

# Workforce Composition and Individual Wages — An Employer–Employee Data Analysis

Annekatrin Niebuhr  and Jan Cornelius Peters 

## Abstract

*The study analyses the impact of workforce composition and employee isolation — based on age, gender and citizenship — on entry wages of new employment relationships in German firms using employer–employee data. We allow for heterogeneous effects across distinct groups of workers and include worker and firm fixed effects to account for selection effects and unobserved heterogeneity. The results point to a negative impact of gender and age diversity for males and females, natives and foreigners and workers across the skill spectrum. Only for high-skilled workers, the negative effect of gender diversity is not statistically significant. Females receive, in addition, relatively low entry wages in establishments with a rather old workforce. With regard to the relative position, mainly gender isolation tends to exert an important influence on entry wages. The effect is positive only for females. In contrast, we estimate significant negative wage effects for males, natives, medium- and high-skilled workers. An international background of a firm's workforce and cultural isolation do not appear to generally affect entry wages.*

## 1. Introduction

Demographic change, immigration and the increasing labour market participation of women give rise to significant changes in workforce

Annekatrin Niebuhr is at IAB Nord Regional Research Network of the Institute for Employment Research, Institute for Employment Research, Kiel, Germany and Empirical Labour Economics and Spatial Econometrics, Department of Economics, Christian-Albrechts-Universität zu Kiel, Kiel, Germany.

Jan Cornelius Peters's present address is Institute of Rural Studies, Johann Heinrich von Thünen Institute, Braunschweig, Germany. His former address is IAB Nord, Regional Research Network of the Institute for Employment Research, Institute for Employment Research, Kiel, Germany. Additional results and copies of the computer programs used to generate the results presented in the article are available upon request. The data used in the empirical analysis may be accessed at the Research Data Centre (FDZ) of the German Federal Employment Agency at the Institute for Employment Research (IAB).

composition. This might have important economic consequences. We investigate the wage effects of workforce composition and employee isolation in a sample of German firms focusing on the entry wages of newly established employment relationships. A growing empirical literature indicates that the characteristics of co-workers matter for workers' productivity, wages and turnover. Comprehensive studies on the issue are, however, still scarce and the evidence so far is ambiguous. This corresponds with different theories providing partly conflicting hypotheses about the wage and productivity effects of workforce composition and worker isolation.

Consequently, different strands of literature are relevant to our analysis. A first group of studies deals with the economic effects of labour force diversity. Diversity may give rise to productivity gains because distinct groups of workers might complement each other in production processes. But significant costs are also likely as heterogeneity might hamper communication and cause conflict in the workplace (Lazear 2000). Several papers investigate the impact of diversity on firm productivity (e.g. Garnero *et al.* 2014; Parrotta *et al.* 2014; Trax *et al.* 2015). However, many studies focus on cultural diversity and effects on individual wages are rarely considered.

Second, our study is related to the literature dealing with the impact of workers' group size in firms on wages and productivity. Discriminatory behaviour (Becker 1971) or referral-based job search networks (Dustmann *et al.* 2016) might give rise to a systematic relationship between wages and the share of (minority) workers, where the groups can be defined according to distinct demographic characteristics such as ethnicity, gender or age. Dustmann *et al.* (2016) use the share of the own ethnic group in the firm as a proxy for a referral hire. Their estimates suggest that referrals result in higher wages and lower turnover in Germany. Leonard and Levine (2006) focus on turnover in a large firm in the United States and show that worker isolation is often associated with a high probability of leaving the firm.

Leonard and Levine (2006) note that there are only a few convincing studies investigating the impact of diversity and the workers' relative position on different outcomes. And there is only little evidence on individual outcomes. Often findings base on case studies that tend to look at the composition of specific work-teams. The corresponding evidence is far from unambiguous and external validity is, of course, a concern. Furthermore, often cross-sectional data are used and thus it is difficult to deal with important econometric problems such as selection and unobserved heterogeneity (Garnero *et al.* 2014).

We investigate the effects of workforce composition and employee isolation on entry wages in a sample of German firms. As we focus on the wages associated with new employment relationships, the effects refer to the expected productivity of newly hired worker in the corresponding working environment and/or discriminatory behaviour. Germany is well suited for a corresponding analysis as demographic change, immigration and the increasing female labour market participation result in a significant variation in workforce composition with respect to age, gender and citizenship. Other dimensions

of workforce composition might, of course, be relevant as well. However, the labour market performance of the groups considered in this analysis differs significantly and these disparities are frequently the target of public policy (see, e.g. Kurtulus 2012), which might have far-reaching consequences for the human resource management in firms.

We use a large representative employer–employee dataset with detailed information on workers and the demographic composition of their workplaces. Focusing on entry wages, we rule out effects that will gain in importance as tenure increases, for example, promotions, on-the-job and professional development training offered by the firm. These time-varying factors are usually unobserved by the econometrician. Moreover, we apply a new approach to control for unobserved heterogeneity and important selection effects at the firm and the worker level. Our data on new employment relationships are mostly cross sectional because for many workers we observe only one new job. In order to account for unobserved heterogeneity, we therefore include worker and establishment fixed effects estimated by Bellmann *et al.* (2020) following the approach proposed by Abowd *et al.* (1999) in our regression models.

## **2. Literature**

### *Theoretical Arguments*

When investigating the impact of the workforce composition of firms we need to consider different theoretical approaches that propose distinct mechanisms which might give rise to significant effects of diversity and the relative position of individual workers on entry wages and expected productivity. According to Pissarides (2009), recruiting involves that firms ascertain the productivity of applicants from interviews, evidence of qualifications and screening devices. He notes that productivity of different workers will usually differ, but also the productivity of the same worker at different firms.

Productive complementarities might establish a link between expected productivity of a new entrant and workforce composition. Workers who differ with respect to age, gender or cultural background likely possess skills that are complementary in production processes. For instance, Böheim *et al.* (2012) consider the effects of birthplace diversity in a model of optimal worker assignment in which they benefit from productivity spillovers of co-workers. The impact of diversity on individual wages consist of two components: The first is the effect of workforce diversity which will be positive or negative depending on the importance of transaction costs caused by heterogeneity and the strength of spillovers between workers. In addition, the own group size matters since the marginal effect on firm diversity declines as group size increases. Therefore, members of a small group receive a higher compensation for their impact on productivity spillovers because they add more to firm diversity and resulting knowledge transfer.

