

**Essays on Human Resource Management
in view of training, retention and compensation**

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Diese Dissertation ist in englischer Sprache verfasst. Eine Zusammenfassung in deutscher Sprache gemäß § 7(2) der geltenden Promotionsordnung vom 19. Oktober 1998 (KMBI II 1999 S.53), zuletzt geändert durch Dritte Satzung vom 19. Dezember 2008, findet sich am Anfang dieser Dissertation.

ZUSAMMENFASSUNG

Das Personalmanagement hat sich in den letzten Jahrzehnten von einer administrativen Funktion im Unternehmen hin zu einem ganzheitlich und strategisch ausgerichteten Prozess entwickelt. Dieser ist vor allem durch verschiedene Veränderungen und Herausforderungen induziert – beispielsweise den demographischen Wandel, die Globalisierung oder den Prozess der Individualisierung. Neben diesen generellen Trends haben in den letzten Jahren aber auch wirtschaftliche Schwankungen und Schocks sowie sich ändernde institutionelle bzw. rechtliche Rahmenbedingungen auf den gesamten Personalprozess Einfluss genommen. Die vorliegende Dissertation greift nach einer kurzen Einleitung in Kapitel 1 drei Bereiche des Personalprozesses – Weiterbildung, Mitarbeiterbindung und Entlohnung – auf und untersucht, welche Auswirkungen kurz- und langfristige Veränderungen auf diese haben.

Der drohende Fachkräftemangel – als langfristige Herausforderung des Personalmanagements – macht es für Unternehmen umso wichtiger, verfügbare Personalressourcen langfristig an das Unternehmen zu binden. Der *erste Aufsatz* (*The retention effect of training*) dieser Dissertation in Kapitel 2 analysiert, inwiefern sich das Angebot von Weiterbildungsmaßnahmen auf den Verbleib von Mitarbeitern im Unternehmen auswirkt. Zur theoretischen Fundierung werden die Humankapital- sowie die Monopson-Theorie herangezogen. Darauf aufbauend werden Hypothesen gebildet, die die Bindungswirkung von Trainingsmaßnahmen im Hinblick auf deren Übertragbarkeit, Sichtbarkeit und Glaubwürdigkeit unterscheiden. Mit Hilfe verknüpfter Betriebs- und Personendaten (WeLL-ADIAB) mit detaillierten Informationen zur individuellen Weiterbildungs- und Erwerbshistorie sowie betrieblichen Charakteristiken können umfangreiche Aspekte der Mitarbeiterbindung berücksichtigt werden. Das verwendete Forschungsdesign sowie die eingesetzten Schätztechniken (OLS, Fixe Effekte, Diff GMM) ermöglichen zudem, für den Selektionseffekt von Weiterbildung sowie unbeobachtete zeitinvariante und zeitvariante Heterogenität zu kontrollieren. Die Ergebnisse zeigen, dass die Teilnahme an Weiterbildungsmaßnahmen den Verbleib von Mitarbeitern im Unternehmen erhöht. Dieser positive Effekt sinkt jedoch, wenn die Trainingsinhalte allgemeines Humankapital fördern – und somit gut auf andere Unternehmen übertragbar sind – sowie durch Weiterbildungszertifikate eine erhöhte Sichtbarkeit der Trainingsinhalte vorliegt. Der negative Effekt auf die Bindungswirkung verstärkt sich, wenn das Training von einer externen, unabhängigen Institution durchgeführt und das Zertifikat dieser Maßnahme von dieser Institution ausgestellt wird.

Neben langfristigen Herausforderungen ist das Personalmanagement außerdem mit kurzfristigen und unvorhersehbaren Veränderungen konfrontiert, beispielsweise durch wirtschaftliche Schocks. In diesem Zusammenhang stellt sich die Frage, ob Unternehmen auch in solchen Zeiten Maßnahmen zur Mitarbeiterbindung einsetzen und wie sie dabei vorgehen. Der *zweite Aufsatz (Training in the Great Recession)* in Kapitel 3 dieser Dissertation analysiert ebenfalls auf Basis der verknüpften Betriebs- und Personendaten (WeLL-ADIAB), ob und inwieweit sich die Wirtschaftskrise der Jahre 2008 und 2009 auf das Weiterbildungsverhalten bestimmter Mitarbeitergruppen in Unternehmen ausgewirkt hat. Aus theoretischer Sicht gibt es Argumente, die sowohl für eine Erhöhung als auch eine Reduzierung der Weiterbildungsteilnahme in wirtschaftlich schwierigen Zeiten sprechen. Auf Basis eines quasi-experimentellen Forschungsdesigns (Diff-in-Diff) wird dabei der kausale Effekt dieses exogenen wirtschaftlichen Schocks auf die individuelle Weiterbildungsteilnahme eruiert. Die Ergebnisse zeigen, dass sich die Krise negativ auf die Weiterbildungsteilnahme auswirkt. Dieser Effekt ist bei ungelerten Mitarbeitern stärker ausgeprägt, als bei Mitarbeitern mit höherem Qualifikationsniveau. Der negative Effekt auf die Weiterbildung setzt mit zeitlicher Verzögerung im Jahr 2009 ein und dauert schließlich bis zum Jahr 2010, obwohl es zu diesem Zeitpunkt bereits einen wirtschaftlichen Aufschwung gibt. Zusätzliche Analysen zeigen, dass auch in wirtschaftlich schwierigen Zeiten das Qualifikationsniveau der Mitarbeiter – im Gegensatz zu anderen individuellen und beruflichen Merkmalen – entscheidend für die Teilnahme an Weiterbildung ist.

Darüber hinaus widmet sich diese Dissertation den Veränderungen innerhalb der rechtlichen und institutionellen Rahmenbedingungen des Personalmanagements. Diese waren in den letzten Jahren vor allem im Bereich der Vorstandsvergütung in Aktienunternehmen vorzufinden. Der *dritte Aufsatz (Institutional isomorphism and executive compensation in Germany)* in Kapitel 4 untersucht, inwiefern es in einem Umfeld, geprägt durch vielschichtige Veränderungen (z. B. VorstOG, VorstAG), zu einer Annäherung der Vorstandsvergütung innerhalb und zwischen unterschiedlichen Börsensegmenten (DAX und MDAX) kommt. Basierend auf der Annahme eines von der Institutionentheorie proklamierten isomorphen Organisationswandels werden Hypothesen hergeleitet, die mit Hilfe von deskriptiven und multivariaten Analysen überprüft werden. Die unter Einsatz eines umfangreichen Datensatzes zur Vorstandsvergütung von DAX und MDAX Unternehmen gewonnenen Ergebnisse zeigen, dass sich die Gehaltsniveaus und -strukturen sowohl innerhalb als auch zwischen Börsensegmenten annähern. Diese Intra- und Inter-Segment-Konvergenzen werden vor allem bei der Vergütung von Vorstandsvorsitzenden deutlich. Bei der Entlohnung der anderen Mitglieder des Vorstands zeigt sich eine

Angleichung der Gehaltsstruktur lediglich innerhalb der Segmente. Hingegen deuten die Ergebnisse weder auf eine Intra- noch auf eine Inter-Segment-Konvergenz des Gehaltsniveaus hin.

Insgesamt betrachtet diese Dissertation mit den drei vorgestellten Aufsätzen unterschiedliche Aspekte des Personalmanagements und analysiert, inwiefern verschiedene Personalprozesse auf die institutionellen und allgemeinen Veränderungen reagieren. Dazu werden unterschiedliche deskriptive als auch multivariate Analysemethoden eingesetzt. Während die ersten beiden Aufsätze eher eine personalökonomische Perspektive einnehmen, bezieht sich das dritte Papier auf einen institutionentheoretischen Ansatz. Die einzelnen Aufsätze sind in sich abgeschlossen und können unabhängig voneinander gelesen werden. Der erste Aufsatz ist in Zusammenarbeit mit Thomas Zwick und der dritte Aufsatz durch eine Kooperation mit Nathalie Haidegger Rieß sowie Robert Wagner entstanden.

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1 INTRODUCTION

Traditionally, human resource departments were more of an administrative unit with rather individual operational and organizational functions (e.g. administration of personnel files) in the establishment (Lawler et al., 2003; Sears, 1984 Wunderer, 1992). Since various changes in technology, environment and social attitudes, human resource management (HRM) has developed to an integrated part in the overall entrepreneurial task (Brewster, 1995). This also applies to Germany, which provides the framework for this dissertation. Meanwhile, the aim of HRM in Germany is to prepare and secure human resource functions in such a way that the establishment is able to generate competitive advantages (Burack and Miller 1976; Delaney and Huselid, 1996). For this purpose, it is important to attract, develop and retain employees to ensure the efficient operation and survival of the organization and its members (Collins and Clark, 2003; Ichniowski et al., 1997; Lazear and Shaw, 2007; Schuler and Jackson, 1987). According to this, establishments must take into account the complete HRM process: starting with the recruitment of suitable employees (Lawler et al., 2003; Sears, 1984), followed by the design of the workplace and the working environment for existing employees, e.g. considering the increased needs for independent and autonomous work forms (Brinkmann, 1996). Also, employees' motivation, fair compensation, further training and binding must not be forgotten in the HRM process (Griffeth et al., 2000; Picchio and van Ours, 2013; Porter and Steers, 1973).

However, the HRM process is still subject to numerous challenges and changes. The keywords globalisation, demographic change, need for higher qualification, digitalisation, innovation and individualisation denote the altered setting in which different HRM practices are carried out today and in the future (Lazear and Shaw, 2007 Sparrow et al., 1994). In addition to these general changes – often referred to as megatrends (James, 1997) – HRM practices must likewise deal with economic and environmental shocks as well as changed institutional and legal framework conditions.

The analysis of how a general change, an economic shock and a modified institutional framework condition affect the HRM process, provide the motivation for the present dissertation. Thereby, the dissertation concentrates on certain areas of the HRM process, namely compensation, further training and retention, as well as changes and challenges that have been subject to a high degree of public interest in recent years. It consists of three essays (Chapter 2 to Chapter 4), all self-contained and independently readable. Essay 1 (The retention effect of training / Co-authored with Thomas Zwick) investigates whether it is possible to keep employees in the establishment by offering further training measures. Thereby, the imminent shortage of

skilled workers as a general change puts the focus on a long-term challenge facing the HRM. Second, the attention is on a short-term unpredictable economic shock: Essay 2 (Training in the Great Recession / Single-authored) analyses whether and to what extent the Great Recession in 2008 and 2009 has had an impact on the individual training behaviour in establishments. Moreover, this dissertation focuses on long-term changes in the institutional and legal framework conditions relating to executive compensation. Essay 3 (Institutional isomorphism and executive compensation in Germany / Co-authored with Nathalie Haidegger-Rieß and Robert Wagner) examines the effects of these changes on the compensation level and structure of establishments from the German DAX and MDAX and the extent to which these converge over time. In addition to this brief overview, the motivation for the different essays, their classification in previous literature and findings are presented in more detail below.

The German economy is already suffering from a lack of qualified personnel. Currently, there are 20,000 vacancies at the DAX companies alone (Die Zeit, 2017). The foreseeable ageing workforce will exacerbate the situation in the future. According to forecasts, German companies will lack up to three million skilled workers in 2030 (Handelsblatt, 2018). Therefore, it is essential for establishments to invest in further training and qualification of the existing workforce (Green et al., 1998; Stevens, 1994). However, it will be even at least as important to keep these trained employees in the establishment (Griffeth et al., 2000; Porter and Steers, 1973). This is the focus of the first essay (Chapter 2) which examines, whether it is possible to retain employees in the establishment by means of training (Craig et al., 2002; Rousseau, 1997).

From a theoretical perspective, the retention effect is decisively dependent on the characteristics of training measures (Leuven, 2005; Manning, 2003). While, according to the human capital theory, general and therefore portable training content tend to reduce the retention, firm-specific content should rather increase it (Loewenstein and Spletzer, 1999; Stevens, 1994a, 1994b). Corresponding to the monopsony theory, however, it is also decisive to what extent market frictions (such as information asymmetries) exist, or whether the training content conveyed is visible and, above all, credible to outside establishments (Acemoglu and Pischke, 1999a; Booth and Bryan, 2005; Loewenstein and Spletzer, 1999). Many empirical studies just focus on the basic employability of trained workers instead of the retention effect at the training establishment (Card and Sullivan, 1988; Gritz, 1993; Picchio and Van Ours, 2013). Only few empirical papers focus on the retention effect of training and find rather divergent results: Brunello and De Palola (2009) as well as Krueger and Rouse (1998) do not find any impact of training participation on retention. Lynch (1991), Haines et al. (2010) and Green et al. (2000) find a negative effect of general and portable as well as off-the-job training measures on the

retention probability. In contrast to this, Benson et al. (2004), Dearden et al. (1997), Loewenstein and Spletzer (1999), Parent (1999) and Veum (1997) find an increasing retention effect of on-the-job, off-the-job as well as self-financed training.

Therefore, the empirical papers come to different conclusions but also have several drawbacks. Most papers are restricted to selected groups or specific training activities. However, the main research gap is that there is no paper so far that is able to assess the joint impact of portability, visibility and credibility of training, although these training characteristics might influence the retention probability. In addition, most previous papers cannot control for selectivity into training because of insufficient data (Card, 1999; Heckman, 1999).

In order to overcome these problems, the first essay in Chapter 2 uses a comparison group approach (Leuven and Oosterbeek, 2008) and compares only training participants with those employees who had been selected by the employer to participate in training but had to cancel it for exogenous reasons. From a methodological point of view, by means of Fixed Effects and Diff GMM estimations, the paper also controls for time-variant and invariant unobserved heterogeneity as well as endogeneity of training participation. By simultaneously considering the components from the human capital theory as well as the monopsony theory, the essay shows that portability of general human capital contents and visibility of training, induced by training certificates, independently reduce the retention effect of training. The negative effect is much stronger if training is certified by external institutions and therefore credible. In addition, the effects of visibility and portability are distinct and thus also reduce the retention effect of training separately. However, the total effect of portable, visible and credible training on retention is still positive. Accordingly, there could be further reasons (e.g. reciprocity) for employees to stay in the establishment after the training participation that cannot be taken into account in the essay (Batt, 2002; Kampkötter and Marggraf, 2015; Sieben, 2007). Therefore, further training appears to be an effective measure to keep the qualified employees in the establishment.

According to a representative survey of German establishments, the most important reason for training is not only the adaption of qualifications to new technologies, but, above all, the retention of skilled workers for the establishment. Consequently, training investments have risen to approx. 33.5 billion euros in 2016 (Schönfeld et al., 2016; Seyda and Placke, 2017). However, what happens to the establishments' training activities when there are unexpected changes and challenges in the economy? In such case, do establishments maintain their training investments or are they forced to reduce them? If the latter is true, do the restrictions apply to

all employees or are training activities reduced only in certain employee groups? The second essay provides answers to those questions.

One of the central challenges that German establishments were facing in recent years was the economic crisis in 2008 and 2009, also known as Great Recession. This crisis was mainly triggered by the collapse of the US real estate market. The bankruptcy of Lehman brothers in late 2008 and the collapse of the interbank market also hit the German economy. In addition to the effects on demand and credit restrictions, the crisis had an impact on the labour market as well (Bond et al., 2005; Ivashina and Scharfstein, 2010). While, there were hardly and only delayed effects on total employment (peak: -0.2% / \emptyset Europe: -2%), especially the work volume and the productivity per worker declined due to the crisis. This can partly be explained by short-time work, which was introduced in some cases by establishments to counteract the crisis (Bellmann and Buttler, 2010; Bogedan, 2010; Möller, 2010).

From a theoretical point of view, the effects of the crisis on establishments' training activities are ambiguous. On the one hand, the underutilized capacities and thus reduced opportunity costs as well as worse external options argue more in favour of an increase in further training (Aghion and Saint-Paul, 1998; Brunello, 2009; Felstead and Green, 1996; Mason and Bishop, 2015). On the other hand, economic theory suggests decreasing training activities in the crisis because of reduced financial resources, uncertain future prospects, and, therefore, unclear returns on training (Bellmann et al., 2014; Bogedan et al., 2009; Mason and Bishop, 2015; Muehleman et al., 2009; Popov, 2014; Stevens, 1994).

Most studies that look at the impact of economically difficult times on training activities focus on apprenticeship training. Based on several observation periods and different countries previous studies indicate that establishments rather cut back their training investments in these times (Bilginsoy, 2003; Dietrich and Gerner, 2008; Felstead and Green, 1996; Muehleman et al., 2009). The few studies in the context of further training find both, positive and negative effects of the crisis, however, mostly refer to a period before the Great Recession in 2008 and 2009 (Bassanini et al., 2007; Majumdar, 2007; Sepulveda, 2004). Focusing on the impact of the Great Recession, Felstead et al. (2012) find only slight reductions of training activities and rather adjustments of the training strategy. By contrast, Mason and Bishop (2015) as well as Popov (2014) find significantly lower training investments in times of crisis. The only evidence for Germany suggests that all establishments reduce their training activities in the crisis. However, some of the studies show shortcomings in their methodological approaches. In some studies, the underlying data structure or the choice of estimation strategy does not allow to analyse

the causal effect of the crisis. In addition, no previous paper considers individual characteristics of training participants although these are decisive for the provision of training.

Using Difference-in-Differences analyses, the second essay avoids endogeneity problems caused by unobservable third factors. The Great Recession in 2008 and 2009 can be seen as an exogenous and time-limited shock: this quasi-experimental setting helps to reveal the causal impact of the crisis on the training intensity and the number of training measures. This is the first study able to control for individual characteristics of the training participants. Results indicate that there is a direct effect of the crisis on individual training activities in 2009 and 2010. This effect is stronger for unskilled employees than for employees with higher skill levels. Furthermore, the negative effect sets in with a time lag and lasts until the year 2010 (although there is already an economic upswing). Numerous analyses are used to check additional heterogeneities in training activities for other employee groups (e.g. gender, experience, age, occupation). Nevertheless, further investigations are still necessary in order to better understand the cost-benefit considerations behind training provision of establishments.

Among others, particularly the area of executive compensation was affected by the economic crisis and the ensuing regulations in institutional framework conditions. The regulation and disclosure of executive compensation in Germany has long been the subject of public and scientific debate (Fabbri and Marin, 2016; Hitz and Müller-Bloch, 2015). Complete transparency about individual executive compensation in Germany was introduced in 2006, as the result of a law passed in 2005 (VorstOG), which requires the full disclosure of individual compensation for each board member of quoted companies. After the onset of the Great Recession in 2008, a new law came into force in 2009 that rules the design as well as the disclosure of executive compensation (VorstAG). According to this, supervisory board members are obliged to ensure that compensation must be appropriate and in accordance with nationwide standards. In the end, additional regulations were introduced in 2010, which mainly relate to fractions of base and variable pay as well as minimum vesting periods. The third essay of this dissertation deals with the question whether these changes had an impact on the compensation level and structure of executive board members. The focus is on the extent to which executive compensation is converging within and between different exchange segments in Germany.

Most empirical evidence on executive compensation takes an economic based view and is often dominated by the agency theory (Daily et al., 2003; Fabbri and Marin, 2016; Finkelstein et al., 2009; Murphy, 2013). However, to better illustrate the complexity of establishments, numerous studies put emphasis on social or behavioural perspectives (e.g. Baker et al., 1988;

Brandes et al., 2006; Bruce et al., 2005; Zajac and Westphal, 1995). Based on the social perspective, there are only a few studies examining different aspects of isomorphism and convergent behaviour in executive pay. Some of them focus on the convergence between US and non-US compensation practices (Cheffins, 2003; Conyon and Murphy, 2000; Fernandes et al., 2012; Sanders and Tuschke, 2007). Other studies consider the effects of institutional pressure on the suitability of pay practices (Bender and Moir, 2006; Brandes et al., 2006).

Therefore, the third essay analyses for the first time the isomorphism of executive pay within the same institutional context over time. Based on a sample of CEOs and non-CEOs of German DAX and MDAX establishments, the evolution of executive compensation levels and structures (i.e., fractions of base pay, short- and long-term incentives) are examined during the period from 2006 until 2012. The results of descriptive as well as multivariate Fixed Effects analyses indicate isomorphism of both, pay levels and pay structures within (intra-segment-convergence) and between (inter-segment convergence) stock exchange segments especially for CEOs. However, for the other members of the management board (non-CEOs), there is only a convergence of the compensation structure within the segments. The results do not indicate either intra- or inter-segment convergence of salary levels. Furthermore, there is neither an intra-segment nor an inter-segment convergence of the compensation structure for these executives.

This essay enhances the knowledge about the phenomenon of institutional isomorphism in the field of executive compensation. For the first time, it takes diverse dimensions of executive compensation in Germany into account: pay level and structure; CEO pay and non-CEO pay; within (intra) as well as between (inter) the exchange segments DAX and MDAX). However, due to the underlying data structure and the estimation techniques used, it is not possible to identify the exact causes of intra- and inter-segment convergence.

Altogether, the three essays of this dissertation provide a selection of the current changes and challenges that HRM has to deal with. From a methodological perspective, all three essays use different applied econometric estimation strategies. In order to eliminate estimation problems caused by time-invariant and variant unobserved heterogeneity and endogeneity, Fixed Effects, Diff GMM as well as Difference-in-Differences approaches are applied (Card, 1999; Heckman, 1999; Wooldridge, 2009). In addition, sample selection, research design as well as identification strategy attempts to avoid estimation bias. The first two essays are based on a linked-employer-employee panel data set and adopt a personnel economic perspective (Backes-Gellner, 2004; Lazear and Shaw, 2007). The third essay uses establishment-level data and is based on institutional theory (Campbell, 2007; DiMaggio and Powell, 1991).

2 THE RETENTION EFFECT OF TRAINING

PORTABILITY, VISIBILITY AND CREDIBILITY¹

2.1 Introduction

In order to maintain competitiveness and to avoid skilled labor shortages, establishments have to invest in the human capital of their employees (Green et al., 1998; Stevens, 1994). However, to be able to benefit from the new skills and to recoup investments in training participants, it is important to keep these trained employees in the establishment in the long term (Acemoglu and Pischke, 1999a; Craig et al., 2002; Griffeth et al., 2000; Porter and Steers, 1973). It might therefore be a problem that training could even reduce the retention of employees if the new skills are of value to other employers and training establishments risk having their trained employees hired away (Black and Lynch, 1998; Green et al., 2000). An empirical assessment of the retention effect of training is therefore an important piece of evidence for the explanation of employer investment in training contents that increase productivity not only in the training establishment.

Differences in the effects of training on retention could be a consequence of differences in training measures – it may, for example, make a difference whether a company pays for courses attended at a community college or offers in-house training awarded by a certificate from its own staff. Human capital theory and monopsony theory show how training characteristics influence the retention effect of training (Leuven, 2005; Manning, 2003). Human capital theory derives differences in the impact of training on employee retention based on the distinction between general and specific human capital in a perfect labour market (Becker, 1962). Training in general human capital should induce a lower retention effect than specific human capital training because general training is portable and also increases productivity in other establishments. These outside establishments are able to outbid training establishments because they do not have to recoup training investments. Therefore, the labour market value and the outside options of employees trained in portable human capital increase (Loewenstein and Spletzer, 1999; Stevens, 1994a, 1994b).

An important condition for the prediction that portable human capital training decreases retention is that there are no market frictions. The monopsony theory proposes a number of

¹ This Chapter is co-authored by Thomas Zwick.

labour market frictions that explain why training establishments can avoid losing employees who obtained general human capital training (Acemoglu and Pischke, 1999a; Stevens, 1994b). Prominent examples of these market frictions are an information advantage of training establishments on the ability of training participants (Acemoglu and Pischke, 1998; Autor, 2001) or on training contents (Chang and Wang, 1996; Katz and Ziderman, 1990), a compressed wage structure (Acemoglu and Pischke, 1999b; Dustmann and Schönberg, 2009) and regional mobility costs (Acemoglu and Pischke, 1999a; Harhoff and Kane, 1997). One important hypothesis from the monopsony literature is that visibility of training might be a pre-condition for the portability of general human capital training (Acemoglu and Pischke, 1999a; 2000; Katz and Ziderman, 1990). In other words, information asymmetries on training contents might transform portable human capital into non-portable human capital (Barron et al., 1997b; Becker, 1962, p. 50–51; Booth and Bryan, 2005; Loewenstein and Spletzer, 1999, p. 730).

There are few empirical papers on the impact of training portability on retention and, in addition, they come to contradictory conclusions with respect to the retention effect of the portability of training contents (Brunello and De Paola, 2009). Differences in the results can even be found for studies on the basis of the same data set. We therefore argue that differences in the measured effects of training on retention might be driven by the visibility of training in addition to differences in the portability of training contents (Loewenstein and Spletzer, 1999; Zweimüller and Winter-Ebmer, 2003). The differences in training visibility are not usually controlled in papers looking at the retention effects of training portability. Besides looking simultaneously at the portability and visibility of training measures, we also introduce into our analysis the novel dimension of credibility of training certificates. We argue that certificates issued from an external institution might have a stronger effect on retention because they are more credible than internal certificates (Katz and Ziderman, 1990; Manchester, 2012). The effect of training visibility might therefore be influenced by the credibility of certificates, for example.

As our main contribution to the literature is of an empirical nature, we are careful to control for the usual sources of estimation bias when assessing the effects of training on retention. One of the central empirical problems is selectivity for training with respect to unobservable drivers also related to retention (Card, 1999; Heckman, 1999). In order to overcome this problem, we use a comparison group approach (Leuven and Oosterbeek, 2008). Instead of comparing training participants with all training non-participants, we use a control group consisting only of those employees who had been selected by the employer to participate in training but had to cancel their participation for exogenous reasons. If training participants and accidental training non-participants differ with respect to relevant unobservable characteristics, although

their employer chose or accepted both groups for training, the training coefficients in the OLS retention equation are still biased, however. Time-invariant unobserved heterogeneity affecting retention and training such as ability or motivation are therefore also controlled for by applying a Fixed Effects estimation. Time-varying unobserved characteristics such as career prospects are controlled for in a final step in Diff GMM estimations. We compare the results from pooled (between), longitudinal (within) and GMM (instrumental) estimates and rigorously test the applicability of the different specifications.

The paper is structured as follows. In Chapter 2.2, we derive our empirical hypotheses from the previous literature. Then, we describe our data set and the estimation strategy (2.3). The following Chapter 2.4 presents and discusses the descriptive and multivariate findings as well as some robustness checks. The paper ends with some conclusions in Chapter 2.5.

2.2 Background discussion

2.2.1 Conceptual considerations

According to Becker's human capital theory, skills can be considered as enablers of individual and firm-level productivity. When assessing the impact of training on retention, we should distinguish between general and firm-specific skills. Whereas training with general contents increases the productivity of trainees at many employers, training measures imparting specific human capital enhances employees' productivity exclusively in the training establishment (Becker, 1962). In perfect labour markets, there is no reason to suppose any impact of specific training on the mobility of employees (Green et al., 2000). However, after general training, training establishments may run the risk of having their trained employees poached² away (Bishop, 1997; Black and Lynch, 1998; Mohrenweiser et al., 2013). The poaching threat is lower if the new skills are not (completely) portable to other establishments. Moreover, employees' benefits from specific training are lost when they leave the establishment. Therefore, employees and employers are interested in retention, and specific training is unambiguously associated with an increase in retention (Barron et al., 1997b; Loewenstein and Spletzer, 1999).

² If an establishment poaches away employees from a training establishment, then training investments are irretrievably lost. However, raiders enhance their establishments' human capital without paying anything for training (Mohrenweiser et al., 2013).

However, there are many reasons why general human capital training might not lead to a decrease in retention. According to the theories based on labour market frictions, the retention probability depends on the visibility of training contents as well as the portability of training (Acemoglu and Pischke, 1999a; Chang and Wang, 1996). In practice, the current employer usually has an information advantage concerning the exact content (for example, focus and type of training) and the amount of training. Training measures are often informal, heterogeneous and tailored to the needs of the training participants (Katz and Ziderman, 1990), and they are therefore hard to assess for outside establishments. Based on this information asymmetry, for outside establishments, it is hardly possible to completely observe and assess the quantity and quality of training. As a consequence, outside firms will not be willing to fully compensate the trained employees for these skills. Thus, they pay a wage below the real productivity of the trained employees (Acemoglu and Pischke, 1998; 1999a; Benson et al., 2004; Katz and Ziderman, 1990). The training establishment with an information advantage should therefore be able to match the outside wage offer for trained employees it would like to retain. As a consequence, portable training that is hard to assess or invisible might not reduce retention. Loewenstein and Spletzer (1999) and Booth and Bryan (2005) therefore argue (but do not show) that invisibility might transform portable training into non-portable training. As a consequence, only visible and portable training might reduce retention.

Besides the complementarity between visibility and portability of training on retention, there might also be a direct effect of training visibility on retention. Acemoglu and Pischke (1998) and Spence (1973) argue that visibility of training per se leads to a reduction in retention irrespective of training portability or other training characteristics. Their argument is that visible training reveals the motivation of the employee to exert effort irrespective of the content of training. However, it is unclear whether the positive retention effect of visible training vanishes if we also control for portability of training.

Finally, in addition to the visibility of training contents, the credibility of training certificates might also play an important role in employee retention. Training employers might be tempted to conceal portable training contents in their certificates in order to increase the retention effect of the training provided (Barron et al., 1997c). However, training employers might also exaggerate training contents attractive to other employers in order to improve the labour market chances of employees they would like to get rid of. Considering various types of training certificates, an independent certification system and certificates issued by accredited external institutions might therefore have higher credibility of the training contents than internal certificates (Katz and Ziderman, 1990; Manchester, 2010). Therefore, training contents acquired in

courses certified by external independent institutions such as chambers of commerce or chambers of crafts are more credible (Acemoglu and Pischke, 2000). We might therefore assume that credible certificates increase the retention effects of portable and visible training.

2.2.2 Previous empirical evidence

The empirical results of the few papers on the retention effects of training are mixed. An important reason for the scarcity of papers is that detailed information on training characteristics over a certain period and especially the timing of training and employment spells is needed (Krueger and Rouse, 1998; Lynch, 1991). Lynch (1991) finds that on-the-job training increases retention and off-the-job training decreases retention for females in the first four employment years after education in the period 1979–1983. Retention is unaffected for males, however. She uses the US National Longitudinal Survey of Youth (NLSY) data and a Cox partial likelihood model in order to capture the length of tenure in the first job. Parent (1999) also uses four years from the NLSY (1988–1991) and distinguishes between training completed at the previous employer and training completed at the current employer. He shows that on-the-job training as well as off-the-job training completed with the current employer decreases the probability of job separations³. He controls for worker heterogeneity by calculating Cox partial likelihood models including individual-specific baseline hazards. Veum (1997) also uses the NLSY (1987–1992) data and finds that only training not paid for by the employer leads to retention. Training paid for by the employer has no influence on retention, however. On the basis of the NLSY data, Loewenstein and Spletzer (1999) find a positive effect of training in 1993 on retention in 1994. However, they do not find significant retention differences with respect to the self-assessed portability of training contents. They also show that the positive retention effect of training is mainly driven by company training. Supposedly, more portable seminars and school training have no impact on retention.

Green et al. (2000) find a positive correlation between portability of training and mobility expectations of workers. There is no additional effect of certification on retention once portability of training is taken into account. They use British cross-section survey data. Dearden et al. (1997) find a positive retention effect of employer-financed training participation (Quarterly

³ He notes, however, that training completed at the previous employer increases retention in most specifications.

Labour Force Survey, QLFS⁴) and training incidence (National Child Development Survey, NCDS⁵), especially for men in Great Britain. This retention effect is smaller if a formal degree is obtained after training. However, the full retention effect remains positive for most training subgroups (for women, some training incidences lead to a decrease in retention). The training content and the characteristics of the degree are unknown, however. Brunello and De Paola (2009) use individual panel data from 12 countries in the European Community Household Panel (ECHP) for the period 1996–2000. They do not find any impact of training participation on retention in their fixed effects regressions.

