Efficiency and Distributional Effects of German Labor Market Institutions

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Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 The relevance of labor market institutions

Labor market institutions, policies and their reforms have been growing in relevance since the beginning of the 21st century (e.g. Belot & van Ours 2004; Botero et al. 2004). The term 'labor market institution' covers legislations such as employment protection (Koeniger et al. 2007), unemployment assistance, minimum wages (e.g. Fortin et al. 2021) but also bargaining and employee representation bodies such as unions and works councils (Grund & Martin 2021; Harju et al. 2021; Farber et al. 2021; Eichhorst 2015). In general, the term refers to a broad set of policy interventions as well as collective organizations that have the power to affect employment, wages and related outcomes (Holmlund 2014). These institutions are acknowledged as a key factor in providing economic growth and fostering technological progress, but also workplace democracy and equality.[1] Institutions also provide the framework and incentives to take up employment and facilitate job-to-job as well as unemployment-to-employment transitions. Those transitions depend, among other things, on the aggregate matching function of the labor market (e.g. Petrongolo & Pissarides 2001; Nickell & Layard 1999).

Taking a careful view of the development of labor market institutions over time, the literature roots a starting point of growing interests towards the end of the 20th century. During the 1990s in particular, scholars observed that despite similar macro-economic policies in the United States and Europe, the United States had higher employment rates coupled with greater productivity growth than most of the European countries (Freeman 2008).[2] Up to this point, macro-economic policies were seen as a remedy for economic obstacles while labor market institutions are seen more as a peripheral to economic performance (e.g. Freeman 2008). Interest among scholars and politicians, however, shifted towards the understanding and design of institutions and their reforms. These perspective shifts stemmed above all from proposals outlined by the Organization for Economic Cooperation and Development (OECD) to increase labor market flexibility (e.g. Michie & Sheehan 2003) by adjusting labor market institutions (OECD 1994a,b). Specific recommendations were, for example, increasing flexibility in working time, wages

[1] The term 'labor market institution' originates in the 19th century, coinciding with the industrialization of Western Europe and North America. After World War II, an institutional framework was implemented in developed countries and, in the following decades, in developing countries. While the term 'institutions' is arguably quite broad, North (1991) defines institutions as "humanly devised constraints that structure political, economic, and social interaction". (North 1991, p. 97)

[2] Such differences, in fact, more or less persist to this day and the literature largely attributes those to heterogeneous labor market institutions between, for example, Germany and the United States (e.g. Morgan & Hauptmeier 2021; Murtin & Robin 2018; Holmlund 2014; Moser et al. 2010).

and more responsive labor costs, and the weakening of employment security and unemployment benefit systems (OECD 1994a,b). As a response to those recommendations, many OECD countries indeed have undertaken reforms in their labor market institutions in the subsequent decades (e.g. Boeri 2011; Bental & Demougin 2010). This marks the trend from a passive towards a more active style of labor market policy (e.g. Larsen 2008). During this period, Germany in particular has evolved from the 'sick man of Europe' (Dauth et al. 2021; Dustmann et al. 2014) to become a far more competitive country in recent years. The consequences of change, especially regarding the efficiency and distributional effects of labor market institutions, however, are far from conclusive at this point. In fact, the relevance of institutions and reforms has not diminished, but rather increased as new challenges continue to arise at the beginning of the 21st century. Increasing use of new automation technologies such as robots and algorithms, intensifying competition, rising inequality (Acemoglu & Restrepo 2021; Jäger et al. 2021; Kehrig & Vincent 2021; De Loecker et al. 2020) but also a paucity of entrepreneurial behavior (Dilli 2021) are just a few examples in this regard. Interest in the relevance and consequences of labor market institutions is therefore widespread and is more than likely to grow in future decades.

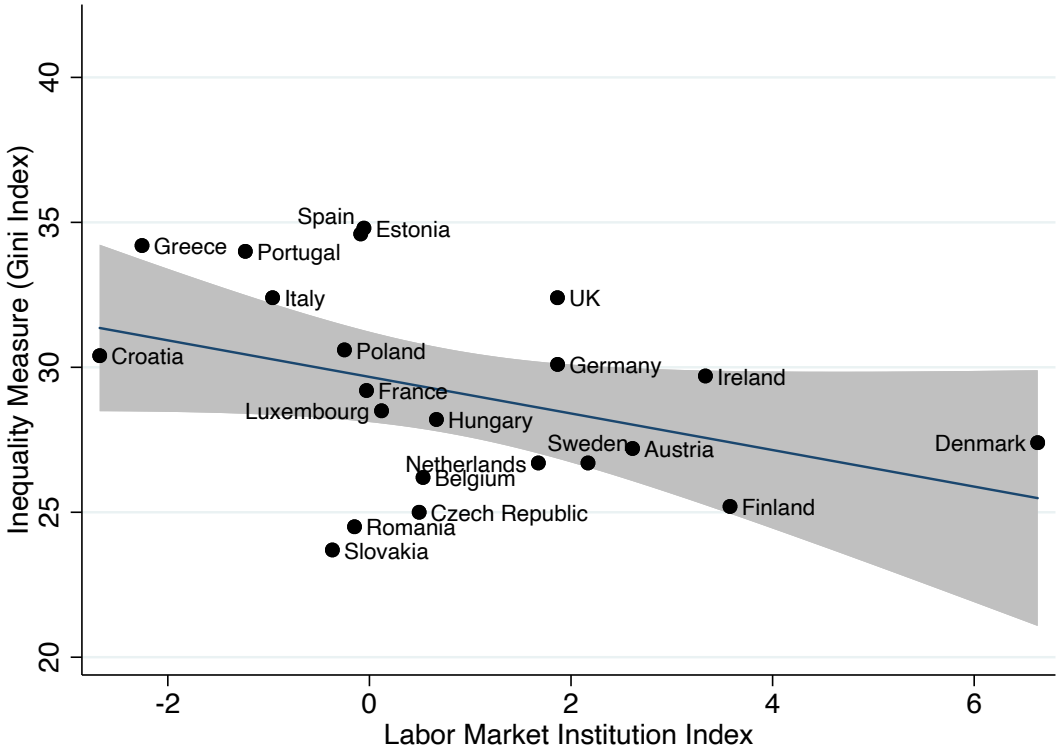
From an empirical perspective and to underline the relevance of institutions, particularly in the context of distribution and inequality, Figure 1.1 provides a first and aggregate overview on this issue. The consideration of distributional outcomes, i.e. capital and labor shares, is not only closely related to chapter five of this thesis, but in terms of inequality also one of the most pressing challenges in developed as well as developing economies (e.g. Iñaki 2020; Song et al. 2019). Figure 1.1 therefore shows an European country comparison between the Gini index as a standard inequality measure (e.g. Benhabib et al. 2017) and the labor market institution index[3] provided by the European Commission, which measures the reliance of the labor market on various institutions.[4] It becomes apparent from Figure 1.1, that countries, which rely more on labor market institutions, are also perceived to be more equal, i.e. have a lower Gini index. However, labor market institutions might vary significantly from country to country and those descriptive results are far from conclusive. Figure 1.1 should be considered more or less as a motivational concept and thus only provides a first glance at the relevance of institutions. Labor market institutions therefore appear to be not only beneficial for the functioning of labor markets but also for reducing inequality on the aggre-

[3]See, for example, Huber et al. (2020) for a recent application of this index.

[4]The Labor market institution index assesses EU countries by five different measures, namely active labor market policies, unemployment benefits, lifelong learning policies, employment protection legislation and activation conditionalities.

gate as well as firm level. Moreover, Figure 1.1 shows not only the relevance of institutions to shaping outcomes, but also that various institutions interact with each other and are closely related. This motivates a combined investigation to measure their full impact (Belot & van Ours 2004).

Figure 1.1: Labor market institutions and the Gini index



Notes: This figure shows a scatter plot of the Gini index as an inequality measure against the labor market institution index. The Gini index ranges from 0 to 100, with 0 representing a perfect equal distribution and 100 representing the greatest possible inequality. Source: Eurostat. The labor market institutions index is provided by the European Commission and assesses European countries in terms of five labor market institutions (ALMP, unemployment benefits, lifelong learning, employment protection, activation policies). Own calculations, unweighted.

This combined investigation of institutions is the starting point. In particular, this thesis then focuses on recent trends in Germany at the company and aggregate level, specifically the consequences of changes in institutional designs in the early years of the 21st century. Given the broad definition of labor market institutions, this thesis focuses on two aspects; employee representation institutions and consequences induced by the Hartz legislation starting in the years 2003 to 2005.

The thesis begins with two essays that examine the changing patterns of employee representation institutions in the form of alternative voice institutions (e.g. Jirjahn et al. 2021; Oberfichtner & Schnabel 2019; Katz & Krueger 2018) and works councils (e.g. Grund & Martin 2021; Freeman 2008) and how they promote workplace democracy in the wake of eroding industrial relations in Germany (Oberfichtner & Schnabel 2019; Addison et al. 2017). In particular, they con-

sider the impact of alternative forms of employee representation (e.g. Jirjahn et al. 2021; Oberfichtner & Schnabel 2019; Katz & Krueger 2018) in the form of round table conferences, employee spokespersons and additional management lines on innovative firm behavior and labor productivity. These chapters explore the trend towards flexibilization within the system of industrial relations (Addison 2016). While alternative voice institutions are closely related to involvement measures such as high-performance work practices (e.g. Hauff 2021; Bloom & Reenen 2010; Cappelli & Neumark 2001), these two chapters are closely related to the human resource management and industrial relations literature (e.g. Delaney & Godard 2001). Second, besides flexibilization trends arising from declining industrial relations on the workplace level, two more essays in this thesis take a broader perspective and consider consequences of labor market reforms induced by the Hartz reform package in Germany. While those Hartz reforms consist of four pieces of legislation, this thesis focuses on the Hartz III and Hartz IV reforms, which are known to have had the most profound impact on the economy (e.g. Carrillo-Tudela et al. 2021; Bradley & Kügler 2019; Hartung et al. 2018). Those reforms are designed, firstly, to provide more efficient matching efficiency by enhancing the productivity of the Federal Employment Agency (FEA). Secondly, changes in unemployment benefits (Hartz IV) might largely increase employees' incentives to take up employment, however, might also come with a distributional impact.

This thesis therefore provides empirical evidence on flexibilization trends in Germany and contributes to the understanding of institutional changes at the governmental and workplace level. In particular, it considers emerging trends in industrial relations and management practices at the establishment level largely aimed at improving flexibility[5] to cope with recent and future challenges. Eichhorst (2015), for example, refers to those trends as the 'New German Model' where we "[...] can observe growing reliance on mechanism of internal flexibility [...]"(Eichhorst 2015, p. 49).[6] In this context, the term flexibilization is used to consider, on the one hand, the emerging trends towards voluntary workplace practices and, on the other hand, changes in institutions induced by the Hartz reform package. The investigation of those trends and effects in terms of efficiency and distribution is the purpose of this thesis. It investigates how employment growth, technological progress and labor productivity are shaped by institutions and how those economic rents are divided between capital and labor.[7]

[5]This term follows the definition by Michie & Sheehan (2003), where flexibility refers to the ability of markets and agents to respond to changing economic conditions.

[6]See also Eichhorst & Marx (2011).

[7]Michie & Sheehan (2003) provide an in-depth discussion on various aspects of flexibility. They use the term 'numerical flexibility' to refer to employment practices such as part-time and fixed-term work, as well as 'functional flexibility' to refer to the ability of firms to use its

1.1.1 Trends towards alternative employee representation

Employee representation institutions are the most central concept of industrial relations and workplace democracy. Whereas various countries have implemented quite different systems of industrial relations, the German system is characterized by its dual structure.[8] First, it consists of unions representing workers and employer associations bargaining about collective agreements on the industry level and thus setting wage floors and working hours (Oberfichtner & Schnabel 2019). Second, under certain conditions, employees are allowed to vote for a works council, i.e. an institution of employee representation at the firm level (Grund & Martin 2021; Harju et al. 2021). Both levels of bargaining are closely connected, and the relationship between both actors is characterized by social exchange where works councils engage in active union membership recruitment and unions support works councils with financial resources (e.g. Behrens 2009). Works councils, however, are not usually engaged in wage bargaining (Barth et al. 2020). The purpose of these employee representation institutions is the harmonization of interests between employees and employers. Therefore, industrial relations contribute to workplace performance in terms of productivity, profits, wages and technological progress (Harju et al. 2021; Jirjahn et al. 2021; Mueller & Stegmaier 2017; Jirjahn & Mueller 2014; Kraft et al. 2011; Kaufman & Kleiner 1993).

The literature usually equates employee voice with unionized collective voice (e.g. Freeman & Medoff 1984) or works councils (Freeman & Lazear 1995). Employee voice institutions are, however, quite multidimensional in various aspects (Pohler & Luchak 2014). They range from institutions with far reaching codetermination rights such as unions or German works councils to more localized and unspecific forms. Examples in this regard are two-way communication and consultation practices (e.g. Jirjahn et al. 2021; Oberfichtner & Schnabel 2019), joint consultative committees (e.g. Gomez et al. 2019) or voluntary partnerships (e.g. Katz & Krueger 2018).[9]

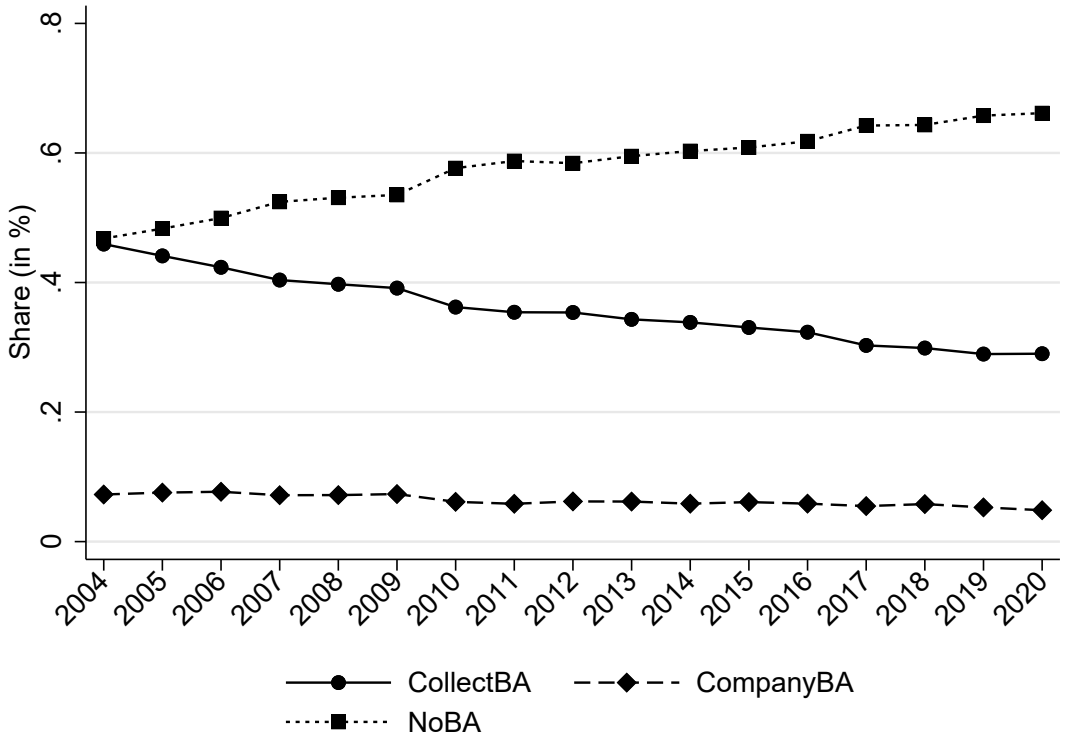
employees to carry out a wide range of tasks instead of relying on external labor. Finally, they use the term 'reward flexibility' to refer to performance enhancing practices such as performance pay (Michie & Sheehan 2003). The term flexibility should thus be understood in this thesis as the ability of firms to cope with changing market conditions and therefore have a positive connotation.

[8]The dual structure in which trade unions and works councils are complements, is sometimes acknowledged as more beneficial compared to the single channel of representation, as provided, for example, in the United States (Berg 2015). The system also considers board level representation in stock corporations (e.g. Jäger et al. 2021), which is not considered in this thesis. For a recent contribution, see Dyballa & Kraft (2020).

[9]Marchington & Suter (2013) provide an overview in terms of degree, level and scope of different voice actors and consider such institutions more generally as employee involvement and participation mechanisms.

Since the mid-1990s, an increasing trend toward localization and decentralization of labor relations has been observed in Germany, but also in other countries (e.g. Brandl & Braakmann 2021; Bossler 2019; Dustmann et al. 2014; Taras 2002; Lloyd 2001). First, collective bargaining institutions such as trade unions and the collective bargaining agreements negotiated by them are in decline (e.g. Oberfichtner & Schnabel 2019; Addison et al. 2017; Kaufman 2008; Machin & Wood 2005). For example, Addison et al. (2017) report that the coverage of sectoral agreements in Germany declined from 47.9 % in 2000 to 32.9 % in the year 2011. Empirical findings furthermore suggest that the decline in bargaining coverage is mainly driven by western establishments that additionally have a works council (Bellmann et al. 2018). The consequences are severe, since falling bargaining power is associated with increases in wage inequality (Stansbury & Summers 2020; Hirsch & Mueller 2020).[10] In this connection, Figure 1.2 provides an overview of the development of collective and company bargaining agreements in Germany in the last two decades.

Figure 1.2: Trends in German bargaining agreements



Notes: This figure shows the trend of collective and company bargaining agreements (BA) in Germany over time for establishments with equal to or more than five employees. Data from the IAB Establishment Panel, own calculations.

Second, on the firm level, works council coverage is declining as well (Ellguth &

[10] For example, Hirsch & Mueller (2020) find that falling collective bargaining coverage can account for 40 % of rising wage inequality.

Kohaut 2020; Addison et al. 2017; Hassel 1999).[11] These trends towards eroding industrial relations are usually explained by the exhaustion of its actors, in which traditional institutions are replaced by new ones which are formed voluntarily (e.g. Haipeter 2011; Streeck 2009). One reason for this is, for example, the lack of appropriate considerations of insider interests, which makes it easier for employees and the management to implement alternative forms (Jirjahn & Smith 2006). One example on the industry level is the increasing use of opening clauses in sectoral agreements (Bossler 2019; Ellguth et al. 2012) which allow large degrees of flexibility in terms of renegotiating on the firm level (Garnero 2020; Bellmann et al. 2015).[12]

In summary, the void left by declining industrial relations appears to be filled by voluntary partnerships. These trends therefore lead to interest in and the emergence of alternative, more direct forms of employee representation on the establishment level aimed at providing a more flexible relationship between management and employees (van der Meer 2019; Hauser-Ditz et al. 2013; Klaas et al. 2012; Dundon & Gollan 2007; Heery & Frege 2006; Bryson 2004).[13] These alternative institutions (e.g. Jirjahn & Mohrenweiser 2016), which do not have to be legally defined (e.g. Artus 2013), are considered under various definitions such as high-performance-work practices (Hauff 2021; Brown et al. 2011; Bloom & Reenen 2010; Cappelli & Neumark 2001), alternative forms of worker voice (Katz & Krueger 2018; Tapia et al. 2015; Klaas et al. 2012) or voluntary workplace partnerships (Dobbins & Gunnigle 2009). Following Heery & Frege (2006) an appropriate definition might be "specialized private agencies [...] created by employers themselves and which have been surprisingly neglected by IR researchers"(Heery & Frege 2006, p. 602). From this perspective, alternative (non-union) forms of employee representation might not only fill the void left by unions (e.g. Godard & Frege 2013; Delaney & Godard 2001) but also that left by works councils on the establishment level. Within the German context, Hertwig (2011) and Addison (2009) provide overviews regarding different nuances of alternative types of worker representation such as employee spokespersons, round table conferences and additional management lines.

The German context, however, is particularly interesting and complex compared

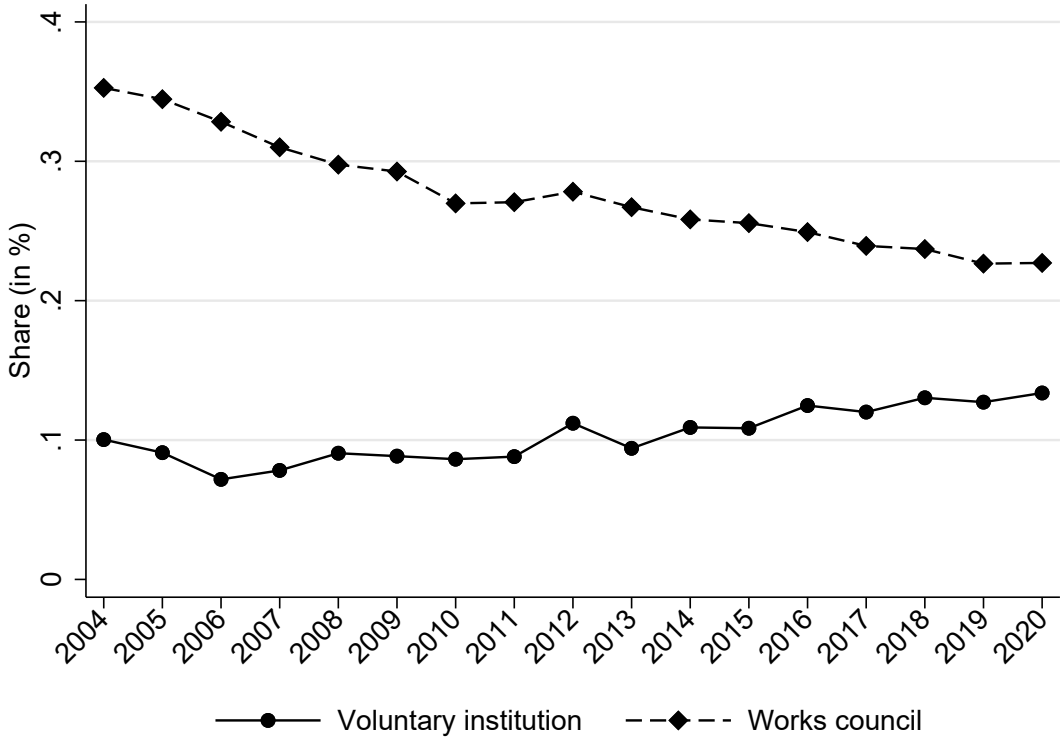
[11] Nevertheless, interest in works councils as the fundamental labor market institutions for providing workplace democracy in Germany is not waning (e.g. Harju et al. 2021; Burdin & Pérotin 2019), despite the fact that decision making is becoming more decentralized (Godart et al. 2017).

[12] Another trend in this regard is flexible time arrangement such as, for example, trust-based work time (Godart et al. 2017). More flexibility in the system of industrial relations might also contribute to more resilience in crises (Dustmann et al. 2014).

[13] Dundon et al. (2006) already identifies growing preferences and interest for this kind of communication-type voice channels.

to other countries such as, for example, Ireland where only the employer has the authority to initiate voluntary voice institutions (Dobbins & Gunnigle 2009). The German context also provides the opportunity to investigate interactions between voluntary and statutory voice provided by works councils. On the one hand, employees can vote for works councils and, on the other hand, alternative institutions can also be additionally present in the workplace. Although voluntary voice is usually initiated by the management (Charlwood & Pollert 2014), it also can emerge within the workplace (Hertwig 2011). The initiation of alternative voice can, however, also be interpreted as an avoidance strategy by using voluntary institutions to avoid works councils with strong bargaining rights (Royle 1998). Summarizing, Figure 1.3 provides descriptive evidence regarding recent trends of statutory (i.e. works councils) and voluntary voice institutions within the German context. It supports the notion of a growing trend towards alternative representation institutions, which is investigated in this thesis.[14]

Figure 1.3: Trends in workplace voice institutions in Germany



Notes: This figure shows the trends in workplace representation in German establishments with equal to or more than five employees. Data from the IAB Establishment Panel, own calculations. Voluntary institutions defined as voluntary forms of representation such as round table conferences, employee spokespersons and additional management lines (e.g. Addison 2009).

While the incidence of works council coverage has been in steady decline for decades, an increasing prevalence of voluntary institutions is discernible during the

[14]For a comparison between formalized employee representation and other institutions such as the German minimum wage, see, for example, Bellmann et al. (2018).

same period of time. While efficiency and the distributional effects of these trends towards alternative voice institutions are of particular interest due to their flexible and firm-tailored characteristics, potential losses in employee bargaining power due to the falling number of works councils might have implications for workplace democracy. With this in mind, there have been recent efforts in Germany to modernize workplace voice and the Works Constitutions Act, while at the same time fostering workplace democracy with strong bargaining rights. While this trend towards an increasing use of voluntary institutions may very well persist in the future, efforts to mitigate any potential downward trend in bargaining power are underway. To this end, the German Parliament recently passed the Works Council Modernization Act of 2021. Due to the increasing relevance of voluntary employee representation, the second and third chapter of this thesis investigate the consequences and effects of those institutions on establishment performance.

1.1.2 The Hartz reform package

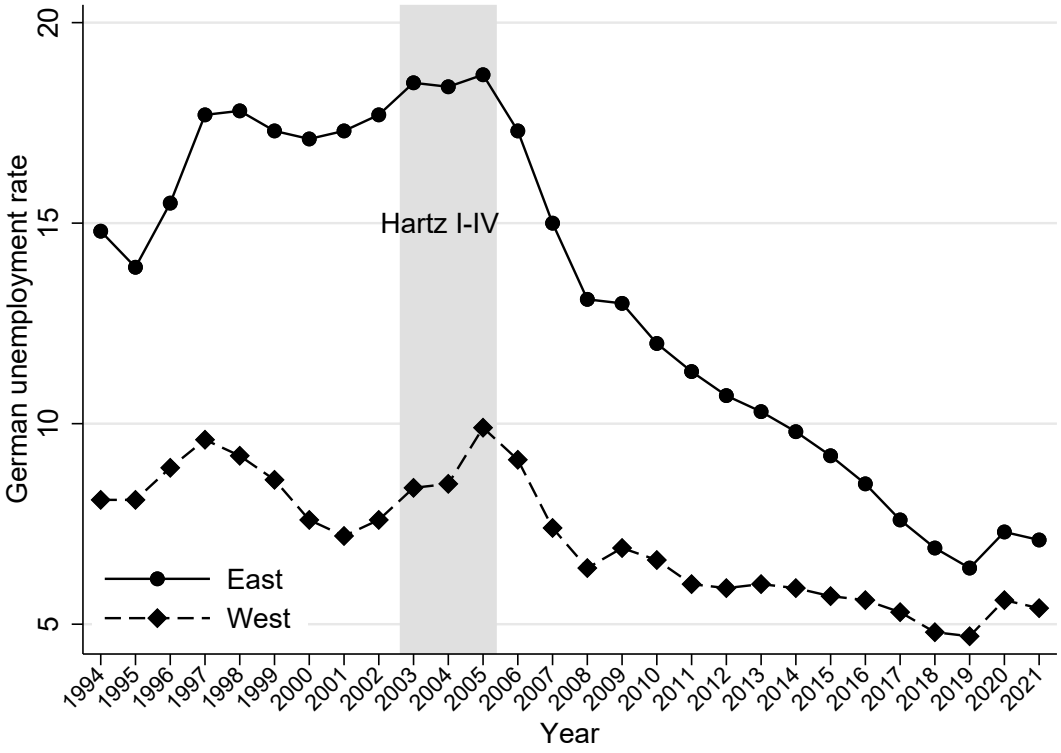
During this period of diminishing industrial relations in Germany, another aspect of labor market institutions has been receiving increased attention. As the bargaining power of workers has declined (e.g. Stansbury & Summers 2020), the beginning of the 21st century in Germany has been equally characterized by high and persistent unemployment peaking at 11.1 percent in 2005 (Carrillo-Tudela et al. 2021; Dustmann et al. 2014). High levels of unemployment are not only associated with low levels of social participation (Kunze & Suppa 2020) and lower employee well-being (Gerlach & Stephan 1996), they are also the main driver of inequality (Angeles-Castro 2006; van der Hoeven 2010).

In the wake of high and persistent unemployment, there was widespread public debate in support of working out labor market reforms. The motivation for introducing labor market reforms was further strengthened by the so-called placement scandal triggered by the Federal Employment Agency in the year 2002 (Fleckenstein 2008).[15] These were two key factors leading to the appointment of a commission in February 2002 to propose labor market reforms. The Hartz Commission, named after the chairman of the commission Peter Hartz, consisted of 15 experts from industry, politics and academia. The commission published its proposals for labor market reforms in August 2002, culminating in the Hartz reform package. The Hartz reforms were largely designed to relax worker protection rules in terms of unemployment benefits, providing more incentive to work and therefore increase labor market flexibility (Poilly & Wesselbaum 2014). In fact, these labor market

[15]This scandal was about the Federal Employment Agency (FEA) manipulating statistics so as to significantly exaggerate the numbers of successfully placed job seekers.

reforms focused in particular on aspects that had been addressed in the OECD proposals mentioned earlier (OECD 1994a,b). The Hartz reforms were divided into four packages that were introduced successively during the years 2003 to 2005 and affected almost all aspects of the German labor market. Figure 1.4 shows the unemployment rate in Germany over time divided between eastern and western Germany as well as the implementation period of the Hartz reform package shown by the gray shaded area. Figure 1.4 thus highlights potential unemployment effects of the reform.

Figure 1.4: Development of German unemployment over time



Notes: This figure shows the trend in the German unemployment rate divided between eastern and western Germany. Data from the Federal Employment Agency, own calculations.

Hartz I and II were introduced and became effective on January 1st, 2003 and aimed at improving labor market flexibility through Mini-Jobs legislation. Above all, Hartz I facilitated the hiring of temporary workers by lifting employment restrictions, as well as subsidizing further training for employees through a voucher scheme. Hartz II reorganized marginal employment by raising the tax-free earnings threshold from 325 to 400 EUR tax-free income per month.

Hartz III took effect on January 1st, 2004 and had the primarily objective of increasing the internal efficiency of the Federal Employment Agency. The most important change was the realignment of the agency as a customer-oriented service facility, in which the claims of each unemployed person were handled by a

single case-worker. The Hartz III reform changed the employment agency from a centralized budgeting system to more of a management-by-objectives system with clearly defined tasks and goals (e.g. Akyol et al. 2013). Moreover, the contact time between caseworkers and jobseekers was increased, while different advisory services were introduced for the short- and long-term unemployed. Furthermore, so-called Job Centers were implemented with the purpose of improving the placement process by enhancing competition among them. The main goal was to reduce frictions and improve the matching efficiency between employers and job seekers (Bradley & Kügler 2019; Launov & Wälde 2016).

Finally, the Fourth Act for Modern Labor Market Services (commonly known as Hartz IV) focused on the abolition of long-term wage-dependent support payments and a transition to fixed benefit levels equivalent to the socio-cultural subsistence level. This last (and centerpiece) part of the reform became effective on January 1st, 2005. Before this reform, there had been a three-tier system consisting of short-term unemployment benefits (*Arbeitslosengeld ALG I*), unemployment assistance (*Arbeitslosenhilfe*) and social assistance (*Sozialhilfe*) (e.g. Hochmuth et al. 2021). The short-term unemployment benefits amounted to roughly between 60 %–67 % of the individual's previous earnings and were usually paid for 12 months. A recent study investigating inequality effects of the Hartz reforms, using also the Gini coefficient found, that the reform in fact increased inequality (e.g. Immel 2021).

While the Hartz I and II reforms are also important for a holistic investigation of the Hartz reform package, this thesis focuses on the latter two, the Hartz III and Hartz IV reforms. In particular, since they focus largely on changes to institutions while at the same time providing more flexibility on the labor market, the investigation of these reforms supplements the analyses of the previous chapters of this thesis. The relationship between the micro- and macro-level is thus highlighted. Moreover, this thesis also fills a gap in the literature by investigating whether the Hartz III reform increases matching efficiency on the establishment level.

Overall, the first three chapters consider efficiency aspects of labor market institutions in terms of establishment performance such as innovative output, productivity and employment growth. The fifth chapter then considers income effects by investigating whether the Hartz IV reform also had a distributional component.

1.2 Overview of chapters

To investigate the efficiency and distributional effects of German labor market institutions, this thesis provides four empirical contributions. To begin with,

two chapters illuminate the system of industrial relations in Germany and focus to a large extent on voluntary employee-employer relationships, investigating how these alternative workplace voice committees are able to shape establishment performance, specifically innovative output (Chapter 2) and labor productivity (Chapter 3). Taking a more macro-economic oriented approach and broadening the analysis, the subsequent two contributions (Chapters 4 and 5) investigate labor market reforms and the flexibilization of labor market institutions brought about by the Hartz reform package, in particular the Hartz III (Chapter 4) and Hartz IV (Chapter 5) legislation. In summary, this thesis provides empirical findings on the emerging trends of flexibilization in Germany (on the workplace and aggregate level) starting at the beginning of the 21st century and the relevance of those trends for firm performance, i.e. labor productivity, innovation and employment growth, but also in terms of income distribution. Since the Hartz IV legislation is currently under debate in Germany and subject to potential future amendments, interest in this particular intervention and especially in evaluation studies on the impact of this reform are thus likely to increase. Within the academic debate, recent contributions in this regard (e.g. Carrillo-Tudela et al. 2021; Immel 2021; Klinger & Weber 2020; Bradley & Kügler 2019; Hartung et al. 2018) already point to this fact. The remainder of this thesis is divided into the following five chapters.

The **second chapter** looks at the relationship between statutory and voluntary employee representation institutions in the context of technological progress and, more specifically, how differences in bargaining power and workplace democracy relate to innovative output. While there is evidence regarding works councils and innovation (e.g. Genz et al. 2019; Kraft et al. 2011; Addison et al. 2001, 1996; FitzRoy & Kraft 1990) there are, besides a German cross-section study by Stettes (2010), no insights regarding voluntary workplace representation in conjunction with technological progress in Germany. Studies examining the relationship between voluntary and statutory voice in the context of innovation are also lacking. With respect to the literature on human resource management practices and employee involvement, the literature indeed supports the view that voluntary partnerships foster innovative behavior (e.g. Felstead et al. 2020; Haneda & Ito 2018).[16] This chapter adds missing evidence in a more institutionalized, industrial relations context and investigates the effects of voluntary workplace voice on technological progress.

Using comprehensive German panel data, this chapter compares statutory and voluntary representation institutions in the context of incremental and radical

[16] A literature review on human resource management practices in the context of innovation is provided by Seeck & Diehl (2017). For an overview regarding different corporate governance mechanisms in the context of innovation, see Belloc (2012).

product and process innovations. Endogeneity of representation institutions is taken into account by applying linear two-stage-least-squares (2SLS) and non-linear recursive multivariate probit models. Further robustness checks using kernel matching techniques are also applied to consider selectivity issues (e.g. Imbens & Wooldridge 2009). The empirical results indeed support the view that alternative, voluntary employee representation institutions in the form of employee spokespersons, round table conferences and additional management lines significantly contribute to successfully conducted innovations. With respect to works councils, this chapter provides mixed evidence for the impact on product innovation. Additionally, the estimation framework allows to implicitly test the relationship between voluntary institutions and works councils, in which the results contribute to the ongoing discussion on whether voluntary and statutory voice institutions are substitutes or complements (e.g. Jirjahn et al. 2021; Oberfichtner & Schnabel 2019). First, the results have important implications for the governance of firms and provide an additional tool in managers' toolboxes to spur innovative behavior by implementing effective workplace voice. Second, this chapter contributes also to the debate on technological change (e.g. Dauth et al. 2021; Acemoglu & Restrepo 2020; Graetz & Michaels 2018; Frey & Osborne 2017) in which voluntary workplace voice appears to provide an additional determinant for innovative firm-level output.

Another aspect of voluntary workplace voice is considered in the **third chapter**, which investigates how voluntary representation institutions are related to labor productivity. While chapter two specifically considers technological progress in combination with statutory and voluntary voice, this chapter considers voluntary voice on its own. First, it puts the focus on the theoretical aspect of voluntary voice with respect to labor productivity. In particular, channels are discussed that draw on considerations of trust and fairness within the social exchange theory (e.g. Cropanzano & Mitchell 2005; Blau 1964), which has recently gained increasing prominence in the literature on employee participation and management (e.g. Della Torre et al. 2021; Holland et al. 2017; Kampkötter & Marggraf 2015). While the literature indeed suggests that the nature of worker participation is largely influenced by the way management treats the workforce (e.g. Bryson et al. 2006), there is a surprising lack of empirical evidence on the effect of workplace voice in the context of the social exchange theory. In this context, this chapter provides empirical evidence on the effects of voluntary voice and labor productivity. Although the effects of statutory employee representation in the form of works councils on labor productivity are well established in the literature (e.g. Mueller & Stegmaier 2017; Jirjahn & Mueller 2014; Mueller 2012; Addison et al. 2001), empirical tests

on the relevance of voluntary voice are virtually absent, with the exception for an empirical study by Stettes (2010). Overall, the empirical findings support the view that voluntary employee voice is generally beneficial for the organization in terms of performance, albeit only in the long run.

To investigate voluntary voice in the form of round table conferences and employee spokespersons as a non-monetary incentive for the alignment of interests between management and workers, this chapter draws from the social exchange theory (e.g. Cropanzano & Mitchell 2005; Blau 1964). Therefore, it provides a simple theoretical model that relates the concept of reciprocity to workers' utility and effort (e.g. Englmaier & Leider 2020). The empirical analysis is based on rich establishment-level data in which the panel structure allows to follow establishments over time. Using a dynamic difference-in-differences approach, introduction effects as well as effects over time are estimated, expanding on the analysis from chapter 2. To mitigate selectivity issues, the regression framework is augmented with matching algorithms (e.g. Imbens & Wooldridge 2009). This chapter provides evidence of a positive association between productivity and voluntary voice that does not arise in the introduction period but rather in the long run. In addition, the data supports the narrative that social exchange relations between employees and the employer are more prevalent in small and owner-managed establishments, in which the relationship between management and workers tends to be closer.

To summarize, the empirical findings of these chapters provide evidence of positive effects of the existence as well as implementation of voluntary employee representation in terms of innovation and labor productivity. Moreover, with respect to labor productivity, the results indicate that effects are driven from the post-introduction period and in relationships that tend to be closer and thus more trustful. Given these results, voluntary workplace voice seems to be a positive factor in the German system of industrial relations. However, potential detrimental effects due to the fact that those institutions have less bargaining power (e.g. Stansbury & Summers 2020), also have to be taken into account. While empirical findings support the view that voluntary institutions are beneficial for firm performance, the declining incidence of unions and works councils and thus bargaining power of employees, might, however, have adverse consequences for employees.

The subsequent two chapters consider labor market institutions from a macroeconomic perspective. **Chapter four** considers German reforms in job search assistance (JSA) under Hartz III, while chapter five takes a closer look at the effects of changes to unemployment insurance (UI) under Hartz IV. As described in the previous chapters, what all of these studies have in common is that they put the focus on the effects and consequences of German labor market institutions.

Furthermore, the combination of workplace human resource policies with active labor market reforms is attracting increased attention in the literature (e.g. Mina 2021).

A first approach to investigate the effects of labor market institutions on a more macro-economic oriented level is provided in chapter four. In this chapter the establishment level outcomes are linked to developments on the governmental level by investigating employment growth effects. For example, it is well known from the literature that differences in job search behavior are related to labor market tightness (e.g. Aguiar et al. 2021), above all to differences between high- and low-skilled labor markets (Wolcott 2021). The restructuring of the Federal Employment Agency under the Hartz III reform is therefore especially relevant in an era of technological change to provide job search assistance for those groups of workers at high risk of being replaced by automation and robots (e.g. Frey & Osborne 2017). Moreover, improved matching efficiency also contributes to labor market flexibility (Lee 2019). While the restructuring of the Federal Employment Agency has led to improved matching efficiency on the macro-economic level (Bradley & Kügler 2019; Launov & Wälde 2016), there is no systematic evidence stemming from the establishment level.

Chapter four therefore investigates the relevance of the Hartz III reform in the year 2004 as an exogenous intervention for improving the matching process. This chapter compares establishments that use the services of the Federal Employment Agency with establishments that do not use those placement services. Using detailed German establishment level data, difference-in-differences estimates reveal an increase in employment growth among those firms that use the agency for their recruitment compared to non-user firms. After the Hartz III reform was in place, establishments using the agency grew roughly two percentage points faster in terms of employment relative to non-users. Robustness checks using inverse-probability weighting are also provided to account for potential selectivity effects. For example, observable characteristics of establishments might lead to different choices in terms of the recruitment channel (e.g. Thomas 1997).

Finally, **chapter five** provides empirical evidence of the Hartz IV reform in terms of distributional effects and impacts on factor shares. While previous chapters in this thesis provide empirical findings regarding the efficiency effects of labor market institutions, this chapter examines distributional effects. In that regard, for example, Chih-Mei (2018) finds that the Hartz IV reform led to a significant growth in the low-paid sector in Germany, with especially negative implications for wages. While previous evidence on determinants of labor shares is quite broad[17],

[17]Regarding potential determinants on the decline of labor shares, there is a wealth of theo-

what has been neglected so far, however, is the influence of bargaining institutions with a focus on changes in the outside option.[18] Chapter five therefore provides evidence on this issue using the Hartz IV labor market reform in Germany as an exogenous shock in employee wage bargaining and investigates its impact on the labor share. First of all, a theoretical model is developed which outlines the effect of a decrease in unemployment benefits, i.e. the outside option, within a wage bargaining framework. Then, the approach is twofold. Combining the EU KLEMS, Penn World Tables, OECD and Worldbank databases, this chapter first endogenously identifies the Hartz IV reform as a significant structural break, i.e. policy intervention, in the German labor share. Second, the effect of the Hartz IV legislation on the aggregate labor share using a synthetic control approach in combination with a counterfactual Germany doppelganger is estimated (e.g. Abadie 2021). Firm-level panel data compiled by Bureau van Dijk supplements the analysis using unemployment variation among German counties (e.g. Immel 2021) for the identification of the Hartz IV treatment effect. The empirical findings provide, among all specifications, consistent evidence that the reform persistently decreases the German labor share on average by two percentage points.

The conclusion in **chapter six** summarizes the empirical findings of this thesis. Moreover, this chapter provides a general view of both types of labor market institutions, i.e. employee representation institutions as well as the Hartz III and IV reforms in terms of firm performance and its implications for employees. Finally, policy implications with respect to the empirical findings of this thesis are outlined and discussed.

retical and empirical literature. One explanation named in this context is technological progress such as the use of robots and algorithms as well as falling price of capital in relation to labor. See, for example, the literature by Acemoglu & Restrepo (2020); Eden & Gaggl (2018); Acemoglu & Restrepo (2018b); Acemoglu (2003); Bentolila & Saint-Paul (2003). Results from those studies suggest that the labor share fell by 4 to 6.3 percentage points for firms that adopt robots (Acemoglu & Restrepo 2020). Another line of research emphasized the role of so-called 'superstar firms'. These firms are based on capital-intensive production and exponential growth. This strand of the literature is notably driven by work from Autor et al. (2020); De Loecker et al. (2020); Kehrig & Vincent (2021). Globalization combined with outsourcing of labor-intensive tasks is another explanation. See for example Elsby & Michaels (2013) in the context of offshoring and Stockhammer (2017) for the impact of financial globalization.

[18] Recent findings support the view that employers largely rely on unemployment benefits rather than outside wage offers to determine the outside option in wage bargaining (Lukesch & Zwick 2021).

Chapter 2

Employee representation and innovation - disentangling the effect of legal and voluntary representation institutions

Joint work with Kornelius Kraft[1]

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2.1 Introduction

Technological progress is the driving force behind firm and economic growth and arises from different kinds of innovations. While earlier contributions to the growth literature such as the Solow growth model assumed that innovation occur exogenously, the more recent endogenous growth theory considers factors that support or may inhibit innovations (e.g. Romer 1990). The theory in particular considers what is known in this literature as 'intellectual capital' such as accumulated or new knowledge (Aghion & Howitt 1998). A constant flow of creativity, new ideas and inventions culminating in different kinds of innovations are important for firms not only to stay competitive, but also to respond to rapidly changing markets. New knowledge is subsequently generated by internal, i.e. exploration and creation, as well as external, i.e. modification and adaption, means (e.g. Capozza & Divella 2019). An understanding of the design of organizational environments and practices are therefore key to encourage innovative behavior at the firm level.

In this chapter we consider two important organizational structures aimed at enhancing communication flows and knowledge diffusion among employees. First, we investigate voluntary employee representation (VER) institutions in the form of round table conferences, employee spokespersons and additional management lines, which are implemented by the management. Second, we look how these committees interact with the statutory employee representation in the form of works councils.[2] While empirical results on codetermination institutions such as unions and works councils in the context of technological progress provide mixed results (Genz et al. 2019; Bradley et al. 2017; Kraft et al. 2011), we add knowledge to the literature on two important facts. We not only contribute to an understanding of voluntary institutions in the context of technological progress, but we also provide new evidence in the context of works councils and therefore how differences in bargaining power relate to innovative output.[3] Our work is related to the literature on economic growth, employee driven innovation (e.g. De Spiegelaere & Van Gyes 2012) and industrial relations whereas in particular the erosion of existing bargaining institutions such as collective bargaining and works council coverage, puts the focus on voluntary institutions (Oberfichtner & Schnabel 2019; Addison et al. 2017; Hassel 1999).

For our analysis we use the German IAB Establishment Panel provided by the Institute for Employment Research (IAB) over the years 2010 to 2018. The data

[2]Works councils are elected by the workforce and have considerable codetermination rights. In particular, they possess codetermination rights regarding the introduction of new production technologies. These rights are outlined in the Works Constitution Act (WCA).

[3]See Belloc (2012) for an overview regarding corporate governance dimensions and innovation.

allows us to compare statutory as well as voluntary representation institutions and additionally provides comprehensive information on successful conducted innovations. Our analysis is based on recursive multivariate probit models estimated via simulated Maximum Likelihood and linear 2SLS models. This allows us to first; consider reverse causality effects and unobserved confounders, and second; apply instrumental variables to provide a more reliable interpretation of employee representation on technological progress. While we find in all specifications significantly positive effects of voluntary representation institutions on the propensity to innovate, works councils have negative point estimates in the baseline models. Our findings are robust when endogeneity of representation is considered. With respect to works councils, we find mixed evidence in this case. Regarding the relationship between both institutions we find a substitutionary relationship.

The remaining chapter is structured as follows. In the Section 2.2 we briefly review related literature regarding management-implemented employee representation, works councils and technological progress. In Section 2.3 we highlight theoretical arguments for the relationship between voluntary representation and technological progress. This section is divided into arguments for both product and process innovation. In the empirical part in Section 2.4 we provide the data description, the econometric methodology and results. Robustness tests are provided in Section 2.5 and finally, the last Section 2.6 draws a conclusion and discusses policy implications regarding the findings of this chapter.

2.2 Related literature

Interest in the determinants of innovation have been part of the research agendas since Schumpeter (1942). Besides industrial organization literature, which considers the relationship between firm size and innovation (Akcigit & Kerr 2018) as well as competition and innovation (Aghion et al. 2018), the industrial relations literature primarily focus on unions and works councils. Recent contributions in this literature also focus on voluntary or alternative forms of employee representation (Jirjahn et al. 2021; Oberfichtner & Schnabel 2019; Ertelt et al. 2017), which are at the intersection between management practices[4] and industrial relations (Delaney & Godard 2001). On the one hand they are implemented by the management in which they should facilitate positive effects regarding organizational performance; otherwise the management might likely dissolve them. On the other hand, they compete with works councils on the establishment level which are equipped with considerable codetermination rights defined by the Works Constitution Act

[4]Regarding the literature on high-performance work practices, see for example Addison (2009); Cappelli & Neumark (2001); Huselid (1995).

(WCA), also in the context of technological progress.

2.2.1 Statutory codetermination

Studies within the industrial relations literature had focused on statutory employee participation implemented at the establishment level via works councils (e.g. Addison et al. 2010). German works councils are equipped with extensive information, consultation and codetermination rights and can be set up in establishments with five or more employees at the request of the workers. Legislation stipulates that employees may request the election of a works council, but are not obliged to do so. Thus, there are establishments with and without works councils. The empirical results of works councils on innovation appear to be limited. A first study is provided by FitzRoy & Kraft (1990) in which they find a negative impact on innovation. Addison et al. (1996) show that works councils have a positive effect on product innovation but not on process innovation. In contrast, Addison et al. (2001) find that councils influence neither product nor process innovation. More recent studies point to positive interaction effects of the presence of a works council and coverage with a collective-bargaining agreement (e.g. Addison et al. 2017). Kraft et al. (2011) consider the effects of codetermination on innovative activity in German firms. Using patent data as a measure for innovations, they find small positive effects of codetermination. Genz et al. (2019) find a negative relationship between the equipment with digital technologies and works councils. The results among the works council innovation nexus thus seem to be mixed.

2.2.2 Voluntary employee representation

On the establishment level, voluntary representation institutions are structurally in between statutory works councils and management-implemented high-performance work practices. Although there is no established definition, their structure might be similar to institutions like spokespersons, staff representation or round table conferences (e.g. Addison 2009). Compared to management-implemented work practices, voluntary institutions provide a framework for human interactions, such as weekly meetings (Artus 2013). The more structural context, which may also be defined in a contract between employers and employees, sets VERs apart from other management practices. Hertwig (2011) offers a more nuanced view on these institutions in which he differentiates on the one hand between personnel management instruments such as advisory boards or additional management lines. In this view VERs are primarily implemented by the management to fulfill a specific purpose. On the other hand, they might have representation patterns (not legally prescribed) in which they can be seen as an employee representation body or a

spokesperson (Hertwig 2011).

For Germany, Hauser-Ditz et al. (2013) and Ellguth (2005, 2009) explain different determinants of VERs. They found that one important factor is dissatisfaction with existing representation institutions such as the works council. Moreover, they find that the occurrence rises with firm size and that voluntary schemes appear to be more common in western Germany. More recent contributions to the literature focus on the incidence of voluntary employee representation (e.g. Oberfichtner & Schnabel 2019; Ertelt et al. 2017) and their relevance in the context of workplace health (e.g. Jirjahn et al. 2021). This literature usually finds that works councils are more stable institutions compared to voluntary employee representation. Whether statutory and voluntary representation institutions, however, are complementary or substitutionary related, is up to debate. Bryson (2004) investigates several arrangements in the UK and finds that a direct voice channel is indeed beneficial for the organization. In the context of innovation, there is limited empirical evidence regarding the contribution of voluntary employee representation on technological progress. By using cross-sectional data[5], Stettes (2010) finds that firms that have a VER are more likely to carry out a process innovation within the next year compared to firms that have no such representation body at all. For product innovations he finds no effects.

In reviewing the literature we find important gaps in which our study contributes to. First, results regarding the effects of works councils on innovation are mixed and studies on voluntary institutions in the context of innovation quite absent. Second, the relationship between statutory and voluntary representation is not finally settled. This study therefore contributes to the understanding of both institutions in the context of innovations. At the same time we consider the relationship between these institutions more closely.

2.3 The role of voice for technological progress

Based on the narrative of 'collective voice' (e.g. Freeman & Medoff 1984), statutory as well as voluntary employee representation institutions are related to this voice function. It is also well-known in the literature, that communication flows in this regard are positively related to economic performance (Sandvik et al. 2020). The ability to quickly process new information and respond to changes in the environment in an appropriate way, is known as the absorptive capacity of firms (Cohen &

[5]Stettes (2010) dataset is based on a survey performed by the German employers association, which might be less favorable towards statutory employee representation in the form of works councils.

Levinthal 1990). Compared to rather formally stipulated and bureaucratic works councils, VERs are far more flexible and reactive since they are firm-tailored. Detrimental effects of inflexible work structures, formalization and centralization with regard to knowledge generation is also well established (Damanpour 1991). To disentangle the channels of VERs with respect to innovative behavior more closely, we look at three mechanisms in detail.

Exit-voice. The well-known exit-voice theory (e.g. Hirschman 1970; Freeman & Medoff 1984; Freeman & Lazear 1995) can be applied to voluntary employee representation as well. According to the exit-voice theory, dissatisfied employees are more likely to talk about concerns and grievances ('voice') instead of quitting the job ('exit') when an institutionalized representation, although it is voluntary, is present. The existence of a representation committee therefore fosters trust, satisfaction, commitment and effort of employees. More satisfied employees perform better and are less likely to quit, which reduces employee turnover and retains important human capital within the establishment. The voice argument is especially relevant for voluntary representation since these bodies might be more sensitive to local shop-floor issues than unions or works councils. Besides an increase in trust, employees also possess skills and abilities that the management does not have (e.g. Roper et al. 2008). In case workers are involved in the production process and are additionally more satisfied, they might be willing to share more job-related information. Such new knowledge might enhance the production process but is also crucial for out-of-the-box thinking and for the implementation of radically new products.

Knowledge flows. Voluntary institutions also improve communication flows and knowledge spreading by implementing effective communication between and within divisions (e.g. Sandvik et al. 2020; Jirjahn & Smith 2006). For example, it becomes easier for an R&D department to assess the economic potential of a product improvement such as potential market gains. While such an interactive process would appear to be self-evident, with a representation body it is institutionalized and will probably also facilitate communication between the management and employees. From the management's point of view, communication with voluntary representation institutions is in all likelihood less controversial than dialogue with works councils, which are introduced at the request of the workforce and have far-reaching veto rights in the case of technological progress. In this view, voluntary institutions reduce information asymmetries as well as transactions costs of communication (e.g. Holmstrom 1989).