When hiring workers, employers might anticipate these effects on the individual productivity of the new employee as well as the external effects on the productivity of the rest of the staff. If the prospective colleague is expected to bring highly complementary skills into the firm he or she might receive a relatively high wage offer. Moreover, the workforce composition likely reflects the recruiting strategy of the firm. More diverse firms might pay more attention to complementarities and take care that job candidates represent a good match in this respect.

However, heterogeneity of the workforce might also hamper the interaction between different groups. Lazear (2000) considers transaction costs of diversity arising from barriers to communication caused by different languages and cultures. Interaction among team members may also decline because persons tend to be attracted to similar individuals. Several authors stress the importance of social similarity for interaction, communication and cohesion among the workforce (Leonard and Levine 2006; Pelled *et al.* 1999). Social identity theory predicts that group membership defined by demographic characteristics will produce discriminative behaviour that favours the in-group at the expense of the out-group (Tajfel 1981). Basset-Jones (2005) argues that diversity may cause misunderstanding, conflicts and uncooperative behaviour. Especially, newly hired workers might be affected by such behaviour. New entrants who differ with respect to demographic characteristics from the majority of the staff likely suffer these adverse effects of diversity. If employers are aware of these effects, we should expect that more diverse firms pay lower entry wages to observationally identical workers than firms with a more homogenous workforce and that the share of the own group affects entry wages positively.

According to Leonhard and Levine (2006), there are complementary theoretical approaches that can explain heterogeneous effects of diversity. For instance, majority groups might be more accustomed to working in establishments characterized by a rather low diversity. Thus, workers who usually belong to a majority group, that is, natives and male workers, might find it more difficult than other employees to cope with workforce diversity or a setting where they belong to the minority.

A subset of similarity theories predicts disadvantages for the minority group. Minority workers may face drawbacks when interacting with a majority group because of prejudice or linguistic differences and, hence, benefit less from knowledge spillovers than majority workers if people interact more frequently with those of their demographic group (Leonard and Levine 2006). This in turn might, *ceteris paribus*, results in lower productivity and in particular impact on workers with short tenure.

Dustmann *et al.* (2016) put forth another theoretical argument that refers to the share of the own group in the workplace. They argue that the percentage of workers from the same ethnic group points to the strength of labour market networks. More generally, majority workers might benefit from being part of a large group as demographically similar employees likely belong to the same social network and these networks are supposed to provide useful job

market information (Leonard and Levine 2006). In the job search model by Dustmann *et al.* (2016), the worker's job-specific productivity is more uncertain in the external than in the referral market giving rise to a better initial match through referral-based job search. A higher matching quality in turn will be reflected by lower turnover and higher productivity and entry wages.

Moreover, Becker's (1971) model of discrimination can motivate a relationship between workforce composition and individual entry wages as well. In principle, discrimination implies that members of a minority group are treated less favourably than members of the majority group with identical productive characteristics. Minority workers may have to accept a lower wage than members of the majority group for identical expected productivity if employers show discriminatory tastes. The wage discount compensates employers for the perceived disamenity of hiring minority workers. Similarly, majority co-workers might only accept a wage offer if it includes a compensation for the presence of workers who are different with respect to characteristics such as gender or ethnicity.

### *Empirical Evidence*

Numerous empirical studies examine effects of workforce composition on various outcome variables. Our overview focuses on studies that investigate effects on productivity and wages at the individual and firm level, respectively. We refrain from discussing the voluminous literature on the composition of specific work-teams and refer to a survey by Horwitz and Horwitz (2007).

There are a few studies that investigate the relationship between workforce diversity and productivity at the firm level, frequently with a focus on cultural diversity. The results of these investigations are far from unambiguous. Findings by Parrotta *et al.* (2014) suggest that ethnic diversity negatively affects the productivity of Danish firms, pointing to significant communication costs. In contrast, heterogeneity with respect to age and gender does not seem to matter. Trax *et al.* (2015) find that stronger fractionalization into different nationalities among foreign workers gives rise to significant productivity gains, whereas the share of foreign workers does not impact firm productivity in Germany. This is in line with findings by Buche *et al.* (2013) pointing to a positive correlation between firm productivity and the number of cultural clusters in the firm's workforce.

Garnero *et al.* (2014) use Belgian linked employer–employee data to estimate the effect of workforce diversity on wages. Their results suggest that heterogeneity with respect to age has a dampening effect on wages. This is in line with evidence provided by Kurtulus (2011) who finds that age diversity is associated with lower labour productivity in a large US firm.

The studies mentioned so far have in common that they focus on average productivity or wages, that is, operate at the firm level. They neither consider the impact of the relative position of the workers nor allow for heterogeneous effects across distinct groups of workers.

Only a few studies deal with the question of whether workforce diversity impacts on individual wages. Boeheim *et al.* (2012) report a positive influence of birthplace diversity on the wages of workers in Austria. They argue that these effects are caused by productivity spillovers between workers that differ with respect to skills and knowledge due to their distinct country of birth. In contrast, the size of the own group exerts a dampening effect on productivity pointing to marginal effects on diversity which decline with group size. Moreover, their findings point to heterogeneous effects as they detect above average productivity increases for white-collar workers and workers with short tenure.

Using longitudinal employer–employee data from the German Employment Register, Ludsteck (2014) detects a significant negative effect of the share of female workers on women's wages while the impact on male wages does not significantly differ from zero or is even positive if unobserved heterogeneity is controlled for. Whereas Ludsteck (2014) motivates the relationship between the proportion of a specific group and wages via discriminatory behaviour, Dustmann *et al.* (2016) focus on the influence of job search networks. They use the share of the own group in the firm as a proxy for a referral hire and find a positive correlation between this percentage and individual wages. However, the size of these initial gains declines with increasing job tenure.

Hellerstein *et al.* (2014) infer from their results for the United States, however, that the share of co-workers from the same group seems to be inappropriate to capture corresponding network effects. They detect a negative relationship between the own-group share and earnings for different groups (blacks, Hispanics, Asians) that is explained by a non-wage amenity, that is, workers accept a wage discount for working together with individuals from their own group.

The two studies which are most comparable to our analysis examine effects of diversity and employee isolation on individual wages and turnover. With respect to wages, only Ilmakunnas and Ilmakunnas (2011) consider both the influence of diversity at the firm level and the effects of employee isolation based on Finnish linked employer–employee data. Their results indicate that diversity with respect to age and gender does not matter for individual wages. In contrast, the relative position in terms of age is an important determinant of the remuneration.

