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How are Work-related Characteristics Linked to Sickness Absence and Presenteeism? Theory and Data*

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This paper investigates how work-related factors affect workers' absence and presenteeism behavior. Previous studies (implicitly) assume that there is a substitutive relationship, i.e., a change in a work-related factor decreases the level of absence and simultaneously increases presenteeism (or vice versa). We set up a theoretical model in which work-related characteristics not only affect a worker's absence decision but also the individual-specific sickness definition. Since work-related factors affect presenteeism through these two channels, non-substitutive relationships between absence and presenteeism are also conceivable. Using European cross-sectional data, we find only few substitutive and complementary relationships, while the bulk of the work-related characteristics is related only to one of the two sickness states.

JEL Classification: J22, J28, I1, M50

1. Introduction

It is well established that sickness absence and presenteeism, i.e., going to work while sick, have negative economic effects through reduced or less productive labor supply (for absence see Pauly et al., 2002; for presenteeism see Pauly et al., 2008). Motivated by this stylized fact, a large number of papers investigate the determinants of absence and presenteeism behavior. Since most of the studies in this field look only at the determinants of one of the two sickness states, the possibility that one factor might influence absence *and* presenteeism behavior at the same time is neglected. Despite this lack of empirical evidence, some studies assume that a determinant which reduces absence leads to an increase in presenteeism (and vice versa) and insinuate thus a substitutive

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relationship. This assumption, however, is motivated rather implicitly by describing both sickness states as the result of the same decision process (Aronsson / Gustafsson, 2005) or by deducing hypotheses for determinants of presenteeism negatively from the literature on absence (Bierla et al., 2013).

In this paper, we contribute to the existing literature by explicitly and comprehensively analyzing how factors influence both sickness absence and presenteeism. Gaining a deeper insight of these interrelations is highly relevant for (personnel) managers and policy makers because it clearly makes a difference whether a factor aimed at reducing absence days is associated with more, unchanged or even fewer presenteeism days. While a decline in absence, c.p., is an economic improvement (for the manager, but of course also for the society), reducing absence at the cost of more presenteeism could reduce overall productivity, depending on the specific productivity effects of presenteeism.[1] On the contrary, economic improvement clearly survives in cases of unchanged or even lower presenteeism.

It is thus important to determine how different factors simultaneously affect both sickness states. This is in particularly true for factors that managers and policy makers can directly influence. For that reason, we focus on the influence of *work-related characteristics* on both sickness states. In our investigation, work-related characteristics comprise not only general features of the employer-employee relationship such as firm size, contract type, workload, work autonomy and others but also specific human resources management (HRM) practices such as piece rate, formalized performance evaluation or production targets. To highlight mechanisms through which both sickness states can be affected by work-related characteristics at the same time, we build a simple theoretical model. Subsequently, we use a rich data set in which indicators for sickness absence and presenteeism are compiled in one survey such that we are able to *simultaneously* analyze how work-related factors are correlated with both sickness absence and presenteeism.

In our theoretical model, the employee is hit by a non-binary health shock which entails disutility from work (see Brown / Sessions, 2004, for a similar approach). Comparing utility from being attendant at the workplace with that of being absent, the individual optimally makes her / his absence / attendance decision. This decision depends on work-related characteristics because they affect costs and returns of attendance. Presenteeism is given if an individual decides to be attendant at the workplace although s / he is sick. In contrast to most of the existing literature, we assume that the definition of sickness is endogenous and individual-specific. It depends on two factors: the individual's evaluation of the health shock in terms of (dis)utility and the firm's evaluation

[1] See (Schultz / Edington, 2007) for a survey on the productivity effects of presenteeism.

of the individual's health shock in terms of productivity. The individual combines both factors to define a critical health level, above which health shocks are considered as sickness. Because both (dis)utility and productivity are affected by work-related factors, the individual-specific sickness definition and thus presenteeism can be influenced by those factors as well.

Our theoretical analysis shows that work-related characteristics can but not necessarily have to imply a substitutive relationship between absence and presenteeism, as is commonly assumed in the literature. Indeed, it can be possible that a change in one work-related factor leads to an increase (decrease) of both sickness states such that its interrelationship is complementary. Moreover, a change in one work-related factor might only influence one sickness state, leaving the other unaffected. The central mechanism behind these results is that presenteeism is affected through two channels. Suppose that a change in one work-related factor makes it more likely that the individual is attendant at work, i.e., absence is reduced. Holding everything else constant, this would also increase the probability of presenteeism and hence imply a substitutive relationship. However, the same work-related factor could also change the individual's sickness definition. If s/he evaluates fewer health shocks as sick, presenteeism could remain constant or could even decline as a response to the changing work-related factor. Furthermore, our theoretical model allows us to define illegitimate absence, i.e., absenteeism. In this case, employees are absent although they do not consider themselves sick.

In our empirical investigation, we estimate separately the relationship between work-related characteristics and the number of sickness absence and presenteeism days. For that purpose, we use the European Working Conditions Survey (EWCS), a cross-sectional survey which covers 34 European countries. This allows us to relate in OLS regressions 17 different work-related characteristics of more than 18,000 employees to their sickness absence and presenteeism behavior.[2] Since there is no panel data on presenteeism available, we cannot deliver causal analysis of the interrelation between absence and presenteeism behavior, but our empirical investigation offers several improvements in other dimensions compared to the existing literature. We cover comprehensively work-related characteristics and use the annual number of days of absence and presenteeism, which is a better measure to investigate the relationship between both sickness states than incidence measures. Moreover, we provide better external validity by using a large data set that is representative for each European country and Europe as a whole. In addition,

[2] Specifically, we look at general work-related characteristics such as supervisory and blue collar status, temporary contracts, tenure categories, whether working part or over time, firm size, private sector employment, work autonomy, adverse working conditions, support by coworkers and the management, flexible working time and time pressure. Furthermore, we include HRM measures such as piece rate, formal performance evaluation and production targets.

we take advantage of the detailed health information in the EWCS which goes far beyond those included in other labor market surveys. This allows us to control for health status more thoroughly, which also mitigates the concern that work-related characteristics are systematically related with health shocks in real-world data.

