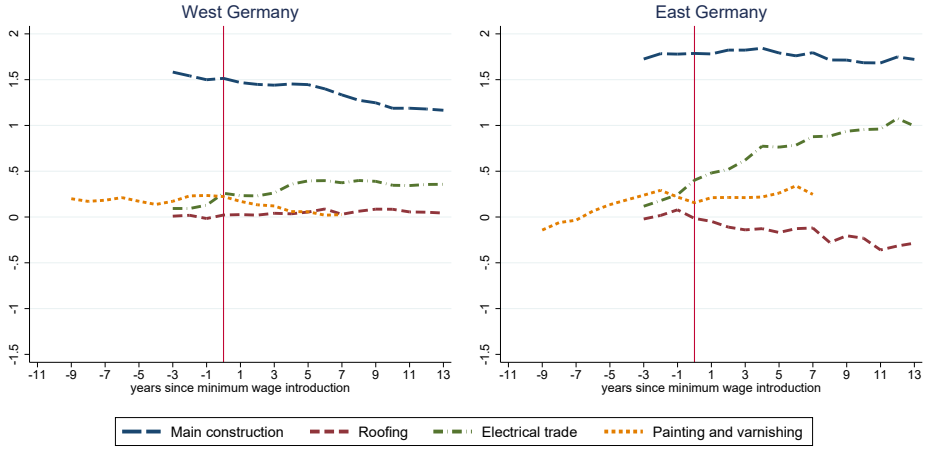
(a) Log total employment (scale effect)



(b) Log share of skilled employment (substitution effect)



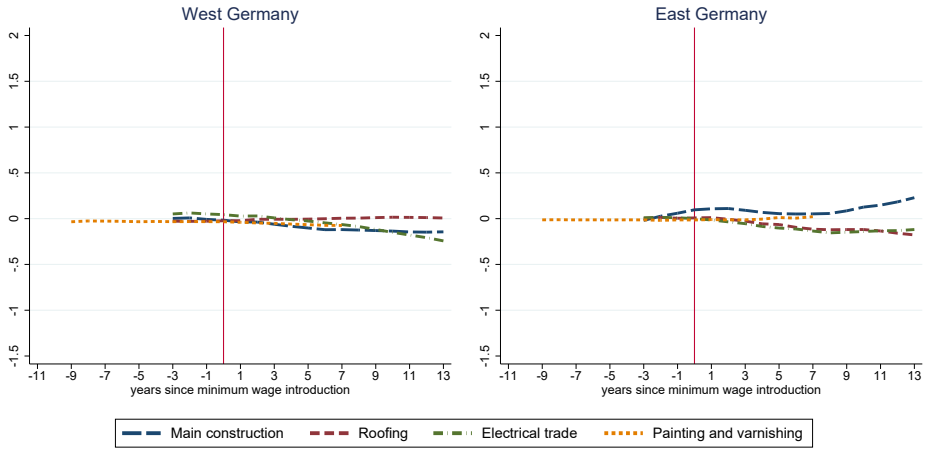
(c) Log skilled employment (net effect)



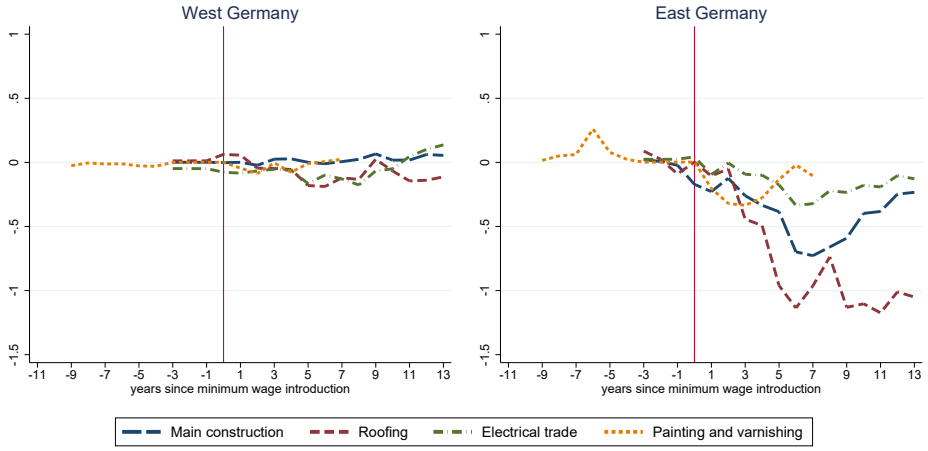
Notes: Estimated effects when applying the synthetic control method to the named variable as outcome variable. Donor pool restricted to broader construction sector, 7 industries West/ East.