In contrast to our study and the analyses mentioned above, which focus on productivity and wages, Leonard and Levine (2006) consider another outcome variable and examine the importance of workforce composition on turnover. They use a longitudinal dataset from a service-sector employer in the United States to investigate the impact of the demographic composition (ethnicity, gender and age) on individual turnover within workgroups. The authors show that diversity at the firm level does not consistently predict turnover, whereas isolation is often associated with a high probability of turnover.

Bygren (2004, 2010) also investigates the relationship between turnover and workforce composition. Using detailed information on Swedish workplaces,

the author focuses on the impact of workplace composition with respect to gender and ethnicity. The results indicate that immigrants have a low propensity to leave workplaces with relatively high share of immigrants. Moreover, the risk of ending-up in unemployment is relatively high for minority women and immigrants employed in workplaces with a high share of natives. Gender isolation does not increase turnover, that is, both men and women seem to prefer workplaces with a high proportion of workers of the opposite gender.

Our study contributes to this literature by investigating the effects of workforce diversity and the relative position of workers with respect to age, gender and cultural background on wages of newly hired workers. We also examine whether the impact of workforce composition differs across distinct groups of workers in Germany. We interpret the wage effects as pointing to discriminatory behaviour and/or the influence of workforce composition on the expected productivity of new entrants.

### **3. Institutional framework and the determination of entry wages**

Significant effects of workforce composition on entry wages require a sufficient amount of flexibility when wages of newly hired workers are negotiated. It is therefore important to consider how the system of industrial relations affects the determination of wages. An important feature of wage-setting in Germany is collective bargaining agreements, which might restrict the possibility to negotiate wages with job candidates. Holmlund and Zetterberg (1991) note that Germany is typically regarded as an intermediate case when it comes to the degree of centralization.

Collective bargaining is mainly conducted at the industry level in regional bargaining areas. However, firms can also negotiate directly with a union for a firm-level contract. The agreements are legally binding if the worker is a union member and the firm is member of the corresponding employer association. In practice, however, they are not confined to union members and, thus, the wages stipulated in collective agreements serve as a sort of minimum wages for many workers (Jung and Schnabel 2011). In firms that do not belong to an association, non-unionized as well as unionized workers are not entitled to the collectively bargained wage. Yet non-member firms often recognize agreements as binding voluntarily.

Although collective agreements still play a significant role, there is considerable scope for decentralized and flexible wage adjustments. Gerlach and Stephan (2006) note that the importance of contracts that are negotiated at the firm or the individual level has increased in Germany since firms dissatisfied with industry-level agreements tend to opt out of the system and newly founded firms are reluctant to join it. While more than 40 per cent of the establishments did not apply collective agreements in 1999, this percentage increased to around 70 per cent in 2013 (see Gartner *et al.* 2013 and

Schnabel 2016). These employers can bargain entry wages with candidates, allowing them to adapt wages to firm-specific conditions (Heinbach 2007).

Moreover, Holmlund and Zetterberg (1991) note that centralized wage bargaining does not necessarily entail little scope for wage adjustment. Firms covered by collective agreements in Germany can opt out from the agreements under certain conditions. The social partners introduced so-called opening clauses into central collective contracts, which enable firms to adapt the agreements to firm-specific needs. Wages and working time can be adjusted if the firm faces tough competition and is severely affected by economic crisis. Heinbach (2007) shows that the share of collective agreements that contain wage-related opening clauses considerably increased in Germany since the 1990s: from about a quarter in 1996 to more than 50 per cent in 2004. The findings also suggest that wage-related opening clauses significantly affect the wage-setting and tend to reduce the wage level.

Even in firms that are bound to collective agreements there seems to be substantial scope for wage adjustment also at the worker level. Collectively agreed norms are minimum standards and firms covered by collective agreements can voluntarily improve upon these terms and conditions (Jung and Schnabel 2011). Holmlund and Zetterberg (1991) note that wage drift, measured as the difference between total wage increases and negotiated (contractual) increases, accounts for a significant percentage of total wage growth, even in economies showing the highest degree of centralization. Jung and Schnabel (2011) show that more than 40 per cent of the plants covered by collective agreements in Germany pay wages above the level stipulated in the agreements. There is significant scope for wage differentiation because collective agreements contain a limited number of wage brackets for job classifications that mainly rest upon formal qualification and tasks. Jung and Schnabel (2011) argue that the wage brackets serve as some kind of minimum wage for workers who belong to the respective category. The average wage cushion, that is, the amount by which actual wages exceeded contractual wages, is around 10 per cent in Germany, pointing a substantial degree of wage differentiation and flexibility.

The structure of industrial relations in Germany is characterized by a dual system of worker representation through unions and works councils. The latter represent the interests of workers at the plant level and might play an important role in this context although they are usually excluded from reaching agreements with firms on wages. However, their extensive rights of information and involvement in many other issues suggests that works councils have some bargaining power, which can be used for rent seeking and pushing through higher actual wages (see Hübler and Jirjahn 2003; Jirjahn 2009). Addison *et al.* (2001) provide evidence that stronger worker involvement via works councils is associated with higher labour productivity, higher wages and lower profit in German firms. However, Gartner *et al.* (2013) show that works councils increase wage growth only in West German firms covered by sectoral agreements.



Firms might also have some leeway in determining the wages of newly hired workers if internal labour markets (ILMs, Doeringer and Piore 1971) are important. ILMs are characterized by a hiring of workers into specific (low) entry level positions, while higher level jobs are filled internally. Lazear and Oyer (2004) note that in the ILM wages are determined by the firm and not by external factors such as collective bargaining. In contrast, in external labour markets the determination of wages is governed by factors external to the firm and firms do not have significant discretion over wage-setting.

The traditional ILM approach assumes that firms have specific positions that serve as ‘ports of entry’ where most hiring takes place. In this setting, workers can only reach higher-level positions via progress within the firm, entry wages are concentrated at certain levels and there is limited leeway to offer differentiated wages to candidates. However, recent research suggests that entry rather takes place at various levels, thus leaving more room for a flexible determination of entry wages since firm might offer different entry positions to job applicants. Using firm data for Sweden, Lazear and Oyer (2004) show that there are entry positions at every level of the firm’s hierarchy and a significant fraction of all vacancies are filled with external candidates. Kampkötter and Sliwka (2014) provide corresponding evidence for banks and financial services companies in Germany.<sup>1</sup>

Summing up, although collective wage agreements still play an important role in the German wage bargaining system, different features of the wage-setting system ensure that firms have some autonomy with respect to their wage bargaining. Thus, we assume that there is sufficient flexibility to determine wages of newly hired workers in such way that accounts for effects of workforce composition on the expected productivity of candidates.