Besides individual level data from large-scale surveys, there are also some case studies with information on the retention effect of training. They generally have the advantage that they include better information on the kind of training. However, their findings might not be easy to generalize. Krueger and Rouse (1998) focus on personnel files from two large US companies. They do not find any effect of participation in portable courses offered by a community college paid for by the employers on retention in a cross-section analysis. Benson et al. (2004) mainly analyse the retention effect of financing college courses at one large employer. They find in Cox regression analyses that participating at classes at college increased retention, however, obtaining a degree after finishing education reduces this effect somewhat. They do not know the training contents and whether additional training measures in addition to college attendance have been undertaken during the observation period, however. Kampkötter and Marggraf (2015) is the only analysis on the retention effect of training using German data according to the best of our knowledge. They show that participation in mainly general training decreases turnover. Their data basis is the personnel records of a large multinational firm for the years 2006–2008.

Finally, there is evidence on the retention effect of training at the company level. Haines et al. (2010) use establishment data from the Canadian Workforce and Employment Survey (WES). They find a positive effect of a generic training dummy on turnover. This is in line with other studies on the basis of enterprise data that find either no or a positive effect on turnover (Batt, 2002; Lincoln and Kalleberg, 1996; Shaw et al., 1998).

Therefore, the empirical papers so far come to different conclusions and have several drawbacks. Many papers have no information on training contents or cover only part of the training activities that might be correlated with other training activities not controlled for. Many

⁴ Retention can only be measured for five quarters between 1992 and 1994.

⁵ This data set only covers people born on six days in 1958 and aged 23–33 years in the observation period with two surveys covering 10 years each.

papers only cover a selected group of training participants such as those in entry jobs after education or young employees. Papers with detailed information on training contents tend to be case studies. Finally, several papers cannot account for selectivity into training because they have cross-section data and no proper instrument for training participation. Most importantly for our contribution, no previous empirical paper could assess the joint impact of portability and visibility of training, although both training characteristics might be complements or substitutes. In other words, uncontrolled differences in visibility of the training measures could, for example, influence differences in the retention effects of portable training found in the literature.

2.2.3 Hypotheses

Before we describe our data set, we derive our empirical hypotheses. As practically all training measures entail some specific training aspects that reduce turnover (Loewenstein and Spletzer, 1999; Mincer, 1988), our first hypothesis on the impact of general training on retention is:

H₁: There is a positive relationship between training and retention.

Our second hypothesis incorporates basic insight from the human capital theory:

H₂: When the training content is general human capital and therefore portable to outside employers, the retention effect is lower than for all training forms.

Certification improves visibility of the training contents and the labour market chances of trained employees, and we therefore assume on the basis of the monopsony theory that:

H₃: When training contents can be signalled by means of a certificate and are therefore visible, the retention effect of training is lower than for all training forms.

The explanatory power of portable training contents on retention might vanish if we additionally control for visibility of training courses. It might however also be the case that

visibility and portability have an orthogonal effect on retention and therefore do not influence each other:

H₄: When we jointly control for portability and visibility, both training characteristics have a separate negative retention effect.

Finally, the credibility of a certificate might improve the value of portable and visible training in the labour market because independent institutions might not have an incentive to misreport training contents:

H₅: When training portability and visibility can be signalled by means of an external certificate, their negative retention effect is increased.

After having assessed the five hypotheses, we will calculate whether even general, visible and credible training leads to a positive retention effect.

2.3 Data and estimation strategy

2.3.1 Data

In order to analyse the retention effect of different training measures and to test our hypotheses, we use the German linked employer–employee data set WeLL-ADIAB⁶. The data set was developed within the project ‘Further Training as a Part of Lifelong Learning (WeLL)’ with the purpose of gaining a better understanding regarding ‘(...) the determinants and consequences of further training in Germany’ (Bender et al., 2009, p. 638). In the project, 149 establishments were selected from the 2005 wave of the Institute of Employment Research (IAB) Establishment Panel⁷. From these establishments, between the years 2007 and 2010, 7,352 randomly selected employees were asked in four annual waves⁸ about their individual training behaviour and specific training measures undertaken during the last year(s). Only employees with jobs covered by social security contributions were included in the sample selection. In addition, apprentices, people in internships and employees in partial retirement were excluded. The survey features, inter alia, the exact start and end date and the duration as well as the thematic focus of the training measures for the years 2006–2010. As the exact job dates are also included, we therefore know exactly at which establishment training took place⁹.

An important advantage of the WeLL data set is the linkage of the individual training survey information with administrative labour market history data provided by the IAB in Nuremberg. Based on the Integrated Employment Biographies (IEB), highly reliable information is available on the individual employment history during the observation period (Bender et al., 2009). This history includes the start and end dates of employment periods, the exact daily wage in the respective periods and further characteristics of employment (e.g. occupation, job status, working time and the start of the first employment spell) as well as unemployment spells. The

⁶ WeLL-ADIAB is the abbreviation for ‘WeLL survey data linked to administrative data on the IAB’ (Schmucker et al., 2014).

⁷ Only establishments with between 50 and 1,999 employees subject to social security contributions, establishments from manufacturing or the service industry and locations in the German federal states of Bavaria, Schleswig-Holstein and North Rhine-Westphalia, Mecklenburg-Western Pomerania and Saxony were selected. By stratification of the selection criteria, 12 employer groups were formed, from which in each case the five establishments with the highest and the five establishments with the lowest overall investment expenditures were asked to participate in the WeLL project. The selection criteria have been chosen in order to guarantee that the results are not driven by specific training patterns correlated with the numbers of employees, branches or regions (Bender et al., 2008b).

⁸ The first wave contains the complete training information for the years 2006 and 2007, the second wave includes the training information for the year 2008, the third wave for 2009 and the fourth wave for 2010.

⁹ Mincer (1988) stresses the importance of information on the incidence as well as timing of training and employee turnover for the causal analysis of the retention effect of training.

data set also comprises administrative socio-demographic information such as age, sex, educational and vocational qualifications (Schmucker et al., 2014). The individual information can be linked to establishment-level information (e.g. establishment size, sector, location) from the IAB Establishment Panel (Bender et al., 2008a; Spengler, 2007).

Given that the selection of establishments did not occur randomly, the WeLL-ADIAB data set cannot claim to be representative of the population of German establishments (Knerr et al., 2012). Despite this limitation, the employer–employee panel structure of the data set as well as the wide range of topics relating to training is unique for Germany. Furthermore, the basic employee sample was defined as the whole workforce of about 56,000 employees in the selected establishments. Survey participants were not selected by the employer but were directly approached by the social research institute conducting the survey. Therefore, the employee sample is representative of the establishments with respect to important observables (Bender et al., 2008a).

For our analysis, we use the longitudinal version of the WeLL-ADIAB data set. In order to increase the homogeneity of our sample (7,352 employees), we eliminate 1,411 employees in part-time employment. Furthermore, note that in our main specifications, 1,623 individuals without training participation have been excluded to obtain a homogeneous comparison group according to the comparison group approach. Thus, our sample consists of 4,318 training participants and accidental training non-participants from 149 establishments. Further descriptive statistics are reported in the next part.

Measures – dependent variable

Brunello and De Paola (2009), Card and Sullivan (1988), Loewenstein and Spletzer (1999) and Picchio and Van Ours (2013) measure the effect of training on employee retention as the probability of staying in employment in the next period of time. In this paper, we adopt their approach but focus on future employment in the same establishment instead of employment in general. Therefore, our dependent binary variable takes the value of 1 if the individual is still employed in the current establishment in the next calendar year. If the individual changes employer or is unemployed in the next year, the variable is 0¹⁰.

¹⁰ We cannot distinguish between voluntary and involuntary turnover.

In the WeLL-ADIAB data set, there are individuals with several employment spells per year measured on a day-to-day basis. These spells can be in the same establishment or in various establishments. In order to calculate the employment duration and the employees' retention in the period from 2006 until 2010, we use the spell that overlaps 1 January as reference point¹¹. If, for example, a training measure was concluded in year t , we regard an employee as retained if he or she still worked for the same employer on 1 January in $t+1$. Besides training information, we also use working time, job status and other job characteristics assigned to each employment spell.

Measures – training information

In each annual survey wave, the respondents were asked about the timing and further characteristics of at most three training measures during the last year in chronological order. If the respondents stated more training measures than requested, we delete this additional information to ensure consistency. We also delete all training measures that had no detailed information concerning their start and end dates. Hence, we are able to assign every single training measure to the appropriate employment spell. For our research question, it is of particular importance that we know which employer offered the training measure. Therefore, we eliminated all training measures that could not be clearly assigned to an establishment (300 eliminations). As the training period is given with monthly precision, we also eliminate training courses that were not finished one month before a job change (42 eliminations). We give the explanatory binary training variable d_{ijt} the value 1 if an individual participates in training offered by the training establishment j in the current calendar year t ; otherwise, the variable takes the value 0.

Barron et al. (1997a), Green et al. (2000) and Loewenstein and Spletzer (1999) note that training definitions differ between establishments and that information on the portability of training provided by the employer is therefore unreliable. They propose using the assessments by training participants because these assessments are more comparable and reliable¹². We

¹¹ Usually, all employment spells start on 1 January in each year. During the year, there are only new spells in the case of well-defined changes (for example, a change of employer).

¹² However, Raffiee and Coff (2016) argue that the perception of specificity of human capital by employees might be problematic. They find, on the basis of the NLSY and Korean Labor and Income Panel Study (KLIPS), that employees with longer tenure and higher commitment do not think they have more specific human capital. They do not find a correlation between the general specificity perception and on-the-job training obtained during a limited time spell in the past. However, they cannot compare perceptions with other training forms. We think that the insignificant correlations might call into question more the assumption that on-the-job training is an indicator of human capital specificity than errors in the perception of specificity.

therefore rely on the subjective assessment of the training participants as to whether their training contents can be used in other establishments¹³.

Besides the portability of training, we also control for the visibility of training. A certificate at the end of the training course can be viewed as a means of conveying the contents and value of the training to the outside labour market (Booth and Bryan, 2005).

Credibility is measured by the fact that the training was provided and the certificate was issued by a third party and not the training establishment itself. We assume that external institutions do not strategically manipulate the certification of training contents.

Measures – control variables

Besides information on training participation, a couple of further individual and establishment-level characteristics may have an impact on the probability of retaining employees in the training establishment and on training participation. Individual characteristics that might influence the retention probability of employees are gender, age, tenure and schooling level (Göggel and Zwick, 2012). Qualification might be positively related to training and retention (Gritz, 1993). In addition, training participation decreases with age, tenure and experience (Pichio and Van Ours, 2013; Zwick, 2015). As an indicator of previous employment history, we consider the years of employment in the same establishment (tenure) and professional experience (Benson et al., 2004; Parent, 1999). Furthermore, we capture age as birth cohort effects (more specifically, as groups of birth years) because birth year is often closely related to experience.

As the propensity of the employer to train might influence the employment prospects and the retention probability of the employees (Wagner and Zwick, 2012), we also take establishment size, sector and the location of the establishment into account (Loewenstein and Spletzer, 1999).

Training is frequently accompanied or followed by wage increases, and these wage increases might have a decisive impact on the decision to stay at the training employer (Brunello and De Paola, 2009; Chéron et al., 2010; Mincer, 1988). Training establishments want to increase employee retention by increasing wages and sharing rents (Becker, 1962; Hashimoto,

¹³ The exact wording of the question is: ‘How easily can the obtained knowledge also be used at another employer according to your opinion?’ (*‘Inwieweit ließen sich nach Ihrer Einschätzung die erworbenen Kenntnisse auch in einem anderen Betrieb verwenden?’*).

1981). Wage increases after training might therefore be a key factor in the retention effect of training (Benson et al., 2004; Grund and Sliwka, 2001). In contrast to previous studies, in which individual wages were observed at only one point in time (Gritz, 1993; Lynch, 1991; Parent, 2003), or at the beginning and end of the observation period (Benson et al., 2004), we have individual wage changes on an annual basis. To control for general wage increases in the establishment, we define an individual wage increase as an individual wage change that exceeds the average establishment-wide wage increase in the respective occupational peer group. According to this definition, our binary wage increase variable takes the value of 1 if the wage increase of an individual is higher than the average wage increase of individuals in the same occupation in the establishment in the current calendar year. In our data structure, wages may differ between several employment spells in one establishment and year. For the calculation of the individual wage increase, we therefore use the weighted daily wage¹⁴ of the employees by establishment and year. In the case of unemployment spells, the daily wage is set to 0.

Job satisfaction is another potential mechanism between training and retention (Georgellis and Lange, 2007; Jones et al., 2009). Job satisfaction might also capture additional dimensions of otherwise unobservable individual characteristics (Brunello and De Paola, 2009). We therefore control for yearly changes in general job satisfaction that is individually assessed in our data set (Zwick, 2015). However, as job satisfaction and wage increases are measured in the same time period as retention, both variables might be outcomes instead of controls for employee retention and therefore so-called ‘bad controls’ in our regressions (Angrist and Pischke, 2009, pp. 64–66). We therefore only use these variables in a robustness check in order to show whether the impact of training on retention is direct or whether it mainly works indirectly through wage increases or higher job satisfaction.

2.3.2 Estimation strategy

Our main contribution to the literature is the analysis of the retention effect of training taking account of portability, visibility and credibility of training. In order to do this, we expand the training participation dummy by indicators of whether training is of general content,

¹⁴ In order to obtain the weighted daily wage, first, daily wage is multiplied by the number of days in the corresponding employment spell and divided by the overall duration of all employment spells by employer and year. Although it is not possible to assign the annual wage increase exactly to the start and end date of training, we are able to take into account changes in daily wages as a consequence of an employer change during the year.

whether training was completed with a certificate or not and whether the certificate was issued by an external provider or not.

In estimations of the impact of training participation on employees' retention in the training establishment, a couple of estimation problems may occur, which might lead to biased estimators and results. In order to avoid them, we first adopt a 'before-and-after' approach, i.e. training participation in period t is related to employment in period $t+1$, because this timing avoids reverse causality (Dearden et al., 1997). We therefore use training participation as a determinant of retention in the training establishment in the next calendar year.

Besides the timing of events, we take into account that the selection of employees into training is usually not random or, in other words, third factors such as job satisfaction, ability or tenure have an influence on training participation in t and on retention in $t+1$ (Card, 1999; Heckman, 1999). There are several solutions to the endogeneity problem, and we show how our results differ if we apply these solutions in turn. One solution to reduce the potential of unobserved third factors to influence the coefficients is proposed by Leuven and Oosterbeek (2008). They compare training participants only with those employees who were selected by the employer to participate in training but could not participate for exogenous reasons. The reduction of the sample to training participants and accidental training non-participants as the comparison group clearly reduces the potential impact of endogeneity because all employees who have not been selected into training on the basis of unobserved characteristics are not compared with the training participants. In the WeLL data, the question used to identify accidental training non-participants is: 'Did you intend to participate in training courses, seminars or lectures in the last two years without realizing this plan?'¹⁵. It is crucial that the reasons for non-participation are random because otherwise selection bias could contaminate the results (Görlitz, 2011). Employees cancelling a course because of high training costs are probably not comparable to training participants, for example. Therefore, we have to take a closer look at the reasons for training cancellation. We regard the following reasons as random: the course was cancelled by the training organizer or an unexpected job had priority¹⁶. We use the reduced

¹⁵ We include accidental training non-participants only for those years in which they had been chosen for training but did not participate.

¹⁶ There is some debate about whether family or health reasons can also be regarded as random cancellation reasons (Görlitz, 2011). The main argument against this assumption is that employees with long-lasting health problems or, for example, employees with young children or care duties for elderly family members might routinely have to cancel training participation. Very few employees indicated that family or health was the reason for training non-participation, and we dropped these cases from our sample. If we include them in the group of training non-participants, our results are unchanged, however.

sample of training and accidental training non-participants in all the main tables in our paper and compare the results obtained with the full sample in a robustness check.

Based on this comparison group approach, in our first estimation of the retention effect of training r_{ijt+1} , we include the training information d_{ijt} in an ordinary least squares estimation. Besides information on whether training took place in year t for employee i at employer j , we also control for whether this training was transferable, visible and credible using interaction terms with the training dummy. In addition, we include birth year, tenure, experience, gender and qualifications in an individual information vector X_{it} . Finally, we also include an establishment characteristics vector Z_{jt} with employer size and sector as well as year dummies t . The variance comes from differences in training participation between employees, and the regression can be written like this (with ε being an idiosyncratic error term):

$$r_{ijt+1} = c + \alpha d_{ijt} + \beta' X_{it1} + \gamma' Z_{jt} + t + \varepsilon_{it} \quad (1)$$

It might be the case, however, that training participants and accidental training non-participants differ in time-variant or time-invariant characteristics related to both training participation and retention. We therefore estimate all variables in time differences (Fixed Effects estimation, FE). Our FE model uses time differences to eliminate all time-fixed individual unobserved heterogeneity such as ability or motivation and can be written as (with Δ as an indicator of differences from year to year and X_{it2} as a smaller vector of the time-varying individual characteristics such as tenure and experience):

$$\Delta r_{ijt+1} = c + \alpha \Delta d_{ijt} + \beta' \Delta X_{it2} + \gamma' \Delta Z_{jt} + t + \varepsilon_{it} \quad (2)$$

Even if we use a comparison group approach and control for time-invariant unobserved heterogeneity, unobserved time-variant factors such as future employment expectations at the training establishment or the chance of the employee gaining promotion within the employer may have an impact on training participation and retention. Therefore, in our third and preferred estimation approach, we use the Arellano–Bond difference General Method of Moments estimator (Diff GMM)¹⁷ (Arellano and Bond, 1991; Roodman, 2006). In the Diff GMM estimation,

¹⁷ More precisely, we use the one-step Arellano–Bond difference GMM estimator, which is not robust to panel-specific autocorrelation and heteroscedasticity (Arellano and Bond, 1991).

lagged levels¹⁸ of the dependent and of endogenous explanatory variables are added in the estimation equation as internal instruments. By so doing, the endogenous variables are pre-determined and not correlated any more with the error term in the preceding estimation equations (Roodman, 2006). Based on the previous FE estimation, the Diff GMM estimation can be written as (with V_{it} as a vector of the lagged levels):

$$\Delta r_{ijt+1} = c + \alpha \Delta d_{ijt} + \beta' \Delta X_{it2} + \gamma' \Delta Z_{jt} + \delta' \Delta V_{it} + t + \varepsilon_{it} \quad (3)$$

Some authors propose using external instruments. However, the usage of available external instruments¹⁹ reduces our sample size substantially²⁰. In addition, many papers on the effects of training argue that it is very hard to come up with a convincing instrument (Dearden et al. 1997; Leuven, 2005). We therefore do not show the results of the Diff GMM estimation with our external instrument.

2.4 Findings

2.4.1 Descriptive statistics

Table 2.1 shows descriptive sample characteristics separately for training participants and accidental training non-participants. The majority of the respondents are male and were born between 1952 and 1971. Whereas most of the survey participants (79.12%) have professional experience of at least 10 years, only 54.63% have worked with the same establishment for more than 10 years. Regarding educational background, 3.72% have no vocational educa-

¹⁸ In the Diff GMM estimation we use two lags of the dependent variable (retention in the last two years) and one lag of all other endogenous explanatory time-varying variables (training information, year dummies, tenure and experience as internal instruments. We test for autocorrelation and use heteroscedasticity corrected standard errors. Furthermore, we apply the small sample adjustment (Arellano and Bond, 1991).

¹⁹ We use establishments' expectations of skill shortages as an external instrument. If establishments expect skill shortages, this should lead to more training in the establishment and therefore to a higher individual training probability. However, expected skill shortages should not affect the short-run individual retention probability. Therefore, this instrument is assumed to be valid.

²⁰ In addition to the differenced equation in the Diff GMM estimation, the system GMM estimator uses the level equation to obtain a system of two equations. As the variables in levels in the second equation are instrumented with their own first differences, additional instruments can be obtained (Blundell and Bond, 1998). However, this approach reduces the sample size by one observation per individual. Furthermore, it is not appropriate to use a system GMM estimation with a comparably small data set as is the case in the current paper.

tion, 68.67% completed vocational education, and 27.63% hold a university degree. Furthermore, 35.57% of the respondents received a higher wage increase than their occupational peer group in the establishment. In 75.22% of the training measures, the employees received training certificates, which are frequently provided by external institutions (84.31%). Furthermore, training participants assess their training measures relatively often as general and therefore portable (82.68%).

We use a comparison group approach and therefore reduce the problem arising from training participants having been selected into the training group by unobserved third factors that may be relevant for retention.²¹ As a consequence, unobservable as well as observable characteristics of training participants and accidental training non-participants should be more similar than the characteristics of training participants and all training non-participants in the original sample. Indeed, accidental training non-participants are more similar to training participants than all training non-participants (compare Table A2.1 in the Appendix with Table 2.1). However, we still find significant differences between training participants and accidental training non-participants for some observable characteristics. More specifically, training participants have significantly higher daily wages than the comparison group. This might be a consequence of training participants being older and having more tenure and experience. However, education level and gender share do not differ significantly between accidental non-participants and training participants. According to Pischke (2001), differences in unobservable characteristics between training participants and training non-participants are often reflected by past wage differentials²². Therefore, an important indicator that accidental training non-participants are more similar to training participants than all training non-participants is the finding that there are no significant differences in earnings in 2005, prior to our observation period when we cannot observe the training participation of both groups. Given the socio-demographic differences between participants and accidental training non-participants, however, we should control for these observable characteristics in our retention estimations. In addition, it is important to perform within estimations such as Fixed Effects in addition to between estimations in order to control for differences in unobserved time-invariant characteristics.

²¹ By using the comparison group approach, Leuven and Oosterbeek (2008) and Görlitz (2008) show that the overestimated wage effect of training decreases. Based on the underlying sample, we can confirm their results. Appendix A2.2 shows that the impact of training on wages is much smaller (3.4 percent) when training participants are compared to accidental training non-participants than in the full sample (9.8 percent).

²² As administrative labour market history data are linked to the survey data, the WeLL-ADIAB also contains wage information for the time before the period covered by the training questions.

Table 2.1: Description of differences between training participants and accidental training non-participants

Socio-demographic factors	Total (%)	Training participants (%)	Accidental training non-participants (%)	t-value
Female	29.55	29.47	30.04	0.43
<u>Birth year</u>				
≤ 1951	9.98	10.51	6.70	-4.35***
1952–61	35.14	35.73	31.44	-3.08***
1962–71	32.06	31.94	32.84	0.66
≥ 1972	22.81	21.83	29.01	5.87***
<u>Experience</u>				
< 10 years	20.88	19.70	28.28	7.24***
10–20 years	49.86	50.46	46.10	-2.99***
> 20 years	29.26	29.84	25.63	-3.17***
<u>Tenure</u>				
< 10 years	45.42	44.19	53.17	6.18***
10–20 years	37.75	38.79	31.22	-5.35***
> 20 years	16.83	17.02	15.61	-1.29
<u>Education</u>				
No vocational education	3.72	3.54	4.91	2.42**
Vocational education	68.67	69.00	66.51	-1.78*
University degree	27.63	27.47	28.58	0.83
Wage increase dummy	35.57	35.97	32.91	-2.11**
Log daily wage 2005 ²³	4.61	4.61	4.58	-1.34
Log daily wage 2006	4.65	4.67	4.60	-2.28**
Log daily wage 2007	4.64	4.67	4.49	-5.24***
Log daily wage 2008	4.65	4.68	4.41	-6.08***
<u>Training</u>				
Training certificate	-	75.22	-	-
External certificate (given a certificate)	-	84.31	-	-
Training with general content	-	82.68	-	-
Observations	8,186	6,860	1,326	

*Statistically significant at the .10 level; **at the .05 level; *** at the .01 level; Source: WeLL-ADIAB 2006–2010.

²³ The log daily wages 2005–2008 are given in absolute numbers.

2.4.2 Retention effect of training

In our multivariate analyses, we first test whether training increases employee retention when we additionally control for important individual and establishment characteristics. Table 2.2 shows the regression output of ordinary least squares (OLS), Fixed Effects (FE) and Diff GMM estimations.

Table 2.2: Determinants of employee retention

Dependent variable: Retention next year	Model with training dummy		
	OLS (1)	FE (2)	Diff GMM (3)
Training	0.087*** (0.007)	0.091*** (0.011)	0.118*** (0.024)
Female	-0.003 (0.005)	–	–
Birth year 1952–1961	-0.014 (0.008)	–	–
Birth year 1962–1971	-0.018** (0.009)	–	–
Birth year > 1972	-0.023** (0.012)	–	–
Tenure < 10 years	-0.027*** (0.009)	0.292*** (0.028)	0.393*** (0.093)
Tenure 10–20 years	0.009 (0.009)	0.207*** (0.028)	0.194** (0.077)
Experience < 10 years	-0.033*** (0.011)	-0.039 (0.036)	-0.070 (0.065)
Experience 10–20 years	-0.007 (0.007)	-0.009 (0.027)	-0.010 (0.038)
Vocational education	-0.012 (0.012)	–	–
University degree	-0.016 (0.013)	–	–
Year dummies	Yes	Yes	Yes
Establishment characteristics	Yes	Yes	Yes
R ²	0.052	0.052	–
Observations	8,186	8,186	3,339
Individuals	–	4,318	2,119
AR-test	–	–	0.844
Hansen-test	–	–	0.334

Dependent variable: retention probability in the next calendar year; reference category for age: birth year \leq 1951; reference category for tenure: tenure \geq 20 years; reference category for experience: experience \geq 20 years; reference category for education: no vocational education; establishment characteristics: size, sector. *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

The OLS estimation suggests that training participation increases retention probability in the training establishment in the next calendar year on average by 8.7 percentage points (PP). Controlling additionally for time-fixed individual unobserved heterogeneity and endogeneity, we find a retention effect of 9.1 PP in the FE and of 11.8 PP in the Diff GMM estimation. We therefore find support for our first hypothesis. It seems that the first two models underestimate the retention effect of training, probably because they have higher measurement errors. When focusing on our preferred model 3 – the Diff GMM estimation – we see that individuals with shorter job tenure have a higher probability of being retained (also compare Benson et al., 2004). The OLS estimation also indicates that there are hardly any gender differences in the retention rate, and older employees have a higher probability of staying in the current establishment (model 1), a result also found by Brunello and De Paola (2009). The AR-test in the Diff GMM estimation indicates that there is no autocorrelation in levels. As the Hansen-test is insignificant ($p=0.334$), we conclude that the internal instruments are valid.

After establishing that training on average increases employee retention in the current establishment, in the next step, we investigate whether the retention effect is influenced by the portability and visibility of training measures (Table 2.3). When the training content is portable to outside establishments, this significantly reduces the retention effect from about 10 PP to about 8 PP in the OLS and FE models. We also find a lower retention effect for visible training measures than for training in general (models 4–6). Visibility reduces retention by about the same magnitude as portability. Note, however, that the impact of visibility and portability is not significant in the Diff GMM estimation. The retention effects of the other control variables in the different model specifications are robust to the addition of the visibility and portability interaction terms. Furthermore, in model 3 as well as in model 6, the AR-tests and Hansen-tests indicate that there is no autocorrelation in levels and that the instruments are valid. We therefore find weak support for our second and third hypotheses only if we do not control for endogeneity using Diff GMM.

Table 2.3: Determinants of employee retention, inclusion of training interacted with visibility and portability

Dependent variable: retention next year	Models with portable training			Models with visible training		
	OLS (1)	FE (2)	Diff GMM (3)	OLS (4)	FE (5)	Diff GMM (6)
Training	0.099*** (0.009)	0.110*** (0.015)	0.130*** (0.027)	0.100*** (0.008)	0.109*** (0.013)	0.136*** (0.028)
Training * portable	-0.014** (0.007)	-0.021* (0.012)	-0.013 (0.015)	-	-	-
Training * visible	-	-	-	-0.017*** (0.006)	-0.022** (0.010)	-0.023 (0.015)
Female	-0.003 (0.005)	-	-	-0.002 (0.005)	-	-
Birth year 1952–1961	-0.014 (0.008)	-	-	-0.012 (0.008)	-	-
Birth year 1962–1971	-0.018** (0.009)	-	-	-0.016* (0.009)	-	-
Birth year > 1972	-0.023** (0.012)	-	-	-0.022* (0.012)	-	-
Tenure < 10 years	-0.026*** (0.009)	0.293*** (0.028)	0.394*** (0.093)	-0.025*** (0.009)	0.292*** (0.028)	0.392*** (0.092)
Tenure 10–20 years	0.009 (0.008)	0.208*** (0.028)	0.194** (0.077)	0.010 (0.009)	0.207*** (0.028)	0.193** (0.077)
Experience < 10 years	-0.033*** (0.011)	-0.039 (0.036)	-0.070 (0.065)	-0.032*** (0.011)	-0.040 (0.036)	-0.069 (0.065)
Experience 10–20 years	-0.007 (0.007)	-0.010 (0.027)	-0.010 (0.038)	-0.007 (0.007)	-0.010 (0.027)	-0.009 (0.038)
Vocational education	-0.012 (0.012)	-	-	-0.012 (0.012)	-	-
University degree	-0.014 (0.013)	-	-	-0.015 (0.013)	-	-
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Establishment Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.053	0.053	-	0.053	0.053	-
Observations	8,186	8,186	3,339	8,186	8,186	3,339
Individuals	-	4,318	2,119	-	4,318	2,119
AR-test	-	-	0.806	-	-	0.816
Hansen-test	-	-	0.338	-	-	0.324

Dependent variable: retention probability in the next calendar year; reference category for age: birth year ≤ 1951; reference category for tenure: tenure ≥ 20 years; reference category for experience: experience ≥ 20 years; reference category for education: no vocational education; establishment characteristics: size, sector. *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

In order to check how the portability and visibility of training interact, in the next step, we simultaneously consider both interactions in one model (Table 2.4, models 1–3). In particular, the coefficients of training with general contents are smaller and lose significance in this specification. Again, the AR-test and Hansen-tests indicate that there is no autocorrelation in levels and that the instruments are valid. Furthermore, the retention effect of the other control variables is practically unchanged in comparison to the previous estimations. Based on these results, we see that training visibility and portability have separate negative effects on retention. Our fourth hypothesis is therefore supported.

According to our hypothesis 6, the negative retention effects of general and certified training measures are stronger when we focus exclusively on training measures provided and certified by external independent institutions (models 4–6). When individuals participate in externally provided training measures with general content, this reduces the retention probability by 3.9 PP. Furthermore, we find a large negative retention effect (3.3% PP) for training measures that are certified by external institutions. Visibility and portability have a distinct impact on retention, and the other covariates barely change compared with the other estimation models. The AR-test in the Diff GMM model indicates that there is no autocorrelation in levels. The instruments are valid (Hansen-test). We conclude that training certificates from external providers can be considered as powerful signals of training participants' ability and the portability of training contents. In consequence, employees participating in these portable and visible measures are able to credibly prove their acquired skills to potential new employers. Individual career and earning prospects can be improved, and employees have higher incentives to leave the current establishment than other training participants.