The main results of the empirical analysis are as follows: First, we find that only few work-related factors (namely supervisory status, over time and flexible working time) lead to a substitutive relationship between absence and presenteeism. This finding casts doubt on the predominant view in the literature that both sickness states are interlinked in a substitutive manner. Second, there are only two work-related factors (namely working conditions and tenure) which lead to a complementary relationship between absence and presenteeism. Specifically, adverse working conditions and longer tenure are positively correlated with both sickness states. Third, the bulk of the considered work-related characteristics is only related to one of the two sickness states while being uncorrelated with the other. From a managerial and policy perspective, this suggests that it might be possible to reduce absence (by regulating or setting the respective work-related factors) without negative side-effects on presenteeism or to reduce presenteeism without the threat of higher absence. Finally, we can identify three factors (namely temporary contracts, employment in the private sector and firm size) that seem to affect illegitimate absence since they are only highly significantly related to absence while being unrelated to presenteeism. Our findings are robust against seemingly unrelated regression models, count data models and in differently defined sub-samples.

The remainder of our paper is structured as follows. Section 2 discusses the related literature. In Section 3, we present our theoretical model and derive conditions under which work-related factors imply a substitutive, complementary or no relationship between sickness absence and presenteeism. The empirical analysis is conducted in Section 4. Section 5 concludes.

2. Related Literature

Our paper is related to three theoretical studies which analyze sickness absence and presenteeism behavior. First, Brown and Sessions (2004) enhance the Barmby et al. (1994) model of absenteeism by including presenteeism. While our approach is inspired by their model, we depart in two ways. We do not focus on shirking and detection technology but on the interrelation between sickness absence and presenteeism. More importantly, we expand their model by defining presenteeism through the endogenously determined definition of sickness.

Second, Chatterji and Tilley (2002) build a principal-agent model in which the employer offers supra-mandatory sick pay to prevent unproductive presen-

teeism.[3] Since they are interested in optimal contractual design, they define presenteeism from the employer's perspective as a situation in which the employee is too unproductive. While we have a similar framework in which bad health negatively affects the firms' profits, we use a wider definition of presenteeism that is closer to our observational data. Specifically, we focus on the employee's perspective that does not only take productivity into consideration but also disutility from work. Furthermore, the critical level that defines sickness is a function of the work-related characteristics in our model and not constant across individuals and firms.

Finally, Hirsch et al. (2015) present a theoretical model to deduce hypotheses for presenteeism behavior which they empirically investigate with German cross-sectional data. Employees differ in their disutility from work due to sickness which is their private information. When deciding about absence, they trade off disutility from work against a higher likelihood of being fired (with ensuing income loss). Due to the information asymmetry, the firm cannot optimally differentiate wages between those with high and low disutility. Paying the same wage to both types of employees leads to inefficiently low attendance of the healthy individuals (absenteeism) and to inefficiently high attendance of the sick individuals (presenteeism). Defining absenteeism as a situation in which attendance at the workplace of healthy employees is lower than under optimal incentives is, however, neither in line with our approach nor with the related literature. Hirsch et al. (2015) write themselves that they abstain from empirically investigating absence behavior because the absence item in their data does not fit to their theoretical definition of absenteeism. In contrast to their framework, the definition of absence in our model matches observational data quite well.

Beside these theoretical contributions, there is a large and growing strand of empirical literature investigating sickness absence and presenteeism behavior. However, most of these studies either investigate determinants of sickness absence (for an early survey article, see Brown / Sessions, 1996; for literature using European cross-country data, see Frick / Malo, 2008; Livanos / Zangelidis, 2013; Lusinyan / Bonato, 2007) *or* they focus on determinants of presenteeism (see Arnold, forthcoming; Aronsson et al., 2000; Aronsson / Gustafsson, 2005; Böckerman / Laukkanen, 2009; Hansen / Andersen, 2008, 2009; Leineweber et al., 2011; Preisendörfer, 2010). In this paper, we are interested in the effect of work-related characteristics on both sickness states at the same time. Therefore, our paper is in particular related to those empirical studies which cover sickness absence *and* presenteeism.

[3] Although this is a way to tackle presenteeism, monetary incentives alone seem to be unable to solve this problem. This is underlined by the fact that employers complain about unproductive presenteeism even in countries with mandatory full replacement of the foregone wage as in Germany (Booz & Company, 2011).

Two Finnish studies investigate work-related determinants of both sickness states, but they do not focus on their interrelation and use binary measures for both sickness states (Böckerman / Laukkanen, 2009, 2010). In their first study, they find that only few determinants are related to both sickness states, be it complementary as shift work or substitutive as regular overtime. Only one of the two variables of interest is related to both sickness states in their follow-up study, while the other is only correlated with presenteeism. The match between desired and actual working hours is associated with a lower probability of sickness absence and presenteeism, whereas a strong emphasis on efficiency in the work place increases the likelihood of presenteeism. The data set, however, is not representative for the Finish workforce since it comprises only a small sample of Finnish trade union members. Furthermore, with employees deciding each day whether to come to work or stay at home, the relation of work-related factors to absence and presenteeism should be better measured in days than in incidence measures.

Johansson / Lundberg (2004) is the only study that explicitly investigates the substitution between sickness absence and attendance, which they refer to as 'illness flexibility'. Contrary to their expectations, presenteeism and absence have only a substitutive relationship with regards to attendance requirements, but not with regards to adjustment latitude (the possibility to adjust work effort when ill). The latter is positively related to the frequency of sickness absence for females, while not affecting presenteeism. There are several differences in regards to our study. First, they use a very selective sample that is taken from Stockholm county and additionally exclude all respondents that report neither absence nor presence behavior. This sample selection could lead to biased estimates, if the excluded observations are systematically related to the explanatory variables, which is quite likely. Second, their dependent variable is measured in four vaguely defined ordinal categories (never, once, a few times, many times). Finally, controlling only for age, health, financial situation and family demands, the authors do not sufficiently address potential omitted variable bias.

