Moving to Productivity:
The Benefits of Healthy Buildings

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Abstract

Health is a critical factor for the generation of value by workers. Companies bear substantial costs associated with absenteeism and presenteeism among their employees. This study investigates the impact of the environmental conditions in the workplace on the health and job satisfaction of employees, as core factors of productivity. We provide quasi-experimental evidence based on the relocation of 70% of the workforce of a municipality in the south of the Netherlands. We constructed a longitudinal dataset based on individual surveys of the entire municipality workforce and include measures before and after the move. The estimation results show a significant improvement in the perceived environmental conditions and health of the relocated workers. The relocation effects remain persistent in the medium term (two years after the moving date). The results from the heterogeneity analysis show the older groups of employees enjoyed larger health impacts.

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1 Introduction

Workers represent a critical input factor for the modern firm. To improve our understanding of the effects of workplace environmental conditions on human performance, we estimate the impact of a major upgrade in office-building infrastructure on employees' health and job satisfaction. Economists have devoted significant effort exploring the relationship between health and labor market performance of individuals. Early work by Grossman (1972) provided the theoretical foundation for the role of health in labor markets. For workers, health is a key factor of individuals' supply of labor, determining the total amount of time they are able to spend producing. On the firm side, companies bear substantial costs in the form of both absenteeism and presenteeism, that is, productivity losses due to workers not being able to work at full capacity (Hemp, 2004). Stewart et al. (2003) estimate in a sample of 28,902 working adults in the US that 13% of the total workforce experienced a loss in productive time due to common pain conditions such as headaches or back problems. The authors estimate a loss of $61.2 billion per year in pain-related productive time.

The link between employee well-being and firm performance has also been the subject of numerous studies. The recruitment and retention of skilled employees is critical for the competitive advantage and value of firms, especially in knowledge-based industries such as technology (Edmans, 2012). Employee satisfaction is essential for the retention of key workers (Mitchell et al., 2001), whose transfer to another company would bring their knowledge and skills to a competitor, weakening the position of the current company. In addition, employee well-being and satisfaction have recently been related to direct productivity benefits. In the manufacturing industry, Böckerman and Ilmakunnas (2012) provide plant-level evidence on the effect of job satisfaction on productivity, showing a one-standard-deviation increase in job satisfaction leads to an increase in value-added per hour worked of 6.6%. Recent evidence from the lab shows a direct link between satisfaction and productivity. Oswald et al. (2015), by experimentally manipulating the levels of short-term happiness with a comedy clip or memories of recent life events, saw a 12% increase in individual productivity, measured by the amount of arithmetic tasks executed by the participants.

Much attention has been devoted to understanding the role of material conditions on people's happiness and well-being. Cattaneo et al. (2009) find that upgrading dirt floors to cement floors increased happiness and reduced symptoms of depression among poor individuals in Mexico. Devoto et al. (2012) show that connecting households to piped water improved households' well-being in Morocco. Evidence from the Moving To Opportunity (MTO) experiment in the US shows significant improvements in subjective well-being 15 years after being relocated to a less distressed neighborhood environment (Ludwig et al., 2012).

Moreover, the economics literature has given much attention to the effect of (material) workplace conditions on employee health and well-being, as critical factors in human performance. Our study is based on the quasi-experimental variation created by the relocation of 70 % of the workforce of a large municipality in the Netherlands (N=1,200). Using survey data, we show significant long-term benefits in the working conditions and health of employees, but not in employee satisfaction. We evaluate changes in (1) employee-perceived environmental conditions in their workplace, (2) health outcomes, and (3) job satisfaction following their relocation to a new office building designed to enhance indoor environmental quality. [1] We develop a unique dataset monitoring the perceived working conditions, health, and job satisfaction of more than 600 municipality workers up to two years after the relocation. In total, we surveyed the employees four times, once before the move and three times after the move. We employ a traditional difference-in-differences (DiD) approach to estimate the impact of the move on perceived working conditions and employee health. The results indicate the relocation led to significant improvements in perceive working conditions and health. However, these improvements did not translate into better general job satisfaction.

The literature documents significant discrepancies between the short- and long-term reported impacts of individuals associated with material upgrades in their lives due to hedonic adaptation, a psychological process that attenuates the long-term impact in conditions. For instance, individuals even adapt to serious chronic health conditions (i.e., disabilities), exhibiting high levels of happiness or life satisfaction close to the baseline level again in the long term (Loewenstein and Ubel, 2008). A recent study by Galiani et al. (2018) shows this adaptation also appears to exist when evaluating the impact of major building infrastructure improvements. Two years after the intervention, Galiani et al. found the beneficiaries of the program reported well-being levels identical to the baseline levels before the intervention.

In a second step of the study, we decompose the estimates of the three surveys administered in the two years after the moving date, to investigate the discrepancy between short- and long-term effects. The estimates of health and perceived environmental quality show a persistence over time. On the other hand, none of the job-satisfaction measures deviate significantly from the baseline in the long term.

The remainder of our paper is organized as follows. In the next section, we discuss the literature investigating the link between environmental conditions in offices and employee health. In section 3, we provide a description of the relocation event and the study design used in the study, and we also explain the construction of our health and environmental-quality survey-based indicators. In section 4, we present our empirical strategy. The results are presented in

[1] Around 70 % of the subjects were relocated; the remaining 30 % stayed in their original workplaces over the entire study period.

section 5, and section 6 concludes.

2 Literature

The effect of indoor environmental quality (IEQ) on measures of employee health, well-being, and productivity has been the focus of a large number of studies in the public health, architecture, and engineering literature (for a recent review of the literature, see Ghaffarianhoseini et al., 2018). The exposure to deficient indoor environmental conditions at work has been associated with health problems, causing nuisance among employees. Usually known as the sick-building syndrome, health problems include eye, nose, or throat irritation, headache, or fatigue associated with the regular occupation of a building with detrimental environmental conditions (Fisk et al., 2009).

The literature provides evidence on the harmful effects of multiple environmental factors in the workplace. Poor indoor air quality in the form of high levels of CO_2 or pollutants has been linked to the prevalence of absenteeism, sick-building symptoms (Fisk et al., 2009), and cognitive performance of workers (Allen et al., 2016; MacNaughton et al., 2016). Inadequate thermal conditions in the form of suboptimal temperatures or relative humidity have been linked to the prevalence of increased heart rate, respiratory problems, sick-building syndrome, and reduced cognitive performance (Lan et al., 2011; Seppänen et al., 2006). Noise is also a risk factor commonly found in workplaces. The exposure to unhealthy decibel levels leads to cardiovascular disease, stress, and sleep disruption, ultimately harming employees' cognitive performance and labor productivity (Dean, 2017). Finally, light quality has been linked to eye-irritation problems and changes in the circadian rhythm of adults (Cedeño-Laurent et al., 2018).

Most of our understanding about the impact of indoor environmental factors on employees is based on occupant surveys. Recent reviews of the literature from MacNaughton et al. (2015) and Altomonte and Schiavon (2013) provide a comprehensive overview of the literature investigating the benefits for occupants located in so-called ”green” environmentally certified buildings. In both reviews, the results from the majority of the surveyed studies indicate that individuals in ”green” buildings evaluate better their perceived health and the environmental conditions at their workplace. These studies are based on cross-sectional comparisons of the reported values of participants working in ”green” buildings against the answers from those working in conventional buildings. The validity of the results therefore relies on strong assumptions about the differences between employers and employees in ”green” and non-”green” buildings. These studies rely on assuming an absence of selection bias, which would arise when the health and working conditions of occupants in sustainable buildings might differ from the health and working conditions of those working in conventional buildings, beyond the building infrastructure.

Singh et al. (2010) is the only study in the field that is based on a longitudinal design. The authors followed a group of 262 individuals who moved from a conventional to a sustainable building in Michigan. The authors found the study participants reported a significant improvement in the perceived environmental conditions at their workplace after the move, a reduction in the number of hours absent from work due to health reasons, and a higher perception of individual productivity. However, the study has some limitations. First, the post- and pre-surveys were implemented in different seasons, where the presence of allergies and other diseases might differ, as well as the impact of outdoor climate conditions on the indoor environment. In addition, the study lacked a control group, serving as a benchmark for changes in the general health status in the organization over time. Finally, some of the participants in the study were asked to fill in the questionnaire retrospectively, after the move took place.

3 Study Set-Up

3.1 Background

In 2016, Venlo, a municipality in the southeast of the Netherlands, inaugurated a second, newly constructed office building. The construction costs of the building were €34.5 million. The new municipality building was built following green and sustainable principles: In addition to glass and concrete, the north wall of the building is covered with vegetation, and includes a green wall of 2,000 m^2. Green or living walls allow plants to grow from the vertical structure. The installation of green walls has been associated with an improvement in outdoor and indoor air quality, transforming carbon dioxide (CO2) into oxygen, and filtering fine particles from outdoor sources of pollution (Perini and Rosasco, 2013). In addition, the plants serve as natural insulation against heat, cold, and sound (Cuce, 2016). The building is also equipped with state-of-the-art natural ventilation technology. The air enters the building at the top, where it is oxygenated by plants and brought to the bottom of the building, from where the purified air then circulates naturally throughout the building using physical principles rather than mechanical ventilation systems (see Figure 1 for a description of the ventilation system).

[Insert Figure 1 about here]

In the summer of 2016, 70% of the 1,461 workers of the municipality were moved to a newly constructed office building within the same city.[2] Office space in the previous workplaces was organized in enclosed private offices that several people shared. In the new building, the office space follows an open office layout. Open offices tend to generate noise complaints among occupants, who can be distracted by high levels of noise and loss of privacy (Kim and de Dear, 2013). The selection of movers was quasi-random, through selection of teams rather than indi-

[2]Estimates are based on the number of individuals with an active corporate email list in the summer 2016.

viduals. In addition to significant changes in indoor conditions, the organizational office layout also changed.