Table 2.4: Determinants of employee retention, joint control of visibility, portability and credibility

Dependent variable: retention next year	Models with portable and visible training			Models with credible training		
	OLS (1)	FE (2)	GMM (3)	OLS (4)	FE (5)	GMM (6)
Training	0.108*** (0.010)	0.123*** (0.016)	0.144*** (0.030)	0.128*** (0.016)	0.143*** (0.026)	0.173*** (0.038)
Training * portable	-0.011 (0.007)	-0.018 (0.012)	-0.010 (0.015)	-0.026** (0.013)	-0.018 (0.019)	-0.039** (0.019)
Training * visible	-0.015*** (0.007)	-0.020** (0.010)	-0.022 (0.015)	-0.021** (0.010)	-0.040** (0.017)	-0.033* (0.019)
Female	-0.003 (0.005)	–	–	0.001 (0.008)	–	–
Birth year 1952–1961	-0.013 (0.008)	–	–	-0.018 (0.008)	–	–
Birth year 1962–1971	-0.018** (0.009)	–	–	-0.018** (0.009)	–	–
Birth year > 1972	-0.023** (0.012)	–	–	-0.023** (0.012)	–	–
Tenure < 10 years	-0.025*** (0.009)	0.293*** (0.028)	0.393*** (0.093)	-0.035*** (0.013)	0.302*** (0.040)	0.285*** (0.100)
Tenure 10–20 years	0.010 (0.009)	0.208*** (0.028)	0.194** (0.077)	0.003 (0.013)	0.203*** (0.039)	0.125 (0.088)
Experience < 10 years	-0.033*** (0.011)	-0.041 (0.036)	-0.070 (0.065)	-0.035** (0.016)	-0.002 (0.051)	-0.035 (0.074)
Experience 10–20 years	-0.007 (0.007)	-0.010 (0.027)	-0.009 (0.038)	-0.008 (0.010)	0.006 (0.038)	-0.010 (0.046)
Vocational education	-0.011 (0.012)	–	–	0.009 (0.019)	–	–
university degree	-0.014 (0.013)	–	–	0.007 (0.019)	–	–
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Establishment Charac- teristics	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.054	0.054	–	0.061	0.054	–
Observations	8,186	8,186	3,339	4,879	4,879	1,954
Individuals	–	4,318	2,119	–	2,734	1,345
AR-test	–	–	0.787	–	–	0.384
Hansen-test	–	–	0.328	–	–	0.121

Dependent variable: retention probability in the next calendar year; reference category for age: birth year ≤ 1951; reference category for tenure: tenure ≥ 20 years; reference category for experience: experience ≥ 20 years; reference category for education: no vocational education; establishment characteristics: size, sector. *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

2.4.3 Robustness checks

In order to ensure that our results are not distorted by estimation problems or the sample selection, we ran a series of robustness checks. First, as the dependent retention variable is a binary variable, for the model specifications in Table 2.4, we also calculate marginal effects in a Linear Probit model (Table A2.3). The results in model 1 suggest that training increases the probability of retaining the employee in the training establishment by 12.8% PP. However, this positive effect is reduced by 1.2 PP when training is portable and by 1.4 PP when trained employees are able to make the contents visible to outside establishments by means of a certificate. Again, these negative effects are stronger when we focus exclusively on externally provided and certified training measures. When individuals participate in externally provided training with general content, this reduces the retention rate by as much as 3.5 PP. Furthermore, when training participants receive certificates from an external independent institution, this also reduces the retention probability by 2.8 PP. Thus, the marginal effects in the Linear Probit model are comparable to the results obtained in the OLS, the FE and the Diff GMM models in Table 2.4. This result is also obtained for the retention effects of the other covariates.

By using the control group approach, we restricted our sample exclusively to training participants and accidental training non-participants. As already shown in the descriptive statistics, both groups in this subsample are much more similar than training participants and all non-trainees in the original sample. In order to test whether unobserved heterogeneity between training non-participants affects the estimation results, based on the full sample, we ran an additional robustness check of our basic models (compare Table A2.4). Whereas the positive retention effects of training are quite robust in all model specifications, the additional effects of general and certified training measures differ. In particular, the additional positive effect of general training contents in the FE and Diff GMM estimations does not make any sense. Moreover, in contrast to all previous results, we only find a significant negative effect in the case of externally provided certificates. The distortion of the effects may be a result of higher unobserved individual heterogeneity in the full sample. Therefore, the restriction of the comparison group to accidental training non-participants seems to be a good strategy.

In our last robustness check, we also include changes in job satisfaction and wage increases after training as potentially additional channels between training and retention in our preferred estimation model (Table A2.5). These potentially endogenous variables have the expected positive impact on retention. The training coefficient and the interaction terms with portability and visibility are comparable to the main specification in Table 2.4. We can therefore

conclude that training as well as portability and visibility have direct effects on retention, and these effects are not fully mediated by job satisfaction and wage increases.

2.5 Conclusions

The objective of this paper is to determine the retention effect of training. On the basis of large linked employer–employee panel data with detailed information on the employees’ employment and training history, we find that training has a significantly positive retention effect. According to human capital theory, portability of training reduces the retention effect (in most specifications). According to monopsony theory, visibility of training also reduces the retention effect of training (in most specifications). These additional negative effects are much stronger if training is credible, i.e. if training is provided and certified by external institutions. In addition, visibility and portability have distinct and comparable negative effects on retention. The reduction in the retention of portable human capital is therefore independent of its visibility. The total retention effect of training after controlling for portability, visibility and credibility is still positive; in other words, training providers can increase their chances of keeping employees even by offering training measures that increase productivity in other establishments and lead to credible certificates that outside employers can easily assess.

We are careful to avoid the estimation problems usually encountered when measuring the effects of training. We use a comparison or control group approach and compare training participants with accidental training non-participants – employees who had been chosen to participate in training but had to cancel participation for exogenous reasons. We have high quality administrative spell data with daily accuracy on the labour market history of all employees included. Our measure of retention therefore indicates whether the employee stayed with the employer s/he worked for during the previous year and whether the training received during this time period was with this employer or not. In addition, we account for unobserved time-invariant heterogeneity in first difference regressions and for endogeneity of training participation in Diff GMM estimations using internal instruments. Finally, we include a broad range of individual and establishment characteristics that determine retention. We show that our results are quite robust with respect to changes in the estimation technique and the inclusion of additional explanatory variables and external instruments. We expand the sample to include all training non-participants in our control group. We also expand our estimations by taking into

account wage increases and changes in job satisfaction in order to control for additional channels between training and retention.

Summing up, we find that there is a strong positive retention effect even of general, visible and credible training. This seems to be a puzzle given the theoretical predictions of the human capital and monopsony theories. A reason for this finding could be that there are additional mobility barriers we cannot control for with our data set²⁴. Training establishments are able to retain their trained employees because important dimensions of ability (such as social skills) cannot be signalled on the basis of the training participation certificates (Acemoglu and Pischke, 1998; Autor, 2001; Manchester, 2010; Mohrenweiser et al., 2015). Reciprocity might also be a mechanism that increases the retention of employees trained with portable and visible human capital (Kampkötter and Marggraf, 2015). Employees perceive firm-sponsored training courses as a kind action, and they reciprocate the training investments by staying with the establishment although they have attractive outside options (Batt, 2002; Sieben, 2007). Finally, the perception of portability of training by the employees might be wrong. Either cognitive dissonance or recall bias might lead to the assessment that training is more portable than it actually is (Raffiee and Coff, 2016). Therefore, further training appears to be an effective measure to keep the qualified employees in the establishment and thus counteract the impending shortage of skilled workers.

²⁴ Manchester (2012) stresses that the retention effect has to be separated into the (stronger) sorting and the pure participation effect. As we calculate the retention effect on the basis of within changes in retention of employees given training participation, we only measure the pure participation effect and control for the sorting effect.

3 TRAINING IN THE GREAT RECESSION

EVIDENCE FROM AN INDIVIDUAL PERSPECTIVE ²⁵

3.1 Introduction

The German system of further training is rather market driven and investment decisions are mainly taken and funded by the establishments (Bender et al., 2008a). Training firms expect productivity gains at the individual and establishment levels (Zwick, 2005) and aim to recoup their training investments by obtaining a difference between productivity and wage increases after training (Dearden et al., 2000). Training therefore might increase the competitiveness of employers. However, in economically difficult and uncertain times, credit constraints and demand reductions might induce employers to reduce training (Bellmann et al., 2014). One line of argument is that training investments might be reduced because of uncertain future employment needs and the lower expected tenure of trained employees. Training might also decrease as employers shift investments to more pressing areas because training investments are often expensive, their true benefits are rather hard to assess, and they may come with a lag (Becker, 1962; Bellmann et al., 2014; Popov, 2014). A contradictory line of argument is that firms use slack periods during recessions in order to increase the share of training in total investments because their opportunity costs are temporarily low (Aghion and Saint-Paul, 1998; Brunello, 2009; López-García et al., 2013). In addition, the outside options for trained employees decrease in uncertain times, and therefore the costs necessary to retain trained employees might be lower in recessions (Bellmann et al., 2014). Both arguments lead to large differences in the consequences of recessions for training investments and competitiveness. Hence, it seems to be important to investigate how establishments' training activities are affected by a recession. As establishments' training provision often depends on the skill level of the employees (Barron et al., 1999; Blundell et al., 1999), the question also arises whether establishments' reactions in training activities are specific to certain employee groups.

This paper focuses on the Great Recession in 2008 and 2009 as an exogenous shock. This crisis was triggered primarily by the collapse of the US real estate market. In particular, the bankruptcy of Lehman brothers in late 2008 and the subsequent collapse of the interbank market then had enormous international impacts for the real economy. In addition to declines

²⁵ This Chapter is single-authored.

in demand, resulting from banks' restricted resources for lending, establishments were mainly affected by credit constraints (Bond et al., 2005; Ivashina and Scharfstein, 2010). In contrast to other countries, the labour market in Germany was only partially affected by the crisis (e.g. export-oriented establishments in the manufacturing industry) (Bellmann and Buttler, 2010; Bogedan, 2010; Möller, 2010). It was not until the end of 2009 that the economic situation relaxed slightly by means of two stimulus packages.

There is only a handful of empirical studies analysing the impact of this economic crisis on establishments' training activities. Based on several data sets and qualitative interviews from the UK, Felstead et al. (2012) find that the crisis does not have a dramatically negative impact on the provision of training. Only a minority of establishments reduce spending per head. Usually employers search for more cost-effective ways of training (i.e. from external to in-house training, usage of e-learning) and adapt these measures to their business needs. In contrast, Mason and Bishop (2015) show that the recession contributes to reductions in adult training in the UK. The reduction can be observed especially for off-the-job training and for skilled and highly skilled employees. On-the-job training is reduced only slightly and rather targeted at employees with identified skills improvement needs. Analysing survey data on small and medium-sized establishments from 25 transition economies, Popov (2014) also stresses that credit constraints are associated with significantly lower training investments. Furthermore, there are stronger negative effects in education-intensive sectors and in sectors with growth potential. Based on the IAB Establishment Panel, Bellmann et al. (2014) find that German establishments reduce their training activities in 2009 – at the peak of the crisis – compared with 2008, independently of whether or not they have been directly affected by the economic crisis. However, establishments that have been directly affected by financial restrictions reduced their training efforts to a much greater extent than other establishments.

In contrast to previous research, this is the first paper to use primarily individual training information to analyse the effect of the economic crisis on the training activities of various groups of employees in Germany. Thus, I take into account that the establishments' training provision often also depends on the skill level of the employees. Higher ability lowers the costs of training (Barron et al., 1999; Blundell et al., 1999), which results in increasing rates of return with qualification (Arulampalam and Booth, 2001; Bassanini and Ok, 2007; Kuckulenz and Zwick, 2005). Furthermore, education and skill levels help employees to adapt more rapidly to new tasks (Blundell et al., 1999; Hochfellner et al., 2015). Nevertheless, firms might also offer up-skilling to low skilled employees during a recession in order to be able to retain them for the next boom phase (Brunello, 2009). Based on the extensive German linked employer–employee

panel data set WeLL-ADIAB, I am able to assign this individual training information to the establishments where the training measure took place (Bender et al., 2008a; Spengler, 2007). Furthermore, by means of the linkage with administrative establishment-level data from the IAB Establishment Panel, information regarding the respective training establishments is available. In addition to rather general information about the establishment (i.e. size, sector, location, business volume), it also includes very detailed information on the degree to which these establishments were hit by the economic crisis²⁶ (Fischer et al., 2008). As the individual training information for the employees and the establishment information originate from two different sources, I consider both types of information as independent. Thus, I am able to minimize the risk of unobserved third factors that may influence both the training behaviour and the probability of being affected by the crisis (Hochfellner et al., 2015; Popov, 2014).

Another disadvantage of the studies mentioned above is that the underlying data structure or the methodological approaches used are often not appropriate to analyse the real causal effect of the crisis on the training behaviour. Sometimes, only cross-sectional data are available (Popov, 2014) or the observation period is too short. For example, Mason and Bishop (2015) only used a survey carried out in mid-2008 and mid-2009. Thus, an insufficient time period before and after the economic crisis was available. Although the surveys by Felstead et al. (2012) cover a longer period of time, they only reported qualitative statements and simple graphical descriptions in order to illustrate training behaviour before, during and after the crisis. Based on the IAB Establishment Panel, Bellmann et al. (2014) compared yearly changes in establishments' training efforts from 2007 to 2009. Owing to their panel data structure, they are able to apply Difference-in-Differences (Diff-in-Diff) analyses in order to figure out the real effect of the crisis on training.

Following the empirical approach of Bellmann et al. (2014), in this paper I also use Diff-in-Diff analysis as my preferred model. However, in the WeLL-ADIAB data set, individual- as well as establishment-level data are even available from 2006 until 2010. Therefore, in addition to the period during the crisis, I am able to include the individual training behaviour before and after the crisis in my analyses. Furthermore, as already mentioned, by means of the underlying employee–employer data set, I know exactly whether each individual training event has taken place in an establishment that was affected by the crisis or not. As a consequence, this data structure enables me to compare the individual training behaviour not only at various times, but

²⁶ Information regarding the economic crisis is only available from the 2010 wave of the IAB Establishment Panel. In this year, establishments were asked retrospectively whether and how much they were affected by the economic crisis in previous years (Bellmann et al., 2014).

also in different affected establishments. By using Diff-in-Diff estimations, I am able to eliminate unobserved third factors (e.g. changed framework conditions for training) that may influence the training behaviour in all establishments irrespective of the crisis. Therefore, I calculate the causal effect of the crisis and assess whether the establishments' reaction in training activities during the crisis differs for unskilled and skilled employees. Evidence on different reactions in training provision in the crisis therefore allows me to better understand the cost–benefit calculations of training firms.

The paper is organized as follows. Chapter 3.2 provides the theoretical framework and derives the hypotheses. Chapter 3.3 presents the data set and the identification strategy, and Chapter 3.4 outlines the estimation strategy. The results of descriptive and multivariate analyses as well as the robustness checks are shown and discussed in Chapter 3.5. The paper ends with a conclusion in Chapter 3.6.

3.2 Theoretical framework

3.2.1 Background discussion

From a theoretical perspective, there is ambiguity as to whether the crisis leads to higher or lower establishments' training activities. In economically tough times, declines in demand often lead to underutilized capacities. As the loss of working time is low in such a case, this reduces the opportunity costs of further training (Aghion and Saint-Paul, 1998; Brunello, 2009). In addition, the fixed training costs can be spread over a larger number of training participants. In the crisis, the outside options for trained employees are also relatively bad and there is less risk of poaching²⁷. Therefore, the lower exit risk additionally reduces the opportunity costs of training (Felstead and Green, 1996; Mason and Bishop, 2015). As a consequence, establishments have higher incentives to exempt employees from everyday work to participate in training measures. Furthermore, the possibility of participating in training even in these times may contribute to employees' motivation and commitment (Bellmann et al., 2014). Another argument for training activities in times of recession is that qualified employees will be more productive in the following upswing. This in turn enables establishments to achieve additional

²⁷ If an establishment poaches employees away from a training establishment, then training investments are irretrievably lost. However, raiders enhance their establishments' human capital without paying anything for training (Mohrenweiser et al., 2013).

profits (Brunello, 2009). Keeping people in the establishment even in these times instead of dismissing them also saves adjustment costs such as dismissal costs and costs of new hiring and initial training (Horning, 1994; Knudsen and Lien, 2015; Mason and Bishop, 2015; Rosen and Nadiri, 1974). The strategy of labour hoarding in combination with training activities is particularly important in view of the expected shortage of skilled workers and the necessity of retaining qualified employees for the future (Möller, 2010).

However, economic theory also suggests that establishments may reduce training activities in times of crisis. Owing to declining sales and possible credit constraints, establishments must limit their investments in all areas (Bogedan et al., 2009; Mason and Bishop, 2015). Training costs are often very high and their effects and benefits are generally rather hard to assess and may come with a lag (Becker, 1962; Bellmann et al., 2014). Therefore, establishments will tend to invest their limited resources rather in areas where short-term returns can be generated (Bellmann et al., 2014; Popov, 2014). Especially when the duration of the crisis and establishments' future prospects are difficult to predict, it is uncertain whether a return on training can be achieved at all. Training measures only become cost-effective for establishments when the marginal productivity of the trained employees is higher than their wages (Barron et al., 1997a). However, when capacity utilization is not expected to return to pre-recession levels, there may also be lower expectations regarding the impact of training on productivity (Mason and Bishop, 2015; Shury, 2010). In the case of limited commercial activities, the capabilities of trained employees cannot be fully utilized. In addition, there is lower demand for initial training because fewer employees are hired (Brunello, 2009). In consequence, establishments may consider further training as unprofitable and reduce their investments (Muehleman et al., 2009; Stevens, 1994).

Obviously, the impact of the crisis on establishments' training activities depends among others on their future expectations, the degree to which they are affected by the downturn and especially their expected returns on training (Bellmann et al., 2014; Mason and Bishop, 2015). However, the return on training is mainly influenced by individual characteristics of the employees.

Cost-benefit considerations of training often suggest skill levels as key drivers for the provision of training. Higher abilities of the qualified employees lower the training costs (Blundell et al., 1999; Cohen and Levinthal, 1989). This is mainly caused by the well-established cumulative effect of knowledge acquisition. Accordingly, employees with higher levels of knowledge learn more easily (Dierickx and Cool, 1989; Hatch and Dyer, 2004). Also, Card

(1999) and Heckman (1999) emphasize that skilled employees with usually higher education have higher learning abilities in the case of further training. This in turn leads to higher rates of return and higher expected values for trained employees with higher skills²⁸ (Arulampalam and Booth, 2001; Barron et al., 1989). In consequence, it is more profitable for an establishment to train well-qualified employees (Bassanini and Ok, 2007; Kuckulenz and Zwick, 2004). Furthermore, skilled employees are able to adapt more rapidly and efficiently to new tasks and are often the main source of innovation (Blundell et al., 1999). Several studies also show that high average levels of labour productivity in establishments are closely related to a high proportion of skilled employees in the workforce (Blundell et al., 1999; Mason, et al., 1994; Steedman and Wagner, 1989). Thus, skilled employees help to better overcome the crisis and are therefore more likely to be hoarded and trained in establishments in these economically difficult times (Hochfellner et al., 2015; Knudsen and Lien, 2015). In the decision to provide training in the crisis, establishments will also include the fact that less well-qualified employees are often less willing to participate in training (Borghans et al., 2008; Fouarge et al., 2013). This is because most of them have already had negative learning experiences in school and accordingly want to avoid any form of training in later life (Illeris, 2006). Nonetheless, training might be offered to low skilled employees to retain them in the economic upswing (Brunello, 2009). In order to gain deeper and undistorted insights into establishments' training activities in times of crisis, it is essential to take into account the individual characteristics of training participants as well. This could also make it possible to disclose establishments' cost–benefit considerations behind the training decision.

3.2.2 Previous empirical evidence

Most empirical studies on the effect of economically difficult times on establishments' training activities are focused on apprenticeship training. Conducted for different countries and in different periods of time, all studies indicate that establishments rather reduce their training activities in these times. Based on data from the British engineering industry, Stevens (1994) and Hart (2005) find pro-cyclical developments for the employment of apprentices. Also,

²⁸ However, in this context, positive selection issues into training have to be considered. It is difficult to know whether the higher earnings of better qualified employees are caused by their higher education, or whether these employees choose to acquire more training. According to this, the return on training will sometimes be overestimated (Blundell et al., 1999; Card, 1999; Heckman, 1999).

Felstead and Green (1996) report a declining number of apprentices in the recession of the early 1990s in the UK. Westergaard-Nielsen and Rasmussen (1999) find reduced probabilities of having new apprentices for the same observation period in Denmark. Using Swiss firm data, Schweri and Mueller (2007) show that the percentage of apprentice establishments is positively correlated with average GDP. Also for Switzerland, Muehleman et al. (2009) find negative effects of the unemployment rate on new apprenticeship contracts. In a survey of the Norwegian labour market between 1990 and 1996, Askilden and Nilsen (2005) find that the share of apprentices decreases with rising unemployment rates. Observing the same period for the German apprenticeship system, Wagner (1998) also shows that fewer establishments offer apprenticeships in economically difficult times. Dietrich and Gerner (2008) confirm that, in Germany, establishments' training offers react more sensitively to economic downturns compared with upturns.

Although all the previous studies suggest pro-cyclical developments of establishments' apprenticeship activities, the few studies in the context of further training lead to contradicting results. Based on data from the US National Longitudinal Survey of Youth (NLSY), Majumdar (2007) also reveals pro-cyclical training activities for the period from 1979 to 1988. He shows that the probability of receiving training decreases with an increasing local unemployment rate. This relationship is explained by better recruitment possibilities in the labour market and therefore reduced incentives for establishments to provide training. Sepulveda (2004) also uses the NLSY data from 1979 to 1998 but finds counter-cyclical developments in training participation. The training incidence and intensity of on-the-job training and off-the-job training increase with a declining GDP. Using data from 15 European countries, Bassanini and Brunello (2008) also suggest a negative relationship between the proportion of employees participating in training and the economic situation. Bassanini et al. (2007) find higher training activities of establishments in the case of increasing unemployment rates in different European countries. However, all the studies described above refer to a period before the onset of the Great Recession in 2008 and 2009.

Thus, there are only a few studies analysing the effects of the Great Recession in 2008 and 2009 on the establishments' training activities. Based on different data sets and qualitative interviews from the UK, Felstead et al. (2012) find that the crisis had no dramatic negative impact on training provision. Only a minority of establishments reduced spending per head. In many cases, establishments searched for more cost-effective ways of training (i.e. from external to in-house training, usage of e-learning) and adapted these measures to their business needs

(Felstead et al., 2012). In contrast, Popov (2014) stresses that limited access to financial resources and bank credit is associated with significantly lower training investments. Analysing survey data on small and medium-sized establishments from 25 transition economies, he also reveals stronger negative effects in education-intensive sectors and in sectors with good global growth potential (Popov, 2014). Based on the IAB Establishment Panel, Bellmann et al. (2014) find that German establishments reduced their training activities in 2009 – at the peak of the crisis – compared with 2008, independently of whether or not they have been directly affected by the economic crisis. In addition, establishments that have been directly affected by the crisis reduced their training efforts to a much greater extent than other establishments (Bellmann et al., 2014). The studies on the current economic crisis all rather suggest decreasing training activities for this period. However, they do not permit separate observation of training participation for different employee groups. Only Mason and Bishop (2015) show different impacts of the recession for different groups. Based on longitudinal data from Employer Skills Updating Surveys in the UK, they find that the downturn has contributed to reductions in training especially for off-the-job training and for skilled and highly skilled employees. On-the-job training was reduced slightly and rather targeted at employees with identified skill improvement needs (Mason and Bishop, 2015). However, also in this study, the information about training is generated by the establishments.²⁹ Moreover, in the survey, the employers were just asked about training needs³⁰ and not about the actual training participation of their employees. Therefore, employers may have an interest in influencing the reported training statistics to their advantage. For example, establishments that are inherently less likely to provide training may use the crisis as an excuse. All studies dealing with the effects of the crisis on training activities are based on establishment-level data. Therefore, reliable statements about whether the training activities of specific groups of employees with different characteristics were affected by the economic crisis are rather limited.

Hochfellner et al. (2015) provide the only analysis that examines the impact of the recent crisis on establishment – as well as on individual-level outcomes such as earnings, unemployment probability and mobility. Based on a linked employer–employee data set for Germany, they show that unskilled, less educated and less experienced employees are most negatively

²⁹ Initially, the employers had to identify ‘core groups (...) which make the greatest contribution to the success of business’ in the survey (Mason and Bishop, 2015, p.741). The employers were then asked questions regarding the training and updating needs of these core groups. As the core employees in each sector hold a mix of qualifications, it is however hardly possible to clearly assign the training needs to specific groups of qualifications.

³⁰ As the training needs are only indicators of possible future training activities, it is not clear whether these training events ever take place.

affected by financial shocks in the downturn. In contrast, employees in the higher skill categories are able to mitigate these shocks. As a result, the crisis increases the existing income differentials between the employee groups. However, this study does not consider any training information from establishments and employees.

Although all the studies mentioned above provide interesting insights into the training activities of establishments in times of crisis, they also have several drawbacks. In many papers, the underlying data structure or the methodological approach used is not appropriate to analyse causal effects. On the one hand, because of cross-sectional data, the analyses are sometimes rather descriptive. On the other hand, because of short observation periods, often insufficient time periods before and after the crisis are available. As already mentioned, in all studies, training information is reported by the employers. Even in the study by Mason and Bishop (2015), which looks at different groups of employees, the training information came from a single source. Thus, both the training information and the probability of being affected by the crisis are not independent and may be influenced by unobserved third factors. Based on the German linked employer–employee panel data set WeLL-ADIAB, this paper tries to overcome these problems. Furthermore, using individual training information, it analyses the effect of the recent economic crisis on the training behaviour of employee groups with different skill levels.

3.2.3 Hypotheses

Before the data set is presented in more detail, the research hypotheses are derived on the basis of theory and the previous empirical evidence. From the theoretical perspective, it is not clear whether difficult economic times lead to rather higher or lower establishments' training activities. There is empirical evidence for a counter-cyclical development (Sepulveda, 2004) and, in contrast to this, also for a pro-cyclical development (Bassanini et al., 2007; Bassanini and Brunello, 2008; Majumdar, 2007) of training in times of crisis. However, all the studies that have analysed the effects of the recent economic crisis in 2008 and 2009 find negative effects on establishments' individual training activities (Bellmann et al., 2014; Felstead et al., 2012; Mason and Bishop, 2015; Popov, 2014). In addition, at the beginning, the duration and dimensions of the crisis were not foreseeable. Therefore, it was not clear for the establishments what consequences the crisis would have for them and how quickly the economy would recover. I therefore assume:

H₁: When establishments are affected by recession, they reduce the training intensity of their employees.

H₂: When establishments are affected by recession, they reduce the number of training of their employees.

In the context of training decisions, for establishments, cost–benefit considerations are decisive. Training only becomes effective when employees' post-training benefits are greater than their costs and establishments achieve positive rates of return (Barron et al., 1997a; Becker, 1962). Owing to the limited financial resources, this is especially essential in times of crisis. Training theory suggests higher returns of training and higher expected values for skilled training participants (Arulampalam and Booth, Barron et al., 1989, 1999; Card, 1999). Furthermore, because of their better adaptability, skilled employees help to better overcome the crisis (Blundell et al., 1999). According to Hochfellner et al. (2015), less skilled employees are more negatively affected by the crisis and have to endure declines in salary and job losses. With regard to establishments' training activities, I therefore assume:

H₃: When establishments are affected by recession, the negative reaction in training intensity is greater for unskilled employees.

H₄: When establishments are affected by recession, the negative reaction in the number of training is greater for unskilled employees.

3.3 Data and identification strategy

In order to test our hypotheses and to analyse the effect of an exogenous shock such as the Great Recession on the training participation of various groups of employees, we use the German linked employer–employee panel data set WeLL-ADIAB. The data set is based on a survey of 149 establishments that were selected from the 2005 wave of the IAB Establishment

Panel³¹. From these establishments, between 2007 and 2010, 7,352 randomly selected employees were asked in four annual waves³² about their individual training behaviour in previous year(s). This includes information on the start and end dates, the duration as well as the thematic focus of the training measures. An advantage of the data set is the linkage of the individual training information with administrative data at individual and establishment level (Bender et al., 2008a; Spengler, 2007). Thus, in addition to sociodemographic information (e.g. age, sex, educational and vocational qualifications), the complete individual employment history³³ for training participants and non-participants is also available (Schmucker et al., 2014). Furthermore, based on the linkage of individual information with establishment-level data from the IAB Establishment Panel, it is also possible to assign the training information to the establishment where the training took place. In addition to information about the establishment that might be related to training provision (size, sector, location), I also have very detailed information on the degree to which these establishments were hit by the economic crisis (Fischer et al., 2008).

In summary, in this paper, the training information and all individual data come from the employees, and the crisis information originates from the establishments. On the one hand, employees can provide much more detailed and reliable information on their educational and employment biographies as well as on certain training measures. Although the training measures are offered by establishments, it is often unclear to what extent employees participate in them³⁴. On the other hand, separating the source of training data from the source of crisis information also avoids common method bias. Therefore, both indicators can be considered as independent. Another problem is that it is often hard to observe when and how establishments are affected by a recession and how the causality runs between business cycle and training. More specifically, it is usually hard to avoid unobservable third factors such as higher manager

³¹ In the selection process, only establishments from manufacturing or the service industry located in the German federal states of Bavaria, Schleswig-Holstein and North Rhine-Westphalia, Mecklenburg-Western Pomerania and Saxony and with between 50 and 1,999 employees were considered. However, as the selection of establishments did not occur randomly, the data set cannot claim to be representative of the population of German establishments. More detailed information on the selection of establishments can be found in Bender et al. (2008b) and Knerr et al. (2012).

³² The first wave contains the complete training information for the years 2006 and 2007, the second wave the training information for the year 2008, the third wave for 2009 and the fourth wave for 2010.

³³ The employment history includes start and end dates of employment periods, the exact daily wage in the respective periods, further characteristics of employment (e.g. occupation, job status, working time) and unemployment spells. This information has been collected for social insurance reasons by administrative institutions and is therefore highly reliable (Bender et al., 2009; Schmucker et al., 2014).

³⁴ Aggregated training information at establishment level is often inaccurate and error prone. Moreover, in the survey, individuals should not have any incentive to embellish the training education information in their favour. Therefore, the individual information on training seems to be a useful indicator of the establishments' training activities.

quality with better growth opportunities influencing both being hit by a recession and the training behaviour (Popov, 2014). Endogeneity therefore might bias the estimated relationship between a recession and training efforts. In order to avoid this problem, a crisis must be exogenous in the sense that it affects firms independently of their training strategy and other factors related to training behaviour. If this is the case, causal statements can be made about the extent to which the crisis affects establishments' training activities for unskilled and skilled employees.

A crisis can be characterized by the fact that it is often the result of unanticipated changes in the environment, such as bursting bubbles in the property or stock market or dramatic changes in commodity prices. Thus, the beginning of such a crisis can be seen as an exogenous shock for establishments and the entire economy (Knudsen and Lien, 2015). In addition, a recession is temporary³⁵, and establishments know that it will be over sooner or later (Koberg, 1987). Since the Great Recession in 2008 and 2009 was triggered by the collapse of the US real estate market and the bankruptcy of Lehman brothers – what was unpredictable – it also can be seen as an exogenous shock.

Previous empirical studies investigating the impact of the current financial crisis use different identification strategies. Felstead et al. (2012) as well as Mason and Bishop (2015) identify the crisis by means of time. They assume that 2008 is a pre-crisis period, 2009 during the crisis and 2010 after the crisis. However, both studies do not differentiate between affected and unaffected establishments. Furthermore, they are not able to rule out that both types of establishments' training efforts as well as the involvement in the crisis may be influenced by unobservable third factors (Popov, 2014). In order to avoid this endogeneity problem, Popov (2014) and Hochfellner et al. (2015) apply Diff-in-Diff approaches. In addition, Hochfellner et al. (2015) exploit an institutional feature of the German banking system to identify a control group that serves as a plausible counter-factual. Only some of the regional Landesbanks speculated in US mortgage-backed securities and lost millions when the market collapsed. As a result, savings banks in these states were forced to provide capital to them. As establishments depend heavily on bank capital provided by savings banks, they have had to accept severe credit restrictions (Schmidt et al., 1999). Despite this convenient empirical setting, however, it is unclear whether all establishments in these states are affected by the crisis. To identify affected establishments, Bellmann et al. (2014) therefore use information from the 2010 wave of the

³⁵ This distinguishes a recession from a technological shock that leads to permanent changes in the economy (Knudsen and Lien, 2015).