3. Theoretical Model

In this section, we build a model that formalizes the absence / attendance decision of individuals and shows under which conditions presenteeism is conceivable. Furthermore, the model formalizes the influence of work-related factors on the probability of absence and the probability of presenteeism.

3.1 Absence / Attendance

3.1.1 Utility

We consider an individual i who is employed at one particular firm. By assumption, there is a contract between both which specifies the wage rate $w_i > 0$ and the working hours per day $h_i > 0$. The individual is confronted with a health shock δ_i which recurs on a daily basis. The random variable δ_i is distributed over the interval $[0, 1]$ with the density $f(\delta_i)$ and determines the individual's privately known health. The higher δ_i, the worse the health shock is (see Brown and Sessions, 2004, for a similar approach).

The individual i's utility has two possible realizations. If s / he is attendant at the workplace, utility is given by:

$$U_i^h = u^h(w_i, T–h_i, X_i) - \bar{u}(\delta_i, X_i), \tag{1}$$

while in case of the individual's absence from the workplace, we have:

$$U_i^a = u^a(s_i, T). \tag{2}$$

The variable T stands for the individual's endowment in time and s_i ($0 \leq s_i \leq w_i$) denotes the exogenously given firm-financed sick pay which the individual receives in the case of absence. The sub-utility functions u^h and u^a are increasing in consumption (w_i and s_i) and leisure ($T - h_i$ and T). We assume that work-related characteristics X_i affect u^h and hence utility from being attendant at work. In order to keep our framework as general as possible, we use X_i as a vector that subsumes all relevant work-related factors. Whether one particular work-related factor raises u^h or reduces it, is a priori unclear. For example, an improvement of the job security could increase u^h, whereas an impairment of working conditions could decrease it.

The function $\bar{u}$ represents the disutility from work conditional on the individual's health shock, with $\bar{u}(\delta_i = 0) = 0$ and $\partial \bar{u} / \partial \delta_i > 0$. Moreover, we presume that $\bar{u}$ depends on work-related characteristics. For example, disutility at any given health shock could decrease if working conditions are improved. Notably, we focus on the disutility that is conditional on attendance and neglect the general disutility of different health shocks that is independent of the absence / attendance decision (see Chatterji / Tilley, 2002, for a modeling approach in this respect).

3.1.2 The Individual's Decision

Under which conditions does individual i decide to be absent (attendant) from (at) the workplace? To find the answer to this question, we define a

threshold health level, denoted by θ_i, at which the individual i is indifferent between attendance and absence. Formally, this requires $U_i^h(\delta_i = \theta_i) = U_i^a$. Using (1) and (2), we obtain:

$$B \equiv \underbrace{u^h(w_i, T - h_i, X_i) - u^a(s_i, T)}_{>0} - \underbrace{\overline{u}(\theta_i, X_i)}_{>0} = 0, \tag{3}$$

which implicitly determines θ_i.[4] After the health shock δ_i of the individual i is revealed, s/he chooses to be attendant on this day if $\delta_i \leq \theta_i \Leftrightarrow B \geq 0$ holds; otherwise ($\delta_i > \theta_i \Leftrightarrow B < 0$) s/he chooses to be absent.

In line with the theoretical literature on absence (see, for instance, Brown/Sessions, 1996), work-related factors affect the absence decision because they influence the utility costs and returns of being attendant, see (3). For example, better working conditions could reduce the disutility from work and hence make absence less likely. This leads to the following Lemma:

Lemma 1 *The threshold health level above which the individual chooses to be absent from the workplace is (among others) a function of X_i and hence influenced by work-related factors: $\theta_i = \theta_i(X_i)$.*

Because the individual i knows θ_i before the health shock is revealed, it is possible to calculate the probability that the individual will be absent from the workplace on a given day. Formally, the probability of absence is given by $A_i = \Pr(\theta_i < \delta_i < 1) = F(\theta_i < \delta_i < 1)$, where $F(\delta_i)$ denotes the distribution function of δ_i. Using the simplifying assumption of a uniform distribution $F(\delta_i) = \delta_i$, we obtain:

$$A_i(X_i) = 1 - \theta_i(X_i). \tag{4}$$

The probability of being attendant on a given day is given by $H_i = 1 - A_i$.

3.2 Presenteeism

As standard practice in the literature, we define presenteeism as a situation where the individual is attendant at the workplace despite s/he is sick (Arnold, forthcoming; Böckerman and Laukkanen, 2010; Hansen and Andersen, 2008). In the previous subsection, we have shown under which conditions individual i chooses to be attendant at the workplace but we have not introduced a formal definition of sickness. We thus have to determine under which conditions the individual considers her/his health shock as sickness.

[4] Notably, we assume that $0 < u^a(s_i, T) < u^h(w_i, T–h_i, X_i)$ holds to ensure an interior solution.

3.2.1 Definition of Sickness

In contrast to most of the existing literature, we assume that the definition of sickness is endogenous and individual-specific. While the individual's perception of sickness might be shaped by several things such as social norms and others, we focus here on two aspects that are related to work-related characteristics: (i) the individual *i*'s evaluation of the health shock δ_i in terms of utility, denoted by I, and (ii) the firm's evaluation of the individual's health shock in terms of productivity, denoted by F. The individual i combines both factors to define a critical level of health ϕ_i, above which s/he considers her/his health shock δ_i as sickness. The threshold level ϕ_i can hence be interpreted as the individual's sickness definition. Formally, this is given by:

$$\phi_i = \phi_i(I, F). \tag{5}$$

Let us have a closer look to the determinants of the sickness definition, starting with I. We assume that the individual's own evaluation of her/his health shock is driven by the associated disutility from work. If disutility exceeds an exogenously given threshold V_i, the individual i evaluates a given health shock as bad. At the margin, we can define a cutoff health shock δ_{ind} such that $\bar{u}(\delta_i = \delta_{ind}, X_i) = V_i$ holds. Hence, any health shock that exceeds δ_{ind} is evaluated as bad by the individual. Because disutility from work is affected by work-related characteristics, the individual's evaluation of the health shock is also influenced by X_i. If, for instance, working conditions get worse, disutility increases and δ_{ind} declines such that the individual evaluates lower levels of δ_i as bad health shocks.