Scheduled as well as unscheduled communications of high intensity between or

within departments is also crucial within the process of knowledge creation (Aiken & Hage 1971). The efficient communication channel provides opportunities for suggestions, improvements, concerns and opinions on work-related matters (Morrison 2014). Employees for example in the marketing or sales divisions with close contact to customers presumably have first-hand information about their preferences. The customers will not hesitate to report any shortcomings of the products and their preferences for future products. This knowledge can be collected by a communication body and transmitted to the R&D department, perhaps resulting in improvements to existing products or the introduction of entirely new products.

Overcome resistance. Voluntary institutions might also be used to overcome employee resistance against innovations (e.g. Zwick 2002) by improving readiness for organizational change (Armenakis et al. 1993). Labor unions and their representatives on the firm level in the form of works councils might be hostile towards technological progress (Ulph & Ulph 1988). This is in particular the case when process innovation is considered. The most important reason for resistance is the fear of employees being replaced by capital. On the one hand, this concern is not without reason as this does actually take place for certain employees. This replacement is often observed in jobs with a high degree of routine tasks as well as jobs relying heavily on unskilled labor (e.g. Brynjolfsson & McAfee 2014; Acemoglu & Restrepo 2020). On the other hand, Harris & Raviv (1978) show that process innovations do not reduce the number of jobs and that product innovations stimulate employment.

Effective communication in the process of implementing new technologies or machines may reduce employees' fear of losing their jobs and gives the management the possibility to emphasize the positive aspects of technological progress and may offer (temporary) job security. To sum up, efficient elaboration on the positive aspects of process innovation as well as efficient information collection by using voluntary employee representation bodies may well improve the implementation of process innovations.

2.4 Empirical investigation

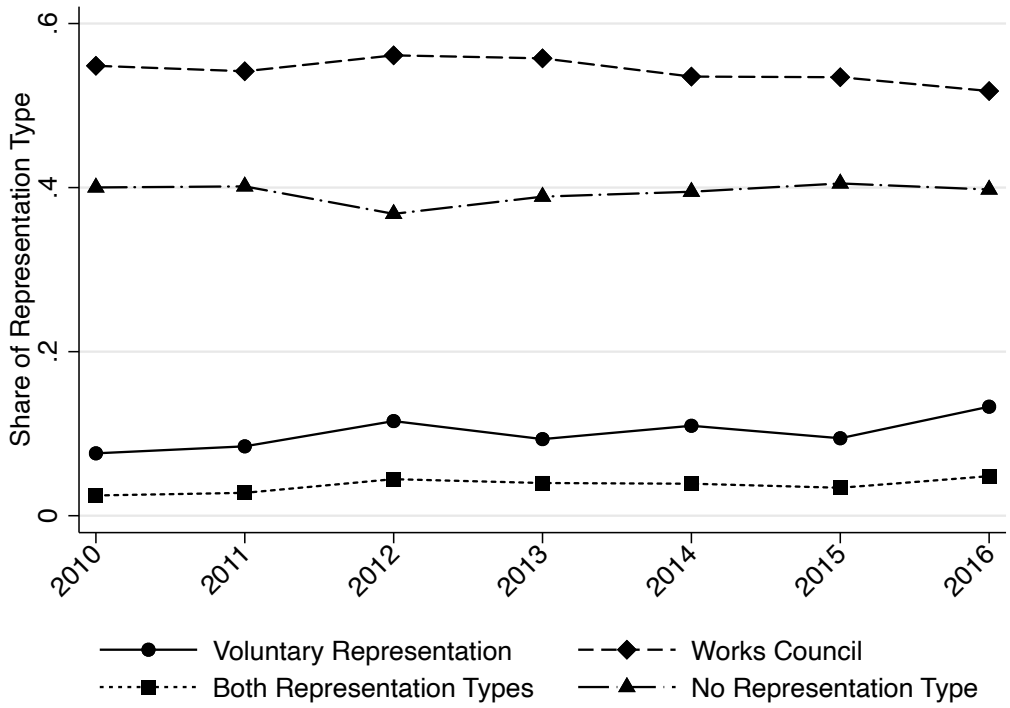
2.4.1 Data and variable description

The data basis for our analysis is the German IAB Establishment Panel provided by the Institute for Employment Research (IAB).[6] The panel has been conducted

[6] An overview regarding the sample and survey design as well as data access and methodology is provided by Bossler et al. (2018); Ellguth et al. (2014); Fischer et al. (2009).

on an annual basis since 1993 in western and since 1996 in eastern Germany and covers roughly 16,000 establishments per year. It is designed to lead to a representative sample regarding a number of criteria including industries and establishment sizes, with every German company employing at least one person covered by social insurance potentially eligible to be present in the sample. The survey asks about a wide variety of establishment and labor market variables, but unfortunately not all questions are posed every year. The panel dataset is optimally suited for our analysis on legally as well as voluntary employee representation since these institutions are regularly covered in the questionnaire. We draw the following sample from the dataset.

Figure 2.1: Proportion of employee representation over time



Notes: The figure shows the distribution of employee representation types over the years in our sample. Definition of representation as outlined in Section 2.2. As several authors (e.g. Hassel 1999; Addison et al. 2017) mention, we also recognize a decline in statutory representation and a slightly but persistent increase in voluntary representation. Therefore, see Figures 1.2 and 1.3 in the introduction of this thesis. IAB Establishment Panel, waves 2010–2018, own calculations.

Works councils are the form of employee representations initialized on the basis of the Works Constitution Act and can only be elected in establishments with five or more employees. Thus, we drop all establishments below this threshold. We focus on manufacturing and knowledge-intensive service industries according to the NACE Rev. 2.0 classification.[7] Such industries are characterized by short product

[7]Regarding the NACE Rev. 2.0 classification, knowledge-intensive services include divisions

life-cycles due to rapid technological change, which makes the analysis particularly suited for this kind of industry (Hobday 1998). Additionally, empirical studies have shown that horizontal coordination via information exchange is particularly relevant in such industries (Rubinstein & McCarthy 2016). See for the distribution of observations among industries in our sample, in particular manufacturing as well as knowledge-intensive business services, Table 2.16 in the Appendix of this chapter.

Potential confounding effects of the financial crisis may bias our results and may have in particular an impact on innovation. We therefore remove the year 2009 from our sample.[8] This left us with an unbalanced panel dataset ranging from the years 2010 to 2018, comprising 7,411 establishment-year observations on 2,725 establishments (we, however, lose two years because of the lead of the innovation measures). Figure 2.1 provides an overview regarding the development of employee representation institutions over the years in our sample.

As shown in Figure 2.1, works councils are far more common than voluntary institutions. There is, however, a surprisingly high fraction of establishments which do not have any representation institutions at all. Despite that result, the fraction of establishments having both statutory and voluntary institutions at the same time, is very low. The shares are also quite constant over time, however it is worth mentioning, that works council coverage is slightly declining and voluntary institutions gain a slightly higher share over time. Thus, we also find the often highlighted erosion of industrial relations (e.g. Hassel 1999; Addison et al. 2017) in our data, which underlines the relevance of other alternative forms of representation which we consider in this chapter.

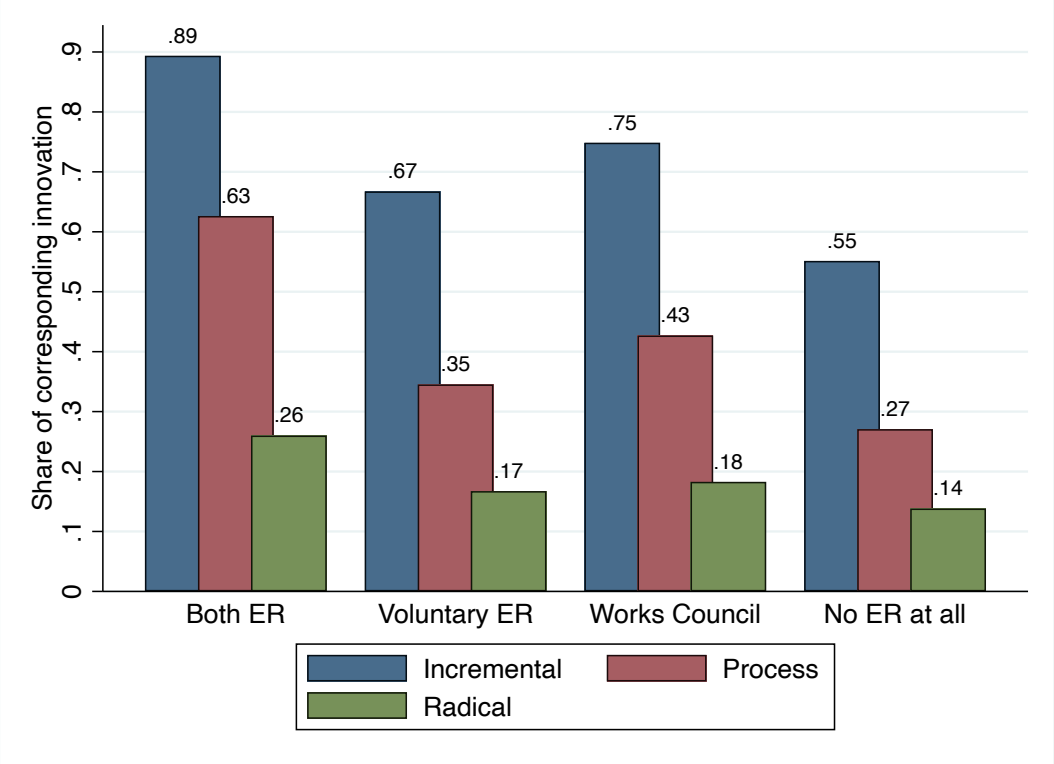
For our empirical analysis, we require information about innovations realized on the establishment level. Questions on the implementation of new products and processes are included on the basis of a consistent definition since the questionnaire year 2008 and are directed to the previous year.[9] Regarding technological progress, the IAB Establishment Panel provides information on different measures of innovation. We consider three different types of innovation for the analysis. First, whether the establishment has improved or further developed a product or

58 to 66 and 69 to 73. The manufacturing industries include divisions 10 to 33. For the definition see for example Peters & Rammer (2013). For the connection between knowledge-intensive services and economic growth see for instance Barras (1986).

[8] In this context, Hausman & Johnston (2014) argue that the development of new innovations and technologies has become crucial during the financial crisis in order to stay competitive. Zouaghi et al. (2018) show, that innovation performance during the financial crisis also varies between high- and low-tech industries.

[9] The same items are also surveyed in the years 2001, 2004 and 2007, however with a lag of two years. In order to prevent measurement errors and thus induce endogeneity, we rely on the one-year lag question.

Figure 2.2: Proportion of successfully conducted innovations



Notes: IAB Establishment Panel (2010–2018), own calculations. Share of innovation type in establishments. Both employee representation (ER) defines the group when a VER and a WOCO is present, 'Voluntary ER' only VER, 'Works Council' only WOCO, and 'No ER at all' are establishments with no representation institution at all.

service which had previously been part of their portfolio which we refer to as incremental innovation. Second, whether the establishment starts to offer a completely new product or service for which a new market has to be created. In line with the literature, we regard this kind of innovation as radical (e.g. Dahlin & Behrens 2005). And finally, we consider process innovation by using the question whether the establishment develops or implements procedures which improved production processes or services. These innovation variables have unit value in the case the corresponding innovation was successful conducted in the previous year and zero otherwise.[10] As shown in Figure 2.2, there are sizable differences between the types of innovation and forms of employee representation institutions.

Regarding codetermination, the IAB Establishment Panel offers information on works councils, voluntary employee representation and coverage by collective bargaining agreements. We use the question whether the 'establishment has another company-specific form of employee representation' and create a 0/1 dummy variable indicating the existence of such voluntary representation institutions. Un-

[10]In the regression analysis in Section 2.4 we, however, explain innovation in the next year, thus we lose the years 2017 – 2018 by shifting the relevant information on innovation to $t + 1$.

fortunately, we have no further information regarding these types of employee representation, which does not allow us to distinguish their purposes and composition in more detail. Information on the presence of a works council as well as coverage of collective bargaining agreements are also regularly collected and coded as a 0/1 dummy variable for existence as well.

To adjust for confounding effects, we use a comprehensive set of control variables capturing the structure of the workforce such as the share of qualified blue-collar workers, the share of female workers as well as the share of fixed-term workers. We also adjust for the size of establishments by using the log of number of employees and its square to control for organizational characteristic effects according to the Schumpeterian hypotheses of innovation (Schumpeter 1942).[11] Since innovations of any type crucially depend on human-capital of the workforce, we add a dummy variable whether the establishment supports further training activities.[12] This variable takes unit value in the case training activities are supported and zero otherwise. We expect this variable to have a significantly positive effect on all kinds of innovations. Another dummy variable expresses whether the firm is covered by a collective bargaining agreement. Coverage by a collective bargaining agreement shifts distributional conflicts to the industry level and employee representation bodies are focused on generating rather than redistributing economic rents (e.g. Hübler & Jirjahn 2003). To take account of the establishment's age we add a dummy variable which takes unit value if the establishment was founded before 1990 and zero otherwise. We expect this dummy variable to have a significant impact on radical innovations since younger firms usually tend to execute riskier R&D investments (e.g. Coad et al. 2016). We adjust for effects whether the establishment is part of a firm group and whether it is a limited liability firm. Moreover, we control for competition status of the establishment (e.g. Aghion et al. 2005; Gilbert et al. 1982). Regarding the technological equipment which is highly relevant for innovations we adjust for investments in ICT as a measure of input to innovation. Table 2.1 provides descriptive statistics of the estimation sample used.

More than half of establishments develop an incremental innovation (improvement of a product or service that had already been part of the portfolio). Radical innovations, however, are far less common (17 %). Roughly every third firm develops a process innovation. Considering the relevant employee representation variables, it turns out that works councils are much more prevalent than voluntary representation introduced by management, which are only present in roughly 10

[11] Schumpeter (1942) highlights that an increase in firm size increases innovations proportionally. Empirical evidence regarding firm size supports this hypothesis (e.g. Cohen 2010).

[12] The question in particular reads: "releases staff for the purpose of participating in internal or external training courses and [...] covers the expense for these in full or at least in part"

Table 2.1: Descriptive statistics for innovation sample

Variables	N (1)	Mean (2)	Std. Dev. (3)	Min (4)	Max (5)
Innovation type					
Incremental product $(t+1)$	7,411	.671	.470	0	1
Radical product $(t+1)$	7,411	.167	.373	0	1
Process $(t+1)$	7,411	.368	.482	0	1
Employee Representation Type					
Works council	7,411	.543	.498	0	1
Voluntary representation	7,411	.101	.301	0	1
Instrumental Variables					
Share of voluntary representat.	7,411	.103	.117	0	1
Share of works council	7,411	.418	.245	0	1
Share of collective bargaining	7,411	.302	.240	0	1
Control Variables					
Log (Employees)	7,411	4.70	1.33	1.61	11.01
Log (Employees squared)	7,411	23.82	13.42	2.59	121.15
Further training	7,411	.853	.354	0	1
Share of female workers	7,411	.284	.209	0	1
Share of fixed-term workers	7,411	.082	.098	.0	1
Share of high-skilled workers	7,411	.129	.175	0	1
Part of firm group	7,411	.214	.410	0	1
Limited liability	7,411	.931	.254	0	1
High competition	7,411	.503	.500	0	1
Western Germany	7,411	.560	.496	0	1
Investment in ICT	7,411	.609	.488	0	1
Collective bargaining	7,411	.330	.470	0	1
Founded before 1990	7,411	.489	.499	0	1

Notes: IAB Establishment Panel, unweighted means for the years 2010–2018. Innovations are measured in the year $t+1$. For the sake of clarity, year and industry dummy variables are omitted from the descriptive statistics, however we provide the distribution in the Appendix in Table 2.14 for federal state, in Table 2.15 for the distribution over establishment size and in Table 2.16 for the industry distribution according to NACE 2.0 classification. Sample is defined as outlined in Section 2.4. Shares of employee representation calculated on every year, NACE rev. 2.0 and federal state cluster. More information and explanation regarding the description of the variables is provided in Table 2.7 in the Appendix of this chapter.

percent of the establishments. Almost 90 percent of the observed establishments release staff for the purpose of further training, highlighting the importance of further development of human capital for manufacturing and knowledge-intensive service industries. Moreover, 61 percent of the establishments invest in information and communication technology (ICT). At the mean, our sample indicates that roughly 13 percent of the employees are high-skilled. Around 33 percent of the observations are covered by a collective bargaining agreement and roughly one half of the sample establishments are established before 1990. Almost half of the establishments in our sample are faced with (self-reported) high competition. Regarding our used instrumental variables, we see that the mean presence of works councils

over all industries is about 42 percent. For the voluntary employee representation, the mean value is only 10 percent. More information regarding the distribution of observations by federal stats, firm size as well as industry classification, see Figures 2.14, 2.15 as well as 2.16 in the Appendix of this chapter.

2.4.2 Baseline results

We start by estimating simple ordinary least squares (OLS) and pooled probit regressions to acknowledge the binary nature of the innovation measures. For the probit models, we calculate average marginal effects. Furthermore, the dependent variables are measured with a lead to mitigate endogeneity problems (e.g. Caroli & Van Reenen 2001; Godart et al. 2017). Because of sample attrition, we do not apply fixed effects regressions, however, we cluster the standard errors to account for establishment-specific production and innovation shocks which is quite common in the literature (e.g. Zhou et al. 2011). We first estimate the following pooled OLS and probit models for innovation type j (incremental, radical, process):

$$INNO^{*}_{jit+1} = \alpha + \gamma\ VER_{it} + \lambda WOCO_{it} + \delta VER_{it} \times WOCO_{it} + \beta X_{it} + \phi_i + \theta_t + \varepsilon_{it} \tag{2.1}$$

where X_{it} denotes a full set of establishment-level control variables which are outlined in the descriptive statistics in Table 2.1. We are interested in the parameters γ and λ for the isolated effect of the corresponding representation institution on innovation as well as the interaction effect measured by the parameter δ. We therefore estimate models with and without the interaction term of the representation institutions. The following Table 2.2 provides the results of estimating Equation (2.1) with interaction term in columns (1), (3) and (5) and without the interaction between voluntary and statutory representation institutions in columns (2), (4) and (6) using OLS.[13]

The baseline models show that voluntary institutions possess a significant positive impact on incremental product and process innovation. In the case a voluntary representation institution is present in the establishment compared to an establishment without VER, the likelihood for an incremental product innovation increases by 6.7 percentage points. The likelihood for an process innovation by 5.7 percentage points. The presence of works councils is associated with a negative effect on radical product and process innovation whereas no effect on incremental innovation is discernible. Moreover, there are no additional interaction effects stemming

[13]Results using univariate probit models, which explicitly take the binary nature of the dependent variables into account, do not differ much in terms of point estimates and significance.

Table 2.2: Pooled OLS results for product and process innovation

Innovation type in $(t+1)$	Incremental		Radical		Process	
	(1)	(2)	(3)	(4)	(5)	(6)
Voluntary represent. (VER)	.067**	.069***	.016	.016	.028	.057**
	(.029)	(.020)	(.022)	(.018)	(.027)	(.023)
Works council (WOCO)	.010	.011	-.043***	-.043***	-.044**	-.037*
	(.022)	(.021)	(.016)	(.016)	(.021)	(.021)
VER × WOCO	.007		.001		.076	
	(.038)		(.039)		(.047)	
Control variables	✓	✓	✓	✓	✓	✓
Industry fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
R^2	.175	.175	.069	.069	.130	.130
Observations	7,411	7,411	7,411	7,411	7,411	7,411

Notes: This table presents results from the estimation of Equation (2.1) using OLS. Data from the IAB Establishment Panel using the years 2010–2018. Industry fixed effects include manufacturing as well as knowledge-intensive services according to NACE Rev. 2.0 as outlined in Section 2.4. Cluster-robust standard errors at the establishment level in parentheses. Control variables included as presented in Table 2.1, results for this full specification is shown in the Appendix in Table 2.8. *, **, and *** denote statistical significance at the .1, .05 and .01 level.

from the presence of both kinds of representation institutions.

2.4.3 Endogeneity of representation institutions

We now take potential biases of the baseline results into account. First, innovativeness and the existence of representation institutions might be determined by an unobserved exogenous factor such as, for example, management quality which leads to an omitted variable bias. Better managed establishments might be more innovative and may also provide efficient communication with employees (e.g. Chen et al. 2015). In this scenario, for example, the VER coefficient in the baseline regressions would overestimate the true effect if the management in question is innovative with respect to new products and processes, and simultaneously prefers innovative organizational structures. On the other hand, there might by plant-specific shocks such as reorganization measures which are conducted in times of changes or crisis. If VERs are implemented in such times to deal with potential changes and to enhance performance, the coefficient of VER would underestimate the true effect. In the context of works councils, unobserved behavior of workers could also affect the results. Employees might vote for the adoption of a works council if they fear job losses connected with the introduction of a process innovation (Jirjahn 2009). In a similar vein, innovations may require retraining and maybe new organization schemes which could lead employees to demand the establishment of a works council when the implementation (i.e. new products or machines) of innovations is due.

Second, there might be also the problem of reverse causality (e.g. Belloc 2012).

On the one hand it is possible that VERs are introduced to induce innovation activity when the establishment is currently not very innovative and management intends to increase it through intensified communication with the workforce. In contrast to this, the opposite rationale is also reasonable. Establishments that have just developed and introduced one or more innovations might introduce an employee representation body to facilitate the handling of the new products and in particular the process innovations at the establishment. This view is theoretically supported by Acemoglu et al. (2007) who show that potentially innovative firms are more likely to choose participative employment schemes.

Recursive multivariate probit model. To consider these endogeneity problems we apply simultaneous equation models in combination with an instrumental variable (IV) framework for nonlinear models (e.g. Freedman & Sekhon 2010; Wooldridge 2010). Such models are frequently applied in the case one wants to investigate a binary outcome and simultaneously are faced with binary endogenous variables.[14] Our three-equation multivariate probit framework can be described as follows:

$$\begin{aligned} INNO^*_{jit+1} &= \alpha + \gamma VER_{it} + \lambda WOCO_{it} + \beta_1 X_{it} + \phi_i + \theta_t + \varepsilon_{1it} \\ VER^*_{it} &= \alpha + \mu_1 z_{ktf} + \beta_2 X_{it} + \phi_i + \theta_t + \varepsilon_{2it} \\ WOCO^*_{it} &= \alpha + \mu_2 z_{ktf} + \beta_3 X_{it} + \phi_i + \theta_t + \varepsilon_{3it} \end{aligned} \tag{2.2}$$

where the first $INNO^*$ equation measures the impact of both representation institutions on innovation type j at time $t+1$. The coefficients of interest are γ and λ which capture the effects of VERs and works councils on the propensity to innovate. $INNO^*$, VER^* and $WOCO^*$ are latent variables describing the underlying propensity of the corresponding type of innovation as well as VERs and WOCOs. The vector X_{it} contains the same set of control variables in all three equations which are defined and described in Table 2.1. Finally, we include time-fixed effects θ_t to capture year-specific shocks as well as industry fixed effects ϕ_i.

The idiosyncratic error terms ε_{1it}, ε_{2it} and ε_{3it} are assumed to be multivariate normal distributed with mean zero and unit variance. They are allowed to be

[14] See MacDonald & Shields (2004) for an example in health economics in which the authors test how problem drinking affects employment status. Finally, and more related to our topic, Savignac (2008) tests how financial constraints affect innovations. A similar bivariate approach in the context of product innovation and patenting activities is conducted by Cucculelli et al. (2016). A more recent example in the context of a multivariate innovation production function is given by Audretsch & Belitski (2020). Moreover, in case of an endogenous variable affecting a binary outcome, these non-linear models might be more efficient than conventional 2SLS estimates (e.g. Bhattacharya et al. 2006). Nevertheless, we also check the robustness of our results using two-stage instrumental variable estimation in Section 2.5.

correlated with each other, which is captured by the parameters ρ_{12}, ρ_{13} and ρ_{23} in the following symmetric variance-covariance matrix in Equation (2.3):

$$\begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho_{12} & \rho_{13} \\ & 1 & \rho_{23} \\ & & 1 \end{pmatrix} \right] \tag{2.3}$$

Unobserved correlations between the $INNO^*$ and VER^* equation (ρ_{12}), $INNO^*$ and $WOCO^*$ (ρ_{13}) as well as the VER^* and $WOCO^*$ equation (ρ_{23}) can be considered by investigating the parameters ρ_i. They measure correlations in the error terms after factoring out all effects of the included explanatory variables.[15]

Unobserved characteristics between employee representation institutions are quite likely and we treat a positive correlation as a sign of complementary relationship among them. They could be substitutive, as the management looks for a communication channel itself if the one based on the legal framework (works council) has not been introduced by the workforce.[16] A negative sign can be interpreted as a substitutional relationship since there are correlations making VERs more likely by simultaneously affecting the propensity of a WOCO in a negative way (or vice versa). In this view the management might not be satisfied with the works council's willingness to communicate and to cooperate. In addition, the establishment of a voluntary employee representative body may have the intention of restricting the influence of works councils.

In general, a negative ρ_i implies a negative correlation between equations, standing for unobserved factors which make the simultaneous observation of the two dependent variables less likely. A positive ρ_i, vice versa, expresses that unobserved factors positively affect the likelihood of a simultaneous existence. A likelihood ratio (LR) test for the joint significance of $\rho_{12}, \rho_{13}, \rho_{23}$ is used as a direct test of endogeneity between the three equations (e.g. Wooldridge 2010; Monfardini & Radice 2008; Knapp & Seaks 1998). In the case $\rho \neq 0$, the univariate probit estimates from Equation (2.1) are inconsistent since the outcome variables and the error terms of the other equations are correlated.[17]

[15] Filippini et al. (2018) provide a further discussion regarding the interpretation in bivariate as well as recursive bivariate probit models.

[16] A substitutive relationship might exist when the management tries to avoid works councils, which are associated with strong bargaining rights on the establishment level. Thus, an increasing threat of a works council might result in the implementation of voluntary representation to avoid works councils.

[17] The null and alternative hypotheses in this case are: $H_0 : \rho_{12} = \rho_{13} = \rho_{23} = 0$ against H_1 : at least one $\rho \neq 0$, where H_1 corresponds to endogeneity. The test compares the log-likelihood of the multivariate probit model with the sum of the log-likelihoods of three separate univariate probit models from Equation (2.2).

Identification. Regarding the identification of γ and λ within the recursive multivariate framework, there are three positions: First, Heckman (1978) argues that a full rank regressor matrix is sufficient for identification. Second, Wilde (2000) highlights identification by functional form in which identification is achieved if the same sets of exogenous variables appear in the system of equations. Third, Maddala (1986) and Han & Vytlacil (2017) argue that the parameters of interest are identified if there is at least one varying exogenous parameter in the regressor matrix X_{it}. We are also convinced that exclusion restrictions (i.e. instrumental variables) in any case facilitate identification.[18] Thus, we include instrumental variables (exclusion restrictions) in both employee representation equations.

Instrumental variables. With respect to instrumental variables, we apply a quite common approach in which we instrument the representation institutions with the industry share in industry k, year t and federal state f cluster. Thus, the share of works councils as well as the share of voluntary institutions are used to instrument both institutions. These instrumental variables are correlated with the existence of a voluntary representation or works council within a specific establishment because of industry and regional factors common to all establishments operating in that industry. In this view, establishments might observe, for example, the market or competitors and apply similar organizational practices. Jirjahn & Mueller (2014) refer to this argument as the workers' general taste of representation within a given region and industry. With respect to exogeneity of these instruments, we do not expect an impact on technological progress of a specific establishment. The reason is that innovations are a complex establishment-specific process which does not necessarily depend on regional geographic shares of representation schemes. For the works council equation, we also apply the same industry shares. Similar types of instruments are well established in the literature. See for instance Machin & Wadhwani (1991) who use the union density in a specific industry as an instrument for union presence. Fisman & Svensson (2007) also use industry-location averages as instruments in a context of taxation and growth and Cornelissen et al. (2011) in the context of performance pay. Finally, Devicienti et al. (2018) use the two-year lagged mean of unionization at a specific region as an instrumental variable.

Estimation. The multivariate probit models requires solving multidimensional integrals which is usually done using approximations. It is, however, shown that standard numerical approximations based on the Newton-Raphson framework are

[18] Nevertheless, Marra & Radice (2011) show in Monte-Carlo simulations that consistent parameter estimates are obtained even in the absence of instrumental variables.

inefficient and yield poor results (Cappellari & Jenkins 2003). We, therefore, estimate our system of equations using the simulated maximum likelihood (SML) estimator of Geweke (1991). For the asymptotically equivalence to the true maximum likelihood estimator re-sampling is required (Hajivassiliou & Ruud 1994). In our case, we use 250 draws (simulations) within in the estimation process. We, however, also use 150 simulations in which the results are numerically equivalent.[19]

2.4.4 Results for the multivariate probit model

Results for the recursive multivariate probit regressions are presented in Table 2.3. Average marginal effects are calculated for the outcome equation which can be interpreted as the average treatment effect (ATE) in this specification (e.g. Marra & Radice 2011). We find significantly positive effects of VERs on all three types of innovation measures. Voluntary institutions increase the likelihood of an incremental innovation by 7.7, of a radical innovation by 8.7 and the likelihood of a process innovation by 2.8 percentage points. In comparison with the results of the univariate probit and OLS models in Table 2.2, the marginal effects do not differ much when the recursive multivariate probit model is applied and endogeneity is considered. There is a slightly increase in the effect for incremental innovation and a slightly decrease in the effect for radical innovation. Furthermore, the weak link between works councils and innovation is in line with earlier results on works councils. Still, the effects of this institution on innovation are rather limited (e.g. Addison et al. 2001; Jirjahn & Kraft 2011).

Control variables in the regression framework take the expected signs and do not differ substantially between the different equations. As expected, input factors for technological progress directly relate to an increase in the likelihood for successful conducted innovations. Thus, the share of high-skilled employees, investment in information and communication technologies as well as further training of employees contribute substantially to a successfully conducted innovation on the establishment level. Moreover, we find evidence that gender diversity contributes to the innovation process, since a higher share of female employees contributes significantly to a successfully conducted innovation. This is also in line with other recent literature indicating positive effects for technological progress stemming for example from gender (e.g. Xie et al. 2020) or cultural diversity. Comparing the coefficients for the competition indicator variable, we see that the workforce is more likely to vote for works councils in the case of high competition. In this

[19]The intuition of the Geweke-Hajivassiliou-Keane (GHK) estimator is to evaluate multidimensional likelihood functions. Therefore, the multivariate normal distribution can be expressed as a sequence of univariate normal distributions. Then, in each draw (replication) the multivariate probability is computed.

view the workforce wants to protect their investments in human capital and the innovation process. This rationale does not apply for the voluntary institutions. Moreover, the results show that voluntary institutions are negatively related to collective bargaining agreements whereas works councils are positively associated with it.

With respect to endogeneity, we find in all specifications a significant negative correlation coefficient (ρ_{23}) between voluntary and statutory representation institutions. Despite of the inclusion of our control variables, there are still unobserved correlations which make VERs more likely and WOCOs less likely (or vice versa). We interpret this finding as a substitutive relationship between works councils on the one hand and voluntary institutions on the other hand. Moreover, the more general likelihood ratio test for $\rho_{12}, \rho_{13}, \rho_{23} = 0$, which considers all ρ_i coefficients, points to the relevance of estimating the multivariate probit model simultaneously. The coefficient is highly significant in all equations and the test can be rejected for all three innovation measures. Endogeneity is clearly present and adjusting for unobserved correlations between equations has a strong effect on the results.

Table 2.3: Recursive multivariate probit estimates for product and process innovation

Innovation type in $(t+1)$	Incremental			Radical			Process		
	WOCO	VER	Innovation	WOCO	VER	Innovation	WOCO	VER	Innovation
Voluntary representation (VER)			.264* [.077]			.335** [.087]			.311** [.028]
			(.145)			(.154)			(.159)
Works council (WOCO)			.206 [.064]			.024 [.006]			.042 [.108]
			(.137)			(.149)			(.137)
Share of VER (in industry, state, year)	-.413 [-.079]	5.06*** [.711]		-.415 [-.079]	5.06*** [.711]		-.422* [-.080]	5.06*** [.711]	
	(.253)	(.270)		(.252)	(.269)		(.251)	(.269)	
Share of WOCO (in industry, state, year)	3.08*** [.585]	-.071 [-.010]		3.07*** [.584]	-.051 [-.007]		3.07*** [.585]	-.063 [.576]	
	(.231)	(.198)		(.233)	(.197)		(.232)	(.198)	
Log (Employees)	1.64*** [.311]	-.529*** [-.074]	.029 [.009]	1.63*** [.310]	-.531*** [-.075]	.025 [.006]	1.60*** [.305]	-.527*** [-.074]	.173 [.058]
	(.242)	(.111)	(.136)	(.241)	(.099)	(.111)	(.250)	(.111)	(.123)
Log (Employees squared)	-.092*** [-.017]	.055*** [.008]	.018 [.005]	-.091*** [-.017]	.055*** [.008]	.012 [.003]	-.088*** [-.017]	.055*** [.008]	.007 [.002]
	(.024)	(.011)	(.015)	(.024)	(.011)	(.010)	(.025)	(.011)	(.012)
Further training	.246*** [.048]	.223** [.029]	.297*** [.095]	.249*** [.048]	.225*** [.029]	.255*** [.054]	.249*** [.048]	.222*** [.029]	.257*** [.084]
	(.077)	(.081)	(.056)	(.077)	(.080)	(.075)	(.077)	(.080)	(.059)
Collective bargaining	.666*** [.133]	-.191** [-.026]	.002 [.001]	.666*** [.133]	-.193** [-.026]	-.054 [-.012]	.667*** [.133]	-.190** [-.026]	.025 [.008]
	(.083)	(.078)	(.062)	(.084)	(.078)	(.064)	(.084)	(.078)	(.057)
Founded before 1990	.041 [.008]	-.014 [-.002]	-.029 [-.009]	.037 [.007]	-.013 [-.002]	-.012 [-.003]	.035 [.007]	-.014 [-.002	.049 [.017]
	(.091)	(.086)	(.059)	(.090)	(.085)	(.059)	(.091)	(.085)	(.056)
Part of firm group	.814*** [.157]	.024 [.003]	-.055 [-.017]	.816*** [.157]	.023 [.003]	-.028 [-.006]	.674*** [.157]	.022 [.003]	.079 [.027]
	(.096)	(.084)	(.065)	(.095)	(.084)	(.064)	(.188)	(.084)	(.059)
Limited liability	.673*** [.129]	.111 [.015]	.056 [.017]	.690*** [.133]	.107 [.014]	.258** [.054]	.217 [.130]	.110 [.015]	.232** [.075]
	(.189)	(.123)	(.098)	(.190)	(.123)	(.113)	(.163)	(.123)	(.101)
High competition	.120** [.023]	-.013 [-.002]	.065 [.020]	.122** [.023]	-.014 [-.002]	.023 [.005]	.121** [.023]	-.013 [-.002]	.100** [.036]
	(.061)	(.054)	(.042)	(.061)	(.054)	(.045)	(.061)	(.054)	(.041)
Investments in ICT	.013 [.002]	.056 [.008]	.247*** [.077]	.014 [.003]	.057 [.008]	.102** [.007]	.012 [.002]	.058 [.008]	.138*** [.046]
	(.059)	(.059)	(.061)	(.058)	(.059)	(.047)	(.059)	(.059)	(.041)
Share of female	-1.06*** [-.202]	-.008 [-.001]	.343** [.104]	-1.07*** [-.203]	-.018 [-.003]	.480*** [.111]	-1.05*** [-.201]	-.008 [-.001]	.387*** [.130]
	(.232)	(.196)	(.227)	(.232)	(.197)	(.168)	(.232)	(.196)	(.144)
Share of fixed-term	-1.42*** [-.271]	-.327 [-.046]	.043 [.013]	-1.39*** [-.265]	-.318 [-.045]	-.025 [-.006]	-1.43*** [-.272]	-.324 [-.046]	.451** [.151]
	(.479)	(.309)	(.150)	(.476)	(.310)	(.251)	(.478)	(.308)	(.220)
Share of high-skilled workers	.806*** [.153]	.005 [.001]	1.29*** [.391]	.809*** [.154]	.021 [.003]	.829*** [.192]	.808*** [.154]	.012 [.002]	.435*** [.146]
	(.259)	(.227)	(.189)	(.259)	(.225)	(.170)	(.258)	(.226)	(.164)
Western Germany	-.456*** [-.083]	-.199** [-.028]	.277*** [.086]	-.455*** [-.083]	-.200** [-.028]	-.008 [-.002]	-.453*** [-.083]	-.199** [-.028]	.082 [.028]
	(.108)	(.095)	(.061)	(.108)	(.095)	(.062)	(.108)	(.095)	(.059)
Constant	-7.21***	-.684**	-.953***	-7.21***	-.670**	-1.82***	-7.13***	-.686**	-2.43***
	(.618)	(.318)	(.320)	(.616)	(.318)	(.313)	(.634)	(.318)	(.308)
Industry fixed effects		✓			✓			✓	
Year fixed effects		✓			✓			✓	
$\rho_{13}, \rho_{12}, \rho_{23}$		-.123, .006, -.512***			-.116, -.135, -.508***			-.095, -.069*, -.511***	
		(.080, .077, .046)			(.090, .082, .046)			(.083, .087, .046)	
LR test for $\rho_{21}, \rho_{31}, \rho_{32} = 0$ (p-value)		192.974 (.000)			196.526 (.000)			193.137 (.000)	
Number of replications		250			250			250	
Log likelihood		-8343.349			-7441.664			-8718.852	
Observations		7,411			7,411			7,411	

Notes: This table presents results of estimating the system of Equations in (2.2) using non-linear multivariate probit models. The share of VER and WOCO are used as exclusion restrictions. Industry fixed effects include manufacturing and knowledge-intensive services according to NACE Rev. 2.0 and as specified in Section 2.4. Correlation coefficient ρ measures the correlation in the error terms among employee representation equations and the outcome equation. Likelihood ratio (LR) test for joint significance of ρ is presented as a test for endogeneity. Average marginal effects (AME) are presented in brackets with level of significance according to the estimated coefficient. Cluster-robust standard errors at the establishment level in parentheses. *, **, and *** denote statistical significance at the .1, .05 and .01 level. IAB Establishment Panel, years 2010–2018.

2.5 Robustness

2.5.1 Linear instrumental variable regressions (2SLS)

In this section we look at the robustness of our results using linear two-stage least squares (2SLS) estimation techniques. First, we re-estimate the same multivariate probit specification using 2SLS linear estimation. The point estimates and significance levels are comparable and results can be found in the Appendix in Table 2.9 of this chapter. The estimated effect for voluntary institutions on process innovations, however, is in the 2SLS estimates slightly larger. Second, as a further robustness test, we apply an additional instrumental variable.

Therefore, we use the share of collective bargaining agreements (CBAs) on the industry, year and federal state level as an additional instrument. On the one hand, collective bargaining agreements might be a substitute for works councils' bargaining power on the establishment level and thus, they are negatively correlated. On the other hand, works councils and CBAs may have a complementary relationship in which distributional conflicts arising from wage-setting are shifted to the industry level (e.g. Hübler & Jirjahn 2003; Bellmann et al. 2018). In terms of exclusion, Addison et al. (2017) show that there are no direct effects of collective bargaining agreement on technological progress discernible. In fact, effects of CBAs might only be driven in conjunction with works councils. We therefore think of CBAs as an appropriate additional instrumental variable in our case.

With these three instrumental variables we also re-estimate the recursive multivariate probit framework and estimate linear instrumental variable models (2SLS). As theoretical outlined by, for example, Bhattacharya et al. (2006), simulated maximum likelihood (SML) estimates using the multivariate probit models, might be more efficient in binary models with binary endogenous variables, however, linear IV models are also appropriate (e.g. Angrist & Pischke 2009). Moreover, the linear 2SLS models provide us with a few advantages. First, we relax the strong functional form assumption of multivariate normality and second, we can assess the set of instruments in more detail using the test of over-identifying restrictions, which is known as the Hansen J test (Hansen 1982). As the results in Table 2.4 show, we fail to reject the Hansen J test in all specifications. The test therefore supports our assumption that the three instrumental variables are exogenous. Results using also the share of collective bargaining agreements, are presented in Table 2.4. Results on the full specifications including all control variables can be found in the Appendix in Table 2.10 for the multivariate probit models and in Table 2.11 for the 2SLS models.

Table 2.4: IV results using collective bargaining shares as additional instrument

Innovation in $(t+1)$	Incremental		Radical		Process	
	(MVP)	(2SLS)	(MVP)	(2SLS)	(MVP)	(2SLS)
Voluntary repr. (VER)	.260* [.075]	.109**	.349**[.091]	.111**	.316**[.109]	.147**
	(.144)	(.051)	(.155)	(.046)	(.159)	(.063)
Works council (WOCO)	.165 [.051]	.040	.028 [.006]	.071	-.009 [-.003]	.015
	(.137)	(.066)	(.144)	(.054)	(.135)	(.069)
Instruments:	Share of VER Share of WOCO Share of CBA		Share of VER Share of WOCO Share of CBA		Share of VER Share of WOCO Share of CBA	
F-Test first stage		86.29		86.29		86.29
Hansen J		1.49		.001		1.55
(p-value)		(.223)		(.979)		(.213)
LR test on ρ	195.429		201.535		195.756	
	(.000)		(.000)		(.000)	
Control variables	✓	✓	✓	✓	✓	✓
Industry fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
Observations	7,411	7,411	7,411	7,411	7,411	7,411

Notes: IAB Establishment Panel for the years 2010 to 2018. Industry fixed effects include manufacturing as well as knowledge-intensive services according to NACE Rev. 2.0. Cluster-robust standard errors at the establishment level in parentheses. Average treatment effects (ATE) for the multivariate probit model (MVP) in square brackets. Control variables included as outlined in Section 2.4 and presented in Table 2.1. *, **, and *** denote statistical significance at the .1, .05 and .01 level.

The results between the nonlinear and linear 2SLS models do not differ much and are almost in the same magnitude as the efficient multivariate probit baseline model presented above. Voluntary representation increase the likelihood for incremental and radical product as well as process innovation. With respect to effect size, the effects are also slightly larger as the baseline models. The potential problem of weak instruments can also be rejected since our F-test on the 2SLS first stage is well above the rule-of-thumb value of 10 (e.g. Staiger & Stock 1997). With respect to the F-statistics as a test for underidentification, we apply the Kleibergen-Paap statistic which is robust to heteroskedasticity, autocorrelation as well as clustering (e.g. Kleibergen & Paap 2006). As shown in Table 2.4, the existence of voluntary representation institution leads to a significant impact on all three kind of innovation measures. With respect to the works council, we do not see any significant effects in these findings.

2.5.2 Selection model using kernel matching

So far we have investigated the effect of voluntary employee representation institutions and works councils by considering possible feedback effects with the use of an IV model. We now again re-estimate these models using a matched non-linear multivariate probit and linear 2SLS models. To do so, we apply a kernel weighted matching regression estimator in which establishments having a voluntary repre-

sentation are considered as the treatment group. Establishments which do not have VERs, constitute the control group. The reason for this is that the implementation of a voluntary consultation/participation institution by management can also be interpreted as the result of a selectivity process. These institutions will preferably be installed in firms, where they provide the greatest benefits. These firms could of course also be those whose innovation activities are particularly low in the initial situation. Estimations that are made without taking possible selectivity effects into account would then lead to biased results. To rule out any selection effects, we apply a kernel matching approach in this section.

Kernel matching. Matching models are widely used to correct for selectivity and refer to observed heterogeneity between samples. In order to consider possible selection effects, we apply a non-parametric kernel matching approach to match treated and control establishments. Therefore we rely on a three-step approach in which we first estimate a probit model on the pooled sample to calculate the propensity score P_i. To prevent unequal matches between groups, we restrict the matching approach to the region of common support in which we lose $N = 7$ treated observations. We then calculate the kernel weights and apply re-weighted regressions as described in the following. The advantages of the kernel matching approach compared to, for example, nearest neighbor matching is, that we use all possible control establishments in the matching process and weight them according to the distance to the next treated establishment. The average treatment effect on the treated (ATT) is calculated as the difference between treated observations and an weighted average of the control observations in which the weights are calculated by the distance between propensity scores, the bandwidth parameter b_n as well as the specific kernel function $K[.]$.

$$\widehat{ATT} = \frac{1}{n_1} \sum_{i \in I_1} \left[Y_{1i} - \sum_{j \in I_0} \omega(i,j) \cdot Y_{0j} \right] \tag{2.4}$$

where the number of observations in the treatment group I_1 are denoted as n_1. The number of observations in the control group are denoted as I_0 and $\omega(i,j)$ are the kernel weights which are calculated as:

$$\omega(i,j) = \frac{K\left[(P_j - P_i)/b_n\right]}{\sum_{m \in I_0} K\left[(P_m - P_i)/b_n\right]} \tag{2.5}$$

where for $K[.]$ we use the Epanechnikov kernel function with a bandwidth $b_n = 0.06$, which provide a good trade off between the variance and the bias of the kernel matching estimator (e.g. Caliendo & Kopeinig 2008). Moreover, because of the interval around each observations it kind of works like an additional common

support condition which increases the reliability of the matching approach (e.g. Marcus 2014).

Matching quality. In principle, two samples are matched, which do not differ in their observable characteristics in terms of the explanatory variables. Especially, variables which are important drivers for innovation such as the share of high-skilled, location of the establishment (western / eastern Germany) as well as firm size are considered. Furthermore, variables measuring the input factors of innovations such as investment decisions and further training activities are also equally important. The success of our matching method is verified by a before-and-after comparison of differences between the means of control variables as shown in Table 2.5. The p-values of the t-test statistics in the last column (6) of Table 2.5 indicate, that the differences in mean values after the kernel matching approach are vanished. The matching approach can therefore be seen as successful and both groups do not differ in terms of observable characteristics. In particular differences regarding the establishment size, investment in ICT decisions, being located in western Germany and having a works councils or not, are removed.

Table 2.5: Differences and t-tests on mean of variables before and after matching

Variables	**Before Matching**			**After Matching**		
	Treated	Controls	t-Test	Treated	Controls	t-Test
	(1)	(2)	(3)	(4)	(5)	(6)
Log (Employees)	4.81	4.69	.018	4.75	4.74	.891
Log (Empl. squared)	25.6	23.6	.000	24.72	24.58	.860
Further training	.889	.849	.004	.888	.881	.671
Share of fixed-term	.083	.082	.860	.084	.083	.873
Share of female	.287	.284	.650	.289	.288	.979
Share of high-skilled	.137	.128	.210	.136	.137	.900
Part of firm group	.205	.215	.526	.207	.205	.915
Limited liability	.940	.930	.311	.939	.936	.835
High competition	.515	.504	.561	.511	.512	.948
Investment in ICT	.646	.605	.031	.642	.638	.870
Collective bargaining	.307	.332	.176	.302	.308	.809
Western Germany	.639	.552	.000	.636	.618	.491
Founded before 1990	.526	.485	.034	.522	.513	.752
Works council	.366	.563	.000	.360	.392	.210

Notes: IAB Establishment Panel, years 2010–2018. We use a sample of 7,411 observations from which $N = 6,666$ establishments are considered as untreated (i.e. have no VER) and $N = 738$ report to have a VER. $N = 7$ observations are off support within the matching approach. We apply a kernel matching approach using an Epanechnikov kernel with a .06 bandwidth. For the application of the matching approach see Section 2.5. The p-values of the corresponding t-tests on differences between treated and control variables are shown in columns (3) and (6).

In the next step we proceed with the analysis on re-weighted regressions in which we augment the proceeding instrumental variable specifications. Thus, we apply these kernel weights, which balance covariates of the treatment and control group, to the linear 2SLS and to the non-linear multivariate probit models.

Regression adjusted matching estimator. Within the matching framework, we are able to remove any observable confounding, and differences in outcomes are solely due to voluntary institutions. After matching both groups in terms of observable characteristics we re-estimate the 2SLS and recursive multivariate probit models (MVP) to additionally consider the described selectivity issue. Thus, we employ a kind of 'doubly robust' approach suggested for example by Imbens (2004), in which we use the kernel weights within these regression frameworks. See for a similar approach, for example, Marcus (2014), who applies re-weighted difference-in-differences regressions as well as Li (2013). Results for the estimated selectivity models are presented in the following Table 2.6. Results regarding all control variables for the three equations multivariate probit model are presented in Table 2.12 and for the 2SLS model in Table 2.13 in the Appendix of this chapter.

Table 2.6: Regression adjusted kernel matching results

Innovation in $(t+1)$	Incremental		Radical		Process	
	(MVP)	(2SLS)	(MVP)	(2SLS)	(MVP)	(2SLS)
Voluntary repr. (VER)	.315*** [.090]	.112***	.242**[.062]	.095**	.191*[.065]	.120**
	(.114)	(.040)	(.122)	(.040)	(.116)	(.050)
Works council (WOCO)	.218 [.068]	.031	.367* [.085]	.274***	.538*** [.188]	.108
	(.236)	(.103)	(.195)	(.106)	(.189)	(.124)
Instruments:	Share of VER		Share of VER		Share of VER	
	Share of WOCO		Share of WOCO		Share of WOCO	
	Share of CBA		Share of CBA		Share of CBA	
F-Test first stage		38.06		38.06		38.06
Hansen J		.028		1.85		.394
(p-value)		(.867)		(.173)		(.530)
LR test on ρ	15715.2		14884.5		16745.8	
	(.000)		(.000)		(.000)	
Control variables	✓	✓	✓	✓	✓	✓
Industry fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
Observations	7,404	7,404	7,404	7,404	7,404	7,404

Notes: IAB Establishment Panel for the years 2010 to 2018. Industry fixed effects include manufacturing as well as knowledge-intensive services according to NACE Rev. 2.0. Cluster-robust standard errors at the establishment level in parentheses. Average treatment effects (ATE) for the multivariate probit model (MVP) in square brackets. Control variables included as outlined in Section 2.4 and outlined in Table 2.1. *, **, and *** denote statistical significance at the .1, .05 and .01 level.

Results from these selection models support our previous findings. Positive effects stemming from voluntary workplace representation are still significant and in the same magnitude as before. Moreover, the F-test on first stage suggest sufficient strength of the instruments and the Hansen J test supports our view on

exogenous instruments. We find these strong associations between VERs and incremental product and process innovation among all specifications ranging from the initial ordinary least squares models to the 2SLS and probit models. Thus, sufficient strong and effective two-way communication channels created by voluntary institutions, foster technological progress as described in the theoretical section.

The effects of works councils, however, are mixed. In the initial OLS estimates, we find a negative correlation between the statutory form of representation and radical product and process innovation. This representation institutions therefore might be protecting employees from technological change, which usually increases the risk of being replaced by robots for certain groups (Frey & Osborne 2017). When we apply the instrumental variables models, which we interpret as the more reliable ones, we find no relationship between works councils and innovation as often discussed in the literature. Mixed effects might be stemming from ambiguous motivations and channels of works councils. On the one hand, strong bargaining power might hinder innovations via rent-seeking activities or delayed decision making (e.g. Addison et al. 2001). On the other hand, works council might also provide a statutory communication channel. In this view, employees might come up with ideas to increase performance while at the same time are protected from dismissals. Thus, works councils might also be associated with technological progress and equipment (e.g. Genz et al. 2019). Especially the selectivity-adjusted models take possible feedback effects of a, for example, bad economic situation into account. In these situations the likelihood for works councils increases (e.g. Jirjahn 2009). Taking this selection effect into account by applying matched instrumental variable estimation, the results points towards a positive effect of works councils on technological progress. Results in which the works council at least does not hinder technological progress, however, are quite in line with the literature (Kraft et al. 2011; Addison et al. 2001, 1996).

2.6 Conclusion

Recent challenges such as the rise in applications for artificial intelligence, big data and the use of robotics within the production process, put adjustment pressure on firms. To stay competitive, firms need to come up with new ideas, inventions and finally new products. While many studies consider the surroundings of organizations such as competition, industry particularities or market dynamics, often neglected are the vast opportunities for technological progress stemming from within the organization. The primary source of creativity resides in employees in the form of 'intellectual capital', which should be efficiently applied in the production

process.

In this chapter, the thesis focuses on the relevance of employee representation institution in the context of knowledge creation. We first investigate the role voluntary employee representation (VER) in the form of round table conferences, employee spokespersons as well as additional management lines for technological progress in German establishments. Second, we also study the so far neglected relationship to the statutory representation institution in Germany which are works councils. As works councils are institutionalized by the legislator and adopted if the workforce votes for them, differences between representation regimes introduced voluntarily by the management are quite likely. This chapter therefore contributes to the understanding how differences in bargaining power relate to innovative output.