#### **4. Data**

In this analysis, we make use of the Linked Employer–Employee Data from the IAB (LIAB). The basis of the LIAB is the IAB Establishment Panel, an annual representative survey covering 1 per cent of all plants in Germany. The LIAB is restricted to those establishments that regularly participated in the survey between 2000 and 2008 (around 10,000 plants). The establishment level dataset is merged with information from the Integrated Employment Biographies (IEB) of the IAB which covers micro data on employment, job-search status, benefit receipt and participation in active labour market policy measures (see Klosterhuber *et al.* 2013 for a detailed description of the LIAB).

The information on individual employment relationships available in the IEB is based on the integrated notification procedure for health, pension and unemployment insurance. Thus, the IEB contains very reliable information on all periods of employment as long as the workers are not exempt from social security contributions, such as civil servants and self-employed persons.

The dataset allows us to identify new employment relationships starting in the period 2000–2009. We focus on new employment relationships with

a length of at least seven days referring to full-time employment subject to social security contributions outside the public sector and the temporary work sector (see Online Appendix for a detailed description). The final dataset comprises almost 280,000 new employment relationships and contains important information on jobs (wage, occupation), workers (educational level, age, nationality, gender, employment biography) and establishments (size, industry, location). We ensure that the workers have not been employed by the hiring firm before by excluding recalled workers from the dataset.

The dataset, thus, provides very accurate information on individual entry wages agreed on by newly hired workers and employers, allows us to control for a wide range of worker and firm characteristics, and enables us to measure diversity at the establishment level as well as the relative position of the individual worker.

The dependent variable is the gross daily wage associated with a new employment relationship. Our pivotal explanatory variables refer to the workforce composition within the establishment a person starts to work in. Our dataset is well suited for the analysis because we observe every worker in the establishments covered by LIAB. This allows us to calculate measures of workforce composition with respect to different worker characteristics. We aggregate the information provided by the individual employment spells to gauge the structure of an establishment's workforce at the date a worker starts to work within an establishment. Summary statistics are provided in Table A1 in the Online Appendix.

In order to control for other factors that influence entry wages, we also use worker and establishment fixed effects estimated by Bellmann *et al.* (2020) following the approach proposed by Abowd *et al.* (1999). They allow controlling for unobserved (time-invariant) characteristics of the workers and establishments which likely impact on negotiated wages as well (see Online Appendix for details). The worker and firm fixed effects have been estimated for different periods in time. In order to avoid endogeneity, we use lagged worker and firm fixed effects, that is, we regress entry wages in the period 2000–2004 on worker and firm fixed effects estimated for the period 1993–1999 and entry wages in the period 2005–2009 are regressed on fixed effects referring to the period 1998–2004. Since these lagged fixed effects are not available for all workers and firms in our sample, we have to restrict the fixed-effects specifications to those observations for which lagged fixed effects are available. In Table 2, we compare the results for the full and the restricted sample.

## 5. Empirical strategy

We estimate the following regression model to identify wage effects of workforce composition distinguishing the impact of workforce diversity from the effects of employee isolation within establishments:

$$w_{ijrt} = \alpha_i + \beta_j + d'_{ij} \gamma + s'_{ij} \delta + x'_{ij} \varphi + z'_{jrt} \phi + \theta_r + \omega_{y(t)} + \varepsilon_{ijrt} \quad (1)$$

where  $w_{ijrt}$  is the wage of worker  $i$  in establishment<sup>2</sup>  $j$  in region  $r$  at date  $t$ .  $d'_{jt}$  is a vector of measures for workforce diversity and  $s'_{ijt}$  a vector of measures for employee isolation. In both cases, we consider the dimensions age, gender and cultural background. The latter is approximated based on the nationality of the workers since information on the country of birth is not available in the IEB.  $x'_{ijt}$  is a vector of (time-varying) worker characteristics that includes age, gender, qualification, occupation, isolation with respect to qualification and information on the individual employment biography.  $z'_{jrt}$  is a corresponding vector of firm characteristics such as sector, size and skill structure. We control for unobserved heterogeneity by including worker, establishment, region and year fixed effects ( $\alpha_i, \beta_j, \theta_r, \omega_{y(t)}$ ) subscript  $y(t)$  denoting the year of date  $t$ . The white noise error term is given by  $\varepsilon_{ijrt}$ .

Applying this model, we assume that employers have some knowledge of how entrants (depending on their relative position) probably fare in the establishment and how this affects their individual productivity and the productivity of the other workers. The recruiting process should involve an assessment of the expected productivity of the job candidates, taking into account their prospective working environment. Based on the empirical strategy at hand, that is, including worker and establishment fixed effects, we compare the starting wage of a given worker in different establishments and examine whether the demographic composition of the plant impacts on the agreed remuneration. With establishment fixed effects, we consider establishment-specific wage mark-ups and discounts. Focusing on entry wages, we rule out productivity and wage effects that will gain in importance as tenure increases, such as promotions and training offered by the firm. These time-varying factors are usually unobserved by the econometrician. However, apart from the productivity-related arguments discriminatory behaviour might affect entry wages. Entrants belonging to a minority group might have to accept a wage discount, while majority workers may demand a mark-up if the staff of the prospective employer includes many minority workers.

Firms report earnings only up to the upper limit for social security contributions such that the wage information in the IEB is right-censored. Following Reichelt (2015), we partly impute the wages applying interval regression, a generalization of Tobit regression, to predict wages above the threshold (approximately 6 per cent of the observations).