Turning to the determinant F, we assume that the health shock is considered bad from the firm's perspective if the profit in case of the worker's attendance, π_i^h, falls short of the profit in case of her/his absence, π_i^a (see Chatterji/Tilley, 2002, for a similar approach). As for the individual's evaluation, we can define a cutoff health shock δ_{firm} at which $\pi_i^h(\delta_i = \delta_{firm}) = \pi_i^a$ holds. To calculate this cutoff, we have to specify the firm's profit situation. We define total profits of the firm as:

$$\Pi = \pi_i + Y_{-i} \quad \text{with} \quad Y_{-i} = \sum_{n=1}^{N_{-i}} \pi_n, \tag{6}$$

where π_i denotes the profit produced by individual i and Y_{-i} represents aggregate profits generated by all other N_{-i} workers. Taking the behavior of the N_{-i} workers as given, we obtain:

$$\pi_i^h = r(h_i, X_i) - \bar{r}(\delta_i) - w_i + Y_{-i}, \tag{7}$$

$$\pi_i^a = -s_i + Y_{-i}. \tag{8}$$

Revenue per worker is denoted by r and positively depends on the hours worked per day. In addition, it is also influenced by work-related characteristics (summarized in the vector X_i), but as for the utility functions, the sign (and magnitude) of this effect depends on the specific work-related factor considered. The function $\bar{r}(\delta_i)$ measures the impact of the worker's health shock on the firm's revenue. For simplicity, we assume that revenues decrease if the health shock becomes worse due to reduced productivity and other related costs, with $\bar{r}(0) = 0$ and $\partial \bar{r} / \partial \delta_i > 0$.[5] In case of absence, revenue of the individual is zero and hence not plagued by its health shock. Furthermore, the firm has to pay the sick pay s_i instead of the wage w_i.

Inserting (7) and (8) into the indifference condition above yields:

$$C \equiv \underbrace{r(h_i, X_i) - \bar{r}(\delta_{firm})}_{\geq 0} - \underbrace{(w_i - s_i)}_{\geq 0} = 0. \tag{9}$$

If $\delta_i \leq \delta_{firm} \Leftrightarrow C \geq 0$ holds, the firm evaluates the individual's health shock as good or at least acceptable; otherwise ($\delta_i > \delta_{firm} \Leftrightarrow C < 0$) the firm considers the health shock as bad. Note that the firm cannot observe δ_i due to our assumption that this is the individual's private information.

Because profits are affected by work-related characteristics, the firm's evaluation also depends on X_i. For example, better working conditions could raise profits in the case of the worker's attendance, thereby implying that even high levels of δ_i are not considered as bad health shocks from the firm's perspective. This yields to the following Lemma:

Lemma 2 *The definition of sickness is individual-specific and (among others) a function of X_i such that it is influenced by work-related factors: $\phi_i = \phi_i(I[\delta_{ind}(X_i)], F[\delta_{firm}(X_i)])$.*

3.2.2 The Individual's Decision

With the threshold health level θ_i that determines the absence/attendance decision and the (individual-specific) definition of sickness ϕ_i at hands, we are able to show under which conditions presenteeism is conceivable, given the optimal behavior of individual i. Suppose that $\theta_i > \phi_i$ holds and that the realized health shock of the individual lies in the interval $\phi_i < \delta_i < \theta_i$. As a consequence, s/he chooses to be attendant at the workplace because δ_i is smaller

[5] In general, bad health shocks reduce not only the worker's productivity but have further negative effects on the firm's profit. For example, one worker could infect other employees (see Barmby/Larguem, 2009) or could lead to distortions in situations with production interdependencies (team production) as suggested by Pauly et al. (2008), which both reduce profits. To keep our analysis as simple as possible, we do not model these influences on the productivity of co-workers.

than her/his threshold level, although s/he considers her/his health shock as sickness. The individual's decision – attendance despite sickness – hence leads to a situation of *presenteeism*. Recall that there is a daily health shock, implying that we measure presenteeism on a daily basis.

Similar to the absence/attendance decision, we can also compute the probability of presenteeism on a given day. In general, this is given by $P_i = \Pr(\phi_i < \delta_i < \theta_i) = F(\phi_i < \delta_i < \theta_i)$. Using $F(\delta_i) = \delta_i$, we obtain:

$$P_i(X_i) = \theta_i(X_i) - \phi_i(X_i). \tag{10}$$

Suppose that instead $\theta_i < \phi_i$ holds. Then, a health shock realization of $\theta_i < \delta_i < \phi_i$ implies that the individual chooses to be absent although s/he does not consider her/his health shock as sickness. We define this situation as *absenteeism* of the individual. Note, however, that in a situation where absenteeism is possible, there is no presenteeism by construction.

3.3 The Impact of Work-related Factors

3.3.1 Theoretical Effects

Our model shows that the probabilities of absence and of presenteeism depend on the utility based threshold level θ_i and on the individual-specific definition of sickness ϕ_i [see (4) and (10)]. In turn, both are affected by variations in work-related factors [see Lemma 1 and Lemma 2]. Hence, we can use our model to shed light on the following question: How does a variation in a work-related factor – holding everything else constant – influence *both* the probability of absence and the probability of presenteeism per day? For notational convenience, we suppress the index i in the following.

Suppose that one particular work-related factor included in the vector X changes and denote this factor as $x \in X$. In general, we can distinguish three cases. First, the variation of x implies a decrease (increase) in the absence probability, while the probability of presenteeism increases (decreases). Then, a change in x leads to a *substitutive* relationship between absence and presenteeism. Second, the change in x leads to an increase (or decrease) in both the absence and the presenteeism probability. Then, the change in x entails a *complementary* relationship between absence and presenteeism. Third, the variation in x is associated with a change (no change) in the probability of absence, while the probability of presenteeism remains constant (changes). Then, x leads neither to a substitutive nor a complementary relationship between presenteeism and absence.