3.2 Survey Design

We received permission from the municipality to send surveys to all of its employees, asking them to complete it via email. [3] The survey included anonymized individual identifiers, allowing us to build a longitudinal dataset that tracks the responses from the same employee over multiple survey waves. Our sample includes the survey responses of the treatment group, individuals relocated to the new ”green” building, and those of the control group, comprising those employees who were not relocated to the new building.

The surveys span both the period before and after the relocation. Figure 2 describes the timeline of the four surveys contained in our data. We first sent a questionnaire to all employees one month before the relocation took place, serving as the baseline survey in the analysis. After the relocation, we surveyed all employees three times - those individuals that were relocated as well as those who remained in their original workplace during the entire sample period.

[Insert Figure 2 about here]

The survey includes the module developed by the Center for the Built Environment (CBE) at the University of California, Berkeley, to monitor the perceived environmental conditions of occupants in their workplaces (Zagreus et al., 2004). Since the early 2000s, the CBE survey has been extensively used to evaluate the performance of buildings globally. The core questions in the survey assess occupant (dis)satisfaction and comfort with indoor environmental quality (IEQ) issues including indoor air quality, thermal comfort, lighting, and acoustics.

Figure 3 shows an example of the two types of questions used in the main analysis to assess changes in perceived environmental conditions. First, we asked participants to rate their satisfaction with different aspects of the environment on a 7-point scale ranging from ”very satisfied” to ”very dissatisfied,” with a neutral midpoint. In a second set of questions, we asked participants to rate each IEQ dimension on 7-point scales ranging from ”support” to ”interferes” in their ability to get their work done.

[Insert Figure 3 and Table B.3 about here]

The survey includes two questions about the health status of individuals. First, we examine changes in the health status of workers based on the prevalence of sick-building-syndrome symptoms. This concept is widely examined in the building science and public health literature and refers to ”a collection of non-specific symptoms including eye, nose and throat irritation,

[3] See Appendix A for the text of the invitation sent to the employees.

mental fatigue, headaches, nausea, dizziness and skin irritations, which seem to be linked with occupancy of certain workplaces" (WHO, 1983). The survey includes a question asking whether the subject suffers from syndrome symptoms ("Do you regularly have symptoms (e.g. tiredness, headache, eye irritation, nasal congestion, dry throat, dry skin) that disappear when you leave the building - when you are at work?"). In addition, we collected self-stated sick-leave data based on the number of days missed due to health reasons in the year before the survey ("How many days were you unable to work this year due to illness?").[4]

We measure the job satisfaction of employees based on a series of Likert scales, where respondents rated the frequency with which they experienced job-related emotions (see Panel B Table 2 for the complete list of questions). The frequency of the scales ranges from "Daily" to "Never," and includes the options "A few times a week," "Once a week," "Few times a month," "Once a month," and "Few times a year or less."

Finally, the survey includes questions about basic demographic characteristics of respondents (i.e., age and gender) and some details of the employee's employment contract (i.e., working hours, and years in the current organization). In addition, the survey includes a series of questions that ask participants to grade their (dis)satisfaction with the layout, and furniture and equipment in their workplace, based on the same scales that are used to grade the perceived environmental conditions in the workplace. We created dummies from the original scales that take the value of 1 if the original scale is "Daily," "A few times a week," or "Once a week," and zero otherwise.

3.3 Descriptive Statistics

The response rate of the surveys ranged between 35% and 40% (see Appendix Table B.1). In the first wave, we gathered 573 valid answers, 585 in the second wave, 569 in the third, and 530 in the fourth. The median completion time of the survey was 11 minutes. We observe no differences in response time between relocated (treated) and non-relocated (control) employees, suggesting no differences in attention or effort between the two groups (but, of course, our goal is not to empirically assess such differences).

Table 1 shows the demographic characteristics of the relocated and non-relocated workers in wave 1. The non-relocated employees were younger, on average, than those in the relocated group, as reflected by the higher percentage of individuals below 31 years old (19% vs. 10%). The gender ratio does not differ between two employee groups.

[Insert Table 1 about here]

Looking at the current contract characteristics of the two groups of employees, we find the non-relocated individuals were less experienced than those in the relocated group (as reflected

[4]Respondents were asked to choose between the following options to report the number of sick days: I did not report sick this year, (2) 1 day, (2) 2-5 days, (3) 5-10 days, and (4) more than 10 days.

in the age difference between the groups). The total working hours does not differ significantly between the treatment and control group.

3.4 Descriptive Results: Difference-in-Difference

Table 2 presents the results of basic DiD comparisons tests. The numbers in column (1) describe the average dissatisfaction scales and health outcomes reported by subjects who were relocated to the sustainable building in the first survey ($k = 0$), the baseline survey. The second column displays the scales reported by the group of employees who were not relocated to the sustainable building, before the relocation ($k = 0$). The scales displayed in columns (1) and (2) indicate employees were the most dissatisfied with air quality and noise levels in the workplace. Column (3) displays the difference between the average scales between those relocated and those not relocated, together with the significance level for the t-test of the difference in means. The results indicate that in the initial baseline survey, before the move took place, the group of individuals who were going to be relocated were less satisfied with the air quality and light quality, on average, than were those employees who were not going to be relocated, as represented by the higher values reported in the corresponding scales. In addition, the relocated individuals had a baseline satisfaction higher for the space available and visual privacy in the workplace, but were less satisfied with the furniture. Finally, we observe no significant differences between the two groups of employees in health outcomes in the baseline survey.

[Insert Table 2 about here]

Columns (4) to (6) in Table 2 show the average responses of the relocated and non-relocated samples after the moving date. Column (4) shows a substantial drop in air-quality, temperature, and light-quality dissatisfaction for the relocated employees, compared to those in the baseline (column (1)). In the group whose workplace remained unchanged, the answers after the move (column (5)) are comparable in magnitude to those before the move (column (2)). When comparing the answers between the treated and the control sample, we observe a reversion from the situation before the move. The relocated group shows significantly lower dissatisfaction in air quality, temperature, and light quality than the non-relocated group. The relocated individuals also show an average improvement in the health status, as reflected in the drop of the proportion of people reporting sick-building-syndrome symptoms. We do not observe any differences in the probability of missing work days due to illness.

Table 2 Panel B shows the descriptive statistics for the job-satisfaction questions. We observe no significant differences in job satisfaction between relocated and non-relocated employees either before or after the move to the new building. We also do not observe a significant change in job satisfaction in any specification considered in this study.[5]

4 Empirical Strategy

We use DiD models to estimate the impact of the improvement in building conditions on workers' perceived working conditions and health status. The basic DiD model takes the following form:

$$Y_{it} = \alpha + \beta Relocated_i + \lambda AfterMove_t + \delta Relocated * AfterMove_{it} + \epsilon_{it} \tag{1}$$

where Y_{it} includes the set of outcome variables describing the perceived working conditions, health status, and job satisfaction of individual i at time t. We include the scales describing the perceived noise, temperature, light, and air quality in the workplace. We consider two health outcomes in the analysis: a dummy variable indicating the individual suffers from sic- building syndrome and a dummy variable indicating the individual missed work in the previous year due to illness. In addition, we include the set of job-satisfaction questions described in the previous section. The $Relocated_i$ dummy variable takes the value of 1 for the group of employees who were relocated to the new building. The $AfterMove_t$ takes the value of 1 for the survey waves after the moving date, and zero otherwise. Our prime parameter of interest is δ, describing the average change in the outcomes (Y_{it}) after the move for the employees who relocated to the new building. ϵ_{it} is the error term, which might be correlated within individuals. Therefore, we cluster standard errors at the individual level.

$$Y_{it} = \mu_i + \tau_t + \delta Relocated * AfterMove_{it} + \beta X_{it} + \epsilon_{it} \tag{2}$$

Our DiD research design relies on the assumption that the characteristics of workers who were relocated to the new building changed over time in a way that is comparable to those who were not relocated. To alleviate concerns of potential biases in our results, we estimate our parameter of interest in a regression model with a rich set of fixed effects and time-varying control variables (Equation 2). First, we replace $Relocated_i$ with a set of individual fixed effects (μ_i) to reduce biases resulting from differences between the movers and non-movers. In addition, we replace the indicator for the post-treatment period ($AfterMove_t$) with a set of time dummy variables τ_t for each survey wave, thereby non-parametrically adjusting for possible shocks in the city or employer that coincide with the move (e.g., pollution reduction in the city). Finally, we include a set of individual time-varying controls, X_{it}. The set of controls includes the average working hours per week and the reported scales rating the *Office Layout* (See Table B.3 for the full list of scales in this category). [6]

[5]We include the remaining results of the analysis of the impacts on job satisfaction in Appendix B

[6]We include two dummy variables indicating the individual works "Less than 10 hours" or "11-30 hours," leaving the category "More than 30 hours" as reference.

Finally, we use an event-study analysis to capture dynamic effects of the new building on the workers. Equation 3 estimates the effects of the relocation separately by year:

$$Y_{it} = \mu_i + \tau_t + \sum_{k=1}^{K} \delta_k Relocated * AfterMove_{it}^k + \beta X_{it} + \epsilon_{it} \tag{3}$$

Here, the coefficient δ_k describes the effect of working in the newly constructed office k periods after the moving date. Thus, $Relocated * AfterMove_{it}^k$ is an indicator for being k time periods relative to the moving date. The reference category is $k = 0$; hence, the post-treatment effects are relative to the year immediately before the treated individuals were relocated to the new building.