In order to gauge the diversity of a firm's workforce, we compute indices that are frequently used in the literature (Table 1). We consider the minority's share within an establishment with respect to gender, the share of foreign workers, and the inverse of a Herfindahl index using information on the shares of cultural groups. Workers with German nationality are excluded from the computation of the Herfindahl index. Thus, it refers to the cultural diversity among foreign workers. In contrast to most previous studies, we define the size of the cultural groups not with respect to single nationalities, but as in Ozgen *et al.* (2014), we use 12 distinct groups of workers whose definition is based on the so-called Global Leadership and Organizational Behaviour

TABLE 1  
Definition of Measures of Diversity and Isolation

<b>Diversity of a firm's workforce</b>	
Share minority, gender	Share of employment held by the gender, which is in the minority in the considered establishment.
Share foreign workers	Share of employment held by workers with Non-German nationality in the considered establishment.
Cultural diversity among foreigners	1 minus the Herfindahl index, which is computed based on the employment shares of 12 distinct cultural clusters of foreign workers (see endnote 3) in the considered establishment.
Mean age	Mean age of the workers employed by the considered establishment.
Standard deviation of ln(age)	Standard deviation of the natural logarithm of the age of the workers employed by the considered establishment.
<b>Relative position within firm</b>	
Isolation gender	Share of employment held by the other gender in the considered establishment.
Isolation culture	1 minus the share of employment held by the own cultural cluster (see endnote 3) in the considered establishment.
Isolation age	Share of employees, who are at least five years younger or at least five years older than the considered worker in the considered establishment.

*Source:* Own representation.

Effectiveness (GLOBE) clusters as defined in Gupta *et al.* (2002).<sup>3</sup> We assume that differences in skills and knowledge as well as transaction costs tend to be relatively small within the cultural clusters.

With respect to the age heterogeneity of a firm's workforce, we consider the mean of age and the standard deviation of the natural logarithm of age assuming that economic effects of age heterogeneity stem from proportional gaps in age (Leonard and Levine 2006).

Employee isolation is measured by the proportion of the other gender, the share of all other cultural clusters and the percentage of workers who belong to other age groups, defined as employees who are at least five years younger or at least five years older than the considered worker.

The longitudinal nature of the IEB allows us to address selection issues at the worker and the firm level. Including worker and firm fixed effects enables us to account for the possible non-random sorting of workers into firms which may bias the wage effects of the workforce composition. First, the estimated wage effects might be biased due to unobserved heterogeneity at the worker level because more able workers might select into firms characterized by a specific workforce composition. Second, more productive firms that pay higher wages might be characterized by specific recruiting strategies and therefore show a specific workforce composition. The coefficient estimates of the pivotal variables might therefore be biased due to various forms of heterogeneity and it is important to control for observed and unobserved characteristics of workers and firms.

However, we cannot control for worker–establishment fixed effects because we only consider the wage of new jobs in our analysis and exclude new

employment relationships that are taken up at a previous employer. Focusing on wages associated with new employment relationships, we investigate the relevance of mechanisms that have fairly instantaneous effects on wages unlike other channels, such as learning, that take some time to materialize. This feature contrasts with most previous studies, which use information on employment at a reference date.

We apply a new approach to control for unobserved heterogeneity and include worker and establishment fixed effects estimated by Bellmann *et al.* (2020) in our regression model. Thereby we avoid disadvantages of the common fixed model and can use both within and between variation to determine wage effects. The worker fixed effects reflect a combination of individual skills and other factors that are rewarded equally across employers (Card *et al.* 2015). Furthermore, the worker fixed effect might also indicate 'persistent luck'. Once a worker gets a job with a relatively high wage due to rent-sharing, efficiency wages etc., she will usually only quit for another job if she receives again a relatively high wage. The establishment fixed effects can be interpreted as a proportional pay premium (or discount) that is paid by the firm to all its employees (Card *et al.* 2015). The fixed effects are available for different time intervals. We use the effects of the two time periods 1993–1999 and 1998–2004 (see Section 4). Thus, unobservable worker and establishment characteristics which influence wages are also allowed to vary to some extent over time. A detailed description of the fixed effects is provided by Online Appendix Section B.

The within estimator, in contrast, only uses the within variation to identify the effects of workforce composition and employee isolation which is much lower than the between variation in our dataset (see Table A1 in the Online Appendix) and leaves a significant part of the information that is incorporated into the cross-sectional dimension of the explanatory variables unused. This approach might, therefore, result in weakly identified effects because the cross-sectional variation cannot be used for identification (see Hausman and Taylor 1981). Furthermore, the differencing may introduce selectivity bias by restricting the sample to workers for whom we observe at least two new employment relationships (see also Ludsteck 2014).<sup>4</sup> Variables that show a relatively low within variation will be particularly affected by these drawbacks. This is important in the present setting because in particular the workforce composition variables show only a rather small within variation (see Table A1 in the Online Appendix).

We cannot make use of a natural experiment that gives rise to an exogenous variation in the workforce composition and employee isolation and would allow to identify causal effects on entry wages. Furthermore, eliminating the endogeneity problem via instrument variable estimation is not feasible with the data at hand as this would involve finding valid instruments for several diversity measures and the relative position of individual workers with respect to different demographic characteristics on a monthly basis. An instrumental variable approach for a model with a significant number of endogenous regressors likely runs into a weak instrument problem. However, the set-up

of the regression analysis aims at reducing the risk of biased estimates due to reverse causality and omitted variables.

First, there is a substantial heterogeneity in entry wages and it is unlikely that the variation in individual wages causes significant changes in workforce diversity. Moreover, we exclude the worker under consideration from the calculation of establishment level composition measures. Second, we include lagged worker and establishment fixed effects together with a number of time-varying characteristics of workers and firms. These fixed effects control for time-invariant and slowly changing characteristics that might influence wages and the matching of workers and firms. Hence, the risk of omitted variable bias should be significantly reduced. Furthermore, we also add region, year, occupation and industry fixed effects in order to consider corresponding shocks.

Given the comprehensive set of controls and various fixed effects, sorting of specific groups of workers into high productivity firms is probably not a problem. Likewise, high productivity firms might pursue special recruitment strategies that give rise to a specific workforce composition. This issue is also considered by including establishment fixed effects. Though, we cannot completely rule out endogeneity. The estimates may suffer from a simultaneity bias if composition effects are caused by co-worker discrimination. Ludsteck (2014) notes that in the model by Becker (1971) the workforce composition and wages are determined simultaneously. Thus, if majority workers increase their demand for a discrimination premium, employers might want to counter their wage claim by decreasing the proportion of minority workers.

The standard errors reported in the next section are clustered at the establishment level to account for cross-sectional correlation in the error terms caused by the explanatory variables referring to the establishment level. To address that the considered worker and firm fixed effects are generated regressors, we also considered clustered bootstrap standard errors as robustness check. They generally confirm the results reported below (results available upon request).