To determine under which conditions a change in work-related factor x leads to a substitutive, a complementary or no relationship between absence and pre-

senteeism, recall that variations of x influence θ and ϕ. Using (4), we can show that the probability of absence increases (decreases) when θ decreases (increases):

$$dA = \underbrace{\frac{\partial A}{\partial \theta}}_{=-1} d\theta > (\leq)\ 0 \Leftrightarrow d\theta < (\geq) 0. \tag{11}$$

Regarding the probability of presenteeism, (10) indicates that changes in θ and ϕ influence P. If $d\theta < 0$ (and thus $dA > 0$) holds, we get:

$$dP = \underbrace{\frac{\partial P}{\partial \theta}}_{=1} \underbrace{d\theta}_{<0} + \underbrace{\frac{\partial P}{\partial \phi}}_{=-1} d\phi < (\geq)\ 0 \Leftrightarrow d\phi \geq 0 \text{ or } d\theta < d\phi < 0\ (d\phi \leq d\theta < 0). \tag{12}$$

If $d\theta \geq 0$ (and thus $dA \leq 0$) holds, we find:

$$dP = \underbrace{\frac{\partial P}{\partial \theta}}_{=1} \underbrace{d\theta}_{\geq 0} + \underbrace{\frac{\partial P}{\partial \phi}}_{=-1} d\phi > (\leq)\ 0 \Leftrightarrow d\phi \leq 0 \text{ or } 0 < d\phi < d\theta\ (0 < d\theta \leq d\phi). \tag{13}$$

With these conditions at hand, we obtain the following Propositions:[6]

Proposition 1 *Presenteeism and absence are substitutes with respect to a work-related factor x (i) if θ changes while ϕ is unaffected, (ii) if the variations in θ and ϕ are oppositional or (iii) if the changes of θ and ϕ have the same sign but the (absolute) change in ϕ is sufficiently weak.*

Proof. A substitutive relationship requires $dA > (<)0$ and $dP < (>)\ 0 < (>)\ 0$. From (11), we obtain $dA > (<)0 \Leftrightarrow d\theta < (>)0$. If $d\phi = 0$ holds, Eqs. (12) and (13) imply that $dP < (>)\ 0$, which proves part (i) of the Proposition. For $d\phi > (<)\ 0$, we also find $dP < (>)\ 0$ as stated in part (ii) of the Proposition. Finally, Eqs. (12) and (13) indicate that $dP < (>)\ 0$ holds if the absolute change in ϕ is lower than the absolute change in θ: $d\theta < d\phi < 0\ (0 < d\phi < d\theta)$. This proves part (iii) of the Proposition.

Proposition 2 *Presenteeism and absence are complements with respect to a work-related factor x if the changes in θ and ϕ have the same sign and the (absolute) change in ϕ is sufficiently strong.*

Proof. A complementary relationship requires $dA > (<)\ 0$ and $dP > (<)0$. Eq. (11) implies that $dA > (<)\ 0 \Leftrightarrow d\theta < (>)\ 0$. Observing (12) and (13), we

[6] As shown by (11), (12) and (13), the assumption of the uniform distribution implies that the partial derivatives equal 1 respectively –1. This simplifies the derived Propositions because changes in θ and ϕ are weighted by 1 (in absolute terms). In the Appendix, we prove that our qualitative findings are robust if the distribution of δ is not specified.

find that $dP > (<)\ 0$ holds if the absolute change in ϕ is higher than the absolute change in θ: $d\phi < d\theta < 0$ $(0 < d\theta < d\phi)$.

Proposition 3 *Presenteeism and absence are neither substitutes nor complements with respect to a work-related factor x (i) if θ remains constant while ϕ changes or (ii) if the changes in θ and ϕ are identical.*

Proof. There is no relationship between absence and presenteeism if $dA = (\neq)\ 0$ and $dP \neq (=)\ 0$ holds. From (11), we obtain $dA = (\neq)\ 0 \Leftrightarrow d\theta = (\neq)\ 0$. Given $d\theta = 0$, Eqs. (12) and (13) imply that $dP \neq 0 \Leftrightarrow d\phi \neq 0$, which proves part (i) of the Proposition. If $d\theta \neq 0$ holds, we see from (12) and (13) that $d\theta = d\phi$ must hold in order to ensure $dP = 0$, which proves part (ii) of the Proposition.

These findings are based on the assumption $\theta > \phi$. However, it can be the case that the reverse relation is true: $\theta < \phi$. As discussed in Section 3.2, there is then no presenteeism by construction, and we normalize its probability to zero: $P \equiv 0 \Leftrightarrow \theta < \phi$. Note that in this scenario, the probability of absenteeism, i.e., illegitimate absence, is positive.

Proposition 4 *Presenteeism and absence are neither substitutes nor complements with respect to a work-related factor x if $\theta < \phi$ holds.*

3.3.2 Empirical Examination

Theoretically, the effects of work-related factors on absence and presenteeism are ambiguous, as shown by Propositions 1–4. Therefore, it is necessary to investigate these effects empirically.[7] In the following, we use data from a cross-sectional survey where individuals self-report their absences and presenteeism days during the last 12 months. In addition, we make use of a rich set of work-related factors to analyze how they are – on average – related to absence and presenteeism days.

With our theory at hand, we are able to disentangle the channels through which work-related factors affect absence and presenteeism days in the data. In this regard, three remarks have to be made. First, we interpret the annual number of days in the data as the aggregated realization of daily absence decisions in the model. Second, to keep our theoretical model as simple as possible, we have assumed that the health shock is exogenous, i.e., the health shock does neither depend on previous presenteeism behavior nor on work-related characteristics. Both assumptions might be problematic with real world data. In our annual data, feedback effects from previous presenteeism on health status could

[7] Note that, given the general form of the utility functions and the definition of sickness, our theory cannot be used to find clear-cut predictions whether a particular work-related factor leads to a substitutive, complementary or no relationship between absence and presenteeism.

not, at the first glance, be ruled out.[8] Additionally, working in a job with specific characteristics, e.g., adverse working conditions, might be systematically related to the health status (either through selection or reversed causality). Although we try to mitigate these endogeneity issues by making use of the particularly rich health information available in our data set, they have to be kept in mind when interpreting our results. Third, we are not able to empirically investigate intra-individual changes as described in the theoretical model because we use cross-sectional data. Instead, we analyze differences between individuals with regards to their absence and presenteeism behavior.