Figure 4.C.5: Effects on Log Total Number of Firms and Log Revenues of Solo Self-Employed and Young Solo Self-Employed in all Minimum Wage Industries vs. their Synthetic Counterparts, by East and West Germany

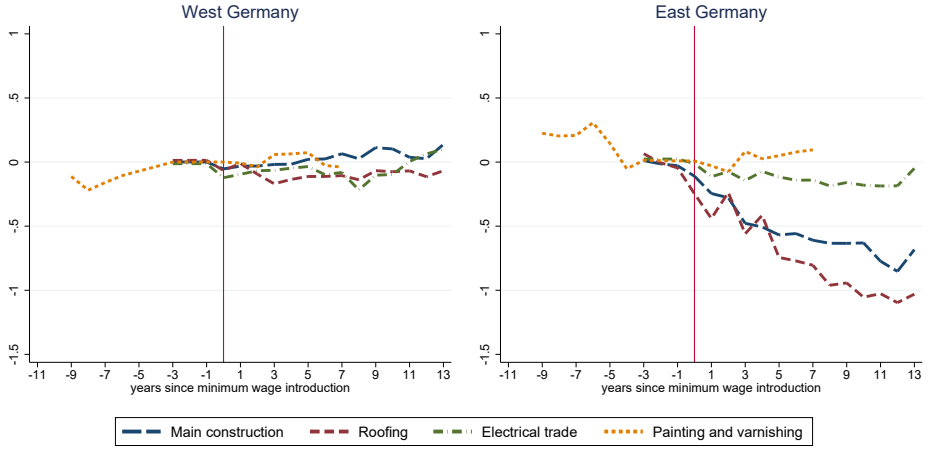
(a) Log total number of firms (w/o solo self-employed)



(b) Log revenues of all solo self-employed



(c) Log revenues of young solo self-employed



Notes: Estimated effects when applying the synthetic control method to the named variable as outcome variable. Donor pool size 43 / 31 in West / East Germany.

Table 4.C.3: Correlations Between the Minimum Wage Effect of Solo Self-Employment and the Effect on Dependent Employment

Dependent Variable: minimum wage effect on the share of solo self-employed	OLS (1)	OLS (2)	FE (3)
Minimum wage effect on skilled employment	-0.08	-0.49	-1.77***
	(-0.09)	(-1.52)	(-26.61)
Industry and region dummies	No	Yes	No
Region-industry FE	No	No	Yes
N	92	92	92

Notes: t-statistics in brackets. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$; Columns 1 and 2 are clustered by industry-region; Sample contains industry-region observations for years after minimum wage was introduced; all variables are in logs.

Table 4.C.4: Additional Results on the Role of the Bite

	(1) OLS	(2) OLS	(3) FE
Dependent Variable: minimum wage effect on log employment (scale effect)			
Log Kaitz-Index	-2.13**	-2.39	-2.01***
	(-3.97)	(-2.01)	(-5.44)
Log Share of workers with wage below next minimum wage	-0.58***	-0.47**	-0.40***
	(-4.34)	(-3.65)	(-6.93)
Dependent Variable: minimum wage effect on share of skilled workers (substitution effect)			
Log Kaitz-Index	0.28***	0.34**	0.43***
	(7.29)	(2.94)	(6.85)
Log Share of workers with wage below next minimum wage	0.08***	0.06***	0.08***
	(11.23)	(4.69)	(7.55)
Dependent Variable: minimum wage effect on revenues of young firms			
Log Kaitz-Index	-1.48*	-1.71	-1.00***
	(-2.09)	(-1.94)	(-3.73)
Log Share of workers with wage below next minimum wage	-0.41*	-0.36**	-0.21***
	(-2.47)	(-4.00)	(-4.88)
industry and region dummies	No	Yes	No
region-industry FE	No	No	Yes
N	92	92	92