For our analysis we use the German IAB Establishment Panel and apply instrumental variable methods. We use three different dependent variables measuring incremental and radical product as well as process innovations in non-linear recursive multivariate probit and linear 2SLS models. Using the nonlinear approach in combination with instrumental variables, we are able to take endogeneity of a binary variable affecting a binary outcome into account. The estimation of linear 2SLS models allow us to check the quality of our instruments. In all specifications we find significantly positive effects of voluntary representation institutions on the propensity to innovate. Finally, we re-estimate all specifications using kernel matching techniques to take observable differences of establishments into account.

Works councils have negative point estimates in the baseline OLS models as expected. First, involvement of employees seems to have the strongest impact when their workplaces are directly affected. In this case, workers can contribute with information and knowledge that the management in many cases does not have. Second, voluntary institutions may reduce resistance to technological progress in the production process which may be a major reason for the introduction of such efficient two-way communication channels. In any case we think information collection and communication at the workplace is valuable for innovation development, especially when this voluntary form of employee voice is company-specific and therefore better designed to address any problems specific on the shop floor level. We also find a substitutive relationship between voluntary representation and the works council. One reason might be that the management intend to avoid works councils with strong bargaining rights and therefore voluntarily implements voluntary representation regimes. Identification of the true relation between the two kinds of worker representation institutions might be an interesting topic for future research, for example, by investigating the introduction of these institutions over

time.

Our study is, however, not without limitations. First, because of data restrictions, we cannot overcome a 'dummy variable approach' in which we are not able to fully address the heterogeneity of voluntary workplace representation. For instance, works councils are based on an explicit legal basis, which defines rights of information, consultation and codetermination in much detail. This problem of definition, in fact, is much more serious for the voluntary institutions, however, we do not have any further information about their tasks, orientation, composition of members and coverage of the workforce. Despite the limitations we provide concise evidence of the effectiveness of an efficient communication channel in the context of creativity and in the end technological progress. Since voluntary representation institutions are firm-tailored they are more likely to efficiently take workplace particularities into account.

With respect to policy implications it is important to not only consider the potential performance effect of voluntary institutions but also disadvantages resulting from voluntary voice, for example, in terms of bargaining power. Mixed results of works councils on innovation might be due to the legally defined rights, which might be to bureaucratic in some firms to foster creativity.

2.7 Appendix

Table 2.7: Description and explanation of variables

Variable	Description and explanation
Dependent variables	
Incremental product innovation $(t+1)$	Dummy variable equals 1 if an establishment improves or further develops a product or service which had previously been part of the portfolio in $t+1$ and 0 otherwise.
Radical product innovation $(t+1)$	Dummy variable equals 1 if an establishment started to offer a completely new product or service for which a new market has to be created in $t+1$ and 0 otherwise.
Process innovation $(t+1)$	Dummy variable equals 1 if an establishment develops or implements procedures which have noticeable improved production or services in $t+1$ and 0 otherwise.
Control variables	
Log(Employees)	Natural logarithm of the number of employees.
Log(Employees squared)	Natural logarithm of the squared number of employees.
Further training	Dummy variable equals 1 if an establishment/office supports training courses in the first half of the year and 0 otherwise.
Part of firm group	Dummy variable equals 1 if an establishment/office is part of a larger company or organization and 0 otherwise.
Limited liability	Dummy variable equals 1 if an establishment has the legal form of a limited liability (e.g. GmbH, UG Ltd.) and 0 otherwise.
High competition	Dummy variable equals 1 if an establishment rates the pressure from competition to be substantial and 0 otherwise.

Variable	Description and explanation
Western Germany	Dummy variable equals 1 if an establishment is based in western Germany and zero otherwise.
Investment in ICT	Dummy variable equals 1 if an establishment has invested in information and communication technologies in the year $t-1$ and 0 otherwise.
Collective bargaining	Dummy variable equals 1 if an establishment is bounded by an industry-wide wage agreement and 0 otherwise.
Founded before 1990	Dummy variable equals 1 if an establishment was founded before the year 1990 and 0 otherwise. (After 1990 spans the time after the reunification of eastern and western Germany).
Share of female workers	Continuous measure for the share of female workers in relation to employment in year t.
Share of high-skilled workers	Continuous measure for the share of high-skilled workers in relation to employment in year t which require a university degree.
Employee representation	
Works council	Dummy variable equals 1 if there is a works council present in an establishment. This shop-floor representation institution can be elected in establishments with more than five permanent employees. Works councils posses comprehensive consultation, information and codetermination rights in areas such as staffing, working hours or safety. Their rights are ruled out in the Works Constitution Act.
Voluntary employee representation	Dummy variable equals 1 if there is a form of voluntary or alternative representation institution present in an establishment. Types are, for example, round table conferences or staff spokespersons (e.g. Addison 2009).

Variable	Description and explanation
Instrumental variables	
Share of voluntary representation	Share of voluntary employee representation in year t, industry k and federal state f.
Share of works council	Share of works council in year t, industry k and federal state f.
Share of collective bargaining agreement	Share of collective bargaining agreements in year t, industry k and federal state f.

Table 2.8: Full results on pooled OLS models for different innovation measures

Innovation type (in $t+1$)	Incremental		Radical		Process	
	(1)	(2)	(3)	(4)	(5)	(6)
Voluntary represent. (VER)	.067**	.069***	.016	.016	.028	.057**
	(.029)	(.020)	(.022)	(.018)	(.027)	(.023)
Works council (WOCO)	.010	.011	-.043***	-.043***	-.044**	-.037*
	(.022)	(.021)	(.016)	(.016)	(.021)	(.021)
VER × WOCO	.007		.001		.076	
	(.038)		(.039)		(.047)	
Log (Employees)	.114***	.114***	-.017	-.017	.064**	.059**
	(.026)	(.026)	(.027)	(.027)	(.030)	(.030)
Log (Employees) squared	-.005**	-.005**	.006**	.006**	.003	.004
	(.002)	(.002)	(.003)	(.003)	(.003)	(.003)
Further training	.117***	.117***	.049***	.049***	.073***	.072***
	(.020)	(.020)	(.013)	(.013)	(.017)	(.017)
Share of high-skilled workers	.354***	.354***	.221***	.221***	.155***	.158***
	(.047)	(.047)	(.047)	(.047)	(.057)	(.057)
Share of fixed-term workers	.024	.024	-.013	-.013	.155***	.153***
	(.071)	(.071)	(.058)	(.058)	(.072)	(.072)
Share of female workers	.087*	.087*	.097**	.097**	.117**	.117**
	(.048)	(.048)	(.040)	(.040)	(.047)	(.047)
Investments in ICT	.085***	.085***	.022**	.022**	.046***	.046***
	(.014)	(.014)	(.011)	(.011)	(.014)	(.014)
Part of firm group	-.004	-.004	.001	.001	.039*	.038*
	(.018)	(.018)	(.016)	(.016)	(.020)	(.020)
Limited liability	.021	.021	.051**	.051**	.054**	.054**
	(.032)	(.032)	(.020)	(.020)	(.027)	(.027)
High competition	.021	.021	.007	.007	.035**	.036**
	(.013)	(.013)	(.011)	(.011)	(.014)	(.014)
Collective bargaining	.004	.004	-.009	-.009	.018	.018
	(.018)	(.018)	(.015)	(.015)	(.019)	(.019)
Founded before 1990	-.009	-.009	-.001	-.001	.021	.021
	(.018)	(.018)	(.014)	(.014)	(.019)	(.019)
Western Germany	.091***	.091***	.003	.003	.032	.030
	(.020)	(.020)	(.014)	(.014)	(.019)	(.019)
Constant	-.023	-.023	.051	.051	-.306***	-.302***
	(.074)	(.074)	(.068)	(.068)	(.076)	(.076)
Industry fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
R^2	.175	.175	.069	.069	.130	.130
Observations	7,411	7,411	7,411	7,411	7,411	7,411

Notes: This table presents results from the estimation of Equation (2.1) using OLS. Data from the IAB Establishment Panel using the years 2010–2018. Industry fixed effects include manufacturing as well as knowledge-intensive services according to NACE Rev. 2.0 as outlined in Section 2.4. Cluster-robust standard errors at the establishment level in parentheses. *, **, and *** denote statistical significance at the .1, .05 and .01 level.

Table 2.9: 2SLS results of baseline specification

Innovation type (in $t+1$)	Incremental	Radical	Process	WOCO	VER
	(1)	(2)	(3)	(4)	(5)
Second Stage				**First Stage**	
Voluntary repr.(VER)	.117**	.111**	.157**		
	(.051)	(.046)	(.064)		
Works council (WOCO)	.077	.071	.055		
	(.073)	(.058)	(.077)		
Log (Employees)	.093**	-.053	.033	.375***	-.097***
	(.036)	(.033)	(.040)	(.023)	(.026)
Log (Employees squared)	-.004	.008***	.005	-.023***	.010***
	(.003)	(.003)	(.003)	(.002)	(.003)
Further training	.111***	.039***	.063***	.057***	.034***
	(.021)	(.014)	(.017)	(.016)	(.011)
Collective bargaining	-.005	-.024	.007	.141***	-.028**
	(.020)	(.018)	(.022)	(.018)	(.012)
Founded before 1990	-.011	-.005	.019	.012	.002
	(.018)	(.014)	(.019)	(.019)	(.013)
Part of firm group	-.014	-.016	.024	.153***	.001
	(.021)	(.018)	(.023)	(.018)	(.013)
Limited liability firm	.018	.045**	.049*	.020	.020
	(.032)	(.020)	(.028)	(.029)	(.018)
High competition	.018	.003	.032**	.036***	-.000
	(.013)	(.011)	(.014)	(.013)	(.008)
Investments in ICT	.084***	.020*	.045***	.006	.008
	(.014)	(.011)	(.014)	(.013)	(.009)
Share of female workers	.103**	.124***	.138***	-.221***	-.001
	(.051)	(.043)	(.051)	(.050)	(.030)
Share of fixed-term workers	.039	.013	.174**	-.186***	-.037
	(.074)	(.061)	(.075)	(.084)	(.043)
Share of high-skilled workers	.342***	.199***	.141**	.174***	.002
	(.049)	(.047)	(.058)	(.051)	(.034)
Western Germany	.088***	-.003	.025	-.090***	-.026*
	(.020)	(.015)	(.020)	(.022)	(.014)
Share of VER				-.096***	.982***
				(.047)	(.049)
Share of WOCO				.599***	-.002
				(.041)	(.026)
Industry fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓
Instruments:	Share of VER Share of WOCO	Share of VER Share of WOCO	Share of VER Share of WOCO		
F-Test first stage	105.78	105.78	105.78		
Observations	7,411	7,411	7,411	7,411	7,411

Notes: IAB Establishment Panel for the years 2010 to 2018. Industry fixed effects include manufacturing as well as knowledge-intensive services according to NACE Rev. 2.0. Cluster-robust standard errors at the establishment level in parentheses. *, **, and *** denote statistical significance at the .1, .05 and .01 level.

Table 2.10: Recursive multivariate Probit (MVP) results with additional instrumental variable (CBA share)

Innovation type (in $t+1$)	Incremental			Radical			Process		
	WOCO	VER	Outcome	WOCO	VER	Outcome	WOCO	VER	Outcome
Voluntary representation (VER)			.260* [.075]			.349** [.091]			.316** [.109]
			(.144)			(.155)			(.159)
Works council (WOCO)			.165 [.051]			.028 [.006]			-.009 [-.003]
			(.167)			(.144)			(.135)
Share of VER (in industry, state, year)	-.315 [-.059]	5.07*** [.712]		-.315 [-.059]	5.07*** [.582]		-.324 [-.065]	5.07*** [.712]	
	(.251)	(268)		(.250)	(.267)		(.250)	(.267)	
Share of WOCO (in industry, state, year)	3.50*** [.653]	-.060 [-.008]		3.50*** [.653]	-.036 [.421]		3.49*** [.653]	-.052 [-.007]	
	(.244)	(.210)		(.245)	(.209)		(.245)	(.210)	
Share of CBA (in industry, state, year)	-1.44*** [-.269]	-.005 [-.001]		-1.46*** [-.272]	-.016 [.421]		-1.44*** [-.270]	.001 [.000]	
	(.259)	(.220)		(.257)	(.220)		(.258)	(.219)	
Log (Employees)	1.60*** [.299]	-.531*** [-.075]	.042 [.013]	1.60*** [.298]	-.533*** [-.054]	.025 [.006]	1.57*** [.294]	-.529*** [-.074]	.195 [.065]
	(.249)	(.112)	(.137)	(.245)	(.111)	(.113)	(.252)	(.112)	(.123)
Log (Employees squared)	-.088*** [-.016]	.055*** [.008]	.017 [.005]	-.088*** [-.016]	.055*** [.006]	.012 [.003]	-.085*** [-.016]	.055*** [.008]	.006 [.002]
	(.025)	(.011)	(.015)	(.025)	(.011)	(.010)	(.026)	(.011)	(.012)
Further training	.249*** [.047]	.223*** [.029]	.300*** [.096]	.253*** [.048]	.224*** [.034]	.255*** [.054]	.251*** [.048]	.221*** [.028]	.260*** [.085]
	(.077)	(.081)	(.056)	(.077)	(.081)	(.074)	(.077)	(.080)	(.059)
Collective bargaining	.827*** [.163]	-.192** [-.026]	.009 [.003]	.829*** [.164]	-.193** [-.022]	-.054 [-.012]	.829*** [.164]	-.191** [-.026]	.033 [.011]
	(.091)	(.085)	(.063)	(.092)	(.085)	(.063)	(.092)	(.085)	(.057)
Founded before 1990	.050 [.009]	-.014 [-.002]	-.028 [-.009]	.046 [.009]	-.014 [.007]	-.012 [-.003]	.044 [.008]	-.015 [-.002]	.051 [.017]
	(.092)	(.086)	(.059)	(.091)	(.085)	(.059)	(.092)	(.086)	(.056)
Part of firm group	.806*** [.153]	.022 [.003]	-.049 [-.015]	.809*** [.153]	.021 [-.006]	-.029 [-.007]	.805*** [.153]	.021 [.003]	.087 [.029]
	(.098)	(.084)	(.066)	(.097)	(.084)	(.064)	(.098)	(.085)	(.059)
Limited liability	.644*** [.122]	.111 [.014]	.057 [.017]	.658*** [.125]	.106 [-.008]	.258** [.054]	.647*** [.122]	.110 [.015]	.234** [.076]
	(.201)	(.124)	(.098)	(.202)	(.123)	(.113)	(.200)	(.123)	(.101)
High competition	.127** [.024]	-.013 [-.002]	.067 [.020]	.128** [.024]	-.015 [-.003]	.023 [.005]	.128** [.024]	-.013 [-.002]	.102** [.034]
	(.062)	(.054)	(.042)	(.062)	(.053)	(.045)	(.062)	(.053)	(.041)
Investments in ICT	.014 [.003]	.057 [.008]	.247*** [.077]	.016 [.003]	.058 [.009]	.102** [.024]	.014 [.003]	.058 [.009]	.138*** [.046]
	(.059)	(.059)	(.042)	(.059)	(.059)	(.047)	(.059)	(.059)	(.041)
Share of female workers	-1.12*** [-.209]	.003 [-.001]	.333** [.101]	-1.12*** [-.209]	-.009 [.013]	.481*** [.112]	-1.11*** [-.208]	.003 [.000]	.375*** [.126]
	(.234)	(.197)	(.150)	(.234)	(.198)	(.168)	(.234)	(.197)	(.144)
Share of fixed-term workers	-1.46*** [-.273]	-.343 [-.047]	.034 [.010]	-1.43*** [-.268]	-.336 [.013]	-.025 [-.006]	-1.46*** [-.273]	-.340 [-.048]	.439** [.147]
	(.495)	(.308)	(.227)	(.492)	(.309)	(.250)	(.495)	(.307)	(.220)
Share of high-skilled workers	.828*** [.155]	.000 [.002]	1.30*** [.393]	.832*** [.155]	.017 [-.007]	.828*** [.192]	828*** [.155]	.008 [.001]	.446*** [.149]
	(.189)	(.227)	(.189)	(.259)	(.225)	(.170)	(.259)	(.226)	(.163)
Western Germany	-.213* [-.039]	-.202** [-.029]	.278*** [.086]	-.209* [.212]	-.201** [-.007]	-.009 [-.002]	-.209* [-.038]	-.203** [-.029]	.084 [.028]
	(.114)	(.101)	(.061)	(.114)	(.100)	(.062)	(.113)	(.101)	(.059)
constant	-6.83***	-.693**	-.987***	-6.83***	-.674**	-1.82***	-6.76***	-.696**	-2.50***
	(.628)	(.327)	(.322)	(.626)	(.327)	(.311)	(.637)	(.326)	(.309)
Industry fixed effects		✓			✓			✓	
Year fixed effects		✓			✓			✓	
$\rho_{13}, \rho_{12}, \rho_{23}$		-.097, .004, -.522***			-.119,-.143*,-.519***			-.060, -.078, -.521***	
		(.081, .077, .047)			(.087,.082,.046)			(.170, .177, .043)	
LR test for $\rho_{21}, \rho_{31}, \rho_{32}= 0$		195.429			201.535			195.756	
Number of replications		250			250			250	
Log likelihood		-8300.786			-7397.824			-8676.207	
Observations		7,411			7,411			7,411	

Notes: IAB Establishment Panel, own calculations for the years 2010 to 2018. Industry fixed effects include manufacturing as well as knowledge-intensive services according to NACE Rev. 2.0. Cluster-robust standard errors at the establishment level in parentheses. The correlation coefficient ρ measures the correlation in the error terms between employee representation equations and the outcome equation. Likelihood ratio (LR) test for joint significance of ρ is presented. Average marginal effects (AME) are presented in brackets; level of significance according to the estimated coefficient. *, **, and *** denote statistical significance at the .1, .05 and .01 level.

Table 2.11: 2SLS results with additional instrumental variable (CBA share)

Innovation type (in $t+1$)	Incremental	Radical	Process	WOCO	VER
	(1)	(2)	(3)	(4)	(5)
Second Stage				**First Stage**	
Voluntary repr.(VER)	.109**	.111**	.147**		
	(.051)	(.046)	(.063)		
Works council (WOCO)	.040	.071	.015		
	(.066)	(.054)	(.069)		
Log (Employees)	.106***	-.052	.048	.365***	-.097***
	(.035)	(.032)	(.039)	(.023)	(.026)
Log (Employees squared)	-.005*	.008***	.004	-.022***	.010***
	(.003)	(.003)	(.003)	(.002)	(.003)
Further training	.114***	.039***	.066***	.056***	.034***
	(.021)	(.014)	(.017)	(.016)	(.011)
Collective bargaining	.001	-.024	.013	.180***	-.028**
	(.020)	(.017)	(.021)	(.019)	(.013)
Founded before 1990	-.010	-.005	.020	.015	.002
	(.018)	(.014)	(.019)	(.019)	(.013)
Part of firm group	-.008	-.016	.030	.148***	.001
	(.020)	(.018)	(.022)	(.018)	(.013)
Limited liability firm	.019	.045**	.050**	.017	.020
	(.032)	(.020)	(.028)	(.029)	(.018)
High competition	.075*	.003	.034**	.037***	-.000
	(.045)	(.011)	(.014)	(.013)	(.008)
Investments in ICT	.020	.020*	.045***	.006	.008
	(.013)	(.011)	(.014)	(.013)	(.009)
Share of female	.094*	.124***	.128***	-.227***	-.001
	(.051)	(.043)	(.050)	(.049)	(.030)
Share of fixed-term	.031	.012	.165**	-.187**	-.037
	(.073)	(.061)	(.074)	(.086)	(.043)
Share of high-skilled workers	.349***	.200***	.149***	.172***	.002
	(.048)	(.047)	(.057)	(.051)	(.034)
Western Germany	.089***	-.003	.026	-.037	-.026*
	(.020)	(.015)	(.020)	(.023)	(.015)
Share of VER				-.072	.982***
				(.047)	(.049)
Share of WOCO				.699***	-.001
				(.044)	(.028)
Share of CBA				-.318***	-.003
				(.047)	(.032)
Industry fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓
Instruments:	Share of VER Share of WOCO Share of CBA	Share of VER Share of WOCO Share of CBA	Share of VER Share of WOCO Share of CBA		
F-Test first stage	86.27	86.27	86.27		
Hansen J	1.49	.001	1.55		
(p-value)	(.223)	(.979)	(.213)		
Observations	7,411	7,411	7,411	7,411	7,411

Notes: IAB Establishment Panel for the years 2010 to 2018. Industry fixed effects include manufacturing as well as knowledge-intensive services according to NACE Rev. 2.0. Cluster-robust standard errors at the establishment level in parentheses. *, **, and *** denote statistical significance at the .1, .05 and .01 level.

Table 2.12: Selectivity adjusted results for weighted multivariate probit (MVP)

Innovation type (in $t+1$)	Incremental			Radical			Process		
	WOCO	VER	Outcome	WOCO	VER	Outcome	WOCO	VER	Outcome
Voluntary representation (VER)			.315*** [.090]			.242** [.062]			.191* [.065]
			(.114)			(.122)			(.116)
Works council (WOCO)			.218 [.068]			.367* [.085]			.538*** [.188]
			(.236)			(.195)			(.189)
Share of VER (in industry, state, year)	.242 [.042]	6.58*** [2.08]		.286 [.049]	6.58*** [2.08]		.315 [.054]	6.59*** [2.08]	
	(.331)	(.331)		(.327)	(.331)		(.327)	(.331)	
Share of WOCO (in industry, state, year)	3.36*** [.577]	.571** [.180]		3.38*** [.582]	.597** [.189]		3.29*** [.567]	.575** [.181]	
	(.321)	(.255)		(.309)	.(253)		(.319)	(.256)	
Share of CBA (in industry, state, year)	-1.33*** [-.229]	-.179 [-.056]		-1.42*** [-.272]	-.204 [-.064]		-1.33*** [-.229]	-.179 [-.057]	
	(.358)	(.262)		(.355)	(.262)		(.350)	(.263)	
Log (Employees)	1.05*** [.181]	-.131 [-.041]	-.056 [-.017]	1.13*** [.194]	-.131 [-.042]	-.134 [-.032]	.972*** [.168]	-.131 [-.041]	.161 [.054]
	(.383)	(.138)	(.158)	(.378)	(.138)	(.142)	(.376)	(.139)	(.152)
Log (Employees squared)	-.020 [-.004]	.036*** [.004]	.024 [.007]	-.029 [-.005]	.013 [.004]	.022* [.005]	-.013 [-.002]	.013[.004]	.002 [.001]
	(.039)	(.013)	(.018)	(.039)	(.013)	(.013)	(.038)	(.013)	(.015)
Further training	.173 [.030]	.045 [.014]	.268*** [.085]	.175*** [.030]	.045 [.014]	.319*** [.068]	.210 [.036]	.045 [.014]	.170* [.057]
	(.164)	(.096)	(.093)	(.163)	(.096)	(.118)	(.161)	(.096)	(.102)
Collective bargaining	.939*** [.185]	-.074 [-.023]	-.025 [-.008]	.949*** [.187]	-.068 [-.021]	-.253** [-.057]	.945*** [.187]	-.075 [-.024]	-.043 [-.014]
	(.128)	(.107)	(.096)	(.127)	(.107)	(.102)	(.125)	(.107)	(.091)
Founded before 1990	-.058 [-.010]	-.053 [-.017]	-.019 [-.006]	-.054 [-.009]	-.055 [-.017]	.005 [.001]	-.040 [-.007]	-.053 [-.017]	-.032 [-.011]
	(.138)	(.100)	(.092)	(.135)	(.100)	(.092)	(.133)	(.100)	(.086)
Part of firm group	.734*** [.135]	.117 [.037]	-.041 [-.012]	.737*** [.135]	.116 [.037]	-.109 [-.025]	.717*** [.137]	.117 [.037]	-.046 [-.015]
	(.133)	(.102)	(.105)	(.129)	(.102)	(.100)	(.130)	(.102)	(.087)
Limited liability	.552** [.092]	-.021 [-.007]	.102 [.031]	.591** [.098]	-.019 [-.006]	.082 [.019]	.509** [.085]	-.021 [-.007]	.209 [.069]
	(.235)	(.147)	(.133)	(.231)	(.147)	(.149)	(.202)	(.148)	(.104)
High competition	.178** [.031]	-.080 [-.025]	.154** [.047]	.181** [.031]	-.081 [-.025]	-.035 [-.008]	.167** [.029]	-.080 [-.025]	.078 [.026]
	(.086)	(.067)	(.061)	(.084)	(.067)	(.068)	(.084)	(.067)	(.063)
Investments in ICT	.041 [.007]	.005 [.002]	.261*** [.081]	.059 [.010]	.006 [.002]	.100 [.023]	.048 [.008]	.005 [.002]	.129** [.043]
	(.087)	(.072)	(.069)	(.087)	(.072)	(.070)	(.088)	(.072)	(.061)
Share of female workers	-1.60*** [-.276]	-.126 [-.040]	.299 [.091]	-1.65*** [-.284]	-.129 [-.041]	.425 [.100]	-.158*** [-.273]	-.110 [-.040]	.468** [.157]
	(.331)	(.234)	(.224)	(.332)	(.232)	(.276)	(.320)	(.233)	(.207)
Share of fixed-term workers	-2.81*** [-.482]	-.154 [-.049]	-.006 [-.002]	-2.62*** [-.451]	-.146 [-.046]	-.030 [-.007]	-2.91*** [-.501]	-.340 [-.047]	.549* [.184]
	(.642)	(.367)	(.318)	(.683)	(.368)	(.396)	(.620)	(.367)	(.320)
Share of high-skilled workers	1.23*** [.212]	-.048 [-.030]	1.24*** [.451]	1.22*** [.210]	-.088 [-.028]	.936*** [.220]	1.18*** [.204]	-.091 [-.029]	.338 [.113]
	(.337)	(.213)	(.194)	(.333)	(.275)	(.251)	(.329)	(.279)	(.259)
Western Germany	-.338** [-.057]	-.480*** [-.149]	.186** [.057]	-.334** [-.056]	-.477*** [-.148]	.044 [.010]	-.347** [-.058]	-.480*** [-.159]	.150* [.050]
	(.165)	(.115)	(.094)	(.163)	(.114)	(.099)	(.161)	(.115)	(.091)
constant	-6.02***	.048	-.620	-6.21***	.052	-1.18***	-5.81***	.046	-2.05***
	(.949)	(.396)	(.406)	(.949)	(.395)	(.412)	(.946)	(.397)	(.412)
Industry fixed effects		✓			✓			✓	
Year fixed effects		✓			✓			✓	
$\rho_{13}, \rho_{12}, \rho_{23}$		-.021, -.053, -.238***			-.309***, -.139*, -.232***			-.371***, -.013, -.228***	
		(.136, .079, .066)			(.108, .082, .065)			(.104, .078, .065)	
LR test for $\rho_{21}, \rho_{31}, \rho_{32}= 0$		15715.2			14884.5			16745.8	
Number of replications		250			250			250	
Log likelihood		-1954.857			-1847.297			-2079.029	
Observations		7,404			7,404			7,404	

Notes: This tables shows re-weighted multivariate probit regressions using the matched samples and kernel weights as calculated in Equation (2.4) and (2.5) and shown in Section 2.5. the IAB Establishment Panel, own calculations for the years 2010 to 2018. Industry fixed effects include manufacturing as well as knowledge-intensive services according to NACE Rev. 2.0. . The correlation coefficient ρ measures the correlation in the error terms between employee representation equations and the outcome equation. Likelihood ratio (LR) test for joint significance of ρ is presented. Average marginal effects (AME) are presented in brackets; level of significance according to the estimated coefficient. Cluster-robust standard errors at the establishment level in parentheses. *, **, and *** denote statistical significance at the .1, .05 and .01 level.

Table 2.13: Selectivity adjusted results for weighted 2SLS

Innovation type (in $t+1$)	Incremental	Radical	Process	WOCO	VER
	(1)	(2)	(3)	(4)	(5)
Second Stage				**First Stage**	
Voluntary repr.(VER)	.112***	.095**	.120**		
	(.040)	(.040)	(.050)		
Works council (WOCO)	.031	.274***	.108		
	(.103)	(.106)	(.124)		
Log (Employees)	.074*	-.100**	.074	.222***	-.032
	(.038)	(.044)	(.054)	(.028)	(.046)
Log (Employees squared)	-.002	.010**	.000	-.008***	.003
	(.003)	(.004)	(.005)	(.003)	(.004)
Further training	.105***	.052***	.045	-.004	.005
	(.034)	(.022)	(.030)	(.020)	(.032)
Collective bargaining	-.005	-.109***	.009	.236***	-.024
	(.033)	(.035)	(.038)	(.030)	(.037)
Founded before 1990	-.010	.007	-.004	.002	-.012
	(.027)	(.025)	(.029)	(.025)	(.033)
Part of firm group	-.003	-.056*	-.003	.156***	.046
	(.029)	(.031)	(.035)	(.027)	(.033)
Limited liability firm	.021	.021	.053	-.013	-.013
	(.045)	(.032)	(.041)	(.028)	(.050)
High competition	.042**	-.017	.032	.043***	-.022
	(.018)	(.019)	(.022)	(.016)	(.022)
Investments in ICT	.085***	.020	.043**	.017	.005
	(.022)	(.017)	(.021)	(.016)	(.024)
Share of female	.067	.144*	.136*	-.263***	-.028
	(.074)	(.082)	(.078)	(.058)	(.078)
Share of fixed-term	-.000	.052	.183	-.236***	-.058
	(.093)	(.113)	(.112)	(.090)	(.119)
Share of high-skilled workers	.355***	.210***	.139	.232***	.019
	(.065)	(.077)	(.095)	(.064)	(.083)
Western Germany	.059**	.011	.048	-.062**	-.111***
	(.029)	(.026)	(.031)	(.030)	(.038)
Share of VER				.104*	1.52***
				(.056)	(.085)
Share of WOCO				.592***	.129*
				(.055)	(.077)
Share of CBA				-.234***	-.079
				(.067)	(.084)
Industry fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓
Instruments:	Share of VER Share of WOCO Share of CBA	Share of VER Share of WOCO Share of CBA	Share of VER Share of WOCO Share of CBA		
F-Test first stage	38.06	38.06	38.06		
Hansen J	.028	1.85	.394		
(p-value)	(.867)	(.173)	(.530)		
Observations	7,404	7,404	7,404	7,404	7,404

Notes: This tables shows re-weighted 2SLS regressions using the matched samples and kernel weights as calculated in Equation (2.4) and (2.5) and shown in Section 2.5. IAB Establishment Panel for the years 2010 to 2018. Industry fixed effects include manufacturing as well as knowledge-intensive services according to NACE Rev. 2.0. Cluster-robust standard errors at the establishment level in parentheses. *, **, and *** denote statistical significance at the .1, .05 and .01 level.

Table 2.14: Distribution of establishments by German federal states

Federal state	Observations	Share
Schleswig-Holstein	256	3.454
Hamburg	114	1.538
Lower Saxony	471	6.355
Bremen	247	3.333
North Rhine-Westphalia	749	10.107
Hesse	436	5.883
Rhineland-Palatinate	450	6.072
Baden-Wuerttemberg	771	10.403
Bavaria	661	8.919
Berlin	192	2.591
Brandenburg	398	5.370
Mecklenburg-West Pomerania	250	3.373
Saxony	1,006	13.574
Saxony-Anhalt	593	8.002
Thuringia	817	11.024
Total	7,411	100

Notes: IAB Establishment Panel, waves 2010 to 2018.

Table 2.15: Distribution of establishments by size categories

Size category	Observations	Share
5-19	682	9.203
20-49	1,464	19.754
50-199	2,824	38.106
200-499	1,558	21.023
500+	883	11.915
Total	7,411	100

Notes: IAB Establishment Panel, waves 2010 to 2018.

Table 2.16: Distribution of establishments by industries

Industry	NACE 2.0	Observations	Share
Manufacturing			
Food products	10	584	7.880
Beverages	11	60	0.810
Tobacco products	12		
Textiles	13	159	2.145
Wearing apparel	14	31	0.418
Leather and related products	15	20	0.270
Wood and of products of wood and cork, except furniture	16	200	2.699
Paper and paper products	17	150	2.024
Printing and reproduction of recorded media	18	108	1.457
Coke and refined petroleum products	19	27	0.364
Chemicals and chemical products	20	412	5.559
Basic pharmaceutical products and pharmaceutical preparations	21	50	0.675
Rubber and plastic products	22	515	6.949
Other non-metallic mineral products	23	390	5.262
Basic metals	24	424	5.721
Fabricated metal products, except machinery and equipment	25	803	10.835
Computer, electronic and optical products	26	356	4.804
Electrical equipment	27	329	4.439
Machinery and equipment n.e.c.	28	1,043	14.073
Motor vehicles, trailers and semi-trailers	29	395	5.330
Other transport equipment	30	89	1.201
Furniture	31	96	1.295
Other manufacturing	32	186	2.510
Repair and installation of machinery and equipment	33	144	1.943
Knowledge intensive business services			
Publishing activities	58	64	0.216
Motion picture, video, television, sound music	59		
Programming and broadcasting activities	60		
Telecommunications	61		
Computer programming, consultancy and related activities	62	129	1.741
Information service activities	63	13	0.175
Financial service activities, except insurance and pension funding	64	16	.216
Insurance, reinsurance and pension funding	65		
Activities auxiliary to financial services and insurance activities	66	31	.418
Legal and accounting activities	69	77	.1039
Activities of head offices; management consultancy activities	70	117	1.579
Architectural and engineering, technical testing and analysis	71	216	2.915
Scientific research and development	72	105	1.417
Advertising and market research	73	45	.607
Total	7,411		100

Notes: IAB Establishment Panel, waves 2010 to 2018. Manufacturing and knowledge-intensive services according to NACE Rev. 2.0. Because of the data protection legislation of the IAB Establishment Panel, statistics which are calculated for less than ten observations, have to be omitted from the results.

Chapter 3

Social exchange and dynamic effects of voluntary employee representation

Joint work with Kornelius Kraft[1]

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3.1 Introduction

Interest in the determinants of firm performance lies in its relevance for competitiveness, economic growth and also living standards of countries (e.g. Bartelsman & Doms 2000; Syverson 2011). Although there are various drivers of performance differences, the literature acknowledges labor productivity as the most important determinant (e.g. Griliches & Regev 1995; Oulton 1998). Differences in labor productivity arise, for example, through managerial practices or internal workflows of firms, but also via spillovers and competition among firms, to name just a few (e.g. Syverson 2011). Besides these, the accumulation of human capital and thus the quality of labor applied in the production process, is a fundamental driver of productivity (Black & Lynch 1996; Romer 1990). It is, however, well known that an effective application of human capital is subject to varying worker effort, which to a great extent explains productivity differences (e.g. Gibbons 1998; Prendergast 1999; Kube et al. 2012). This is rooted in the fact that a perfect alignment of interests between management and workers is rarely achieved. For example, discretionary power allows employees to take actions which are not in the interest of the employer. As a response, the management thus employs monitoring mechanisms to prevent shirking or invokes incentives as theoretically shown e.g. by application of the principal-agent theory (e.g. Holmstrom & Milgrom 1987). For the alignment of interests, the theory considers monetary but also non-monetary (e.g. Corgnet et al. 2018) factors as motivation measures to overcome the incentive problem, allowing firms to achieve productivity gains.

In this study, we add new evidence to the literature by focusing on less considered non-monetary management incentives (e.g. Bender et al. 2018; Corgnet et al. 2018) which challenges the view that workers exclusively rely on monetary incentives and thus extrinsic motivation (Bénabou & Tirole 2003; James 2005). In particular, we consider how the implementation of voluntary employee representation (VER), provided by the management, such as round table conferences or employee spokespersons, contributes to labor productivity within a dynamic setting. We think of these representation institutions as a form of voluntarily provided worker involvement scheme. Compared to statutory forms of non-union employee representation, voluntary institutions do not possess any co-determination rights granted by law. Compared to high-performance work practices such as job rotation or profit sharing, VERs are more institutionalized on the firm level. The German context with its dual system of industrial relations thus provides a unique setting since on the one hand the workforce has the right to vote for a non-union representation with strong co-determination rights. On the other hand, voluntary

employee representation implemented by the management may be launched in addition to or as an alternative to legal co-determination institutions. Moreover, it is shown within an industrial relations context, that the workforce to a great extent reciprocates management behavior (Bryson et al. 2006). Although the effects of employee involvement on labor productivity are generally expected to be positive, we also provide effect heterogeneity on two important factors. First, depending on the physical closeness of the worker management relationship, we show that a closer connection fosters social exchange (e.g. Cox & Deck 2005). Second, for voluntary representation to be effective, employees in a particular workplace should feel some kind of being 'underpaid' in terms of having a say (Jirjahn & Lange 2015; Jeworrek & Mertins 2019). This chapter thus provides evidence that the effects of voluntarily provided involvement also depend on the affection of employees. Positive effects are therefore more pronounced when the relationship between management and employees is not influenced by the existence of statutory employee representation institutions. Finally, we also find evidence for a lagged productivity effect of voluntary institutions where the effect does not occur in the introduction period but instead after some time (Kato 2006).

Prior literature so far has focused largely on monetary incentives for the alignment of interests such as, for example, profit sharing (e.g. Hambly et al. 2019; Kraft & Lang 2016; Kraft & Ugarković 2006; Fitzroy & Kraft 1987), employee stock options (e.g. Cappelli et al. 2020; Pendleton & Robinson 2010) or incentive pay (e.g. Dur et al. 2010; Bellemare & Shearer 2009; Lazear 2000). Less emphasis is put on non-monetary incentives such as workers' participation (Brown et al. 2011; Saridakis et al. 2017), or the voluntary involvement in decision-making, although voluntarily agreed cooperation is usually more powerful than an exogenous enforced agreement scheme (Budd et al. 2017; Kleiner & Bouillon 1991). Another possible obstacle to the effectiveness of monetary incentives is the crowding out effect of intrinsic worker motivation, in particular in creative work (Kvaløy et al. 2015; Amabile et al. 1986). Short-run monetary incentives can also be counterproductive in work environments with high uncertainty regarding the outcome of activities like in R&D departments (Manso 2011).

We draw on the social exchange theory (e.g. Englmaier & Leider 2020; Ashraf & Bandiera 2018; Dur et al. 2010; Cropanzano & Mitchell 2005) and provide a simple theoretical utility model in which workers reciprocate management's voluntary introduction of employee representation with higher effort. This is known as the 'gift of reciprocity' where workers positively reciprocate to gifts (e.g. treating the workforce kindly) by exerting higher effort (Kube et al. 2012; Akerlof 1982). In our case, the gift however, is not monetary but rather non-monetary in the form

of expanding workers' discretionary power by providing voluntary involvement.

The empirical analysis is based on the IAB Establishment Panel, which is provided by the Institute of Employment Research, located in Nuremberg, Germany. This rich panel data set is a representative survey of German firms employing at least one employee covered by social insurance from all sectors in the economy. For this investigation, establishments are especially well suited since they are the smallest unit of investigation where variation in management practices and quality are most significant. The panel data set further allows us to investigate voluntary institutions over a long period of time, in particular their introduction and dissolution. For the analysis, we consider the years 2009 to 2016 and focus on establishments within a profit maximizing framework using a common measure of labor productivity (Peutere et al. 2020; Audretsch & Belitski 2020; Bertschek & Kaiser 2004). The final sample consists of $43,426$ establishment-year observations in which one quarter of these observations belong to the treatment group (i.e. establishments that introduce voluntary institutions at least at one point in their observation window).

Using a dynamic difference-in-differences framework, we compare VER introducing establishments to non-introducing establishments. Within our study design, a very likely source of selection bias arises since the introduction of voluntary institutions is not random. Firms might differ, among other things, with respect to managerial quality, internal structures and workforce characteristics which are also related to productivity and the incidence of voluntary institutions. Assuming that VERs are randomly assigned among establishments and thus ignoring potential confounding, would possibly lead to biased estimates. To consider this selection bias we augment the regression framework with matching methods. In particular we use an inverse-probability weighting approach (Busso et al. 2014; Imbens & Wooldridge 2009) to estimate the dynamic effect of voluntary institutions on productivity. We therefore reweight the non-VER introducing establishments to match the firm and workforce characteristics of the VER introducer as closely as possible.

The remainder of this chapter is organized as follows. Section 3.2 provides a brief outline of the related literature in the field of social exchange and labor productivity. Section 3.3 provides the mechanism where voluntary employee representation is associated with an increase in effort and organizational performance. In particular, we provide a simple theoretical model linking reciprocity to higher effort. Section 3.4 discusses the empirical evidence and in Section 3.5 this chapter draws a conclusion in which policy implications are discussed.

3.2 Related literature

Monetary and non-monetary incentives. Employee participation and involvement is an highly important topic, in particular in modern workplaces. For example, about 40 % of British workplaces use monetary incentive systems (Pendleton & Robinson 2017). Frequently investigated, in particular based on the principle-agent theory (e.g. Holmstrom & Milgrom 1987), were profit sharing schemes (i.e. Hambly et al. 2019; Kraft & Lang 2016; Kraft & Ugarković 2006; Fitzroy & Kraft 1987) or employee stock ownership plans (i.e. Cappelli et al. 2020; Pendleton & Robinson 2010). By using monetary inventive, managers provide incentives to stimulate employee behavior in positive ways and try to induce higher levels of effort.

The dominant focus on monetary incentives within the principle-agent framework compared to non-monetary incentives, however, is somewhat surprising since cash rewards might crowd out intrinsic worker motivation, in particular in creative work (Corgnet et al. 2018; Amabile et al. 1986). Behavioral economists (e.g. Frey & Jegen 2001; Bénabou & Tirole 2003) had challenged the narrative that workers exclusively rely on monetary incentives and thus extrinsic motivation for quite some time. The literature shows, for example, that non-monetary incentives are also related to different measures of employee well-being such as satisfaction or commitment (Baard et al. 2004). This strand of literature, for example, considers status incentives (Charness et al. 2014), social recognition such as 'employee of the month' awards (Kosfeld & Neckermann 2011), autonomy (Falk & Kosfeld 2006), trust (Dickinson & Villeval 2008), goal setting (Corgnet et al. 2015) and also the provision of 'meaning' in the job (e.g. Cassar & Meier 2018). There are also studies at the intersection between monetary and non-monetary measures, in which the combination of these incentives is empirically analyzed (Kato & Morishima 2002) and theoretically implemented in the principle-agent theory (Corgnet et al. 2018).

Labor-management relations and productivity. Voluntary employee representation are also relevant in the labor-management relations literature. For example, there is evidence of non-monetary incentives such as management practices fostering involvement and participation of employees (e.g. Huselid 1995; Ichniowski et al. 1997; Kato 2006; Birdi et al. 2008; Bloom et al. 2015; Bender et al. 2018; Chang & Kang 2019). In general, the evidence from these studies show that better management practices lead to an increase in organizational performance. Moreover, empowerment of workers via direct voice does not only increase productivity but also job satisfaction (e.g. van der Meer 2019) and employee well-being in general (Böckerman & Ilmakunnas 2012).

Regarding formalized, statutory representation institutions, the literature provides evidence on productivity effects from labor unions (e.g. Barth et al. 2020; Doucouliagos & Laroche 2003; Addison & Hirsch 1989; Brown & Medoff 1978) and German works councils (e.g. Mueller & Stegmaier 2017; Jirjahn & Mueller 2014; Mueller 2012; Addison et al. 2001). One study in the context of reciprocity and employee representation institutions is in particular Jirjahn & Lange (2015) who find that workers with positive reciprocal inclinations might sort away from co-determined firms. Workers with these reciprocal characteristics are therefore more prone to work in firms with no formal employee representation. Regarding alternative or voluntary institutions there is evidence on determinants of introduction (Hauser-Ditz et al. 2013), the relationship to works councils (Jirjahn et al. 2021; Oberfichtner & Schnabel 2019; Ertelt et al. 2017) and effects on firm performance using cross-sectional data (Stettes 2010).

Besides empirical evidence on non-monetary incentives in a broad context and studies in the field of labor-management relations and productivity, there is to our knowledge no study at this specific intersection, in particular with a focus on the social exchange theory. Therefore, our empirical investigation links the literature strands on non-monetary incentives and labor-management relations.

3.3 Voluntary employee voice and social exchange

In this chapter, we draw from the social exchange theory for the understanding of workplace incentives (e.g. Cropanzano & Mitchell 2005; Bellemare & Shearer 2009; Akerlof 1982; DellaVigna 2009). Important strands of this theory, especially for employee-management relationships, are grounded in the social psychology (e.g. Gouldner 1960) as well as sociology literature (e.g. Blau 1964). Generally speaking and in difference to the concept of altruism[2], social exchange generates interactions between the management and the workforce which entails obligations (Cropanzano & Mitchell 2005). These obligations generate incentives in the workplace 'to give something back' (e.g. Konovsky & Pugh 1994; Tepper & Taylor 2003; Englmaier & Leider 2020), reduce discretionary actions and motivates workers to go beyond the expected job role.

These incentives are often provided by monetary means (e.g. Dur et al. 2010; Akerlof 1982) and are considered in the principle agent framework (e.g. Holmstrom & Milgrom 1987). We consider the non-monetary incentive (e.g. Corgnet et al. 2018) of voluntary employee involvement provided by the management, which in

[2]Altruism, for example, is a form of unconditional kindness in which an employee does not have to receive kindness in the first place (e.g. Fehr & Gächter 2000).

particular fosters trust and commitment between management and workers. Involvement and participation discards anxieties about a potential job loss, which would otherwise prevent employees from sharing private information. Afterwards, long-term commitment and trust enables employees to invest more in human capital or integrate their knowledge in the production process (e.g. Wilkinson et al. 2014). Another advantage of non-monetary incentives is that monetary rewards can crowd out intrinsic worker motivation, in particular in creative work (e.g. Corgnet et al. 2018; Amabile et al. 1986).

3.3.1 Trust and commitment

Voluntary employee representation affects organizational performance through the channels of trust and commitment (Gritti & Leoni 2012). The management signals that personal needs of employees (i.e. job autonomy, involvement in decision-making, efficient communication) are taken into account and that the establishment is interested in long-term relationships. The voluntarily provision of employee voice in the form of employee spokespersons or round table conferences thus acts as a strong signal from the management. This feeling ob being cared of by an employer makes the employees more likely to reciprocate such behavior due to implicit moral obligations (Gouldner 1960; Flynn 2003). Thus, a self-enforcing relationship between management and the workforce is created (Dodlova & Yudkevich 2009). Such intrinsic motivated relationships are characterized with trust and respect and foster reciprocity (Carnevale et al. 2017). Types of such reciprocity might be enhanced cooperation and extra effort that go beyond the duty. Because of the efficient communication channel, employees are more likely to speak up to supervisors or managers, they often have contact to, and therefore build up high-quality relationships. Workers are more inclined to share knowledge and to foster cooperation with supervisors and co-workers (Jones et al. 2017; Brandes et al. 2004; Kleiner & Bouillon 1991). Employees then reciprocate trust, cooperation and good workplace climate by an increase in effort and information sharing (Carmichael & MacLeod 1997; Regts et al. 2019). Finally, there is an increase in innovation, productivity as well as commitment (e.g. Eisenberger et al. 1990).

Equally important in the relationship between management and the workforce is commitment (e.g. Cropanzano & Mitchell 2005; Brown et al. 2011). Commitment implies the emotional attachment of workers to the organization which is often associated with lower turnover and absenteeism and also higher worker performance (e.g. Meyer & Allen 1991). Reciprocity in this context may imply that employees would turn down outside job offers in favor of their current job which leads to the retention of important human capital (Eisenberger et al. 1990). There should

be less resistance to employer initiated changes as well as less resistance to new technologies which, in turn, should increase labor productivity. Especially this form of commitment might be important for effects stemming from the introduction of voluntary involvement. Another positive channel might be, that workers reciprocate the transfer of responsibility in which workers positively respond to an increase in choice autonomy and control (Charness et al. 2012).

3.3.2 Model of reciprocity and effort

In this section, we provide a formal model of motivation and reciprocity by providing non-monetary incentives in the form of voluntary involvement. The model is a simplified and slightly adjusted model of Englmaier & Leider (2020, 2012). Building on these models, we additionally consider utility from non-monetary benefits.

We follow Englmaier & Leider (2020) and consider a risk neutral management, which maximizes expected returns, in addition to risk averse workers. The workers, who reciprocate good (or generous) working contracts, exert some effort in the workplace $\alpha \geq 0$ with costs of this effort defined as $c(\alpha)$. The model additionally assumes that there are no fixed costs of effort and that the costs of effort increase with an increasing rate.[3] In case the workers exert effort, this creates positive value for the management in terms of expected returns $ER(\alpha)$, however with a decreasing rate.[4] This expected profits have some monetary output market value M. Therefore, managers monetary return from workers effort α is $M \times ER(\alpha)$.

There is an (incomplete) contract between management and workers which defines payment (w) as well as requests on effort ($\hat{\alpha}$). We further add non-monetary workplace conditions such as involvement and participation schemes as an additional characteristics of the employment contract in the model using the parameter γ. Workers gain utility from good workplace conditions (monetary as well as non-monetary) which they reciprocate with an parameter $\eta \in [0, +\infty]$.[5] Good workplace conditions are associated with positive benefits compared to the outside option ($\bar{u}$) of the worker (i.e. another job or unemployment). In this view, good workplaces might provide different wages compared to other job offers or more positive working environments because of involvement practices which for example provide (valuable) voice options.

The elements above define the workers' utility function which capture the idea of reciprocal motivation on monetary terms (e.g. Englmaier & Leider 2020) as well

[3] i.e. $c'(0) = 0$, $c'(\alpha) > 0$ as well as $c''(\alpha) > 0$.

[4] i.e. $ER'(\alpha > 0)$ and $ER''(\alpha \leq 0)$.

[5] See Jirjahn & Lange (2015) who use the German Socio-Economic Panel (GSOEP) to measure the degree of reciprocity.

as non-monetary benefits. Employees only choose the level of effort α they exert. The utility function depends on the wage ($\tilde{w}$) according to the wage contract, the requested effort ($\hat{\alpha}$) as well as the actual effort (α) and the non-monetary workplace conditions (γ):

$$U(\tilde{w}, \alpha, \hat{\alpha}, \gamma) = u(\tilde{w}, \gamma) - c(\alpha) + \eta \left[u(\tilde{w}, \gamma) - c(\hat{\alpha}) - \bar{u}\right] \times M \times (ER(\alpha) - \tilde{w} - \gamma) \tag{3.1}$$

As shown, in the first part of the utility function, the workers gain utility from monetary as well as non-monetary workplace conditions minus the costs of effort they exert. In the second part of the utility function workers gain utility from reciprocity. Consider a good workplace in which the difference between the utility, effort and outside option is positive (i.e. $\eta[u(\tilde{w}, \gamma) - c(\hat{\alpha}) - \bar{u}] > 0$). In this case, worker reciprocate with intensity η the positive difference times the utility from managers profit which is the market value M times the expected profit $ER(\alpha)$ minus the costs for wages and the provision of workplace involvement measures. In terms of reciprocity, a worker is therefore more prone to work harder, when the impact on managers surplus is stronger (e.g. Englmaier & Leider 2020).

We first show the result from Englmaier & Leider (2020) for monetary incentives, but also that the effort of workers increase with non-monetary benefits. First, the optimal level of effort (α^*) is given by:

$$\frac{\partial U(\tilde{w}, \alpha, \hat{\alpha}, \gamma)}{\partial \alpha} = -c'(\alpha^*) + \eta \left[u(\tilde{w}, \gamma) - c(\hat{\alpha}) - \bar{u}\right] \times M \times (ER'(\alpha^*)) \tag{3.2}$$

Calculating second derivatives from Equation (3.2) reveal that the optimal level of effort (α^*) increases in (i) with wage as shown in Equation (3.3), $\tilde{w}$ but also in (ii) non-monetary benefits such as employee involvement, participation and representationγ as shown in Equation (3.4):

$$\frac{\partial^2 U(\tilde{w}, \alpha, \hat{\alpha}, \gamma)}{\partial \alpha \partial \tilde{w}} = \eta \times u'(\tilde{w}, \gamma) \times M \times ER''(\alpha^*) > 0 \tag{3.3}$$

$$\frac{\partial^2 U(\tilde{w}, \alpha, \hat{\alpha}, \gamma)}{\partial \alpha \partial \gamma} = \eta \times u'(\tilde{w}, \gamma) \times M \times ER''(\alpha^*) > 0 \tag{3.4}$$

Therefore, the adapted (and slightly refined) model from Englmaier & Leider (2020) predicts that the effort of workers increase which wage ($\tilde{w}$). This results might come without surprise and as shown, the incentive in this case arises from

reciprocity which is theoretically modeled.[6] Even more interesting, however, is that the model also predicts a positive effect on worker's effort stemming from non-monetary incentives such as participation in decision-making, involvement or voluntary representation institutions.

3.4 Empirical evidence

3.4.1 Data description

The empirical analysis in this chapter is based on the IAB Establishment Panel, which is provided by the Institute of Employment Research.[7] The panel is a representative survey of German firms employing at least one employee covered by social insurance from all sectors in the German economy. The dis-aggregated and comprehensive panel data set allows us to investigate voluntary institutions over time, in particular their introduction and dissolution. Starting in 1993 with an annual survey for western German firms and 1996 for eastern Germany, the panel now contains more than 16,000 observations per year. This is about 1 % of all firms and about 7 % of all employees in Germany. Furthermore, the IAB Establishment Panel provides considerably detailed information on various firm specific variables such as value added, investment activities, composition of the workforce as well as annual wages. Data access is gained through controlled remote data access via the research data center (FDZ) of the IAB.