IAB Establishment Panel. Based on self-assessments, establishments were asked whether and to what extent they were affected by the recent economic crisis.

By linking the data set Well-ADIAB with the IAB Establishment Panel, Bellmann et al.'s (2014) identification strategy can also be applied in this study. Based on the explicit questions 'have you been affected by the economic crisis in the last two years?' and 'were the effects on your establishment predominantly negative?', I calculate a dummy variable that is equal to one if the establishments agree to both questions; otherwise, the crisis dummy is 0. In the 2010 wave of the Establishment Panel, there are a total of 78 establishments³⁶ with information about the crisis. Of these, 40 establishments³⁷ claimed that they had been negatively affected by the crisis and are therefore henceforth referred to as crisis establishments. Another 30 companies stated that they were not affected by the crisis and are referred to in this study as non-crisis establishments³⁸. As the training activities in all 70 establishments can be considered over time, it is possible to examine whether crisis establishments actually reacted differently in times of crisis in 2008 and 2009 compared with non-crisis companies. In the survey, the companies were asked about the crisis retrospectively in 2010. Therefore, they should no longer have had any incentive to make false statements at that time, and the crisis information can be considered as reliable.

In addition, I test and compare the classification of crisis and non-crisis establishments with other crisis indicators. Applying the identification strategy of Hochfellner et al. (2015), most of the establishments in the states in which the regional Landesbanks were affected also claimed to be affected by the crisis in the underlying data set. Furthermore, I compare the business expectations of crisis and non-crisis establishments over time. Although there are no differences in 2006, 2007 and 2010, more crisis establishments expected a negative development of business volume, especially in 2008 and 2009. Thus, the conducted classification of crisis and non-crisis companies seems to be robust in comparison with other indicators. As in Bellmann et al. (2014) and Hochfellner et al. (2015), crisis establishments have fewer employees and are found especially in manufacturing industry. Due to the data protection agreement of the

³⁶ Questions concerning the crisis are available only in the 2010 wave of the IAB Establishment Panel. Therefore, from the original 149 WeLL establishments, only those 78 that took part in the 2010 survey can be considered.

³⁷ Basically, the classification of the establishments is fixed and does not change over time. However, 11 of these 40 companies reported that they had overcome the crisis in 2010. Therefore, in the underlying data structure, these establishments switch from crisis to non-crisis establishments in the year 2010. The other establishments keep their status.

³⁸ The remaining eight establishments were eliminated from the sample because they indicated that they had been affected both positively and negatively by the crisis.

IAB no descriptive results can be presented at the operational level for both crisis and non-crisis establishments³⁹.

Of the 40 crisis and 30 non-crisis establishments, there is detailed information from 2,398 employees altogether. Only employees with jobs covered by social security contributions⁴⁰ are included in the sample. Furthermore, in order to obtain a homogeneous sample, I eliminate 442 employees who were affected by short-time work⁴¹. Thus, the sample consists of 5,983 observations from 1,956 individuals employed in 70 establishments. For the analysis, I use the longitudinal version of the WeLL-ADIAB data set between 2006 and 2010. Therefore, in addition to the period during the crisis, it is possible to include training activities and other individual-level and establishment-level information before and after the crisis in my analyses. By means of the underlying employee–employer data set, I also know exactly whether training measures for skilled and unskilled employees have taken place in an establishment that was affected by the crisis or not.

3.4 Estimation strategy

The main goal of this paper is the identification of the causal effect of the crisis on establishments' individual training activities. In addition to the appropriate data structure, this also requires the application of the corresponding estimation strategy. The training activities of individuals must be compared not only between crisis establishments and non-crisis establishments, but also before, during and after the crisis. An experimental design such as the Difference-in-Differences specification (Diff-in-Diff) would achieve such a comparison. From a methodological point of view, the basic developments of the control group are subtracted from the developments of the treatment group, which is influenced by the treatment. In this way, distortions between control and treatment group resulting from fundamental differences in both groups as well as distortions resulting from temporal trends can be removed (Angrist and Pischke, 2009; Wooldridge, 2009). Therefore, the Diff-in-Diff estimation makes it possible to

³⁹ According to the data protection agreement of the IAB, results based on less than 20 observations may not be published. This would partially apply to the description of crisis and non-crisis establishments.

⁴⁰ Therefore, apprentices, people in internships and employees in partial retirement have been excluded from the sample.

⁴¹ As training is often offered in conjunction with short-time work, in this case, establishments' training decisions are based on other than the usual cost–benefit considerations. However, to ensure that short-time work does not bias the results, I conduct an additional analysis with short-time work as a robustness check in Chapter 3.5.3.

examine whether employees' training activities in crisis establishments are more strongly affected in the crisis than those of employees in non-crisis establishments and to what extent. In addition, it must be ensured that the differences in training activities between affected and unaffected establishments must have been caused by exogenous and random shocks. As already described in the identification strategy, the Great Recession can be seen as an exogenous and random shock for establishments and the training activities of their employees. By using the Diff-in-Diff approach and the identification strategy, it is therefore possible to control for endogeneity and time-invariant unobserved heterogeneity (e.g. higher manager quality) between crisis and non-crisis establishments. Using i to index an individual, j an establishment and t the time, I specify the following estimation model:

$$y_{ijt} = \beta_0 + C_{ij} * T'_t \beta_1 + C_{ij} \beta_2 + T'_t \beta_3 + X'_{ijt} \beta_4 + Z'_{ijt} \beta_5 + \varepsilon_{ijt}$$

This is the first paper to use individual training information to analyse the effect of an exogenous shock such as the Great Recession on the training participation of employees. More precisely, I use the intensity of training and the number of training as indicators. In previous empirical studies, the intensity is measured using a training dummy, which indicates establishments' provision of training in the respective year (Bellmann et al., 2014; Mason and Bishop, 2015; Popov, 2014). Focusing on the individual perspective in this paper, the dependent binary variable y_{ijt} takes the value of 1 if an employee i participates in training offered by the training establishment j in the respective year t . Otherwise, the variable takes the value 0. As it is not clear in this case whether the employee participates in one or more training measures, in addition to the intensity, I take the number of individual training measures⁴² per year into account. For the research question, it is important to know when and in which establishment the training measure took place. Therefore, I eliminate all training measures that have no detailed information concerning their start and end dates and that could not be clearly assigned to an establishment (126 eliminations). In addition, I only consider training measures that are financed (at least partially) by the establishment. Brunello (2009) suggests that training measures with different durations will be affected differently by the crisis. However, this information is poorly filled out in the present survey and therefore cannot be considered⁴³.

⁴² In order to ensure consistency, I limit the maximum number of training measures per year to 12 and delete four observations with additional information.

⁴³ Also, detailed information such as training hours, training costs and thematic focus provide no satisfactory results and are therefore not considered in more detail.

To identify the causal effect of the crisis on training, information on two independent variables in the estimation equation are of particular interest. First, the binary variable C_{ij} , which indicates whether an establishment was hit by the economic crisis ($C_{ij} = 1$) or not. Second, the binary variable T'_t , which reflects the normal differences in training activities over time. T'_t is a vector of time dummies for the years 2006 to 2010 including the year 2006 as reference category. The interactions of all variants of the two variables $C_{ij} * T'_t$ can be interpreted as the differences in the development of individual training activities over time between employees in crisis and non-crisis establishments⁴⁴. In the present case, there are four Diff-in-Diff dummies: the interactions of the years 2007 to 2010 with the crisis dummy C_{ij} in each case. Given the exogenous shock of the crisis, prior to the occurrence of this shock, the development of training measures should be the same between both groups. In order to verify this identification assumption, a placebo test should indicate no significant interaction effect for the pre-crisis period (Bellmann et al., 2014).

In addition to the crisis information, further individual- and establishment-level characteristics are considered in the estimation equation that may influence training participation and the likelihood of being affected by the crisis simultaneously. Being uncontrolled, they could distort the coefficients of interest. Empirical evidence suggests lower training participation especially for women and older employees with higher tenure and work experience (Blundell et al., 1996; Picchio and Van Ours, 2013). In contrast, qualified employees have a higher probability of participating in training (Arulampalam and Booth, 2001; Card, 1999; Gritz, 1993). In addition, it is known that qualified employees with higher work experience are less affected by the crisis (Hochfellner et al., 2015). Therefore, the individual characteristics vector X'_{ijt} includes the variables gender, age, qualification level, tenure and work experience⁴⁵. Studies focusing on establishment-level determinants of training find that especially employees in larger establishments have a higher probability of receiving training. Furthermore, the sector and the location of the establishment also have an impact on the likelihood of training (Bellmann and Gerner, 2011; Gerlach and Jirjahn, 2001; Holtmann and Idson, 1991; Lynch, 1991). At the same time, these establishment characteristics may also influence the likelihood of being affected by

⁴⁴ The usual set up for a Diff-in-Diff estimation is to consider one control and one experimental group at two points in time. The treatment group is exposed to a treatment in the second period, whereas the control group is never exposed to a treatment.

⁴⁵ Age is measured as a cohort effect for the following birth year groups: birth year before 1951, between 1952 and 1961, between 1962 and 1971 and after 1972. Qualification level is captured by the categories: without vocational education, with vocational education and with university degree. For the two variables tenure and work experience, in each case, I use the classification less than 10 years, between 10 and 20 years and more than 20 years of tenure or experience.

the crisis and may distort the crisis dummy in the equation. Bellmann et al. (2014) and Möller (2010) find that the crisis mainly affects larger establishments from the manufacturing sector. To consider these aspects, the establishment characteristics vector Z'_{ijt} includes the variables establishment size, sector and location⁴⁶. ε_{ijt} reflects an idiosyncratic error term.

I estimate the regression model separately as a linear probability model with the intensity of training and as a linear regression with the number of training measures as dependent variable by OLS. In the basic analysis, both regressions are performed for the same sample. In order to gain insights into whether employees with specific characteristics are affected differently by the economic crisis, the sample is also subdivided into skilled and unskilled employees. However, as individuals with lower school-leaving qualifications can also pursue a better profession later on, the subdivision is made concretely on the basis of the variable ‘position in the job (stib⁴⁷)’. For the separate samples, I estimate identical regression models for each training indicator. In addition, I compare the coefficients of interest in the two samples using a Chi² test. In all analyses, the standard errors were adjusted using a robust, cluster-adjusted sandwich estimator (Bellmann et al., 2014). As clustering is carried out at the individual and the establishment level, it is possible to control for correlated observations within the individuals and the establishments (Moulton, 1990).

⁴⁶ As a result of the selection process, only establishments from manufacturing and the service industry with a maximum of 1,999 employees were available in the data set. The establishment size is classified as less than 199, between 200 and 499 and between 500 and 1,999 employees. The location is captured with a dummy, indicating Western or Eastern Germany.

⁴⁷ In the group of unskilled employees are workers who do not work as skilled workers. The group of skilled employees includes skilled workers, master craftsmen and foremen as well as white-collar workers. Subdividing the sample according to qualification levels produces similar results.

3.5 Findings

3.5.1 Descriptive statistics

Table 3.1 shows descriptive sample characteristics of individuals employed in crisis and non-crisis establishments. Most participants are male (64.62%), born between 1952 and 1971 (61.62%) and have at least a vocational education (94.55%). Although 78.63% have more than 10 years of professional experience, only 53.48% have been working in the same establishment for more than 10 years. Looking at the personal characteristics of employees in crisis and non-crisis establishments, there are only a few differences between the two groups. Significantly fewer women and university graduates are employed in crisis establishments. However, this is probably because the affected establishments are more likely to be in the manufacturing sector (cf. Table A3.1), where the proportion of women and university graduates is lower by nature. In addition, employees in non-crisis establishments have a slightly higher income. In contrast, there are hardly any differences in terms of the other personal characteristics of age, professional experience and tenure between the establishment groups.

Employees in non-crisis establishments have a higher probability of participating in further training (70.29%) and a higher average number of training measures (1.37) per year than employees in crisis establishments (60.89%/1.11). Figure 3.1 shows the development of training intensity and the number of training measures over the entire observation period. In principle, a declining trend can be observed for both indicators in all establishments. For employees in non-crisis establishments, the probability of participating in training declines slightly in 2008 and otherwise remains constant between 2006 and 2009. However, there is a decline in the year 2010. In contrast, there is a sharp and continuous decline in the training probability for employees in crisis establishments from 2008 onwards. A similar picture is evident for the development of the second training indicator in all establishments. Whereas the number of training measures for employees in non-crisis establishments in 2008 and 2009 only declines slightly and then more sharply in 2010, employees in crisis establishments again experience strong and continuous declines from 2008 until 2010. Thus, the training activities of employees in crisis-affected establishments are more negatively affected than those of employees in unaffected establishments.

Table 3.1: Description of differences of employees in crisis and non-crisis establishments

Sociodemographic factors	Total	Crisis establishments	Non-crisis establishments	t-values
	%	%	%	
Female	35.38	23.31	41.72	14.49***
<u>Birth year</u>				
≤ 1951	14.67	13.67	15.20	1.63
1952–61	34.41	35.56	33.80	–1.37
1962–71	27.21	28.52	26.51	–1.67*
≥ 1972	23.71	22.25	24.49	1.93*
<u>Experience</u>				
< 10 years	21.37	19.44	22.39	2.67***
10–20 years	48.64	51.89	46.92	–3.68***
> 20 years	29.99	28.67	30.69	1.63
<u>Tenure</u>				
< 10 years	46.52	46.86	46.34	–0.39
10–20 years	39.06	41.46	37.80	–2.78***
> 20 years	14.42	11.68	15.86	4.41***
<u>Education</u>				
No voc. education	5.45	5.36	5.50	–0.22
Vocational education	56.58	60.89	54.29	–4.90***
University degree	37.97	33.75	40.21	4.91***
Log daily wage	4.63	4.58	4.64	5.21***
Training intensity	67.05	60.89	70.29	7.44***
Number of training	1.28	1.11	1.37	6.48***
Observations	5,983	2,089	3,894	
Individuals	1,956	734	1,222	
Establishments	70	40	30	

(Log) daily wage is measured as the logarithmic weighted daily wage; Number of training: number of training measures per year; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level.

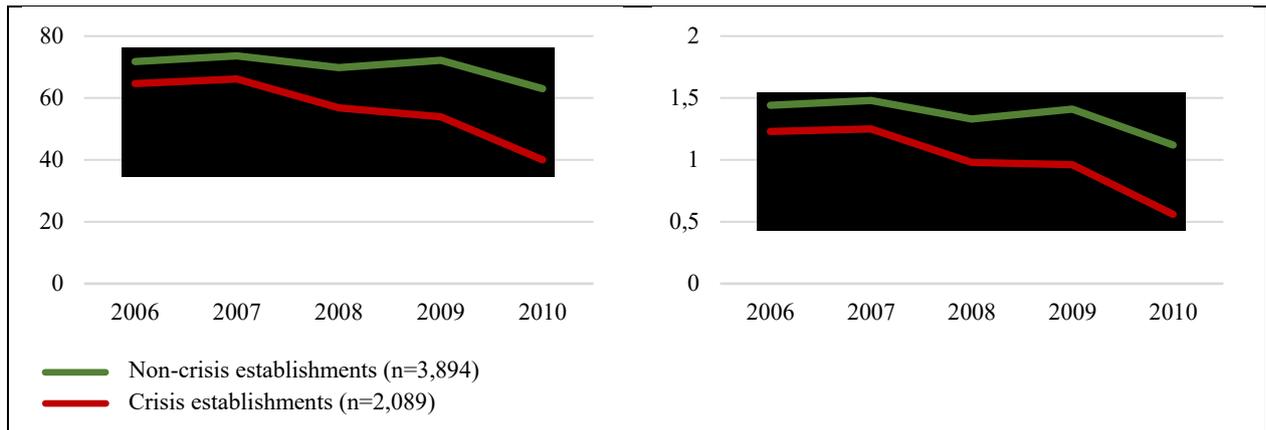


Figure 3.1: Development of the training intensity in % (left) and the number of training measures (right) in crisis and non-crisis establishments. Standard errors are included

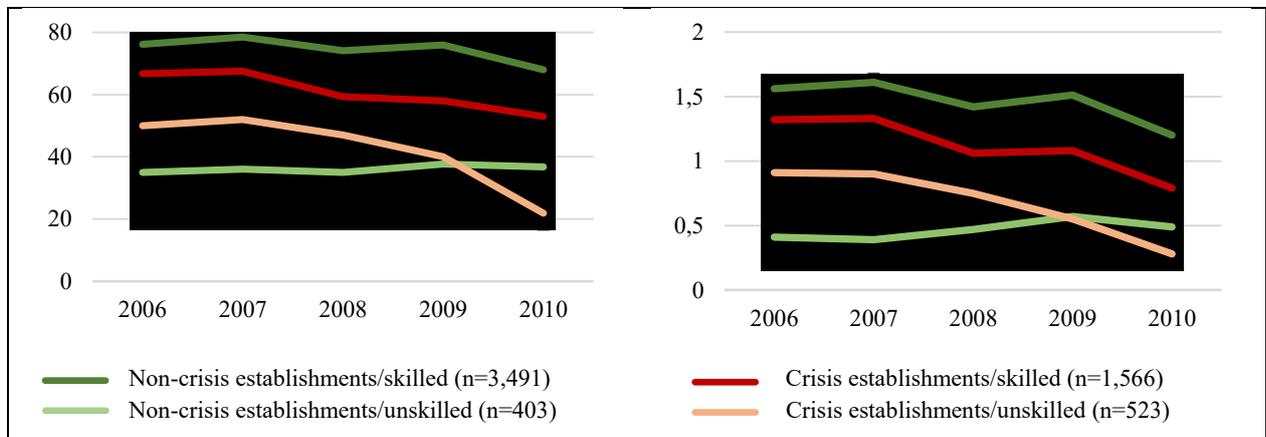


Figure 3.2: Development of training intensity in % (left) and the number of training measures (right) separated by skill groups in crisis and non-crisis establishments. Standard errors are included

Taking the skill levels of the employees into account in Figure 3.2, differences in training activities are also evident here. As expected, skilled employees have a significantly higher probability of participating in training as well as a higher average number of training measures in both crisis and non-crisis establishments. Differences between skill groups are larger in non-crisis than in crisis establishments, but converge over time. Considering the training intensity of skilled employees, a stronger negative effect can be observed in crisis establishments, especially in 2008 and 2009. Otherwise, the development in both establishment groups is relatively identical. A completely different picture can be seen for the development of training intensity among unskilled employees. Whereas unskilled employees in the non-crisis establishments even experience a slight increase in the training intensity from 2008 to 2009 and remain relatively constant in 2010, the picture for unskilled employees in crisis companies is exactly the

opposite. Although they have a higher probability of participating in training before the crisis, this declines since 2008 and collapses sharply in 2009 and 2010.

The number of training measures for skilled employees also declines in both crisis and non-crisis establishments, but with slightly more negative tendencies in crisis establishments from 2008 onwards. In the case of unskilled workers, again, the number of training measures in affected establishments is higher than in unaffected establishments before the crisis, but declines sharply from 2008 onwards. In contrast, the number of training measures for unskilled employees in non-crisis establishments remains relatively constant over time. All in all, both for skilled and especially for unskilled employees, there is a stronger negative effect on training in establishments that indicated they are affected by the crisis.

Consideration of the control group (non-crisis establishments) makes it possible to take account of effects that are not attributable to the crisis. By deducting these effects from the training development in the treatment group (crisis establishments) and comparing it before, during and after the crisis, I succeed in determining the causal effect of the crisis on training participation.

3.5.2 Multivariate analyses

For this purpose, I apply a Diff-in-Diff estimation and control for additional individual and establishment characteristics in the multivariate analyses. The regression output in Table 3.2 shows the impact of different determinants on the probability of participating in training (model 1) and on the number of training measures (model 2). The main focus is on the interaction terms of crisis dummy and years, which indicate the concrete effect of the crisis on both training indicators over time.

Table 3.2: Determinants of the training intensity and the number of training

Dependent variable:	Training dummy	Number of training
	(1)	(2)
	Diff-in-Diff	Diff-in-Diff
Crisis * Year 2007	-0.003 (0.013)	-0.009 (0.029)
Crisis * Year 2008	-0.053* (0.032)	-0.106 (0.092)
Crisis * Year 2009	-0.117*** (0.039)	-0.266** (0.114)
Crisis * Year 2010	-0.193*** (0.068)	-0.488*** (0.132)
Year 2007	0.016** (0.008)	0.022 (0.020)
Year 2008	-0.031* (0.018)	-0.165*** (0.060)
Year 2009	-0.002 (0.021)	-0.047 (0.069)
Year 2010	-0.142*** (0.026)	-0.473*** (0.072)
Crisis (treatment)	0.030 (0.027)	0.141 (0.121)
Individual characteristics	Yes	Yes
Establishment characteristics	Yes	Yes
R ²	0.091	0.099
Observations	5,983	5,983

Dependent variables: training intensity (model 1), number of training (model 2); further individual characteristics: qualification, tenure, professional experience, age, gender; establishment characteristics: size, location, sector. Standard errors based on a robust cluster-adjusted sandwich estimator given in parentheses; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

The results for model 1 show no significant Diff-in-Diff effect for the pre-crisis period in 2007. Thus, the identification assumption is fulfilled that, without a crisis, at least the training behaviour for employees in crisis and non-crisis establishments is the same, and the Diff-in-Diff approach identifies the causal direct crisis effect (Bellmann et al., 2014)⁴⁸. However, there is an additional decline in training intensity by 5.3 PP (PP) in 2008 and 11.7 PP in 2009 for individuals employed in crisis establishments. In addition, I even find a significantly negative Diff-in-Diff effect for the post-crisis period in 2010 (-19.3 PP). Hence, employees in affected

⁴⁸ This assumption can be identified by the placebo test, which is given when the Diff-in-Diff coefficient is insignificant and irrelevant in the period before treatment. This method serves as an alternative for more data-intensive approaches such as matching (Bellmann et al., 2014).

establishments suffer greater losses in training intensity between 2008 and 2010 than in non-crisis establishments. This effect can be interpreted as the direct causal crisis effect. Therefore, I find support for the first hypothesis. Significant year dummies in 2008 and 2010 indicate a decline in training intensity for employees in all establishments irrespective of whether they were directly hit by the crisis or not – an effect that can be labelled as trickle-down or an indirect crisis effect (Bellmann et al., 2014). The insignificant crisis dummy indicates no principal differences in the training participation of employees in the treatment group (crisis establishments) and the control group (non-crisis establishments). Furthermore, Table A3.1 in the Appendix, which reflects detailed estimation results, shows that especially qualified employees with higher professional experience and lower age have a higher training intensity. In addition, employees from larger companies and from the service sector tend to participate more in training.

Results for model 2 suggest similar effects of the crisis on the number of training measures. Again, there is a basic negative effect for employees in all establishments for the years 2008 and 2010. Beyond this effect, significantly negative Diff-in-Diff effects for the years 2009 (-0.266) and 2010 (-0.488) indicate that the decline in the number of training measures is greater for employees in crisis establishments than in non-crisis establishments. This supports the assumption of the second hypothesis. Effects of further individual and establishments characteristics are quite similar to the first training indicator. The results therefore confirm the empirical evidence of Popov (2014) and Bellmann et al. (2014). However, in addition to their results, I find a negative significant direct crisis effect for the year 2010. Thus, although the tense situation relaxed somewhat in 2010 because of the economic upswing, all establishments rather decide to hold back their training investments nevertheless. The delayed effect of the crisis in 2010 could be because training measures are often planned on a longer-term basis. Many measures could already have been booked at the beginning of the crisis and could not be cancelled at short notice. Möller (2010) also shows that the development of employment follows the business cycle with a certain time lag.

In the next step, I analyse whether the training activities of employees with different skill levels are affected differently by the crisis. For this purpose, I first look at the effects on training intensity (Table 3.3) and then on the number of training measures (Table 3.4) separately for unskilled and skilled employees.

Table 3.3: Determinants of the training intensity separated by skill groups

Dependent variable	Training dummy		Differences (Chi ² test)
	Unskilled employees	Skilled employees	
	(1)	(2)	
Crisis * Year 2007	0.051 (0.038)	-0.014 (0.013)	2.68 (0.102)
Crisis * Year 2008	-0.054 (0.082)	-0.048 (0.036)	0.00 (0.946)
Crisis * Year 2009	-0.215** (0.100)	-0.081* (0.042)	1.56 (0.212)
Crisis * Year 2010	-0.427*** (0.123)	-0.024 (0.086)	7.40*** (0.007)
Year 2007	0.002 (0.025)	0.020** (0.008)	0.77 (0.380)
Year 2008	-0.017 (0.059)	-0.030 (0.019)	0.05 (0.828)
Year 2009	0.062 (0.072)	-0.012 (0.022)	0.96 (0.327)
Year 2010	0.060 (0.081)	-0.156*** (0.027)	6.63*** (0.009)
Crisis (treatment)	0.213*** (0.070)	-0.019 (0.030)	9.54*** (0.002)
Individual characteristics	Yes	Yes	
Establishment characteristics	Yes	Yes	
R ²	0.122	0.057	
Observations	926	5,057	

Dependent variables: training intensity; separate analysis for skill groups; further individual characteristics: qualification, tenure, professional experience, age, gender; establishment characteristics: size, location, sector. Standard errors based on a robust cluster-adjusted sandwich estimator in parentheses; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

Results in Table 3.3 show that the crisis reduces the probability to participate in training for unskilled individuals additionally by 21.5 PP in 2009 and 42.7 PP in 2010. In contrast, there is only a slight negative effect on training intensity for skilled employees of 8.1 PP in the year 2009 and hardly any negative Diff-in-Diff effect in 2010 (–2.4 PP, not significant). Furthermore, the Chi² test indicates that the coefficients of both skill groups are significantly different in the year 2010. Thus, the findings suggest a stronger negative direct effect of the crisis on training intensity for unskilled employees than for employees with a higher skill level. Therefore, the third hypothesis can be confirmed. As already evident from the descriptive results, the significant crisis coefficient in model 1 basically implies a higher training intensity for unskilled

employees in crisis establishments. In addition, there is also an indirect negative crisis effect for skilled employees in all establishments in 2010.

Table 3.4 shows the impact of the crisis on the number of training measures for unskilled and skilled employees. As with training intensity, the crisis had a significant additional negative effect on the number of training for unskilled employees in 2008 (-0.279), 2009 (-0.452) and especially in 2010 (-0.936). In contrast, there is a significantly negative Diff-in-Diff effect for skilled employees only in 2009 (-0.216). Thus, the Chi² test again suggests significantly different Diff-in-Diff coefficients for the year 2010. Consequently, as the crisis has a greater impact on the number of training measures for unskilled than for skilled employees, the fourth hypothesis can be confirmed. Further individual- and establishment-level determinants for both training indicators are robust to the overall view and can be found in the complete tables in Appendices A3.2 and A3.3. To summarize, there is a stronger negative effect of the crisis on the training intensity for unskilled employees than for employees with higher skill levels. Furthermore, the negative effect of financial constraints on training efforts sets in with a time lag and also lasts until the year 2010.

Table 3.4: Determinants of the number of training separated by skill groups

Dependent variable	Number of training		Differences (Chi ² test)
	Unskilled employees	Skilled employees	
	(1)	(2)	
Crisis * Year 2007	0.071 (0.063)	-0.028 (0.032)	2.03 (0.155)
Crisis * Year 2008	-0.279* (0.158)	-0.091 (0.104)	1.00 (0.316)
Crisis * Year 2009	-0.452** (0.203)	-0.216* (0.128)	0.99 (0.320)
Crisis * Year 2010	-0.936*** (0.228)	-0.249 (0.178)	5.76** (0.016)
Year 2007	0.005 (0.037)	0.036 (0.022)	0.89 (0.346)
Year 2008	-0.099 (0.102)	-0.186* (0.106)	5.64** (0.018)
Year 2009	0.194 (0.118)	-0.091 (0.074)	4.24** (0.039)
Year 2010	0.129 (0.128)	-0.509* (0.276)	18.80*** (0.000)
Crisis (treatment)	0.511*** (0.132)	-0.065 (0.095)	8.57*** (0.003)
Individual characteristics	Yes	Yes	
Establishment characteristics	Yes	Yes	
R ²	0.114	0.067	
Observations	926	5,057	

Dependent variables: number of training; separate analysis for skill groups; further individual characteristics: qualification, tenure, professional experience, age, gender; establishment characteristics: size, location, sector. Standard errors based on a robust cluster-adjusted sandwich estimator in parentheses; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

3.5.3 Robustness checks

In order to control that the results are not influenced by the division of the sample, a common regression equation with triple interaction terms is calculated as a robustness check. For this purpose, all four Diff-in-Diff interaction terms ($C_{ij} * T'_t$) are additionally interacted with a binary variable that takes the value of 1 if individuals are unskilled. Thus, the triple interaction terms (Difference-in-Difference-in-Differences) in Table A3.4 in the Appendix imply the additional effects of the crisis for unskilled in comparison to skilled employees between

2007 and 2010. This approach also avoids possible distortions caused by the unequal distribution of the qualification structure between crisis and non-crisis establishments. As with the division of the sample, the results in Table A3.4 again show stronger negative effects for the unskilled employees. The crisis reduces the intensity of training for unskilled employees additionally by 14.2 PP in 2009 (however, not significantly) and even by 42.9 PP more in 2010 than for skilled employees in non-crisis establishments. Additional negative effects of the crisis for unskilled employees are also evident in the number of training measures. However, again the triple Diff-in-Diff effect is only significant in 2010 (-0.673). In addition to the direct causal effect of the crisis, again there is a trickle-down effect for all employees, which gets stronger over time and is particularly negative in 2010. Therefore, the training activities of individuals are also declining regardless of whether or not their establishments were affected by the crisis. In addition to the improved clarity of the tables, the separate analysis thus achieves the same results.

As already explained, individual characteristics such as experience, tenure and especially the level of qualification are often decisive for establishments' training offers (Arulampalam and Booth, 2001; Blundell et al., 1996; Picchio and Van Ours, 2013). Results in this paper suggest that the training activities of the unskilled, who naturally receive less training, were also more affected by the crisis compared with skilled employees. However, it must be ensured that the impact of the crisis is mainly driven by different skill levels and not by further characteristics. Therefore, in further robustness checks, I analyse whether there are additional heterogeneities in training activities for other employee groups than those based on skill levels. For this purpose, employee groups are classified according to experience⁴⁹, age and gender. The extent to which the crisis has an impact on the number of further training measures is considered separately for the individual groups. As the results in Table A3.5 in the Appendix show, there is no pattern regarding the impact of the crisis on training in groups classified by experience. Training activities of employees with medium experience (10–20 years) are the most affected by the crisis. In contrast, there are no significant Diff-in-Diff effects for the other subgroups. There is also no pattern for the different age groups with regard to the impact of the crisis (cf. Table A3.6). On the one hand, the negative Diff-in-Diff interactions increase with decreasing age but, on the other hand, there is the lowest crisis effect among the youngest. Finally, there

⁴⁹ For the employee groups, according to experience I use the classification less than 10 years, between 10 and 20 years and more than 20 years of experience. According to age, I use the classification: birth year before 1951, between 1952 and 1961, between 1962 and 1971 and after 1972.

The model based on tenure cannot be identified because of a lack of observations in several subgroups of tenure. However, the findings should be similar to those of experience.

are no gender-specific differences in the effects of the crisis on the number of training courses (cf. Table A3.7)⁵⁰.