In a final step, we estimate to what extent the changes in each of the environmental scales with respect to their baseline level translate into changes in health status with respect to the baseline:

$$Health_{it} - Health_{ib} = \tau_t + \Theta_s(IEQ_{its} - IEQ_{ibs}) + \beta(X_{it} - X_{ib}) + u_{it} - u_{ib} \tag{4}$$

where $Health_{it}$ takes the value of 1 if individual i reports sick-building-syndrome symptoms at time t, and zero otherwise. $Health_{ib}$ takes the value of 1 if individual i reports sick-building-syndrome symptoms in the baseline survey. $Health_{it} - Health_{ib}$ describes the difference between individual i's probability of stating sick-building-syndrome status at time t and in the baseline survey b. Similarly, $IEQ_{its} - IEQ_{ibs}$ describes the changes in the values reported in the environmental scale s for individual i at time t, with respect to his answers in the baseline survey b. The coefficients of interest, Θ_s, describe how changes in environmental scale s translate into changes in the probability of reporting sick-building-syndrome symptoms. In addition, we include the changes in a set of control variables for building quality $X_{it} - X_{ib}$. Error terms are clustered again at the individual level.

5 Results

5.1 Regression Models Difference-in-Differences

In this section, we report the estimated coefficients and standard errors of the coefficients associated with the DiD variable in equation 1 and 2. Table 3 provides the estimation results, where each row displays the estimated DiD coefficient ($\hat{\delta}$) in 1 and 2 for a different outcome. Each column provides a different specification of the model, introducing in a stepwise fashion different sets of fixed effects and time-varying control variables. Column (1) shows the estimated DiD coefficients of equation 1. The estimation results indicate the relocation of workers was associated with a significant decrease in the level of dissatisfaction of perceived environmental quality in all measures, except for noise and privacy. The highest impact associated with the relocation was on the air-quality dimension, where the dissatisfaction scale dropped 1.6 points on a 7-point scale. In relative terms, when compared to the average value of these scales in the baseline survey for the relocated group, the relocation to the new building improved employee satisfaction with the air quality by 35% (1.61/4.50). Similarly, the relocated employees attached a 31% (1.31/4.14) lower value to the scale evaluating whether air quality hinders work.

[Insert Table 3 about here]

Columns (2) to (5) provide insights into the robustness of the results across different specifications of equation 2. The estimates remain significant with the inclusion of time, individual fixed effects, and time-varying controls.[7] The relocation of workers to the sustainable building also generated significant improvements in the perception of light quality and temperature. The absolute and relative improvement in the scales of these two parameters is smaller than the changes observed for the air-quality dimension. Temperature dissatisfaction among relocated workers dropped, on average, by 0.68% - 17% compared to the average value of the relocated group before the move. Similarly, the relocation reduced dissatisfaction with the light quality in the building by 0.80% - 28% compared to the average value of the relocated group before the move.

The estimates displayed in columns (2) to (5) show the stability of the estimates, supporting the robustness of the results across specifications. The estimation results show no significant improvement in any of the scales in the acoustic-quality dimension. This indicates finding the noise-satisfaction level remained constant after the move from an enclosed office to an open office, and therefore that the open-office environment did not generate significant nuisance for employees, which was an initial concern of the employer. In addition, the heterogeneity in reported satisfaction across dimensions supports the independence of the scales, and implies our results are not driven by the overall relocation itself, but rather by the characteristics of the new building.

We also observe significant improvement in the health of individuals. Although we observe no changes in absence due to illness, we observe significant changes in the health status of individuals. Column (1) of Table 2 shows the relocation of employees to the new building reduced the percentage of workers suffering from sick-building syndrome by 16.5%. The results from the more flexible specifications (Columns (2) to (5)) indicate the inclusion of a richer set of fixed effects and individual controls increased the estimated coefficient. The most conservative estimation including time-varying controls, individual and time fixed effects (column (5)), shows a decrease of 21.6% in the prevalence of sick-building syndrome among the relocated workers after the move. The relocation of workers, generates a substantial drop in the prevalence of sick

[7] In column (5), we include changes in working hours, perceived quality of furniture, and layout as time-varying controls.

leave syndrome symptoms when compared to the baseline probability of reporting sick building syndrome symptoms among the relocated employees, by 42%. [8]

5.2 Dynamic Effects

In this section, we test for the existence of a possible rebound in the improvement of perceived satisfaction and health experienced by the relocated employees. Evidence from psychology and behavioral economics shows that individuals tend to adapt, in the medium term, to changes in their physical or material conditions (e.g., Kahneman and Deaton, 2010). Thus, the estimated changes in the subjective assessments presented in the previous section might be biased by an overreaction of individuals in the short term. In addition, the potential material depreciation of the new building might also distort the results.

Figure 4 shows the coefficients ($\hat{\delta_k}$) describing the changes in responses across survey waves (k) with respect to the baseline survey for the relocated (blue) and non-relocated employees (gray), together with their associated confidence intervals. Our surveys are taken from six months to two years after the relocation. In addition, the three surveys cover both the cold and warm seasons (see Figure 2 for the exact timeline of the surveys).

Overall, we observe stability in the coefficients describing the indoor environmental-dissatisfaction scales. For the group of employees who stayed in their initial workplaces, we observe no changes in reported scales or prevalence of sick-building syndrome over time. For the transferred group, we observe that the initial decrease in dissatisfaction with the indoor environmental quality in the workplace persisted over time. Thus, we observe no rebound in the initial perceived benefits toward the initial levels, suggesting the results are not caused by the move itself, but by the indoor environmental quality of the building. These results also support the hypothesis that no drop occurred in the quality of the building over time.

[Insert Figure 4 about here]

Figure 5 presents the changes in health status over time. In line with the improvement in the perceived indoor environmental quality, we find no evidence of a rebound in the estimated changes in the health status of the employees. The estimation results indicate the initial drop in the prevalence of sick-building syndrome, symptoms remained at the initial level ($\delta_{k=1} = 0.210$). [9]

[8] The baseline probability of reporting sick-building-syndrome symptoms for the treatment group is reported in column (1) in Table 1.

[9] Figure B.1 in Appendix B presents the changes in job satisfaction over time. We observe no deviations to the baseline responses to any question in the block of satisfaction questions except for the item *"I am proud of the work that I do"*. In the first survey after the move ($k = 1$), the relocated group showed a significantly higher frequency that they felt proud of their work. By contrast, in the group of employees who were not relocated, we observe a drop in the frequency with which the average respondent felt proud of his or her work. In the following surveys ($k > 1$), the differences with respect to the baseline frequencies and between the two groups of employees disappear.

[Insert Figure 5 about here]

5.3 Heterogeneous Effects

In this section, we study whether some subgroups are more sensitive to indoor environmental conditions than others. First, we explore gender differences. The current indoor climate regulations in office buildings tend to be based on a thermal comfort model developed in the 1960s. That model optimizes the environmental conditions to satisfy an average male. A recent study in biophysics indicates the existing model significantly miscalculates the metabolic rate of female thermal demand (Kingma and Van Marken Lichtenbelt, 2015). This is line with the many field studies showing females express more dissatisfaction than males with low temperatures (for a review of the literature, see Karjalainen, 2012). Recent experimental evidence indicates these differences have implications for cognitive performance. Chang and Id (2019) find women perform better in verbal and numeric tasks at experimentally manipulated higher temperatures, whereas the reverse pattern is observed for men.

In addition, the presence of pre-existing diseases in the respiratory or cardiovascular systems among older population groups might exacerbate the health impacts of certain hazards in the indoor environment (e.g., indoor pollutants) (Li et al., 2018). For the analysis of the differences across demographic groups, we therefore stratify our sample by gender and age.

Table 4 presents the results of the heterogeneity analysis. The first two columns display the results for the two gender subsamples, and the last three columns show the estimates for the three age groups in our sample. We observe no significant discrepancies in responses to scales in the noise, air, and light-quality dimensions across gender or age groups. However, the results for thermal dissatisfaction indicate the drops in dissatisfaction rates associated with the new building are present only among male employees. Relocated women did not significantly adjust their ratings after being transferred to the new building. Similarly, we observe significant changes in thermal dissatisfaction among the older employees only (beyond 30 years old).

When focusing on the health measures, we find the relocation of workers to the new building generated similar drops in the prevalence of sick-building-syndrome symptoms in female and male employees. The estimates suggest the impact of the relocation becomes more significant with the age of employees. We observe significant drops only in the probability of reporting sick-building syndrome among the oldest group of employees (over 50 years old). The coefficient associated with the group of workers between 30 and 50 years old is marginally significant (i.e., at the 10% level).

[Insert Table 4 about here]

5.4 Association between environmental conditions and health

The relocation to a new building involves significant changes in a variety of factors regarding the workplace of employees. We analyze how the changes in the different indoor environmental-conditions dimensions contributed to the drop in the prevalence of sick-building-syndrome symptoms, with respect to the initial situation just before the moving date.

Figure 6 presents the estimated coefficients Θ_s of equation 4, describing the association between the probability of reporting sick-building-syndrome symptoms and each of the four factors related to the indoor environmental conditions in the workplace (i.e., elements of Θ). The estimation results indicate poor air quality is, on average, the only significant contributor to the prevalence of sick-building-syndrome symptoms. The presence of perceived deficient air quality is associated with an increase of about 10 percentage points in the odds of reporting sick-building syndrome in our sample.

We also include a series of furniture-quality factors as regressors in the empirical model, as placebos to construct a falsification test. The absence of significant coefficients associated with these factors supports the hypothesis that the health improvements displayed in this study are mainly driven by an improvement in environmental conditions in the workplace and not by a general building-quality improvement.

[Insert Figure 6 about here]

6 Conclusions

Human health is a critical factor for the generation of output by workers. Companies bear substantial costs associated with absenteeism and presenteeism among their employees (Hemp, 2004; Stewart et al., 2003). In addition, increasing evidence shows job satisfaction translates into higher productivity for workers and ultimately higher value for companies (Edmans, 2012).

This study investigates the impact of the indoor environmental conditions in the workplace on the health and job satisfaction of employees, as core factors of productivity. We provide quasi-experimental evidence based on the relocation of 70% of the workforce of a municipality in the south of the Netherlands. We construct a longitudinal dataset based on individual surveys of the entire municipal workforce and include measures before and after the relocation.