## 6. Results

Table 2 summarizes the results of regressions with and without lagged worker and establishment fixed effects covering the entire sample and the subsamples for which these fixed effects are available. We only display the estimates for the workforce composition and the relative position of the worker. The results of the full models are summarized in Table A2 in the Online Appendix.

Columns (1) and (5) of Table 2 show the estimates of a model omitting worker and establishment fixed effects for the entire sample (Column (1)) and the restricted sample for which lagged individual and firm fixed effects have been estimated (Column (5)). A comparison of the two columns indicates that confining the analysis to this latter sample slightly changes the size of the coefficients. However, the main findings seem to be robust. In addition, we

TABLE 2  
Effects of Workforce Diversity and Employee Isolation on Entry Wages — Pooled and Fixed-Effects Models

	Full sample	Sample for fixed-effects model			
	(1)	(2)	(3)	(4)	(5)
<b>Workforce diversity</b>					
Share minority, gender	-0.209*** (0.035)	-0.210*** (0.035)	-0.089*** (0.025)	-0.088*** (0.024)	-0.228*** (0.040)
Share foreign workers	0.054 (0.055)	0.075 (0.071)	-0.035 (0.043)	-0.031 (0.054)	0.082 (0.085)
Cultural diversity among foreigners	0.012 (0.017)	0.006 (0.017)	-0.004 (0.012)	-0.006 (0.012)	0.004 (0.019)
Mean age	-0.000 (0.001)	-0.000 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Standard deviation of ln(age)	-0.356*** (0.064)	-0.329*** (0.063)	-0.229*** (0.054)	-0.193*** (0.053)	-0.395*** (0.075)
<b>Relative position within firm</b>					
Isolation gender	-0.034*** (0.009)	-0.035*** (0.008)	-0.035*** (0.009)	-0.034*** (0.008)	-0.044*** (0.009)
Isolation culture	-0.026 (0.022)	-0.013 (0.022)	-0.047*** (0.018)	-0.039 (0.020)	-0.024 (0.026)
Isolation age	0.012 (0.029)	0.011 (0.015)	-0.015 (0.033)	-0.008 (0.016)	0.022 (0.019)
Number of observations	276,840	185,920	259,188	173,025	173,025
R <sup>2</sup>	0.719	0.764	0.737	0.780	0.739
Worker fixed effects	No	Yes	No	Yes	No
Establishment fixed effects	No	No	Yes	Yes	No

Notes: Standard errors in parentheses clustered at the establishment level. All models include control variables (Table A1 in the Online Appendix) as well as fixed effects for industry, labour market region, year and occupation.

Source: LIAB and Bellmann *et al.* (2020), own calculations.

\*Statistically significant at the 0.05 level, \*\* at the 0.01 level, \*\*\* at the 0.001 level.

observe more pronounced differences between the models with and without fixed effects (Columns (2)–(4)). Our discussion of the regression results will therefore focus on the fixed-effects subsample.

Only a few attributes of the workforce composition seem to significantly impact on individual entry wages. The negative coefficient of the minority share with respect to gender points to a dampening wage effect of a more balanced gender composition. However, in absolute size the effect of the gender composition more than halves if we include establishment fixed effects. This change points to important selection effects meaning that low-productivity firms show a more balanced gender composition. If we consider unobserved heterogeneity, our results indicate that an increase in gender diversity by one standard deviation decreases entry wages by 1.25 per cent [ $(\exp(-0.088 \times 0.144) - 1) \times 100$ ]. Similarly and in accordance with results by Garnero *et al.* (2014), age diversity exerts a negative influence on negotiated wages as well. The point estimate of the fixed-effects specification indicates that an increase in age diversity by one standard deviation gives rise to a

decline of entry wages by about 1 per cent [ $(\exp(-0.193 \times 0.054) - 1) \times 100$ ]. These adverse effects of gender and age diversity on wages of newly hired workers might be caused by employers expecting that communication barriers and conflicts in heterogeneous establishments will dampen the productivity of entrants and outweigh potential gains from gender and age diversity.

The negative relationship between age diversity and entry wages could also be explained by ILM and wage growth within stable employment relationships. If the firms recruit primarily young workers to entry positions at the bottom of the hierarchy, a steep age–wage profile might give rise to a negative correlation between age diversity and wages of newly hired workers. Bargaining power of older workers could enable them to improve their relative position by raising their own wages and depressing the wages of newly hired young workers.<sup>5</sup>

There is no direct evidence on the significance of these issues for the German labour market. However, we think that it is unlikely that these arguments apply. First, there are studies that point to a relatively low bargaining power of older workers in Germany. Yang *et al.* (2013) show that the promotion probability of workers in manufacturing firms in Germany is initially high and decreases significantly with years of age and tenure. The findings of Gordo and Mertens (2010) indicate that the returns to endowments differ across age groups to the disadvantage of older workers. Second, and related to the first argument, age-earnings profiles tend to be rather flat or even concave in Germany (see Dustmann and van Soest 1997; Orłowski and Riphahn 2008). Wages increase strongly until the age of 30, but the age-earnings profile flattens out after age 40 or even turns negative. Orłowski and Riphahn (2008) also show that returns to tenure are small and insignificant. Finally, we observe a significant number of placements across all age groups in our data. The mean age of newly hired workers in our sample is 38, the 90th percentile is 52. This is not in line with a recruitment process in which firms primarily hire young workers to low-level entry positions.

As regards the cultural background of the workforce, neither the share of foreign workers in the hiring establishments nor the diversity among foreigners impact on entry wages. This also applies to the mean age of the workforce.

Regarding the relative position of workers in the establishment, only gender seems to matter. For all indicators of isolation, we estimate negative coefficients when including worker and firm fixed effects. This points to adverse effects of a minority position. However, only the impact of gender isolation differs from zero at conventional levels of significance. The estimate indicates that increasing the share of the other gender by one standard deviation (24 percentage points) decreases the entry wage by 0.8 per cent.