In the analyses carried out so far, the sample has been reduced by employees who attend short-time work. As training in the crisis was often offered in conjunction with short-time work, establishments' training decisions were based on other than the usual cost–benefit considerations. In order to ensure that the range of training opportunities offered in the crisis was not driven by short-time working arrangements, my last robustness check also includes employees who attended short-time work. The results in Table A3.8 in the Appendix confirm the previous findings. Again, there is a significantly negative impact of the crisis on training intensity and the number of training measures in the years 2009 and 2010. As the results are thus robust, short-time work does not affect the results.

3.6 Conclusion

The objective of this paper is to determine the causal effect of the crisis on the training activities of different employee groups. From a theoretical point of view, an ambiguity can be ascertained, as there are arguments that establishments both increase as well as decrease or keep their training efforts constant in these difficult economic times (Bellmann et al., 2014). The few already existing empirical studies rather indicate a counter-cyclical development of training (Bellmann et al., 2014; Felstead et al., 2012; Mason and Bishop, 2015; Popov, 2014). However, there is no empirical evidence regarding the individual training behaviour of certain employee groups. Based on a unique German linked employer–employee panel data set, this paper seeks to fill this gap. Using Diff-in-Diff analyses, I avoid endogeneity problems caused by unobservable third factors (e.g. manager quality) that otherwise influence both the training activities and the probability of being hit by the recession (Hochfellner et al., 2015; Popov, 2014). Furthermore, by separating the source of training data from the source of crisis information and considering both indicators as independent, I avoid common method bias. Moreover, as the so called Great Recession in 2008 and 2009 can be seen as an exogenous and time-limited shock, this quasi-experimental setting helps to reveal the causal impact of the crisis on training intensity and the number of training measures. In addition, I also consider that the establishments'

⁵⁰ In addition, I have also examined in detail the effects of the crisis in various task categories (Antonczyk et al., 2009) and have not gained any new insights.

training provision often also depends on the skill level of the employees. This allows me to assess whether the establishments' reaction in training activities during the crisis differs for unskilled and skilled employees.

In summary, I observe two different effects of the crisis. On the one hand, there is an indirect effect called a trickle-down effect. According to this, the training activities for all employees are reduced regardless of whether they work in establishments affected by the crisis or not. This could be an indication that it was also the general economic situation that contributed to the reduction and not only the individual involvement of the establishments. On the other hand, I find a direct effect of the crisis on individual training activities in 2009 and 2010. Thus, there are additional and stronger declines in training activities for employees in establishments hit by the crisis than for employees in unaffected establishments. This is especially true for unskilled employees. Although there is only a slight direct negative effect of the crisis on skilled employees in 2009, I observe a much greater negative impact for unskilled employees even between 2008 and 2010. Obviously, credit constraints and demand reductions hit the training of unskilled employees harder than that of their more highly skilled colleagues. Lower returns in training and a reduction in the expected tenure and therefore in the expected value of unskilled employees may be possible reasons (Arulampalam and Booth, 2001; Barron et al., 1989, 1999; Card, 1999). Arguments such as lower opportunity costs for training in times of crisis or worse outside options do not seem to play such a decisive role. However, the indirect negative crisis effect must also be considered. As can already be seen from the training development in Figure 3.2 in Chapter 3.5.1, this negative trend is evident in all groups except for unskilled employees in unaffected establishments. As this is not plausible at first glance, I also consider descriptively which types of training the two groups have participated in (cf. Table A3.9 in the Appendix). As is to be expected, the unskilled employees tend to take part in measures offered within the establishment that are shorter and less expensive⁵¹. Consequently, these measures can be maintained and, if necessary, adjusted even in tough economic times. This applies in particular to establishments that were not affected by the crisis. Mason and Bishop (2015) also show in their study that, in some cases, establishments maintain training measures especially for their operations staff in times of crisis. Based on the results, I also find out that establishments reduced their training measures, especially in 2010, regardless of whether they were affected by the crisis or not. Taking into account the severity of the crisis, it can be assumed that

⁵¹ As already explained, I also tried to analyse the effects of the crisis on the different types of training and in combination with the different skill levels. However, this does not lead to meaningful results on account of poorly completed information.

even establishments that do not claim to have been directly affected have considered the economic situation and future prospects to be difficult and have restrained their training decisions (Bellmann et al., 2014). Furthermore, training measures are usually booked well in advance and cannot be cancelled at short notice, which again explains the delayed effect in 2010.

However, there are also some limitations in this paper that should be mentioned. On the one hand, numerous observations are lost because of the elaborate generation of the quasi-experimental design and the linking of the individual data sets. On the other hand, much important information in the data set is barely filled out. Therefore, a combined analysis of the different skill groups with the types of continuing education is lacking in sufficient observations. In addition, the data set is limited to certain sectors (service and manufacturing sector) and certain federal states (e.g. Bavaria, North Rhine-Westphalia, etc.). Therefore, the representativeness of the results has to be examined critically in some cases. Furthermore, this does not allow a review of the results based on alternative identification strategies (e.g. Hochfellner et al., 2015). Nevertheless, this study succeeds in providing valuable insights into the cost–benefit considerations of individual training activities in difficult economic times on which further research can be built.

4 INSTITUTIONAL ISOMORPHISM AND EXECUTIVE COMPENSATION IN GERMANY⁵²

4.1 Introduction

After the financial market crisis in 2008, executive compensation was blamed as one of the major reasons for the crisis and the harsh economic downturn that followed, causing a storm of indignation and calls for regulatory action. Although the compensation packages of financial institutions were initially the centre of interest, the large body of executive pay regulation that soon followed around the globe affected not only financial firms but all listed companies, no matter what industry. From 2009 onwards, institutional pressure on executive pay – whether from regulatory and corporate governance bodies, from the media, labour unions or the general public – has been rising constantly. Although it seems perfectly clear to some observers that the root of the evil is risk-encouraging executive incentives and that the remedy has to be harsh regulatory action, others are more sceptical about whether executive compensation can generally be blamed as a trigger factor for the financial market crisis. They warn about hasty regulatory measures that may even lead to further unintended consequences and call for a thorough assessment of and a careful approach to regulatory action on executive compensation – a concern increasingly supported by a growing number of studies in recent years (DeYoung et al., 2013; Dittmann et al., 2011; Fahlenbach and Stulz, 2011; Gregg et al., 2012; Murphy, 2013). It therefore seems vital to explore further and understand the impact of regulatory action and other institutional forces on executive compensation. The present study aims to contribute to this knowledge by analysing how executive pay in Germany has evolved between 2006 and 2012, a period characterized by an unprecedented amount of pay regulation and major institutional change.

From a theoretical point of view, most research on executive incentives takes an economic view and is dominated by agency theory (Finkelstein et al., 2009; Murphy, 2013). Thus, many researchers call for other aspects and theories to be taken into account in order to adequately reflect the complexity of organizations, and complementary research streams have developed, including social, behavioural and political perspectives (Finkelstein et al., 2009). The present study takes a social perspective and applies institutional theory. We believe that, in a period characterized by unprecedented institutional change, this theory provides an outstanding

⁵² This Chapter is co-authored by Nathalie Haidegger-Rieß and Robert Wagner.

opportunity to enhance our knowledge of the determinants and consequences of executive pay. Based on the institutionalist prediction of isomorphic organizational practices, we analyse whether the growing institutional pressure on executive pay has led to isomorphic pay practices.

For our empirical analysis, we rely on a sample of German DAX and MDAX companies and examine the evolution of executive compensation levels and structures (i.e. fractions of base pay, short-term incentives and long-term incentives) during the period from 2006 to 2012 by carrying out descriptive as well as multivariate analyses. According to our hypotheses, we observe isomorphic pay practices in terms of converging pay levels within (intra-segment convergence) and between stock exchange segments (inter-segment convergence) especially for CEOs. Furthermore, we observe intra-segment convergence for the compensation structures of all DAX and MDAX executives. However, converging compensation structures between exchange segments can only be observed for CEOs. This study provides new insights and contributes to the existing literature about executive compensation. It enhances our knowledge about the phenomenon of isomorphism and, to our knowledge, it is the first study to measure the effects of national regulatory action and institutional change on executive compensation.

The remainder of this paper is structured as follows: in Chapter 4.2, we present the conceptual background of this study and provide a review of institutional theory and its prediction of isomorphic organizational change. We discuss the role of the institutional context as a determinant of executive pay and show how this context changed dramatically in Germany between 2006 and 2012. In Chapter 4.3, we develop our hypotheses, Chapter 4.4 describes the underlying data set, and Chapter 4.5 presents the findings. In Chapter 6, we discuss the contribution of this study, limitations and the potential for further research.

4.2 Contextual development

Research on executive compensation has traditionally been dominated by agency theory, which takes an economic view and provides a model to describe the relationship of economic exchange between a principal (the shareholder) and an agent (the executive) based on divergent interests and asymmetric information. In order to overcome the divergent interests of principal and agent, it is advisable to establish efficient incentive systems that reconcile the interests of executives with those of shareholders. Although agency theory has dominated the-

oretical and empirical literature on pay-related phenomena and remains the most important theory applied in corporate governance studies (Daily et al., 2003), researchers have come to the conclusion that additional perspectives need to be considered in order to better reflect the complexity of organizational reality and explain the determinants and consequences of executive pay (Baker et al., 1988; Brandes et al., 2006; Bruce et al., 2005; Eisenhardt, 1989; Finkelstein and Boyd, 1998; Zajac and Westphal, 1995).

In this study, we take a social perspective and apply institutional theory, which stresses the influence of social forces on organizations. Institutional theory focuses on the way that organizations interact with society: it explains how they seek legitimacy by adapting their structures, processes and practices to institutionalized norms and the expectations of their internal or external environment in order to survive (Selznick, 1996). It also describes how – as a consequence of this striving for legitimacy – a process of institutional isomorphic change unfolds and organizations become more and more similar (DiMaggio and Powell, 1983). This idea of increasingly similar organizations is the core of the present study. Given the fundamental changes in the institutional environment for executive pay in the new millennium, we examine how executive compensation in Germany has evolved and test whether isomorphic organizational practices can be observed.

4.2.1 Legitimacy

Suchman (1995) defines legitimacy as ‘[...] a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions’ (p. 574 f). Legitimacy is a social construct of what is desirable or appropriate, and organizations can ensure legitimacy by adapting to the expectations and rules of their environment. These rules or expectations have different causes or roots (e.g. law, educational systems, public opinion, media coverage, traditions), and achieving legitimacy by complying with these standards increases an organization’s stability as well as comprehensibility. Legitimate organizations are even perceived by their environment as more meaningful, more predictable and more trustworthy.

A vast amount of academic research has examined the role of institutional legitimacy in executive compensation. For example, a common measure for legitimizing executive pay is to employ professional compensation consultants as external experts in order to justify decisions

on compensation packages (Conyon et al., 2009; Wade et al., 1997). Another stream of research is based on what Meyer and Rowan (1977) call ‘decoupling’: organizations need to instal compensation practices that comply with institutionalized social expectations in order to gain or maintain legitimacy, even if these practices are not compatible with the requirements of economic efficiency or are not even intended actually to be implemented (Staw and Epstein, 2000; Westphal and Zajac, 1994, 1998).

Referring to Suchman’s (1995) definition of legitimacy, the question arises as to how these perceptions or assumptions come about. Academic research extensively examines the role of the media, which evaluates firms and leaders, acts ‘[...] as carriers of prevailing institutional logics [...]’ (Bednar, 2012: p. 131) and defines the focus of public attention. Researchers therefore investigate the influence of public opinion on executive compensation and observe that public outrage and unfavourable media attention can lead to a change in chief executive officer (CEO) pay (Bebchuck et al., 2002; Carberry, 2009; Kuhnen and Niessen, 2012). Cheffins (2003) describes a mechanism in which executive pay becoming too high triggers media investigation, which in turn may lead to a general perception of inequality and the call for government reform of excessive pay.

Just as social norms and expectations develop over time, the legitimacy of executive compensation evolves as well. Joutsenvirta (2012) comes to the conclusion that the financial crisis in 2008 caused a change in the political climate and social perception of economic life: whereas the legitimacy of executive pay was formerly based on economic and rationalistic reasons, the author observes a dramatic shift in the value basis towards ethical values and social acceptability.

4.2.2 Isomorphism

DiMaggio and Powell (1983) describe how striving for legitimacy leads to isomorphic institutional change. They identify and describe three mechanisms through which this isomorphism happens: coercive, mimetic and normative isomorphism.

Coercive isomorphism is based on formal and informal rules and on cultural expectations. It occurs because organizations respond to political influence and legal requirements such as law, formal and informal pressures, norms and the expectations of society. Law is the most

powerful source of institutional isomorphism as it leaves no room for deviation, and organizations need to change their processes and structures to comply with the new legal framework. As for executive compensation, law has undoubtedly become the most important source of isomorphism.

Mimetic isomorphism is the result of imitation caused by uncertainty: in a situation where organizations seek legitimacy but are uncertain about a clear course of action, they imitate other organizations that they perceive to be more legitimate and successful. Copying other, more successful peers seems plausible not only from a legitimacy point of view, but also from an economic one: what works well for others might work for oneself – much faster and at less expense by imitating proven concepts within a given institutional context. Once certain practices or structures are perceived as successful and legitimate, others who face uncertainty imitate in order to gain legitimacy themselves. Thus, a dynamic process of mimetic isomorphism unfolds.

Normative isomorphism refers to normative values and assumptions about professional standards as the source of isomorphic change, e.g. professional standards of how a company has to be run, how structures and processes have to be established and carried out, and what methods have to be applied. There are two major sources of normative isomorphism: one is formal education and professional training that managers and top-level professionals undergo. This leads to a common knowledge of how an organization has to be run in a professional way within a certain institutional context. The other source of normative isomorphism is professional networks and exchange relationships where managers and specialized professionals interact with other organizations or via professional associations. Also, affiliations and exchange relationships between companies as well as the professional ties of executives, such as seats on supervisory boards, can lead to normative isomorphism and the diffusion of isomorphic compensation models.

A meta-analysis carried out by Heugens and Lander (2009) confirms that isomorphic pressures lead to more homogeneous organizations. At the same time, according to DiMaggio and Powell (1983) ‘[...] the types [of isomorphism] are not always empirically distinct’ (p. 150). Isomorphic change happens over time: in the beginning, organizations vary in their characteristics and practices. Over time, coercive, mimetic or normative forces (or a mixture of them) come into play, starting a process of increasing change towards similar organizational structures and practices.

A number of studies have been carried out to explore the isomorphism of executive pay. Although some work focuses more on the comparison between US and non-US practices and the probability of convergence (Cheffins, 2003; Conyon and Murphy, 2000; Fernandes et al., 2012), others take a look at the cultural dimensions of compensation systems (Pennings, 1993; Tosi and Greckhamer, 2004) or focus on the circumstances that favour (or disfavour) the adoption and diffusion of US-style pay practices in other countries around the world (Buck et al., 2004; Chizema, 2010; Tuschke and Sanders, 2007). Some researchers go one step further and point to possible pitfalls and unintended consequences caused by coercive, mimetic and normative pressures, such as an overly high degree of standardization of corporate reports and websites (Pointa and Tyson, 2006) or the conflict between institutional pressure and the suitability of legitimate pay practices for firm-specific requirements (Bender and Moir, 2006; Brandes et al., 2006). However, we are not aware of any other study investigating isomorphism of executive pay within one institutional context over time.

4.2.3 The institutional context in Germany

Since the beginning of the new millennium, the regulation of executive compensation has become a centre of interest in Germany, starting with calls for the disclosure of executive compensation. Traditionally and in contrast to the US, placing one's fortune on display is considered rather inappropriate in the German egalitarian system, and levels of income did not used to be disclosed or discussed, either in private or in public. They were treated rather discreetly because of the fear that high income or wealth would cause envy rather than admiration. Complete transparency about individual executive pay in Germany has only existed since 2006, as the result of a law passed in 2005⁵³ which requires the full disclosure of individual compensation for each board member of quoted companies. Thus, only from 2006 onwards has comprehensive data about individual executive compensation been available. Additionally, after the start of the financial crisis, a new law came into force in 2009⁵⁴ which rules the design as well as the disclosure of executive compensation: supervisory board members are obliged and personally liable to ensure that compensation packages are 'appropriate' and in accordance with

⁵³ German Act on the Disclosure of Management Board Remuneration (*Gesetz über die Offenlegung von Vorstandsvergütungen, VorstOG*), 2005.

⁵⁴ German Act on the Appropriateness of Management Board Remuneration (*Gesetz zur Angemessenheit der Vorstandsvergütungen, VorstAG*), 2009.

industry and nationwide standards; compensation has to be based on multiannual measures and must ensure the pursuit of ‘sustainable corporate development’; a cap for ‘extraordinary developments’ has to be set; rules for the ‘reduction of salaries in case of a deteriorating situation of the company’ have to be in place; and more extensive disclosure rules have to be followed. In 2010, additional regulation was put in place for financial institutions⁵⁵, concerning the fractions of base and variable pay as well as minimum vesting periods.

In sum, the government had decided to specify certain bandwidths, but not to interfere in the detailed design of individual executive contracts. This approach had the obvious advantage of providing a reliable framework for all parties involved and – from an institutional point of view – a foundation for the legitimacy of executive pay practices, while at the same time not interfering with individual compensation arrangements at the firm level. On the other hand, a great deal of uncertainty arose because a large number of questions remained open when it came to implementing the new regulations: probably one of the most fiercely debated issues was and still continues to be the level of executive pay. The German government had deliberately decided not to lay down a rule concerning compensation amounts – which it declared to be ‘not a matter of the state but of the parties involved’⁵⁶ – but required the ‘appropriateness’ of pay. It therefore remained up to the supervisory board to decide on the level of pay, an even more critical task given the fact that the new law had made supervisory board members personally liable for this appropriateness.

These and many other questions remained unanswered and have caused uncertainty among supervisory board members and executives who not only fear legal consequences in case they do not get things right, but are also aware that the media and the public in general critically observe their actions. Since the introduction of obligatory individual pay disclosure in 2006, executive compensation has increasingly attracted critical attention from a broad audience of politicians, regulators, trade unions and the general public, startled by media reports about excessive pay packages. Thus, the pressure to legitimize compensation decisions towards shareholders, stakeholders and the general public has constantly intensified.

In principle, this applies to all listed establishments in Germany. However, public interest in Germany is primarily focused on companies from the DAX and MDAX indexes, which are the most important German stock market segments. The German stock market index DAX

⁵⁵ Ordinance on the Supervisory Requirements for Institutions’ Remuneration System (*Verordnung über die aufsichtsrechtlichen Anforderungen an Vergütungssysteme im Versicherungsbereich, VersVergV*); (*Verordnung über die aufsichtsrechtlichen Anforderungen an Vergütungssysteme für Institute, InstitutsVergV*), 2010.

⁵⁶ Minister of Justice Brigitte Zypries, 18 May 2009.

comprises the 30 largest German companies in terms of market capitalization and trading volume and measures the performance of these companies.⁵⁷ The MDAX includes the 50 largest companies from classic industries – excluding the technology industry – that rank immediately below DAX companies.⁵⁸ Since DAX management board members are the top earners of all stock exchange segments, they attract the highest public interest in terms of executive pay. In contrast, MDAX companies receive much less coverage than their larger peers. Since DAX executives are the top earners of all stock exchange segments, they attract the highest public interest in terms of executive compensation. In addition, these companies have the best human, capital and networking resources to face institutional challenges and come up with some kind of ‘legitimate’ common standard. For this reason, DAX companies serve as a unique role model, for MDAX companies adapting institutional requirements regarding executive compensation. In accordance with the German Stock Corporation Act (AktG), companies from both segments are managed by the management board.

From a legal point of view, all board members in Germany have the same rights. However, if there are several board members, a CEO can be elected (§84 Abs.2 AktG). In line with the practices of US companies, this has also become established in the practice of DAX and MDAX companies. Thus, the CEOs have a greater decision-making authority and generate special public interest. This applies in particular to the level and structure of their remuneration. Existing academic literature on top management compensation is almost entirely focused on CEO pay (e.g. Bebchuck et al., 2002; Berrone and Gomez-Mejia 2009; Bruce et al. 2005; Cadman et al. 2012; Carberry 2009; Conyon and Schwalbach 2000; DeYoung et al. 2013; Murphy 2013; Tuschke 2003). Also, media reports about executive pay - typically yearly "league tables" of executive compensation - focus on CEO pay both in the US (e.g. Forbes, Wall Street Journal, Financial Times) as well as in Germany (e.g. Manager Magazin; Spiegel FAZ; Handelsblatt; Welt; Sueddeutsche Zeitung). Typically, the CEO earns the highest amount of pay of all board members and target compensation for other board members is usually set in relation to CEO

⁵⁷ Moreover, the DAX index ‘[...] represents approximately 75 percent of the aggregate capital stock of listed German stock corporations. DAX shares account for approximately 85 percent of trading volume in German equities. DAX stocks are admitted to trading in the Regulated Market segment and are listed in Prime Standard. The criteria for weighting the stocks in the index are: trading volume and market capitalization on the basis of the number of shares in free float, as well as position in the respective industry. DAX is calculated by Deutsche Börse AG as both a price and a performance index on the basis of Xetra® prices, and updated by the second. The calculation procedure is independently monitored on a regular basis. Deutsche Börse decides whether changes are to be made to the composition of the index on an annual basis in September.’ (http://deutsche-boerse.com/dbg/dispatch/en/kir/dbg_nav/about_us/30_Services/40_Know_how/10_Stock_Exchange_A_Z).

⁵⁸ The composition of the MDAX index ‘[...] is reviewed on a semi-annual basis and adjusted in March and September. The criteria for weighting the shares in the index are: trading volume and market capitalization on the basis of the number of shares in free float, as well as position in the respective industry.’ (http://deutsche-boerse.com/dbg/dispatch/en/kir/dbg_nav/about_us/30_Services/40_Know_how/10_Stock_Exchange_A_Z).

compensation. Thus, CEO pay is often regarded as an indicator of a company's executive pay policy. The special interest in the CEOs is also because they represent a significantly more homogeneous group in terms of job description than the other members of the board (non-CEOs). Due to the different and often not comparable functions of the non-CEOs, the difference in their compensation is correspondingly high. Therefore, when other board members are considered at all, data of aggregate pay on a larger set of top managers is often applied (Finkelstein et al. 2009).

4.3 Hypotheses

Before the data set is presented, the research hypotheses are derived based on theory and previous empirical evidence. The institutional changes outlined above provide evidence to believe that German executive compensation has been subject to isomorphic change. Since it is not possible to separate the three types of isomorphism (DiMaggio and Powell, 1983), this applies to coercive, mimetic as well as normative isomorphism. First, a wave of new legal frameworks have been put in place since 2006, obliging companies to disclose individual executive pay, review their compensation policies and adjust their pay practices. Second, many questions remained open when it came to the implementation of the new regulations. We therefore expect that the uncertainty about a clear course of action favours the imitation of other organizations that are perceived as legitimate and successful. Third, owing to the legal requirements and the enormous public interest in executive compensation, it became vital for executives to demonstrate that the design of and decision-making on all pay-related issues were carried out according to the highest professional standards and norms.

One of the measures required by law is that the compensation has to be appropriate and in accordance with industry and nationwide standards.⁵⁹ This leads to a procedure of benchmarking to comparable and better peers and affects both pay levels and pay structures. The convergence of executive compensation should therefore take place primarily within the segments. We therefore assume:

*H₁: Triggered by the introduction of new regulatory frameworks and growing institutional pressure on executive compensation, the level of executive pay converges **within** MDAX and DAX companies.*

⁵⁹ VorstAG

Based on the role model function of DAX companies for MDAX companies, we assume:

*H₂: Triggered by the introduction of new regulatory frameworks and growing institutional pressure on executive compensation, the level of executive pay converges **between** MDAX and DAX companies.*

Usually, the CEO is the "public face" of a company and closely watched by the media, analysts and the general public. Since existing academic literature as well as reports on the level of executive pay typically focus on CEOs, this makes it easier to orientate on their compensation. We therefore assume:

*H₃: The level of executive pay converges stronger for CEOs than for non-CEOs **within** and **between** MDAX and DAX companies.*

In the same way as the changes affect the level of executive pay, there are effects on the compensation structure. In Germany, the executive compensation traditionally comprises only a small proportion of variable pay, mostly based on accounting figures (Evers, 2001). The new legal frameworks require compensation to be based on multiannual measures and therefore to ensure the pursuit of sustainable corporate development. This leads to a reduction in the fraction of base salaries and at the same time to an increase in variable pay, especially long-term variable pay in order to fulfil the multiannual criterion. In line with the first hypothesis, the compensation structure should therefore converge again within the segments and we therefore assume:

*H₄: Triggered by the introduction of new regulatory frameworks and growing institutional pressure on executive compensation, the structure of executive pay converges **within** MDAX and DAX companies.*

Since the MDAX companies will also orient themselves towards DAX companies in terms of compensation structure, we therefore assume:

*H₅: Triggered by the introduction of new regulatory frameworks and growing institutional pressure on executive compensation, the structure of executive pay converges **between** MDAX and DAX companies.*

As in addition to the compensation level, more information on CEOs' compensation structure is available and will be published, we assume:

*H₆: The structure of executive pay converges stronger for CEOs than for non-CEOs **within and between** MDAX and DAX companies.*

After having assessed the six hypotheses, we will analyse whether isomorphic change leads to convergence of executive compensation level and structure.

4.4 Data

Our analysis is based on a proprietary database provided by the German consulting company Kienbaum, a long-established and leading provider for executive search, organization and human resources consulting in Germany with more than half a century of expertise in compensation consulting. The data used in our study cover German DAX and MDAX companies for the period between 2006 and 2012 and provide a unique, hand-collected set of information about German executive compensation. Our data were collected by analysing company reports and provide information on firm size (number of employees), profit (annual net income/loss), industry, stock exchange segment (DAX, MDAX) and executive compensation. Each DAX and MDAX company can be uniquely identified by a firm ID and, therefore, tracked across all years from 2006 to 2012. To ensure a consistent database, our data only include companies that were part of the same stock index in at least two consecutive years. Therefore, to avoid the results being distorted by segment changers, eleven companies⁶⁰ that have changed between the stock index are eliminated. Furthermore, seven companies appear in one year only and are therefore not considered in our analysis⁶¹. Five additional companies⁶² dropped out of one of the two exchange segments for at least one year and returned at a later stage. Another three companies⁶³ could not be considered because these companies either did not publish information on execu-

⁶⁰ ALTANA, Beiersdorf, Continental, Fresenius, Heidelberg Cement, K+S Kassel, MAN, Merck, Metro, Salzgitter and Lanxess.

⁶¹ Talanx, Duerr, TAG Immobilien, IKB Deutsche Industriebank, KarstadtQuelle, AWD Holding and Patrizia Immobilien.

⁶² Deutsche Postbank, Deutz, KUKA, TUI and Deutsche Wohnen.

⁶³ GAGFAH, EADS and Kabel Deutschland Holding.

tive compensation in at least one year or were not considered during the data collection process⁶⁴. Our final sample therefore consists of 436 firm–year observations from a total of 73 companies⁶⁵. Some 37.4% (24) of the companies belong to the DAX and 62.6% (49) are listed in the MDAX. The distribution of firms to stock exchange segments is stable over the entire observation period. Overall, we consider our sample to be highly representative of German listed companies. It offers a broad variation in firm size and a solid coverage of DAX and MDAX firms, which represent more than 90% of the total German market capitalization. Summary statistics on firm size and stock exchange segment can be found in Appendices A4.1 and A4.2.

Our data on executive compensation cover information on base pay, annual variable pay (short-term incentives/STI) and long-term variable pay (long-term incentives/LTIs). LTI components include share-based as well as cash-based components. Owing to numerous changes in German legislation regulating the disclosure of executive pay before and during our observation period, the way companies published pay-related information was heterogeneous and changed significantly over time. This is especially true for the disclosure of LTIs – the very fraction of executive compensation that has gained enormous importance in the aftermath of the financial crisis. Some German companies publish the pay-out value of share options, whereas others disclose the grant-date value or the target value. Some companies even provide a value for LTIs without any explanation at all, and it is not always possible to consistently distinguish LTI plan types and pay-out values. Unfortunately, no widely acknowledged German database on executive compensation exists (as opposed to ExecuComp database in the US, which is the most commonly used database in US executive compensation research). Our database was hand-collected by Kienbaum who screen all available compensation data per year and maintain one of Europe’s most exhaustive compensation databases⁶⁶. As for LTIs, because of changing LTI disclosure standards and practices between 2006 and 2012, Kienbaum proceeded as follows: between 2006 and 2008, LTIs were only collected if explicitly disclosed in the company report. In any other case, LTIs are included in total compensation at grant-date value. From 2009, data about LTIs was collected separately: share-based components were collected at their fair market value at grant, and cash-based LTIs were collected at their target value or grant-date value, if this information could be retrieved from the annual financial report. From 2010 onwards and

⁶⁴ Companies with head offices outside Germany (e.g. EADS) have not been considered by Kienbaum during the data collection process.

⁶⁵ In principle, it is possible for companies to be removed from the individual segments or to be taken up again. The same applies to the observations in the data set. Therefore, the data set is an unbalanced panel.

⁶⁶ <http://www.kienbaum.com/web/EN-Services/CompensationDataServicesEN.aspx>

on account of LTI data quality improvements because of new regulations and the revision of the German accounting standard⁶⁷, LTI plan types that reward past achievements were collected at their pay-out value, LTI plan types that reward future achievements were considered in the year of the actual payment⁶⁸, and share-based LTI plans were collected at their fair market value at grant.

Owing to the restricted data quality on LTIs, we decided to define a proxy variable that combines all possible values for LTIs and allows for a consistent calculation of LTI values across all years. Based on the fact that our data provide reliable information about base pay, short-term incentives and total compensation, we define the following proxy variable for long-term incentive plans, which we use in our descriptive analysis of compensation structure (Chapter 4.5.2):

$$LTI\ Proxy = Total\ Compensation - Base\ Pay - Short\ Term\ Incentives.$$

For our study, we focus on average pay for CEOs and for non-CEO board members (non-CEOs) and examine how the level and structure of compensation develop over time. Data were collected by Kienbaum as follows: provided that individual pay for the CEO as well as for each individual non-CEO was disclosed, CEO pay could easily be retrieved and average non-CEO pay was calculated by dividing the sum of non-CEO pay by the number of non-CEOs. Some firms only disclose CEO pay and the total amount of board compensation (including the CEO). Whereas again CEO pay could be retrieved easily, average non-CEO pay was calculated by subtracting CEO pay from the total amount of board compensation and dividing the remainder by the number of non-CEOs. If only one total amount of board compensation (including CEO and non-CEOs) was disclosed, this amount was divided by the total number of board members (CEO plus non-CEOs), and the result was used as average non-CEO pay, taking into account that average non-CEO pay will be slightly increased. Out of our final sample of 436 firm-year observations, 342 provide information on CEO compensation, and information on non-CEO compensation is completely available. Since this study takes an institutional point of

⁶⁷ Deutscher Rechnungslegungs Standard Nr. 17 states how long-term incentives have to be disclosed in financial reports and forced companies into a more homogeneous approach.

⁶⁸ Note: not all companies in the sample followed the instructions in DRS 17. Some published (e.g.) pro rata value of provisions as long-term incentives.

view, we focus on the impact of institutional changes on corporate compensation practices for board members, independent of any individual executive turnover.