The estimation results show a significant improvement in the perceived indoor environmental conditions and health of the relocated workers. We find the largest improvements in perceived air quality of the workplace, reducing the level of dissatisfaction by 1.62 points on a 7-point Likert scale. In addition, we observe significant improvements in the health status of individuals. In particular, we observe a 0.22-percentage-point reduction in the prevalence of sick-building syndrome. Finally, we observe no significant changes in job-satisfaction scales associated with the relocation event. The decomposition of effects over time indicates the estimated changes remained persistent in the medium term (two years after the moving date).

The results of the heterogeneity analysis show the existence of differences among workers. The relocation to the new building had significant effects on men and not women. On the contrary, the relocation led to a drop in sick-building syndrome that was similar in magnitude between men and women. The analysis of different age subsamples indicates increasing benefits with age. Older individuals benefited the most from the move in terms of perceived environmental quality and health status.

Of course, the analysis in this paper is restricted by the availability of data. First, the analysis relies on self-reported data of participants' sick leave, based on a categorical variable. Ideally, the analysis would include administrative data of sick leave with the exact number of sick days in the year (or months) preceding the survey. Similarly, the changes in environmental conditions are based on the perceived environmental conditions of workers in their workplaces. Ideally, we would rely on sensor data to objectively document changes in indoor environmental quality. Advances in indoor sensor technology should make such data available in the near future.

The results in this paper add to a significant body of research that is mostly based on engineering measures or on cross-sectional analysis. The quality of indoor environmental conditions may have significant economic implications for our service society, depends on buildings in order for workers to be productive. Our findings show that variation in different dimensions of indoor environmental quality affect perceived health outcomes, which may have implications not just on worker productivity, but also on the cost of absenteeism.

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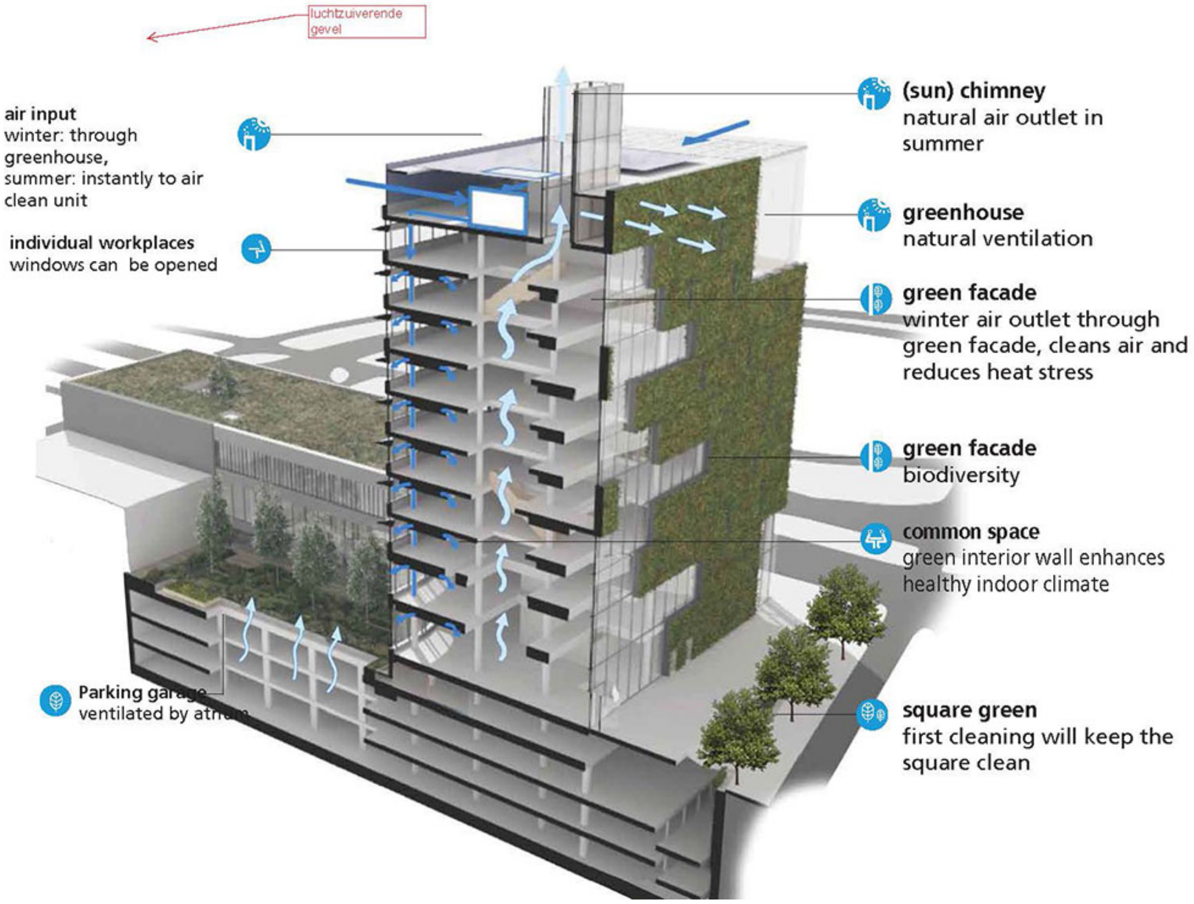
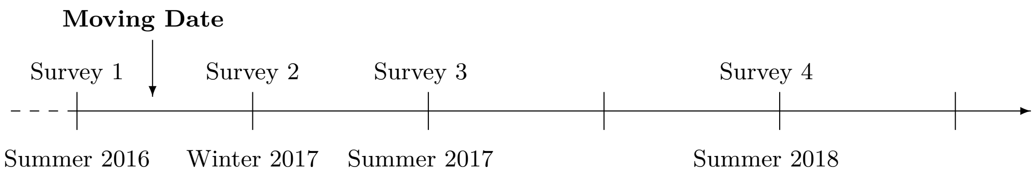
Figures And Tables

Figure 1: Ventilation System in Newly Constructed Building



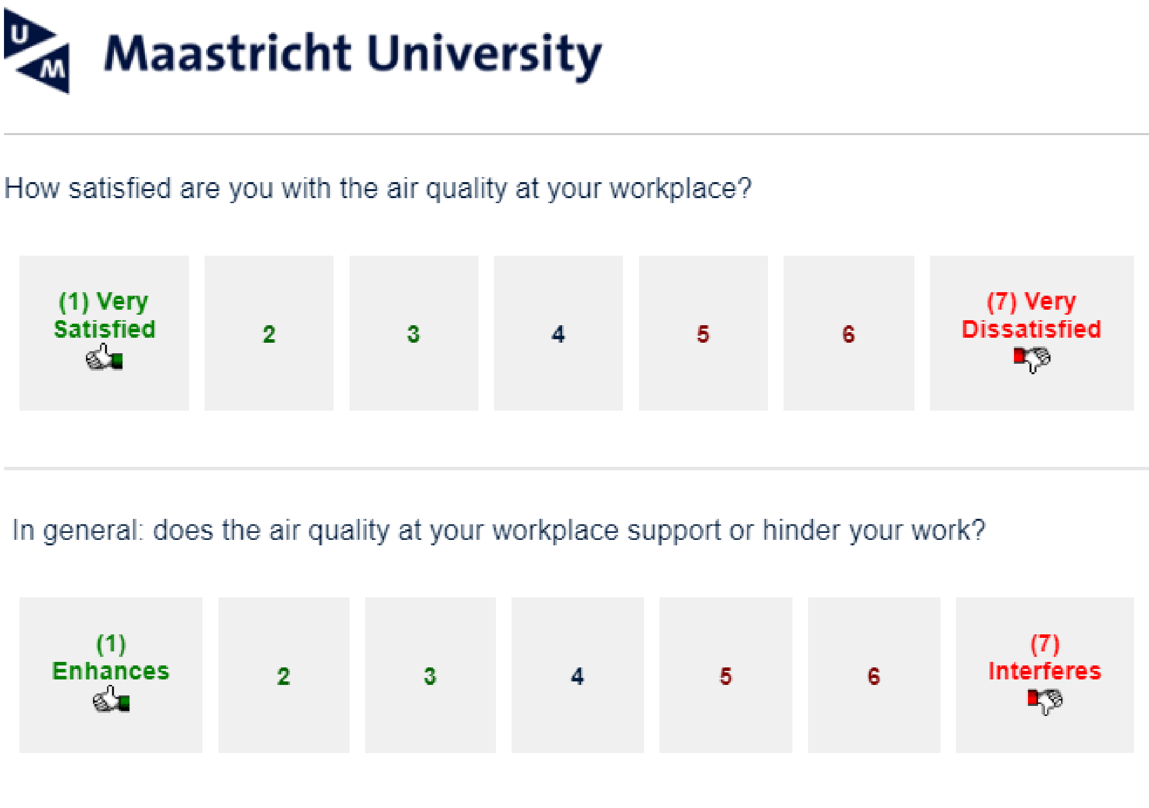
Source:`https://www.royalhaskoningdhv.com/en-gb/projects/new-municipal-office-venlo-nl/5931`

Figure 2: Timing of Survey Waves



Note: The figure illustrates the exact timing of each survey wave. The first survey (k=0) took place before the moving date (August 2016). The second (k=1), third (k=2) and fourth (k=3) took place after the relocated group moved to the new building, in respectively January 2017, July 2017 and October 2018.