Suppose that a change in one work-related factor leads to more absence days and less presenteeism days on average and implies hence a substitutive relationship between both. The increase in absence can be explained by a decline in the utility based threshold level θ. Holding everything else constant, more absence implies that presenteeism is automatically reduced. This effect on presenteeism survives if the sickness definition ϕ is unchanged and is even amplified if the individual considers fewer health shocks as sick, i.e., ϕ increases.

It can, however, also be possible that a change in one work-related factor implies more absence and *more* presenteeism days on average. If we would find this complementary relationship in our data, the above mentioned change in absence has to be complemented by a sufficiently strong decrease in the definition of sickness ϕ. Then, individuals are more likely absent (due to lower θ) which, c.p., reduces presenteeism, but also consider more health shocks as sick (due to lower ϕ) which, c.p., increase presenteeism. If the latter effect is strong enough, a changing work-related factor could induce a simultaneous increase in absence and presenteeism days.

The endogenous definition of sickness also helps us to explain why a change in one work-related factor could lead to more presenteeism days (absence days), while leaving absence days (presenteeism days) unaffected. This would be the case if the utility based threshold level θ does not vary with the work-related factor while the definition of sickness ϕ changes (absence remains constant) or if both are affected in the same way (presenteeism remains constant). In addition, the constancy of presenteeism could also be explained if the work-related factor has an impact on absence and *absenteeism*. This would be the case if the utility based health threshold level falls short of the threshold level that defines sickness, implying that individuals choose to stay at home although they do not consider themselves as sick.

To illustrate these mechanisms, assume that working conditions become worse and that the individual (due to higher disutility) decides to be more days

[8] Notably, there is empirical evidence that presenteeism affects future health realizations, but these effects tend to be rather on the longer term than within twelve months as in our case (Hansen / Andersen, 2009).

absent from the workplace. This would imply a substitutive relationship between absence and presenteeism, if the definition of sickness is not affected by the impairment of working conditions. Suppose instead that the individual considers more health shocks as sickness due to the change in working conditions, presenteeism could remain constant or even increase. The latter implies that worse working conditions come with more absence and more presenteeism days, i.e., it leads to a complementary relationship between both sickness states. In the former case, presenteeism remains constant and only absence changes. Finally, suppose that the impairment of working conditions affects the sickness definition but not the attendance decision, then only presenteeism days would change.

4. Empirical Analysis

4.1 Data and Empirical Strategy

To analyze the impact of work-related characteristics on the relationship between absence and presenteeism empirically, we use the fifth wave of the EWCS, a repeated cross-sectional survey on working conditions in Europe. The EWCS is conducted every five years by an agency of the European Union and profits from a single questionnaire guaranteeing consistent data across countries. In 2010, the EWCS covered for the first and only time *an item on sickness presenteeism* and is hence the first large-scale survey integrating information about sickness absence and presenteeism behavior. It comprises the population aged 15 and above living in 34 European countries. In our investigation, we consider employees aged 18 – 65 years who have been employed during the last 12 months prior to the interview and who have been working at least 10 hours per week, excluding the self-employed, students, apprentices, employees without work contracts and those working two jobs.[9]

As the dependent variables, we use the annual duration of absence and presenteeism measured in days. The sickness absence item reads as follows: *"Over the past 12 months how many days in total were you absent from work for reasons of health problems?"* The sickness presenteeism item asks: *"Over the past 12 months did you work when you were sick? a) Yes b) No. If yes, how many working days?"*

We prefer the annual duration of absence and presenteeism over incidence or frequency measures for several reasons. First, the productivity effects of sick-

[9] The sample covers all 27 European Union member states, Albania, Croatia, Kosovo, Macedonia, Montenegro, Norway, and Turkey. Note further that we disregard employees unrealistically claiming to work more than 80 hours per week. The results are not sensitive to the exclusion of those either working less than 10 or more than 80 hours per week.

ness depend among others on how long the employee's productivity is impaired by the sickness (see Pauly et al., 2008). Hence, the annual duration of absence and presenteeism is a better proxy for productivity effects than their frequency or incidence. Second, since employees decide each day whether to come to work or stay at home, the relation of work-related factors to absence and presenteeism is better measured in days than in frequency or incidence measures. Furthermore, it fits well with our theoretical model describing daily absence decisions. Finally, asking for the number of sickness presenteeism and absence days in an open question is better than offering predefined frequency categories (as done by Johansson / Lundberg, 2004) because this avoids the establishment of reference points. Note that we disregard outliers, i.e., those with either more than 50 sickness presenteeism or 100 absence days within 12 months, resulting in a loss of around 150 observations. However, the central results do not depend on this sample selection (see Section 4.3). We also exclude those 30 employees with a very bad health status. In total, the number of observations amounts to 18,804.

The descriptive statistics provided in Table 1 show that sickness absence and presenteeism is a widespread and quantitatively relevant phenomenon in Europe. In our sample, the average number of sickness presenteeism and absence days amounts to 2.7 and 5.4, respectively. Conditioning on those who go to work while sick at least ones during the last twelve months leads to an average of more than seven presenteeism days. For absence, this number amounts to more than eleven absence days. There is a large cross-sectional variation with standard deviations of more than five presenteeism days and over eleven absence days. The distribution of the conditional sickness presenteeism and absence days is shown in Figure 1.