Table 3 summarizes results that differentiate by gender and citizenship. We only present estimates based on the reduced sample that enables us to consider establishment and worker fixed effects. However, a specification without fixed effects is displayed as well in order to assess selection effects. As regards workforce diversity, we observe — like in Table 2 for the entire sample — significant negative effects of gender and age diversity for each of the four



TABLE 3  
Effects of Workforce Diversity and Employee Isolation on Entry Wages by Gender and Citizenship

	Female workers		Male workers		Foreigners		Natives	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Workforce diversity</b>								
Share minority, gender	-0.063* (0.030)	-0.158*** (0.039)	-0.090*** (0.027)	-0.217*** (0.045)	-0.148** (0.054)	-0.266*** (0.063)	-0.080*** (0.024)	-0.218*** (0.039)
Share foreign workers	-0.082 (0.057)	-0.038 (0.062)	-0.027 (0.058)	0.099 (0.094)	-0.015 (0.056)	0.029 (0.068)	-0.074 (0.057)	0.060 (0.094)
Cultural diversity among foreigners	-0.007 (0.014)	-0.002 (0.019)	-0.011 (0.013)	-0.002 (0.019)	-0.014 (0.025)	-0.006 (0.031)	-0.004 (0.012)	0.006 (0.018)
Mean age	-0.0022* (0.0009)	-0.0021 (0.0014)	0.0002 (0.0008)	-0.0005 (0.0012)	-0.0031 (0.0017)	-0.0006 (0.0022)	-0.0005 (0.0008)	-0.0010 (0.0012)
Standard deviation of ln(age)	-0.278*** (0.070)	-0.478*** (0.088)	-0.172*** (0.052)	-0.381*** (0.077)	-0.444*** (0.116)	-0.525*** (0.143)	-0.180*** (0.052)	-0.389*** (0.074)
<b>Relative position within firm</b>								
Isolation gender	0.053* (0.022)	0.086** (0.027)	-0.070*** (0.019)	-0.117*** (0.027)	-0.003 (0.020)	-0.002 (0.022)	-0.036*** (0.008)	-0.046*** (0.009)
Isolation culture	-0.001 (0.040)	0.010 (0.039)	-0.034 (0.021)	-0.017 (0.027)	-0.012 (0.044)	0.035 (0.051)		
Isolation age	0.001 (0.025)	0.024 (0.028)	-0.014 (0.015)	0.020 (0.018)	-0.032 (0.037)	-0.004 (0.039)	-0.005 (0.017)	0.023 (0.020)
Number of observations	48,077	48,077	124,948	124,948	9,318	9,318	163,707	163,707
R <sup>2</sup>	0.771	0.730	0.785	0.745	0.759	0.729	0.782	0.741
Worker fixed effects	Yes	No	Yes	No	Yes	No	Yes	No
Establishment fixed effects	Yes	No	Yes	No	Yes	No	Yes	No

Notes: Standard errors in parentheses clustered at the establishment level. All models include control variables (Table A1 in the Online Appendix) as well as fixed effects for industry, labour market region, year and occupations.

Source: LIAB and Bellmann *et al.* (2020), own calculations.

\*Statistically significant at the 0.05 level, \*\* at the 0.01 level, \*\*\* at the 0.001 level.

considered groups of workers. The size of the point estimates differs to some extent across the samples. Both are largest for foreign workers which suggest that in particular for these workers it is difficult to cope with adverse effects of workforce diversity such as communication barriers and conflict, resulting in a lower (expected) productivity.

For female workers, we additionally detect an adverse effect of the mean age of the workforce. The point estimate indicates that a 3.68-year higher mean age (which corresponds to one standard deviation) comes along with a 0.85 per cent lower entry wage. We suppose that the adverse wage effect may point to discriminative behaviour due to outdated gender stereotypes, which might prevail primarily in establishments with a rather old workforce as compared with plants marked by a relatively young staff. The result indicates that the gender pay gap, *ceteris paribus*, increases with the mean age of the workforce since the effect of the latter is virtually zero for male workers. The corresponding regression result for the foreign workers points in a similar reasoning. However, the adverse effect of mean age is not precisely estimated for this group.

Isolation by age and cultural background do not influence entry wages of the groups considered in Table 3. For gender isolation, in contrast, our results indicate opposed wage effects for female and male workers. While women tend to benefit from a high share of male, male entrants receive, *ceteris paribus*, lower entry wages in firms showing a relatively high percentage of female workers. The positive effect for female workers may point to complementarities between female and male workers. More specifically, the result suggests that employers seem to expect that female entrants bring along skills and knowledge that complement the capabilities of their co-workers in a work environment that is dominated by males. Applying the theoretical arguments discussed in Section 2 (cf. Böhnheim *et al.* 2012), we hypothesize that female entrants receive a wage premium for the complementarity. An increase in gender isolation by one standard deviation (24 percentage points) increases the entry wage of women by 1.3 per cent.

As regards male workers, in contrast, our results suggest that these workers, who usually belong to a majority group in German establishments, may find it more difficult to cope with isolation. The minority position might, therefore, affect expected productivity and entry wages of males, outweighing the above-mentioned beneficial complementarity effects. The dampening effect on entry wages of male workers somehow confirms results by Ilmakunnas and Ilmakunnas (2011) who report a negative wage effect for males in plants with female majority. An alternative explanation for the adverse effect of gender isolation on wages of males, which shows also up for natives but not for foreign workers, is discriminative behaviour in plants with a relatively high share of female labour.

It is important to note that our findings are not driven by gender diversity merely reflecting the share of female workers. In the majority of German firms female workers are still outnumbered. The mean proportion of females in the establishments covered by our sample amounts to 34 per cent. However,

TABLE 4  
Effects of Workforce Diversity and Employee Isolation on Entry Wages by Skill Level

	<i>Low-skilled</i>		<i>Medium-skilled</i>		<i>High-skilled</i>	
	(1)	(2)	(3)	(4)	(5)	(6)
<b>Workforce diversity</b>						
Share minority, gender	-0.209*** (0.049)	-0.307*** (0.059)	-0.091*** (0.024)	-0.241*** (0.040)	-0.059 (0.041)	-0.167** (0.057)
Share foreign workers	0.027 (0.045)	0.107 (0.060)	-0.004 (0.073)	0.122 (0.110)	-0.270** (0.130)	-0.214 (0.180)
Cultural diversity among foreigners	-0.034 (0.022)	-0.037 (0.027)	-0.005 (0.012)	0.000 (0.018)	-0.010 (0.017)	0.009 (0.024)
Mean age	-0.001 (0.002)	0.000 (0.002)	-0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)	0.001 (0.002)
Standard deviation of ln(age)	-0.282** (0.102)	-0.352** (0.120)	-0.157** (0.052)	-0.337*** (0.072)	-0.315*** (0.090)	-0.686*** (0.120)
<b>Relative position within firm</b>						
Isolation gender	0.004 (0.017)	0.002 (0.017)	-0.032*** (0.009)	-0.044*** (0.010)	-0.042*** (0.012)	-0.045*** (0.013)
Isolation culture	-0.018 (0.027)	0.014 (0.028)	-0.064* (0.032)	-0.071 (0.041)	0.106 (0.117)	0.148 (0.157)
Isolation age	0.034 (0.026)	0.045 (0.027)	-0.009 (0.014)	0.012 (0.015)	-0.008 (0.042)	0.037 (0.054)
Number of observations	10,310	10,310	122,079	122,079	40,636	40,636
R <sup>2</sup>	0.776	0.751	0.771	0.719	0.612	0.567
Worker fixed effects	Yes	No	Yes	No	Yes	No
Establishment fixed effects	Yes	No	Yes	No	Yes	No

Notes: Standard errors in parentheses clustered at the establishment level. All models include control variables (Table A1 in the Online Appendix) as well as fixed effects for industry, labour market region, year and occupation.