Figure 3: Example question about evaluating indoor air quality (translated in English



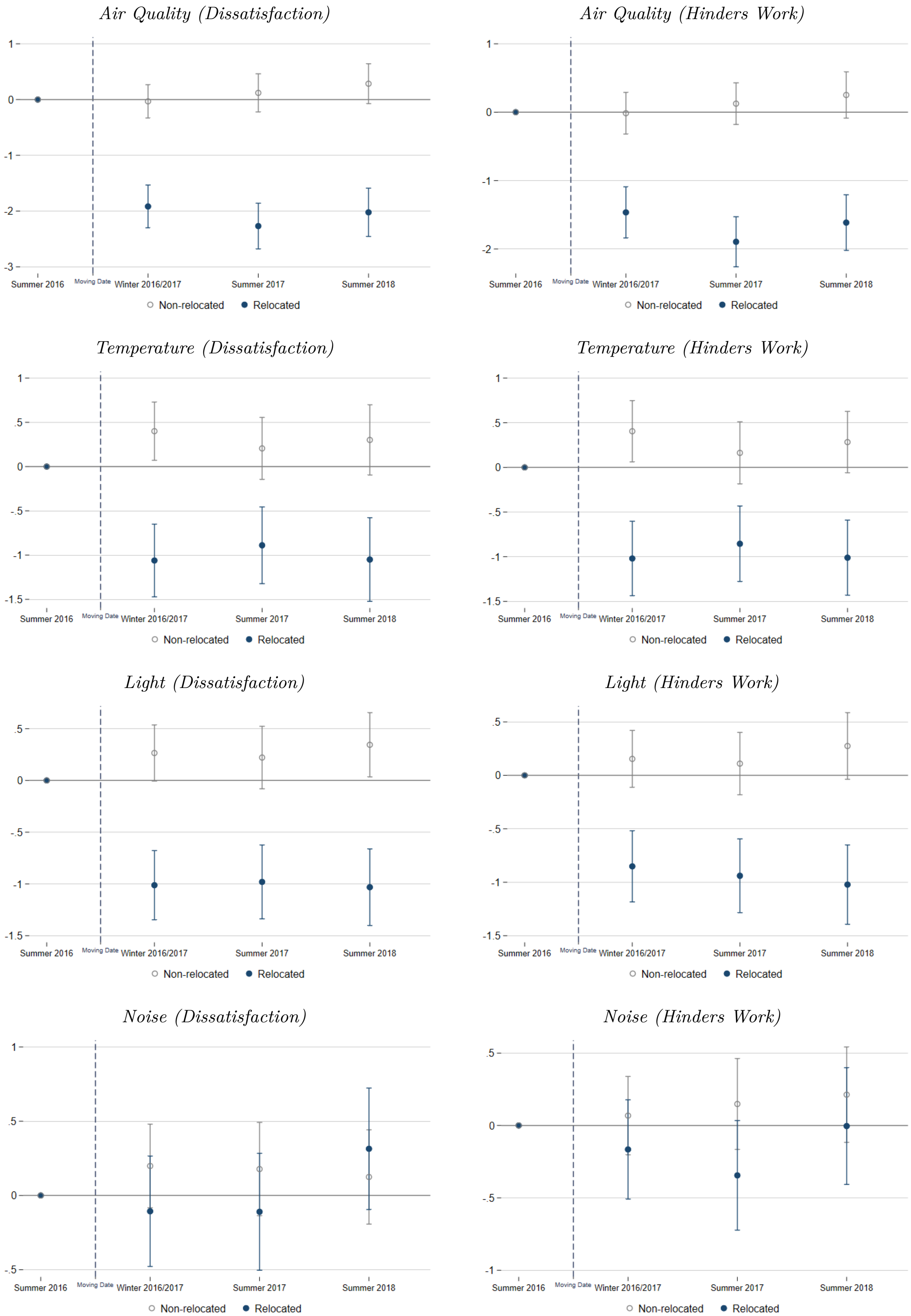
Full survey (in Dutch) available here: `https://maastrichtuniversity.eu.qualtrics.com/jfe/form/SV_0e4EEdnROnzIyGh`

Table 1: Descriptive statistics sample in first survey wave (Before the move, July 2016)

	Non-Relocated (N=247)	Relocated (N=326)	Diff.
Age			
Below 31 Years Old (1=Yes)	0.19	0.10	0.09**
31-50 Year Old (1=Yes)	0.34	0.45	-0.11**
50 Years Old or Older (1=Yes)	0.47	0.45	0.02
Gender			
Female (1=Yes)	0.46	0.50	-0.04
Health			
Sick Building Syndrome (1=Yes)	0.44	0.42	0.03
No Days on Sick Leave (1=yes)	0.53	0.53	-0.01
Time Working for The Company			
Less than 1 Year	0.23	0.12	0.11***
1-2 Years	0.38	0.24	0.14***
3-5 Years	0.16	0.27	-0.11**
More than 5 Years	0.23	0.37	-0.14***
Working Hours per Week			
Less than 10 Hours	0.06	0.03	0.03
11-30 Hours	0.41	0.49	-0.08
More than 30 Hours	0.53	0.48	0.05

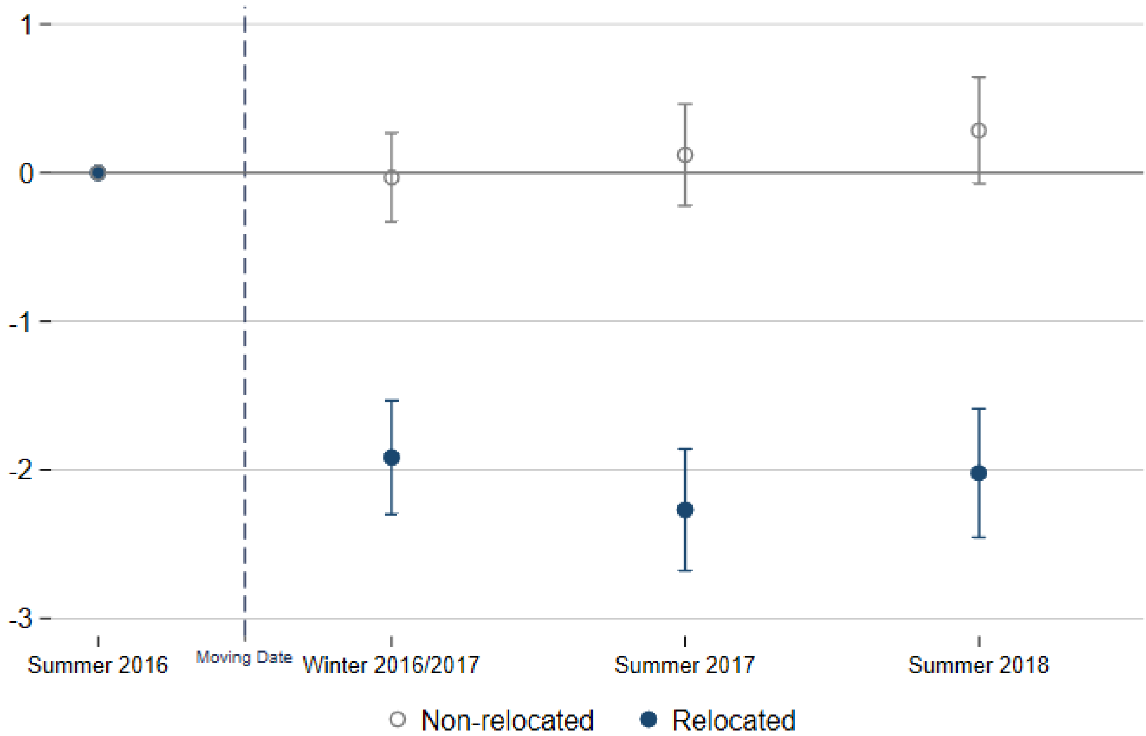
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Figure 4: Trends in Perception of Indoor Environmental Conditions



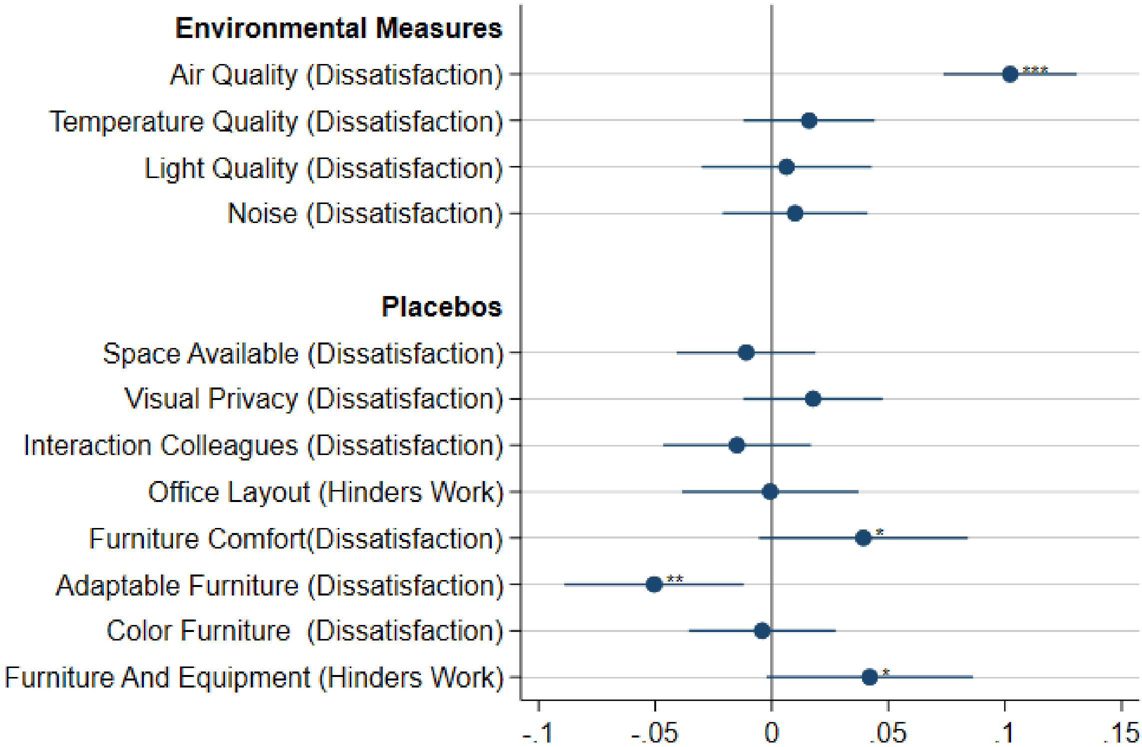
Note: The figures show the estimated coefficient of the time dummies describing the survey times before (= 0) and after the moving date. The dots represent the point estimates and the bars the 95% confidence intervals. All regressions include the time varying controls, individual and survey wave fixed effects. The vertical, dashed gray line indicates the moving date.