For the analysis we consider the waves 2009 to 2016 of the IAB Establishment Panel which cover all industries. Moreover, we focus on establishments which consider their business volume to be sales (rather than total assets, budget volume or total premium paid). In doing so we focus one establishments within a profit maximizing environment. The primary interest lies in the analysis of establishments which introduce voluntary representation as a non-monetary incentive between t and $t-1$ within our observation window of the year 2009 and 2016. We consider establishments which switch their status of having a voluntary institution (i.e. establishments which implement such a committee) as the treatment group. We compare this group to the control group which do not introduce voluntary representation at all. Because of the comprehensive panel design we are able to estimate dynamic introduction effect as well as long term effects over time. We

[6] Empirical studies in this case consider for instance profit sharing (e.g. Hambly et al. 2019; Kraft & Ugarković 2006; Fitzroy & Kraft 1987), employee stock ownership plans (e.g. Cappelli et al. 2020; Pendleton & Robinson 2010) or incentive pay (e.g. Dur et al. 2010; Bellemare & Shearer 2009; Lazear 2000) which empirically support the theoretical hypotheses.

[7] See for a detailed discussion regarding the sampling methodology and comparisons to administrative data Fischer et al. (2009); Ellguth et al. (2014); Bossler et al. (2018).

consider labor productivity as the dependent variable, which we measure as the logarithm of sales divided by the number of employees.[8]

Regarding establishment control variables, we consider the log of employees to adjust for size effects. We also include an indicator variable which takes unit value whether the establishment is part of a firm group and zero otherwise. Being part of a firm group might on the one hand affect the probability to implement voluntary representations and on the other hand might affect productivity because of synergy effects with the main office. We include the variable 'limited liability' if the establishment has the legal form of a limited liability company and zero otherwise. As usual in the literature, we add export intensity measured by the percentage of export sales to total sales (e.g. Doraszelski & Jaumandreu 2013). The variable can also be interpreted as a measure of globalization. As a measure for the production technology we include the rating of the technological equipment rated on a 5-point Likert scale. In this scale, the category 'very good' is the reference category in the regression results. To adjust for any effects stemming from other forms of co-determination such as works council or collective bargaining agreements, we include an indicator variable which takes unit value whether such an institution is present in the workplace and zero otherwise. Regarding the composition of the workforce, several shares of employment groups are included to adjust for confounding effects. We include the share of high-skilled employees, the share of part-time as well as apprentices and finally the share of female workers in relation to the employment level.

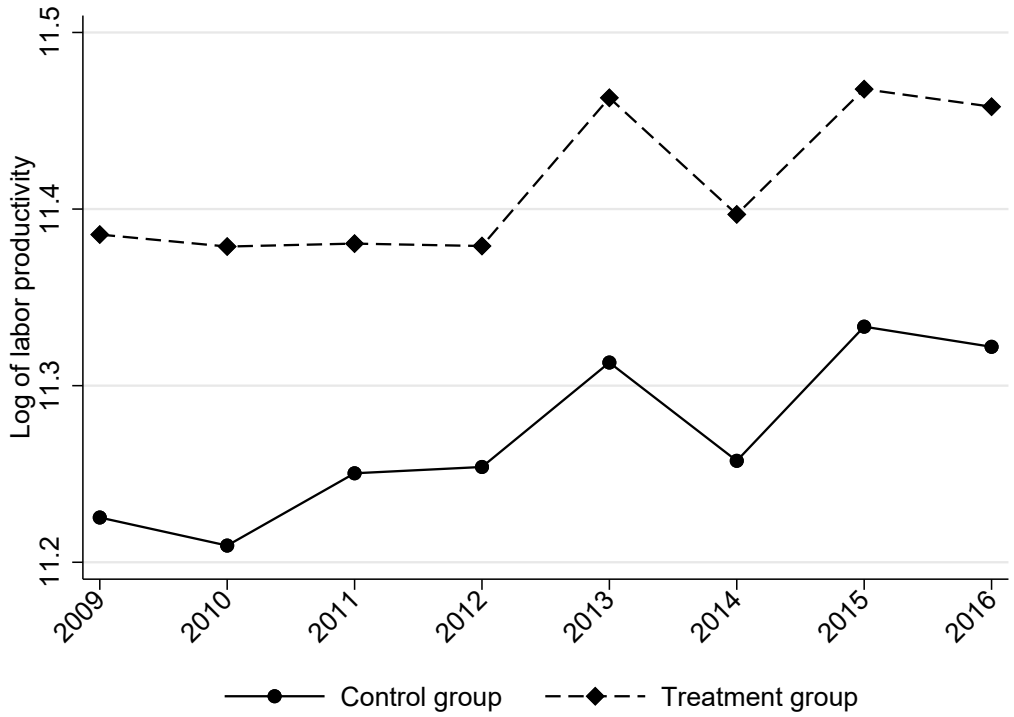
[8]See for a similar application, for example, Peutere et al. (2020); Audretsch & Belitski (2020); Mueller & Stegmaier (2017).

Table 3.1: Descriptive statistics and differences between treatment and control group

	Treatment group				Control group				Difference
	Mean	SD	Min	Max	Mean	SD	Min	Max	(1)-(5)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent variable									
Log labor productivity	11.41	.943	7.60	16.28	11.26	.956	3.82	16.60	0.145***
Establishment controls									
Log (Employees)	3.44	1.48	0	10.77	3.00	1.62	0	9.96	0.439***
Part of firm group	.156	.362	0	1	.104	.305	0	1	0.052***
Limited liability	.650	.477	0	1	.559	.497	0	1	0.091***
Collective agreement	.382	.456	0	1	.276	.447	0	1	0.106***
Works council	.241	.428	0	1	.210	.407	0	1	0.031***
Exports (in % of sales)	.082	.191	0	1	.073	.182	0	1	0.008***
Stand of technology	2.15	.784	1	5	2.25	.760	1	5	-0.096***
Western Germany	.757	.429	0	1	.559	.497	0	1	0.093***
Workforce controls									
Share of high-skilled workers	.078	.155	0	1	.068	.145	0	1	0.010***
Share of part-time workers	.284	.252	.001	1	.300	.253	.001	1	-0.016***
Share of apprentices	.046	.073	0	.940	.038	.071	0	1	0.008***
Share of female workers	.429	.299	0	1	.423	.295	0	1	0.006
Observations	10,082				33,344				

Notes: IAB Establishment Panel, waves 2009–2016. The treatment group introduces voluntary employee representation between t and $t-1$ within the observation window of our sample. The control group does never introduce voluntary institutions. Furthermore, groups are defined as outlined in Section 3.4. Column (9) displays the differences in mean values between treatment and control group. The dependent variable is calculated as the log labor productivity which is measured as $log\left(\frac{sales}{N}\right)$. Significance: *, **, *** significant at the 10%, 5%, 1% level.

Figure 3.1: Trends in labor productivity over time



Notes: IAB Establishment Panel, waves 2009–2016, unweighted means. The figure shows the trends in log labor productivity measured as $log\left(\frac{sales}{N}\right)$ among the treatment and control group. The treatment group implements voluntary employee representation between t and $t-1$ within the observation window of the sample. The control group does never introduce voluntary institutions. Furthermore, groups are defined as outlined in Section 3.4.

For the analysis we have information on $N = 43,426$ establishment-year records. In this sample, $N = 1,751$, which are $4.03\,\%$ introduce a voluntary institution at one point in time. We then consider an establishment, that at least once introduce a voluntary institution, to be in the treatment group, for which we have $N = 10,082$ establishment-year records. $N = 33,344$ establishment-year records are considered to be in the control group since they never implement voluntary representation between t and $t-1$ in the sample period. Descriptive statistics between the treatment and control group are provided in Table 3.1. The trends in labor productivity over time among these groups is presented in Figure 3.1.

3.4.2 Econometric approach

To investigate the impact of introducing voluntary employee representation in the workplace, we estimate the following specification by using ordinary least squares (OLS) including establishment fixed effects. Establishment-specific effects are especially important to separate VER effects from (time-invariant) management ef-

fects (e.g. Kato & Morishima 2002).[9]

$$y_{it} = \alpha + \sum_{k} \gamma_k D_{ik} + \beta X_{it} + \phi_i + \mu_i + \varepsilon_{it} \tag{3.5}$$

In Equation (3.5), $y_{it} = log\left(\frac{sales}{N}\right)_{it}$ is the logarithm of labor productivity which is calculated as the ratio of sales to the total number of employees for establishment i in year t.[10] Moreover, ϕ_i are industry fixed effects, μ_i establishment fixed effects and ε_{it} is the idiosyncratic error term. To measure the effects of VER introduction, D_{ik} is an indicator variable taking the value one when establishment i implements and constantly reports having a voluntary institutions in all $k \geq t$ periods. Thus, γ_k is the difference-in-differences coefficient which measures the change in labor productivity after establishments i implements voluntary institutions compared to the control group, which never implements or has a VER. We therefore take into account that establishments implement voluntary representation at different points in time and thus, the treatment periods are time varying.[11]

3.4.3 Baseline results

First we test for the effects of the introduction of voluntary employee representation on our measure of labor productivity. Results from estimating Equation (3.5) are presented in Table 3.2. Using the fixed effects regression model allows us to control for time-invariant management quality. On the one hand, management quality may affect the choice of HR practices and on the other hand it clearly affects organizational performance.

What becomes evident in Table 3.2 is that the introduction of voluntary representation institutions does not have an effect on labor productivity, despite adjusting for selection effects. The post introduction effects, however, are significant at least at the 5 percent level indicating that after the introduction, labor productivity is raised by roughly 8 to 12 %. Within the estimation we adjust for a variety of control variables as outlined in Table 3.1 as well as fixed effects.[12] The coefficients are also selectivity adjusted. In the next step we want to estimate the post treatment effects in more detail and thus, we estimate Equation (3.5) including every post indicator variable in the specification. As shown in Table 3.2, the intro-

[9] A similar approach is provided by Power (1998).

[10] See for a similar productivity measure, for example, Peutere et al. (2020); Audretsch & Belitski (2020) as well as Bertschek & Kaiser (2004).

[11] See for a similar approach in a different context for example Stevenson & Wolfers (2006).

[12] In case we remove the industry and federal state fixed effects among the baseline and robustness specifications, the results still remain robust in terms of significance and the magnitude of the effect.

Table 3.2: Baseline fixed effects models for the effects on labor productivity

	Log labor productivity	
	Fixed Effects Model (1)	Fixed Effects Model (2)
VER Introduction	0.008	0.009
	(0.008)	(0.008)
VER Post Introduction	0.033***	
	(0.011)	
Post Introduction $t+0$		0.018
		(0.012)
Post Introduction $t+1$		0.051***
		(0.016)
Post Introduction $t+2$		0.048*
		(0.025)
Post Introduction $t+3$		0.088***
		(0.029)
Post Introduction $t+4$		0.063*
		(0.037)
Post Introduction $t+5$		0.109**
		(0.047)
Post Introduction $t+6$		0.128**
		(0.063)
Post Introduction $t+7$		0.223***
		(0.077)
Control variables	✓	✓
Establishment FE	✓	✓
Industry FE	✓	✓
Federal state FE	✓	✓
Observations	43,426	43,426

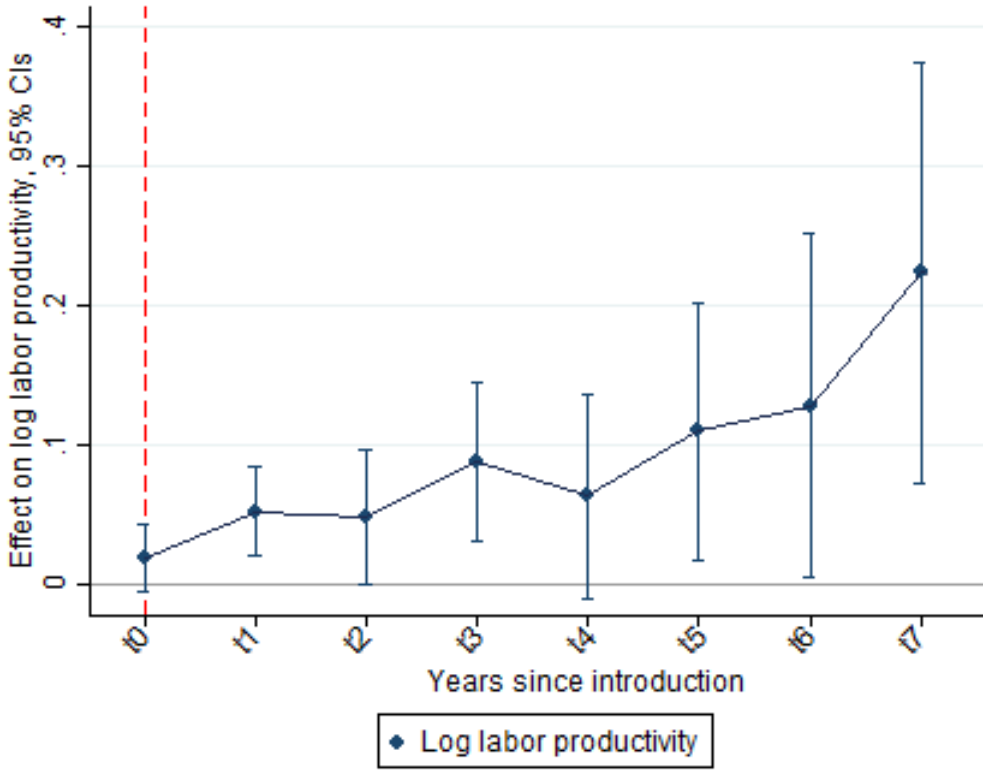
Notes: The tables shows estimation results from Equation (3.5). The post introduction period is pooled over all years per establishment in which the voluntary institution is present after its introduction. Fixed effects specifications include establishment, industry as well as federal state fixed effects. IAB Establishment Panel, waves 2009–2016. Log labor productivity is measured as $log\left(\frac{sales}{N}\right)$ between the treatment and control group. The treatment group introduces voluntary employee representation between t and $t-1$ within the observation window of our sample. The control group does never introduce voluntary institutions. Control variables are included as outlined in Section 3.4.1. Results including control variables are presented in Table 3.12 in the Appendix. Significance: *, **, *** significant at the 10%, 5%, 1% level.

duction of voluntary employee representation is still insignificant indicating that there are no introduction effects on labor productivity.[13] Still, this remains quite plausible as a new committee on the workplace level needs time to adjust until it might productively work. Especially in line with the theory outlined in Section 3.2, the building of trust and commitment needs some time to foster reciprocal relationships. Then, roughly two to five years after introduction, there are signifi-

[13]In case we remove the industry and federal state fixed effects among the baseline and robustness specifications, the results still remain robust in terms of significance and the magnitude of the effect.

cant effects on labor productivity at least at the 10 % level. The same effects are present when we split the sample to either works councils establishments (i.e. they have a statutory employee representation institution present which might alter the effects of voluntary institutions), or no works councils establishments. Figure 3.2 displays the results from the baseline estimation of Equation (3.5) and shows the point estimates as well as 95 % confidence intervals.

Figure 3.2: Impact of voluntary employee representation introduction over time



Notes: IAB Establishment Panel, waves 2009–2016. The figure shows point estimates obtained from estimating Equation (3.5). Results are adjusted to take selection effects into account by weighting with inverse probability weights (IPW). Fixed effects specifications include establishment, industry as well as federal state fixed effects. Log labor productivity is measured as $log\left(\frac{sales}{N}\right)$ between the treatment and control group. The treatment group introduces voluntary employee representation between t and $t-1$ within the observation window of our sample. The control group does never introduce voluntary institutions. Furthermore, groups are defined as outlined in Section 3.4. Control variables are included as outlined in Section 3.4.1. Error bars represent 95 percent confidence intervals from establishment clustered standard errors.

3.4.4 Inverse probability weighting

The major concern in observational studies is the endogeneity of the treatment. It is reasonable to assume that firms establishing voluntary participation measures might substantially differ in terms of their observable characteristics compared to firms which never establish such management practices. The issue of selectivity

is present if these characteristics are systematically related to firm productivity. Although we take unobserved time-invariant effects into account, simple comparisons between both groups of firms would lead to biased estimates. We therefore estimate fixed effects models of Equation (3.5) which are re-weighted using the inverse of the propensity score to account for selection effects. In the following we therefore describe how we estimate the average treatment effect on the treated (ATT) using an inverse probability weighing (IPW) technique. Since IPW is based on the propensity score, we therefore use a variant of propensity score weighting which creates a pseudo-population in which the VER introduction is independent of confounding establishment characteristics. To do so, we assign each establishment a weight which is proportional to the inverse of the propensity score in the sample (e.g. Imbens & Wooldridge 2009).

Average treatment effect on the treated (ATT). The selection of observables strategy in this section is used to identify the treatment effect on the treated (ATT), which is the effect of the introduction of voluntary employee representation on labor productivity. The implementation of the IPW estimator relies on several steps. First, we calculate the propensity score for the VER introduction and non introduction status. Therefore, we calculate the propensity score conditional on confounding variables. The calculation and comparison of establishment within each years prevents the matching of establishments which are closely related to each other in terms of the propensity score, however, are observed in different points in time.

When calculating the ATT, the idea of the IPW estimator is to re-weight just the observations from the untreated group to create a counterfactual pseudo-population (Imbens 2004). Moreover, it is shown that the IPW estimator outperforms nearest-neighbor as well as local-linear matching estimators (Busso et al. 2014). The IPW estimator for the average treatment effect on the treated is then the difference between the average labor productivity of the treated and the re-weighted labor productivity of the control group:

$$\tau^{IPW} = \left[\frac{1}{N^1}\sum_{i\in I^1} Y_i\right] - \left[\sum_{i\in I^0} \frac{Y_i \hat{P}(W_i)}{1-\hat{P}(W_i)}\right] \tag{3.6}$$

where $\hat{P}(W_i)$ ist the estimated propensity score. We therefore apply the following weights to the sample which are used to calculate the ATT (Imbens 2004). Since we only re-weight the control group (c), we just define the weight for the treatment

group (t) as $\psi_i^t = 1$, if VER existence= 1 and

$$\psi_i^c = \frac{\hat{P}(W_i)}{1 - \hat{P}(W_i)} \tag{3.7}$$

if VER existence = 0.[14] Thus, weighting by these terms creates a pseudo-population in which we want the distributions of control variables among the treated and control group to be as similar as possible. Moreover, the IPW approach has some methodological advantages such that we do not rely on choosing values of bandwidth parameters for example (e.g. Campolieti 2018).

Covariate balancing. Second, we check whether treatment and control observations are indeed balanced. We therefore compare the means of the control variables before and after the weighting procedure for the treatment and control group. As becomes evident from Table 3.3, variables were unbalanced before matching and establishment are quite heterogeneous in terms of their observables.

Table 3.3: Differences and t-tests on mean of variables before and after matching

Variables	**Before Matching**			**After Matching**		
	Treated (1)	Controls (2)	t-Test (3)	Treated (4)	Controls (5)	t-Test (6)
Log (Employees)	3.44	2.99	.000	3.43	3.25	.136
Share of part-term	.284	.300	.000	.303	.327	.240
Share of female	.429	.423	.059	.416	.397	.423
Share of apprentices	.046	.038	.000	.042	.031	.026
Share of high-skilled	.077	.068	.000	.091	.079	.370
Part of firm group	.156	.104	.000	.151	.137	.629
Limited liability	.650	.557	.000	.657	.612	.235
Collective bargaining	.382	.276	.000	.352	.310	.260
Works council	.241	.210	.000	.228	.228	.999
Share export on sales	.082	.073	.000	.090	.091	.921
State-of-the-art tech	.204	.150	.000	.169	.169	.994

Notes: IAB Establishment Panel, years 2009–2016. We use a sample of 43,426 observations from which $N = 33,344$ establishments are considered as untreated and do not implement a voluntary institutions and $N = 10,082$ report to at least one introduce a VER. Weighted means are calculated using Equation (3.6).The p-values of the corresponding t-tests on differences between treated and control variables are shown in column (3) and (6).

After the IPW weighting, however, as shown in Table 3.3, column (6), control variables are quite balanced. We apply t-tests for the comparisons of these characteristics and besides the share of apprentices, all variables are balanced. Thus, we interpret the IPW as successful and proceed now with the weighted regressions.

[14] See for a similar approach in estimating the average treatment effect of labor unions on wages, for example, Campolieti (2018).

IPW estimates for VER introduction. Our IPW approach mitigates confounding effects of observables variables. In using fixed effects models, we additionally adjust for time-invariant unobserved factors such as for example management quality. As shown in Table 3.4, the results are comparable to the results of the baseline fixed effects models in which we do not re-weight the control group. What we consistently find in all specifications, is that the effect of VER introduction is only discernible in the post introduction periods. The size of the point estimates are also slightly smaller compared to the baseline results. These findings, are also well consistent with the literature in which these effects are explained, for example, by learning effects of such an institution (e.g. Mueller & Stegmaier 2017) or with the limited nature and scope of such an institution in its introduction period (e.g. Kato 2006).

3.4.5 Heterogeneity and channels

Differences in works council status. The relationship between voluntary and statutory representation in the form of works councils is, theoretically as well as empirically, still up to debate (Jirjahn et al. 2021; Oberfichtner & Schnabel 2019). On the one hand, the management might implement voluntary forms of employee representation for communication purposes which might be less controversial than negotiations with works councils. The management might also apply some kind of works council avoidance or suppression strategy by using alternative forms (Jirjahn & Mohrenweiser 2016). On the other hand, both types of representation might also have an complementary relationship in which they are used for different purposes (Jirjahn et al. 2021). Effects of voluntary representation may thus well depend on works council presence.

There are actually three narratives which can explain effect heterogeneity among those institutions. First, there is worker sorting in which more positive effects on labor productivity in non-works council establishments can be explained quite well by channels provided by Jirjahn & Lange (2015). They argue that employees with strong reciprocal inclinations sort away from establishments with works councils. The reason is that employees prefer more direct behavior, interaction and feedback from the management which is provided on a more personal basis using voluntary, more establishment tailored representation institutions. In this case, the management provides a more intrinsic willingness to cooperate with the workforce (Jirjahn & Lange 2015).

Second, the gift of voluntary involvement is only perceived as such when workers feel being kind of 'underpaid' in having a say (e.g. Jeworrek & Mertins 2019). The voluntarily provided institutions should therefore have a more pronounced effect

Table 3.4: IPW fixed effects models for the effects on labor productivity

	Log labor productivity	
	IPW Fixed Effects Model (1)	IPW Fixed Effects Model (2)
VER Introduction	-0.004	-0.004
	(0.009)	(0.009)
VER Post Introduction	0.031**	
	(0.015)	
Post Introduction $t+1$		0.012
		(0.015)
Post Introduction $t+2$		0.045*
		(0.023)
Post Introduction $t+3$		0.040*
		(0.027)
Post Introduction $t+4$		0.081***
		(0.027)
Post Introduction $t+5$		0.084**
		(0.043)
Post Introduction $t+6$		0.127**
		(0.060)
Post Introduction $t+7$		0.176***
		(0.066)
Control variables	✓	✓
Establishment FE	✓	✓
Industry FE	✓	✓
Federal state FE	✓	✓
Observations	43,426	43,426

Notes: The tables shows estimation results from Equation (3.5). Results are adjusted to take selection effects into account by weighting with inverse probability weights (IPW) which are outlined in Equation (3.7). The post introduction period is pooled over all years per establishment in which the voluntary institution is present after its introduction. Fixed effects specifications include establishment, industry as well as federal state fixed effects. IAB Establishment Panel, waves 2009–2016. Log labor productivity is measured as $log\left(\frac{sales}{N}\right)$ between the treatment and control group. The treatment group introduces voluntary employee representation between t and $t-1$ within the observation window of our sample. The control group does never introduce voluntary institutions. Control variables are included as outlined in Section 3.4.1. Results also on control variables are presented in Table 3.13 in the Appendix. Significance: *, **, *** significant at the 10%, 5%, 1% level.

when a works councils is not present. Otherwise workers are already covered with a voice institutions. And finally, it might be the case that already the presence of works councils is sign of a relationship which is characterized by mistrust in which social exchange relationships cannot bloom. Such a conjecture is also supported by Budd et al. (2017), who find that voluntary agreements are more effective compared to statutory ones. Whatever the channel may be, all three explanations point to more pronounced effects of VERs in non-works council establishments. We therefore split the sample according to works council status and re-estimate the IPW-fixed effects regression in both samples.[15]

[15] A sample split according to works council status, i.e. yes/no, reveals the following. Within

Table 3.5: Heterogeneous effects depending on works council status

	Log labor productivity			
	With works council		w/o works council	
	IPW-FE	IPW-FE	IPW-FE	IPW-FE
	(1)	(2)	(3)	(4)
VER Introduction	-0.016	-0.016	-0.000	-0.000
	(0.020)	(0.020)	(0.010)	(0.010)
VER Post Introduction	0.023		0.035**	
	(0.023)		(0.017)	
Post Introduction $t+1$		0.007		0.015
		(0.024)		(0.017)
Post Introduction $t+2$		0.047		0.049*
		(0.041)		(0.026)
Post Introduction $t+3$		0.052		0.042
		(0.040)		(0.031)
Post Introduction $t+4$		0.030		0.090***
		(0.054)		(0.030)
Post Introduction $t+5$		0.068		0.093**
		(0.097)		(0.047)
Post Introduction $t+6$		0.130		0.127**
		(0.148)		(0.063)
Post Introduction $t+7$		0.222***		0.183**
		(0.067)		(0.072)
Control variables	✓	✓	✓	✓
Establishment FE	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓
Federal state FE	✓	✓	✓	✓
Observations	9,435	9,435	33,991	33,991

Notes: The tables shows estimation results from Equation (3.5). Results are adjusted to take selection effects into account by weighting with inverse probability weights (IPW). Fixed effects specifications include establishment, industry as well as federal state fixed effects. IAB Establishment Panel, waves 2009–2016. Columns (1, 2) show results for establishments with works councils and columns (3, 4) results for establishments without works councils. Results including control variables are presented in Tables 3.14 and 3.15 in the Appendix. Significance: *, **, *** significant at the 10%, 5%, 1% level.

What becomes evident from Table 3.5 is that the post introduction effect of voluntary institutions is only significant when a works council is not present in the establishment. Thus, in establishments without works councils, the post introduction effect of an increase in labor productivity by 5.5 %, is comparable to the baseline and IPW effects. It therefore appears that the positive effect after the introduction period of alternative / voluntary employee representation is quite robust. Our results actually support such an interpretation in which the effects of

the group of works council establishments, roughly 4 %, i.e. around 350 establishments, also introduced an alternative voice institutions. Among the group of establishments which do not have a works council, around 4.1 % also implement an alternative institutions. Due to a larger sample size in this group, there are roughly 1,400 alternative voice introducing establishments in this sample.

VERs are only present in establishments without non-union representation. In a similar vein, the existence of a works council might also represent a latent mistrust of the workforce towards management. With these workers attitude, a voluntary institutions in these firms would probably have no effect at all. That is exactly the narrative that the empirical findings support.

Differences in collective bargaining status. A similar rational as with works councils might also be applied to unions. In case there is already an employee representation in form of an union, which negotiate collective bargaining agreement, the gift of employee involvement and voice might be 'less generous'. However, as argued by Jirjahn (2017), the coverage by an collective bargaining agreement increases the effectiveness of managerial practices which are negotiated between employees and the employer. Thus, the moderating effect of collective bargaining agreements with respect to VERs are an empirical question. Results are presented in Table 3.6. First, we find similar results as before. It becomes evident that positive productivity effects of VERs are still present when the establishment is not covered by collective bargaining agreements. These results are quite in line with the results from the sample split with respect to works councils. In case formal voice is present, the effects of VERs are smaller or not present at all.

Closeness between management and employees. As a plausibility test for the social exchange relationship between management and employees, we consider two measures of closeness. It is, for example, well known from the literature that lower social distance increases positive reciprocity (Cox & Deck 2005). Furthermore, the literature also provides evidence that more direct forms of participation are more often present when the relationship between management and employees is more close (Jirjahn & Smith 2006). We therefore test this 'closeness' hypothesis by investigating the effect in different firm sizes and different ownerships. We expect more pronounced effects in small establishments, which provide a more direct relationship between management and employees. A similar argument is also put forward by Irlenbusch & Sliwka (2005), who argue that direct reciprocal behavior is more pronounced in transparent situations. In such settings, employees' effort can be transparently revealed to the management. Such transparency is likely to be more common in small businesses, as well as in companies with an owner-manager who tends to have a more paternalistic management style.

As shown in Table 3.7 and theoretically expected, the effects of VERs are more pronounced in small establishments which provide more opportunities for closer reciprocal relationships between management and employees. In particular the smallest firm size of 1-19 employees seems to especially benefit from VERs. As

Table 3.6: Heterogeneous effects depending on collective bargaining coverage

	Log labor productivity			
	With collective bargaining		w/o collective bargaining	
	IPW-FE	IPW-FE	IPW-FE	IPW-FE
	(1)	(2)	(3)	(4)
VER Introduction	-0.004	-0.004	-0.010	-0.010
	(0.014)	(0.014)	(0.012)	(0.012)
VER Post Introduction	0.023		0.040**	
	(0.024)		(0.020)	
Post Introduction $t+1$		-.001		0.020
		(0.023)		(0.021)
Post Introduction $t+2$		0.004		0.069*
		(0.034)		(0.030)
Post Introduction $t+3$		0.042		0.039
		(0.040)		(0.046)
Post Introduction $t+4$		0.074*		0.068*
		(0.043)		(0.040)
Post Introduction $t+5$		0.075		0.122
		(0.073)		(0.065)
Post Introduction $t+6$		0.112		0.115
		(0.120)		(0.075)
Post Introduction $t+7$		0.237***		0.150
		(0.105)		(0.079)
Control variables	✓	✓	✓	✓
Establishment FE	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓
Federal state FE	✓	✓	✓	✓
Observations	13,063	13,063	30,363	30,363

Notes: The tables shows estimation results from Equation (3.5). Results are adjusted to take selection effects into account by weighting with inverse probability weights (IPW). Fixed effects specifications include establishment, industry as well as federal state fixed effects. IAB Establishment Panel, waves 2009–2016. Columns (1, 2) show results for establishments with collective bargaining coverage and columns (3, 4) results for establishments without collective bargaining coverage. Significance: *, **, *** significant at the 10%, 5%, 1% level.

a further robustness check we also provide IPW results in Table 3.8 in which we account for the selection effects of introducing VERs. We still find a significant effect of voluntary institutions in case the relationship among employees and management is close (i.e. in small establishments).

As a second test for the 'closeness' between management and employees, we consider establishments with different owners. We expect that the relationship among the owner and employees is more close, compared to, for example, employees and external managers. We also expect a higher level of trust among those relationships. Thus, positive effects from reciprocal relationships might in particular arise in establishments in which the owner is also the manager. Empirical results for this hypothesis are provided in Table 3.9; selectivity adjusted evidence on this issue is provided in Table 3.10.

Table 3.7: Heterogeneous effects depending on 'size closeness', unweighted

	Log labor productivity				
	1-19	20-49	50-199	200-499	500+
	(1)	(2)	(3)	(4)	(5)
VER Introduction	.024*	.001	-.005	-.009	-.028
	(.012)	(.014)	(.017)	(.026)	(.041)
VER Post Introduction	.053***	.015	.002	.045	.011
	(.020)	(.020)	(.028)	(.034)	(.038)
Control variables	✓	✓	✓	✓	✓
Establishment FE	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓
Federal state FE	✓	✓	✓	✓	✓
Observations	21,892	8,714	8,295	2,954	1,571

Notes: The tables shows estimation results from Equation (3.5) using sample splits with respect to establishment size. Fixed effects specifications include establishment, industry as well as federal state fixed effects. IAB Establishment Panel, waves 2009–2016. Significance: *, **, *** significant at the 10%, 5%, 1% level.

Table 3.8: Heterogeneous effects depending on 'size closeness', weighted

	Log labor productivity				
	1-19	20-49	50-199	200-499	500+
	(1)	(2)	(3)	(4)	(5)
VER Introduction	.021	-.013	-.029	-.007	-.035
	(.013)	(.016)	(.018)	(.035)	(.045)
VER Post Introduction	.077***	.014	-.006	.040	-.026
	(.027)	(.027)	(.027)	(.045)	(.058)
Control variables	✓	✓	✓	✓	✓
Establishment FE	✓	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓	✓
Federal state FE	✓	✓	✓	✓	✓
Observations	21,892	8,714	8,295	2,954	1,571

Notes: The tables shows estimation results from Equation (3.5) using sample splits with respect to establishment size. Results are adjusted to take selection effects into account by weighting with inverse probability weights (IPW). Fixed effects specifications include establishment, industry as well as federal state fixed effects. IAB Establishment Panel, waves 2009–2016. Significance: *, **, *** significant at the 10%, 5%, 1% level.

The results indicate that the productivity effect indeed arises within a more direct relationship among management and employees. In case the manager is at the same time also the owner, the effects are much more pronounced. For establishments with external managers we find no effects of VERs on productivity. At the same time, when there are both the owner-manager and an external manager present, we also see a more pronounced effect on productivity. This indicates that on the one hand, a close reciprocal relationship among the management and employees is important. And on the other hand, that also external knowl-

Table 3.9: Heterogeneous effects depending on 'owner closeness', unweighted

	Log labor productivity		
	Owner-Manager	External Manager	Both
	(1)	(2)	(3)
VER Introduction	.019**	-.009	.018
	(.010)	(.018)	(.036)
VER Post Introduction	.035**	.016	.066*
	(.015)	(.024)	(.037)
Control variables	✓	✓	✓
Establishment FE	✓	✓	✓
Industry FE	✓	✓	✓
Federal state FE	✓	✓	✓
Observations	29,090	9,238	3,187

Notes: The tables shows estimation results from Equation (3.5) using sample splits with respect to manager status. Fixed effects specifications include establishment, industry as well as federal state fixed effects. IAB Establishment Panel, waves 2009–2016. Significance: *, **, *** significant at the 10%, 5%, 1% level.

edge stemming from an external management leads to an additional performance increase, but only in establishments in which the owner is also still present.

Table 3.10: Heterogeneous effects depending on 'owner closeness', weighted

	Log labor productivity		
	Owner-Manager	External Manager	Both
	(1)	(2)	(3)
VER Introduction	.005	-.021	-.019
	(.011)	(.019)	(.032)
VER Post Introduction	.047**	-.001	.039
	(.019)	(.029)	(.036)
Control variables	✓	✓	✓
Establishment FE	✓	✓	✓
Industry FE	✓	✓	✓
Federal state FE	✓	✓	✓
Observations	29,090	9,238	3,187

Notes: The tables shows estimation results from Equation (3.5) using sample splits with respect to manager status. Results are adjusted to take selection effects into account by weighting with inverse probability weights (IPW). Fixed effects specifications include establishment, industry as well as federal state fixed effects. IAB Establishment Panel, waves 2009–2016. Significance: *, **, *** significant at the 10%, 5%, 1% level.

3.4.6 Robustness tests

Entropy balancing. As a first robustness test we take the inverse-probability weighing (IPW) approach under investigation. Sometimes, the IPW approach can lead to measurement errors since the weights do not take other distributional moments besides the mean into account (Hainmueller & Xu 2013). Entropy balancing

(Hainmueller 2012), however, enables us to also consider the second (variance) and third (skewness) distributional moment for non-binary covariates and thus create more reliable weights. The approach is similar as before in which we create the sample weights and only re-weight the control group to match the distribution of the VER introducing establishments. The weights are chosen in a way to resemble uniform weights as close as possible and thus to mitigate biased estimates because of the weighting (e.g. Phillippo et al. 2020). Moreover, recent research shows that entropy balancing is also doubly robust, provides reliable estimates of the treatment effect and allows us to directly implement the weights in the regression framework (e.g. Zhao & Percival 2017).

What we find is, that the results of the entropy balanced estimates are very similar to the IPW weighted and baseline reults. Both, in terms of significance and effect size. Moreover, the same pattern of no introduction effects in combination with significant post introduction effect emerges. This results hold for all three kind of weighting approaches in which we first consider the mean, the mean and variance as well as in addition the skewness in the re-weighting approach.

Different IPW weights. In this section we try a different specification of the inverse-probability weights. Compared to the approach before in which we only re-weight the control group to match the distribution of the treatment group, we now weight both groups, however with slightly different weights.[16] The treatment (t) therefore receives the weight calculated as $\psi_i^t = \frac{1}{\hat{P}(W_i)}$ and the control group (c) the weight $\psi_i^c = \frac{1}{1-\hat{P}(W_i)}$. Moreover, we normalize the weights to sum to one in which the results might be more robust in finite samples (e.g. Busso et al. 2014). Again, the results are similar compared to the baseline results and also similar compared to the entropy weighted results. As a final test, we trim the propensity score in which we drop propensity scores which are below the threshold of 0.01 and above 0.09 to ensure a better overlap in the covariate distributions (e.g. Crump et al. 2009). This leads to a reduction in sample size by $N = 5,089$ observations in which we are left with $N = 38,337$ establishment-year observations. Results among the different specifications, however, differ only slightly and lead to similar conclusions.

3.5 Conclusion

Labor productivity is without doubt one of the most important determinants of firm performance. There is abundant literature focusing on various factors that

[16] See for a comprehensive exposition of different re-weighting schemes in combination with the description of the estimated effect, for example, Li et al. (2018).

explain productivity differences among firms. Non-monetary management incentives, however, especially those with a focus on social exchange relationships, have not yet been sufficiently investigated. Theoretical and empirical work quite often neglects the fact that voice opportunities in the workplace are also valuable and able to implement gift-exchange relationships. We contribute to this literature on organizational performance by showing that not only monetary but also non-monetary incentives are relevant within managements' toolboxes.

To answer our research question how the voluntary provision of employee involvement affects labor productivity, we use the IAB Establishment Panel, waves 2009–2016. It is a comprehensive German data set offering information on such voluntary involvement measures. We identify establishments as voluntary representation introducer and non-introducer and estimate the effects of the introduction as well as dynamic effects over time. To do so, we rely on a difference-in-differences framework which allows us to dynamically compare those two establishment groups before and after the introduction of voluntary representation. Since selectivity effects might bias the results, we apply inverse probability weighting to match establishments in terms of their observable characteristics. The results of the empirical study show that the introduction of voluntary involvement practices such as round table conferences or employee spokespersons, which so far are neglected in the literature, is highly beneficial for labor productivity. Moreover, positive effects of voluntary involvement take some time to become apparent, since scope and nature of such an institution have to grow until productivity gains can be achieved. We contribute to the literature on organizational performance by showing that not only monetary incentives but also non-monetary incentives should be considered within the principle-agent framework.

Our study, however is not without limitations. Our results do not rely on the gold-standard of a randomized controlled trial but rather on observational data. Therefore, endogeneity issues might still be present although we take observational characteristics between establishments (inverse-probability weighting) and unobserved characteristics which are constant over time (difference-in-differences) into account. Furthermore, there may be particularities of such voluntary institutions which we cannot measure with our indicator variable. Thus, potential effects might also differ between different working environments they are implemented in.

What can we learn from our results? First, from a managerial perspective, we propose an alternative to monetary incentives, in particular in creative work environments characterized by trust, cooperation and commitment. Voluntary employee involvement is in particular highly beneficial for small establishments as well as establishments with an owner-manager. Among those firms there is more

transparency and scope for more direct relationships between the management and the workforce. These structures are especially relevant within social exchange relationships.

An interesting avenue for further research in this regard is to investigate potential combinations of monetary and non-monetary incentives. In particular, the relevance of the crowding-out effect of monetary incentives in terms of intrinsic motivation might have important implications not only for firm innovation but also for other performance indicators such as labor productivity. Second, and with respect to policy conclusions, our results also have implications for statutory workplace representation in Germany. No doubt, the relevance of bargaining power and co-determination rights, which are fundamentally important for employees, cannot be stressed enough. A statutory workplace representation as a more or less one-size fits all solution might, however, not always fit the needs of a heterogeneous corporate landscape. Eventually, future amendments of the Works Constitution Act therefore might carefully consider corporate heterogeneity, especially in terms of technical equipment but also workforce and industry particularities.

In summary, this chapter not only establishes voluntary representation institutions as an increasingly important element of corporate culture that can flexibly respond to operational needs, but also for the system of industrial relations.

3.6 Appendix

Table 3.11: Description and explanation of variables

Variable	Description and explanation
Dependent variables	
Log labor productivity	Logarithm of sales divided by the number of employees: $log\left(\frac{sales}{N}\right)$ Similar applications, for example, in Peutere et al. (2020); Audretsch & Belitski (2020); Mueller & Stegmaier (2017).
Establishment controls	
Log(Employees)	Natural logarithm of the number of employees.
Part of firm group	Dummy variable equals 1 if an establishment/office is part of a larger company or organization and 0 otherwise.
Limited liability	Dummy variable equals 1 if an establishment has the legal form of a limited liability (e.g. GmbH, UG Ltd.) and 0 otherwise.
Collective bargaining	Dummy if equals 1 whether an establishment is bounded by an industry-wide wage agreement and 0 otherwise.
Works council	Dummy variable equals 1 if there is a works council present in an establishment. This shop-floor representation institution can be elected in establishments with more than five permanent employees. Works councils posses comprehensive consultation, information and codetermination rights in areas such as staffing, working hours or safety. Their rights are ruled out in the Works Constitution Act.
Exports (in % of sales)	Percentage of exports in annual sales.
Status of technology	Rated on a 5-point Likert scale ranging from the category 'very poor' (= 1) to 'very good' (= 5) in which the latter is the reference category.
Workforce controls	
Share of female workers	Continuous measure for the share of female workers in relation to employment in year t.

Variable	Description and explanation
Share of high-skilled workers	Continuous measure for the share of high-skilled workers in relation to employment in year t which require a university degree.
Share of part-time workers	Continuous measure for the share of part-time workers in relation to employment in year t.
Share of apprentices	Continuous measure for the share of apprentices in relation to employment in year t.

Table 3.12: Full results on baseline fixed effects models

	Log labor productivity	
	Fixed Effects Model	Fixed Effects Model
	(1)	(2)
VER Introduction	0.008	0.009
	(0.008)	(0.008)
VER Post Introduction	0.033***	
	(0.011)	
Post Introduction $t+1$		.018
		(.012)
⋮		⋮
Post Introduction $t+7$		0.195*
		(0.101)
Log (Employees)	-.400***	-.401***
	(.023)	(.023)
Part of firm group	.009	.009
	(.017)	(.017)
Limited liability	.023	.023
	(.024)	(.024)
Collective agreement	-.013	-.013
	(.009)	(.009)
Works council	.015	.016
	(.018)	(.018)
Exports (in % of sales)	.100**	.100**
	(.050)	(.050)
Stand of technology	.004	.004
	(.007)	(.006)
Share of high-skilled workers	.088**	.088**
	(.041)	(.041)
Share of part-time workers	-.085***	-.085***
	(.021)	(.021)
Share of apprentices	-.322***	-.322***
	(.052)	(.052)
Share of female workers	-.004	-.004
	(.034)	(.034)
Establishment FE	✓	✓
Industry FE	✓	✓
Federal state FE	✓	✓
Observations	43,426	43,426

Notes: The tables shows estimation results from Equation (3.5). Fixed effects specifications include establishment, industry as well as federal state fixed effects. IAB Establishment Panel, waves 2009–2016. Log labor productivity is measured as $log\left(\frac{sales}{N}\right)$ between the treatment and control group. The treatment group introduces voluntary employee representation between t and $t-1$ within the observation window of our sample. The control group does never introduce voluntary institutions. Post Introduction coefficient omitted for the sake of clarity; these coefficients can be found in Table 3.2. *, **, *** significant at the 10%, 5%, 1% level.

Table 3.13: Full results on baseline IPW fixed effects models

	Log labor productivity	
	Fixed Effects Model	Fixed Effects Model
	(1)	(2)
VER Introduction	-0.004	-0.004
	(0.009)	(0.009)
VER Post Introduction	0.031**	
	(0.015)	
Post Introduction $t+1$		.012
		(.015)
⋮		⋮
Post Introduction $t+7$		0.266***
		(0.086)
Log (Employees)	-.419***	-.420***
	(.039)	(.039)
Part of firm group	-.008	-.008
	(.036)	(.036)
Limited liability	.029	.029
	(.088)	(.088)
Collective agreement	-.000	.000
	(.015)	(.015)
Works council	.011	.012
	(.031)	(.031)
Exports (in % of sales)	.187*	.188*
	(.098)	(.098)
Stand of technology	.003	.003
	(.015)	(.015)
Share of high-skilled workers	.090	.091
	(.070)	(.070)
Share of part-time workers	-.068*	-.069**
	(.030)	(.030)
Share of apprentices	-.135	-.136
	(.166)	(.166)
Share of female workers	-.023	-.023
	(.063)	(.062)
Establishment FE	✓	✓
Industry FE	✓	✓
Federal state FE	✓	✓
Observations	43,426	43,426

Notes: The tables shows estimation results from Equation (3.5). Coefficients are adjusted to take selection effects into account by weighting with inverse probability weights (IPW) as shown in Equation (3.6) and (3.7). IAB Establishment Panel, waves 2009–2016. Log labor productivity is measured as $log\left(\frac{sales}{N}\right)$ between the treatment and control group. The treatment group introduces voluntary employee representation between t and $t-1$ within the observation window of our sample. The control group does never introduce voluntary institutions. Post Introduction coefficient omitted for the sake of clarity; these coefficients can be found in Table 3.4. *, **, *** significant at the 10%, 5%, 1% level.

Table 3.14: Full results on IPW fixed effects models: with works council

	Log labor productivity	
	Fixed Effects Model	Fixed Effects Model
	(1)	(2)
VER Introduction	-0.016	-0.016
	(0.020)	(0.020)
VER Post Introduction	0.023	
	(0.023)	
Post Introduction $t+1$		.007
		(.024)
⋮		⋮
Post Introduction $t+7$		0.222***
		(0.067)
Log (Employees)	-.263***	-.264***
	(.086)	(.086)
Part of firm group	-.054	-.054
	(.054)	(.055)
Limited liability	-.046	-.054
	(.053)	(.057)
Collective agreement	-.012	-.012
	(.023)	(.023)
Works council		
Exports (in % of sales)	.298	.297
	(.199)	(.199)
Stand of technology	.019	.019
	(.024)	(.024)
Share of high-skilled workers	.092	.091
	(.152)	(.153)
Share of part-time workers	-.081	-.082
	(.094)	(.094)
Share of apprentices	-.329	-.325
	(.286)	(.287)
Share of female workers	.163	.165
	(.135)	(.135)
Control variables	✓	✓
Establishment FE	✓	✓
Industry FE	✓	✓
Federal state FE	✓	✓
Observations	9,435	9,435

Notes: The tables shows estimation results from Equation (3.5) for only establishments with works council presence. Coefficients are adjusted to take selection effects into account by weighting with inverse probability weights (IPW) as shown in Equation (3.6) and (3.7). IAB Establishment Panel, waves 2009–2016. Log labor productivity is measured as $log\left(\frac{sales}{N}\right)$ between the treatment and control group. The treatment group introduces voluntary employee representation between t and $t-1$ within the observation window of our sample. The control group does never introduce voluntary institutions. Post Introduction coefficient omitted for the sake of clarity; these coefficients can be found in Table 3.5. *, **, *** significant at the 10%, 5%, 1% level.

Table 3.15: Full results on IPW fixed effects models: w/o works council

	Log labor productivity	
	Fixed Effects Model (1)	Fixed Effects Model (2)
VER Introduction	-0.000	-0.000
	(0.010)	(0.010)
VER Post Introduction	0.035**	
	(0.017)	
Post Introduction $t+1$		.015
		(.017)
⋮		⋮
Post Introduction $t+7$		0.234***
		(0.078)
Log (Employees)	-.442***	-.443***
	(.042)	(.042)
Part of firm group	.032	.031
	(.041)	(.041)
Limited liability	.037	.039
	(.099)	(.099)
Collective agreement	.001	.001
	(.017)	(.017)
Works council		
Exports (in % of sales)	.108	.109
	(.098)	(.098)
Stand of technology	-.000	-.000
	(.017)	(.017)
Share of high-skilled workers	.089	.091
	(.077)	(.077)
Share of part-time workers	-.059	-.060
	(.031)	(.031)
Share of apprentices	-.114	-.116
	(.173)	(.172)
Share of female workers	-.036	-.036
	(.041)	(.067)
Control variables	✓	✓
Establishment FE	✓	✓
Industry FE	✓	✓
Federal state FE	✓	✓
Observations	33,991	33,991

Notes: The tables shows estimation results from Equation (3.5) for only establishments without works council presence. Coefficients are adjusted to take selection effects into account by weighting with inverse probability weights (IPW) as shown in Equation (3.6) and (3.7). IAB Establishment Panel, waves 2009–2016. Log labor productivity is measured as $log\left(\frac{sales}{N}\right)$ between the treatment and control group. The treatment group introduces voluntary employee representation between t and $t-1$ within the observation window of our sample. The control group does never introduce voluntary institutions. Post Introduction coefficient omitted for the sake of clarity; these coefficients can be found in Table 3.5. *, **, *** significant at the 10%, 5%, 1% level.

Table 3.16: Distribution of establishments by German federal states

Federal state	Observations	Share
Schleswig-Holstein	2,092	4.82
Hamburg	815	1.88
Lower Saxony	3,191	7.35
Bremen	2,154	4.96
North Rhine-Westphalia	4,215	9.71
Hesse	2,503	5.76
Rhineland-Palatinate	4,197	9.66
Baden-Wuerttemberg	3,443	7.93
Bavaria	3,649	8.40
Berlin	1,872	4.31
Brandenburg	2,558	5.89
Mecklenburg-West Pomerania	2,454	5.65
Saxony	3,738	8.61
Saxony-Anhalt	2,936	6.76
Thuringia	3,609	8.31
Total	43,426	100

Notes: IAB Establishment Panel, waves 2009 to 2016.

Table 3.17: Distribution of establishments by size categories

Size category	Observations	Share
1-19	21,892	50.41
20-49	8,714	20.07
50-199	8,295	19.10
200-499	2,954	6.80
500+	1,571	3.62
Total	43,426	100

Notes: IAB Establishment Panel, waves 2009 to 2016.

Table 3.18: Distribution of establishments by IAB defined industries

Industry classification (IAB Establishment Panel)	Observations	Share
Agriculture/forestry; fishery	1,039	2.39
Mining; quarrying	106	0.24
Energy/water supply; waste disposal etc.	813	1.87
Manufact. of (luxury)food products	1,231	2.83
Manufact. of textiles; leather goods; footwear etc.	505	1.16
Manufact. of wood products; paper; print products	1,183	2.72
Manufact. of chem./pharm. prod.; coking; mineral oil process.	679	1.56
Manufact. of rubber/plastics products	749	1.72
Manufact. of glass/ceramics; process. of stone a. ind. minerals	775	1.78
Manufacture of basic metals; fabricated metal products	923	2.13
Manufact. of metal products; steel/light-metal engineering	1,898	4.37
Manufact. of electr./optic products; data process.equip.	564	1.30
Manufact. of electrical equipment	608	1.40
Mechanical engineering	1,790	4.12
Manufact. of motor vehicles/components; other vehicle prod.	807	1.86
Manufact. of furniture and related goods	1,078	2.48
Repair/installation of machinery/equip.	482	1.11
Building construction; civil engineering	1,085	2.50
Building installation; finishing trade	2,635	6.07
Automobile trade/-repair	1,400	3.22
Wholesale; trade brokerage	1,921	4.42
Retail; petrol stations	4,312	9.93
Transportation; warehousing	1,927	4.44
Information; communication	1,016	2.34
Accommodation; gastronomy	2,464	5.67
Financial/insurance services	481	1.11
Real estate; housing	627	1.44
Legal/tax advice; auditing	1,095	2.52
Business management; consulting	303	0.70
Architect./engineer. office; tech./phys./chem. inspect.	911	2.10
Research and development	187	0.43
Marketing; design; photography; translation	201	0.46
Veterinary services	37	0.09
Rent. of movable prop.	30	0.07
Temp.-employment/placement services	431	0.99
Travel industry; guard services; landscape construction etc.	1,433	3.30
Education; teaching	660	1.52
Healthcare; social services	3,908	9.00
Arts; sports; entertainment; vacation; lottery	219	0.50
Repair of personal/household goods	94	0.22
Other personalized services	769	1.77
Lobbies; associations; religious groups	50	0.12
Total	43,426	100

Notes: IAB Establishment Panel, waves 2009 to 2016.