Source: LIAB and Bellmann *et al.* (2020), own calculations.

\*Statistically significant at the 0.05 level, \*\*at the 0.01 level, \*\*\* at the 0.001 level.

the estimates for the minority share and gender diversity are quite robust to the inclusion of the proportion of females in the full model covering male and female workers (Column (4) of Table 2): For gender diversity, we obtain a point estimate of  $-0.061$  ( $p$ -value: 0.013) and for gender isolation an estimate of  $-0.033$  ( $p$ -value: 0.000).

There are also important differences across workers' skill levels (see Table 4). We differentiate three qualification groups: low-skilled workers (no formal vocational qualification), medium-skilled employees (completed apprenticeship training), and high-skilled workers (university degree). We detect the significant negative impact of gender diversity observed in Tables 1 and 2 only for low- and medium-skilled workers in the fixed effect model. For high-skilled workers, we obtain a substantially smaller coefficient which does not differ from zero at conventional levels of significance. Hence, these workers can apparently cope best with a balanced gender composition and employers seem to anticipate that there might be no negative effect on their productivity. We observe the strongest adverse effect of gender diversity for wages of low-skilled workers. The corresponding estimate indicates that increasing the

share of the minority gender by 14.4 percentage points, that is, one standard deviation, decreases the entry wages of low-skilled employees by 3 per cent. The results in Table 4 show, furthermore, that the dampening effect of gender isolation on entry wages reported in Table 2 is driven by medium- and high-skilled workers, whereas negative effects of age diversity show up for each skill group.

Differentiating between skill groups also indicates that the composition of the workforce with respect to cultural background might influence the expected productivity and, thus, entry wages. The negative coefficient of cultural isolation observed of low- and medium-skilled workers could possibly point to discriminative behaviour affecting the entry wages of these skill groups, although the effect is statistically significant only for the medium-skilled. For the high-skilled, in contrast, the coefficient is positive and also economically meaningful. However, the effect is not precisely estimated. Finally, we detect a negative effect of the share of foreign worker when focussing on entry wages of high-skilled workers. A potential explanation is that high-skilled workers consider a high share of foreign workers as an amenity, meaning that these workers accept lower wages in establishments with a high percentage of international colleagues.

## 7. Conclusions

Taking into account observed and unobserved heterogeneity at the individual and the plant level, we detect only a few important effects of workforce composition in German establishments on wages of newly hired workers. Comparing models with and without worker and establishment fixed effects proves that it is important to address selection effects. The regression results suggest that both diversity at the firm level and the relative position of the worker matter for negotiated wages.

There is a very robust negative influence of age diversity that seems to impact on all newly hired workers, though the size of the effect varies to some extent across different groups. The estimates indicate that, on average, an increase in age diversity by one standard deviation gives rise to a decline of entry wages by about 1 per cent. For other diversity measures and indicators of workers' isolation, we detect that only specific groups tend to be affected. This applies to gender diversity and isolation, the share of foreign workers and isolation with respect to the cultural background. As regards the relative position, it is mainly gender isolation that appears to exert a negative influence on different groups. However, female workers seem to benefit from a high share of male co-workers.

The heterogeneity of effects indicates that workforce diversity is likely associated with positive and negative net effects, depending on the considered characteristic and the demographic group. This suggests, in line with the theoretical arguments discussed above, that there are in fact costs and benefits of diversity which influence the productivity of newly hired workers

and corresponding expectations of employers. For some groups, benefits of diversity and its costs seem to balance while other groups are mainly impaired by heterogeneity.

In particular, the effects of diversity and isolation on entry wages differ significantly for men and women and between foreigners and natives. Thus, attempts to reduce the corresponding pay gaps need to consider the heterogeneous relationship between workforce composition and the remuneration of specific demographic groups. This raises important issues for future research. First, more evidence on the significance of different mechanisms that might establish a link between negotiated wages, diversity and isolation is required to better inform policy decisions. For instance, the workers' relative position might capture potential complementarities and their impact on expected productivity and offered wages. But it may also reflect discriminatory behaviour or the impact of referral-based job search networks. Second, there is as yet no comprehensive evidence on the role of mediating factors such as organizational structures and institutional settings which might govern the relationship between workforce composition and economic outcomes and which are likely to differ across countries and firms (see Ozgen *et al.* 2014).

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### **Notes**

1. They distinguish six hierarchical levels and show that there is a significant proportion of newly hired employees at every level. Although the share of entrants is highest at the lowest level, there is no systematic decline of the share of newly hired workers as one moves up the hierarchy. Moreover, the authors show that wages differ between newly hired employees and equally able incumbents on the same job, pointing to some leeway of German firms in wage determination. We are grateful to a referee for suggesting this argument.

2. The establishment identifier that is used to merge the establishment panel with the IEB refers to establishments, not to firms. However, we use the terms workplace, establishment, plant and firm interchangeably throughout the article.
3. Based on their nationalities, we distinguish workers from Germany, English-speaking countries, Eastern Europe, Southeastern Europe, Germanic Europe and BeNeLux, Latin Europe, Nordic Europe, Southern Asia, Confucian Asia, Latin America, Middle East and Sub-Sahara Africa. For details, see Ozgen *et al.* (2014: Table 2).
4. Results of within regressions are available upon request. Actually, the number of observations strongly declines to around 5,000 new employment relationships if we consider worker fixed effects.
5. We are grateful to a referee and the editor for pointing this out and suggesting alternative explanations for the adverse effects of age diversity.

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### **Supporting Information**

Additional supporting information may be found online in the Supporting Information section at the end of the article.