Figure 5: Trends in Sick Building Syndrome (1=Yes)



Note: The figure shows the estimated coefficient of the time dummies describing the survey times before (= 0) and after the moving date. The dots represent the point estimates and the bars the 95% confidence intervals. The vertical, dashed gray line indicates the moving date. The set of control variables include the average hours worked per week and the layout scales (See Table B.3 for the full list). The estimation results are also presented in B.4 in the Appendix.

Figure 6: Effect Environmental Problems on Sick Building Syndrome



Note: The figure shows the point estimates of and confidence intervals associated with each ot the elements of vector Θ in Equation 4. The dots represent the point estimates and the bars the 95% confidence intervals. All regressions include time varying controls (contract type), individual and survey-wave fixed effects. * p<0.1, ** p<0.05, *** p<0.01.

Table 2: Panel A. Basic difference-in-difference

	Before Moving Date			After Moving Date		
	Relocated	Non-Relocated	Diff	Relocated	Non-Relocated	Diff
	(1)	(2)	(3)	(4)	(5)	(6)
Indoor Environmental Conditions						
Air Quality (Dissatisfaction)	4.50	4.18	0.31**	2.65	3.95	-1.30***
Air Quality (Hinders Work)	4.14	3.95	0.19	2.68	3.80	-1.12***
Temperature Quality (Dissatisfaction)	4.15	3.94	0.21	3.60	4.07	-0.47***
Temperature Quality (Hinders Work)	4.02	3.84	0.18	3.45	3.92	-0.47***
Light Quality (Dissatisfaction)	2.83	2.57	0.26**	2.15	2.68	-0.53***
Views (Dissatisfaction)	3.14	2.83	0.31**	2.50	2.85	-0.34***
Light Quality (Hinders Work)	3.25	2.90	0.35***	2.58	2.93	-0.35***
Noise (Dissatisfaction)	3.58	3.61	-0.03	3.82	3.73	0.10
Privacy (Dissatisfaction)	4.54	4.40	0.15	4.37	4.41	-0.05
Noise (Hinders Work)	4.03	3.93	0.10	4.06	4.00	0.06
Health						
Sick Building Syndrome (1=Yes)	0.42	0.44	-0.03	0.26	0.45	-0.19***
No days on sick leave (1=yes)	0.53	0.53	0.01	0.57	0.61	-0.04
Office Layout						
Space Available (Dissatisfaction)	2.66	3.03	-0.38***	2.72	2.90	-0.19**
Visual Privacy (Dissatisfaction)	3.06	3.41	-0.35**	3.35	3.51	-0.15
Interaction Colleagues (Dissatisfaction)	2.48	2.58	-0.11	2.43	2.47	-0.04
Office Layout (Hinders Work)	2.89	3.05	-0.16	2.85	3.02	-0.16*
Furniture Comfort(Dissatisfaction)	3.37	3.18	0.19	2.23	2.81	-0.58***
Adaptable Furniture (Dissatisfaction)	3.56	3.22	0.34**	2.20	2.77	-0.58***
Color Furniture (Dissatisfaction)	3.87	3.68	0.19	2.32	3.06	-0.73***
Furniture And Equipment (Hinders Work)	3.27	3.17	0.10	2.31	2.89	-0.58***

Notes: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.
The scales in the "*Indoor Environmental Conditions*" section and the "*Indoor Environmental Conditions*" are 7-point Liker scales ranging from "*Satisfied*" (1) to "*Dissatisfied*" (7)

Table 2: Panel B. Basic difference-in-difference

	Before Moving Date			After Moving Date		
	Relocated	Non-Relocated	Diff	Relocated	Non-Relocated	Diff
	(1)	(2)	(3)	(4)	(5)	(6)
Job Satisfaction						
At work I am full of energy	0.90	0.90	0.00	0.91	0.93	-0.02
When I work I feel fit and strong	0.90	0.90	-0.00	0.90	0.92	-0.02
I am enthusiastic about my job	0.93	0.94	-0.02	0.92	0.93	-0.02
My work inspires me	0.94	0.91	0.02	0.90	0.92	-0.02
When I get up in the morning, I feel like going to work	0.92	0.91	0.01	0.90	0.91	-0.02
When I am working very intensively, I feel happy	0.94	0.95	-0.01	0.92	0.94	-0.02
I am proud of the work that I do	0.94	0.92	0.02	0.92	0.91	0.01
I am completely absorbed in my work	0.93	0.89	0.03	0.90	0.90	-0.00
When I am working, I can go on for a long time	0.89	0.90	-0.00	0.87	0.85	0.02
My work is transporting me	0.66	0.75	-0.08**	0.66	0.71	-0.04
At work I have a great mental (mental) resilience	0.89	0.92	-0.03	0.87	0.89	-0.02
I always keep going at work, even when things are not going well	0.89	0.94	-0.05*	0.90	0.95	-0.05***

Notes: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Table 3: Estimation results difference-in-difference

		(1)	(2)	(3)	(4)	(5)
Indoor Environmental Conditions						
Air Quality	Dissatisfaction	-1.615***	-1.612***	-2.066***	-2.068***	-1.443***
		(0.163)	(0.163)	(0.179)	(0.179)	(0.163)
	Hinders Work	-1.314***	-1.314***	-1.654***	-1.654***	-1.091***
		(0.146)	(0.146)	(0.165)	(0.165)	(0.149)
Temperature Quality	Dissatisfaction	-0.684***	-0.679***	-1.000***	-0.999***	-0.593**
		(0.162)	(0.163)	(0.191)	(0.192)	(0.195)
	Hinders Work	-0.653***	-0.650***	-0.962***	-0.960***	-0.529**
		(0.155)	(0.155)	(0.183)	(0.183)	(0.182)
Light Quality	Dissatisfaction	-0.796***	-0.794***	-1.006***	-1.006***	-0.503**
		(0.141)	(0.141)	(0.152)	(0.152)	(0.157)
	Hinders Work	-0.703***	-0.703***	-0.927***	-0.926***	-0.435**
		(0.137)	(0.136)	(0.152)	(0.153)	(0.150)
Views	Dissatisfaction	-0.648***	-0.651***	-0.895***	-0.895***	-0.338*
		(0.139)	(0.139)	(0.153)	(0.153)	(0.146)
Noise	Dissatisfaction	0.118	0.127	0.004	0.002	0.211
		(0.160)	(0.161)	(0.172)	(0.171)	(0.158)
	Hinders Work	-0.051	-0.042	-0.182	-0.186	0.069
		(0.148)	(0.149)	(0.162)	(0.162)	(0.148)
Privacy	Dissatisfaction	-0.206	-0.194	-0.336	-0.339	-0.024
		(0.171)	(0.171)	(0.180)	(0.180)	(0.171)
Health Indicators						
Sick leave	Dummy (1=Yes)	0.033	0.041	0.004	0.001	- 0.019
		(0.049)	(0.049)	(0.055)	(0.055)	(0.066)
Sick Building Syndrome	Dummy (1=Yes)	-0.165***	-0.164***	-0.286***	-0.286***	-0.216***
		(0.049)	(0.049)	(0.053)	(0.053)	(0.056)
Wave-Fixed Effects		NO	YES	NO	YES	YES
Individual-Fixed Effects		NO	NO	YES	YES	YES
Controls		NO	NO	NO	NO	YES

Notes: Robust standard error clustered at the individual level. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. Controls in Column (5) include the satisfaction scales for layout and furniture scales listed in Table and average working hours per week.

Table 4: Heterogeneity Analysis

		(1)	(2)	(3)	(4)	(5)
				Age	Age	Age
		Men	Women	Below 31	30-50	Above 50
Indoor Environmental Conditions						
Air Quality	Dissatisfaction	-1.622***	-1.545***	-1.766**	-1.439***	-1.677***
		(0.256)	(0.229)	(0.627)	(0.280)	(0.231)
	Hinders Work	-1.077***	-1.322***	-1.615***	-1.516***	-1.125***
		(0.232)	(0.198)	(0.432)	(0.267)	(0.215)
Temperature Quality	Dissatisfaction	-1.070***	-0.437	-0.794	-0.707*	-0.698**
		(0.263)	(0.272)	(0.737)	(0.302)	(0.267)
	Hinders Work	-1.056***	-0.359	-1.041	-0.624	-0.741**
		(0.260)	(0.233)	(0.608)	(0.339)	(0.231)
Light Quality	Dissatisfaction	-0.607**	-0.720**	-0.871	-0.038	-0.871***
		(0.191)	(0.223)	(0.530)	(0.228)	(0.184)
	Hinders Work	-0.473*	-0.695***	-1.531**	-0.172	-0.677***
		(0.190)	(0.207)	(0.480)	(0.208)	(0.192)
Views	Dissatisfaction	-0.560**	-0.544**	-1.454*	-0.233	-0.478*
		(0.212)	(0.196)	(0.601)	(0.180)	(0.192)
Noise	Dissatisfaction	0.014	0.097	1.006*	-0.104	0.006
		(0.216)	(0.196)	(0.486)	(0.229)	(0.206)
	Hinders Work	-0.155	0.065	1.130**	-0.127	-0.208
		(0.199)	(0.191)	(0.396)	(0.219)	(0.199)
Privacy	Dissatisfaction	-0.318	-0.014	0.470	-0.158	-0.397
		(0.230)	(0.245)	(0.645)	(0.263)	(0.239)
Health Indicators						
Sick leave	Dummy (1=Yes)	-0.277***	-0.223**	-0.355	-0.216*	-0.255**
		(0.075)	(0.078)	(0.223)	(0.085)	(0.078)
Sick Building Syndrome	Dummy (1=Yes)	0.053	-0.002	0.333*	0.089	-0.000
		(0.085)	(0.084)	(0.159)	(0.107)	(0.082)
Wave-Fixed Effects		YES	YES	YES	YES	YES
Individual-Fixed Effects		YES	YES	YES	YES	YES
Controls		YES	YES	YES	YES	YES

Notes: Robust standard error clustered at the individual level. * p<0.1, ** p<0.05, *** p<0.01. Controls in Column (5) include the satisfaction scales for layout and furniture scales listed in Table and average working hours per week.