4.5 Findings

Following our hypotheses of isomorphism of executive pay, we analyse whether a convergence of executive compensation levels and compensation structure can be observed between 2006 and 2012. In each case, we first focus on the convergence of executive compensation levels within each stock exchange segment of DAX and MDAX. This intra-segment analysis is rather based on descriptive⁶⁹ indicators. Convergence is measured as the decrease in the coefficient of variance (COV) over time. The coefficient of variance is a standardized measure of the variance and robust as well as dimensionless (Campano and Salvatore, 2007). Furthermore, we establish a ranking to determine whether companies that have paid less at the beginning will catch up over time with companies that have paid more or vice versa. For this purpose, based on the level of executive pay in 2006, companies are divided into four compensation groups in each exchange segment. The thresholds for the classification are the 0.25 quantile, the 0.5 quantile and the 0.75 quantile.⁷⁰ However, this comparison within both segments is only possible for the subgroup of companies for which information are available in 2006.⁷¹ As the group allocation remains the same over time, the development of average executive pay levels and the respective compensation structure in the different groups can be compared in this way. The range⁷² of average values between the compensation groups and its development over time therefore serves as an additional indicator of convergence within the segment.

In order to analyse the convergence between the segments (inter-segment analysis), we first also refer to the COV. To ensure that developments in the segments are not distorted by unobserved factors (e.g. the power of the supervisory board), additional multivariate OLS and Fixed Effects estimations are conducted. For the consideration of convergence in the structure

⁶⁹ In addition to the descriptive analyses we have also tried intensively to calculate multivariate analyses to reveal intra-segment convergence. Based on the longitudinal data format, different quantile regressions (xtqreg, qrpd) were calculated (Geraci and Bottai, 2013). However, due to the low observations in the individual subgroups, the models do not provide any meaningful results. Even on the basis of a simple quantile regression no clear results can be seen. The same applies to Fixed Effects estimations for the different compensation groups.

⁷⁰ Thus, the first group contains the 25% of companies in this exchange segment that paid the least in 2006. The second and third group each contain the next 25% of the companies in terms of payment. The fourth group includes the 25% of companies that paid the most in 2006.

⁷¹ Due to the loss of too many observations, the entire sample is not restricted to the subgroups from 2006.

⁷² The range is calculated from the difference between the largest and smallest values.

of executive compensation, the procedure and the conducted analyses are the same as for the compensation level. To ensure comparability, all analyses are based first on the CEOs and then on the non-CEOs.

4.5.1 CEO and non-CEO compensation levels

4.5.1.1 Intra-segment analyses

Tables 4.1a and 4.1b show the development of total compensation for DAX and MDAX CEOs between 2006 and 2012. Average total compensation levels in both segments clearly dropped during the financial crisis in 2008 and 2009 and recovered during the following years in both exchange segments. The COV as indicator for the convergence decrease moderately over time for DAX CEOs and rather strong for MDAX CEOs. Comparing only the period before (2006–2007) and after the crisis (2010–2012) (cf. Appendix A4.3), the average compensation level after the crisis is higher in both segments. In addition, the COV is smaller in the post-crisis period than before the crisis, which also indicates convergence within DAX and MDAX CEOs.

Table 4.1a: Total compensation of DAX CEOs (in k €)

	2006	2007	2008	2009	2010	2011	2012
Average (Avg.)	4,678.9	4,917.0	4,113.3	4,043.3	5,074.6	5,320.9	5,340.8
SD	2,665.1	2,785.3	2,096.2	2,253.9	2,089.1	2,650.3	2,707.8
COV (SD/Avg.)	0.570	0.566	0.510	0.557	0.412	0.498	0.507
N	21	23	19	23	22	23	22

Table 4.1b: Total compensation of MDAX CEOs (in k €)

	2006	2007	2008	2009	2010	2011	2012
Average	1,878.6	2,182.9	1,667.9	1,567.5	1,941.7	2,167.8	2,228.9
SD	1,382.2	1,770.1	865.8	927.8	1,070.7	921.0	1,039.3
COV (SD/Avg.)	0.736	0.811	0.519	0.592	0.551	0.425	0.466
N	21	25	27	25	31	30	30

In the next step, we look at the development of the average compensation levels for the different compensation groups from the reference year 2006 within each exchange segment

(Tables 4.2a and 4.2b). For DAX CEOs, the range between ‘high-paying’ and ‘low-paying’ companies decrease sharply at the beginning of the crisis and then gets larger again. Especially in the group of those who paid the most in the base year (DAX_{75C}), there is the biggest decline in total compensation in the crisis. In Figure 4.1, it can be seen that CEO payment in the different groups is becoming more similar especially after the financial crisis and after the law on the appropriateness of compensation (VorstAG) comes into force. This is particularly true for the three groups that tended to pay the most in 2006. Correspondingly, there is also a decline in the range, which suggests convergence between the different DAX CEO groups. Compared with the DAX CEOs, the range between the different MDAX CEO compensation groups is smaller, in principle. Again, the range decreases in 2008 and 2009 and then increases afterwards. From 2010 onwards, again the three groups that tended to pay the most in the base year converge strongly. The fact that the range increases again in 2011 and 2012 results from the relatively constant pay level of the lowest group.

Table 4.2a: Comparison of compensation groups of DAX CEOs⁷³ (in k €)

	2006	2007	2008	2009	2010	2011	2012
Avg. DAX _{25C}	2,574.3	2,862.0	2,714.0	2,234.9	3,320.0	3,277.2	3,494.0
Avg. DAX _{25-50C}	3,466.5	3,953.7	3,632.9	3,193.3	5,290.3	5,596.9	5,442.1
Avg. DAX _{50-75C}	4,498.0	4,813.6	4,066.4	4,011.3	4,970.0	4,800.4	5,209.6
Avg. DAX _{75C}	8,597.7	7,440.5	4,901.8	5,724.8	6,128.9	6,126.2	6,282.8
Range	6,023.4	4,578.5	2,187.8	3,489.9	2,808.9	2,849.0	2,788.8
N	21	18	17	16	14	15	16

⁷³ As already mentioned the classification of compensation groups was based on quantiles. Thus, companies in the first group DAX_{25C} (n=6) paid less than 3,113 k € in 2006. Companies in the group DAX_{25-50C} (n=5) paid between 3,113 and 3,862 k €. The third group DAX_{50-75C} (n=5) includes companies that paid between 3,862 and 5,260 k € in 2006. In the group DAX_{75C} (n=5) are companies that paid more than 5,260 k € for their CEO. The total number only refers to the 21 companies from 2006. The fact that the observations go back first and then rise again is because companies have left the sample but can be observed again later.

Table 4.2b: Comparison of compensation groups of MDAX CEOs⁷⁴ (in k €)

	2006	2007	2008	2009	2010	2011	2012
Avg. MDAX _{25C}	798.5	1,350.5	1,003.2	1,046.0	1,199.1	1,042.2	1,122.2
Avg. MDAX _{25-50C}	1,471.8	1,737.5	1,326.3	1,205.6	2,146.2	2,974.3	3,111.5
Avg. MDAX _{50-75C}	2,056.2	2,074.5	1,988.8	1,848.2	2,491.8	2,920.1	2,241.4
Avg. MDAX _{75C}	3,404.1	3,722.2	2,992.5	2,703.3	2,201.6	2,281.3	2,351.8
Range	2,605.6	2,371.7	1,989.3	1,657.3	1,292.7	1,932.1	1,989.3
N	21	18	18	16	17	16	15

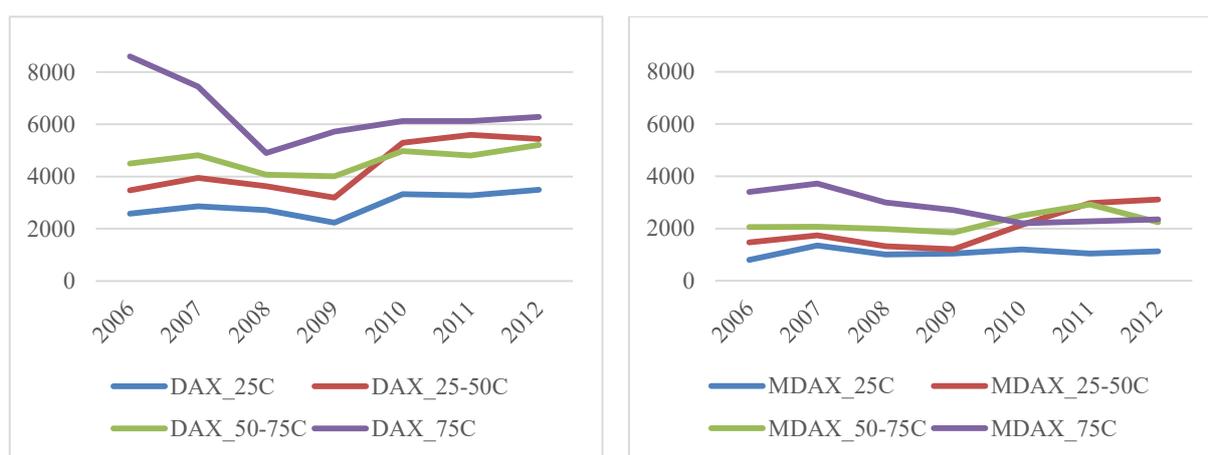


Figure 4.1: Development of total compensation in different groups of DAX CEOs (left) and MDAX CEOs (right) (in k €)

Tables 4.3a and 4.3b show the development of executive compensation for non-CEOs in DAX and MDAX companies. Again, we observe a drop in total compensation during the financial crisis. In the following years, total compensation recovers. Although the COV for the DAX non-CEOs tends to decline slightly over time, the MDAX non-CEOs show hardly any declines in this indicator. As with the CEOs, in the period after the crisis, DAX and MDAX non-CEO average pay exceeds the pre-crisis level (cf. Appendix A4.3).

Table 4.3a: Total compensation of DAX non-CEOs (in k €)

	2006	2007	2008	2009	2010	2011	2012
Average	2,519.8	2,528.5	2,000.7	2,079.1	2,440.3	2,670.4	2,626.0
SD	1,092.9	949.4	880.8	1,057.6	879.1	1,265.7	1,041.7
COV (SD/Avg.)	0.434	0.375	0.440	0.509	0.360	0.474	0.397
N	24	24	23	23	23	23	23

⁷⁴ In terms of MDAX CEOs, the group **MDAX_{25C}** (n=6) includes companies that paid less than 1,141 k € in the year 2006. Companies in the second group (**MDAX_{25-50C}**, n=5) paid between 1,141 and 1,860 k €. The group **MDAX_{50-75C}** (n=5) comprises companies that paid between 1,861 and 2,149 k € in 2006. In the group **MDAX_{75C}** (n=5) are companies that paid more than 2,149 k € in 2006.

Table 4.3b: Total compensation of MDAX non-CEOs (in k €)

	2006	2007	2008	2009	2010	2011	2012
Average	1,138.9	1,278.9	1,012.9	1,024.0	1,280.7	1,232.8	1,260.9
SD	597.9	685.5	589.8	811.4	785.1	643.4	685.7
COV (SD/Avg.)	0.525	0.536	0.582	0.792	0.613	0.522	0.544
N	31	38	43	41	42	40	38

Looking at the development of executive pay levels in the distinct compensation groups in Tables 4.4a and 4.4b, it can be seen that, in comparison with the CEOs, the range between non-CEO groups is clearly smaller in both exchange segments. Furthermore, there is not so much variation over time as in the CEO compensation. Only the 25% of companies that paid the highest executive compensation in 2006 (DAX_{75NC}) again had to face declines in the beginning of the crisis (cf. Figure 4.2). Especially for the groups DAX_{25-50NC} and DAX_{50-75NC}, we find increasing executive pay levels and therefore a strong convergence of the top three groups from 2010 onwards. On the one hand, this could be due to the economic upswing after the crisis and on the other hand to the introduction of the new law in 2009. The fact that the range still rises in 2012 is mainly a result of the decreasing compensation of the lowest group in this year. The compensation of MDAX non-CEOs shows a constant development across all groups. Although there have been slight declines in executive pay levels during the crisis, these are much more moderate than for MDAX CEOs and for the DAX executives. Accordingly, the distance at the beginning also decreases, but then remains relatively constant over time.

Table 4.4a: Comparison of compensation groups of DAX non-CEOs (in k €)⁷⁵

	2006	2007	2008	2009	2010	2011	2012
Avg. DAX _{25NC}	1,472.1	1,871.9	1,592.2	1,658.7	1,965.9	2,077.3	1,655.3
Avg. DAX _{25_50NC}	2,029.4	2,161.6	1,934.1	1,677.9	2,359.7	2,958.7	2,941.9
Avg. DAX _{50_75NC}	2,458.2	2,481.6	1,841.7	1,755.0	2,431.3	2,635.9	2,695.1
Avg. DAX _{75NC}	4,119.3	3,598.8	2,566.7	3,154.8	2,925.5	2,910.7	3,050.1
Range	2,647.2	1,726.9	974.5	1,496.1	959.6	881.4	1,394.8
N	24	24	23	23	23	23	23

⁷⁵ Based on the group classification, companies in the first group DAX_{25NC} (n=6) paid less than 1,831 k € in 2006. Companies in the group DAX_{25-50NC} (n=6) paid between 1,831 and 2,175 k €. The third group DAX_{50-75NC} (n=6) includes companies that paid between 2,175 and 2,788 k € in 2006. In the group DAX_{75NC} (n=6) are companies that paid on average more than 2,788 k € for their non-CEO.

Table 4.4b: Comparison of compensation groups of MDAX non-CEOs (in k €)⁷⁶

	2006	2007	2008	2009	2010	2011	2012
Avg. MDAX _{25NC}	480.8	1,075.7	638.4	570.0	701.6	803.4	690.0
Avg. MDAX _{25-50NC}	871.9	1,137.5	826.9	894.6	1,139.0	1,207.9	1,293.1
Avg. MDAX _{50-75NC}	1,330.4	1,456.3	1,416.6	1,587.2	1,533.2	1,335.0	1,215.3
Avg. MDAX _{75NC}	1,847.5	1,839.4	1,587.8	1,217.9	1,555.3	1,490.6	1,392.2
Range	1,366.7	763.7	949.4	647.9	853.7	687.2	702.2
N	31	31	30	28	27	25	24

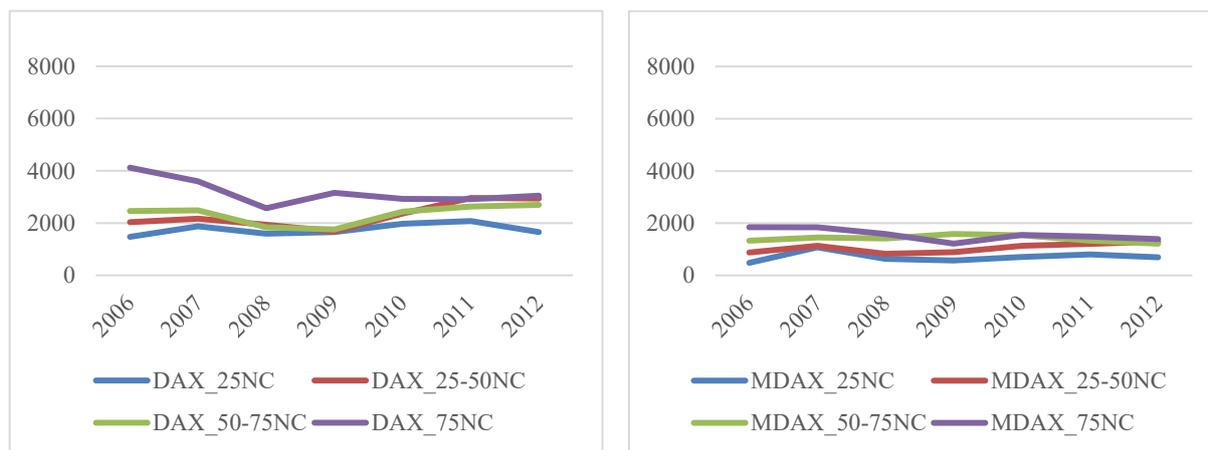


Figure 4.2: Development of total compensation in different groups of DAX non-CEOs (left) and MDAX non-CEOs (right) (in k €)

In total, based on the COV and the development between the compensation groups, we find intra-segment convergence for DAX and MDAX CEOs and a slight convergence for DAX non-CEOs. In contrast, there is hardly any indication of convergence for MDAX non-CEOs. Thus, the first hypothesis can be confirmed for DAX and MDAX CEOs as well as for DAX non-CEOs. Since the convergence is more pronounced among CEOs than among non-CEOs, this also confirms the third hypothesis. The comparison of the different compensation groups also shows that the initially poorer paying groups are catching up and the better paying groups are partly more cautious in terms of executive pay over time.

⁷⁶ The group **MDAX_{25NC}** (n=7) includes companies that paid less than 669 k € in the year 2006. Companies in the second group (**MDAX_{25-50C}**, n=9) paid between 669 and 1,063 k €. The group **MDAX_{50-75C}** (n=7) comprises companies that paid between 1,063 and 1,551 k € in 2006. In the group **MDAX_{75C}** (n=8) are companies that paid more than 1,551 k € in 2006.

4.5.1.2 Inter-segment analyses

In order to reveal convergence between the two exchange segments DAX and MDAX, first of all we perform descriptive comparisons of average total compensation and the coefficient of variance (COV). As the previous results have shown, average compensation decreases in the financial crisis and then even rises above the pre-crisis level. As this development can be observed for both DAX and MDAX companies, the coefficient of variance remains fairly constant for non-CEOs and decreases slightly over time for CEOs. Hence, this rather suggests inter-segment convergence for CEOs. This is also confirmed by the comparison of pre-crisis and post-crisis levels in Appendix A4.3.

Table 4.5: Total compensation of CEOs in both segments (in k €)

	2006	2007	2008	2009	2010	2011	2012
Average DAX	4,678.9	4,917.0	4,113.3	4,043.3	5,074.6	5,320.9	5,340.8
Average MDAX	1,878.6	2,182.9	1,667.9	1,567.5	1,941.7	2,167.8	2,228.9
Average all	3,278.8	3,493	2,678	2,753.8	3,242.2	3,536.1	3,545.5
SD all	2,530.7	2,671.4	1,916.5	2,092.8	2,202.9	2,436.0	2,404.5
COV (SD/Avg.)	0.772	0.765	0.716	0.760	0.679	0.689	0.678
N	42	48	46	48	53	53	52

Table 4.6: Total compensation of non-CEOs in both segments (in k €)

	2006	2007	2008	2009	2010	2011	2012
Average DAX	2,519.8	2,528.5	2,000.7	2,079.1	2,440.3	2,670.4	2,626.0
Average MDAX	1,138.9	1,278.9	1,012.9	1,024.0	1,280.7	1,232.8	1,260.9
Average all	1,741.4	1,762.6	1,357.1	1,403.2	1,691.1	1,757.6	1,775.6
SD all	1,088.6	1,000.7	844.0	1,033.9	986.3	1,147.0	1,064.4
COV (SD/Avg.)	0.625	0.568	0.622	0.737	0.583	0.653	0.599
N	55	62	66	64	65	63	61

However, since the descriptive comparison of all CEOs and non-CEOs across both segments does not yet show whether the MDAX companies actually come closer to the DAX companies or whether the opposite is true, multivariate analyses will be conducted in the next step. Therefore, based on OLS we use Fixed Effects estimations with the log total compensation for

CEOs and non-CEOs as dependent variable. Furthermore, we consider control variables including firm size, year, stock market segment, industry sector⁷⁷ and profit. To expose the convergence between both exchange segments over time, we include additional interaction effects between stock market segment and year. Again, we run our analysis for both CEO and non-CEO compensation.

In model (1) in Table 4.7, we find a significant positive effect on compensation for companies with more than 150,000 employees. Furthermore, in the years 2011 and 2012, there are significantly higher CEO compensation levels than in 2006. The largest effect can be observed for the stock exchange segment. Average CEO compensation in MDAX companies is 77% lower than in DAX companies. Profit also shows a significant effect; however, the coefficient has no practical relevance because of its small absolute size. In specification (2), we add interaction terms between stock market segment and year, although none of the interaction terms shows significant estimates.

Table 4.7: Determinants of CEO total compensation

Dependent variable:	(1)	(2)	(3)	(4)
CEO total compensation (log)	OLS	OLS	FE	FE
10,000–20,000 empl.	0.025 (0.107)	0.028 (0.108)	–	–
20,000–50,000 empl.	–0.165 (0.104)	–0.161 (0.105)	–	–
50,000–100,000 empl.	–0.055 (0.129)	–0.064 (0.130)	–	–
100,000–150,000 empl.	–0.095 (0.157)	–0.078 (0.160)	–	–
>150,000 empl.	0.353** (0.154)	0.345** (0.156)	–	–
Year 2007	0.090 (0.095)	0.002 (0.137)	0.124* (0.070)	0.012 (0.100)
Year 2008	–0.052 (0.098)	–0.068 (0.148)	–0.041 (0.072)	–0.166 (0.108)
Year 2009	–0.099 (0.097)	–0.119 (0.140)	–0.108 (0.071)	–0.161 (0.101)
Year 2010	0.104 (0.094)	0.085 (0.142)	0.109 (0.070)	0.028 (0.102)
Year 2011	0.175* (0.094)	0.084 (0.140)	0.173** (0.070)	0.051 (0.100)
Year 2012	0.209** (0.096)	0.098 (0.142)	0.175** (0.071)	0.046 (0.101)

⁷⁷ In our analyses, we add 24 industry dummies (e.g. banking, insurance, automotive, construction, chemicals, services, retail trade, etc.) to control for industry effects

MDAX	-0.770*** (0.115)	-0.870*** (0.174)	-	-
Profit	8.75e-05*** (1.35e-05)	8.95e-05*** (1.38e-05)	6.96e-05*** (1.16e-05)	7.00e-05*** (1.19e-05)
MDAX*2007		0.168 (0.192)		0.225 (0.141)
MDAX*2008		0.041 (0.198)		0.243* (0.146)
MDAX*2009		0.040 (0.194)		0.112 (0.143)
MDAX*2010		0.0468 (0.193)		0.174 (0.141)
MDAX*2011		0.171 (0.192)		0.249* (0.141)
MDAX*2012		0.204 (0.194)		0.262* (0.143)
Constant	7.616*** (0.353)	7.663*** (0.358)	7.692*** (0.054)	7.678*** (0.055)
24 Industry dummies	Yes	Yes	Yes	Yes
R ²	0.657	0.659	0.237	0.252
Observations	341	341	341	341
Number of firms	-	-	64	64

Dependent variable: CEO total compensation (log), reference group: DAX companies with less than 10,000 employees in the year 2006; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level.

However, our OLS estimates are likely to be biased by unobserved heterogeneity between firms caused by firm-specific characteristics, e.g. the power of the supervisory board (who are responsible for setting executive compensation), the shareholder structure or the actual extent of employee co-determination in setting executive pay. In the next step, we therefore run a fixed effects regression to avoid unobservable time-invariant firm heterogeneity. In our preferred specification (4) CEO compensation shows a fall in the financial crisis (2008: -16.6%; and 2009: -16.1%), albeit insignificant. The interaction effects of MDAX, indicating convergence, are positive in all years. The magnitude of the effects initially increase in 2007 and 2008, decline in 2009 and rise again steadily from 2010 onwards. However, the effects are significant only in 2008 (24.3%), 2011 (24.9%) and 2012 (26.2%). On the one hand, this suggest a convergence of CEO compensation levels in MDAX companies towards DAX companies rather at the beginning of the crisis. However, as not all companies disclosed their compensation in 2006 despite the new law (VorstOG), this could also be due to a delayed effect. On the other hand, there is an inter segment convergence of CEO compensation levels especially after the economic upswing. Following the adoption of VorstOG in 2009, the MDAX companies were able

to base themselves on the figures for 2010 and adjust their compensation accordingly from 2011 onwards

Table 4.8 shows OLS and Fixed Effects regressions for the log of non-CEO compensation on the different control variables. Comparable to CEO compensation, in models (1) and (2), we find significant positive effects especially for companies with more than 150,000 employees. Average non-CEO compensation in MDAX companies is 60.5% lower than in DAX companies (model 2). For the interaction variables, no further significant effects can be identified.

The fixed effects estimations in models (3) and (4) also show negative significant effects for the years 2008 and 2009. However, in contrast to CEO compensation, we cannot find any significant effects for the interactions between exchange segment and years. Also, there is no clear trend for the magnitude of interaction coefficients. Therefore, the results suggest no inter-segment convergence of non-CEO compensation.

Table 4.8: Determinants of non-CEO total compensation

Dependent variable: non-CEO total compensation (log)	(1) OLS	(2) OLS	(3) FE	(4) FE
10,000–20,000 empl.	0.142* (0.079)	0.141* (0.079)		
20,000–50,000 empl.	–0.001 (0.092)	0.001 (0.093)		
50,000–100,000 empl.	0.098 (0.121)	0.086 (0.122)		
100,000–150,000 empl.	0.151 (0.149)	0.153 (0.151)		
>150,000 empl.	0.406*** (0.145)	0.398*** (0.146)		
Year 2007	0.071 (0.083)	–0.015 (0.129)	0.096 (0.059)	–0.001 (0.092)
Year 2008	–0.132 (0.082)	–0.153 (0.133)	–0.105* (0.059)	–0.169* (0.095)
Year 2009	–0.169** (0.083)	–0.161 (0.133)	–0.167*** (0.060)	–0.172* (0.095)
Year 2010	0.051 (0.083)	–0.059 (0.133)	0.068 (0.060)	–0.043 (0.094)
Year 2011	0.054 (0.083)	–0.003 (0.132)	0.087 (0.061)	0.011 (0.093)
Year 2012	0.070 (0.084)	0.006 (0.133)	0.093 (0.061)	0.027 (0.093)
MDAX	–0.520*** (0.107)	–0.605*** (0.156)	–	–
Profit	8.18e ⁻⁰⁵ *** (1.31e ⁻⁰⁵)	8.42e ⁻⁰⁵ *** (1.35e ⁻⁰⁵)	5.97e ⁻⁰⁵ *** (1.10e ⁻⁰⁵)	6.17e ⁻⁰⁵ *** (1.14e ⁻⁰⁵)
MDAX*2007		0.148 (0.169)		0.166 (0.120)
MDAX*2008		0.0471 (0.171)		0.117 (0.122)
MDAX*2009		0.001 (0.171)		0.026 (0.122)
MDAX*2010		0.181 (0.171)		0.187 (0.122)
MDAX*2011		0.100 (0.171)		0.135 (0.122)
MDAX*2012		0.110 (0.172)		0.120 (0.123)
Constant	6.809*** (0.256)	6.853*** (0.262)	7.143*** (0.045)	7.132*** (0.046)
24 Industry dummies	Yes	Yes	Yes	Yes
R ²	0.576	0.578	0.199	0.208
Observations	435	435	435	435
Number of firms	–	–	73	73

Dependent variable: non-CEO total compensation (log), reference group: DAX companies with less than 10,000 employees in the year 2006; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level.

To test whether the different results between CEO and non-CEO compensation could also be caused by the different sample sizes, we re-estimate the Fixed Effects estimations in Table 4.8. Therefore, we use a reduced sample of companies that published both CEO and non-CEO compensation. In other words, companies in Appendix A4.4 are the same companies as in Table 4.7. Comparable to model (4) in Table 4.8, there are negative significant effects for the financial crisis in 2008 and 2009. The interaction terms show significant effects for the years 2007, 2011 and 2012. Although this would imply a slight convergence, we cannot detect a clear trend of the effects.

To sum up, our estimations on CEO and non-CEO executive compensation show a negative effect for MDAX compared with DAX companies and a decrease in pay levels during the financial crisis, although the last effect is not statistically significant for CEO compensation. Furthermore, CEOs in MDAX companies seem to catch up slightly with their DAX peers over time, indicating an inter-segment convergence of MDAX CEO pay levels towards DAX CEO pay levels. Thus, the second hypothesis can be confirmed for the CEOs. Even if the reduced sample size of the non-CEOs shows slight convergence, this does not apply to the entire sample. As inter-segment convergence is therefore more pronounced among CEOs than among non-CEOs, the third hypothesis can also be confirmed.

4.5.2 CEO and non-CEO compensation structure

Apart from information on total compensation levels, our data provide information on the compensation structures of DAX and MDAX firms. Thus, we are able to extend our previous findings with further insights into whether companies within and between the exchange segments also converge concerning their compensation structures over time. Although not all companies in our sample provide their executives with LTIs or even publish any LTI information, 76% of the companies in our sample publish information on base pay, short-term incentives and long-term incentives. For these companies, Figures 4.3 and 4.4 show the development of the three compensation components over time.

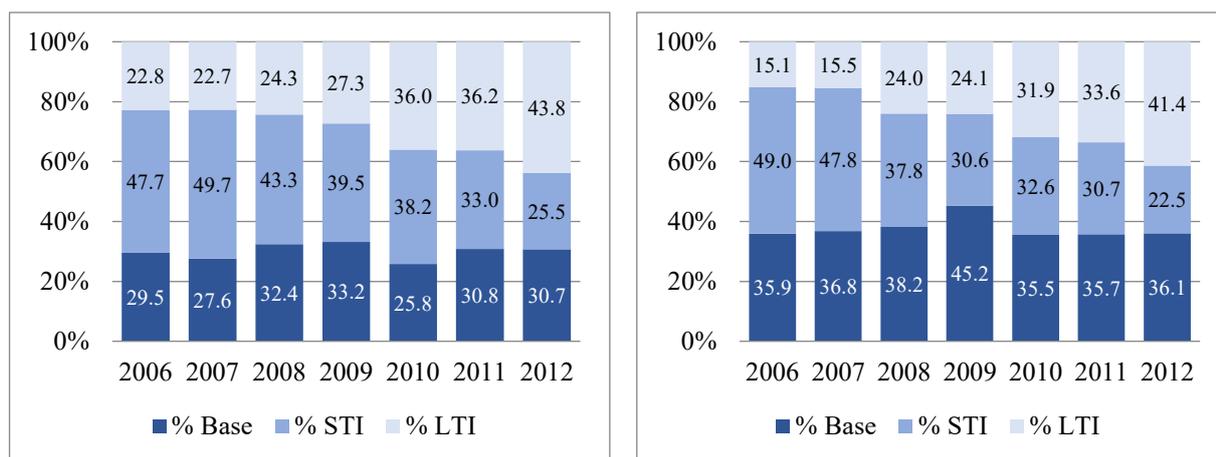


Figure 4.3: Development of compensation structure of DAX CEOs (left, N=110) and MDAX CEOs (right, N=93)

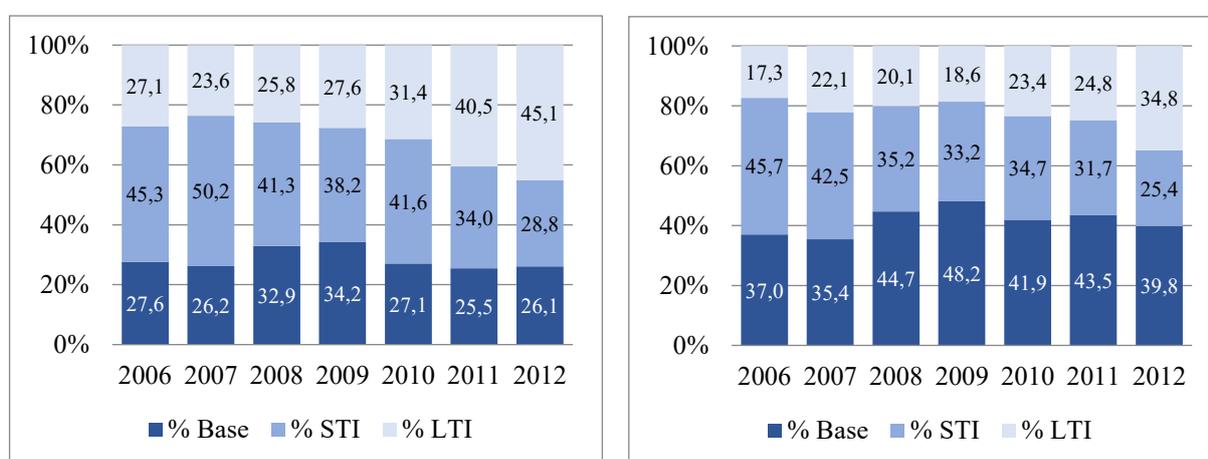


Figure 4.4: Development of compensation structure of DAX non-CEOs (left, N=124) and MDAX non-CEOs (right, N=148)

As can be seen in Figures 4.3 and 4.4, base pay as a fraction of total compensation is lower for DAX CEOs and non-CEOs than for their MDAX peers. During the financial crisis years of 2008 and 2009, the fraction of base pay increases in both exchange segments for all executive board members. This indicates that the variable fractions of compensation dropped during the financial crisis and confirms that the pay-for-performance principle of executive pay proved to be effective. Furthermore, we observe a clear shift within variable compensation over time: The fraction of short-term incentives (STI) decreases, whereas the fraction of long-term incentives (LTI) increases. Especially after 2009, when the new law (VorstAG) was ratified, a ‘leap’ in LTIs can be observed for DAX and MDAX CEOs. A comparison of the pre-crisis (2006–2007) and post-crisis (2010–2012) levels of compensation structures shows a significant fall in the STI fraction and a huge increase in the LTI fraction. The biggest leap can be identified for MDAX CEOs and non-CEOs with more than a doubling of the LTI share.