Since we are interested in how work-related characteristics are related to absence and presenteeism behavior, we have to select specific work-related factors and cover them empirically. In our cross-sectional model, this selection of explanatory variables is key. Therefore, we guide our choice by the literature on sickness absence behavior (Frick / Malo, 2008; Livanos / Zangelidis, 2013; Puhani / Sonderhof, 2010; Ziebarth / Karlsson, 2010) and by the literature on sickness presenteeism (Arnold, forthcoming; Aronsson et al., 2000; Aronsson / Gustafsson, 2005; Böckerman / Laukkanen, 2009, 2010; Hansen / Andersen, 2008; Leineweber et al., 2011; Preisendörfer, 2010). We present a parsimonious model as preferred specification excluding some insignificant explanatory variables, which does not change our results (see Section 4.3).

In our main specification, we include rather formal job characteristics such as supervisory and blue collar status, temporary contracts, tenure categories (1 – 2 years, 3 – 14 years, $\geq$ 15 years), part time (10 – 30h per week), over time ($\geq$ 45h per week), flexible working time, firm size, industry (modified NACE-17 classification) and sector information (private sector). To measure the working conditions, we construct an index measuring adverse working conditions.

Table 1

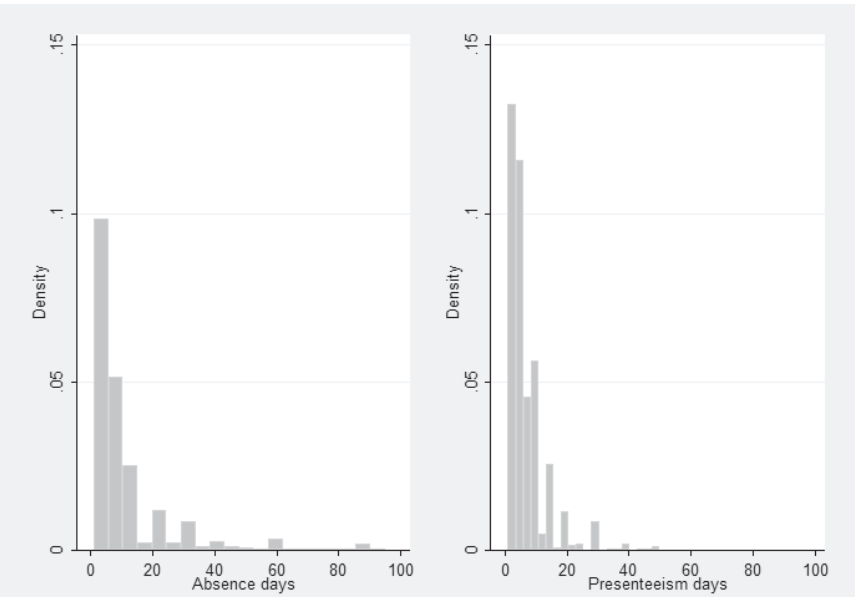
Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Sickness absence days	18,804	5.39	11.63	0	100
Sickness presenteeism days	18,804	2.67	5.35	0	50
		Work-related characteristics			
Tenure (<1 years)	18,804	0.08	0.26	0	1
Tenure (1–2 years)	18,804	0.16	0.36	0	1
Tenure (3–14 years)	18,804	0.49	0.50	0	1
Tenure (≥ 15 years)	18,804	0.27	0.45	0	1
Flexible schedule	18,804	0.04	0.19	0	1
Work autonomy index	18,804	1.97	1.17	0	3
Supervisor	18,804	0.15	0.36	0	1
Part time (10–30h)	18,804	0.11	0.31	0	1
Over time (≥ 45h)	18,804	0.13	0.31	0	1
Lack of time to get work done	18,804	2.05	0.98	1	5
Adverse working conditions	18,804	2.78	2.56	0	15
Social support	18,804	5.78	1.88	0	8
Blue collar worker	18,804	0.31	0.46	0	1
Temporary contract	18,804	0.12	0.33	0	1
Size (<10 employees)	18,804	0.28	0.45	0	1
Size (10–49 employees)	18,804	0.34	0.48	0	1
Size (50–99 employees)	18,804	0.13	0.33	0	1
Size (100–249 employees)	18,804	0.11	0.31	0	1
Size (≥250 employees)	18,804	0.14	0.35	0	1
Private sector	18,804	0.62	0.49	0	1
Piece rate	18,804	0.12	0.33	0	1
Production target	18,804	0.38	0.49	0	1
Performance assessment	18,804	0.43	0.50	0	1

Source: 2010-EWCS. Own calculations.

The index is a sum of dummy variables measuring whether the individual is exposed half of the time or more to a number of adverse working conditions. These comprise: exposure to vibrations from hard tools or machinery; to noise; high temperatures; low temperatures; breathing in smoke, fumes, powder or dust; breathing in vapours; handling or being in skin contact with chemical products or substances; breathing tobacco smoke from other people; handling or being in direct contact with materials which can be infectious; having a job that involves tiring or painful positions; lifting or moving people; carrying or

moving heavy loads; standing; performing repetitive hand or arm movements; and handling angry clients or patients. Additionally, we take subjective properties of a job into account such as work autonomy, support by co-workers and the management, and time pressure (lack of time to get work done).[10] Finally, we include three HRM measures, namely piece- or productivity pay, production targets that determine work speed and individual formalized performance assessment. The corresponding descriptive statistics of the two dependent variables and the work-related characteristics are provided in Table 1.



Source: 2010-EWCS. Own calculations.

Figure 1: Distribution of sickness absence and presenteeism days conditional on absence and presenteeism. Observations with zero sickness absence or presenteeism days not shown but included in analysis (53 and 62 % of the full sample, respectively).

[10] Work autonomy is captured by an index summing up three dummy variables measuring whether the employee has control over work order, work methods and work speed. Lack of time to get work done is measured on a 5 point Likert scale, while social support is the sum of two 5 point Likert scales capturing support by colleagues and supervisors (see Table 1). In order to relax the assumptions with regard to the comparability across individuals in these subjective dimensions, we use binary measures of the Likert scales ('always', 'most of the time', 'sometimes' against 'rarely' or 'never') as a robustness check which does not qualitatively change our findings (results available upon request).