A Appendix

Invitation to Participate in Survey

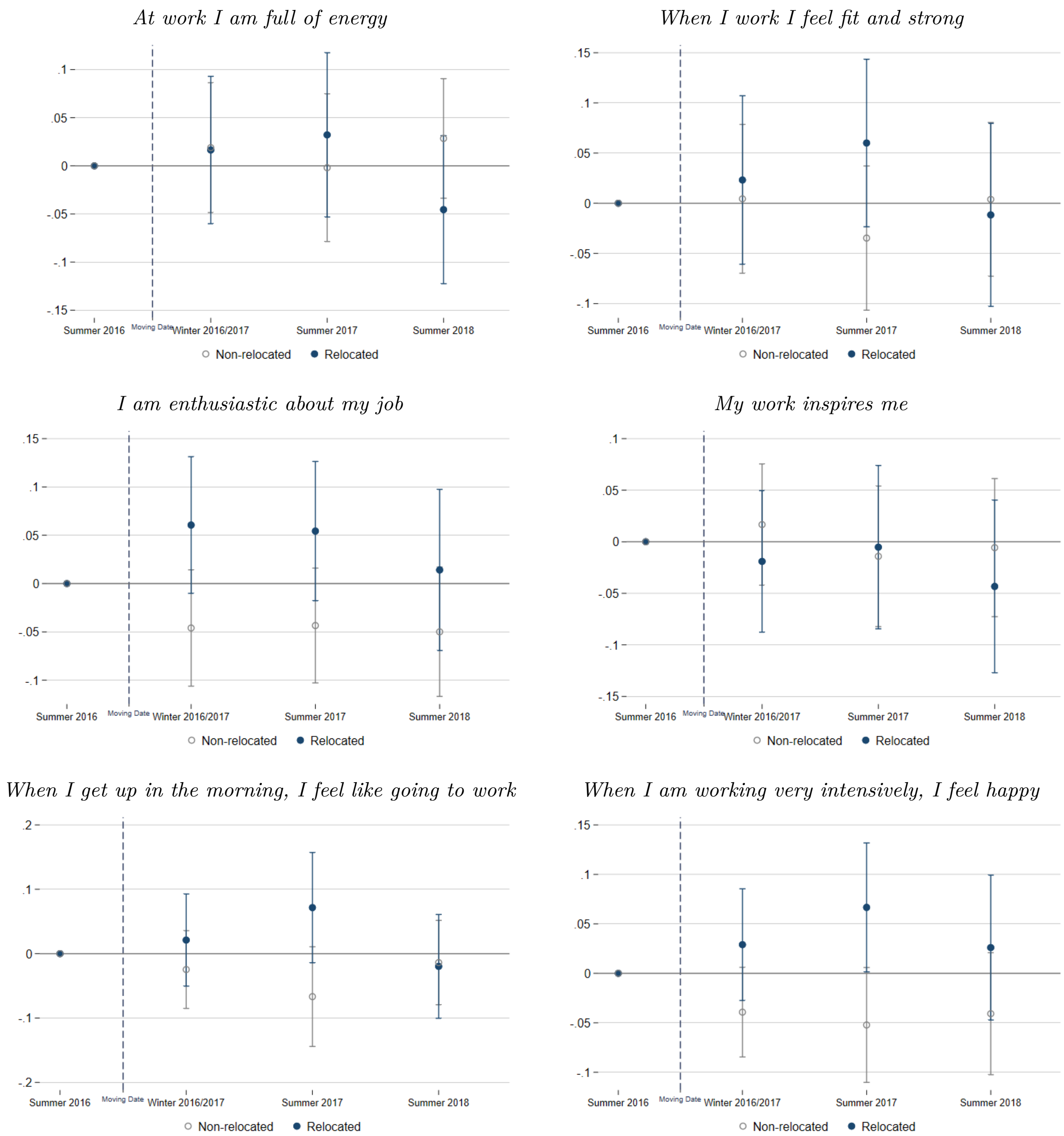
Dutch (original)
Maastricht University en de gemeente Venlo nodigen u uit om deel te nemen aan een onderzoek over werkplek beleving en kwaliteit. Dat doen we door middel van een enquete over uw werkplek en het gebouw waarin die zich bevindt.
De enquete gaat over uw huidige werkplek. Over een paar maanden zullen we u opnieuw vragen om de vragenlijst in te vullen, of u nu gaat verhuizen naar het nieuwe stadskantoor of niet. De informatie wordt gebruikt om gebouwen en werkplekken te verbeteren, niet alleen in Venlo, maar ook in de rest van Nederland en daarbuiten. Het invullen van de vragenlijst duurt ongeveer tien minuten. We danken u heel hartelijk voor uw hulp!
English (translated)
Maastricht University and the municipality of Venlo invite you to participate in a study on workplace experience and quality. We do this by means of a survey about your workplace and the building in which it is located.
The survey is about your current workplace. In a few months we will ask you again to complete the questionnaire, whether you are moving to the new city office or not. The information is used to improve buildings and workplaces, not only in Venlo, but also in the rest of the Netherlands and beyond. It takes approximately ten minutes to complete the questionnaire. We thank you very much for your help!

B Appendix

Table B.1: Response rate

Survey wave	Total Employees	Valid surveys	Response rate
1 (Summer 2016)	1461	589	40.31%
2 (Winter 2017)	1461	596	40.79 %
3 (Summer 2017)	1550	584	37.67 %
4 (Summer 2018)	1525	537	35.25 %

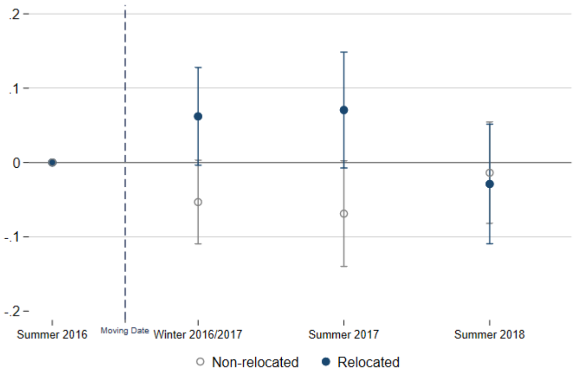
Figure B.1: Panel A. Trends in Job Satisfaction



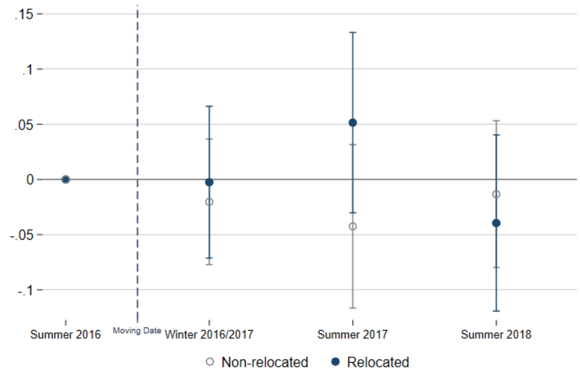
Note: The figure shows the estimated coefficient of the time dummies describing the survey times before (= 0) and after the moving date. The dots represent the point estimates and the bars the 95% confidence intervals. All regressions include the *Elo score* individual fixed effects. The vertical, dashed gray line indicates the moving date.