In the next step, we examine whether a convergence in executive pay structures within each stock exchange segment of DAX and MDAX ('intra-segment analysis') can be observed, followed by an analysis of whether such convergence exists between the two segments ('inter-segment analysis'). In order to be able to perform the analyses on the same sample as the compensation levels, from this point on, we focus on the fraction of base pay exclusively, which is available for almost all companies.

4.5.2.1 Intra-segment analyses

In order to reveal intra-segment convergence of the compensation structure, we base our analyses again on average levels and on the COV. Tables 4.9a and 4.9b show a rise in the fraction of base pay for DAX and MDAX CEOs during the crisis (2008–2009), which results mainly from the substantial reduction in variable compensation. After the crisis, base pay declines slightly again. Although the coefficient of variance for MDAX CEOs shows a declining trend over time, this is rather not the case for DAX CEOs. Comparing only the period before (2006–2007) and after the crisis (2010–2012) (cf. Appendix A4.5), the COV has a fairly equal level for DAX CEOs at both times. For MDAX CEOs, both the fraction of base pay as well as the COV are falling after the crisis, which indicates convergence.

Table 4.9a: Base pay fraction (of total compensation) for DAX CEOs (in %)

	2006	2007	2008	2009	2010	2011	2012
Average	27.2	26.5	36.1	39.6	29.8	31.7	33.4
SD	14.4	14.3	20.6	23.7	11.6	19.0	19.5
COV (SD/Avg.)	0.529	0.540	0.571	0.598	0.389	0.597	0.584
N	21	23	19	23	22	23	22

Table 4.9b: Base pay fraction (of total compensation) for MDAX CEOs (in %)

	2006	2007	2008	2009	2010	2011	2012
Average	42.3	37.2	42.7	49.6	39.5	35.7	36.1
SD	17.5	13.2	16.7	20.1	17.8	12.9	11.1
COV (SD/Avg.)	0.414	0.355	0.391	0.405	0.451	0.361	0.307
N	21	25	27	25	31	30	30

In line with the compensation level, again the companies in the individual exchange segments are divided into subgroups for the purpose of comparing the compensation structure for CEOs and non-CEOs (cf. Tables 4.10a and 4.10b). To this end, the fraction of base pay quantiles (0.25/0.5/0.75) in 2006 were used as threshold values for classification. Thus, the development of companies that already had a high proportion of base pay in 2006 can be compared over time with companies that still had a rather smaller fraction of base pay in total compensation. First, it is apparent that there are clear differences in the compensation structure of both DAX and MDAX CEOs between the individual subgroups of companies before the crisis. Figure 4.5 also shows that all groups increase the base pay and decrease the variable pay in times of crisis. Regarding the compensation structure for DAX CEOs, the subgroups are converging after the crisis and the adoption of the new law (VorstAG). As a result, all of them have a fraction of base pay of between approximately 30% and 40%. Thus, based on the group comparison, this would imply a convergence of DAX CEOs. For the MDAX CEOs there is also a convergence over time, although this is lower than for the DAX CEOs. The increase in the range in 2011 and 2012 is mainly due to the decline in base pay for the group MDAX_{25C}. This implies only a slight convergence for the MDAX CEOs.

Table 4.10a: Comparison of: base pay fraction groups of DAX CEOs⁷⁸ (in %)

	2006	2007	2008	2009	2010	2011	2012
Avg. DAX _{25C}	15.4	14.7	37.7	22.7	29.3	28.0	28.4
Avg. DAX _{25-50C}	23.5	23.4	40.4	51.5	23.5	36.9	36.1
Avg. DAX _{50-75C}	27.4	26.7	31.3	31.8	30.3	31.9	29.8
Avg. DAX _{75C}	43.3	38.6	31.9	50.9	37.5	31.5	42.5
Range	27.9	23.9	9.1	28.8	8.2	8.9	14.1
N	21	20	16	20	19	20	19

⁷⁸ The first group DAX_{25C} (n=6) includes the 25% of companies that had less than 21.7% fraction of base pay in 2006. The next highest group DAX_{25-50C} (n=5) had less than 25.4% fraction of base pay. The third group DAX_{50-75C} (n=5) includes companies with between 25.4% and 28.6% fraction of base pay in the reference year. In the group DAX_{75C} (n=5) are companies that had more than 28.6% base pay in 2006.

Table 4.10b: Comparison of: base pay fraction groups of MDAX CEOs⁷⁹ (in %)

	2006	2007	2008	2009	2010	2011	2012
Avg. MDAX _{25C}	26.4	29.1	35.2	34.4	31.5	22.4	24.0
Avg. MDAX _{25-50C}	34.9	35.8	44.9	63.9	52.8	30.7	37.9
Avg. MDAX _{50-75C}	44.3	44.0	49.3	46.3	43.7	44.6	40.0
Avg. MDAX _{75C}	65.3	37.6	54.7	61.7	35.1	43.4	42.8
Range	33.9	14.9	17.3	19.5	15.3	22.2	16.4
N	21	18	18	16	17	16	15

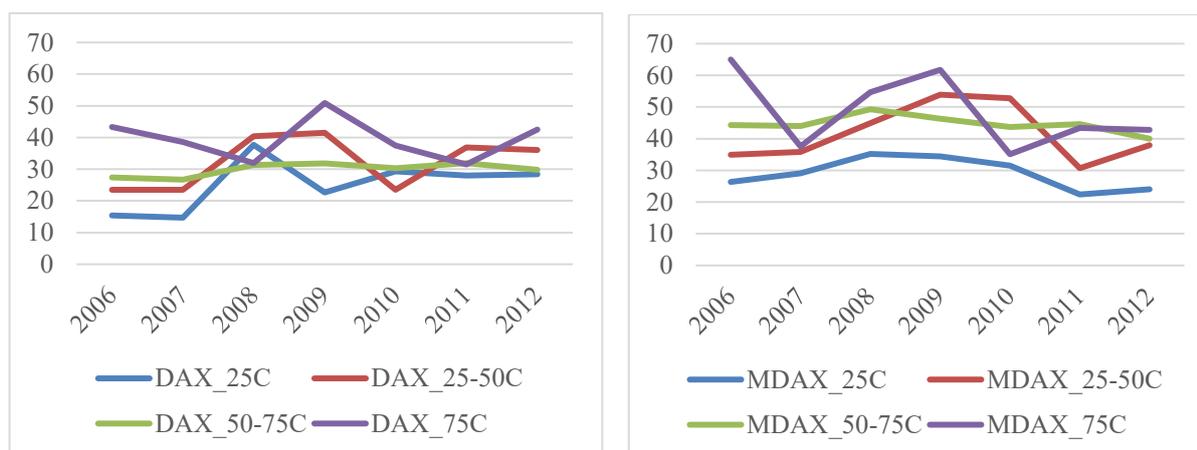


Figure 4.5: Development of fraction of base pay in different groups of DAX CEOs (left) and MDAX CEOs (right)

Tables 4.11a and 4.11b show the development of compensation structures for DAX and MDAX non-CEOs. Both DAX and MDAX companies reduced the variable compensation components also for their non-CEOs in the crisis. Thus, the fraction of base pay increased. After the crisis, the fraction of base pay declined again somewhat but, in both segments, it remains above the pre-crisis level. Based on the declining COV, both for DAX and MDAX non-CEOs we find an intra-segment convergence for the fraction of base pay on total compensation. The comparison of pre-crisis and post-crisis levels in Appendix 5 also shows an increase in the fraction of base pay and a reduction in the COV over time.

⁷⁹ The group **MDAX_{25C}** (n=6) includes the 25% of companies that had less than 33.2% fraction of base pay in the reference year 2006. Threshold values for the second group (**MDAX_{25-50C}**, n=5) are 33.2% and 36.9%. The group **MDAX_{50-75C}** (n=5) comprises companies with less than 49.4% fraction of base pay. In the group **MDAX_{75C}** (n=5) are companies that had more than 49.4% fraction of base pay in 2006.

Table 4.11a: Base pay fraction (of total compensation) for DAX non-CEOs (in %)

	2006	2007	2008	2009	2010	2011	2012
Average	28.9	27.4	40.9	39.0	32.3	32.6	32.9
SD	15.4	14.5	26.3	23.2	17.4	18.4	13.2
COV (SD/Avg.)	0.533	0.529	0.643	0.595	0.539	0.564	0.401
N	24	24	23	23	23	23	23

Table 4.11b: Base pay fraction (of total compensation) for MDAX non-CEOs (in %)

	2006	2007	2008	2009	2010	2011	2012
Average	41.7	38.8	47.2	52.5	42.6	43.8	42.4
SD	19.3	18.4	18.4	20.0	17.3	16.2	11.8
COV (SD/Avg.)	0.463	0.474	0.390	0.381	0.406	0.370	0.278
N	29	38	42	40	42	40	38

Looking at the fraction of base pay in the subgroups of companies in Tables 4.12a and 4.12b, we find a similar picture for DAX and MDAX non-CEOs we find similar development to the CEOs as for their CEO counterparts. All groups again increase their fraction of base pay in the crisis. After the crisis and the implementation of the new law (VorstAG) in 2010, the groups that initially had the lowest fraction (DAX_{25NC} and MDAX_{25NC}) remain well above the pre-crisis level. In contrast, the initially highest groups regarding to the fraction of base pay goes below the pre-crisis level or remain relatively constant. This overall development is also reflected in a reduction of the range for DAX as well as MDAX non-CEOs. Based on the comparison of the subgroups, we also find an intra-segment convergence for both DAX and MDAX non-CEOs.

Table 4.12a: Comparison of: base pay fraction groups of DAX non-CEOs⁸⁰ (in %)

	2006	2007	2008	2009	2010	2011	2012
DAX _{25NC}	15.6	18.6	38.8	26.8	24.4	25.8	27.3
DAX _{25-50NC}	23.6	24.3	46.4	48.6	40.1	41.1	34.5
DAX _{50-75NC}	28.9	23.8	30.4	30.4	29.1	29.5	33.3
DAX _{75NC}	47.5	43.0	49.4	52.7	36.1	34.3	37.2
Distance	31.9	24.4	20.6	25.9	21.7	15.3	9.9
N	24	24	23	23	23	23	23

⁸⁰ The first group DAX_{25NC} (n=6) includes the 25% of companies that had less than 21.6% fraction of base pay in 2006. The next highest group DAX_{25-50NC} (n=6) had less than 25.4%. The third group DAX_{50-75C} (n=6) includes companies with between 25.4% and 32.3%. In the group DAX_{75C} (n=6) are companies that had more than 32.3% base pay in 2006.

Table 4.12b: Comparison of: base pay fraction groups of MDAX non-CEOs⁸¹ (in %)

	2006	2007	2008	2009	2010	2011	2012
MDAX_25NC	21.5	23.6	43.0	51.2	46.9	52.8	43.2
MDAX_25-50NC	35.1	30.7	45.3	46.0	46.8	40.2	36.3
MDAX_50-75NC	43.6	37.1	55.0	44.9	36.6	41.8	46.5
MDAX_75NC	64.6	55.8	54.7	63.1	46.5	45.8	46.4
Distance	43.1	30.5	12.0	16.7	6.8	5.7	11.5
N	29	29	28	26	25	23	22

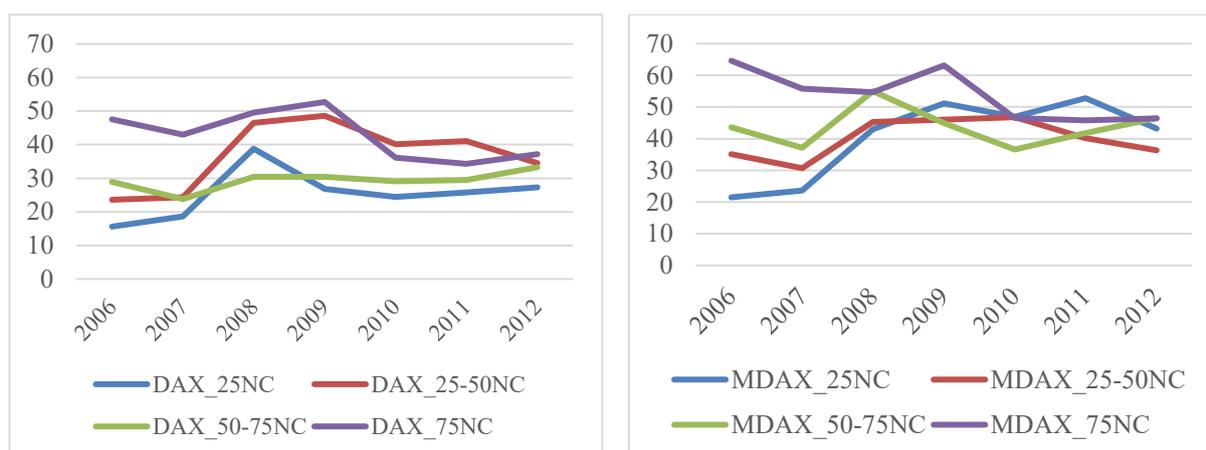


Figure 4.6: Development of fraction of base pay in different groups of DAX non-CEOs (left) and MDAX non-CEOs (right)

In total, based on the COV and the development of the fraction of base pay between the subgroups, we find intra-segment convergence for DAX non-CEOs and MDAX CEOs and non-CEOs. Even though the COV tends to show a constant trend, the development between the individual subgroups would also imply a convergent behaviour for the DAX CEOs. Thus, the fourth hypothesis can be confirmed for both MDAX executives as well as for DAX non-CEOs and, to a limited extent, for the DAX CEOs. However, as there is no stronger convergence among CEOs compared to the non-CEOs, the sixth hypothesis is rejected on the basis of the intra-segment analyses.

⁸¹ The group MDAX_{25NC} (n=7) includes the 25% of companies that had less than 28.3% fraction of base pay in the reference year 2006. Threshold values for the second group (MDAX_{25-50C}) (n=8) are 28.3% and 39.8%. The group MDAX_{50-75C} (n=6) comprises companies with less than 48.6% fraction of base pay. In the group MDAX_{75C} (n=8) are companies that had more than 48.6% fraction of base pay in 2006.

4.5.2.2 Inter-segment analyses

As the previous analyses have shown, DAX companies generally have a substantially lower proportion of base pay than MDAX companies. In addition, the fraction of base pay in DAX companies increases by more than in MDAX companies. This would imply that, in addition to intra-segment convergence in the compensation structure, there is also inter-segment convergence. In order to find out, the average fraction of base pay and the coefficient of variance in both segments are initially compared with each other. Table 4.13 shows that the differences in fraction of base pay among CEOs between the two segments are converging and that the COV is also decreasing over time. In contrast, the COV for the non-CEOs in Table 4.14 does not show such a clear downward trend as for the CEOs. This is also confirmed by the comparison of pre-crisis (2006–2007) and post-crisis (2010–2012) levels in Appendix A5. Hence, on a descriptive basis, this suggests an inter-segment convergence for CEOs and a slight convergence for non-CEOs.

Table 4.13: Fraction of base pay of CEOs in both segments

	2006	2007	2008	2009	2010	2011	2012
Average DAX	27.2%	26.5%	36.1%	39.6%	29.8%	31.7%	33.4%
Average MDAX	42.3%	37.2%	42.7%	49.6%	39.5%	35.7%	36.1%
Average all	34.8%	32.0%	40.0%	44.8%	35.4%	34.0%	35.0%
SD all	17.4%	14.6%	18.5%	22.2%	16.2%	15.1%	15.1%
COV (SD/Avg.)	0.500	0.456	0.463	0.496	0.458	0.444	0.431
N	42	48	46	48	53	53	52

Table 4.14: Fraction of base pay of non-CEOs in both segments

	2006	2007	2008	2009	2010	2011	2012
Average DAX	28.9%	27.4%	40.9%	39.0%	32.3%	32.6%	32.9%
Average MDAX	41.7%	38.8%	47.2%	52.5%	42.6%	43.8%	42.4%
Average all	35.9%	34.4%	45.0%	47.6%	38.9%	39.8%	38.8%
SD all	18.6%	17.8%	21.6%	22.0%	17.9%	20.8%	18.1%
COV (SD/Avg.)	0.518	0.517	0.480	0.462	0.460	0.523	0.466
N	53	62	66	64	65	63	61

In order to ensure that the results are not influenced by other factors, we additionally conduct multivariate OLS and Fixed Effects estimations. In doing so, we use base pay as a fraction of total compensation for CEOs and non-CEOs as the dependent variable. Furthermore,

to ensure consistent analysis, we use the same interaction terms, control variables and the same sample that we used for the analysis of pay levels. Model (1) in Table 4.15 shows our OLS estimates for the fraction of base pay for the control variables firm size, year, exchange segment, profit and industry dummies. The results again show a significant positive effect of 9.7 percentage points (PP) for firms with more than 150,000 employees. As in the regressions of pay levels, the coefficient on profit is not of any practical relevance. Model (1) also shows that the fraction of CEO base pay at MDAX firms is 10 PP higher than in DAX firms. In addition, we find that the fraction of base pay in 2009 increases by 8.5 PP compared with 2006. This increase indicates that the reduction in CEO compensation in the crisis (cf. Chapter 4.5.1.2) can be explained by a reduction in variable compensation while the fraction of base pay increases. To reveal the inter-segment convergence between DAX and MDAX companies, in model (2), we add interactions between exchange segment and year to the set of independent variables from model (1). The significant estimates for firm size and profit remain robust, but the coefficient for MDAX almost doubles (17.1 PP). In addition, the interaction terms of year and MDAX show statistically significant negative effects in 2011 (12.7 PP) and in 2012 (14.4 PP).

To control for time-invariant unobserved heterogeneity, in models (3) and (4), we again run Fixed Effect estimations for the fraction of base pay on the different control variables. In specification (3), besides the robust effect of profit, we find significant positive effects in the crisis years 2008 (5.7 PP) and 2009 (10.0 PP). When adding the interaction terms in our preferred specification (4), the positive effect of 2009 remains rather stable. The effect of the year 2008 almost doubles (10.4 PP), and we find an additional positive significant effect in the year 2012 (9.2 PP). The interaction terms of MDAX are negative in all years. However, we find significant negative effects only in the years 2011 (-10.1 PP) and 2012 (-12.8 PP). On the one hand, this is because DAX companies have slightly increased the fraction of their fixed compensation after the crisis and the implementation of the new law on the appropriateness of executive pay (VorStAG). On the other hand, it is because MDAX companies have slightly reduced the originally high fraction of base pay. This suggests an inter-segment convergence of MDAX and DAX CEOs.

Table 4.15: Determinants of fraction of base pay (total CEO compensation)

Dependent variable:	(1)	(2)	(3)	(4)
Base pay fraction (CEO)	OLS	OLS	FE	FE
10,000–20,000 empl.	0.021 (0.036)	0.017 (0.036)	–	–
20,000–50,000 empl.	0.051 (0.035)	0.047 (0.035)	–	–
50,000–100,000 empl.	0.023 (0.044)	0.028 (0.044)	–	–
100,000–150,000 emp.	0.058 (0.053)	0.042 (0.054)	–	–
>150,000 empl.	0.097* (0.052)	0.096* (0.053)	–	–
Year 2007	–0.023 (0.032)	0.010 (0.046)	–0.024 (0.028)	0.010 (0.040)
Year 2008	0.039 (0.033)	0.070 (0.050)	0.057* (0.029)	0.104** (0.043)
Year 2009	0.085** (0.033)	0.096** (0.047)	0.100*** (0.028)	0.108*** (0.040)
Year 2010	0.002 (0.032)	0.038 (0.048)	0.020 (0.028)	0.051 (0.041)
Year 2011	–0.012 (0.032)	0.056 (0.047)	0.008 (0.028)	0.057 (0.040)
Year 2012	0.001 (0.032)	0.079* (0.048)	0.029 (0.028)	0.092** (0.040)
MDAX	0.100** (0.039)	0.171*** (0.059)	–	–
Profit	–2.52e ^{-05***} (4.59e ⁻⁰⁶)	–2.60e ^{-05***} (4.66e ⁻⁰⁶)	–1.92e ^{-05***} (4.62e ⁻⁰⁶)	–1.97e ^{-05***} (4.74e ⁻⁰⁶)
MDAX*2007		–0.063 (0.065)		–0.069 (0.056)
MDAX*2008		–0.060 (0.067)		–0.092 (0.058)
MDAX*2009		–0.023 (0.065)		–0.019 (0.057)
MDAX*2010		–0.071 (0.065)		–0.067 (0.056)
MDAX*2011		–0.127* (0.065)		–0.101** (0.052)
MDAX*2012		–0.144** (0.065)		–0.128** (0.056)
Constant	0.209* (0.120)	0.195 (0.121)	0.359*** (0.022)	0.365*** (0.021)
24 Industry dummies	Yes	Yes	Yes	Yes
R ²	0.334	0.350	0.168	0.192
Observations	341	341	341	341
Number of firms			64	64

Dependent variable: Fraction of base pay on total CEO compensation; reference group: DAX companies with less than 10,000 employees in the year 2006; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level.

Table 4.16 shows OLS and Fixed Effect estimates for non-CEO base pay as a fraction of total compensation. According to model (1) and (2), base pay for companies with more than 150,000 employees is again significantly higher. During the financial crisis, we observe a significant increase in the fraction of base pay compared with the reference year 2006. As with CEOs, for non-CEOs, we also find a significantly higher fraction of base pay for MDAX companies compared with DAX companies (14.3 PP in model 2). The coefficient for profit is again significant but has no economic relevance. Also, the interaction terms show no statistically significant coefficients.

In models (3) and (4), again we conduct fixed effect estimations to control for unobserved heterogeneity. Both models show significant increases in the fraction of base pay during the financial crisis. As in the OLS specification above, these positive coefficients indicate that the reduction in executive compensation during the financial crisis can be explained by decreasing variable compensation. The interaction terms in our preferred specification (4) are negative (except in the year 2009) but insignificant. Hence, the results suggest no inter-segment convergence of non-CEO compensation.

Table 4.16: Determinants of fraction of base pay (total non-CEO compensation)

Dependent variable:	(1)	(2)	(3)	(4)
Base pay fraction (non-CEO)	OLS	OLS	FE	FE
10,000–20,000 empl.	0.037 (0.028)	0.038 (0.028)	–	–
20,000–50,000 empl.	0.047 (0.033)	0.047 (0.033)	–	–
50,000–100,000 empl.	0.036 (0.043)	0.039 (0.043)	–	–
100,000–150,000 empl.	0.067 (0.053)	0.064 (0.054)	–	–
>150,000 empl.	0.114** (0.052)	0.116** (0.052)	–	–
Year 2007	–0.019 (0.030)	–0.006 (0.046)	–0.022 (0.025)	–0.006 (0.038)
Year 2008	0.069** (0.030)	0.085* (0.047)	0.066*** (0.025)	0.084** (0.040)
Year 2009	0.095*** (0.030)	0.075 (0.047)	0.100*** (0.025)	0.072* (0.040)
Year 2010	0.020 (0.030)	0.040 (0.047)	0.024 (0.025)	0.032 (0.040)
Year 2011	0.028 (0.030)	0.048 (0.047)	0.032 (0.025)	0.038 (0.040)
Year 2012	0.021 (0.030)	0.050 (0.047)	0.027 (0.026)	0.041 (0.040)
MDAX	0.123*** (0.038)	0.143** (0.056)	–	–
Profit	–2.44e ⁻⁰⁵ *** (4.64e ⁻⁰⁶)	–2.50e ⁻⁰⁵ *** (4.78e ⁻⁰⁶)	–1.99e ⁻⁰⁵ *** (4.58e ⁻⁰⁶)	–2.06e ⁻⁰⁵ *** (4.77e ⁻⁰⁶)
MDAX*2007		–0.023 (0.061)		–0.027 (0.051)
MDAX*2008		–0.029 (0.061)		–0.030 (0.052)
MDAX*2009		0.029 (0.061)		0.042 (0.052)
MDAX*2010		–0.035 (0.061)		–0.015 (0.052)
MDAX*2011		–0.034 (0.061)		–0.011 (0.052)
MDAX*2012		–0.049 (0.062)		–0.023 (0.052)
Constant	0.247** (0.103)	0.242** (0.106)	0.386*** (0.019)	0.388*** (0.020)
24 Industry dummies	Yes	Yes	Yes	Yes
R ²	0.374	0.378	0.154	0.162
Observations	431	431	431	431
Number of firms			73	73

Dependent variable: Fraction of base pay on total non-CEO compensation; reference group: DAX companies with less than 10,000 employees in the year 2006; standard errors in parenthesis; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level.

In order to ensure that the different results between CEOs and non-CEOs do not result from the different sample sizes, we re-calculate the fixed effect regressions for the fraction of non-CEO base pay for the reduced sample size of firms who published information on CEO compensation. The results are shown in Appendix A4.6. Different from the regression with the full sample size, we observe a significant negative effect for the interaction between year 2012 and MDAX (-9.4 PP). Even if we base our analyses for non-CEO compensation structure on the restricted sample, this implies only a slight convergence between DAX and MDAX non-CEOs in 2012. This indicates that the compensation structure for CEOs develops differently from that for non-CEOs. Another explanation could be measurement errors in the data for non-CEOs, as they mainly capture average values across the entire executive board and are not as precise as the data on CEO compensation.

To sum up, the Fixed Effects estimations show a positive effect of the crisis on the fraction of base pay for CEOs as well as non-CEOs. This is mainly because variable pay was reduced in this economically difficult time. In addition, there are significant negative interaction effects for 2011 and 2012, indicating an inter-segment convergence of the compensation structure of MDAX and DAX CEOs. Based on the full sample, however, there are no significant interaction effects for the non-CEOs. Thus, the fifth hypothesis can only be confirmed for the CEOs. As inter-segment convergence is therefore again more pronounced among CEOs than among non-CEOs, the sixth hypothesis can be confirmed.

Finally, the main results of this study will be briefly summarized and discussed. Based on our first hypothesis, we investigate to what extent the compensation levels converge within the individual exchange segments DAX and MDAX. Our different descriptive analyses show intra-segment convergence especially for DAX and MDAX CEOs as well as a slight convergence for DAX non-CEOs from 2010 onwards. Furthermore, based on our second hypothesis, we also investigate whether the level of executive pay converges between MDAX and DAX companies. Multivariate analyses confirm a slight inter-segment convergence between the exchange segments only for CEOs. For both intra- and inter-segment analyses, we find a stronger convergence of CEO compared to non-CEO compensation levels. Therefore, also the third hypothesis can be confirmed. It seems plausible that convergence within and between the segments is particularly evident among CEOs. As they are more in the public eye, information on their compensation is available in media or compensation studies. This is particularly true for

the period following the adoption of the new laws (VorstOG and VorstAG), requiring the disclosure and the appropriateness of individual executive pay. Therefore, it is easier for other companies to base their compensation on previously unknown information. Based on the role model function of DAX companies regarding compensation practices and ‘legitimate’ standards, the convergence of MDAX companies also appears plausible. However, this is not as pronounced as convergence with comparable companies (intra-segment convergence).

In addition to the compensation level, this study also examines isomorphism regarding the compensation structure. Based on our fourth hypothesis, we investigate to what extent the compensation structures converge within the individual exchange segments DAX and MDAX. Descriptive analyses reveal intra-segment convergence for all executives in DAX as well as MDAX companies. Furthermore, there is no stronger effect for CEOs than for non-CEOs. Based on our fifth hypothesis, we also investigate whether the structure of executive pay converges between MDAX and DAX companies. As with the compensation level, we find inter-segment convergence only for CEOs. Accordingly, the sixth hypothesis can be confirmed at least for the inter-segment convergence. Overall, the convergence of the compensation structure also appears plausible. As the compensation structure is more closely linked to legal requirements than the compensation level, it is therefore easier to implement this structure. This could facilitate convergence with other companies in the sector – also for non-CEOs. The inter-segment convergence for CEOs may be an intended result of disclosure, putting MDAX executives under pressure to accept a lower fraction of base pay and a higher fraction of variable pay than in the past. The fact that the analyses indicate no inter-segment convergence of pay levels and pay structure for non-CEOs, may also result from restricted data quality or measurement errors in non-CEO compensation data or the much higher heterogeneity of responsibilities and total pay levels.

4.6 Conclusion

The objective of this paper is to examine whether the level and structure of executive pay in Germany have undergone isomorphic change during the period 2006–2012. We conduct descriptive as well as multivariate analyses for two groups of executives (CEOs and non-CEOs) and for the two most important German stock exchange segments, DAX and MDAX. We find confirmation for the evolution of isomorphic pay practices in terms of converging pay levels

within (intra-segment convergence) and between (inter-segment convergence) stock exchange segments especially for CEOs. Furthermore, we observe intra-segment convergence for the compensation structures of all DAX and MDAX executives. However, converging compensation structures between exchange segments can only be observed for CEOs.

This study enhances our knowledge about the phenomenon of institutional isomorphism and provides new insights into the evolution and extent of isomorphism in the field of executive compensation. First, it contributes to knowledge about the determinants of executive pay by applying a social perspective and exploring the role of institutional change in organizational pay practices. Second, it adds to the empirical literature about the institutional phenomenon of isomorphism in general and isomorphism of executive compensation in particular. Third, although some academic work on the convergence of executive pay systems does exist, these studies focus on comparisons of pay practices in different institutional contexts. In contrast, the present study focuses on Germany and explores the effects of institutional change on compensation practices within this context. Fourth, we are able to measure the extent of isomorphism regarding diverse dimensions: levels and structure of pay; CEO pay and non-CEO pay; within (intra) as well as between (inter) the segments DAX and MDAX. Fifth, with access to a hand-collected database about German executive compensation, we contribute to the know-how about executive compensation in a country where the disclosure of executive pay and hence the extent of empirical research on this subject are historically by no means comparable to the US. This allows us to gain knowledge about an institutional context that has not yet been extensively researched.