Notes: t-statistics in brackets. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$; Columns 1 and 2 are clustered by industry-region; Sample contains industry-region observations for years after minimum wage was introduced; all variables are in logs.

Table 4.C.5: Accumulated Effects of the Minimum Wage on Solo Self-Employment at Different Years after Introduction in East and West Germany, Different Specifications

Specification:	(1) Main	(2) craft donor	(3) additional pre-treatm. years	(4) no further predictors	(5) no lagged outcomes
	Donor pool size				
West Germany	103	19	103	103	103
Main construction					
t+3	2.224*	0.635*	1.773*	1.230***	2.449**
	[9]	[1]	[8]	[1]	[2]
t+6	4.815**	1.784*	4.029**	3.284***	5.076**
	[4]	[1]	[4]	[1]	[2]
t+13	9.092**	5.703*	8.450**	7.427***	9.102***
	[5]	[1]	[4]	[1]	[1]
Roofing					
t+3	0.104	-0.0345	0.152	0.0401	0.446
	[34]	[14]	[35]	[39]	[20]
t+6	0.480	0.303	0.552	0.532	1.038**
	[17]	[13]	[17]	[21]	[5]
t+13	1.300**	1.399	1.628*	1.875*	1.902**
	[5]	[3]	[6]	[10]	[4]
Electrical trade					
t+3	0.226	-0.756	0.557	0.250	0.827
	[74]	[9]	[29]	[93]	[15]
t+6	0.282	-1.649	0.938	0.410	1.442*
	[79]	[6]	[24]	[79]	[6]
t+13	0.388	-4.015	1.078	0.459	1.684*
	[63]	[7]	[26]	[56]	[7]
Painting and varnishing					
t+3	1.755**	1.175*	1.499**	1.551***	8.226*
	[2]	[1]	[2]	[1]	[7]
t+6	2.406*	1.206	1.835**	2.230*	8.466
	[7]	[3]	[4]	[7]	[12]
	Donor pool size				
East Germany	72	17	72	72	72
Main construction					
t+3	4.339*	3.591	3.216	3.767*	3.051**
	[4]	[2]	[11]	[4]	[1]
t+6	10.45**	8.703	7.940*	8.808**	8.018**
	[2]	[2]	[4]	[1]	[1]
t+13	17.88**	15.95*	14.36**	16.52**	15.33**
	[1]	[1]	[1]	[1]	[1]
Roofing					
t+3	0.735**	0.646	0.532**	0.972**	1.269*
	[3]	[2]	[1]	[2]	[5]
t+6	3.206**	3.030*	2.583**	3.350**	3.861**
	[1]	[1]	[1]	[1]	[1]
t+13	6.375**	6.158*	5.105**	6.565**	6.934**
	[1]	[1]	[1]	[1]	[1]
Electrical trade					
t+3	1.131**	0.895	1.198**	1.870**	1.869**
	[1]	[2]	[1]	[1]	[2]
t+6	2.400**	2.265	2.666**	3.889**	3.515**
	[1]	[2]	[1]	[1]	[2]
t+13	3.028**	1.383	3.160**	4.520**	4.218**
	[1]	[4]	[1]	[1]	[2]
Painting and varnishing					
t+3	3.044*	2.802	3.450*	2.994**	1.377
	[4]	[2]	[6]	[2]	[71]
t+6	2.657*	2.328	3.078	2.619	2.275
	[7]	[2]	[17]	[8]	[67]

Note: p-values indicated by $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$; rank statistics in square brackets; Respective donor pool size indicated above each column.

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