Table B.1:Panel B.Trends in Job Satisfaction

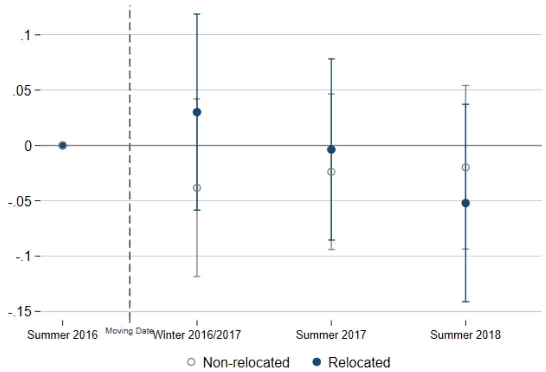
I am proud of the work that I do



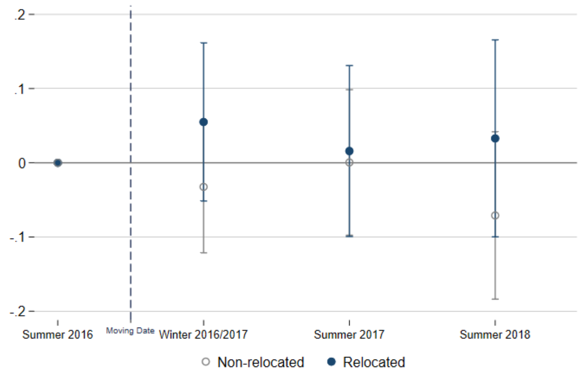
I am completely absorbed in my work



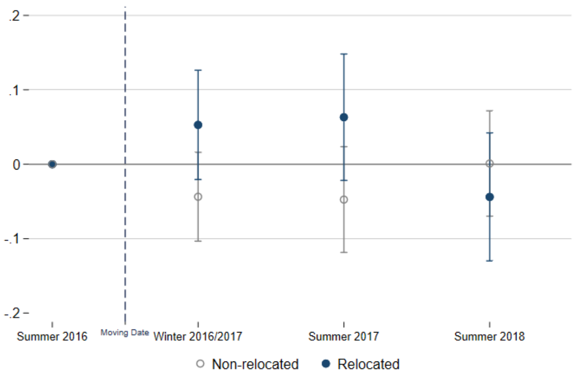
I am proud of the work that I do



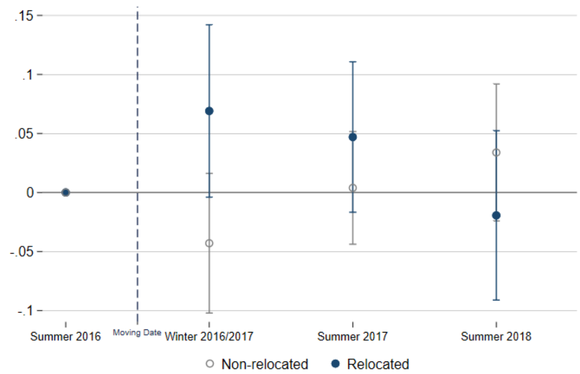
My work is transporting me



At work I have a great mental (mental) resilience



I always keep going at work, even when things are not going well



Note: The figure shows the estimated coefficient of the time dummies describing the survey times before (= 0) and after the moving date. The dots represent the point estimates and the bars the 95% confidence intervals. All regressions include the *Elo score* individual fixed effects. The vertical, dashed gray line indicates the moving date.

Table B.2: Description questions in survey

Variable Name	Survey Question
Indoor Environmental Condition	
Temperature Quality (Dissatisfaction)	How satisfied are you with the temperature at your workplace?
Temperature Quality (Hinders Work)	In general: does the thermal comfort at your workplace support or hinder your work?
Air Quality (Dissatisfaction)Â	How satisfied are you with the air quality at your workplace (i.e. stuffy/stale air, air cleanliness, odors)?
Air Quality (Hinders Work)	In general: does the air quality at your workplace support or hinder your work?
Light Quality (Dissatisfaction)	How satisfied are you with the amount of light in your workplace?
Views (Dissatisfaction)	How satisfied are you with the visual comfort at your workplace (glare, reflections, contrast ratios)?
Light Quality (Hinders Work)	In general: does the light in your workplace support or hinder your work?
Noise (Dissatisfaction)	How satisfied are you with the noise level at your workplace?
Privacy (Dissatisfaction)	How satisfied are you with the acoustic privacy at your workplace (possibility of having conversations without colleagues listening in)?
Noise (Hinders Work)	In general: does the noise at your workplace support or hinder your work?
Office Layout	
Space Available (Dissatisfaction)	How satisfied are you with the space available for carrying out your work and storing work equipment?
Visual Privacy (Dissatisfaction)	How satisfied are you with the visual privacy at your workplace?
Interaction Colleagues (Dissatisfaction)	How satisfied are you with the opportunities for interaction with your colleagues?
Office Layout (Hinders Work)	In general: does the workplace structure support or hinder your work?
Furniture Comfort(Dissatisfaction)	How satisfied are you with the comfort of your office furniture and equipment (eg chair, desk, computer)?
Adaptable Furniture (Dissatisfaction)	How satisfied are you with the options to adjust your furniture to your needs?
Color Furniture (Dissatisfaction)	How satisfied are you with the color and quality of floor coverings, furniture and other surface materials?
Furniture And Equipment (Hinders Work)	In general: Does the office furniture and equipment support or hinder your work?

All questions are based on 7-point Likert scales, from satisfied (1) to dissatisfied (7).

Basic difference-in-difference job satisfaction

	(1)	(2)	(3)	(4)	(5)
Job Satisfaction					
At work I am full of energy	-0.025	-0.037	0.006	0.006	-0.001
	(0.030)	(0.030)	(0.035)	(0.035)	(0.038)
When I work I feel fit and strong	-0.023	-0.040	0.027	0.027	-0.005
	(0.031)	(0.031)	(0.037)	(0.037)	(0.042)
I am enthusiastic about my job	0.001	-0.010	0.046	0.046	0.080*
	(0.027)	(0.027)	(0.031)	(0.031)	(0.038)
My work inspires me	-0.041	-0.054	-0.021	-0.021	-0.024
	(0.028)	(0.028)	(0.033)	(0.033)	(0.041)
When I get up in the morning, I feel like going to work	-0.022	-0.034	0.028	0.028	0.023
	(0.029)	(0.029)	(0.034)	(0.034)	(0.040)
When I am working very intensively, I feel happy	-0.009	-0.019	0.041	0.042	0.029
	(0.023)	(0.023)	(0.025)	(0.025)	(0.030)
I am proud of the work that I do	-0.005	-0.014	0.041	0.041	0.043
	(0.027)	(0.027)	(0.031)	(0.031)	(0.037)
I am completely absorbed in my work	-0.035	-0.043	0.007	0.007	0.000
	(0.027)	(0.027)	(0.030)	(0.030)	(0.037)
When I am working, I can go on for a long time	0.029	0.015	-0.003	-0.003	-0.002
	(0.031)	(0.031)	(0.033)	(0.033)	(0.040)
My work is transporting me	0.042	0.027	0.035	0.036	0.025
	(0.045)	(0.045)	(0.048)	(0.048)	(0.058)
At work I have a great mental (mental) resilience	0.013	0.007	0.031	0.031	0.000
	(0.029)	(0.029)	(0.032)	(0.032)	(0.039)
I always keep going at work, even when things are not going well	-0.004	-0.006	0.039	0.039	0.023
	(0.024)	(0.024)	(0.027)	(0.027)	(0.034)
Wave Fixed-Effects	NO	YES	NO	YES	YES
Individual Fixed-Effects	NO	NO	YES	YES	YES
Controls	NO	NO	NO	NO	YES

Notes: Robust standard error clustered at the individual level. * p<0.1, ** p<0.05, *** p<0.01. Controls in Column (5) include the satisfaction scales for layout and furniture scales listed in Table and average working hours per week.

Table B.3: Heterogeneity analysis job satisfaction

	(1)	(2)	(3)	(4)	(5)
	Men	Women	Below 30	30- 50	Above 50
Job Satisfaction					
At work I am full of energy	-0.033	0.021	0.092	-0.019	0.005
	(0.059)	(0.051)	(0.121)	(0.074)	(0.055)
When I work I feel fit and strong	0.011	0.017	0.171	-0.001	0.016
	(0.056)	(0.059)	(0.143)	(0.081)	(0.057)
I am enthusiastic about my job	0.069	0.079	0.168	0.046	0.076
	(0.059)	(0.045)	(0.128)	(0.054)	(0.053)
My work inspires me	-0.036	-0.015	0.089	-0.014	-0.033
	(0.051)	(0.054)	(0.110)	(0.055)	(0.059)
When I get up in the morning, I feel like going to work	0.000	0.056	0.009	-0.002	0.059
	(0.059)	(0.052)	(0.115)	(0.088)	(0.046)
When I am working very intensively, I feel happy	0.017	0.055	0.291*	0.026	0.021
	(0.043)	(0.036)	(0.135)	(0.042)	(0.042)
I am proud of the work that I do	0.013	0.084	0.191	-0.024	0.086
	(0.055)	(0.045)	(0.119)	(0.052)	(0.050)
I am completely absorbed in my work	-0.069	0.078	0.149	-0.001	0.017
	(0.053)	(0.048)	(0.125)	(0.066)	(0.050)
When I am working, I can go on for a long time	-0.018	0.051	0.079	-0.059	0.019
	(0.055)	(0.051)	(0.056)	(0.065)	(0.053)
My work is transporting me	0.014	0.049	-0.120	-0.013	0.030
	(0.074)	(0.078)	(0.124)	(0.089)	(0.076)
At work I have a great mental (mental) resilience	0.021	0.039	-0.061	0.046	0.022
	(0.054)	(0.050)	(0.157)	(0.059)	(0.049)
I always keep going at work, even when things are not going well	0.030	0.055	0.029	0.028	0.032
	(0.051)	(0.041)	(0.092)	(0.048)	(0.046)
Wave Fixed-Effects	YES	YES	YES	YES	YES
Individual Fixed-Effects	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES

Notes: Robust standard error clustered at the individual level. * p<0.1, ** p<0.05, *** p<0.01. Controls in Column (5) include the satisfaction scales for layout and furniture scales listed in Table and average working hours per week.

Table B.4: Estimation results impact of indoor environmental quality on sick building syndrome

	(1)
Air Quality (Dissatisfaction)	0.102***
	(0.015)
Temperature Quality (Dissatisfaction)	0.016
	(0.014)
Light Quality (Dissatisfaction)	0.006
	(0.019)
Noise (Dissatisfaction)	0.010
	(0.016)
Space Available (Dissatisfaction)	-0.011
	(0.015)
Visual Privacy (Dissatisfaction)	0.018
	(0.015)
Interaction Colleagues (Dissatisfaction)	-0.015
	(0.016)
Office Layout (Hinders Work)	-0.001
	(0.019)
Furniture Comfort(Dissatisfaction)	0.039*
	(0.023)
Adaptable Furniture (Dissatisfaction)	-0.050**
	(0.020)
Color Furniture (Dissatisfaction)	-0.004
	(0.016)
Furniture And Equipment (Hinders Work)	0.042*
	(0.022)
Observations	1,279
R-squared	0.243

Notes: The table shows the point estimates of and standard errors associated with each ot the elements of vector Θ in Equation 4. All regressions include time varying controls (contract type), individual and survey-wave fixed effects. * $p<0.1$, ** $p<0.05$, *** $p<0.01$. Standard errors are clustered at the individual level.