Of course, this study is subject to various limitations: first of all, data quality is an obvious limitation, especially concerning LTIs. It is expected that, going forward, disclosure and transparency regarding this part of compensation will improve, thus enabling more refined research on short-term and long-term compensation and the structure of executive pay. One further limitation is obviously the data we use. Unfortunately, no recognized and generally accessible database on German executive pay is available. Although we are grateful for the opportunity to base our analysis on the database provided by Kienbaum, who maintain one of Europe's most exhaustive compensation databases, other researchers using other data may reach different results. It is therefore highly desirable, that in future a recognized and generally accessible database on German executive pay is created. Moreover, the analyses used in this study does not allow to explore the exact causes of the convergence we observe (and not observe). On the one hand, the intra-segment analyses only describe the underlying developments in pay levels and pay structure. However, the use of multivariate methods such as quantile regressions

or Fixed Effect estimations has failed due to low observation numbers in the subgroups or has not produced any meaningful results. On the other hand, the multivariate analyses do not allow for causal statements either. On the basis of the used methods and the data design, it is not possible to separate the effect of the crisis from the effect of institutional changes on convergence. To this end, it would have been necessary to use a quasi-experimental design. Based on additional information on whether a company was affected by the crisis or to what extent the legal requirements on executive pay have already been implemented, the effects of convergence could possibly be separated.

Having found clear signs of isomorphism for German executive compensation within our observation period, it would be highly desirable to learn whether this phenomenon can also be observed in the years that follow: does convergence of certain pay characteristics endure? Which direction does it take? What are the triggering factors or events? What is the impact of recent and future measures of regulation and institutional change? In order to better understand the impact of the institutional context on the determinants and consequences of executive pay, future research from an institutional perspective could contribute a great amount of insight, e.g., are different strategies of legitimation of executive pay packages successful in different time or institutional contexts? Does national or transnational isomorphism of executive pay occur with regard to different executive functions (e.g. Chief Financial Officer) or industries? This, however, is beyond the scope of this study.

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APPENDIX TO CHAPTER 2

Table A2.1: Description of differences between training participants and all training non-participants

Socio-demographic factors	Total (%)	Training participants (%)	Training non-participants (%)	t-value
Female	28.52	29.47	27.57	-3.06***
<u>Birth year</u>				
≤ 1951	12.09	10.51	13.91	-7.43***
1952–61	35.52	35.73	33.94	1.62*
1962–71	30.76	31.94	29.45	-3.91***
≥ 1972	21.63	21.83	19.85	-3.54***
<u>Experience</u>				
< 10 years	20.62	19.70	18.40	-2.41**
10–20 years	50.12	50.46	50.71	0.35
> 20 years	29.27	29.84	30.89	1.66*
<u>Tenure</u>				
< 10 years	43.89	44.19	42.82	-2.01**
10–20 years	37.52	38.79	38.14	-0.96
> 20 years	18.59	17.02	19.04	3.79***
<u>Education</u>				
No vocational education	6.06	3.54	6.85	10.31***
Vocational education	73.41	69.00	75.59	10.56***
University degree	20.53	27.47	17.56	-17.24***
Wage increase dummy	34.46	35.97	34.49	-2.21**
Log daily wage 2005 ⁸²	4.52	4.62	4.46	-7.98***
Log daily wage 2006	4.57	4.66	4.52	-9.22***
Log daily wage 2007	4.54	4.67	4.46	-11.17***
Log daily wage 2008	4.52	4.68	4.42	-11.09***
<u>Training</u>				
Training certificate	–	75.22	–	–
External certificate	–	84.40	–	–
Training with general content	–	82.68	–	–
Observations	21,069	6,860	14,209	

*Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

⁸² The log daily wages 2005–2008 are given in absolute numbers.

Table A2.2: Determinants of wage in the next year (Mincer equation)

Dependent variable:	Full sample	Restricted sample
Log(daily wage) in the next year	OLS (1)	OLS (2)
Training	0.098*** (0.005)	0.034*** (0.009)
Female	-0.158*** (0.005)	-0.126*** (0.008)
Birthyear 1952-1961	-0.033** (0.008)	-0.031*** (0.011)
Birthyear 1962-1971	0.033*** (0.08)	0.038*** (0.012)
Birthyear > 1972	0.005 (0.011)	-0.033** (0.016)
Tenure < 10	-0.002 (0.009)	-0.017 (0.012)
Tenure 10-20	0.001 (0.008)	-0.025** (0.012)
Experience < 10	-0.383*** (0.011)	-0.333*** (0.016)
Experience 10-20	-0.250*** (0.007)	-0.227*** (0.010)
Work satisfaction	0.024*** (0.001)	0.016*** (0.002)
Vocational education	0.121*** (0.010)	0.075*** (0.017)
University degree	0.462*** (0.011)	0.386*** (0.018)
Year	yes	yes
Firm characteristics	yes	yes
R ²	0.347	0.334
Observations	21,069	8,186

Dependent variable: Log(daily wage) in the next year; reference category for age: birth year \leq 1951; reference category for tenure: tenure \geq 20 years; reference category for experience: experience \geq 20 years; reference category for education: no vocational education; establishment characteristics: size, sector. *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

Table A2.3: Determinants of employee retention; marginal effects after Probit

Dependent variable: retention next year	Basic models	Basic models with credible training
	Probit (1)	Probit (2)
Training	0.139*** (0.026)	0.237*** (0.057)
Training * portable	-0.011** (0.005)	-0.035*** (0.011)
Training * visible	-0.017*** (0.004)	-0.028*** (0.009)
Female	-0.003 (0.004)	0.001 (0.006)
Birth year 1952–1961	-0.023** (0.011)	-0.045** (0.021)
Birth year 1962–1971	-0.029** (0.012)	-0.053** (0.021)
Birth year > 1972	-0.036** (0.016)	-0.053** (0.027)
Tenure < 10 years	-0.025*** (0.009)	-0.035*** (0.012)
Tenure 10–20 years	-0.005 (0.008)	-0.003 (0.012)
Experience < 10 years	-0.015 (0.010)	-0.019 (0.014)
Experience 10–20 years	-0.005 (0.005)	-0.006 (0.008)
Vocational education	-0.007 (0.009)	0.012 (0.014)
University degree	-0.011 (0.007)	0.008 (0.013)
Year dummies	yes	yes
Establishment characteristics	yes	yes
R ²	0.131	0.136
Observations	8,186	4,879
Individuals	–	–
AR-test	–	–
Hansen-test	–	–

Dependent variable: retention probability in the next calendar year; reference category for age: birth year ≤ 1951 ; reference category for tenure: tenure ≥ 20 years; reference category for experience: experience ≥ 20 years; reference category for education: no vocational education; establishment characteristics: size, sector. *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

Table A2.4: Determinants of employee retention; full sample

Dependent variable: retention next year	Basic models			Basic models with credible training		
	OLS (1)	FE (2)	GMM (3)	OLS (4)	FE (5)	GMM (6)
Training	0.093*** (0.010)	0.083*** (0.011)	0.074*** (0.012)	0.113*** (0.017)	0.109*** (0.020)	0.117*** (0.020)
Training * portable	-0.006 (0.009)	0.004 (0.011)	0.015 (0.010)	-0.019 (0.015)	0.008 (0.018)	0.006 (0.016)
Training * visible	-0.013* (0.007)	-0.011 (0.009)	-0.002 (0.010)	-0.021* (0.013)	-0.032** (0.015)	-0.025 (0.016)
Female	0.007 (0.005)	–	–	0.010* (0.005)	–	–
Birth year 1952–1961	-0.009 (0.006)	–	–	-0.008 (0.007)	–	–
Birth year 1962–1971	-0.008 (0.007)	–	–	-0.008 (0.008)	–	–
Birth year > 1972	-0.026*** (0.010)	–	–	-0.026** (0.011)	–	–
Tenure < 10 years	-0.059*** (0.007)	0.310*** (0.017)	0.402*** (0.035)	-0.070*** (0.009)	0.311*** (0.023)	0.384*** (0.041)
Tenure 10–20 years	0.020 (0.007)	0.155*** (0.017)	0.120*** (0.030)	0.019** (0.009)	0.135*** (0.020)	-0.079** (0.036)
Experience < 10 years	-0.060*** (0.010)	-0.086*** (0.026)	-0.123*** (0.036)	-0.066*** (0.011)	-0.070** (0.031)	-0.109** (0.043)
Experience 10–20 years	-0.026*** (0.006)	-0.024 (0.018)	-0.021 (0.019)	-0.029*** (0.007)	-0.020 (0.021)	-0.019 (0.023)
Vocational education	0.004 (0.008)	–	–	0.012 (0.010)	–	–
University degree	-0.001 (0.004)	–	–	0.006 (0.011)	–	–
Year dummies	yes	yes	yes	yes	yes	yes
Establishment Characteristics	yes	yes	yes	yes	yes	yes
R ²	0.078	0.070	–	0.080	0.071	–
Observations	17,862	17,862	11,992	14,555	13,958	8,332
Individuals	–	6,116	5,544	–	5,931	4,499
AR-test	–	–	0.000	–	–	0.000
Hansen-test	–	–	0.122	–	–	0.228

Dependent variable: retention probability in the next calendar year; reference category for age: birth year ≤ 1951; reference category for tenure: tenure ≥ 20 years; reference category for experience: experience ≥ 20 years; reference category for education: no vocational education; establishment characteristics: size, sector. *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

Table A2.5: Determinants of employee retention (consideration of wage increase and satisfaction)

Dependent variable: retention next year	Models with portable and visible training			Models with portable, visible and credible training		
	OLS (1)	FE (2)	GMM (3)	OLS (4)	FE (5)	GMM (6)
Training	0.105*** (0.010)	0.119*** (0.016)	0.141*** (0.030)	0.121*** (0.016)	0.149*** (0.026)	0.179*** (0.038)
Wage increase	0.031*** (0.005)	0.029*** (0.007)	0.036*** (0.012)	0.040*** (0.007)	0.044*** (0.011)	0.044*** (0.014)
Training * portable	-0.013** (0.006)	-0.017 (0.011)	-0.016 (0.014)	-0.030** (0.012)	-0.021 (0.019)	-0.040** (0.019)
Training * visible	-0.016** (0.007)	-0.018* (0.010)	-0.017 (0.015)	-0.017* (0.010)	-0.041** (0.016)	-0.036* (0.019)
Female	-0.002 (0.005)	–	–	0.002 (0.008)	–	–
Birth year 1952–1961	-0.010 (0.008)	–	–	-0.015 (0.012)	–	–
Birth year 1962–1971	-0.014* (0.008)	–	–	-0.020* (0.012)	–	–
Birth year > 1972	-0.021* (0.012)	–	–	-0.018 (0.017)	–	–
Tenure < 10 years	-0.040*** (0.009)	0.091*** (0.032)	0.177* (0.104)	-0.041*** (0.013)	0.082* (0.046)	0.057 (0.100)
Tenure 10–20 years	-0.001 (0.008)	0.038 (0.031)	0.008 (0.086)	-0.012 (0.012)	0.015 (0.043)	-0.068 (0.084)
Experience < 10 years	-0.029** (0.011)	-0.021 (0.035)	-0.057 (0.065)	-0.033** (0.016)	0.001 (0.050)	-0.027 (0.075)
Experience 10–20 years	-0.003 (0.007)	0.007 (0.026)	0.005 (0.039)	-0.001 (0.010)	0.014 (0.037)	0.001 (0.048)
Job satisfaction	0.012*** (0.001)	0.011*** (0.00)	0.006 (0.008)	0.014*** (0.002)	0.015*** (0.005)	0.012 (0.011)
Vocational education	-0.006 (0.012)	–	–	0.016 (0.018)	–	–
University degree	-0.006 (0.013)	–	–	0.018 (0.019)	–	–
Year dummies	yes	yes	yes	yes	yes	yes
Establishment charac- teristics	yes	yes	yes	yes	yes	yes
R ²	0.069	0.039	–	0.082	0.054	–
Observations	7,901	7,901	3,281	4,682	4,682	1,915
Individuals	–	4,186	2,071	–	2,626	1,312
AR-test	–	–	0.763	–	–	0.352
Hansen-test	–	–	0.303	–	–	0.075

Dependent variable: retention probability in the next calendar year; reference category for age: birth year ≤ 1951; reference category for tenure: tenure ≥ 20 years; reference category for experience: experience ≥ 20 years; reference category for education: no vocational education; establishment characteristics: size, sector. *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

APPENDIX TO CHAPTER 3

Table A3.1: Determinants of the training intensity and number of training, (full regression output)

Dependent variable	Training dummy	Number of training
	(1) Diff-in-Diff	(2) Diff-in-Diff
Crisis * Year 2007	-0.003 (0.013)	-0.009 (0.029)
Crisis * Year 2008	-0.053* (0.032)	-0.106 (0.092)
Crisis * Year 2009	-0.117*** (0.039)	-0.266** (0.114)
Crisis * Year 2010	-0.193*** (0.068)	-0.488*** (0.132)
Year 2007	0.016** (0.008)	0.022 (0.020)
Year 2008	-0.031* (0.018)	-0.165*** (0.060)
Year 2009	-0.002 (0.021)	-0.047 (0.069)
Year 2010	-0.142*** (0.026)	-0.473*** (0.072)
Crisis (treatment)	0.030 (0.027)	0.141 (0.121)
Vocational education	0.059 (0.042)	0.102 (0.098)
University degree	0.208*** (0.042)	0.567*** (0.103)
Tenure < 10 years	0.069** (0.032)	0.216** (0.087)
Tenure 10–20 years	0.063** (0.033)	0.223** (0.086)
Experience < 10 years	-0.146*** (0.043)	-0.325** (0.130)
Experience 10–20 years	-0.064** (0.028)	-0.199** (0.087)
Birth year 1952–1961	0.076*** (0.028)	0.204** (0.080)
Birth year 1962–1971	0.097*** (0.031)	0.327*** (0.090)
Birth year > 1972	0.196*** (0.043)	0.548*** (0.128)
Female	0.002 (0.020)	0.210*** (0.066)

Employees_199	-0.184*** (0.026)	-0.596*** (0.070)
Employees_499	-0.081*** (0.023)	-0.137* (0.071)
Western Germany	0.005 (0.025)	0.041 (0.076)
Service sector	0.151*** (0.022)	0.505*** (0.064)
R ²	0.091	0.099
Observations	5,983	5,983

Dependent variables: training intensity (model 1), number of training (model 2); reference category for age: birth year ≤ 1951 ; reference category for tenure: tenure ≥ 20 years; reference category for experience: experience ≥ 20 years; reference category for education: no vocational education; reference category for establishment size: ≥ 500 employees. *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

Table A3.2: Determinants of the training intensity separated by skill groups, (full regression output)

Dependent variable	Training dummy	Training dummy
	Unskilled employees (1)	Skilled employees (2)
	Diff-in-Diff	Diff-in-Diff
Crisis * Year 2007	0.051 (0.038)	-0.014 (0.013)
Crisis * Year 2008	-0.054 (0.082)	-0.048 (0.036)
Crisis * Year 2009	-0.215** (0.100)	-0.081* (0.042)
Crisis * Year 2010	-0.427*** (0.123)	-0.024 (0.086)
Year 2007	0.002 (0.025)	0.020** (0.008)
Year 2008	-0.017 (0.059)	-0.030 (0.019)
Year 2009	0.062 (0.072)	-0.012 (0.022)
Year 2010	0.060 (0.081)	-0.156*** (0.027)
Crisis (treatment)	0.213*** (0.070)	-0.019 (0.030)
Tenure < 10 years	-0.051 (0.090)	0.086** (0.034)
Tenure 10–20 years	-0.167** (0.081)	0.075** (0.036)
Experience < 10 years	-0.045 (0.103)	-0.104** (0.046)
Experience 10–20 years	-0.089 (0.065)	-0.017 (0.031)
Birth year 1952–1961	0.006 (0.093)	0.084*** (0.030)
Birth year 1962–1971	0.025 (0.096)	0.098*** (0.032)
Birth year > 1972	0.025 (0.112)	0.164*** (0.044)
Female	-0.189*** (0.057)	-0.012 (0.021)
Employees_199	-0.165** (0.064)	-0.137*** (0.029)
Employees_499	-0.038 (0.059)	-0.044* (0.026)
Western Germany	0.049 (0.058)	0.033 (0.027)

Service sector	0.117** (0.054)	0.118*** (0.025)
R ²	0.122	0.057
Observations	926	5,057

Dependent variables: training intensity; separate analysis for skill groups; reference category for age: birth year \leq 1951; reference category for tenure: tenure \geq 20 years; reference category for experience: experience \geq 20 years; reference category for education: no vocational education; reference category for establishment size: \geq 500 employees. Standard errors based on a robust cluster-adjusted sandwich estimator in parentheses; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

Table A3.3: Determinants of the number of training separated by skill groups, (full regression output)

Dependent variable	Number of training	Number of training
	Unskilled employees (1)	Skilled employees (2)
	Diff-in-Diff	Diff-in-Diff
Crisis * Year 2007	0.071 (0.063)	-0.028 (0.032)
Crisis * Year 2008	-0.279* (0.158)	-0.091 (0.104)
Crisis * Year 2009	-0.452** (0.203)	-0.216* (0.128)
Crisis * Year 2010	-0.936*** (0.228)	-0.249 (0.178)
Year 2007	0.005 (0.037)	0.036 (0.022)
Year 2008	-0.099 (0.102)	-0.186* (0.106)
Year 2009	0.194 (0.118)	-0.091 (0.074)
Year 2010	0.129 (0.128)	-0.509* (0.276)
Crisis (treatment)	0.511*** (0.132)	-0.065 (0.095)
Tenure < 10 years	-0.063 (0.166)	0.245** (0.098)
Tenure 10–20 years	-0.144** (0.155)	0.210** (0.098)
Experience < 10 years	-0.107 (0.219)	-0.131** (0.148)
Experience 10–20 years	0.084 (0.129)	-0.035 (0.103)
Birth year 1952–1961	0.183 (0.142)	0.202** (0.089)
Birth year 1962–1971	0.158 (0.138)	0.300*** (0.103)
Birth year > 1972	0.383** (0.193)	0.388*** (0.143)
Female	-0.255** (0.100)	-0.203*** (0.074)
Employees_199	-0.408*** (0.147)	-0.531*** (0.082)
Employees_499	-0.018 (0.142)	-0.063 (0.085)
Western Germany	0.021 (0.128)	0.132 (0.091)

Service sector	0.363*** (0.134)	0.450*** (0.076)
R ²	0.114	0.068
Observations	926	5,057

Dependent variables: training intensity; separate analysis for skill groups; reference category for age: birth year \leq 1951; reference category for tenure: tenure \geq 20 years; reference category for experience: experience \geq 20 years; reference category for education: no vocational education; reference category for establishment size: \geq 500 employees. Standard errors based on a robust cluster-adjusted sandwich estimator in parentheses; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

Table A3.4: Determinants of the training intensity and the number of training, triple-Diff-in-Diff-estimation

Dependent variable	Training dummy	Number of training
	(1) Diff-in-Diff	(2) Diff-in-Diff
Crisis * Year 2007 * Unskilled	0.059 (0.041)	0.114 (0.071)
Crisis * Year 2008 * Unskilled	-0.005 (0.089)	-0.158 (0.198)
Crisis * Year 2009 * Unskilled	-0.142 (0.108)	-0.225 (0.246)
Crisis * Year 2010 * Unskilled	-0.429*** (0.146)	-0.673*** (0.264)
Crisis * Year 2007	-0.014 (0.013)	-0.028 (0.032)
Crisis * Year 2008	-0.048 (0.036)	-0.091 (0.105)
Crisis * Year 2009	-0.081* (0.042)	-0.215* (0.128)
Crisis * Year 2010	-0.027 (0.085)	-0.262 (0.175)
Crisis * Unskilled employees	0.281** (0.072)	0.588*** (0.152)
Year 2007 * Unskilled employees	-0.022 (0.026)	-0.056 (0.043)
Year 2008 * Unskilled employees	0.007 (0.062)	0.250** (0.118)
Year 2009 * Unskilled employees	0.068 (0.075)	0.271* (0.139)
Year 2010 * Unskilled employees	0.199** (0.087)	0.609*** (0.151)
Year 2007	0.020** (0.008)	0.033 (0.022)
Year 2008	-0.032 (0.019)	-0.191*** (0.066)
Year 2009	-0.013 (0.022)	-0.096 (0.074)
Year 2010	-0.156*** (0.027)	-0.516*** (0.075)
Unskilled employees	-0.391*** (0.053)	-1.015*** (0.097)
Crisis (treatment)	-0.020 (0.028)	0.037 (0.090)

Individual characteristics	Yes	Yes
Establishment characteristics	Yes	Yes
<hr/>		
R ²	0.103	0.100
Observations	5,983	5,983

Dependent variables: training intensity, number of training; separate analysis for skill groups; reference category for age: birth year ≤ 1951 ; reference category for tenure: tenure ≥ 20 years; reference category for experience: experience ≥ 20 years; reference category for education: no vocational education; reference category for establishment size: ≥ 500 employees. Standard errors based on a robust cluster-adjusted sandwich estimator in parentheses; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

Table A3.5: Determinants of the number of training separated by experience groups

Dependent variable	Number of Training (Diff-in-Diff)		
	experience < 10	experience 10–20	experience > 20
Crisis * Year 2007	0.002 (0.145)	-0.040 (0.061)	0.072 (0.063)
Crisis * Year 2008	0.277 (0.226)	-0.223 (0.175)	-0.111 (0.138)
Crisis * Year 2009	-0.049 (0.260)	-0.334* (0.168)	-0.214 (0.171)
Crisis * Year 2010	-0.238 (0.243)	-0.589*** (0.197)	-0.328 (0.538)
Year and crisis information	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes
Establishment characteristics	Yes	Yes	Yes
R ²	0.095	0.096	0.111
Observations	1,285	2,901	1,797

Dependent variables: number of training; separate analysis for experience groups; Further individual characteristics: qualification, tenure, age, gender; establishment characteristics: size, location, sector. Standard errors based on a robust cluster-adjusted sandwich estimator in parentheses; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

Table A3.6: Determinants of the number of training separated by age groups

Dependent variable	Number of training (Diff-in-Diff)			
	< 1951	1952–1961	1962–1971	> 1972
Crisis * Year 2007	-0.030 (0.046)	0.026 (0.018)	-0.003 (0.026)	-0.007 (0.113)
Crisis * Year 2008	0.066 (0.223)	-0.179 (0.174)	-0.262 (0.183)	0.152 (0.207)
Crisis * Year 2009	-0.018 (0.277)	-0.321* (0.188)	-0.320 (0.214)	-0.133 (0.252)
Crisis * Year 2010	0.421 (0.336)	-0.549** (0.227)	-0.802** (0.323)	-0.294 (0.277)
Year and crisis information	Yes	Yes	Yes	Yes
Individual characteristics	Yes	Yes	Yes	Yes
Establishment characteristics	Yes	Yes	Yes	Yes
R ²	0.094	0.120	0.108	0.083
Observations	880	2,058	1,626	1,419

Dependent variables: number of training; separate analysis for age groups; Further individual characteristics: qualification, tenure, age, gender; establishment characteristics: size, location, sector. Standard errors based on a robust cluster-adjusted sandwich estimator in parentheses; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

Table A3.7: Determinants of the number of training separated by gender

Dependent variable:	Number of training (Diff-in-Diff)	
	Female	Male
Crisis * Year 2007	0.017 (0.088)	-0.025 (0.037)
Crisis * Year 2008	-0.004 (0.182)	-0.186 (0.124)
Crisis * Year 2009	-0.194 (0.206)	-0.305** (0.140)
Crisis * Year 2010	-0.688** (0.325)	-0.433** (0.169)
Crisis (treatment)	Yes	Yes
Individual characteristics	Yes	Yes
Establishment characteristics	Yes	Yes
R ²	0.089	0.095
Observations	2,103	3,880

Dependent variables: Number of training; separate analysis for gender groups; Further individual characteristics: qualification, tenure, age, gender; establishment characteristics: size, location, sector. Standard errors based on a robust cluster-adjusted sandwich estimator in parentheses; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

Table A3.8: Determinants of the training intensity and number of training (sample with short-time workers)

Dependent variable:	Training intensity	Number of training
	Diff-in-Diff	Diff-in-Diff
Crisis * Year 2007	0.005 (0.015)	0.004 (0.043)
Crisis * Year 2008	-0.024 (0.032)	-0.077 (0.089)
Crisis * Year 2009	-0.075** (0.036)	-0.241*** (0.089)
Crisis * Year 2010	-0.171*** (0.041)	-0.343*** (0.097)
Crisis (treatment)	Yes	Yes
Individual characteristics	Yes	Yes
Establishment characteristics	Yes	Yes
R ²	0.101	0.113
Observations	7,763	7,763

Dependent variables: training intensity and number of training; separate analysis for experience groups; Further individual characteristics: qualification, tenure, age, gender; establishment characteristics: size, location, sector. Standard errors based on a robust cluster-adjusted sandwich estimator in parentheses; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

Table A3.9: Differences in types of training (unskilled vs. skilled employees)

Type of training	Unskilled employees	Skilled employees	t-values
External training	29.81%	43.55%	-4.36***
Internal training	70.19%	56.45%	
Short-term measures	82.95%	78.10%	1.84*
Long-term measures	17.05%	21.90%	
Average training hours	32.29	37.91	-1.05
Average training costs	395.59	559.00	-0.83
Certificate	78,87%	72.40%	2.27**
Observations	926	5,057	

*Statistically significant at the .10 level; **at the .05 level; *** at the .01 level. Source: WeLL-ADIAB 2006–2010.

APPENDIX TO CHAPTER 4

Table A4.1: Summary statistics on firm size

Firm size (number of employees)	2006	2007	2008	2009	2010	2011	2012	Total
≤10,000	36.4%	40.3%	40.8%	39.1%	38.5%	31.8%	32.8%	162
>10,000								
≤20,000	10.9%	11.3%	12.1%	12.5%	13.9%	19.1%	18.0%	61
>20,000								
≤50,000	21.8%	17.7%	15.2%	18.8%	18.5%	17.5%	14.8%	77
>50,000								
≤100,000	16.4%	14.5%	16.7%	14.1%	13.9%	14.3%	14.8%	65
>100,000								
≤150,000	1.8%	4.8%	4.6%	4.7%	4.6%	7.9%	9.8%	24
>150,000								
>150,000	12.7%	11.4%	10.6%	10.9%	10.8%	9.5%	9.8%	47
Total	55	62	66	64	65	63	61	436

Table A4.2: Summary statistics on exchange segment

Exchange segment	2006	2007	2008	2009	2010	2011	2012	Total
DAX	43.6%	38.7%	39.0%	34.9%	35.4%	36.5%	37.7%	163
MDAX	56.4%	61.3%	61.0%	64.1%	64.6%	63.5%	62.3%	273
Total	55	62	66	64	65	63	61	436

Table A4.3: Summarized comparison of pre- and post-crisis compensation levels (in k €)

DAX						
	CEO			non-CEO		
	Pre-crisis	Delta in %	Post-crisis	Pre-crisis	Delta in %	Post-crisis
Average	4,803.4	9.23%	5,246.6	2,524.1	2.17%	2,578.9
SD	2,699.5	-7.37%	2,500.6	1,012.7	4.95%	1,062.8
COV (SD/Avg.)	0.562	-15.19%	0.477	0.401	2.72%	0.412
N	44		67	48		69
MDAX						
	CEO			non-CEO		
	Pre-crisis	Delta in %	Post-crisis	Pre-crisis	Delta in %	Post-crisis
Average	2,044.0	3.27%	2,110.9	1,216.0	3.49%	1,258.5
SD	1,594.9	-36.70%	1,009.5	646.8	8.74%	703.3
COV (SD/Avg.)	0.780	-38.71%	0.478	0.532	5.07%	0.559
N	46		91	69		120
All						
	CEO			non-CEO		
	Pre-crisis	Delta in %	Post-crisis	Pre-crisis	Delta in %	Post-crisis
Average	3,385.9	1.63%	3,441.3	1,752.0	-0.61%	1,741.4
SD	2,601.1	-9.74%	2,347.8	1,044.7	2.03%	1,065.9
COV (SD/Avg.)	0.769	-11.31%	0.682	0.597	2.34%	0.611
N	90		158	117		189

Table A4.4: Determinants of non-CEO total compensation (log), reduced sample

Dependent variable:	(1)	(2)
non-CEO total compensation (log)	FE	FE
Year 2007	0.134** (0.065)	-0.010 (0.092)
Year 2008	-0.068 (0.067)	-0.165* (0.010)
Year 2009	-0.144** (0.066)	-0.169* (0.093)
Year 2010	0.099 (0.065)	-0.004 (0.094)
Year 2011	0.144** (0.065)	0.011 (0.092)
Year 2012	0.129* (0.066)	0.015 (0.093)
MDAX*2007		0.287** (0.130)
MDAX*2008		0.200 (0.134)
MDAX*2009		0.061 (0.132)
MDAX*2010		0.211 (0.130)
MDAX*2011		0.268** (0.130)
MDAX*2012		0.235* (0.131)
Profit	6.15e ⁻⁰⁵ *** (1.08e ⁻⁰⁵)	6.43e ⁻⁰⁵ *** (1.10e ⁻⁰⁵)
Constant	7.131*** (0.050)	7.114*** (0.050)
24 Industry dummies	Yes	Yes
R ²	0.248	0.271
Observations	341	341
Number of firms	64	64

Dependent variable: non-CEO total compensation (log); sample reduced to companies that published information on CEO compensation; reference group: DAX companies with less than 10,000 employees in the year 2006; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level

Table A4.5: Summarized comparison of pre- and post-crisis compensation structure

DAX						
	CEO			non-CEO		
	Pre-crisis	Delta in %	Post-crisis	Pre-crisis	Delta in %	Post-crisis
Average	26.8%	17.9%	31.6%	28.1%	15.9%	32.6%
SD	14.4%	16.0%	16.7%	14.8%	9.4%	16.2%
COV (SD/Avg.)	0.535	-2.2%	0.523	0.526	-5.6%	0.497
N	44		67	48		69
MDAX						
	CEO			non-CEO		
	Pre-crisis	Delta in %	Post-crisis	Pre-crisis	Delta in %	Post-crisis
Average	39.8%	-6.8%	37.1%	40.0%	7.5%	43.0%
SD	15.4%	-9.7%	13.9%	18.7%	-18.2%	15.3%
COV (SD/Avg.)	0.387	-3.6%	0.373	0.468	-23.9%	0.356
N	46		91	67		120
All						
	CEO			non-CEO		
	Pre-crisis	Delta in %	Post-crisis	Pre-crisis	Delta in %	Post-crisis
Average	33.4%	-11.7%	34.8%	35.2%	7.5%	39.2%
SD	16.0%	-3.1%	15.5%	18.2%	-18.2%	18.9%
COV (SD/Avg.)	0.483	-8.1%	0.444	0.517	-6.5%	0.483
N	90		158	117		189

Table A4.6: Determinants of non-CEO base pay fraction (total compensation), reduced sample

Dependent variable:	(1)	(2)
Base pay fraction (non-CEO)	FE	FE
Year 2007	-0.034 (0.028)	0.002 (0.039)
Year 2008	0.045 (0.029)	0.067 (0.042)
Year 2009	0.097*** (0.028)	0.080** (0.040)
Year 2010	0.010 (0.028)	0.021 (0.040)
Year 2011	0.004 (0.028)	0.047 (0.039)
Year 2012	0.019 (0.028)	0.066* (0.040)
Profit	-1.97e ⁻⁰⁵ *** (4.59e ⁻⁰⁶)	-2.13e ⁻⁰⁵ *** (4.70e ⁻⁰⁶)
MDAX*2007		-0.071 (0.055)
MDAX*2008		-0.046 (0.057)
MDAX*2009		0.030 (0.056)
MDAX*2010		-0.028 (0.056)
MDAX*2011		-0.086 (0.055)
MDAX*2012		-0.094* (0.056)
Constant	0.386*** (0.021)	0.392*** (0.022)
24 Industry dummies	Yes	Yes
Observations	341	341
Number of firms	64	64
R-squared	0.176	0.202

Dependent variable: Fraction of base pay on total non-CEO compensation; sample reduced to companies that published information on CEO compensation; reference group: DAX companies with less than 10,000 employees in the year 2006; *Statistically significant at the .10 level; **at the .05 level; *** at the .01 level