Chapter 4

The effects of reforming a Federal Employment Agency on labor demand

Joint work with Kornelius Kraft[1]

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4.1 Introduction

The functioning of frictional labor markets with imperfect and asymmetric information largely depend on the efficiency of the matching process between unemployed and vacancies (e.g. Petrongolo & Pissarides 2001; Mortensen & Pissarides 1994). In recent years, economies, firms and employees are faced with serious challenges within the labor market. The automation of tasks within jobs is accelerated and an increasing fraction of jobs is at risk of being replaced by advanced technologies such as algorithms or robots (e.g. Acemoglu & Restrepo 2018a; Frey & Osborne 2017; Brynjolfsson & McAfee 2014). At the same time, labor markets in several European countries are further challenged by large inflows of workers which have to be efficiently integrated into the labor market (Battisti et al. 2019). The matching of workers to vacancies therefore becomes an increasingly relevant task which is at the same time extremely demanding and highly important in terms of e.g. government spending. While the effects of an increase in the labor market matching efficiency on workers such as unemployment duration or satisfaction are broadly studied, the view on the labor demand side is mostly not analyzed in detail. The literature, however, provides evidence that matching rates and the filling of vacancies are rather firm-specific (Kaas & Kircher 2015; Davis et al. 2013). Moreover, the placement process depends, among other factors, on the effectiveness of labor market institutions such as the Federal Employment Agency (FEA).

In this chapter we investigate an important policy reform which was explicitly framed at improving the employment agency in terms of job matching efficiency in Germany. During the first years of the 21st century, various labor market reforms were implemented in Germany. Our focus is on the Hartz III reform, which became effective on January 1st, 2004. This reform was embedded in the so-called Hartz reform package which was successively implemented between the years 2003–2005 and consists of the reforms Hartz I–IV. We exploit this exogenous policy intervention aiming to improve the efficiency of the FEA and investigate whether establishments using the FEA for their job recruitment benefit from an improvement of the internal restructuring of the FEA. We measure this improvement in terms of employment creation of establishments which use the placement services, compared to establishments which do not use the placement services.

We use detailed establishment level information for the years 2000 to 2008 from the German IAB Establishment Panel provided by the Institute for Employment Research (IAB). From this data set we create a sample of 14,658 establishment-year observations. We apply difference-in-differences estimation in which the establishments using the FEA constitute the treatment group and establishments which

do not use the placement services the control group. Using this estimation framework allows us to: (1) estimate the causal link between reforming a federal agency and employment creation of establishments and (2) account for macroeconomic common shocks, for example, that the Hartz reforms were implemented during an expansionary time in Germany (e.g. Bradley & Kügler 2019).[2] Robustness tests are provided in Section 4.5.2 in which we explicitly look at selection effects for choosing the employment agency as a recruitment channel in the first place using inverse-probability-weighting (IPW) with different specifications.

In terms of employment creation, we look at the share of new hires as the ratio of hirings to total employment as well as employment growth. The unweighted regression results indeed provide evidence for positive reform effects for establishments using the placement services relative to establishments which do not use the FEA. The share of hires on average increased by two percentage points. According to our estimation results, the reform of the Federal Employment Agency led to higher growth of employment by roughly 3 percentage points. The weighted regression results are slightly smaller.

This chapter contributes to the microeconomic literature on matching efficiency as well as to the literature on the evaluation of the Hartz reforms.[3] There are also macroeconomic studies that examine the impact of the Hartz III reform, for example by considering unemployment duration or aggregate flows into and out of unemployment. In contrast, we use a microeconomic approach and examine the labor demand side and the effects of the reform on the establishment level. We therefore examine whether the behavior of establishments has actually changed after the reform is in place, which we measure in terms of employment growth and hiring rates.

This chapter proceeds as follows. In the following Section 4.2 we provide a literature review on micro- and macroeconomic studies regarding matching efficiency, in particular in the context of the Hartz legislation. Section 4.3 provides theoretical arguments for the connection between the use of the Federal Employment Agency, matching efficiency and employment growth. Our empirical investigation as well as robustness tests are provided in Sections 4.4 and 4.5.2. Finally, the last Section 4.7 draws a conclusion and provides policy implications.

[2]Regarding macroeconomic shocks, for example, Davis & Haltiwanger (1992) report that significant job creation and destruction coexist in all phases of the business cycle.

[3]A comprehensive summary of micro-evaluation studies regarding the Hartz reforms can be found, for example, in Akyol et al. (2013).

4.2 Literature review

Regarding matching efficiency, there is a burgeoning literature on the evaluation of the Hartz reforms in the past decade. With respect to Hartz II, for example, Bradley & Kügler (2019) found an increase in mini-job workers from 13 percent in 2003 to 16 percent in 2006. Dlugosz et al. (2014) investigate the Hartz IV reform and show that the reduction of unemployment benefit entitlement provides incentives to stay employed for older workers. In a similar vein, Krebs & Scheffel (2013) use a calibrated model to simulate the effects of Hartz IV which reduced structural unemployment by 1.4 percentage points. In combination with Hartz I–III, the aggregated effect is an 1.5 percentage point reduction in structural unemployment. Gehrke et al. (2019) find positive labor market performance shocks which are caused by the Hartz reforms. They argue that these reforms are the main driver for good performance during the great financial crisis in Germany between 2008 and 2009. With respect to the relevance of placement services, almost 50 % of all vacancies in Germany are registered at the Federal Employment Services. Moreover, the literature often finds that, compared to the private market, applicants send by the employment agency are usually less suited for the job and thus firms usually pay lower wages for these applicants (e.g. Holzner & Watanabe 2015).[4] Pellizzari (2010) exploits a policy intervention in the Italian employment and recruitment services, which aimed at making the recruitment services more competitive. He finds higher wages for employees being matched via more efficient employment agencies. Using a synthetic control method, Ehrich et al. (2018) find that the Hartz reforms raised labor force participation, specifically among women and older workers.

While the studies discussed so far examine other effects of the Hartz reforms, more closely related to our research are some recent macroeconomic studies, which consider matching efficiency. Here, for example, it is to mention Stops (2016), who estimates macroeconomic matching functions. He finds that matching efficiency increased after the Hartz III reform. Fahr & Sunde (2009) find similar results and in particular that the Hartz reforms accelerate outflows from unemployment. Launov & Wälde (2016) provide evidence that the reorganization of the FEA is responsible for a .69-.88 percentage point decline of the equilibrium unemployment rate. Klinger & Rothe (2012) find increases in the matching efficiency by 10 percent. This result is supported by Klinger & Weber (2016) who find an increase in matching efficiency after 2005. Hartung et al. (2018), however, argue that

[4]Holzner & Watanabe (2015) also point out that more efficient Federal Employment Services might crowd out private search effort. This result is also found, for example, by Launov & Wälde (2016).

positive reform effects are driven by lower separation rates.

The literature also provides evidence from other countries. For example, with respect to an increase in the duration of unemployment benefit, Le Barbanchon (2016) does not find any effects on the matching quality for France. Liechti (2020) shows for Switzerland, that recommendation from an employment agency can act as a substitute for social contacts. In a similar context, Horton (2017) considers the effect of algorithmic recommendations for employers. He finds that such recommendations are very effective for hiring, especially when firms are faced with a small pool of applicants. These results have important policy implications since it may be a good strategy to improve social connections between job seekers and employers.

Summing up, most of the reviewed literature focuses either (i) on aggregate effects, the reduction of unemployment duration and equilibrium effects or (ii) on effects on the level of unemployed workers. Explicit microeconomic studies with a focus of the Hartz III legislation and its impact on the labor demand side in terms of employment creation, in particular on the establishment level, are missing in this literature.

4.3 Job matching and employment growth

Labor market institutions such as the Federal Employment Agency exert a strong influence on the job matching process. The agency is in particular responsible for bringing together supply and demand, i.e. unemployed who are seeking for a job and employers who post vacancies. A match is characterized by the placement of an unemployed person in a vacancy in which the efficiency is determined by the matching function (e.g. Davis et al. 2013; Petrongolo & Pissarides 2001).[5] Within this process the Federal Employment Agency provides job search assistance which helps unemployed workers to find suitable jobs and monitors the search effort of unemployed people.

Because of the Hartz III reform, the efficiency of the job placement is highly increased. The employment agency moved from a centralized budgeting system to a more management-by-objectives system in which specific tasks and goals are defined (Akyol et al. 2013). The contact time per unemployed was increased and „Job Centers“ were implemented which further aimed at improving the placement process. With regard to these considerations, the Hartz III reforms can be consid-

[5]According to various job search models, employers post vacancies to attract potential job seekers. The matching function then links the combination of job seekers and job vacancies and produce new hires (e.g. Davis et al. 2013).

ered as a positive technological shock for the matching production function of the Federal Employment Agency (e.g. Petrongolo & Pissarides 2001).

After the restructuring of the agency, unemployed workers are more closely monitored, in many cases better motivated and thus more suitable for the job market. Moreover, the agency may help employers to better overcome information asymmetries by placing workers in occupations that fits their qualification. In a similar vein, Marinescu & Rathelot (2018) show that geographic mismatch is a potential driver for unemployment. Bauer & King (2018) argue that a more efficient employment agency can improve the placement results, because with their assistance the employees are also made aware of jobs outside of their former profession. The result is a reduction in mismatch caused by imperfect labor mobility.

A more efficient employment agency then reduces search and recruitment costs for employees but also for establishments. The reduction in search costs is associated with an increase in productivity since workers and establishments can consider potential matches more efficiently (Autor 2001; Pissarides 1990). More capable job candidates due to an efficient search channel leads to better matches which may improve labor productivity and reduce the need for further training activities. Bryson & Nurmi (2011) point out in this connection that specific job-related tasks can be performed more efficiently resulting in a competitive advantage and in employment growth. Ultimately, better matches between employers and employees lower search and recruitment costs for employers which facilitate the process of job creation (e.g. Blasco & Pertold-Gebicka 2013; Pissarides 1990). This line of reasoning, that lower search costs are associated with higher productivity, is well established in the labor market search theory (e.g. Autor 2001; Pissarides 1990). Moreover, Blasco & Pertold-Gebicka (2013) note that firms' performance in the short run might be reduced due to adaption costs, however, long-run effects might indeed be positive.

To sum up, the reduction of search costs because of a more efficient placement process of the Federal Employment Agency, leads to better matches, reduces the necessity for further training activities and in the end increases productivity (Autor 2001; Pissarides 1990). Ultimately, this mechanism increases the competitiveness of the benefiting establishment and facilitates job creation. Whether this hypothesis really applies is subject of the following empirical test in which we test whether the Hartz III reform is indeed associated with employment growth among those establishments which actually use the placement services.

4.4 Empirical analysis

4.4.1 IAB Establishment Panel

To examine the effect of the Hartz III reform on the establishment level, we use data from the German IAB Establishment Panel provided by the Institute for Employment Research (IAB).[6] This panel has been conducted since 1993 in Western Germany and since 1996 in Eastern Germany on an annual basis and surveys roughly 16,000 establishments per year. The panel is designed to lead to a representative sample for Germany which is explicitly analyzed, for example, by Bossler et al. (2018). The questionnaire asks a wide variety of establishment characteristics including the use of the Federal Employment Agency as a recruitment channel for establishments. This information is crucial for our identification strategy and is available for the survey years 2000 to 2008 in which we are able to create a sample of 14,658 establishment-year observations. Descriptive statistics are provided in Table 4.2.

4.4.2 Treatment and control group

To divide establishments into a treatment (Federal Employment Agency user) and control group (non user) we use information on whether establishments use the Federal Employment Agency as a recruitment channel. More precisely, we have information on reported vacancies[7] to the agency. We utilize this information to construct a treatment indicator which takes unit value for firms which continuously report vacancies greater than zero to the employment agency and additionally report vacancies at all for every sample year and zero otherwise. Establishments might anticipate a more effective placement process and therefore start to use the placement services. Our treatment indicator, however, is exogenously constructed before the reform was in place and thus we consider establishments that do not change their job search behavior, i.e. do not switch between FEA and private agents. We therefore assign establishments to the treatment and control group before the treatment occurs in 2004. On the other side, the control group consists of establishments which report zero vacancies to the Federal Employment Agency and also report vacancies greater than zero which ensures that both groups are comparable. In doing so, we are able to distinguish establishments between the year 2000 and 2008 which are directly affected by an improvement of the placement

[6] For more details regarding the sampling methodology see, for example, Bossler et al. (2018); Ellguth et al. (2014); Fischer et al. (2009).

[7] The question from the questionnaire reads in particular: "How many vacancies have you planned to be filled immediately? [...] How many of these vacancies are registered with the employment office?"

service and establishments which are not.[8] An overview regarding the distribution of establishments using the federal placement services on those which are not, is provided in Table 4.1.

Table 4.1: Raw distribution of vacancies and establishment size

	Treatment group				**Control group**			
	Observations		#Vacancies		Observations		#Vacancies	
	N	%	all	FEA	*N*	%	all	FEA
Employees	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1-19	1,717	20.57	1.74	1.68	1,928	30.56	1.47	0.00
20-49	1,343	16.09	3.52	3.39	1,267	20.08	2.07	0.00
50-199	2,239	26.82	6.34	5.98	1,644	26.05	3.30	0.00
200-499	1,618	19.38	8.46	7.50	849	13.45	5.40	0.00
500+	1,431	17.14	20.37	17.66	622	9.86	17.07	0.00
Total	8,348	100			6,310	100		

Notes: This table shows the distribution of establishments over size categories. The control group consists of establishments which do not use the Federal Employment Agency (FEA) which is identified as reported in Section 4.4.2. The treatment group consists of establishments which are using the placement services and thus are affected by the Hartz III reform, which became effective in January 1st, 2004. Data from the IAB Establishment Panel, waves 2000–2008 with an overall sample size of $N = 14,658$ establishment-year observations.

It becomes evident, that smaller establishments tend to be more prone to other recruitment channels and establishments employing more workers tend to also rely more on the Federal Employment Agency as a recruitment channel. Moreover, Table 4.1 shows the reported vacancies from the treatment and control group. As shown, the treatment group reports slightly more vacancies in every establishment size category. Most important, however, for the group definition regarding treatment and control group is column (4) and (8) in Table 4.1 which shows the vacancies among both groups which are reported to the Federal Employment Agency. Interestingly, the rates of vacancies in both groups are very similar, which is favorable for a comparison. By definition, reports of vacancies to the FEA are zero for the control observations. The treatment observations report a quite high ratio of their vacancies to the employment agencies.

[8] See, for example, Blasco & Pertold-Gebicka (2013) and Hud & Hussinger (2015) for a similar approach in classifying treatment and control groups.

4.4.3 Methodology

Dependent variables. For the difference-in-differences specification, we create the following dependent variables. As standard in the literature (e.g. Chodorow-Reich 2014; Davis et al. 2013) we compute a symmetric employment growth rate as the difference in the number of employees E_{it} in establishment i at year t and year $t-1$, divided by the average of employees in both years:

$$g_{it} = \frac{E_{it} - E_{it-1}}{(E_{it} + E_{it-1})/2} \tag{4.1}$$

The raw trend of employment growth as calculated in Equation (4.1) over time between the treatment and control group, is shown in Figure 4.2. The employment growth calculated this way is quite convenient since the rate is bounded in the range $[-2, 2]$ and furthermore can accommodate employee entries and exits, which is explicitly helpful to limit the influence of outliers in employment growth.[9] Second, we use the share of hires in relation to existing employment as proposed, for example, by Gralla & Kraft (2018) which is defined as the number of hires h_{it} in the year $t+1$ divided by the number of employees E_{it} in establishment i at year t. The raw trend of the share of hires as calculated in Equation (4.2) over time between the treatment and control group, is shown in Figure 4.1.

$$sh_{it} = \frac{100 * h_{it+1}}{E_{it}} \tag{4.2}$$

We expect this share to be positively affected by an increased employment service performance in the treatment group relative to the control group after the Hartz III reform was in place. We consider hirings and do not differentiate between employees who were previously unemployed or in employment (job-to-job transitions). For a similar approach see, for example, Blasco & Pertold-Gebicka (2013) who consider new hires stemming from the pool of unemployed, and the procedure applied by Bauer & King (2018), who consider job-to-job transitions. We model the joint movement of job-to-job seekers and job seekers who are currently unemployed.

Estimation framework. To measure the effects of an increase in placement service efficiency we rely on a difference-in-differences estimation strategy to measure whether establishments tend to exhibit a higher employment growth. For the share

[9] In this context, see for example, Chodorow-Reich (2014); Brändle & Goerke (2018); Bryson (2004); Wooden & Hawke (2000) for a similar specification of employment growth, however, in different economic contexts. Furthermore, this measure has the property of being approximately normally distributed.

of hires as the dependent variable, we apply a corner solution model estimated by a heteroscedastic tobit model to take the fraction of non-hiring establishments into account.[10] For robustness and to allow for fixed effects (FE), we also apply OLS models. We estimate the following specification:

$$y_{it} = \alpha + \beta_1 FEAuser_i + \beta_2 HartzIII_t + \tau HartzIII_t \times FEAuser_i + \beta_m X_m + \gamma_t + \rho_i + \lambda_i + \varepsilon_{it} \quad (4.3)$$

in which y_{it} represents the dependent variables 'share of hires' and 'employment growth' in establishment i at year t as calculated in Equation (4.1) and (4.2). The $HartzIII$ term is an indicator variable for the Hartz III reform and takes unit value after the reform was enacted in January 1st, 2004 and is zero otherwise. $FEAuser_i$ is an indicator variable for establishment using the Federal Employment Agency which takes unit value in this case and is zero otherwise. Our difference-in-differences estimation strategy identifies the treatment effect on the treated (ATT) which is the treatment effect for those establishments using the agency relative to those establishments which do not (Imbens & Wooldridge 2009). This effect is identified by the coefficient τ of the interaction term in Equation (4.3). Establishment particularities in recruitment behavior are taken into account by industry fixed effects ρ_i and federal state fixed effects λ_i, which capture regional labor demand shocks at a given point in time. Since the Hartz reforms consist of three packages which are implemented successively we also add year fixed effects γ_t.[11] The idiosyncratic error term is denoted as ε_{it}.

Control variables. The vector X_m represents control variables in which we add a very comprehensive set of establishment and workforce characteristics. First, we use the logarithm of employees as well as the log of employees squared to account for establishment size effects since larger firms might tend to use the agency more frequently. We use an indicator variable identifying whether the firm is a stand-alone independent establishment or part of a firm group. This variable takes unit

[10] In presence of heteroscedasticity, coefficient as well as standard error estimates in tobit models are inconsistent. It is, however, feasible to calculate a Wald test statistic to test for heteroscedasticity. Our applied Wald test clearly rejects the assumption of homoscedasticity and we therefore replace the variance σ with $\sigma_i = \sigma \times exp(w_i'\alpha)$ within the likelihood maximization (e.g. Greene 2008). The test statistic provides a value of 1199.19 with a p-value of .000. Thus, we apply a heteroscedastic tobit model in which we consider group-wise multiplicative heteroscedasticity. In this case α denotes estimated parameters of the heteroscedasticity term and w_i' is a vector of variables in which we include establishment-size as well as industry dummy variables to capture different hiring behavior among establishments and industries. Estimates from homoscedastic tobit models are also shown for reference.

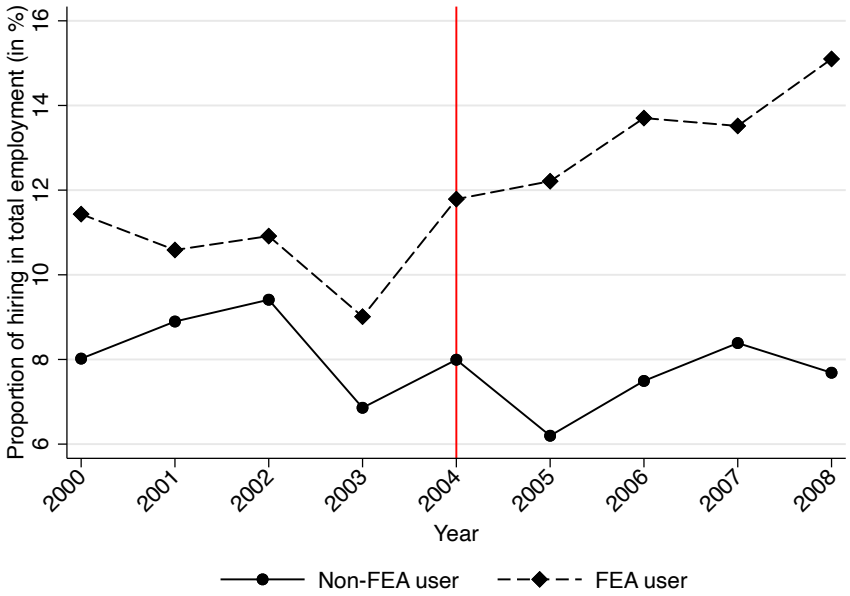
[11] In a similar context of the Hartz reforms, Launov & Wälde (2016), for example, capture other potential confounding reform effects using time dummy variables for the year 2002 and 2004.

value when the establishment is not part of a firm group and is zero otherwise. To adjust for possible age effects of establishments in a sense that older establishments are more prone to use the employment agency, we include a dummy variable which takes unit value when the establishment was founded in the year 2000 or later, and is zero otherwise. We take account of the possible influence of the legal form with the dummy variable 'limited liability'.

Furthermore, we measure effects arising from the coverage of a collective bargaining agreement with an indicator variable which takes unit value if the establishment is covered by a collective bargaining agreement and is zero otherwise. To control for different effects of concentrated ownership (one or few dominant owners) versus no dominant owner of the establishment, we use a dummy variable 'no dominant ownership' which has unit value if the ownership is broadly spread and is zero otherwise. Finally, to take employment expectations into account, we include a dummy variable which assumes unit value if the establishment indicates to have such positive expectations and is zero otherwise. This variable is obviously relevant, because positive expectations will most likely result in plans for hiring and possibly the involvement of the Federal Employment Agency as well.

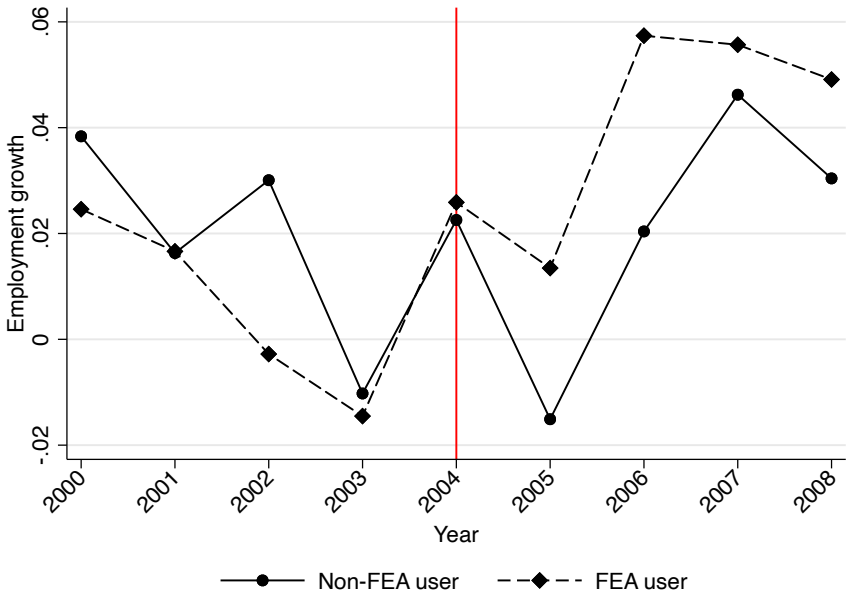
Regarding the composition of the workforce, we include the share of part time employees, the share of female employees, share of qualified employees, share of fixed term employees as well as the share of apprentices. Descriptive statistics which are differentiated according to the treatment and control groups are presented in Table 4.2.

Figure 4.1: Raw trend in share of hires in total employment



Notes: The figure shows the proportion of hiring in total employment as calculated in Equation (4.2) compared between the treatment and control group. Information on $N = 14,658$ observations on $N = 8,348$ treatment and $N = 6,310$ control observations. The treatment group consists of establishments that use the FEA and the control group of establishments that do not. The red line indicates the implementation of the Hartz III reform which became effective in January 1st, 2004. IAB Establishment Panel, own calculations, waves 2000 to 2008.

Figure 4.2: Raw trend in employment growth



Notes: The figure shows the employment growth as calculated in Equation (4.1) compared between the treatment and control group. Information on $N = 14,658$ observations on $N = 8,348$ treatment and $N = 6,310$ control observations. The treatment group consists of establishments which use the federal employment agency and the control group does not use the employment agency. The red line indicates the implementation of the Hartz III reform which became effective in January 1st, 2004. IAB Establishment Panel, own calculations, waves 2000 to 2008.

Table 4.2: Descriptive statistics of treatment and control group (N=14,658)

	Treatment group $N = 8,348$		**Control group** $N = 6,310$		**Differences**	
	Mean	Std. dev.	Mean	Std. dev.	(1)-(3)	p-value
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables						
Share of hires	12.16	29.96	7.96	20.08	4.19***	.000
Employment growth	.027	.223	.022	.223	.005	.202
Establishment controls						
(log) Employees	4.51	1.74	3.91	1.76	.601***	.000
(log) Employees squared	23.37	15.82	18.36	14.61	5.01***	.000
Western Germany	.718	.450	.771	.420	-.054***	.000
Founded in 2000 or later	.231	.421	.251	.433	-.020**	.004
Single establishment	.608	.488	.634	.482	-.026***	.001
Limited liability	.619	.486	.604	.489	.015*	.066
No dominant shareholder	.057	.231	.062	.242	-.006	.153
Positive employment expectations	.302	.459	.319	.466	-.017**	.028
Collective bargaining agreement	.523	.500	.473	.499	.050***	.000
Workforce controls						
Share of part time workers	.186	.226	.199	.241	-.013***	.001
Share of female workers	.410	.285	.414	.280	-.004	.356
Share of qualified workers	.691	.266	.699	.280	-.008*	.078
Share of fixed term workers	.094	.176	.055	.127	.038***	.000
Share of apprentices	.049	.087	.040	.075	.010***	.000

Notes: For the definition of the treatment and control group, see Section 4.4.2. Data from the IAB Establishment Panel, waves 2000–2008 with an overall sample size of $N = 14,658$. Column (5) displays the differences in mean values between treatment and control group and column (6) shows the corresponding p-value from standard t-tests. Dependent variables are calculated as outlined in Section 4.4.3 in Equation (4.1) and (4.2). *, **, *** significant at the 10%, 5%, 1% level.

4.5 Baseline results and treatment effects

Baseline results on the Hartz III reform effect are considered in this section in which we estimate the difference-in-differences specification using ordinary least squares (OLS), fixed effects (FE) as well as tobit models as outlined in Section 4.4.3. The regression results for both dependent variables ('share of hires' and 'employment growth') are presented in Table 4.3.[12] In the case of the corner-solution tobit, marginal effects are presented. These marginal effects are computed at the intensive margin, which are the marginal effects for observations with values of the dependent variable above zero, which is $\mathbb{E}(Y|Y > 0)$ (McDonald & Moffitt 1980).

In our context, the most important variable in Equation (4.3) is the coefficient τ of the interaction term $HartzIII_t \times FEAuser_i$ which measures the impact of an increase in the efficiency of the Federal Employment Agency on the proportion of hires as well as employment growth in the treatment relative to the control group. It turns out that the coefficient of this variable is positive and at least significant at the 5 percent level indicating a positive effect of the reform. In the baseline OLS models, the Hartz III reform increases the share of hires in the treatment group by roughly 2 percentage points compared to the control group. Evaluated at the sample mean of the share of hires variable, this corresponds to an increase by roughly 20% in which our results are in line with the findings by Launov & Wälde (2016), Krebs & Scheffel (2013) and Klinger & Rothe (2012). According to the tobit models the effect is slightly smaller with point estimates ranging from 0.4 to 1.01 percentage points, which are, however, also significant. The Hartz III reform therefore seems to have a positive impact on the hiring rate in the treatment group relative to the control group.

The results on all variables included can be found in the Appendix Table 4.11. First, our results show that younger establishments exhibit faster employment growth compared to older establishments which is quite in line with the literature (e.g. Haltiwanger et al. 2013). Variables capturing establishment size and age effects are highly significant. For single establishments not belonging to a multi-plant firm, we only find significant effects for the tobit specification as well as the employment growth variable. These positive effects may arise in particular because of replacement hires for employees who have left the establishment. More interestingly, though, are the effects of the workforce composition. First, we observe that the coefficient of fixed term contracts is highly significant and positive

[12] See for the full specifications including all results for the control variables, Table 4.11 in the Appendix.

Table 4.3: Results for OLS, fixed effects and tobit models

Dependent variable	Share of hires				Employment growth	
	OLS (1)	FE (2)	Tobit (3)	Het. Tobit (4)	OLS (5)	FE (6)
HARTZIII	-3.45***	-6.11***	-1.76***	-.832***	-.020**	-.093***
	(.852)	(1.30)	(.450)	(.152)	(.008)	(.015)
FEAuser	1.74***		1.05***	.041	-.014***	
	(.586)		(.304)	(.105)	(.005)	
HARTZIII × *FEAuser*	2.01**	2.03**	.927**	.417***	.025***	.037***
	(.791)	(.864)	(.414)	(.141)	(.007)	(.014)
Establishment fixed effects		✓				✓
Industry fixed effects	✓	✓	✓	✓	✓	✓
Federal state fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓	✓
R^2 / Pseudo R^2	.166	.861	.027	.034	.073	.820
Left (0) censored obs.			3,854	3,854		
Uncensored obs.			10,804	10,804		
Observations	14,658	14,658	14,658	14,658	14,658	14,658

Notes: IAB Establishment Panel, waves 2000–2008 with an overall sample size of $N = 14,658$ observations. Cluster-robust standard errors at the establishment level in parentheses. The control group consists of establishments which do not use the Federal Employment Agency which is identified as reported in Section 4.4.2. The treatment group consists of establishments which are using the placement services. The latter group is affected by the Hartz III reform which was implemented in January 1st, 2004. Estimation of the specification in Equation (4.3). Tobit model denotes the homoscedastic tobit model and in the heteroscedastic tobit model we include a vector of establishment size and industry dummy variables for the variance estimation. For more information regarding the heteroscedastic tobit model see Section 4.4.3. Year fixed effects include year dummy variables ranging from the year 2001 to 2008 with the year 2000 being the base category. Control variables are included as outlined in Section 4.4.3. Fixed effects are nested within establishment cluster. *, **, *** significant at the 10%, 5%, 1% level.

indicating that establishments might rely on a large share of fixed-term workers to fill vacancies. Second, a higher share of apprentices seems to decrease the share of hires. It might be case that workers stay in the job after their apprenticeship which decreases the need for further recruitment. Finally, we also find significant effects for the limited liability coefficient which is positive for the share of hires but negative for the employment growth variable. Thus, limited liability establishments may therefore have a higher fraction of hires, however, may grow with a lower pace compared to other establishments which have not the legal form of a limited liability.

4.5.1 Structural break test for the Hartz III reform

In this section we check whether the effect of the Hartz III reform can be measured not only by the treatment effect coefficient τ in Equation (4.3), but also by changes in all covariates. We therefore draw from the structural break literature (e.g. Chow 1960; Gujarati 1970; Dufour 1982; Cantrell et al. 1991; Antoch et al. 2019) to support our difference-in-differences results from Table 4.3. The literature on change point detection is well developed and besides studies in a time series context, recent empirical applications also in particular consider the panel data context (e.g. Jayachandran et al. 2010; Wiese 2014; Antoch et al. 2019; Lunsford

2020).

With a (variant of a) Chow test, we investigate whether the Hartz III reform may well have changed the effects of a large number of variables. We therefore test whether the Hartz III reform does not only constitutes a shift in our dependent variables as shown in Table 4.3, but also affects the whole set of control variables as well. In this view, the Hartz III reform constitutes a regime shift in terms of recruitment behavior in which the reform also affects other establishment characteristics. To do so, we apply a more generalized version of the Chow test (Chow 1960; Cantrell et al. 1991) using the dummy variable technique as proposed by Gujarati (1970) which is, for example, applied in Lunsford (2020). Whereas the classical Chow test provides evidence for the difference between two regression models, the dummy variable approach is also able to specify the source of difference. Which is either due to the intercept, the slope or both (Smith 2015; Gujarati 1970).

To implement this approach we augment our baseline specification (presented in Section 4.4.3) by adding a set of interaction variables consisting of the control variables multiplied by the Hartz III dummy variable. This specification is shown in Equation (4.4). We expect a significant break point at the timing of the Hartz III reform in the year 2004 in the series for the treatment group, but not in the control group since the latter group is unaffected by the reform.

We perform the estimates for Equation (4.4) separately for the treatment and control observations for our two dependent variables y_{it}, i.e. the 'share of hires' and 'employment growth'.[13] Consider the following regressions which we separately fit for the treatment and control group, which are denoted as $g = (T, C)$.

$$y_{itg} = \alpha_{1g} + \alpha_{2g} HartzIII_{tg} + \beta_{1g} X_{mg} + \beta_{2g} HartzIII_{tg} \times X_{mg} + \varepsilon_{itg} \tag{4.4}$$

where $i = 1, \ldots, N$ are the observations within the treatment and control group. $t = 2000, \ldots, 2008$ and the indicator variable $HartzIII_{tg}$ is defined as $HartzIII = 0$ if the year equals 2000–2003 and $HartzIII = 1$ if the year is equal to 2004–2008. In using the generalized dummy variable Chow approach (Gujarati 1970; Cantrell et al. 1991; Lunsford 2020), we inspect the following sources of structural change

[13]The industry as well as federal state fixed effects which are denoted ρ_i in Equation (4.3) are in this specification summarized within the X_m control variables. They are also subject to a potential break point.

due to the Hartz III reform:

$$\begin{aligned} \mathbb{E}(y_{it}|HartzIII = 0) &= \alpha_{1g} + \beta_{1g} X_{mg} \\ \mathbb{E}(y_{it}|HartzIII = 1) &= \underbrace{(\alpha_{1g} + \alpha_{2g})}_{\text{Break in intercept}} + \underbrace{(\beta_{1g} + \beta_{2g})}_{\text{Break in slope}} X_{mg} \end{aligned} \tag{4.5}$$

Table 4.4: Results for structural break tests

	Employment growth		**Share of hires**	
Break point:	Treatment	Control	Treatment	Control
Hartz III (2004)	(1)	(2)	(3)	(4)
Break in intercept	1.84	1.95	.610	2.40
	(.175)	(.163)	(.435)	(.121)
Break in slope	2.09***	1.23	1.52***	1.04
	(.000)	(.120)	(.004)	(.398)
Industry fixed effects	✓	✓	✓	✓
Federal state fixed effects	✓	✓	✓	✓
Control variables	✓	✓	✓	✓
R^2	.086	.090	.211	.125
Observations	8,348	6,310	8,348	6,310

Notes: This table shows the dummy variable technique chow test according to the specification in Equation (4.4) and (4.5) as outlined in Gujarati (1970). Results show the Wald-statistic and the corresponding p-value in parenthesis. The Wald test is calculated for both dependent variables between the treatment and control group including the industry and federal state dummy variables. Critical values for the test statistics differ because of different sample sizes and thus degrees of freedom between the samples. Control variables are included as outlined in Section 4.4.3. Results account for selection effects using IPW weights as outlined in Section 4.5.2. Different weights provide very similar results. Significance: *, **, *** significant at the 10%, 5%, 1% level.

For each of our two dependent variables y_{itg} and for the treatment and control group $g = (T, C)$ we perform Wald-tests on the α and β coefficients separately to check whether the α or β coefficients are jointly different from zero to test for a structural break in the intercept or the slope. We therefore perform eight different regressions and in the case the reform effects are strong enough, we should see a significant difference in the treatment group but not in the control group. Results of these tests are provided in Table 4.4.

As expected and shown in Table 4.4, the test results indicate no reform effect on the establishments forming the control group, neither for the employment growth variable nor for the share of hires. For observations from the treatment group, however, there are significant differences between the pre- and post-intervention Hartz

III period. We therefore find supplementary evidence besides the difference-in-differences estimation, that there is indeed a reform effect in the Hartz III affected treatment group, but not in the control group. Furthermore, the dummy variable approach Chow test (Gujarati 1970; Cantrell et al. 1991; Lunsford 2020) allows us to test whether the structural break arises because of shifts in the intercept or the slope coefficients. For the 'employment growth' and 'share of hires' variables, we find significant differences for the slope coefficients but not for the intercepts.

4.5.2 Selectivity of Federal Employment Agency

Although our difference-in-differences model include a large set of establishment control variables, there might also be pre-existing differences which determine the FEA user status which is not captured by these variables. For example, establishments might need highly specialized personnel for whom the employment office is not the right service provider. Another possibility is an unobserved demand shock, which has a positive effect on the growth opportunities and simultaneously causes companies to contact the employment office, which was not necessary in other times. If this is actually the case, we face a selection problem since unobserved variables affecting both, the decision to use the employment agency as well determinants of employment growth.

We tackle this problem by applying difference-in-differences estimation with an inverse probability weighing (IPW) approach (e.g. Imbens & Wooldridge 2009).[14] The idea behind this approach is to create a similar sample of establishments in which the treatment (FEA usage) is independent of observed confounders. This process follows a twostep approach. First, we use the binary dependent variable which is defined as the treatment indicator and takes unit value if the establishment uses the employment agency for their recruiting and zero otherwise. Then, we estimate the propensity score p_t for each available year from 2000 to 2008 using a probit model for binary dependent variables. We adjust for the composition of the workforce by including the share of part-time workers, the share of female workers, the share of high-qualified, apprentices as well as the share of workers which are employed on the basis of fixed term contracts. We also include a comprehensive set of control variables which are the same as in the regressions in Equation (4.3) and Equation (4.6). We also take industry fixed effects into account. The results of the probit regressions which are used to calculate the propensity score for each year are presented in the Appendix in Table 4.12. Second, we calculate the inverse

[14]For a similar approach in the context of unemployment benefits and re-employment rates, see for example Uusitalo & Verho (2010). In Section 4.6.1 we also apply different definitions of the IPW approach in which we additionally use propensity score trimming, different weights and normalized weights.

of these obtained propensity scores to re-weight the difference-in-differences regressions accordingly.[15] Finally, we provide mean comparisons between the FEA users and non-users which are provided in Table 4.13 in the Appendix of this chapter.

Table 4.5: Results for IPW OLS, fixed effects and tobit models

Dependent variable	Share of hires				Employment growth	
	OLS (1)	FE (2)	Tobit (3)	Het. Tobit (4)	OLS (5)	FE (6)
HARTZIII	-3.66 ***	-5.64***	-1.72***	-.836***	-.025***	-0.79***
	(.920)	(1.17)	(.472)	(.172)	(.009)	(.014)
FEAuser	1.99***		1.14***	.042	-.013**	
	(.565)		(.293)	(.110)	(.005)	
HARTZIII × *FEAuser*	1.83**	1.92**	.704*	.313*	.025***	.029**
	(.804)	(.931)	(.422)	(.170)	(.008)	(.013)
Establishment fixed effects		✓				✓
Industry fixed effects	✓	✓	✓	✓	✓	✓
Federal state fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓	✓
R^2 / Pseudo R^2	.155	.875	.028	.037	.074	.837
Left (0) censored obs.			3,847	3,847		
Uncensored obs.			10,770	10,770		
Observations	14,617	14,617	14,617	14,617	14,617	14,617

Notes: IAB Establishment Panel, waves 2000–2008. Cluster-robust standard errors at the establishment level in parentheses. Estimation regarding the specification in Equation (4.3). Tobit model denotes the homoscedastic tobit model and in the heteroskedastic tobit model we include a vector of establishment size and industry dummy variables for the variance estimation. Heteroscedastic Tobit specification as in Section 4.4.3. Year fixed effects include year dummy variables ranging from the year 2001 to 2008 with the year 2000 being the base category. Control variables are included as outlined in Section 4.4.3. The control group receives the weights which are calculated as $w_t^c = \frac{1}{(1-p_t)}$ and the treatment group receive weights which are calculated as $w_t^t = \frac{1}{p_t}$. Here, p_t is the propensity score for each cross-section calculated as the predicted probability of receiving the treatment stemming from probit estimates provided in Table 4.12. For robustness tests regarding the calculation of weights see Section 4.6.1. Fixed effects are nested within establishment cluster. Significance: *, **, *** significant at the 10%, 5%, 1% level.

As shown in the last column of Table 4.13, all differences in covariates between the treatment and control group are vanished after the IPW matching procedure. Results of these re-weighted regressions are presented in Table 4.5. As before, the interaction term denotes the treatment effect which is positive and significant for the OLS, fixed effects and tobit specifications. The coefficients in the difference-in-differences regressions are very similar to the unweighted ones, presented in Table 4.3. After the Hartz III reform is in place, establishments using the Federal Employment Agency have a 1.8 percentage point increased share of hires compared to the establishments not using the placement services. This results are still significant at the 1 percent level. The marginal effects based on the Tobit estimations are again smaller than the OLS coefficients and also slightly smaller than the marginal effects presented in Table 4.3 but they remain significant. In terms of employment growth, our results show that establishments which use the placement services,

[15]The control group then receives the weights which are calculated as $w_t^c = \frac{1}{(1-p_t)}$ and the treatment group receive weights which are calculated as $w_t^t = \frac{1}{p_t}$ (e.g. Imbens & Wooldridge 2009). For different specifications of the weights, see Section 4.6.1.

indeed have also a higher employment growth in the magnitude of 2.5 percentage points.

4.5.3 Test for common trend before the Hartz III reform

A crucial assumption for the identification of the treatment effect within the difference-in-differences framework is the common trend assumption. It states that trends in outcome variables among the treatment and control group should be similar before the intervention (e.g. Imbens & Wooldridge 2009). In our case this assumption states that the treatment group has the same trend in employment growth and share of shires before the Hartz III intervention. As for example shown in Figure 4.2 and 4.1, the unadjusted raw trends in both dependent variables are roughly similar before the intervention. After the reform was implemented, however, both trends diverge.

To test the common trend assumption, we apply the following augmented regression for both dependent variables (e.g. Mora & Reggio 2015). To do so, we re-estimate the model given in Equation (4.3) and replace the Hartz III dummy variable and interaction with a set of time dummies and its interaction terms with the treatment dummy, resulting in the model presented in Equation (4.6). A similar approach in this context is also provided, for example, by Giebel & Kraft (2019) and Hangoma et al. (2018).

$$y_{it} = \alpha + \beta_1 FEAuser_i + \sum_{t=2001}^{2008} \tau_t \times FEAuser_i \times Year_t + \beta_m X_m + \gamma_t + \rho_i + \varepsilon_{it} \tag{4.6}$$

In this setting, y_{it} are the dependent variables as outlined in Section 4.4.3. X_m is a vector of control variables. A set of industry fixed effects is denoted as ρ_i, year fixed effects as γ_t. and the idiosyncratic error term is denoted as ε_{it}. The estimation results which also include control variables are presented in Table 4.6.[16]

For the common-trend to hold, we test whether all year-FEA user interaction variables in the pre-treatment period before the year 2004 are jointly not different from zero. Thus, we test the parallel trend assumption with $H_0 : \tau_t = 0 \; \forall \; t \leq 2003$. By estimating Equation (4.6) we test for the joint significance of the pre-treatment year-treat interaction effects. As before we use OLS to explain employment growth and (heteroscedastic) tobit to explain hire rates. Furthermore we also estimated the selectivity adjusted IPW models explained and presented in Section 4.5.2.[17]

[16] We also estimated fixed effects models using this specification, however, the results of the test statistics do not change much and we do not reject H_0.

[17] We also estimated these models using inverse probability reweighed models in which we

Table 4.6: Flexible model and test for common trends

Dependent variable	Share of hires		Employment growth	
	Het. Tobit	Het. Tobit IPW	OLS	OLS IPW
	(1)	(2)	(3)	(4)
FEA user	-.009	-.001	-.014	-.013
	(.414)	(.450)	(.009)	(.010)
FEA user × 2001	.529	.356	.014	.014
	(.506)	(.601)	(.013)	(.014)
FEA user × 2002	.067	-.001	-.019	-.020
	(.561)	(.740)	(.014)	(.014)
FEA user × 2003	-.553	-1.069	.003	.004
	(.752)	(.740)	(.016)	(.017)
FEA user × 2004	.816	1.456*	.008	.011
	(.631)	(.834)	(.016)	(.018)
FEA user × 2005	.655	-.860	.035**	.044***
	(.602)	(.994)	(.016)	(.019)
FEA user × 2006	1.515**	1.144*	.048***	.041**
	(.604)	(.692)	(.016)	(.017)
FEA user × 2007	.972*	.323	.015	.009
	(.577)	(.601)	(.014)	(.015)
FEA user × 2008	1.312**	1.225*	.021	.026*
	(.551)	(.666)	(.013)	(.015)
Constant	-11.96***	-10.09***	-.167***	-.171***
	(4.10)	(3.83)	(.028)	(.029)
$H_0 : \tau_t = 0 \; \forall \; t \leq 2003$:	2.62	3.16	1.86	1.53
F / Wald-statistic (p-value)	(.455)	(.368)	(.135)	(.205)
Industry fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Control variables	✓	✓	✓	✓
R^2/ Pseudo R^2	.164	.150	.074	.075
Observations	14,658	14,617	14,658	14,617

Notes: IAB Establishment Panel, waves 2000–2008 with an overall sample size of $N = 14,658$ observations and $N = 14,617$ observations for the IPW re-weighted estimation results in column (2) and (4). Cluster-robust standard errors at the establishment level in parentheses. Estimation regarding the specification in Equation (4.6) in which the treatment effect is shown over time. Stated null hypothesis tests for common pre-treatment trends (i.e. joint significance of treatment-year interaction terms before the year 2004). Point estimates as well as the test results are also quite the same in case we apply different weighting schemes as explained in the next Section 4.6.1. Significance: *, **, *** significant at the 10%, 5%, 1% level.

For the share of hires in column (1) we perform Wald-tests and find $Wald = 2.62$ with a p-value of .455; and (2) for the share of hires (IPW) weighted: $Wald = 3.16$ with a p-value of .368. For the employment growth dependent variable, we obtain

apply different weights, as well as propensity score trimming and normalized weights as outlined in Section 4.6.1. The results of the common trend tests, however, did not change and there is no specification in which we reject H_0. We thus conclude that the common trends assumptions is satisfied in our sample.

in column (3) unweighted: $F = 1.86$ with a p-value of .135 and (4) (IPW) weighted: $F = 1.53$ with a p-value of .205. The joint F-tests reveal that we can indeed not reject that all pre-treatment year-treat interaction effects are different from zero. Thus, the common trend assumption seems to be fulfilled. To sum up, the results of the estimation of Equation (4.6) supports the common trend assumption in which the trends of the employment growth and share of hires are equal before the Hartz III intervention.

4.6 Robustness tests

4.6.1 Different IPW weights

The results so far have to be interpreted as the average treatment effect (ATE) in which we use calculated weights as described in Section 4.5.2. As a further robustness test we calculate different weights and calculate the average treatment effect on the treated (ATT) (e.g. Stuart 2010). Compared to the ATE results in which we weight the treatment and control group, we now only re-weight the comparison group to match the distribution of control variables compared to the treatment group. Thus, the control group receives weights which are calculated as $w_t^c = \frac{p_t}{(1-p_t)}$ and the treatment group receive weights $w_t^t = 1$. Similar as before, p_t is the propensity score for each cross-section calculated as the predicted probability of using the Federal Employment Agency stemming again from probit estimates provided in the Appendix in Table 4.12.[18] Results are provided in Table 4.7.

Reweighted estimates using ATT weights are usually slightly larger in magnitudes (e.g. Uusitalo & Verho 2010), which is what we also find in our results for the most specifications. The results are, however, at similar levels of significance. In all specifications using the selectivity adjusted difference-in-differences specification we find robust and significant positive employment effects for the FEA user group compared to the non-user group after the reform was in place. Comparisons of means among the covariates after the re-weighting approach are also balanced which is a necessary condition for interpreting the results. See Table 4.14 for the balancing of covariates with respect to ATT weights.

4.6.2 Trimmed and normalized weights

Extreme values of the weights might impose a threat to the identification of the treatment effect and the variance of the estimates (e.g. Kranker et al. 2021). This rationale holds for both the ATE as well as the ATT results. The usual solution

[18] See Campolieti (2018); Uusitalo & Verho (2010) for a similar application.

Table 4.7: Results for IPW OLS, fixed effects and tobit models: ATT weights

Dependent variable	Share of hires				Employment growth	
	OLS (1)	FE (2)	Tobit (3)	Het. Tobit (4)	OLS (5)	FE (6)
$HARTZIII$	-3.88***	-5.78***	-1.74***	-.922***	-.024**	-0.75***
	(1.09)	(1.38)	(.542)	(.212)	(.010)	(.014)
$FEAuser$	1.98***		1.12***	-.010	-.012**	
	(.593)		(.304)	(.131)	(.006)	
$HARTZIII \times FEAuser$	2.72***	1.79*	1.21***	.514**	.028***	.025*
	(.888)	(1.02)	(.455)	(.209)	(.008)	(.013)
Establishment fixed effects		✓				✓
Industry fixed effects	✓	✓	✓	✓	✓	✓
Federal state fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓	✓
R^2 / Pseudo R^2	.177	.870	.027	.039	.067	.827
Left (0) censored obs.			3,847	3,847		
Uncensored obs.			10,770	10,770		
Observations	14,617	14,617	14,617	14,617	14,617	14,617

Notes: IAB Establishment Panel, waves 2000–2008. Cluster-robust standard errors at the establishment level in parentheses. Estimation regarding the specification in Equation (4.3). Year fixed effects include year dummy variables ranging from the year 2001 to 2008 with the year 2000 being the base category. Control variables are included as outlined in Section 4.4.3. The control group receives the weights which are calculated as $w_t^c = \frac{p_t}{(1-p_t)}$ and the treatment group receive weights which are calculated as $w_t^t = 1$. Here, p_t is the propensity score for each cross-section calculated as the predicted probability of receiving the treatment stemming from Probit estimates in Table 4.12. For robustness tests regarding the calculation of weights see Section 4.6.1. Fixed effects are nested within establishment cluster. Significance: *, **, *** significant at the 10%, 5%, 1% level.

to this threat relies on dropping values which extreme large or small weights. As a further robustness check we therefore apply symmetric trimming in which we exclude establishments with propensity scores outside of the range of $[\alpha, 1-\alpha]$ in which α is a threshold parameter which can be chosen by the researcher (Li et al. 2018). We choose a quite common value of $\alpha = 0.1$ and discard these establishments with propensity scores below and above the threshold to ensure a better overlap (Crump et al. 2009). We therefore loose $N = 421$ observations for the following regressions.

As a final step, we normalize the applied weights to sum to one when estimating the reweighted difference-in-differences specifications (Busso et al. 2014). There are in fact many empirical examples in which normalized matching estimators are used in the empirical literature (e.g. Robins et al. 2007; Imbens 2004). They provide some efficiency advantages and moreover, they are more reliably in finite samples (e.g. Busso et al. 2014). Results for using trimmed and normalized ATT weights are provided in Table 4.8 and results for ATE weights in Table 4.9. As a final robustness check we also estimated each specification using either (i) only propensity score trimming with a similar trimming value of $\alpha = 0.1$ or (ii) normalized weights. For every specification in which we estimate OLS, fixed effects as well as Tobit models, we find very similar results as presented in the Tables 4.8 and 4.9.

Table 4.8: Trimmed propensity score and normalized ATT weights

Dependent variable	Share of hires				Employment growth	
	OLS (1)	FE (2)	Tobit (3)	Het. Tobit (4)	OLS (5)	FE (6)
HARTZIII	-2.94***	-4.37**	-1.39***	-.763***	-.016*	-.075***
	(.993)	(1.09)	(.500)	(.183)	(.009)	(.014)
FEAuser	2.29***		1.26***	.066	-.010*	
	(.580)		(.297)	(.127)	(.005)	
HARTZIII × *FEAuser*	2.05**	1.97**	.941**	.442***	.019**	.023*
	(.843)	(.953)	(.434)	(.171)	(.008)	(.013)
Establishment fixed effects		✓				✓
Industry fixed effects	✓	✓	✓	✓	✓	✓
Federal state fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓	✓
R^2 / Pseudo R^2	.158	.893	.028	.036	.066	.833
Left (0) censored obs.			3,757	3,757		
Uncensored obs.			10,439	10,439		
Observations	14,196	14,196	14,196	14,196	14,196	14,196

Notes: IAB Establishment Panel, waves 2000–2008. Cluster-robust standard errors at the establishment level in parentheses. Year fixed effects include year dummy variables ranging from the year 2001 to 2008 with the year 2000 being the base category. Control variables are included as outlined in Section 4.4.3. The control group receives the weights which are calculated as $w_t^c = \frac{p_t}{(1-p_t)}$ and the treatment group receive weights which are calculated as $w_t^t = 1$. We also apply symmetric trimming using the threshold parameter $\alpha = 0.1$ as well as normalized IPW weights (e.g. Busso et al. 2014). Fixed effects are nested within establishment cluster. Significance: *, **, *** significant at the 10%, 5%, 1% level.

Table 4.9: Trimmed propensity score and normalized ATE weights

Dependent variable	Share of hires				Employment growth	
	OLS (1)	FE (2)	Tobit (3)	Het. Tobit (4)	OLS (5)	FE (6)
HARTZIII	-3.04***	-4.77***	-1.45***	-.740***	-.018**	-.080***
	(.885)	(1.05)	(.457)	(.156)	(.009)	(.014)
FEAuser	2.21***		1.23***	.089	-.011**	
	(.563)		(.292)	(.108)	(.005)	
HARTZIII × *FEAuser*	1.46*	2.07**	.606*	.310**	.019**	.030**
	(.791)	(.929)	(.353)	(.145)	(.008)	(.013)
Establishment fixed effects		✓				✓
Industry fixed effects	✓	✓	✓	✓	✓	✓
Federal state fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
Control variables	✓	✓	✓	✓	✓	✓
R^2 / Pseudo R^2	.142	.890	.029	.033	.070	.840
Left (0) censored obs.			3,757	3,757		
Uncensored obs.			10,439	10,439		
Observations	14,196	14,196	14,196	14,196	14,196	14,196

Notes: IAB Establishment Panel, waves 2000–2008. Cluster-robust standard errors at the establishment level in parentheses. Year fixed effects include year dummy variables ranging from the year 2001 to 2008 with the year 2000 being the base category. Control variables are included as outlined in Section 4.4.3. The control group receives the weights which are calculated as $w_t^c = \frac{1}{(1-p_t)}$ and the treatment group receive weights which are calculated as $w_t^t = \frac{1}{p_t}$. We also apply symmetric trimming using the threshold parameter $\alpha = 0.1$ as well as normalized IPW weights (e.g. Busso et al. 2014). Fixed effects are nested within establishment cluster. Significance: *, **, *** significant at the 10%, 5%, 1% level.

4.7 Conclusion

Since their introduction, the Hartz reforms have been the subject of much controversy and the intensity of this discussion is increasing rather than decreasing. Our

contribution focuses at a less noticed part of the reforms, which is the modernization of the employment agency stipulated in the Hartz III reform. In this chapter we analyze an increase in the job placement efficiency of the Federal Employment Agency on employment growth. Compared to other studies, we measure the effect not on the individual or macro, but rather on the establishment level.

A unique exogenous shock arising from the Hartz III legislation in the matching technology of the agency in Germany in 2004 allows us to investigate hiring behavior and employment growth on the labor demand side. We use the IAB Establishment Panel provided by the Institute for Employment Research (IAB) to identify establishments which actually use the placement service of the Federal Employment Agency and compare those firms to the control group which do not use the placement services. We apply conditional difference-in-differences estimations to measure the treatment effect on the treated. In addition, we take selectivity issues for the decision to use the placement service into account by applying inverse probability weighting. We provide evidence that the reform, which re-framed the agency, is indeed beneficial for the job placement. Our estimates show that establishments which use the services, realize an increase in the proportion of hires and the employment growth is also higher compared to establishments which do not use the placement service. These results are robust to selectivity which we checked using inverse-probability weighting with different specifications for the weights. The common trend assumption also seems to be fulfilled prior to the Hartz III intervention.

An important extension to our study is the differentiation of employment, for example, into temporary and permanent employment. The Federal Employment Agency may be in particular relevant for unskilled and low-educated workers (e.g. Fougère et al. 2009) and thus, there may be substitution effects in a sense that firms substitute costly permanent employment by temporary agency workers.

With respect to policy implications, we provide further evidence for the importance of the placement service in the labor market. The need for efficient placement agencies will probably increase even more if, for example, members of certain qualification groups (low but also medium qualified) are dismissed because of technical progress. Getting them back into work requires efficient matching. The current problems on the labor market in the context of the COVID-19 pandemic also result in an additional need for efficient job finding.

4.8 Appendix

Table 4.10: Description and explanation of variables, $N = 14,658$

Variable	Description	Mean (Std. dev.)
Dependent variables		
Employment growth	Number of employees E_{it} in establishment i, year t and $t-1$, divided by the average of employees in both years. $$g_{it} = \frac{E_{it} - E_{it-1}}{(E_{it} + E_{it-1})/2}$$	.025(.223)
Share of hires	Number of hires h_{it} in the year $t+1$ divided by the number of employees E_{it} in establishment i at year t. $$sh_{it} = \frac{100 * h_{it+1}}{E_{it}}$$	10.351(26.248)
Control variables		
log(Employees)	Natural logarithm of the number of employees.	4.251(1.773)
log(Employees squared)	Natural logarithm of the squared number of employees.	21.212(15.506)
Pos. empl. expec.	Dummy variable equals 1 whether establishment expects a positive employment trend in the next two years and 0 otherwise.	.309(.462)
Single establishment	Dummy variable equals 1 whether the establishment is not part of a larger company or organization (i.e. single establishment) and 0 otherwise.	.619(.486)
Limited liability	Dummy variable equals 1 whether the establishment is the legal form of a limited liability (e.g. GmbH, UG Ltd.) and 0 otherwise.	.613(.487)

Variable	Description	
Western Germany	Dummy variable equals 1 whether the establishment is based in Western Germany and zero otherwise.	.741(.438)
Diverse ownership	Dummy variable equals 1 whether the establishment has no dominant shareholder and 0 otherwise.	.059(.236)
Collective bargaining	Dummy variable equals 1 whether the establishment is bound by an industry-wide wage agreement and 0 otherwise.	.501(.500)
Founded after 2000	Dummy variable equals 1 whether the establishment was founded after the year 2000 and 0 otherwise.	.239(.427)
Workforce controls		
Share of female	Continuous measure for the share of female workers in relation to employment in year t.	.412(.283)
Share of part-time	Continuous measure for the share of part-time workers in relation to employment in year t.	.192(.232)
Share of fixed-term	Continuous measure for the share of fixed-term workers in relation to employment in year t.	.077(.158)
Share of high-skilled	Continuous measure for the share of high-skilled workers in relation to employment in year t which require a university degree.	.694(.272)
Share of apprentices	Continuous measure for the share of apprentices in relation to employment in year t.	.045(.082)

Table 4.11: Full results for OLS, fixed effects and tobit models

Dependent variable	Share of hires				Employment growth	
	OLS (1)	FE (2)	Tobit (3)	Het. Tobit (4)	OLS (5)	FE (6)
$HATRTZIII$	-3.45***	-6.11***	-1.76***	-.832***	-.020**	-.093***
	(.852)	(1.30)	(.450)	(.152)	(.008)	(.015)
$FEAuser$	1.74***		1.05***	.041	-.014***	
	(.586)		(.304)	(.105)	(.005)	
$HARTZIII \times FEAuser$	2.01**	2.03**	.927**	.417***	.025***	.037***
	(.791)	(.864)	(.414)	(.141)	(.007)	(.014)
(log) Employees	2.908***	28.701***	4.827***	2.731***	.078***	.723***
	(.486)	(1.160)	(.416)	(.238)	(.007)	(.067)
(log) Employees squared	-.360***	-2.469**	-.405***	-.214***	-.007***	-.046***
	(.050)	(1.042)	(.037)	(.021)	(.001)	(.007)
Single establishment	.677	-.405	.481**	.074	.016***	-.004
	(.473)	(1.242)	(.227)	(.076)	(.004)	(.013)
Limited liability	-.724	-1.102	-.305	.525***	-.015***	-.011
	(.556)	(1.405)	(.289)	(.119)	(.005)	(.017)
Share of part time employees	.209	4.623	.244	1.026**	.043***	-.058
	(1.470)	(3.435)	(.757)	(.422)	(.013)	(.036)
Share of female employees	-4.416***	5.191	-2.328***	-1.094***	-.001	.095*
	(1.256)	(6.105)	(.663)	(.358)	(.012)	(.052)
Share of qualified employees	-6.523***	2.215	-2.399***	-.893***	.009	-.014
	(1.235)	(4.657)	(.615)	(.251)	(.010)	(.032)
Share of fixed term empl.	32.611***	21.849***	15.730***	14.181***	.043**	.190***
	(3.772)	(7.947)	(1.578)	(1.002)	(.021)	(.050)
Share of apprentices	-18.847***	-22.003***	-11.238***	-5.617***	.025	-.214*
	(1.948)	(7.538)	(1.312)	(.845)	(.028)	(.116)
Diverse ownership	-.804	1.851	-.086	.124	-.010	.008
	(.763)	(1.340)	(.393)	(.159)	(.008)	(.022)
Positive empl. expec.	3.215***	1.192	1.721***	1.032***	.050***	.029***
	(.527)	(.737)	(.267)	(.101)	(.004)	(.007)
Collective bargaining	-.033	.811	-.376	-.691***	-.018***	.016
	(.490)	(1.112)	(.246)	(.096)	(.004)	(.010)
Founded year ≥ 2000	7.778***	-1.182	4.538***	.642***	.067***	.026
	(.749)	(2.332)	(.411)	(.162)	(.006)	(.022)
Constant	9.59***	-73.26***	24.58***	16.04***	-.166***	-2.26***
	(2.64)	(25.44)	(1.46)	(.463)	(.028)	(.180)
Establishment fixed effects		✓				✓
Industry fixed effects	✓	✓	✓	✓	✓	✓
Federal state fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓
R^2 / Pseudo R^2	.166	.861	.027	.034	.073	.820
Left (0) censored obs.			3,854	3,854		
Uncensored obs.			10,804	10,804		
Observations	14,658	14,658	14,658	14,658	14,658	14,658

Notes: IAB Establishment Panel, waves 2000–2008 with an overall sample size of $N = 14,658$ observations. Cluster-robust standard errors at the establishment level in parentheses. The control group consists of establishments which do not use the Federal Employment Agency which is identified as reported in Section 4.4.2. The treatment group consists of establishments which are using the placement services. The latter group is affected by the Hartz III reform which was implemented in January 1st, 2004. Estimation regarding the specification outlined in Equation (4.3). Tobit model denotes the homoscedastic tobit model and in the heteroscedastic tobit model we include a vector of establishment size and industry dummy variables for the variance estimation. For more information regarding the heteroscedastic tobit model see Section 4.4.3. Year fixed effects include year dummy variables ranging from the year 2001 to 2008 with the year 2000 being the base category. Fixed effects are nested within establishment cluster. *, **, *** significant at the 10%, 5%, 1% level.

Table 4.12: Probit estimates for obtaining propensity scores to calculate inverse probability weights

Dependent variable: FEA user	2000 (1)	2001 (2)	2002 (3)	2003 (4)	2004 (5)	2005 (6)	2006 (7)	2007 (8)	2008 (9)
(log) Employees	-.036	-.052	.012	.159	.121	.324***	-.042	.189**	.142*
	(.085)	(.084)	(.092)	(.098)	(.102)	(.103)	(.091)	(.081)	(.077)
(log) Employees squared	.017*	.021**	.014	.002	-.001	-.021*	.018*	-.003	-.001
	(.009)	(.009)	(.010)	(.011)	(.011)	(.011)	(.010)	(.009)	(.009)
Single establishment	-.016	.016	.017	.023	.005	.121	.037	.146**	.148**
	(.073)	(.070)	(.079)	(.094)	(.090)	(.090)	(.077)	(.068)	(.067)
Limited liability	-.149*	-.004	-.007	-.071	-.012	.032	.126	.045	-.054
	(.077)	(.080)	(.089)	(.108)	(.111)	(.117)	(.097)	(.085)	(.080)
Share of part time employees	-.094	-.128	-.391**	-.092	-.596***	-.242	-.386**	-.310*	-.428***
	(.192)	(.181)	(.192)	(.216)	(.225)	(.230)	(.189)	(.168)	(.153)
Share of female employees	-.208	-.081	.005	-.058	-.049	-.086	.024	.090	.020
	(.180)	(.167)	(.183)	(.210)	(.207)	(.225)	(.195)	(.161)	(.154)
Share of qualified employees	-.038	-.026	-.273*	-.044	.024	.243	-.217	-.124	-.022
	(.135)	(.130)	(.146)	(.174)	(.179)	(.189)	(.162)	(.139)	(.128)
Share of fixed term empl.	1.249***	1.270***	1.051***	.961***	.735***	1.162***	1.070***	.580***	.802***
	(.331)	(.297)	(.287)	(.282)	(.283)	(.282)	(.246)	(.210)	(.193)
Share of apprentices	1.340***	1.320***	.874*	2.394***	.266	1.624**	.146	1.066**	1.067**
	(.465)	(.394)	(.451)	(.618)	(.554)	(.648)	(.472)	(.485)	(.416)
Diverse ownership	.058	-.051	.100	-.065	.268	.102	-.108	.034	-.183
	(.147)	(.140)	(.160)	(.173)	(.178)	(.183)	(.147)	(.135)	(.123)
Positive empl. expec.	.124*	.125*	.019	-.050	-.077	.024	.083	.025	.035
	(.072)	(.070)	(.081)	(.094)	(.093)	(.097)	(.076)	(.065)	(.062)
Collective bargaining	.038	-.015	-.144*	-.068	.031	-.001	-.049	.054	.005
	(.073)	(.069)	(.080)	(.091)	(.092)	(.091)	(.077)	(.068)	(.065)
Founded year ≥ 2000	-.036	.102	-.091	.104	.076	.041	-.022	-.069	.110
	(.110)	(.096)	(.091)	(.101)	(.100)	(.103)	(.082)	(.070)	(.067)
Constant	.024	-.390	-.208	-.033	-.850**	-.799	-.220	-.688*	-.894**
	(.451)	(.399)	(.340)	(.531)	(.432)	(.503)	(.413)	(.373)	(.377)
Industry fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Federal state fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pseudo R^2	.119	.128	.123	.140	.130	.161	.117	.120	.119
Log-Likelihood	-1062.43	-1177.99	-961.18	-688.58	-705.94	-660.68	-959.08	-1194.99	-1310.64
Observations	1773	1979	1621	1179	1198	1144	1574	1986	2163

Notes: IAB Establishment Panel, waves 2000–2008 and an overall sample size of $N = 14,617$ observations own calculations. Robust standard errors in parentheses. Control variables are included as outlined in Section 4.4.3. Predicted propensity scores from these regressions are used in each cross-section to balance observations and adjust for observable differences as suggested by Imbens & Wooldridge (2009). These probit estimates are the basis to calculate ATT and ATE weights. Significance: *, **, *** significant at the 10%, 5%, 1% level.

Table 4.13: Mean differences of matched covariates using ATE weights

Year	Mean		t-Test		Mean		t-Test		Mean		t-Test
2000	Control	Treated	p-value	**2001**	Control	Treated	p-value	**2002**	Control	Treated	p-value
(log) Employees	4.364	4.380	.863		4.269	4.259	.914		4.140	4.124	.891
(log) Employees squared	21.846	22.069	.792		21.109	21.049	.940		20.408	20.312	.924
Single establishment	.624	.611	.607		.634	.632	.938		.642	.640	.951
Limited liability	.583	.575	.744		.596	.588	.758		.549	.540	.772
Share of part time employees	.155	.158	.782		.176	.177	.889		.201	.204	.810
Share of female employees	.410	.410	.992		.412	.415	.852		.430	.426	.823
Share of qualified employees	.637	.638	.930		.675	.672	.852		.644	.662	.332
Share of fixed term empl.	.054	.055	.889		.053	.055	.755		.090	.076	.444
Share of apprentices	.051	.048	.618		.047	.047	.986		.063	.054	.510
Diverse ownership	.056	.055	.929		.055	.061	.692		.052	.055	.790
Positive empl. expec.	.321	.331	.698		.272	.288	.516		.239	.243	.889
Collective bargaining	.569	.572	.908		.546	.542	.892		.502	.518	.611
Founded year $\geq$ 2000	.114	.116	.929		.119	.117	.929		.190	.189	.951

Notes: Weighted means for FEA user and FEA non-user establishments. The control group receives the weights which are calculated as $w_t^c = \frac{1}{(1-p_t)}$ and the treatment group receives weights which are calculated as $w_t^t = \frac{1}{p_t}$. Here, p_t is the propensity score for each cross-section calculated as the predicted probability of receiving the treatment stemming from probit estimates in Table 4.12. Each last column displays the p-value of a t-test for the difference in mean values. Significance: *, **, *** significant at the 10%, 5%, 1% level.

Mean differences of matched covariates using ATE weights: *continued*

Year	Mean		t-Test		Mean		t-Test		Mean		t-Test
2003	Control	Treated	p-value	**2004**	Control	Treated	p-value	**2005**	Control	Treated	p-value
(log) Employees	4.029	4.059	.815		4.390	4.391	.999		4.358	4.344	.920
(log) Employees squared	19.510	19.770	0.813		22.591	22.529	.960		22.386	22.422	.976
Single establishment	.657	.648	.764		.626	.620	.840		.556	.560	.903
Limited liability	.581	.579	.930		.638	.652	.663		.632	.628	.899
Share of part time employees	.183	.192	.538		.185	.175	.555		.172	.174	.857
Share of female employees	.421	.428	.688		.413	.408	.791		.416	.414	.902
Share of qualified employees	.709	.704	.785		.690	.697	.717		.713	.718	.800
Share of fixed term empl.	.068	.073	.671		.094	.087	.655		.099	.097	.930
Share of apprentices	.048	.047	.920		.049	.045	.691		.043	.043	.995
Diverse ownership	.050	.056	.671		.064	.063	.943		.068	.071	.900
Positive empl. expec.	.265	.270	.874		.254	.256	.936		.279	.289	.761
Collective bargaining	.483	.467	.656		.495	.506	.756		.515	.518	.924
Founded year $\geq$ 2000	.220	.225	.871		.243	.232	.712		.255	.270	.623

Notes: Weighted means for FEA user and FEA non-user establishments. The control group receives the weights which are calculated as $w_t^c = \frac{1}{(1-p_t)}$ and the treatment group receives weights which are calculated as $w_t^t = \frac{1}{p_t}$. Here, p_t is the propensity score for each cross-section calculated as the predicted probability of receiving the treatment stemming from probit estimates in Table 4.12. Each last column displays the p-value of a t-test for the difference in mean values. Significance: *, **, *** significant at the 10%, 5%, 1% level.

Mean differences of matched covariates using ATE weights: *continued*

Year	Mean		t-Test		Mean		t-Test		Mean		t-Test
2006	Control	Treated	p-value	**2007**	Control	Treated	p-value	**2008**	Control	Treated	p-value
(log) Employees	4.253	4.204	.676		4.158	4.173	.872		4.041	4.020	.824
(log) Employees squared	21.473	20.954	.633		20.442	20.504	.937		19.458	19.350	.889
Single establishment	.628	.619	.742		.610	.610	.986		.630	.632	.948
Limited liability	.640	.624	.604		.657	.655	.959		.618	.321	.913
Share of part time employees	.209	.215	.720		.189	.192	.765		.213	.213	.952
Share of female employees	.408	.413	.781		.390	.392	.888		.416	.409	.653
Share of qualified employees	.729	.732	.878		.728	.725	.843		.708	.701	.620
Share of fixed term empl.	.079	.083	.754		.089	.089	.998		.093	.091	.904
Share of apprentices	.044	.042	.656		.041	.040	.818		.048	.044	.549
Diverse ownership	.062	.067	.788		.059	.059	.992		.062	.062	.978
Positive empl. expec.	.312	.308	.873		.387	.394	.780		.332	.332	.984
Collective bargaining	.454	.456	.955		.440	.446	.801		.457	.463	.806
Founded year $\geq$ 2000	.288	.280	.755		.329	.326	.906		.358	.350	.749

Notes: Weighted means for FEA user and FEA non-user establishments. The control group receives the weights which are calculated as $w_t^c = \frac{1}{(1-p_t)}$ and the treatment group receives weights which are calculated as $w_t^t = \frac{1}{p_t}$. Here, p_t is the propensity score for each cross-section calculated as the predicted probability of receiving the treatment stemming from probit estimates in Table 4.12. Each last column displays the p-value of a t-test for the difference in mean values. Significance: *, **, *** significant at the 10%, 5%, 1% level.

Table 4.14: Mean differences of matched covariates using ATT weights

Year	Mean		t-Test		Mean		t-Test		Mean		t-Test
2000	Control	Treated	p-value	**2001**	Control	Treated	p-value	**2002**	Control	Treated	p-value
(log) Employees	4.507	4.592	.417		4.451	4.510	.546		4.389	4.417	.826
(log) Employees squared	23.153	24.036	.374		22.713	22.332	.509		22.566	22.806	.844
Single establishment	.631	.599	.253		.630	.614	.551		.621	.628	.829
Limited liability	.584	.572	.694		.606	.609	.892		.549	.535	.709
Share of part time employees	.152	.154	.833		.169	.178	.422		.196	.201	.757
Share of female employees	.396	.393	.828		.401	.411	.564		.438	.431	.705
Share of qualified employees	.621	.636	.413		.666	.661	.732		.624	.658	.112
Share of fixed term empl.	.064	.065	.963		.064	.064	.971		.118	.090	.300
Share of apprentices	.059	.052	.502		.052	.053	.907		.075	.057	.364
Diverse ownership	.055	.052	.868		.050	.050	.959		.057	.061	.842
Positive empl. expec.	.324	.332	.768		.262	.282	.393		.216	.228	.658
Collective bargaining	.584	.602	.531		.569	.567	.956		.493	.524	.390
Founded year ≥ 2000	.109	.095	.450		.115	.122	.697		.171	.175	.869

Notes: Weighted means for FEA user and FEA non-user establishments. The control group receives the weights which are calculated as $w_t^c = \frac{p_t}{(1-p_t)}$ and the treatment group receives weights which are calculated as $w_t^t = 1$. Here, p_t is the propensity score for each cross-section calculated as the predicted probability of receiving the treatment stemming from probit estimates in Table 4.12. Each last column displays the p-value of a t-test for the difference in mean values. Significance: *, **, *** significant at the 10%, 5%, 1% level.

Mean differences of matched covariates using ATT weights: *continued*

Year	Mean		t-Test		Mean		t-Test		Mean		t-Test
2003	Control	Treated	p-value	**2004**	Control	Treated	p-value	**2005**	Control	Treated	p-value
(log) Employees	4.351	4.383	.820		4.640	4.717	.591		4.580	4.733	.220
(log) Employees squared	22.150	22.433	.825		24.715	25.201	.739		24.008	25.335	.263
Single establishment	.645	.624	.697		.605	.599	.868		.553	.554	.827
Limited liability	.583	.568	.697		.628	.643	.702		.634	.640	.885
Share of part time employees	.176	.193	.279		.182	.177	.797		.165	.175	.487
Share of female employees	.419	.433	.499		.417	.414	.898		.414	.409	.818
Share of qualified employees	.717	.705	.513		.689	.707	.397		.714	.722	.716
Share of fixed term empl.	.080	.089	.600		.117	.140	.572		.128	.119	.704
Share of apprentices	.057	.054	.705		.053	.048	.670		.047	.045	.739
Diverse ownership	.044	.058	.290		.072	.070	.922		.069	.063	.783
Positive empl. expec.	.231	.238	.810		.230	.248	.533		.258	.276	.594
Collective bargaining	.517	.490	.484		.523	.549	.483		.548	.560	.743
Founded year ≥ 2000	.202	.214	.683		.248	.233	.655		.244	.252	.788

Notes: Weighted means for FEA user and FEA non-user establishments. The control group receives the weights which are calculated as $w_t^c = \frac{p_t}{(1-p_t)}$ and the treatment group receives weights which are calculated as $w_t^t = 1$. Here, p_t is the propensity score for each cross-section calculated as the predicted probability of receiving the treatment stemming from probit estimates in Table 4.12. Each last column displays the p-value of a t-test for the difference in mean values. Significance: *, **, *** significant at the 10%, 5%, 1% level.

Mean differences of matched covariates using ATT weights: *continued*

Year	Mean		t-Test		Mean		t-Test		Mean		t-Test
2006	Control	Treated	p-value	**2007**	Control	Treated	p-value	**2008**	Control	Treated	p-value
(log) Employees	4.493	4.536	.744		4.434	4.471	.699		4.280	4.362	.400
(log) Employees squared	23.745	23.802	.967		22.602	22.839	.786		21.366	21.888	.558
Single establishment	.628	.611	.571		.603	.601	.930		.622	.627	.864
Limited liability	.653	.611	.800		.682	.686	.878		.619	.658	.169
Share of part time employees	.203	.203	.963		.173	.186	.239		.199	.206	.577
Share of female employees	.413	.404	.612		.385	.391	.692		.421	.412	.596
Share of qualified employees	.728	.724	.791		.728	.721	.662		.709	.706	.838
Share of fixed term empl.	.098	.109	.445		.103	.103	.991		.112	.113	.942
Share of apprentices	.045	.044	.713		.046	.044	.788		.054	.047	.504
Diverse ownership	.054	.054	.999		.055	.056	.985		.052	.054	.837
Positive empl. expec.	.319	.311	.788		.376	.394	.492		.321	.342	.428
Collective bargaining	.460	.479	.535		.449	.468	.488		.473	.477	.864
Founded year ≥ 2000	.275	.280	.860		.304	.319	.546		.370	.373	.909

Notes: Weighted means for FEA user and FEA non-user establishments. The control group receives the weights which are calculated as $w_t^c = \frac{p_t}{(1-p_t)}$ and the treatment group receives weights which are calculated as $w_t^t = 1$. Here, p_t is the propensity score for each cross-section calculated as the predicted probability of receiving the treatment stemming from probit estimates in Table 4.12. Each last column displays the p-value of a t-test for the difference in mean values. Significance: *, **, *** significant at the 10%, 5%, 1% level.

Table 4.15: Distribution of establishments by German federal states

Federal state	Observations	Share
Schleswig-Holstein	651	4.441
Hamburg	659	4.496
Lower Saxony	1,122	7.655
Bremen	1,136	7.750
Nord Rhine-Westphalia	1,703	11.618
Hesse	1,149	7.839
Baden-Wuerttemberg	1,473	10.049
Bavaria	1,184	8.078
Saarland	642	4.380
Berlin	808	5.512
Brandenburg	618	4.216
Mecklenburg-West Pomerania	501	3.418
Saxony	838	5.717
Saxony-Anhalt	622	4.243
Thuringia	764	5.212
Rhineland-Palatinate	788	5.376
Total	14,658	100

Notes: IAB Establishment Panel, waves 2000 to 2008.

Table 4.16: Distribution of establishments by size categories

Size category	Observations	Share
1-19	3,645	24.867
20-49	2,610	17.806
50-199	3,883	26.491
200-499	2,467	16.830
500+	2,053	14.006
Total	14,658	100

Notes: IAB Establishment Panel, waves 2000 to 2008.

Table 4.17: Distribution of establishments by IAB defined industries

Industry classification (IAB Establishment Panel)	Observations	Share
Agriculture/forestry	169	1.153
Mining/energy	189	1.289
Food/luxury	381	2.599
Textiles/clothing	108	.737
Paper/printing	216	1.474
Wood sector	125	.853
Chemical sector	270	1.842
Plastics industry	256	1.746
Glass/stone/ore extraction	140	.955
Metal production	313	2.135
Recycling	20	0.136
Metal goods/steel production	551	3.759
Engineering	739	5.042
Vehicle engineering	208	1.419
Other vehicle production	91	0.621
Electrical engineering	359	2.449
Precision engineering/optics	236	1.610
Furniture/jewelry/toys	108	0.737
Main building sector	323	2.204
Building/installation	461	3.145
Car-rent/repairs/gas-stations	310	2.115
Wholesale trade	564	3.848
Retailing/repairs	618	4.216
Traffic	606	4.134
Telecommunications	47	0.321
Financial sector	336	2.292
Insurance	230	1.569
Data processing	305	2.081
Research/development	271	1.849
Judiciary/advertising	397	2.708
Realty/homes	124	0.846
Renting	1,286	8.773
Restaurants	500	3.411
Educational institutions	535	3.650
Health/social	1,567	10.690
Waste-management	68	0.464
Culture/sports/entertaining	169	1.153
Other services	260	1.774
Organizations	270	1.842
Civil service/social insurance	932	6.358
Total	14,658	100

Notes: IAB Establishment Panel, waves 2000 to 2008.

Chapter 5

Bargaining power and the labor share - a structural break approach

Joint work with Kornelius Kraft[1]

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5.1 Introduction

There is intense debate on how economic outputs are divided between capital and labor (Rodriguez & Jayadev 2013). Usually, this division is measured using the concept of the labor share which is the ratio of labor compensation to economic output. In macroeconomic models, the stability of the labor share is often referred to as a stylized fact of growth (e.g. Kaldor 1957). This stability, however, is challenged since declining labor shares are observed in many countries over several decades (e.g. Cantore et al. 2021; Barkai 2020; Karabarbounis & Neiman 2014).[2] In Germany, for example, the labor share declined by five percentage points from 70 % in the 1970s to 65 % in 2015 which also raises distributional questions regarding inequality (e.g. Iñaki 2020; Card et al. 2020; Piketty & Zucman 2014).

Regarding potential determinants on the decline of labor shares, there is a wealth of theoretical and empirical literature. One explanation named in this context is technological progress such as the use of robots and algorithms as well as a decreasing price of capital in relation to labor.[3] Another line of research emphasized the role of so-called 'superstar firms'. These firms are based on capital-intensive production and exponential growth.[4] Globalization combined with outsourcing of labor-intensive tasks is another explanation.[5]

In this chapter we consider the decline of bargaining power as an so far overlooked reason for the observed decrease in labor shares, in particular with a focus on changes in the outside option. We therefore utilize the unique exogenous reform shock of the Hartz IV legislation, leading to a decrease in the threat point of unions within a bargaining framework. For the investigation, our approach is twofold. We first show that the Hartz legislation and, in particular, the Hartz IV reform in Germany contribute to a significant structural break in the time series of the aggregate labor share. We therefore apply several endogenous tests drawn from the change point literature (e.g. Antoch et al. 2019; Andrews 2003; Bai & Perron 2003) in which we identify the Hartz IV reform as a significant structural break. In a second step, we estimate the reform effect on the labor share using (i) data on the aggregate labor share and (ii) firm-level data (i.e. the 'dafne'

[2]Figure 5.7 in the Appendix of this chapter provides an overview of developments for different countries.

[3]See for example the literature by Acemoglu & Restrepo (2020); Eden & Gaggl (2018); Acemoglu & Restrepo (2018b); Acemoglu (2003); Bentolila & Saint-Paul (2003). Results from these studies suggest that the labor share declined by 4 to 6.3 percentage points for firms that adopt robots (Acemoglu & Restrepo 2020).

[4]This strand of the literature is in particular driven by work from Autor et al. (2020); De Loecker et al. (2020); Kehrig & Vincent (2021).

[5]See for example Elsby & Michaels (2013) in the context of offshoring and Stockhammer (2017) for the impact of financial globalization.

dataset) compiled by Bureau van Dijk. We apply ordinary least squares as well as a synthetic control approach (e.g. Abadie 2021) in which we construct a Germany doppelganger as a counterfactual for what would have happened with the German labor share in the absence of the Hartz IV reform. For this analysis we use the EU KLEMS data combined with the Penn World Table database to investigate the German labor share for the period 1970 to 2015. Regarding the firm-level data, we apply fixed effects as well as System GMM estimation techniques. We provide evidence that the exogenous shock of the Hartz IV reform reduces the German labor share by around 2 percentage points. The synthetic approach additionally suggests that this decline is lasting, at least up to ten years after the reform was implemented.

Related literature exists which examines the relationship between bargaining power and the labor share, however, with a different focus. For the aggregate labor share, Young & Zuleta (2018); Blanchard & Giavazzi (2003) consider the direct bargaining power of unions. In a similar vein, Fichtenbaum (2011) finds that the decline in union density explains roughly one third of the decline in the share of labor. Bental & Demougin (2010) develop a theoretical model which explain movements in the labor share which depend on labor market institutions, and Brock & Dobbelaere (2006) develop a bargaining framework for the effects of globalization on the labor share. More closely related are, for example, Bazillier & Najman (2017), who investigate how crisis events affect the threat points of workers. More recently, Stansbury & Summers (2020) investigate the relevance of bargaining institutions for workers in the United States and Ciminelli et al. (2020) consider the impact of job protection deregulation. These authors in particular find that the decline in workers' bargaining power might be the main reason for changes in the labor share. On the firm level, there are numerous studies examining the role of firm-specific factors such as workforce or firm characteristics for the labor share (Harju et al. 2021; Siegenthaler & Stucki 2015). There is, however, so far no study on legislative action which renders the outside option in a bargaining context less attractive.

This chapter proceeds as follows. Section 5.2 provides the institutional framework and background of the Hartz legislation in Germany. Moreover, we provide a simple bargaining model in which we derive implications for the connection between changes in the outside option in wage bargaining and the labor share. Section 5.3 then provides empirical evidence on the Hartz IV reform and identifies the reform as a structural break in the German labor share where we apply several endogenous and exogenous change point tests. Section 5.4 provides estimates of the magnitude of the reform on the aggregate labor share and Section 5.5 provides

firm-level evidence. Section 5.6 concludes and provides policy implications.

5.2 Institutional framework and theory

5.2.1 The Hartz legislation

The persistent and high unemployment rate in Germany in the early years of the 21st century led to the implementation of the so-called Hartz Reforms which are named after the chairman of the commission, Peter Hartz.[6] The reform consists out of four packages (Hartz I–Hartz IV) which were implemented successively during the years 2003–2005 and are designed to increase the flexibility of the labor market. Their main purpose was the reduction of long-term unemployment.

The reform package starts with Hartz I and II which were introduced January 1st, 2003. Both of these reforms lead to increased labor market flexibility by deregulating temporary work, dismissals and fixed-term contracts. Empirical evidence on these two reforms is, for example, provided by Bradley & Kügler (2019) who find an increase in mini-job usage. The Hartz III reform was aimed at increasing the matching efficiency on the labor market by restructuring the Federal Employment Agency. It became effective on January 1st, 2004. Regarding empirical evidence from a macroeconomic point of view on effects of the reform on matching efficiency see for example Launov & Wälde (2016) and Klinger & Weber (2016).

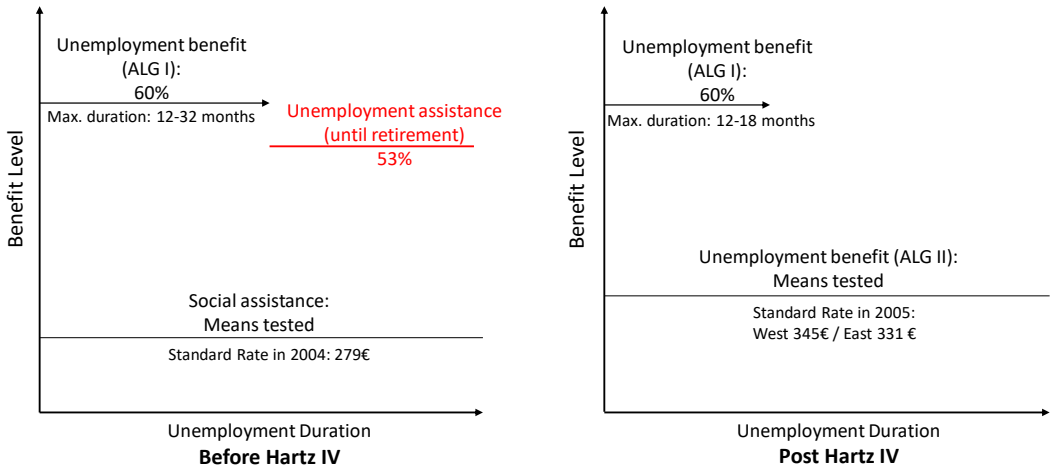
Finally, the Fourth Act for Modern Labor Market Services (commonly known as Hartz IV) focused on the abolition of long-term wage-dependent support payments and a transition to fixed benefit levels equivalent to the socio-cultural subsistence level. This last (and centerpiece) part of the reform became effective on January 1st, 2005. Before this reform, there was a kind of three-tier system consisting of short-term unemployment benefits (*Arbeitslosengeld ALG I*), unemployment assistance (*Arbeitslosenhilfe*) as well as social assistance (*Sozialhilfe*). The short-term unemployment benefits mounted roughly between 60 and 67 % of the previous earnings and were usually paid for 12 months.

The Hartz IV reform transformed this system into a two-tier system which is depicted in Figure 5.1. In particular, the reform comprised the following elements: Merging of unemployment assistance (*Arbeitslosenhilfe*) and social assistance (*Sozialhilfe*) into unemployment benefit II (ALG II); reduction of the period of entitlement to unemployment benefit (ALG I) from a maximum of 32 to a maximum of 18 months; reduction of support for children and young people, ex-

[6]The unemployment rate in Germany was persistent high at roughly 10 percent and a peak was reached at 11.1 percent in the year 2005 (Dustmann et al. 2014).

panded crediting of own fortune and income of partners against transfer payments and new and stricter sanctions for unfulfilled conditions in the search for employment. The reform therefore leads to a dramatically cut in the received benefits for long-term unemployed workers since they are no longer eligible for long-term unemployment assistance (which was wage-dependent). As a result of the reform the consequences of unemployment in terms of wage cuts were more severe and therefore pressure on the employed to make wage concessions and on the unemployed to accept unattractive job offers increased.

Figure 5.1: Hartz IV reform: reduction in outside option



Notes: This figures shows the effects of the Hartz IV reform for a single household. The reform transformed the three-tier system of unemployment benefits ('Arbeitslosengeld'), unemployment assistance ('Arbeitslosenhilfe') as well as social assistance ('Sozialhilfe') into a two-tier system of only unemployment benefits and social assistance ('ALG II'). Slightly deviating illustration from Hochmuth et al. (2021).

In a similar vein, also Hartung et al. (2018) highlight in particular for long-term employed workers with high wage payments that the Hartz IV reform represents a drastic reduction in benefits if they may become unemployed. This is also reported by Bradley & Kügler (2019), who find that wage payments were significantly reduced, especially for unskilled workers. This, however, was intended and the reform was designed to shift the focus from unemployment benefits as a form of insurance to incentives to take up work in such situations.

5.2.2 A simple bargaining model

This section draws on the previous narrative and theoretically relates the exogenous Hartz IV reform shock to labor market institutions such as unions. Drawing from the rent-sharing literature, we derive a model of union bargaining in which

the threat point of unions is lowered because of the exogenous shock on alternative income stemming from the Hartz IV legislation. In this literature, there are direct and indirect factors affecting bargaining outcomes for workers in the labor market. Whereas direct factors increase the power of workers in negotiations (e.g. Blanchard & Giavazzi 2003), indirect factors alter the outside option in case the negotiations break down. The focus in this chapter is on the latter.[7]

Explanations of the labor share based on bargaining power have to assume a rent-sharing framework in which economic rents at either the organizational or the country level have to be shared between capital and labor. Firms are therefore not price-takers and possess market power (e.g. De Loecker et al. 2020). In our model, however, markups do not arise due to market power in the product market, but rather through the power of unions which are able to shift the wage above its marginal product of labor.

We derive a simple model where we assume a market with two duopolists (firm 1 and firm 2) and a union which are involved in bargaining. The union's utility function is based on risk-neutral agents and is specified for the maximization of the rent of its members. The rent that employee's realize is the difference between the wage w and an alternative wage w_a. The monetary value of the alternative wage is determined either by unemployment benefits alone, or by a weighted average of (i) the wage when employed in another company and (ii) the unemployment benefit. The weights are the results of the employees' assessment of the probability of the two alternatives occurring. The value of w_a determines the lower limit of the negotiated wage w or the outside option in case negotiations fail. Thus, we focus on the so far overlooked relative change in workers' bargaining power. The introduction of the Hartz IV reform has led to a deterioration in financial support for large parts of the workforce. With the implementation of the Hartz IV reform, the alternative wage w_a therefore had decreased for parts of the workforce or at least is a very credible threat for lower wages when bargaining fails.

In the bargaining model, the rent per employee is multiplied by the number of employees who are members of the union. The aim of the union is to maximize the difference between the wage w and the alternative wage w_a which is simultaneously the threat point of the union. The term $\bar{N}$ is considered as union membership in which not all employees from the pool of employment N have to be union members ($0 < N \leq \bar{N}$). We consider the following union's objective function of a utilitarian

[7]There are in fact a few studies in this context which investigate indirect effects stemming from welfare services in several countries (e.g. Stockhammer 2017; Onaran 2009; Jayadev 2007). Although direct effects of bargaining power are not specifically considered in this chapter, we include union density as a measurement of direct bargaining power in our regressions to adjust for this channel.

form:

$$U(w) = N(w - w_a) \tag{5.1}$$

The function in Equation (5.1) is the well-known Stone-Geary utility function with risk- neutral workers which is frequently applied in the literature (e.g. Blanchflower et al. 1996; Dobbelaere 2004). We also assume that, in an event of bargaining delay, the firm earns zero profit because of the lack of workers, and employees receive the alternative wage w_a since they are unemployed for the time-being. Because of the dual structure of the industrial relations systems in Germany, unions at the industry-level usually bargain with employers' associations and determine wages but not employment. Thus, the bargaining framework in this chapter considers wage bargaining, since the determination of employment levels is outside the scope of unions.[8]

Firm's utility is symmetric for firm i, where $i = 1, 2$ in this model and equals its profits π_i which is the output q_i times the price p. Output is produced using a Cobb-Douglas production technology in which we assume no fixed costs F and labor as the only variable input factor. Thus, the simple production function is $q_i = N$ in which the firm only has to pay the input costs w. The profit function then reads as follows:

$$\pi_i(w, N) = pq_i - wq_i \tag{5.2}$$

For pricing, the following linear inverse demand function is assumed:

$$p = d - b(q_1 + q_2) \tag{5.3}$$

As usual and shown in Equation (5.2), firms maximize the difference between sales and costs which leads to the following profit function for firm 1:

$$\begin{aligned} \pi_1 =& (d - b(q_1 + q_2))q_1 - wq_1 \\ =& (d - b(q_1 + q_2) - w)q_1 \end{aligned} \tag{5.4}$$

We consider the more realistic case of asymmetric generalized bargaining power (e.g. Dobbelaere 2004; Blanchflower et al. 1996) in which the bargaining power of two players is denoted by ϕ for the union and $1 - \phi$ for the firm. The aims of the two parties are combined by the well-known Nash bargaining solution with

[8] On the firm-level, however, wages are outside the field of application since they are determined on the industry-level by unions. On this level, firm owners or managers bargaining with co-determination institutions such as works council to determine employment. For a bargaining model on the company-level see for example Kraft (1998). For the empirical wage determination depending on different contracts between German unions and employer associations, see for example Fitzenberger et al. (2013).

Equation (5.1) and (5.4):

$$\Phi = (N(w - w_a))^{\phi}((d - b(q_1 + q_2) - w)N)^{(1-\phi)} \tag{5.5}$$

For pure wage bargaining (and not efficient bargaining), N must be replaced by a function of w, respectively $N(w)$, before maximizing this Nash bargaining function. For this purpose, the profit function in Equation (5.4) is differentiated with respect to q_i and solved for output. Under the assumption of symmetric duopolists (with $q_1 = q_2$), this leads to:

$$q_1 = \frac{d - w}{3b} \tag{5.6}$$

This function is inserted into the bargaining Equation (5.5) and after taking the logarithm, this function reads:

$$ln\,\Phi = \phi \ln\left(\frac{(w - w_a\ )(d - w)}{3b}\right) + (1 - \phi)\ln\left(\frac{(d - w)^2}{9b}\right) \tag{5.7}$$

From differentiation Equation (5.7) with respect to w (i.e. $\frac{\partial ln\Phi}{\partial w}$) follows:

$$w = \frac{1}{2}\left(\phi(d - w_a)\right) + w_a \tag{5.8}$$

Unsurprisingly the negotiated wage w increases with w_a. Inserting Equation (5.8) for w into the expression for q_1 which is Equation (5.6) gives the output and labor demand:

$$N = q_1 = \frac{(2 - \phi)(d - w_a)}{6b} \tag{5.9}$$

Output and thus also the demand for labor decrease with higher w_a. Then, in this Cournot model profits are given by:

$$\pi_1 = \frac{q_1^2}{b} = \frac{(2 - \phi)^2(d - w_a)^2}{36b} \tag{5.10}$$

Therefore as shown in Equation (5.10), profits also fall with w_a. We conclude from this simple model that in the case of a lowered outside option resulting from the Hartz IV legislation, wages will decrease, labor demand will increase and profits will rise. These results are consistent with existing empirical research (e.g. Grüner 2019).

The less obvious question, however, is what happens with the labor share if w_a falls. The labor share is defined as $ls = wN/pq$, and since in this simple model $q = N$, the expression reduces to $ls = w/p$. By use of Equations (5.3) and (5.9)

the following expression for p can be derived:

$$p = d - \frac{1}{3}(2-\phi)(d-w_a) \tag{5.11}$$

Then, after some rearrangement the labor share ls is now the following simple expression:

$$ls = \frac{\frac{3}{2}(\phi(d-w_a)+2w_a)}{\phi(d-w_a)+2w_a+d} \tag{5.12}$$

As a final step and to show the effect of changes in the alternative wage w_a, we take the derivative with respect to this coefficient:

$$\frac{\partial ls}{\partial w_a} = \frac{\frac{3}{2}(2-\phi)d}{((2-\phi)w_a+(1+\phi)d)^2} > 0 \tag{5.13}$$

As evident from Equation (5.13) and outlined in the theoretical Section 5.2 in this chapter, the labor share ls falls with decreasing w_a.

5.3 The Hartz reforms as a structural break

5.3.1 Data sources and measurement

We first want to identify the Hartz IV reform which was implemented in January 1st, 2005, as a significant break point in the time series of the German labor share. Tests for structural breaks in an economic context in fact have a long history starting with the early work by Chow (1960) and Quandt (1960). More recent theoretical contributions include Bai & Perron (1998); Han & Park (1989) as well as Hansen (2001) and nowadays there are many applications of change point tests in different fields (e.g. Lunsford 2020; Antoch et al. 2019; Link & van Hasselt 2019; Wiese 2014; Jayachandran et al. 2010). The general idea is to check whether an economic reform or an intervention constitutes a fundamental change in the data generating process and thus can interpreted as a change point. We apply different exogenous and endogenous tests to check whether the Hartz IV in the year 2005 in Germany constitutes a significant impact on the labor share. Whereas in exogenous tests we have to explicitly define the year of the break point, endogenous tests detect the break point year from within the data.

We use the data from the EU KLEMS[9], revision 2019 dataset which we combine which data from the Penn World Tables and the OECD STAN database. Then we

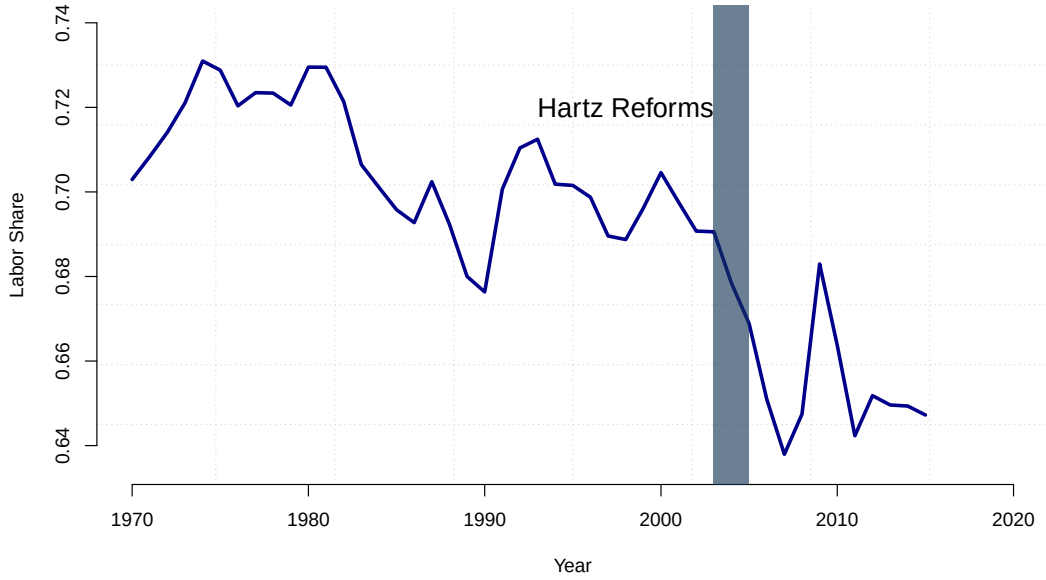
[9]For a comprehensive discussion of the dataset and methodology, see Stehrer et al. (2019).

calculate the labor share LS_t for Germany for the years 1970 to 2015 as follows:

$$LS_t = \frac{W_t L_t}{Y_t} \tag{5.14}$$

where the expression $W_t L_t$ denotes labor compensation and Y_t gross value added at year t. One additional advantage of the EU KLEMS dataset is the consideration of self-employed workers which is often neglected when calculating the labor share (e.g. Cette et al. 2020). In using this data we therefore assume that self-employed receive in every industry and year the same hourly wage as employees and thus prevent measurement errors in the labor share calculation (Stehrer et al. 2019).

Figure 5.2: Trend in the German labor share



Notes: This figures shows the trend in the German labor share LS_t over the years 1970 to 2015. The German labor share is calculated as the ratio of labor compensation to gross value-added for all industries in year t as described in Equation (5.14). The data for the EU KLEMS release 2019 can be obtained on https://euklems.eu/. For an overview of variable construction and methodology see Stehrer et al. 2019. The blue shaded area indicates the implementation of the Hartz legislation in which Hartz I and II are implemented in 2003, Hartz III in 2004 and finally Hartz IV in 2005.

As shown in Figure 5.2, the aggregate labor share for Germany is in line as reported in several other studies (e.g. Karabarbounis & Neiman 2014). There are three main events in the past decades which contribute to a change in the labor share in Germany. First, changes in the 70s can be attributed to the two oil price shocks in which the labor share sharply increases (Berthold et al. 2002). Second, the German reunification in 1990 also constitutes a sharp increase in the labor share because of large monetary transfers from western to eastern Germany in which the currency was not devalued.[10] And finally the Hartz reforms contribute

[10]For an synthetic control analysis of the effects of the German reunification on GDP, see for

to a significant decline in the labor share in which the share stays rather constant hereafter.

The only exception and sharp increase is because of the financial crisis in the year 2009 which can be explained by sticky wages and labor hoarding which primarily affects capital incomes (Bazillier & Najman 2017). For example, many firms applied working-time arrangements such as 'time-accounts' or other work-sharing schemes (Teague & Roche 2014) during this period of time. Empirical studies indeed find that the labor share increases in case of economic downturns as for example the great financial crisis between 2008 and 2009 in Germany (e.g. Bazillier & Najman 2017). Whether these changes, however, are significant in a statistical manner is the question which can obviously be raised. In the following, we therefore test these hypotheses using structural break tests.

5.3.2 Supremum of a sequence of Wald tests

As it is apparent from Figure 5.2, there is a notable decline in the labor share around the Hartz legislation between the year 2003 and 2005. Around this period of time, Figure 5.2 suggests a change point in the mean of the labor share. Of course, we could apply a simple t-test for pre- and post-reform mean differences using time dummy variables, however that would require that the break occurs at a known point in time. This is easy in principle since we know the exact time of the implementation of the Hartz reforms and the potential break points.[11] Choosing a fixed break date, however, might nevertheless be arbitrary since we do not know whether there are any delay or anticipation effects of the reform (e.g. Wiese 2014; Piehl et al. 2003).

As a more sophisticated approach, we apply endogenous tests for structural breaks in the mean for unknown break dates (e.g. Lunsford 2020; Wiese 2014; Jayachandran et al. 2010; Hansen 2001). The endogenous approach is much more reliable than the one with, for example, exogenously determined breakpoints, because the endogenous test checks all possible alternatives. As a first test, we therefore calculate Wald test statistics whether there is indeed a structural break for a variety of break dates and take the maximum as the test statistic (Chow 1960; Quandt 1960).

We test for a break in the mean of the labor share (LS_t) in year τ between $t = 1, \ldots, T$ where $t = 1970$ and $T = 2015$ estimating the following model several

example Abadie et al. (2015).

[11] In such cases, the Chow test might be a feasible alternative (Chow 1960).

times[12] for every possible break point,

$$LS_t = \alpha + \delta_t D_t(\tau) + \gamma trend + \varepsilon_t \tag{5.15}$$

where $D_t(\tau)$ describes an indicator variable with $D_t(\tau) = 1$ if $t > \tau$ and $D_t(\tau) = 0$ otherwise. Thus, we test for all possible breaks in the mean for each year in the interval 1975 to 2009.[13] Given our stationary time series, which we confirm using a Dickey-Fuller test, we included a trend variable (e.g. Rodriguez & Jayadev 2013) and define the following Wald test statistic in which there is no change before and after the Hartz IV reform in the null hypothesis:

$$\begin{aligned} &H_0 : \delta_t = \delta_0 \; \forall \; t, \\ &H_1(\pi) : \delta_t = \begin{cases} \delta_1, & t = 1, \ldots, T\pi \\ \delta_2, & t = T\pi + 1, \ldots, T, \end{cases} \end{aligned} \tag{5.16}$$

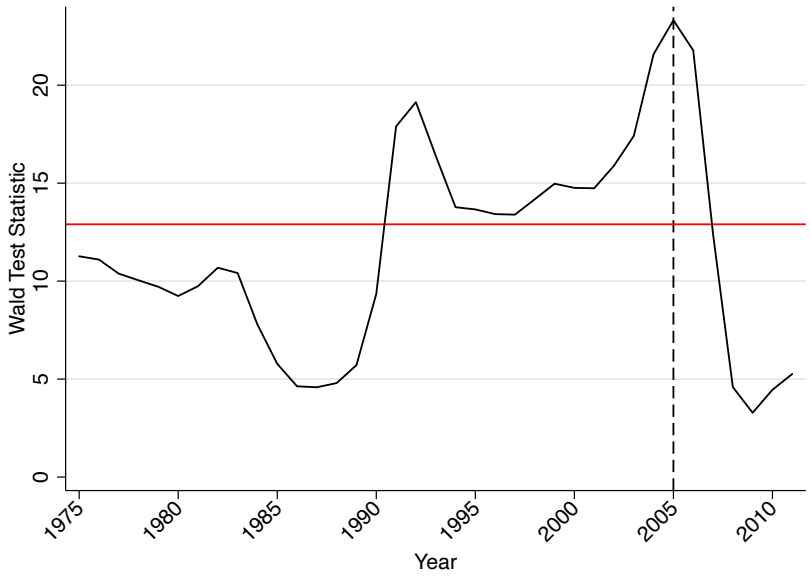
where the parameter $\pi\epsilon(0, 1)$ is the sample fraction before and after the break point and $T\pi$ corresponds to the year of the change point. Then, we test the null hypothesis that there is no break point which is $\delta_t = 0$. The maximum value of the Wald statistic (sup Wald) over all possible breaks is used to inspect the break point and the significance of the break. Figure 5.3 shows the values for every possible Wald test statistics for every year. The red line indicates the critical value provided by Andrews (1993, 2003) for the assessment of significance.

As shown in Figure 5.3, the test statistic exceeds the critical value in the year of the German reunification in 1990. Hereafter the test stays significant indicating that the German reunification constitutes a rather persistent impact on the share of labor. The second break is indicated in the year 2005, which is also the maximum of the Wald test statistic (sup Wald). It therefore appears that the Hartz IV reform is a profound structural break in the mean of the German labor share. Table 5.1 presents results for the applied single structural break tests. The p-values are calculated by the method provided by Hansen (1997) and the test statistic are derived and tabulated by Andrews (1993, 2003). In addition to the supremum Wald test we also apply an average Wald and exponential Wald test. These tests tend to have more power compared to the supremum test (Andrews & Ploberger 1994). Our results, however, do not change.

[12] We also estimated the model with successively added control variables in which we include the number of strike days, the unemployment rate as well as the growth rate of GDP. Results can be found in Table 5.8 and Table 5.9 in the Appendix of this chapter.

[13] The test uses a slightly smaller sample size to ensure that the test has enough power. A common approach therefore is to trim 15 percent from both ends of the sample (e.g. Jayachandran et al. 2010).

Figure 5.3: Wald test statistic for structural break



Notes: The figure shows values of Wald test statistics as outlined in Equation (5.15) and (5.16). Test for a change point in the mean of the labor share (LS_t) in year τ between $t = 1, \dots T$ where $t = 1975$ and $T = 2009$. The labor share is calculated as outlined in Equation (5.14). The blue line shows the values of the test statistics. The maximum value (sup Wald) of the Wald test statistic is 23.32 which occurred in 2005. The red line indicates the critical value of the test statistics as provided by Andrews (1993, 2003). Values of the test statistics are provided in Table 5.1. We trim 15 percent from both ends of the sample to ensure that the test has sufficient power.

Table 5.1: Values for Wald test statistics

Test	Value of test statistic (1)	Break year (2)	p-value (3)
Supremum Wald	23.32	2005***	.0002
Average Wald	12.10		.0005
Exponential Wald	8.99		.0003

Notes: The table reports values of the Wald test statistics as outlined in Equation (5.15) and (5.16). Test for a change point in the mean of the labor share (LS_t) in year τ between $t = 1, \dots T$ where $t = 1975$ and $T = 2009$. The labor share is calculated as outlined in Equation (5.14). Critical Values were obtained from Andrews (1993, 2003).

5.3.3 Bai and Perron test for multiple breaks

The sequence of Wald tests are frequently applied in the empirical literature (e.g. Lunsford 2020; Link & van Hasselt 2019; Jayachandran et al. 2010; Piehl et al. 2003; Hansen 2001), however these tests are limited to the occurrence of only one break point. A look at the labor share time series in Figure 5.2 reveals, however, that there might be eventually more break points. We therefore expand the analysis and additionally allow for unknown timings and different numbers of change points

in the labor share time series using the Bai & Perron (2003, 1998) test for multiple break points.[14]

The idea of the test is to create a step-wise route through the adjusted labor share time series LS_t and create an optimal model with m breaks in $m+1$ regimes. Drawing on a linear regression model (e.g. Casini & Perron 2019), we consider a model of the following form. In addition to a common method in which only a constant term is included (Wiese 2014), we also include the trend in the following regression model.

$$\begin{aligned} LS_t &= \delta_1 + \beta_1 x + u_t, \quad t = 1, 2, \dots T_1 \\ LS_t &= \delta_2 + \beta_2 x + u_t, \quad t = T_1 + 1, \dots T_2 \\ &\vdots \\ LS_t &= \delta_m + \beta_m x + u_t, \quad t = T_m + 1, \dots T \end{aligned} \tag{5.17}$$

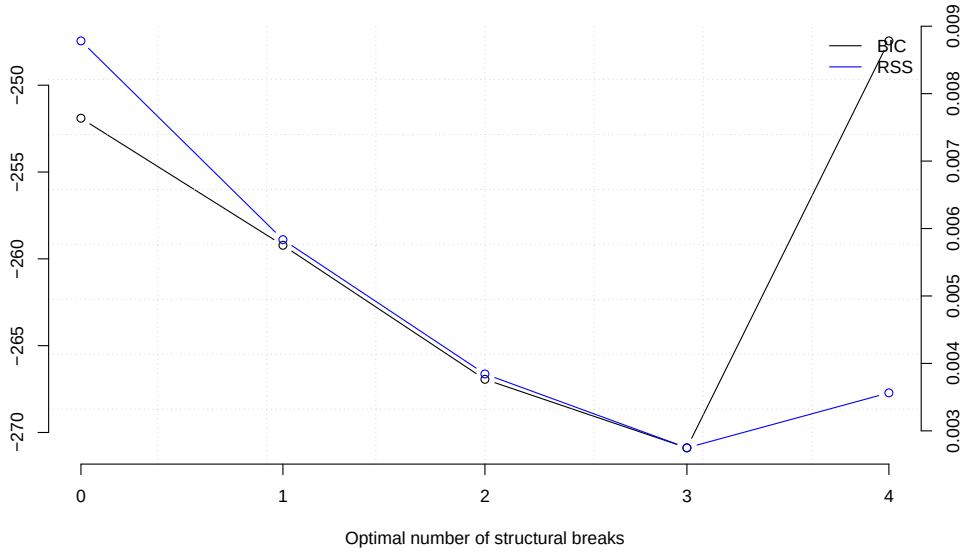
in which the dependent variable is the labor share LS_t and δ_m being a vector of estimated constants of $m+1$ possible regimes. Thus, it is the mean of the different segments which are divided into m breaks. The tests then checks whether the change points are statistically significant. The number of break points is selected according to the lowest overall Residual Sum of Square (RSS) for a given number of breaks and the Bayesian Information Criterion (BIC) which are shown in Figure 5.4. Both criteria refer to the optimal number of $m = 3$ breakpoints, dividing the labor share time series in Figure 5.2 in $m+1 = 4$ regimes with different intercepts.

The Bai & Perron (1998, 2003) test has different sequential stages, which will be briefly outlined. First, a supF type test is carried out to determine whether there is no structural break ($m = 0$) at all or a fixed number of breaks ($m = k$). In the next step, the Null hypothesis that no structural break is present is tested versus the alternative hypothesis of an unknown number of structural breaks, with an upper limit being set. This test is implemented with double maximum tests. The first of these tests is based on equal weighting, while the second uses weights for the individual tests, which are calculated in a way that the marginal p-values are equal across values of m. The weighting is implemented because with an equal weighting the power of the test decreases when the number of structural breaks increases.

The next step is to identify the optimal number of structural breaks. Bai & Perron (1998, 2003) propose a test for a particular number of structural breaks

[14]See for example Wiese (2014); Benati (2007) for a similar application of the Bai & Perron test as well as Casini & Perron (2019) for a general assessment of structural break tests in time series.

Figure 5.4: Optimal number of break points

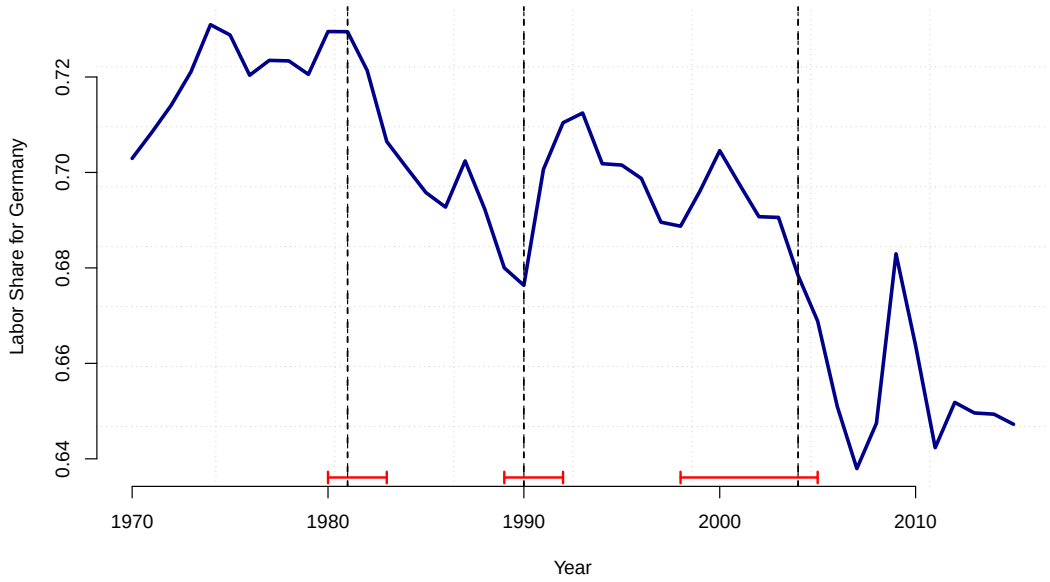


Notes: This figures shows the values of the selection criteria of the optimal number of unknown break points m in the Bai & Perron (1998, 2003) test. According to the lowest Residual Sum of Square (RSS) and Bayesian Information Criterion (BIC), the labor share times series in Figure 5.2 is divided into $m + 1 = 4$ regimes as shown in Figure 5.5.

l versus $l + 1$. The corresponding test $supF_t\ (l + 1|l)$ then gives the maximum of the F-statistic, which tests the null hypothesis that no additional structural break exists versus the existence of an additional structural break. This test is performed sequentially for all possible points in time. The optimal number of structural breaks is then identified using residual sum of squares (RSS) and the Bayesian Information Criterion (BIC). The approach allows for non-symmetric confidence intervals since the variance before and after a break does not have to be constant. Furthermore, the variance covariance matrix is robust to serial correlation and heteroscedasticity (Andrews 1991). The results of the described sequential testing procedure are summarized in Figure 5.4. On the horizontal axis, the number of breaks is plotted, while the two vertical axes show the values of the BIC statistics and the residual sum of squares. Both statistics have its minimum at three breaks.

Figure 5.5 shows the exact years identified by the Bai & Perron (1998, 2003) test. We first find that these results are consistent with our visual assessment based on the previous graphs. For two breaks, the Bai-Perron estimates identify the same time points that the previous statistics found. Second, further change points that we found in this time series are also in line with theoretical predictions from the literature. The first break occurs right after the second oil price crisis in the year 1981 in which the oil prices rapidly declined (Autor et al. 2020). Thus, the severe drop in oil prices might spur capital intensive production thus leading to a decline in the labor share. The second break shortly occurs after the Eastern and Western

Figure 5.5: German labor share with identified break points



Notes: Own calculations using the EU KLEMS release 2019. The German labor share over the year 1970–2015 is calculated as the ratio of labor compensation to gross value-added for all industries as shown in Equation (5.14). Dotted lines show endogenously identified change points using the Bai & Perron (1998, 2003) test explained above. Red bars at the bottom indicate 95 % confidence intervals around the estimated break point. The break points occur in the year 1981 after the oil crisis, in 1990 in the period of the eastern and western German reunification as well as in the year 2004 during the implementation of the Hartz reforms.

German reunification in the year 1990 and the third break occurs at the time of the Hartz reforms were introduced in the year 2004. 95 % confidence intervals are shown in Figure 5.5 around the break points. Because of our rather short time series, since we use yearly data compared to for example daily or monthly data, the confidence intervals are rather wide. Nevertheless, the breakpoints are consistent with the previous analysis of Wald statistics which is summarized in Table 5.1. Important to note in our analysis, however, is the fact that these change points are endogenously identified within the labor share time series and interestingly they also highlight the Hartz reforms as a significant impact.

To summarize, we use an endogenous Wald test for a single break point as well as the Bai & Perron (2003) test for the identification of multiple endogenous break points. We indeed can verify that the Hartz reforms in Germany constitute a significant shift in the mean of the labor share. This result can be explained by the fact that the introduction of the Hartz IV reform has reduced the outside option in our bargaining framework for employees and therefore had a negative impact on the outcome in wage negotiations. The macroeconomic analysis has the advantage that tests on structural breaks can be carried out without predetermined break points and with several breaks.

5.4 Impact of the Hartz IV reform

5.4.1 First results using aggregate data

The structural break tests indeed indicate a significant break right before the Hartz IV legislation in Germany became effective in the year 2005. In this section we therefore inspect the effect of this exogenous shock of the Hartz IV reform on the aggregate labor share. As outlined in Section 5.2.2, Equation (5.13), we expect that the exogenous negative shock on the outside option in the bargaining equation subsequently results in lower wages and therefore in a decrease in the labor share. To examine our hypothesis, we first apply Ordinary Least Squares (OLS) regressions of the following form:[15]

$$\begin{aligned} LS_t = \alpha + \beta_1 HartzIV_t + \beta_2 Unemp + \beta_3 Strike \\ + \beta_4 Union + \beta_5 ExImRatio + \beta_6 trend + \varepsilon_t \end{aligned} \tag{5.18}$$

Where LS_t is the labor share in Germany ranging from $t = 1970$ to $T = 2013$. As control variables we include the trade union density (*Union*) which is a measure for the bargaining power of employees.[16] In fact, there is much literature on the impact of labor unions on the distribution of incomes and factor shares by different channels. First, there are direct positive effects stemming from bargaining in which labor unions reduce within-group as well as between-group wage inequality (e.g. Kristal & Cohen 2017). Furthermore, and more in line with our research, a strand of literature suggests that labor unions affect the compensation of the management and also returns to capital (e.g. Lee & Mas 2012). Second, a more recent paper suggests that labor unions do not affect the wages of employees directly, but rather that positive distributional effects arise from more generous fringe benefits (e.g. Knepper 2020). In this context, Card et al. (2020) provide a very recent overview on labor unions and inequality.

In addition, we also include the unemployment rate of Germany (*Unemp*). A higher unemployment rate constitutes a higher risk for employees to find a new job and hence there is less bargaining power for employees. Unemployment in this view constitutes a higher threat which restricts the demands and thus the power of employees and unions within a bargaining framework. We also include lost workdays due to strike *Strike* (measured in 1,000 employees) as an additional measure for workers bargaining power. Finally, the export-import ratio (*ExIm-*

[15] Results from regressing the labor share on year dummies is provided in Figure 5.10.

[16] Trade union density is measured as the members in the German federation of trade unions in the corresponding year (which can be found here: https://www.dgb.de/uber-uns/dgb-heute/mitgliederzahlen) over the total employment as reported in the EU KLEMS dataset.

Ratio) is included, which is a measure for trade openness and globalization (e.g. Elsby & Michaels 2013). We expect this variable to carry a negative sign since there is much evidence that the relationship between globalization and the labor share is negative (Elsby & Michaels 2013).

Table 5.2 shows the descriptive statistics for the EU KLEMS data which is used for estimating Equation (5.18).

Table 5.2: Descriptive statistics for German EU KLEMS sample (1970–2013)

Variables	Mean (1)	Std. dev. (2)	Min (3)	Max (4)
Labor share	0.69	0.03	0.64	0.73
Unemployment rate	7.09	3.12	0.58	11.72
Trade union density	0.32	0.04	0.24	0.41
Export-import ratio	1.00	0.11	0.80	1.19
Lost workdays	24.05	60.01	0.40	278.60
Year			1970	2013
Observations	44			

Notes: The table shows the descriptive statistics for the German labor share sample ranging from 1970 to 2013. Data from the EU KLEMS release 2019 dataset and trade union information from the German federation of trade unions. Lost workdays due to strike from Hans Böckler Foundation, per 1,000 employees. The labor share is calculated as $LS_t = \frac{W_t L_t}{Y_t}$ as explained in Section 5.3. For an overview of variable construction and methodology see Stehrer et al. (2019).

First results from estimating Equation (5.18) using OLS are presented in Table 5.3 with additionally adding control variables in column (2). As expected and derived in the theoretical model, the Hartz IV reform has a significantly negative impact on the labor share in the magnitude of -1.6 percentage points when adjusting for control variables. Regarding the control variable as shown in column (2) of Table 5.3, the unemployment rate also carries a negative sign as described above. The results are also similar when we use year dummy variables instead of a Hartz 4 indicator variable as shown in Figure 5.10 in the Appendix of this chapter. The coefficient of trade union density has an expected positive sign and measures the impact of an increase in bargaining power of employees on the labor share (e.g. Brock & Dobbelaere 2006). Finally, the measure of globalization (export-import ratio) also has a negative coefficient. As expected and shown in various studies, trade openness and globalization lead to more offshoring of labor-intensive work and thus a decrease in the labor share (e.g. Elsby & Michaels 2013).

Table 5.3: Results of OLS regressions for the German labor share

	Labor Share	
	(OLS) (1)	(OLS) (2)
Hartz IV	-.028***	-.016*
	(.006)	(.009)
Unemployment rate		-.001
		(.001)
Lost workdays		-.016
		(.018)
Trade union density		.191**
		(.090)
Export-import ratio		-.061
		(.037)
Linear trend	-.001***	-.001*
	(.000)	(.000)
Constant	.725***	.728***
	(.004)	(.043)
R^2	.817	.838
Observations	44	44

Notes: This table show results from estimating Equation (5.18). Data from the EU KLEMS release 2019 dataset and trade union information from the German DGB trade union association. The labor share is calculated as $LS_t = \frac{W_t L_t}{Y_t}$ as explained in Section 5.3. For an overview of variable construction and methodology see Stehrer et al. (2019). Results from regressing the labor share on year dummies is provided in Figure 5.10. Robust standard errors in parentheses. *, **, and *** denote statistical significance at the .1, .05 and .01 level.

5.4.2 Synthetic control method using a counterfactual Germany

By application of endogenous structural break models and simple OLS regressions as shown in Table 5.3, our results presented so far support the hypothesis that the Hartz reforms affected the labor share. In the next step we take possible selectivity effects into account.

Considering causal models, there is the well-known fundamental problem of causal inference which states that it is only possible to observe outcomes for entities (such as countries or firms) which are either treated or untreated (e.g. Rubin 1974; Imbens & Wooldridge 2009). A clearly defined control group with similar characteristics as the treatment group is therefore needed to draw causal conclusions. In our specific case, however, the Hartz reforms affected the whole economy in Germany and the labor share and there is no natural control group. We therefore

apply a more advanced form of structural break analysis by using the synthetic control method (e.g. Abadie et al. 2010, 2015; Abadie 2021). This method is not only more in line with recent developments in econometrics (e.g. Imbens & Wooldridge 2009) but also referred to as one of the most important innovation in the recent policy evaluation literature (Athey & Imbens 2017). In fact, there is an ongoing further development of this method regarding the implementation of covariates (e.g. Botosaru & Ferman 2019) as well as many empirical applications in different fields of economics (e.g. Chen 2020; Peri & Yasenov 2019).

Data and sample construction. For the application of the synthetic control method and the construction of a 'synthetic twin of Germany' the analysis requires additional data for other countries. These countries are referred to as the donor pool to construct the German doppelganger. We therefore combine the EU KLEMS dataset with the Penn World Tables 9.0 database[17] for information regarding GDP spendings and the OECD STAN database for trade union density. Unfortunately we do not have such rich information for other countries that allow us to create such long time series as we have for Germany starting in the 1970s. Our analysis in this section therefore starts in the year 1995 for which we have all information on control variables.

According to the literature, we use quite common variables to construct the Germany doppelganger. First, trade union density as well as the unemployment rate are included as a measure of bargaining power (Blanchard & Giavazzi 2003; Bental & Demougin 2010). Also, the share of capital formation (as % of GDP) is included as a measure of capital accumulation in the economy which is relevant to account for production capacities (Piketty & Zucman 2014). The share of government consumption is also included as a proxy for the welfare state, i.e. a proxy for social protection, which is for example also applied by Bazillier & Najman (2017). As a measure for globalization we include the share of exports and imports (as % of GDP) (Elsby & Michaels 2013). And finally we account for the stock and quality of human capital in the economy by using the 'human capital index' provided by the Penn World Tables data set.[18] Descriptive statistics are provided in Table 5.4.

[17]The Penn World Table database 9.0 covers information on relative levels of income, output, input and productivity for 182 countries between 1950 and 2014. For an overview of the methodology as well as variables see, for example, Feenstra et al. (2015). Missing data on the unemployment rate for different countries were supplemented by World Bank data.

[18]For example firms need human capital to innovate and improve existing technologies which in turn effects capital and the production process. Thus, recent lines of research suggest to account for this measurement in labor share regressions (e.g. Arif 2021).

Table 5.4: Descriptive statistics for EU / world sample

Variables	Mean (1)	Std. dev. (2)	Min (3)	Max (4)
Labor share	0.62	0.06	0.49	0.86
Trade union density	32.35	21.20	5.50	95.80
Unemployment rate	8.27	4.05	2.25	27.48
Human capital index	3.21	0.27	2.55	3.73
Share of gross capital formation	0.25	0.05	0.10	0.47
Share of government consumption	0.19	0.05	0.09	0.42
Share of exports	0.48	0.27	0.08	1.39
Share of import	-0.51	0.28	-1.47	-0.11
Year			1995	2015
Observations	412			

Notes: The table shows the descriptive statistics for the shorter but more comprehensive country panel dataset. Data from the EU KLEMS release 2019, Penn World Table 9.0, OECD STAN as well as World Bank. The labor share is calculated as $LS_t = \frac{W_t L_t}{Y_t}$ as explained in Section 5.3 for each country. Figure 5.7 in the Appendix of this chapter provides the labor share trends for each country. Data sets are merged using country names and the corresponding year. For an overview of the EU KLEMS data see Stehrer et al. (2019) and for Penn World tables see Feenstra et al. (2015). More information regarding the human capital index is provided in Table 5.11. The sample comprises the countries: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Slovenia, Spain, Sweden, United Kingdom and the United States.

Methodology. Following the notation of Abadie et al. (2010) we apply the synthetic control method for the case that a single unit (Germany) is exposed to some treatment (the Hartz IV legislation) and there is no natural control group. The other $(J + 1)$ countries remain unexposed to the reform and are referred to as the donor pool. This pool is then used to construct the Germany doppelganger. Basically, the idea of this approach is to build a counterfactual Germany without the Hartz IV reform from the donor pool of the other $N = 22$ countries.[19]

We observe the labor share for T periods in which the intervention starts in some period $T_0 + 1$ which is in our case the year 2005. Furthermore, we define the outcomes Y_{jt} which are the observed outcomes for the treated as well as control countries. The fundamental problem in such a causal analysis is that we do not observe the labor share Y_{1t} for a counterfactual Germany, without the Hartz IV reform, after period T_0. Fortunately, the synthetic control method offers a solution for the estimation of Y_{1t}, by creating a 'synthetic control Germany' as a

[19]The countries that comprise the donor pool are in alphabetical order: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Slovenia, Spain, Sweden, United Kingdom and the United States.

weighted combination of other countries ($w_j Y_{jt}$) which best approximate relevant pre-intervention variables. The weighting vector is defined as $W = (w_2, \ldots, w_{(J+1)})$ in which w_j is the contribution of each of the $N = 22$ donor pool countries.[20] The counterfactual Germany is constructed as a convex combination of the observed outcomes of the other countries and there should be no difference in real and synthetic Germany prior to the intervention, given by:

$$Y_{1t} = \sum_{j=2}^{J+1} w_j Y_{jt}, t = 1, \ldots, T_0 \tag{5.19}$$

The effect of the intervention for the aggregated time period after T_0 is then obtained by the difference of Equation (5.19) for the time period after the intervention compared to prior the intervention which is $\delta_{jt} = Y_{1t} - \sum_{j=2}^{J+1} w_j Y_{jt}$. This can be estimated using a difference-in-differences (DiD) framework in which we regress the difference between real and synthetic Germany on a Hartz IV variable which takes the value one for all years after 2004 and zero otherwise. This synthetic control method derives the average treatment effect on the treated (ATT) (e.g. Abadie 2021).

Country weights and counterfactual Germany. As shown in Table 5.5 there are four states which in particular resemble the German trend in the labor share quite well. These countries receive the corresponding weights that is shown in Table 5.5 for the construction of the counterfactual Germany as shown in Equation (5.19). Thus, using the synthetic control method with covariates (e.g. Botosaru & Ferman 2019) as provided in Table 5.4 for the construction of the Germany doppelganger, the Netherlands, Spain, Slovenia as well as the United Kingdom are in particular used as weighted aggregated comparisons.

Balancing of covariates. Similar to other matching algorithms depending, for example, on the propensity score (e.g. Caliendo & Kopeinig 2008), the credibility of the synthetic control method also relies on the balancing of covariates. The balancing of the pre-intervention variable means should be checked, which is done in Table 5.6 by comparing the means between the weighted control group and treated Germany. In our case, we construct the synthetic Germany as a convex combination of the 22 donor pool states that resemble Germany as close as possible in terms of pre-intervention variables. As becomes apparent from Table 5.6, the means between real and synthetic Germany are balanced.

[20] Since Germany is the treatment state it is not part of the weighting vector. Moreover, the weights are constrained that $w_j \geq 0$ and they sum up to one ($w_2 + \ldots + w_{(J+1)} = 1$).

Table 5.5: Country weights from donor pool

Country	Weight	Country	Weight
Austria	< 0.01	Japan	< 0.01
Belgium	< 0.01	Latvia	< 0.01
Czech Republic	< 0.01	Lithuania	< 0.01
Denmark	< 0.01	Luxembourg	< 0.01
Estonia	< 0.01	Netherlands	0.276
Finland	< 0.01	Poland	< 0.01
France	< 0.01	Spain	0.273
Greece	< 0.01	Slovenia	0.226
Hungary	< 0.01	Sweden	< 0.01
Ireland	< 0.01	United Kingdom	0.225
Italy	< 0.01	United States	< 0.01

Notes: This table shows how the weighting vector in Equation (5.19) is resembled and which weights (i.e. $W = (w_2, \ldots, w_{(J+1)})$) each donor pool country receives for the construction of the counterfactual Germany. Within the synthetic control method, variables are averaged for the pre-intervention 1995 – 2004 period (the share of capital formation, government sending, export as well as imports are averaged 1995 – 1999). Own calculations using the parametric synthetic control approach (e.g. Abadie et al. 2010, 2015; Abadie 2021).

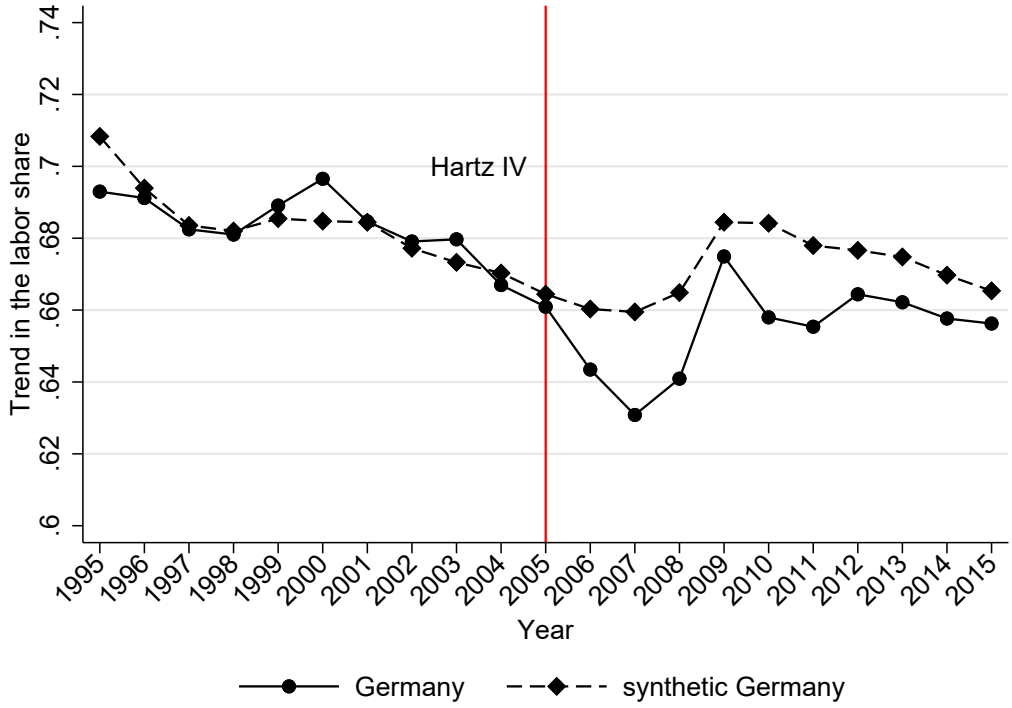
Table 5.6: Labor share predictor means before intervention

	Germany	
Covariates	Real (1)	Synthetic (2)
Labor share	.684	.684
Trade union density	25.22	28.06
Unemployment rate	8.81	8.44
Human capital index	3.55	3.10
Share of capital formation	.251	.252
Share of government consumption	.137	.160
Share of exports	.356	.356
Share of imports	-.355	-.390

Notes: This table shows mean comparisons of used covariates for the calculation of the counterfactual labor share which is shown in Figure 5.6 and the real German labor share. Means for the synthetic Germany are calculated using the weights provided in Table 5.5. For the construction of the weights, all variables are averaged for the pre-intervention 1995 – 2004 period (the share of capital formation, government sending, export as well as imports are averaged 1995 – 1999).

Results of the synthetic control method. Depicted in Table 5.6, the pre-intervention differences are balanced and trends between both labor shares are quite the same prior to the Hartz IV treatment. Results from the synthetic control approach in addition to the trends among the synthetic and real Germany are presented in Figure 5.6. The Hartz IV reform was enacted at the beginning of the year 2005 in which we see a sharp decline in the German labor share, however, not in the counterfactual trend. Interestingly, both trends capture the effects of the financial crisis in the year 2009 quite well, however the real German increase is much more pronounced. What is additionally important besides the strong decline in the real German labor share is the fact, that the differences between both labor shares are persistent after the Hartz IV legislation was implemented.

Figure 5.6: Trends in labor shares: real vs. synthetic Germany



Notes: The figure shows the trends in the real and the synthetic labor share of Germany. The labor share is calculated as outlined in Equation (5.14). All variables are averaged for the pre-intervention 1995–2004 period (the share of capital formation, government sending, export as well as imports are averaged 1995–1999). Data from the EU KLEMS, Penn World Tables, OECD STAN and World bank.

Using the synthetic control approach, we are able to compare the real Germany where the Hartz IV legislation was enacted, with our synthetic control Germany doppelganger which never experienced the Hartz IV reform. Our graphical results in Figure 5.6 show the significant negative impact of the Hartz IV reforms for the aggregate real labor share in Germany compared to the synthetic labor share. Since

Table 5.7: Results for synthetic control regression

	Labor Share
	(OLS)
expl. variable	(1)
Hartz IV (pooled)	-.016***
	(.003)
R^2	.552
Observations	21

Notes: This table shows the impact of the Hartz IV legislation on the labor share within the synthetic control framework. The labor share is calculated as outlined in Equation (5.14). Trends for synthetic Germany are calculated using the corresponding weights as shown in Table 5.5. Calculation according to Equation (5.19). All variables are averaged for the pre-intervention 1995–2004 period (the share of capital formation, government sending, export as well as imports are averaged 1995–1999). Data from the EU KLEMS, Penn World Tables, OECD STAN as well as World bank. Robust standard errors in parentheses. *, **, and *** denote statistical significance at the .1, .05 and .01 level.

the comparison of real and synthetic Germany resembles a kind of randomized experiment (under the assumption of balanced covariates), the reform effect can be estimated by investigating the difference between both trends (Angrist & Pischke 2009).[21] Regression results using a Hartz IV dummy variable which takes unit value after the year 2005 and zero otherwise, yield similar results as before and are presented in Table 5.7. Compared to the estimates using only the longer time series for Germany, as presented in Table 5.3, the effect of the synthetic method is slightly smaller, but also highly significant. The labor share declined by 1.6 percentage points after the Hartz IV reform was implemented at the beginning of 2005. The comparison of Germany with the synthetic control group shows that both follow the same downward trend in the labor share over time, but in contrast to the control observation, this trend became stronger for Germany after the Hartz reforms. Moreover, the impact of the reform is strongest in the early years before the great financial crisis in the year 2009, although the difference remains, albeit slightly smaller in terms of magnitude.

While the estimates provided in this section support our theoretical model and are also supported by the change point tests, there is still a lack of a cross-sectional

[21] In our approach we regress the difference between both trends on the Hartz IV variable, which takes the value one after the year 2005 and zero otherwise. Given alignment of both trends and thus randomization before the reform was implemented, this difference-in-differences approach aims at estimating the causal effect of the reform.

dimension. It is quite likely that industries and firms are affected differently, in particular when estimates are additionally adjusted by control variables. For example, the decline in the degree of trade union organization or the increasing decentralization of the negotiation process (e.g. Dustmann et al. 2014) may explain the low wage increases, and in fact the often discussed real wage reductions in the 2000s. Since variables vary between sectors and firms, we carry out additional research using OLS, fixed effects and System-GMM estimation combined with a different identification strategy to provide comprehensive firm-level evidence.

5.5 Robustness using firm-level evidence

In this section we investigate the effects of the Hartz IV reform on the labor share based on firm level data.[22] The use of firm-level data has two main advantages. First, we are able to take changing sector and industry compositions into account that may affect the labor share (Siegenthaler & Stucki 2015). Second, as mentioned by Gollin (2002) and Karabarbounis & Neiman (2014), aggregate labor share measures may be confounded by capital incomes earned by entrepreneurs and sole proprietors. We use firm-level data stemming from the 'dafne' dataset compiled by Bureau van Dijk, which allows us to measure the impact of a change in the outside option more precisely. We use information for the years 2000–2011.

Dependent variable. For the dependent variable, we use the same variable as explained earlier in Equation (5.14). Thus, we measure the labor share as the share of labor compensation to value added of the firm. We measure value added as the gross output minus intermediate inputs, depreciation and interest expenses. See Figure 5.11 for a histogram of the labor share and Figure 5.12 for the development of the firm-level labor share over time. Comparing the firm-level labor share with the aggregate German labor share, we find a similar development; a sharp decline around the Hartz legislation and a spike during the financial crisis.

Control variables. With respect to control variables, we implement variables which are common in the literature as determinants of the labor share. First, in neoclassical growth models, the labor share is a function of the capital-to-output ratio (Bentolila & Saint-Paul 2003; Siegenthaler & Stucki 2015). Thus, we implement the logarithm of the capital-to-output ratio as an explanatory variable. The sign of the capital-to-output ratio depends on the elasticity of substitutions between capital and labor (Siegenthaler & Stucki 2015). In the case where labor

[22] See, for example, Harju et al. (2021) regarding the effects of co-determination on the firm-level labor share.

and capital are complements, the ratio increases the labor share. In the case of a substitutive relationship between capital and labor, the capital-to-output ratio decreases the labor share. The empirical literature usually finds controversial signs in different studies.

To account for unobserved demand shocks within the regression framework, we also add the logarithm of the ratio of intermediate inputs to firms' value added and its square to the regression equation. The idea is to take changes in the input factors into account when firms are hit by various demand shocks (e.g. Levinsohn & Petrin 2003; Siegenthaler & Stucki 2015). The labor share also depends on the degree of organization of the workforce which we measure using union density. Given the relevance of collective bargaining agreements as well as the trend of declining unionization (Oberfichtner & Schnabel 2019) we expect lower wages (e.g. Akyol et al. 2013). In the case of a rather inelastic demand curve this also implies a reduction of the labor share (Siegenthaler & Stucki 2015). With respect to the sign of the coefficient, we therefore expect a positive sign of our union measure. We use a unique measure for union density at the industry level. See the Appendix of this chapter for the construction of the index.

Finally, we include further control variables subsumed in $\mathbf{X}_{it}$. The vector includes an indicator variable whether the firm is a stock company and whether the firm is located in Western Germany. We also include detailed NACE (rev. 2.0) two-digit industry-fixed effects as well as year-fixed effects in the regression model. Descriptive statistics are provided in Table 5.8.

Table 5.8: Descriptive statistics for firm-level data

Variables	Mean (1)	Std. dev. (2)	Min (3)	Max (4)
Laborshare	.456	.173	.001	.998
ln (Capital-output ratio)	.141	.272	-5.23	4.18
ln (Intermediate inputs)	.692	.546	-.559	6.96
ln (Intermediate inputs squared)	.777	1.57	.001	48.42
Trade union density	.196	.095	.008	.960
Stock company	.272	.445	0	1
Western Germany	.797	.425	0	1
Year			2000	2011
Observations	36,789			

Notes: The data is based on the "dafne" dataset compiled by Bureau van Dijk; years 2000 – 2011. The labor share is calculated as $LS_t = \frac{W_t L_t}{Y_t}$ as explained in Section 5.3. Trade union density is measured at the industry level as outlined in the Appendix of this chapter.

Regression framework. We apply the following regression framework by using the logarithm of the labor share $ln(LS_{it})$ as the dependent variable for firm i in year t as follows:

$$ln(LS_{it}) = \beta_0 + \beta_1 ln(k_{it}) + \beta_2 Unemploy_j^{2002} + \tau HartzIV \times Unemploy_j^{2002} + \beta_3 Org_{it} + \beta_4 \mathbf{Z}_{it} + \beta_5 \mathbf{X}_{it} + \mu_i + \theta_t + \varepsilon_{it} \quad (5.20)$$

In this specification the labor share depends on the capital-to-output ratio (k_{it}), the vector $\mathbf{Z}_{it}$ subsumed intermediate inputs of the firm as well as its square, Org_{it} measures bargaining power as union density and we include a set of firm specific control variables ($\mathbf{X}_{it}$). Finally, we insert time dummies θ_t to capture year specific shocks as well as NACE 2.0 industry classification dummy variables μ_i. The German unemployment rate is measured on the county-level j as shown in Figure 5.13 in the Appendix of this chapter. We estimate this specification using ordinary least squares (OLS), random effects (RE) as well as fixed effects (FE) models shown in Table 5.9.

As an additional approach and to take potential input factor endogeneity into account, we estimate System-GMM models (Blundell & Bond 1998). Therefore, we estimate dynamic models of the labor share with lagged levels of the labor share in the dynamic setting.[23] Regarding the generated instruments within the System-GMM approach, we stack them into one vector to prevent the problem of weak instruments. To test the validity of our instrumental variables, we apply the standard Hansen test to check over-identifying restrictions (Hansen 1982). In addition, the System-GMM estimator requires the absence of second-order auto-correlation in the residuals. We therefore also test for first-order AR(1) and second-order AR(2) auto-correlation (Arellano & Bond 1991). With respect to standard errors, we use the standard two-step clustering approach and apply the Windmeijer (2005) finite sample correction.

Identification. Similar as described in the previous section, the Hartz IV reform was introduced simultaneously for whole Germany, which implies the lack of a natural control group. While the previous section deals with this obstacle using a synthetic control approach, the identification on the firm level relies on county-level variation in the unemployment rate before the Hartz reforms. Therefore, a variant of a difference-in-differences framework is applied (e.g. Immel 2021; Giebel & Kraft 2019; Card 1992). In particular German county-level variation in the unemployment rate in the year 2002 is used as an exogenous measure for treatment intensity before the Hartz reforms were introduced. Thus, the effect of the

[23] For a similar approach, see for example Böckerman & Maliranta (2012); Yang & Tsou (2021).

Hartz reform is expected to be stronger in case the value of this variable, i.e. the unemployment rate increases. Basically, a higher unemployment rate implies less attractive outside options which lowers the labor share at an increasing rate. For the distribution of the unemployment rate by German counties, see Figure 5.13 in the Appendix of this chapter. What becomes apparent is that there is a huge difference between eastern and western Germany in terms of the unemployment rate. Similar to the common difference-in-differences model, the treatment variable, i.e. the Hartz IV dummy variable, is included in the regression in Equation (5.20) unchanged as before and interacted with the German county-level unemployment rate in the year 2002. Thus, the $HartzIV \times Unemploy_j^{2002}$ coefficient takes the value of the corresponding unemployment rate of the county the firm is located in and zero for all years before 2005.[24]

Results. Similar to our initial results for Germany, as well as the more sophisticated synthetic control approach, we also find a reduction of the labor share on the firm level stemming from the Hartz IV legislation. The size of reduction is similar to the magnitude found in the regressions on the aggregate labor share. Those firm-level results are consistent among pooled OLS, random and fixed effects as well as System-GMM estimation.[25] With respect to the latter estimation results, the test statistics also support our results. After adjusting for time specific shocks in the labor share series using year-fixed effects, the Hartz IV interaction term points to a significant negative relationship. Thus, an increase in the unemployment rate by 1 % results in a reduction of the labor share by 0.051 percentage points (System-GMM) to 0.086 percentage points (FE).[26] The point estimates are consistent among specifications and similar to the findings on the aggregate labor share. With respect to the German east/west comparison, it becomes apparent that the decline of the labor share is in particular pronounced among the firms which are located in eastern Germany and thus consistent with our expectations. The labor share is reduced by 0.414 (fixed effects) to 0.526 percentage points (System-GMM)[27] for firms which are located in eastern Germany after the Hartz

[24]Since we use firm-level data, firms are matched with the county-level unemployment rate depending on the postal code using NUTS 3 classification to match the postal code with the corresponding German county identifier.

[25]We also applied different specifications in which the results are consistent among specifications.

[26]For the GMM estimator, the point estimate τ is considered as the short-term effect while the long-term effect τ_L of the reform can be approximated by $\tau_L = -0.00051 * [1/(1-0.687)] = 0.002$ where 0.687 being the lag-coefficient. An increase in the unemployment rate by 1 % therefore results in a decrease of the labor share by 0.2 percentage points in the long-run. The results in the System-GMM and FE specifications are similar if we also include industry fixed effects.

[27]Again as before, the long-term effect in this specification is approximated by $\tau_L = -0.00526 * [1/(1-0.694)] = 0.017$. Thus, the long-term effect of the reform using variation in the unemployment rate between eastern and western Germany results in a decrease of the labor share by

Table 5.9: Firm-level robustness using unemployment rate treatment intensity

	Labor Share			
	OLS	RE	FE	Sys-GMM
	(1)	(3)	(3)	(4)
Lag labor share				0.687***
				(0.05)
Unemploy	0.001	0.001		0.001
	(0.001)	(0.001)		(0.001)
Hartz IV × Unemploy	-0.00062**	-0.00083***	-0.00086***	-0.00051**
	(0.00029)	(0.00020)	(0.00021)	(0.00024)
Capital-output ratio	0.039***	0.066***	0.076***	-0.055
	(0.006)	(0.007)	(0.009)	(0.084)
Intermediate inputs	0.009	0.069***	0.102***	0.158***
	(0.006)	(0.009)	(0.011)	(0.076)
Stock company	-0.002	-0.005	-0.003	0.063*
	(0.004)	(0.006)	(0.003)	(0.034)
Trade union density	0.010**	0.008**	0.007**	0.029***
	(0.005)	(0.003)	(0.003)	(0.006)
Intermediate inputs squared	-0.011***	-0.008**	-0.006	-0.063**
	(0.002)	(0.004)	(0.004)	(0.031)
Western Germany	0.019***	0.021***		-0.003
	(0.006)	(0.006)		(0.003)
Constant	0.335***	0.252***	0.330***	0.123***
	(0.018)	(0.016)	(0.012)	(0.046)
Industry fixed effects	✓	✓		
Time fixed effects	✓	✓	✓	✓
R2	.164	.130	.137	
No. of instruments				43
AR1 (p-value)				.000
AR2 (p-value)				.223
Hansen-J (p-value)				.532
Observations.	36,789	36,789	36,789	27,934

Notes: This table shows results from estimating Equation (5.20). The data is based on the 'dafne' dataset compiled by Bureau van Dijk; years 2000 – 2011. The labor share is calculated as $LS_t = \frac{W_t L_t}{Y_t}$ as explained in Section 5.3. The Hansen (1982) test is applied to check for over-identifying restrictions, and tests for first-order AR(1) and second-order AR(2) auto-correlation are provided by Arellano & Bond (1991). Firm-level clustered standard errors in combination with Windmeijer (2005) finite sample correction in parentheses. *, **, and *** denote statistical significance at the .1, .05 and .01 level respectively.

IV reform was implemented. Similar results among both specifications, i.e. intensity as well as east-west, are also obtained when we drop the years 2003 (Hartz I-II) as well as 2004 (Hartz III) from the analysis as shown in Tables 5.12 and

1.7 percentage points. Again, the results are similar, in case we also include industry fixed effects in the System-GMM and FE specifications.

Table 5.10: Firm-level robustness using eastern / western Germany comparison

	Labor Share			
	OLS	RE	FE	Sys-GMM
	(1)	(3)	(3)	(4)
Lag labor share				0.694***
				(0.086)
Hartz IV × East	-0.00280	-0.00440*	-0.00414*	-0.00526**
	(0.003)	(0.002)	(0.003)	(0.002)
East	-0.013***	-0.011***		-0.002
	(0.004)	(0.004)		(0.005)
Capital-output ratio	0.039***	0.066***	0.076***	-0.059
	(0.006)	(0.007)	(0.009)	(0.089)
Intermediate inputs	0.009	0.070***	0.101***	0.159**
	(0.006)	(0.009)	(0.011)	(0.081)
Stock company	-0.002	-0.005	-0.032	0.062*
	(0.004)	(0.005)	(0.030)	(0.033)
Trade union density	0.010**	0.007**	0.007**	0.029***
	(0.005)	(0.003)	(0.003)	(0.006)
Intermediate inputs squared	-0.010***	-0.008**	-0.006	-0.064**
	(0.002)	(0.004)	(0.004)	(0.043)
Constant	0.346***	0.269***	0.331***	0.115***
	(0.016)	(0.013)	(0.012)	(0.045)
Industry fixed effects	✓	✓		
Time fixed effects	✓	✓	✓	✓
R2	.163	.129	.136	
No. of instruments				42
AR1 (p-value)				.000
AR2 (p-value)				.218
Hansen-J (p-value)				.521
Observations.	36,789	36,789	36,789	27,934

Notes: This table shows results from estimating Equation (5.20). The data is based on the 'dafne' dataset compiled by Bureau van Dijk; years 2000 – 2011. The labor share is calculated as $LS_t = \frac{W_t L_t}{Y_t}$ as explained in Section 5.3. The Hansen (1982) test is applied to check for over-identifying restrictions, and tests for first-order AR(1) and second-order AR(2) auto-correlation are provided by Arellano & Bond (1991). Firm-level clustered standard errors in combination with Windmeijer (2005) finite sample correction in parentheses. *, **, and *** denote statistical significance at the .1, .05 and .01 level respectively.

5.13. The idea behind this approach is to mitigate potential confounding effects stemming from the Hartz I-III reforms, which were implemented in those years.

In line with the literature (e.g. Arif 2021; Siegenthaler & Stucki 2015), we also find that labor and capital in our data are complements (measured by the positive impact of capital-to-output ratio). With respect to our measure of trade union density, we find a positive association between bargaining power and the labor

share as, for example, also found by Stansbury & Summers (2020). Regarding the measurement of intermediate inputs, our results are also in line with the findings by Siegenthaler & Stucki (2015) in which we also see an inverted u-shaped relationship.

Summarizing, our additional robustness test by application of microeconomic data and different econometric methods as well as identification strategy supports our earlier results based on aggregate data. Our results are well in line with the empirical literature (e.g. Karabarbounis & Neiman 2014).

5.6 Conclusion

In this chapter we investigate the relevance of bargaining institutions for the decline in the German labor share. The Hartz IV reform, enacted in Germany in the year 2005 provides a unique exogenous reform shock which allows us to estimate the impact of a reduction in the outside option in wage bargaining. Since the reform reduces long-term unemployment benefits for all workers in Germany, the threat point in bargaining between unions and employers is reduced and the threat of unemployment is more severe. We first present a simple bargaining model in which we analyze the relevance of the reduction in the outside option for the decline of the labor share. The model implies that rents are generated within a duopoly in which a union is the bargaining partner. Furthermore, the model connects the wage which is bargained for and the alternative wage which is exogenously reduced because of the Hartz IV reform.

The empirical part consists of three parts. We first combine the EU KLEMS, Penn World Tables and OECD STAN databases to identify the Hartz reforms as a significant structural break in the time series of the labor share. We therefore apply a variety of endogenous change point tests for single as well as multiple breakpoints, in which the tests reveal the Hartz reforms as a significant structural break in the labor share. They additionally point to the fact that, besides the Hartz IV reform, also the reunification of eastern and western Germany is an interesting factor worth considering with respect to the labor share. Second, estimates on the aggregate labor share imply that the Hartz IV reform shock reduces the labor share by around two percentage points, in particular after the first five years after the reform was implemented. Using a synthetic control approach to construct a counterfactual Germany doppelganger, we provide evidence that the effect is rather persistent. In a final robustness section, we additionally use rich firm-level panel data compiled by Bureau van Dijk in combination with fixed effects and System-GMM estimation techniques to support the previous findings on the aggregate

labor share. Identification is achieved by using unemployment variation before the Hartz reforms were implemented in the year 2002 within a variant of a difference-in-differences framework. We therefore contribute to the burgeoning literature regarding the labor share in the context of technological progress, globalization and mark-ups stemming from increasing market concentration. In this context, using a unique exogenous reform shock we provide novel evidence of the effects of a reduction in the outside option within a bargaining model on the labor share.

Besides the endogenously identified Hartz reforms in the labor share series and the application of recent econometric methods in the area of program evaluation, our study is not without limitations. First, there is a debate regarding the measurement of the labor share in which the income of self-employed and real estate income is often neglected (e.g. Cette et al. 2020). With respect to the database, our data includes income of the self-employed but does not take revenues from real estate into account. Second, because of data limitations, our time series for the construction of the synthetic Germany is slightly shorter compared to the time series which only considers Germany.

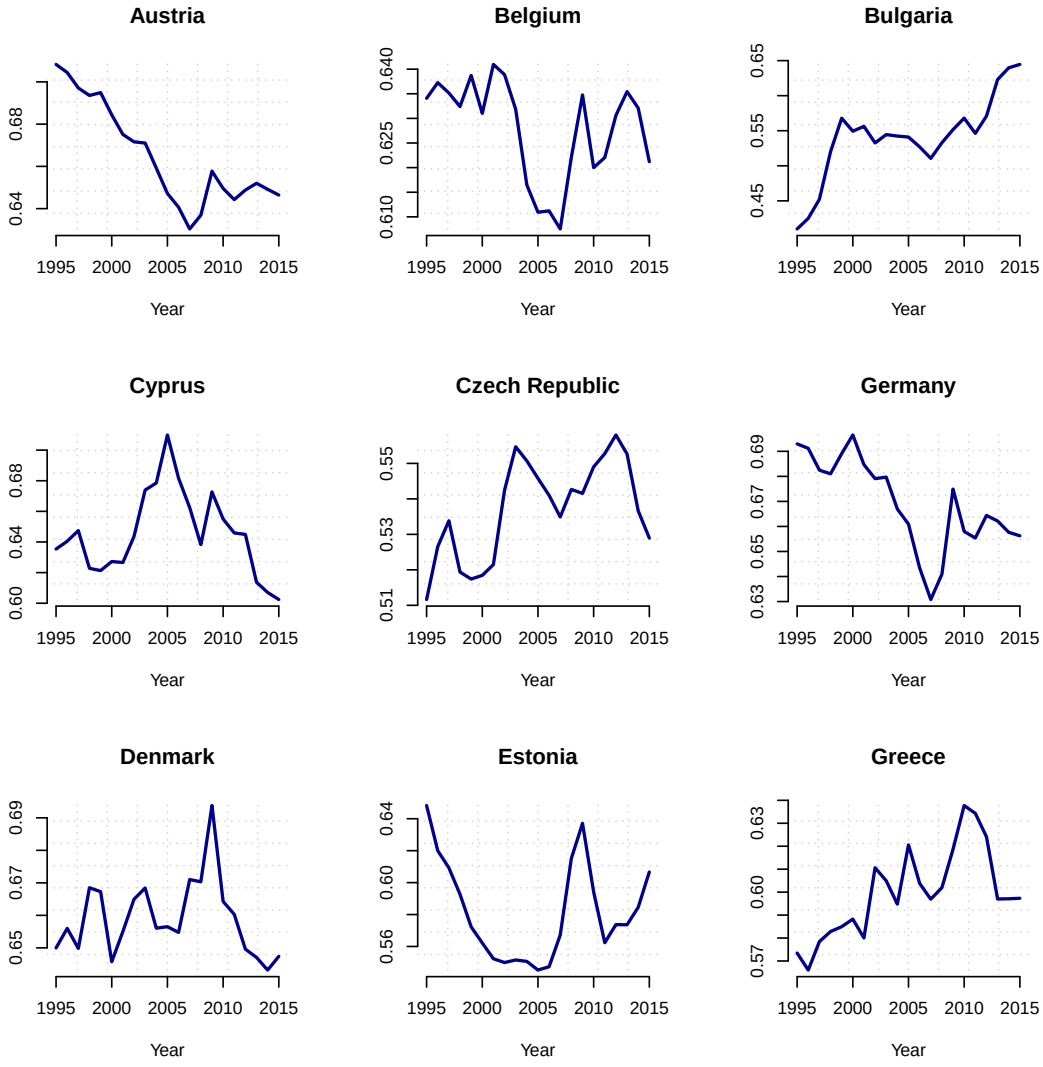
With respect to policy implications, we provide a missing link for the effects on the labor share. Whereas studies as, for example, De Loecker et al. (2020) investigate the relevance of decreasing competition and thus an increase in power and mark-ups for the decrease in labor share, we provide evidence from a different direction. Our results show that also the decrease in unionization and thus bargaining power to increase the wage over its marginal product is reduced. Further studies in this context (e.g. Stansbury & Summers 2020) even argue that the decline in worker power is the major aspect of structural changes in the labor share. For Germany, the decline in unionization and representation of workers by co-determination rights on the establishment level, as mentioned, for example, by Addison et al. (2017), should therefore be in the focus of research on developments of the labor share. In summary, our study adds knowledge to the burgeoning literature on determinants of the labor share. Besides technological progress, globalization and mark-ups, we show within a bargaining framework the relevance of changes in the outside option, which has been neglected so far.

To this end, additional research might be helpful to investigate the reform effect on different types of employment such as temporary or marginal employment. Furthermore, future work should address the question of how to estimate the labor share more precisely and consistently within and between countries. Since the relevance and interest in technological progress and union power seems likely to increase in the future, more studies are to be expected on this topic.

5.7 Appendix

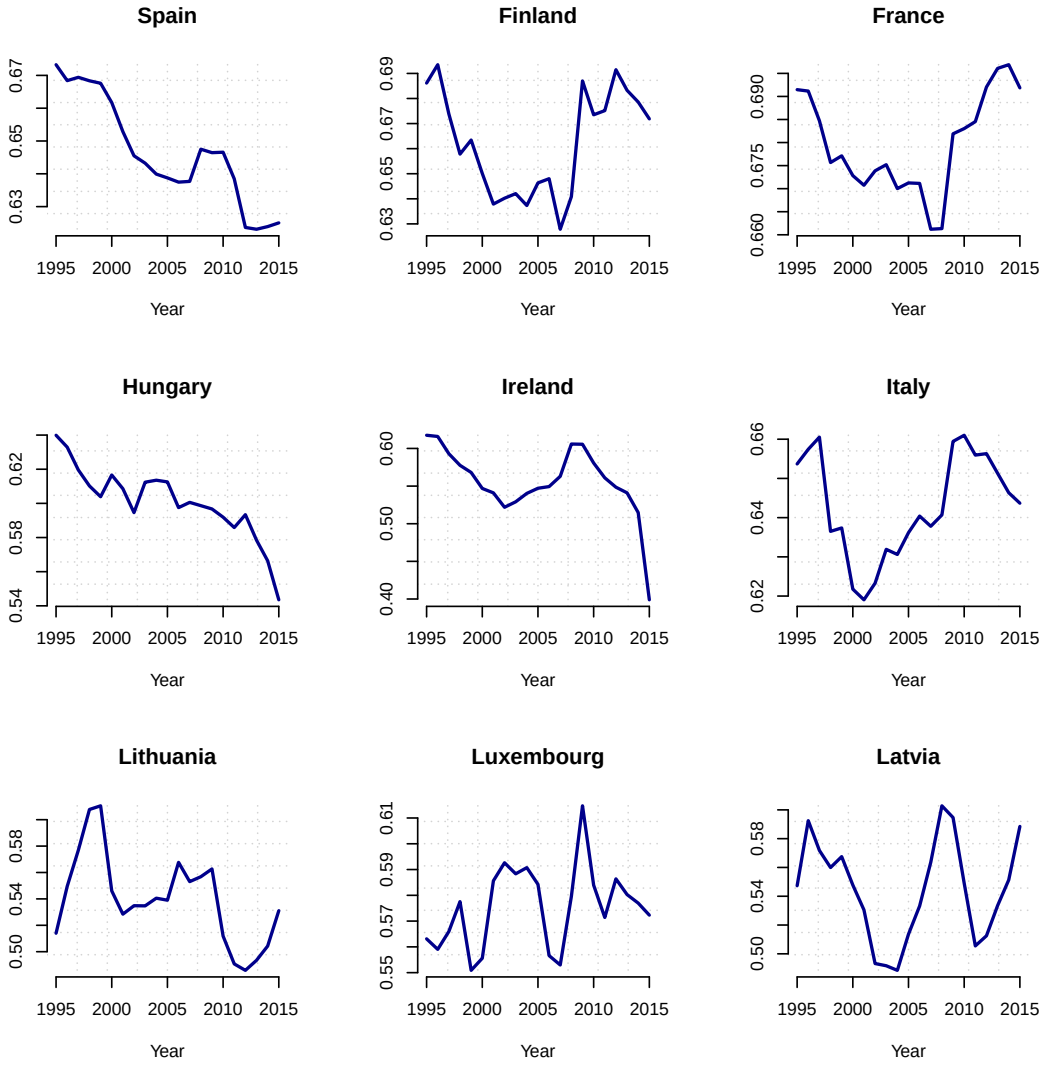
5.7.1 Additional Figures

Figure 5.7: Labor share trend for different countries



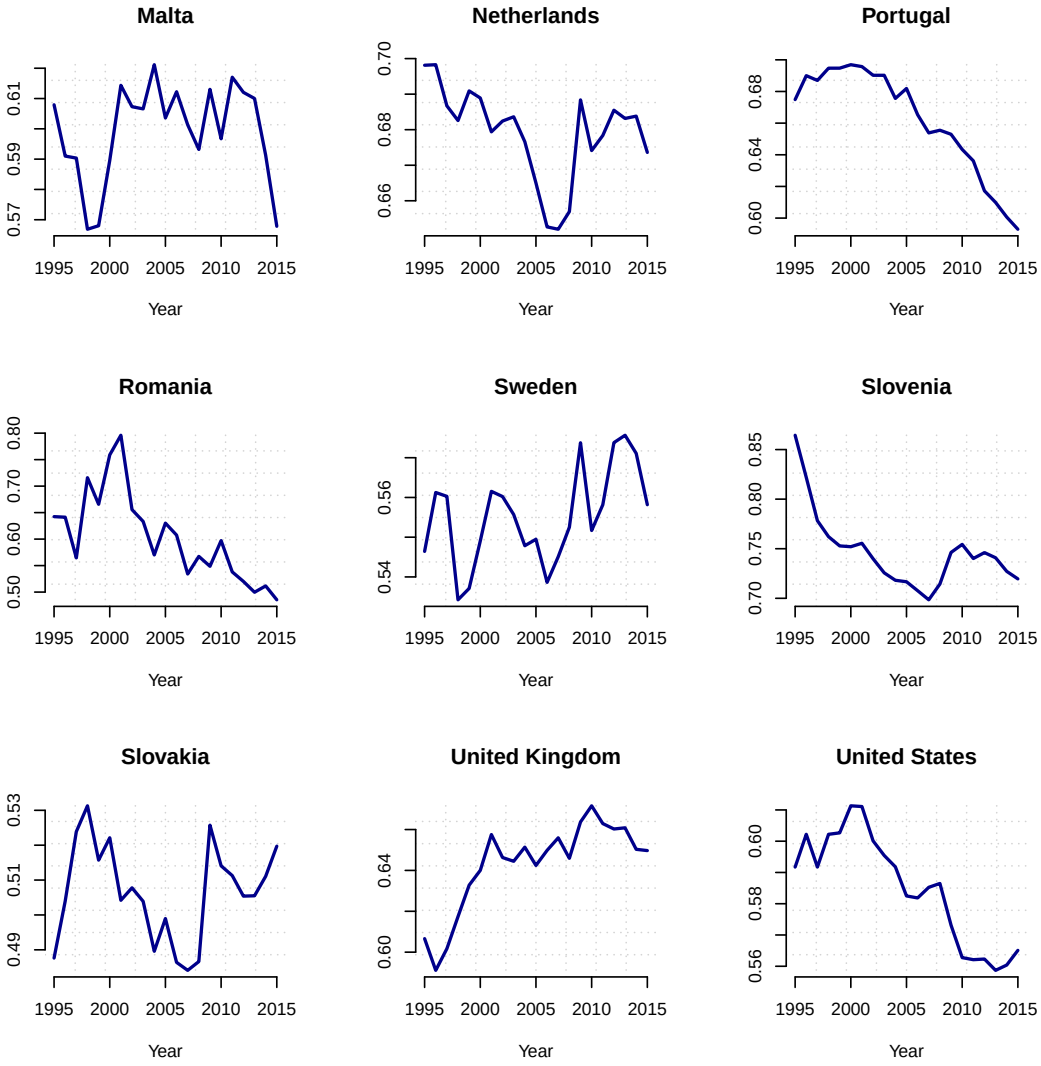
Notes: The figure plots the labor share for different countries between 1995 and 2015. The labor share is calculated as $LS_t = \frac{W_t L_t}{Y_t}$ which is the total compensation of employees in the economy in relation to gross valued added. Data from the EU KLEMS release 2019. For an overview of variable construction and methodology see Stehrer et al. (2019).

Labor share trend for different countries: *continued*



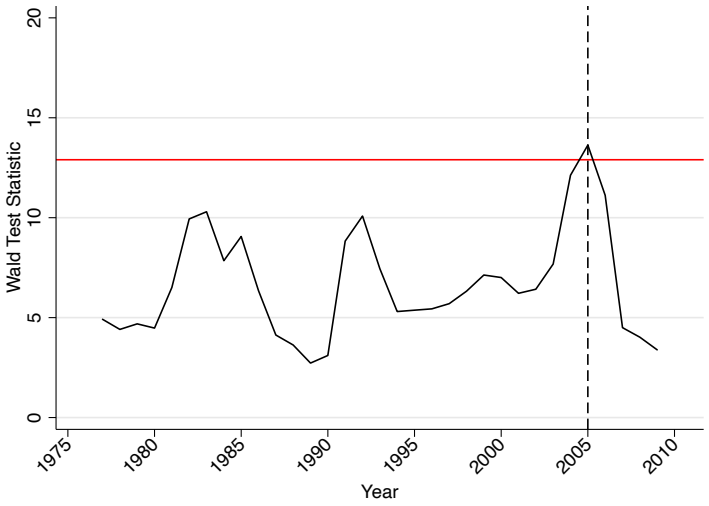
Notes: The figure plots the labor share for different countries between 1995 and 2015. The labor share is calculated as $LS_t = \frac{W_t L_t}{Y_t}$ which is the total compensation of employees in the economy in relation to gross valued added. Data from the EU KLEMS release 2019. For an overview of variable construction and methodology see Stehrer et al. (2019).

Labor share trend for different countries: *continued*



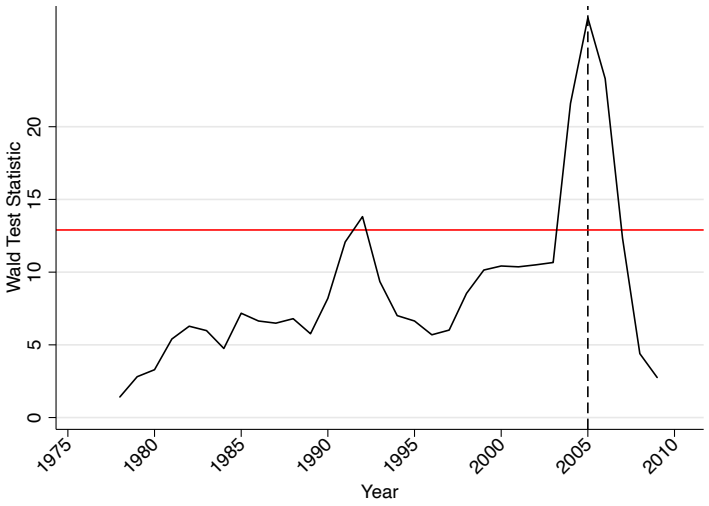
Notes: The figure plots the labor share for different countries between 1995 and 2015. The labor share is calculated as $LS_t = \frac{W_t L_t}{Y_t}$ which is the total compensation of employees in the economy in relation to gross valued added. Data from the EU KLEMS release 2019. For an overview of variable construction and methodology see Stehrer et al. (2019).

Figure 5.8: Wald test robustness I



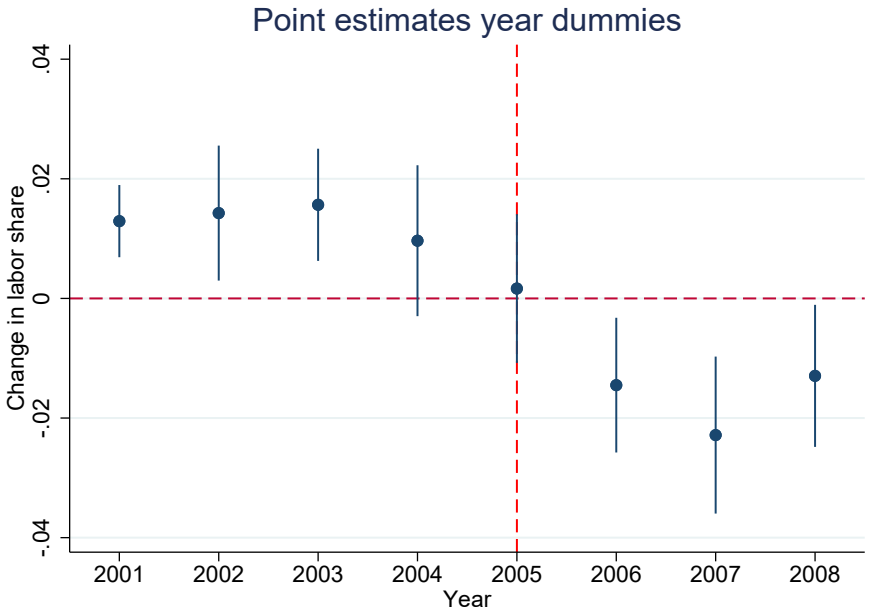
Notes: The figure shows values of the Wald test statistics as outlined in Equation (5.15) and (5.16). Regression include the number of strike days as well as the unemployment rate as additional control variables. Test for a change point in the mean of the labor share (LS_t) in year τ between $t = 1, \dots T$ where $t = 1977$ and $T = 2009$. The labor share is calculated as outlined in Equation (5.14). The blue line shows the values of the test statistics. The maximum value (sup Wald) of the Wald test statistic is 13.63 which occurred in 2005. The red line indicates the critical value of the test statistics as provided by Andrews (1993, 2003). We trim 15 percent from both ends of the sample to ensure that the test has sufficient power.

Figure 5.9: Wald test robustness II



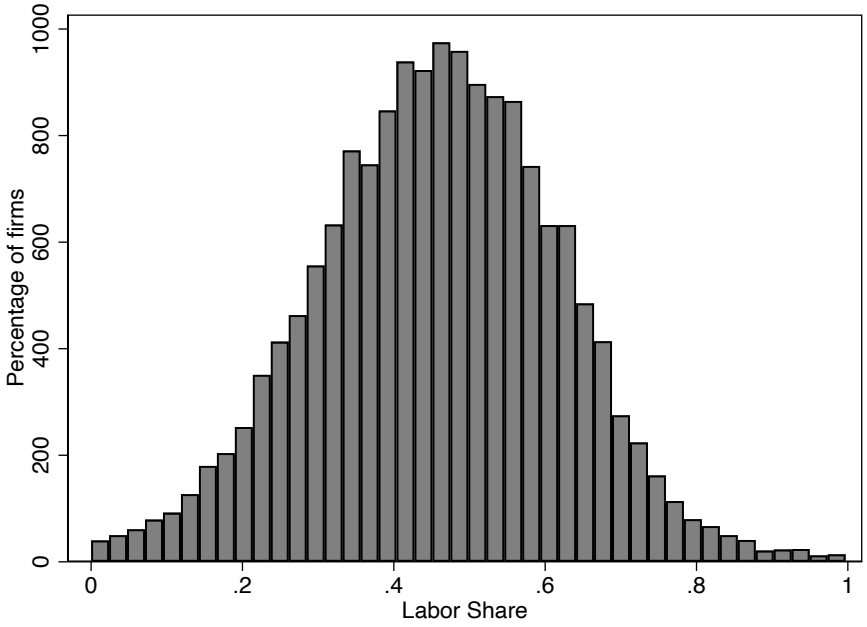
Notes: The figure shows values of the Wald test statistics as outlined in Equation (5.15) and (5.16). Regression include the number of strike days, unemployment rate as well as GDP growth as additional control variables. Test for a change point in the mean of the labor share (LS_t) in year τ between $t = 1, \dots T$ where $t = 1977$ and $T = 2009$. The labor share is calculated as outlined in Equation (5.14). The blue line shows the values of the test statistics. The maximum value (sup Wald) of the Wald test statistic is 27.48 which occurred in 2005. The red line indicates the critical value of the test statistics as provided by Andrews (1993, 2003). We trim 15 percent from both ends of the sample to ensure that the test has sufficient power.

Figure 5.10: Hartz IV dummy variable point estimates



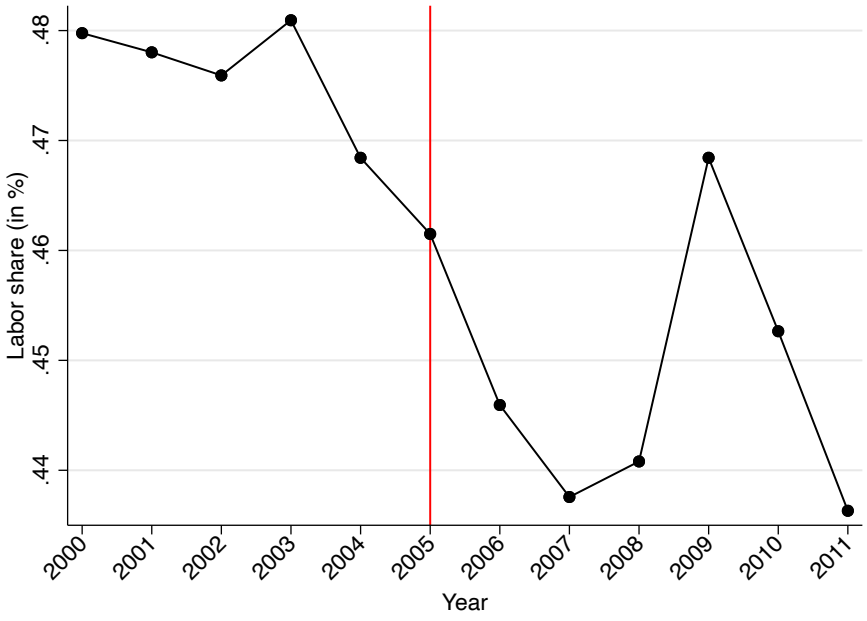
Notes: The figure plots the Hartz IV dummy variable point estimates from regressing the labor share also on all control variables and year dummies as outlined in Equation (5.18).

Figure 5.11: Distribution of the firm level labor share



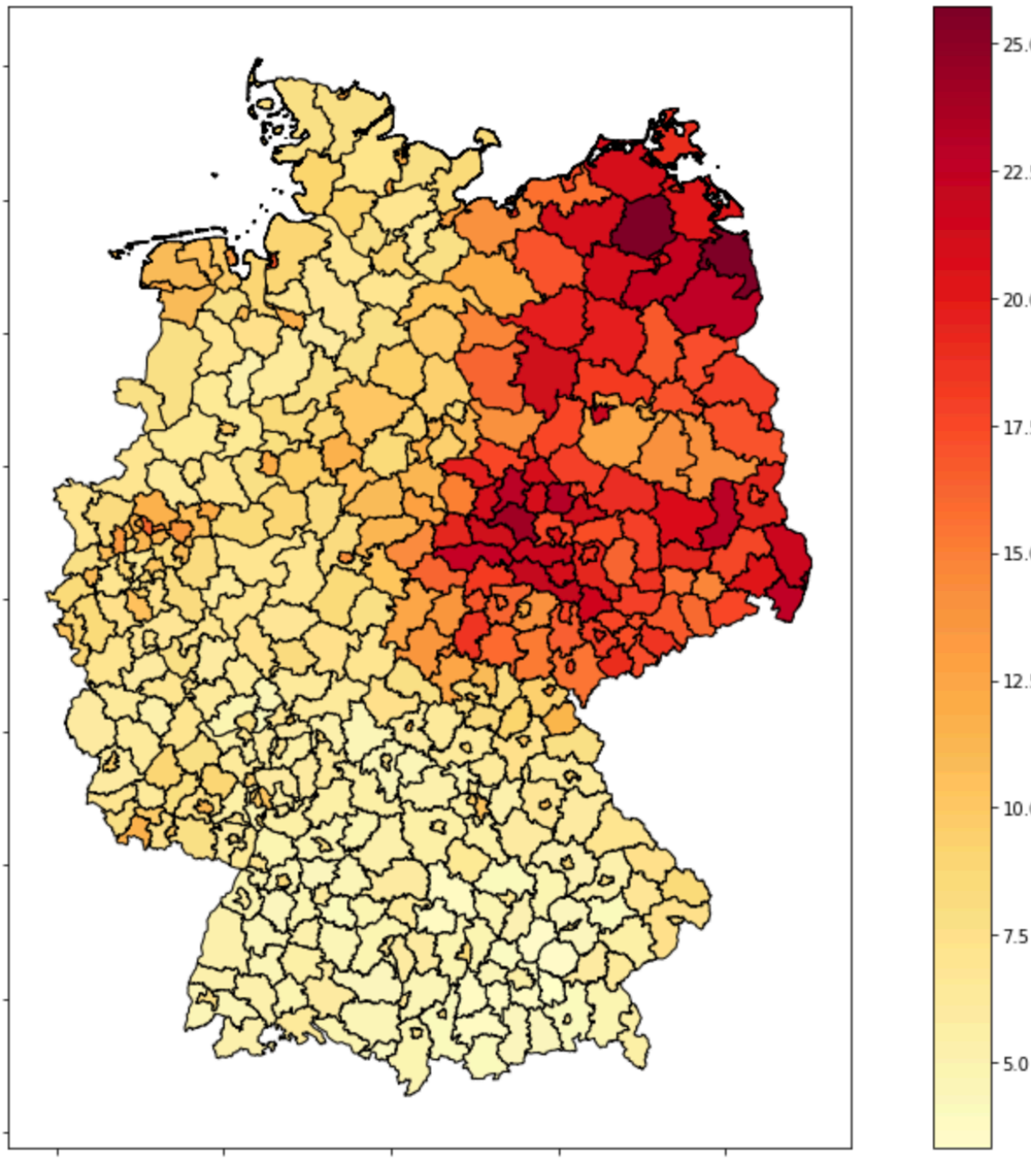
Notes: The figure plots the firm-level labor share. The data is based on the 'dafne' data set compiled by Bureau van Dijk; years 2000 – 2011.

Figure 5.12: Development of the firm level labor share



Notes: The figure plots the development of the firm-level labor share. The data is based on the 'dafne' data set compiled by Bureau van Dijk; years 2000 – 2011.

Figure 5.13: German unemployment rates by county in the year 2002



Notes: This figure shows the German county-level unemployment rate in the year 2002. Data from the Federal Employment Agency. The data is matched with firm-level data by the postal code as an identifier for the location of the firm for each county using the NUTS 3 classification. The unemployment rate is measured in percent.

5.7.2 Additional Tables

Table 5.11: Description, explanation and source of variables

Variable	Description and explanation
Dependent variable	
Labor share	*Sources: EU KLEMS; Bureau van Dijk* $$LS_t = \frac{W_t L_t}{Y_t}$$ Which is labor compensation $W_t L_t$ in relation to gross value added Y_t at year t in the corresponding country / firm.
Control variables	
Share of gross capital formation	*Source: Penn World Tables 9.0.* The share in relation to GDP measures the stock in real capital within a country.
Share of government consumption	*Source: Penn World Tables 9.0.* The share in relation to GDP measures the government consumption within a country.
Share of exports	*Source: Penn World Tables 9.0.* The share in relation to GDP measures the exports within a country.
Share of import	*Source: Penn World Tables 9.0.* The share in relation to GDP measures the imports within a country.
Human capital index	*Source: Penn World Tables 9.0.* The human capital index is based on average years of schooling as calculated in Barro & Lee (2013) in combination with an assumed rate of return to education stemming from a Mincer equation as defined in Psacharopoulos (1994). See also the more comprehensive and detailed definition In the PWT Definition File.
Unemployment rate	*Source: The World Bank.* Unemployment is the share of the labor force that is without work but available for work and seeking employment.
Trade union density	*Source: OECD STAN.* Members of trade unions compared to total employment within in defined industry.

Table 5.12: Results with unemployment variation, without years 2003 and 2004

	Labor Share			
	OLS	RE	FE	Sys-GMM
	(1)	(3)	(3)	(4)
Lag labor share				0.666***
				(0.121)
Unemploy	0.001	0.001		0.008
	(0.001)	(0.001)		(0.005)
Hartz IV × Unemploy	-0.00064**	-0.00080***	-0.00080***	-0.00662*
	(0.00031)	(0.00021)	(0.00021)	(0.00377)
Capital-output ratio	0.040***	0.069***	0.084***	0.045
	(0.006)	(0.008)	(0.010)	(0.128)
Intermediate inputs	0.008	0.069***	0.108***	0.352***
	(0.006)	(0.009)	(0.011)	(0.136)
Stock company	-0.003	-0.007	-0.017	0.022
	(0.004)	(0.006)	(0.022)	(0.006)
Trade union density	0.012**	0.010***	0.010***	-0.002
	(0.005)	(0.003)	(0.003)	(0.007)
Intermediate inputs squared	-0.009***	-0.008**	-0.006	-0.134**
	(0.002)	(0.003)	(0.004)	(0.053)
Western Germany	0.017***	0.019***		-0.005
	(0.005)	(0.006)		(0.004)
Constant	0.344***	0.263***	0.326***	0.003
	(0.019)	(0.016)	(0.010)	(0.011)
Industry fixed effects	✓	✓		
Time fixed effects	✓	✓	✓	✓
R2	.161	.135	.144	
No. of instruments				40
AR1 (p-value)				.153
AR2 (p-value)				.151
Hansen-J (p-value)				.858
Observations.	31,513	31,513	31,513	24,372

Notes: This table shows results from estimating Equation (5.20). The data is based on the 'dafne' dataset compiled by Bureau van Dijk; years 2000 – 2011. The labor share is calculated as $LS_t = \frac{W_t L_t}{Y_t}$ as explained in Section 5.3. The Hansen (1982) test is applied to check for over-identifying restrictions, and tests for first-order AR(1) and second-order AR(2) auto-correlation are provided by Arellano & Bond (1991). Firm-level clustered standard errors in combination with Windmeijer (2005) finite sample correction in parentheses. Years 2003 (Hartz I-II) and 2004 (Hartz III) are excluded from these regressions. Results similar with industry fixed effects in FE and Sys-GMM specifications. *, **, and *** denote statistical significance at the .1, .05 and .01 level respectively.

Table 5.13: Results with east/west variation, without years 2003 and 2004

	Labor Share			
	OLS	RE	FE	Sys-GMM
	(1)	(3)	(3)	(4)
Lag labor share				0.694***
				(0.086)
Hartz IV × East	-0.00280	-0.00440*	-0.00414*	-0.00526**
	(0.00354)	(0.00245)	(0.00251)	(0.00245)
East	-0.012***	-0.011***		0.008
	(0.005)	(0.004)	(.)	(0.008)
Capital-output ratio	0.040***	0.070***	0.076***	-0.059
	(0.006)	(0.008)	(0.010)	(0.089)
Intermediate inputs	0.008	0.070***	0.101***	0.159**
	(0.006)	(0.009)	(0.011)	(0.081)
Stock company	-0.004	-0.007	-0.018	-0.079
	(0.004)	(0.005)	(0.029)	(0.033)
Trade union density	0.011**	0.008**	0.008**	0.029***
	(0.005)	(0.003)	(0.004)	(0.006)
Intermediate inputs squared	-0.010***	-0.008**	-0.007	-0.064*
	(0.002)	(0.004)	(0.005)	(0.034)
Constant	0.354***	0.279***	0.331***	0.115***
	(0.017)	(0.014)	(0.011)	(0.045)
Industry fixed effects	✓	✓		
Time fixed effects	✓	✓	✓	✓
R2	.160	.133	.136	
No. of instruments				42
AR1 (p-value)				.00
AR2 (p-value)				.218
Hansen-J (p-value)				.521
Observations.	31,513	31,513	31,513	24,372

Notes: This table shows results from estimating Equation (5.20). The data is based on the 'dafne' dataset compiled by Bureau van Dijk; years 2000 – 2011. The labor share is calculated as $LS_t = \frac{W_t L_t}{Y_t}$ as explained in Section 5.3. The Hansen (1982) test is applied to check for over-identifying restrictions, and tests for first-order AR(1) and second-order AR(2) auto-correlation are provided by Arellano & Bond (1991). Firm-level clustered standard errors in combination with Windmeijer (2005) finite sample correction in parentheses. Years 2003 (Hartz I-II) and 2004 (Hartz III) are excluded from these regressions. Results similar with industry fixed effects in FE and Sys-GMM specifications. *, **, and *** denote statistical significance at the .1, .05 and .01 level respectively.

Construction of industry union density measure

Data. For the construction of the union density measure on the industry level we use the number of trade union members as provided by the German trade union association as well as the EU KLEMS data set for information regarding the number of employees in every industry.

Calculation. For the calculation we performed the following steps:

- Trade unions must be assigned to the sectors in order to obtain a specific degree of organization. The constitutions (*Satzungen*) of the DGB trade unions were reviewed and the organizational areas listed were assigned to the respective sectors.
- The degree of organization is recorded as a ratio. This involves dividing the number of union members in a specific union in a year by the number of employees in all industries in a year in which the union is active. A major problem here is that some industries have more than one union. In such cases, the employees in an industry are divided by the number of relevant unions.
- This calculation results in what is known as the gross degree of organization, since union members also include those who have left the labor force.
- The degree of organization calculated for a union as an average across all sectors (relevant for the respective union) is assigned to the sectors in the next step. For example, if the union *IG Metall* is relevant in some sectors for examples 1 and 2, the same degree of organization is found in both sectors. If several unions are represented in these industries, the unweighted average of the n unions is used.
- The gross degree of organization for industry j at time t and union i is then calculated as:

$$Org_{jt}^{gross} = \frac{M_{it}}{\left[\sum_{j=1}^{K}\left(\frac{1}{n}B_{jt}\right)\right]} \tag{5.21}$$

  where M is the number of union members in a given trade union, B the number of employees in an industry and K the number of industries which are represented by trade union i and finally n is the number of trade unions in a given industry j.

Chapter 6

Summary and conclusion

6.1 Summary

This thesis aims at expanding knowledge on the efficiency and distributional effects of German labor market institutions. First, the erosion of industrial relations in combination with an increasing adoption rate of voluntary employee representation institutions, i.e. round table conferences, employee spokespersons, additional management lines, is considered. While empirical findings still underline the relevance of works councils as the dominant form of workplace representation in Germany, trends towards flexibilization are discernible whereby works councils and collective bargaining coverage are in decline (e.g. Ellguth & Kohaut 2020; Oberfichtner & Schnabel 2019). These trends are generating greater interest in "Institutions [that] can increase information and communication flows inside firms, which can in turn improve decisions by management and labor" (Freeman 2008, p. 649).[1] Descriptive evidence based on the IAB Establishment Panel in this thesis indeed show a falling trend in works council coverage and a growing trend in alternative forms of employee representation. Based on these developments, this thesis begins by investigating efficiency effects of employee representation institutions on the establishment level with respect to technological progress and labor productivity. Those chapters contribute to the understanding of "micro-level dynamics in industrial relations and company employment practices" (Eichhorst 2015, p. 49).

In addition to employee representation, this thesis then takes a macro-economic-oriented approach and investigates consequences of the Hartz reforms. These have come to be regarded as some of the most controversial reforms of labor market institutions in Germany, with an enduring economic impact that captures the interest of politicians and scholars to this day. At the start of the 21st century, Germany was known as the 'sick man of Europe' due to high and persistent unemployment (e.g. Dauth et al. 2021; Dustmann et al. 2014). In response to recommendations made by the OECD a decade earlier to foster productivity and economic growth in European countries (OECD 1994a,b), Germany introduced the Hartz reform package. While the implementation of the reforms dates as far back as 2003, empirical studies and the interest of scholars on the effects of the reforms do not appear to be diminishing (e.g. Carrillo-Tudela et al. 2021; Bradley & Kügler 2019; Hartung et al. 2018; Launov & Wälde 2016). Indeed, the empirical findings of this thesis point to the fact that the effects of the Hartz IV reform in particular are still evident today. To analyze the impact of those changes, this thesis focuses on the Hartz III and Hartz IV labor market reforms.

[1] Empirical evidence suggests that such 'weak' forms of employee involvement (e.g. Dobbins & Gunnigle 2009) are often found in those sectors that rely to a large extent on cost minimization and thus tend to be more competitive (Godard 2004).

Overall, this thesis takes a two-step approach and investigates changes during the early years of the 21st century in Germany. It first provides knowledge on the efficiency effects of institutional changes on establishment performance in terms of innovation (Chapter 2), labor productivity (Chapter 3) and employment growth (Chapter 4). Second, distributional effects of those trends are then investigated (Chapter 5). This thesis therefore contributes to the recent debate on inequality (e.g. Farber et al. 2021; Stansbury & Summers 2020) and presents new empirical findings that labor market reforms under certain conditions provide efficiency gains, albeit with negative distribution effects for workers. In summary, establishments appear to benefit from those developments in terms of performance indicators; however, the distributional impact – measured by the labor share – implies the opposite.[2] The main empirical findings of this thesis are summarized in the following.

Chapter 2 enlarges knowledge on (i) the relationship between workplace employee representation and innovative output and (ii) disentangles the relationship between statutory and voluntary representation in this regard. This chapter addresses the issue mentioned by Addison et al. (2001): A "first step in this direction would be to identify the large variety of direct and indirect employee involvement mechanisms available to management, additional to representative participation through the works council, and to examine their impact and interaction." Addison et al. (2001, p. 691). While earlier studies find negative (e.g. FitzRoy & Kraft 1990) or no systematic relationships between works councils and innovation (Addison et al. 2001), scholars indeed pointed towards the potential relevance of management-implemented alternative forms of representation in the innovation process (Addison et al. 2001).

Empirical studies with a focus on establishment investments, for example, find no detrimental effects of works councils on investment decisions (Addison et al. 2007). More recent studies show that German collective bargaining agreements appear to inhibit innovative output. At the same time, however, positive effects are found in combination with existing works councils (e.g. Addison et al. 2017). A more recent study in this regard found that the German co-determination system at least does not slow down technological progress (Kraft et al. 2011). However, Genz et al. (2019) find a negative correlation between works councils and establishments' technological equipment. A positive impact of works councils on digital equipment, however, is found in establishments employing more workers with physically demanding activities (Genz et al. 2019). Overall, the effects of statu-

[2]The large expansion of precarious and short-time work in Germany are just a few examples in this regard. See for example Prosser (2015).

tory workplace representation with respect to innovation are mixed, and empirical findings suggest that the impact on technological progress receives a somewhat more positive connotation over time. The application of more reliable and comprehensive (panel) datasets in combination with advanced (causal) econometric methods, which enables researchers to disentangle selection effects (e.g. Jirjahn 2009), seem to be important in industrial relations research. Indeed, if selection effects are taken into account, Chapter 2 of this thesis also provides evidence that works councils are associated with positive effects for technological progress.

Regarding empirical evidence on voluntary workplace representation in Germany, there is in fact less evidence within the context of technological progress. One study provides cross-sectional evidence that voluntary representation seems to be related to innovation (e.g. Stettes 2010). Comparisons between statutory and voluntary institutions in this regard, however, are lacking. Voluntary employee representation implemented by the management is often subsumed with human resource management practices due to the nature of those institutions. Such practices are associated with positive effects on employee involvement and innovation. The term often includes profit sharing, teamwork, quality circles, flatter hierarchies or problem-solving groups that are efficiently combined (e.g. Addison 2009; Cappelli & Neumark 2001; Huselid 1995). Regarding effects on technological progress and innovation, an early study by Michie & Sheehan (1999) finds a positive link between employee participation practices and innovative activity for the UK. Marsden (2013) considers forms of management-initiated voice channels for Great Britain and France. Laursen & Foss (2003) explicitly consider innovation in the context of employee involvement. Using Japanese data, Haneda & Ito (2018) investigate human resource management practices and their impact on different kinds of innovation measures. Their results also indicate positive effects for involvement practices and product innovations. Arvanitis et al. (2016) provide an expansive overview of international studies regarding HRM measures and how they contribute to innovation.

Chapter 2 of this thesis therefore adds to the above-mentioned literature, albeit in a more institutionalized, industrial relations context. First, using very comprehensive German panel data, this chapter applies selectivity-adjusted econometric models to investigate the effects of works councils and alternative representation, i.e. round table conferences, employee spokespersons and additional management lines, on both product and process innovation. It also attempts to disentangle the effects of both institutions. The empirical findings indeed support previously mentioned studies where the relationship between works councils and innovation appears to be negative. The appropriate implementation of selection models to

take negative feedback effects into account, however, points towards a positive direction. The results from this chapter are quite consistent with earlier studies, in which cross-sectional estimates are unable to disentangle negative feedback effects stemming, for example, from an economic downturn (e.g. Jirjahn 2009). The results presented in this chapter indicate that employee involvement seems to have the strongest impact on technological progress in cases where the workplace is directly affected. Positive effects of voluntary employee representation are found not only for incremental and radical product innovation but also for process innovation. While the relationship between both forms of representation are discussed somewhat controversially in the literature (e.g. Jirjahn et al. 2021; Oberfichtner & Schnabel 2019), this chapter finds a substitutive relationship between statutory and voluntary representation.

The results presented here thus contribute not only to the ongoing literature regarding the effects of workplace representation on technological progress but also have implications for human resource management practices such as involvement measures. In this regard, for example, Andries & Czarnitzki (2014) found that employee involvement, especially the ideas of non-managerial employees in small firms, contribute significantly towards the innovative performance of firms. While those results are in line with the results from Chapter 2, Andries & Czarnitzki (2014) conclude that "findings enrich the current view on the entrepreneurial team, but also warn against the implementation of one-size-fits-all employee involvement programs in small firms" (Andries & Czarnitzki 2014, p. 21). Their study therefore also matches the findings of Chapter 2 of this thesis with respect to works councils: Since works councils are legally defined within the Work Constitution Act, they might also be referred to as a kind of one-size fits-all-solution. Positive effects of alternative, firm-tailored forms of employee representation with respect to technological progress are thus quite in line with findings from this literature.

While also considering alternative employee representation, Chapter 3 takes a different approach, focusing specifically on a theoretical model to derive testable hypotheses. First, the impact of voluntary representation on labor productivity within a panel context is considered. Second, this chapter also aims to combine the concept of the social exchange theory (Cropanzano & Mitchell 2005; Blau 1964) within employee-employer related research.[3] In terms of productivity and labor management relations, this chapter adds to the involvement and participation literature (e.g. Huselid 1995; Ichniowski et al. 1997; Kato 2006; Birdi et al. 2008;

[3]This theory in fact receives increasing attention in various fields of industrial relations and personnel economics. See, for example, Grund & Titz (2021); Cappelli et al. (2020); Regts et al. (2019); Kampkötter & Marggraf (2015); Kube et al. (2012). For a general overview see Cropanzano & Mitchell (2005).

Bloom et al. 2015; Bender et al. 2018; Chang & Kang 2019). In this view, empowerment of workers via direct voice increases not only productivity but also job satisfaction (e.g. van der Meer 2019) and employee well-being in general (Böckerman & Ilmakunnas 2012). The literature on industrial relations research in the context of formalized, statutory representation institutions provides evidence on the productivity effects of labor unions (e.g. Barth et al. 2020; Doucouliagos & Laroche 2003; Addison & Hirsch 1989; Brown & Medoff 1978) and German works councils (e.g. Mueller & Stegmaier 2017; Jirjahn & Mueller 2014; Mueller 2012; Addison et al. 2001). Regarding alternative voice institutions, there is so far only evidence on determinants of introduction (Hauser-Ditz et al. 2013), the relationship to works councils (Jirjahn et al. 2021; Oberfichtner & Schnabel 2019; Ertelt et al. 2017) and effects on firm performance using cross-sectional data (Stettes 2010).

Results from this chapter add to the previous literature and provide evidence that voluntary (alternative) employee representation in the form of round table conferences, additional management lines and employee spokespersons raise labor productivity by roughly 8 to 12 percent.[4] The pronounced effects found in this chapter take some time to become apparent since the scope and nature of an representation institution have to grow until productivity gains can be achieved (e.g. Mueller & Stegmaier 2017; Kato 2006). In addition, another finding of this chapter is that, in terms of social exchange, productivity effects tend to be more pronounced when the relationship between management and employees is closer. While earlier studies measure closeness in terms of social distance (e.g. Cox & Deck 2005), this chapter takes a new approach by considering closeness in terms of establishment size and management type. Empirical results show that in smaller establishments as well as in establishments with an owner-manager, social exchange relations and thus productivity effects are more pronounced. In particular, owner-managers are characterized by a paternalistic governance style which leads to more sophisticated employee-employer relationships. While the literature on trust and commitment suggests that positive effects take time to become apparent, the empirical findings support those delayed effects.

The following two chapters (Chapters 4, 5) take a more macro-economic-oriented approach and investigate efficiency and distributional effects induced by the Hartz reforms. While the Hartz reform package consists of four stages, this thesis considers the two which have attracted the most attention in the literature (e.g. Carrillo-Tudela et al. 2021; Bradley & Kügler 2019). First, Chapter 4 considers the Hartz

[4]These findings are in line with, for example, recent studies such as Jäger et al. (2021), who find that shared governance on supervisory boards also leads to productivity gains of 2 to 8 percent.

III reform which was intended to improve the matching efficiency by restructuring the Federal Employment Agency. Literature, particularly in relation to the Hartz III reform, is provided by various studies. For example, Stops (2016) estimates parameters of macroeconomic matching functions before, during and after the Hartz Reforms. Fahr & Sunde (2009) show that the Hartz reforms accelerate outflows from unemployment to employment after the Hartz III reform was implemented. Launov & Wälde (2016) structurally estimate the reform effect of an increase in matching efficiency on the unemployment rate. They provide evidence that the reorganization of the Federal Employment Agency is responsible for a 0.69-0.88 percentage point decline of the equilibrium unemployment rate. Klinger & Rothe (2012) also find increased matching efficiency by roughly 10 percent using simultaneous stock-flow matching functions for the short-term and long-term unemployed. Those results are supported by Klinger & Weber (2016) who find an extraordinary increase in matching efficiency after the Hartz reforms. Hartung et al. (2018) argue that instead of an increased hiring rate, lower separation rates explain the decline in the unemployment rate in Germany after the Hartz reforms. Bauer & King (2018) use a reallocation model to investigate the effects of the reforms. Empirical effects of the Hartz III reform in terms of matching efficiency on the macro-economic level are therefore well understood. What is missing in this literature, however, are employment growth effects on the establishment level. Given the relevance of the establishment level in terms of job matching (e.g. Davis et al. 2013), this chapter aims to fill this gap in the literature.

Empirical findings in this chapter provide evidence that establishments which use the Federal Employment Agency as their recruitment channel realize an increase in employment growth compared to establishments which do not use the placement services. Those findings are robust to potential selection effects, i.e. that establishments sort themselves into the status of using the employment agency. The empirical findings indicate that the exogenous reform shock leads to a significant increase in the share of hires as well as employment growth among those establishments which use the placement services. The results therefore not only support well known macro-economic effects in the literature in terms of aggregate worker matching, but they also imply that firms are able to find more suitable matches and grow. The findings of this chapter are important for recent developments in the labor market but also with respect to future challenges, for example, in the context of technology adoption and changing worker skills. The need for efficient placement agencies will probably increase even more in this scenario if members of certain qualification groups are made redundant as a result of technological progress (e.g. Frey & Osborne 2017). Recent challenges in the labor

market arising from the COVID-19 pandemic also intensify the need for efficient job finding and matching. A modernization and flexibilization of public labor market institutions, as in Germany via the Hartz III reform, can be helpful in this context.

Overall, the first 3 chapters (Chapters 2, 3 and 4) provide evidence of efficiency effects of German labor market institutions. Empirical findings support the view of increasing establishment performance in terms of innovation (Chapter 2), productivity (Chapter 3) and employment growth (Chapter 4). The impact of labor market institutions in Germany therefore appears to be primarily beneficial for establishments. Looking at the Hartz IV reform during this period of time, however, empirical evidence suggests that distributional effects for workers are far from conclusive.

Chapter 5 investigates whether labor market institutions also generate distributional effects. This chapter not only considers the most influential and controversial labor market reform in Germany, i.e. Hartz IV, but also contributes to the ongoing debate on distributional effects and how economic outputs are divided between capital and labor (e.g. Kehrig & Vincent 2021; Jäger et al. 2021; Yang & Tsou 2021; Acemoglu & Restrepo 2021; Harju et al. 2021; Stansbury & Summers 2020). The literature in this regard provide evidence of falling labor shares with respect to technological progress (Acemoglu & Restrepo 2020), market power (Autor et al. 2020; De Loecker et al. 2020; Kehrig & Vincent 2021), globalization (Elsby & Michaels 2013) and de-unionization (Stansbury & Summers 2020). Neglected in this literature, however, is the influence of a decreasing outside option in wage bargaining. The Hartz IV reform provides an exogenous reduction of the outside option by reducing alternative wages and thus provides the opportunity to investigate this exogenous shock in detail.

This chapter of the thesis investigates this exogenous shock within a bargaining framework. First, a simple bargaining model is presented in which the relevance of the reduction in the outside option for the decline of the labor share is investigated. The model implies that rents are generated within a duopoly in which a union is the bargaining partner. Furthermore, the model connects the wage negotiated through bargaining and the alternative wage, which is exogenously reduced due to the Hartz IV reform. By combining EU KLEMS, Penn World Tables and World Bank data, this chapter provides empirical evidence on the distributional impacts of the Hartz IV legislation. First, using endogenous change point tests[5] (e.g. Casini & Perron 2019; Bai & Perron 2003), the Hartz IV reform is identified as

[5]For recent applications of these tests, see for example Lunsford (2020); Wiese (2014); Jayachandran et al. (2010); Hansen (2001).

a significant policy intervention with respect to labor share developments. Those tests reveal that besides the Hartz IV reform, the reunification of eastern and western Germany is also an interesting factor worth considering with respect to labor share developments. Second, a synthetic control approach (e.g. Abadie 2021) provides evidence that the Hartz IV reform shock has persistently reduced the labor share by around 1.6 percentage points, with the effect most pronounced during the first five years after the reform was implemented. The final robustness section of this chapter also supports the aggregate findings by using rich firm-level panel data compiled by Bureau van Dijk. Using unemployment rate variation among German counties in the year 2002, treatment effects are estimated using a variant of a difference-in-differences specification (e.g. Immel 2021; Giebel & Kraft 2019; Card 1992). This chapter contributes to the ongoing debate about falling labor shares in the context of technological progress, globalization and mark-ups. In fact, Chapter 5 provides empirical evidence that workers have become worse off during this period of time, since labor shares declined on average by two percentage points. Despite efficiency effects of German labor market institutions, those results imply that workers are now receiving a decreasing fraction of their produced economic output in terms of labor compensation.

In summary, this thesis provides empirical evidence on efficiency (Chapters 2, 3 and 4) and distributional (Chapter 5) aspects of German labor market institutions during the last two decades. The flexibilization of employee representation institutions in the form of management-initiated voluntary forms of involvement seem to be beneficial for establishments in terms of innovative output and labor productivity. Moreover, institutional changes induced by the Hartz III reform appear to be beneficial for establishments in terms of employment growth and their recruitment behavior. However, this applies only for those establishments using the recruitment services of the Federal Employment Agency after the reform was implemented. In terms of distributional effects, employees seem to bear the cost in terms of lower labor shares during this period in Germany.

6.2 Final remarks and policy implications

Closely linked international markets, characterized by increasing technological progress with applications in artificial intelligence and robotics, are having unforeseen consequences (e.g. Graetz & Michaels 2018; Frey & Osborne 2017). Their use, although in different aspects and industries (e.g. Dauth et al. 2021), is likely to increase in the future (e.g. de Vries et al. 2020). These recent challenges, and those yet to present themselves in the future, put immense pressure on the design

of labor market institutions, on both the workplace and governmental level. In this respect, institutions provide not only the context in which actors live, produce and interact, but also an environment for innovation, incentives and, not least, economic prosperity. In the context of technological progress and innovation, there might be a trade-off between strong labor market institutions, such as employee protection legislation, and a laissez-fair approach. Both forms might provide different incentives for employees to come up with ideas and innovations.

One important finding of this thesis is that flexible employment practices are important to remain competitive in the face of technological change. Voluntary forms of employee representation are not only positively related to innovative performance but also to increases in productivity on the establishment level. Overall, the observed trends of flexibilization through increased use of alternative forms of employee representation seem to increase establishment performance. Due to the potential additional existence of statutory representation in the form of works councils with strong bargaining rights in Germany, efforts to provide managerial flexibility while at the same time maintaining employees' bargaining rights are highly important but sometimes difficult to achieve. While works councils do not appear to actually hinder technological progress, the relationship between voluntary and statutory representation needs to be taken into account. The relevance of and interest in these developments are likely to increase in the future.

While this is one source of efficiency effects from labor market institutions within establishments, another one is induced by the Hartz reform package. First, the Hartz III reform increased employment growth, thus contributing to improved international competitiveness. Second, in the face of technological change with potential workplace implications, an efficient Federal Employment Agency is essential to match job seekers to establishments and thus facilitate employment growth.

However, there are two sides to the coin. While establishment efficiency appears to increase in terms of innovation, productivity and employment growth, empirical findings from Chapter 5 point towards detrimental effects for employees. In fact, workers receive a decreasing fraction of economic outputs in terms of labor shares after the Hartz IV reform was implemented. During this period in Germany, the labor share decreases by an average of two percentage points, as shown by aggregate and firm-level regressions.

The design of labor market institutions is therefore gaining in significance, not only for providing good industrial relations and workplace democracy but also employment protection to generally improve workers' well-being and reduce inequality. In this connection, however, whether alternative forms of employee rep-

resentation can provide real engagement (e.g. Marchington & Suter 2013) and workplace democracy, or rather generate a perception of voice due to the lack of statutory bargaining rights (e.g. Nechanska et al. 2020), is an important issue for further research. A similar observation is also highlighted in related studies (e.g. Charlwood & Pollert 2014; Townsend et al. 2012), which question the opportunities for voluntary representation in terms of providing workplace democracy. For example, Charlwood & Pollert (2014) find, that the effects of manager-initiated workplace representation are, in terms of equality, not comparable to unions with strong bargaining rights. In view of diminishing workers' representation, technological change and reforms in labor market institutions, some scholars are even arguing in favor of a new social contract between employers and employees (e.g. Kochan & Kimball 2019). This might include increased opportunities not just to provide, for example, more further training for employees to prevent skill depreciation, but also to adjust to emerging trends by developing soft skills that are becoming increasingly relevant in the modern workplace (e.g. Deming 2017). These considerations are gaining even more prominence since research has begun to acknowledge in recent decades that the interests of workers are shifting from pure material interests towards the nature and purpose of work (e.g. Doellgast et al. 2021; Cassar & Meier 2018; Corgnet et al. 2018).

Overall, while efficiency gains of labor market institutions are certainly relevant, the importance of bargaining power, the well-being and motivation of employees as a potential source of future innovations is not to be underestimated. As, for example, Kochan & Riordan (2016) put it: "Equally important, however, are actions aimed at [...] modernization of labor polices that allow workers to build new sources of bargaining power consistent with the modern economy, [...]" (Kochan & Riordan 2016, p. 435). First efforts in this direction to offer more flexibilization while at the same time retaining workers' bargaining power are indeed observable in Germany, as the recent Works Council Modernization Act of 2021 shows. This act aims to provide structures that enable establishments to remain competitive on international markets at the same time as providing more 'real' workplace democracy.[6]

To summarize and in light of the empirical findings of this thesis, future designs and reforms of labor market institutions should carefully balance efficiency gains with equity considerations.

[6]The recent amendment proposes easier voting rights for establishing works councils and greater protection against dismissal, for example. In particular, however, changes in remote work and work from home (WFH) might contribute to more flexibility of statutory employee representation while at the same time providing 'real' bargaining power.

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