Additionally to the work-related characteristics, we control for sociodemographic variables and health status (for descriptives of the controls see Table 2). As sociodemographic variables, we include sex (female=1), having children, living with a partner, age categories (aged 18 – 24, 25 – 34, 35 – 44, 45 – 54, and 55 – 65 years), educational status (primary, secondary and higher education status) and having financial problems as a proxy for the household income.[11]

As argued in Section 3.3.2, it is important to filter out individual heterogeneity in health as well as possible. Fortunately, the EWCS data offers a rich set on health information that goes far beyond those included in other labor market surveys. Hence, we do not only control for self-rated general health (very good, good, fair and bad), which alone is already a very good predictor of general health and mortality (Idler / Benyamini, 1997), but we also include a set of dummy variables that measures specific diseases or health issues from which the respondents have suffered within the last 12 months. The dummies on specific diseases and symptoms include: hearing problems, skin problems, backache, muscular pain in shoulders, neck and / or upper limbs, muscular pain in lower limbs, headaches and eyestrain, stomach ache, respiratory difficulties, cardiovascular diseases, injuries, depression or anxiety, overall fatigue, insomnia or general sleeping problems and other health problems. Since absence and presenteeism behavior might not only be affected by the respondent's physical health, we also include a mental health index. This index is a sum of five Likert scales measuring for the last two weeks whether the respondent has 'felt cheerful and in good spirits', 'felt calm and relaxed', 'felt active and vigorous', 'woken up feeling fresh and rested', and whether her or his 'daily life has been filled with things that interest [her or him]'. The index runs from zero to 25 with higher values indicating better mental health.

Finally, we include country dummies in order to account for average aggregated country differences in absence and presenteeism behavior that might be due to country specific effects such as labor market institutions, social norms, or health care institutions. In doing so, we indirectly control also for the generosity of sick pay entitlements that strongly vary across countries and affect absence behavior (Frick / Malo, 2008; Puhani / Sonderhof, 2010; Ziebarth / Karlsson, 2010).[12]

To find out whether a change of a work-related factor implies a substitutive, complementary or no relationship between sickness presenteeism and absence, we investigate separately how they are related to the number of presenteeism

[11] The EWCS includes also a crude net income measure that exhibits many non-responses. Including this variable does not change our findings. The respective estimations are available upon request to the authors.

[12] We use country dummies in cross-sectional data since they are a general way to control for cross country differences. Furthermore, including both country dummies and sick pay generosity is not feasible due to multi-collinearity.

Table 2

Control Variables (Descriptive Statistics)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
		Socio-demographic controls			
Sex (female=1)	18,804	0.52	0.50	0	1
Children	18,804	0.54	0.50	0	1
Partnership	18,804	0.69	0.46	0	1
Age (18 – 24 years)	18,804	0.06	0.23	0	1
Age (25 – 34 years)	18,804	0.24	0.43	0	1
Age (35 – 44 years)	18,804	0.28	0.45	0	1
Age (45 – 54 years)	18,804	0.27	0.45	0	1
Age (55 – 65 years)	18,804	0.15	0.35	0	1
Primary education	18,804	0.22	0.42	0	1
Secondary education	18,804	0.40	0.49	0	1
Higher education	18,804	0.38	0.49	0	1
Financial problems	18,804	0.42	0.49	0	1
		Health status			
Very good health	18,804	0.25	0.43	0	1
Good health	18,804	0.52	0.50	0	1
Fair health	18,804	0.21	0.41	0	1
Bad health	18,804	0.02	0.14	0	1
Mental health index	18,804	16.5	5.0	0	25
Hearing problems	18,804	0.06	0.25	0	1
Skin problems	18,804	0.08	0.28	0	1
Back ache	18,804	0.45	0.50	0	1
Muscular pain in upper limbs	18,804	0.42	0.50	0	1
Muscular pain in lower limbs	18,804	0.31	0.46	0	1
Headaches and eyestrain	18,804	0.41	0.49	0	1
Stomach ache	18,804	0.13	0.34	0	1
Respiratory difficulties	18,804	0.06	0.24	0	1
Cardiovascular diseases	18,804	0.06	0.23	0	1
Injuries	18,804	0.08	0.27	0	1
Depression or anxiety	18,804	0.11	0.31	0	1
Overall fatigue	18,804	0.39	0.49	0	1
Insomnia or general sleeping problems	18,804	0.20	0.40	0	1
Other health problems	18,804	0.03	0.16	0	1

Source: 2010-EWCS. Own calculations.

and absence days and classify them accordingly. A substitutive relationship between presenteeism and absence days is given if a work-related factor leads to an opposite change in these two sickness states. For a complementary relationship between presenteeism and absence days, a work-related factor affects both sickness states at the same time either positively or negatively. Finally, if a work related factor is either significantly related to sickness presenteeism *or* absence, its relationship is neither substitutive nor complementary.

We investigate the relationship between the work-related characteristics and the number of presenteeism and absence days by estimating unweighted OLS regression models with cluster adjusted standard errors at the country level. Since there is no panel data on presenteeism available at the moment, we can offer only cross-sectional correlations, which should be kept in mind when interpreting the ensuing results. Despite having a count data structure, we prefer OLS to count data models since they are less contingent on distributional assumptions and easier to interpret (for count data models, see Cameron and Trivedi, 1998, pp. 59 ff.). Particularly, assuming an average linear relationship between independent and dependent variable, OLS models make it easier to draw a general picture with regards to a substitutive, a complementary or no relationship than count data models where there might be different effects at different points on the distribution. To be sure that our results do not depend on this simplifying assumption, we present a Poisson regression model as a robustness check in Section 4.3.

Specifically, we estimate the two following regressions for absence and presenteeism days, respectively:

$$\begin{aligned}\text{absence days}_i = {} & \alpha_0 + \mathbf{workcharacteristics}_i' \boldsymbol{\alpha_1} + \mathbf{sociodemographics}_i' \boldsymbol{\alpha_2} \\ & + \mathbf{healthstatus}_i' \boldsymbol{\alpha_3} + \mathbf{country}_i' \boldsymbol{\alpha_4} + \epsilon_i. \end{aligned} \tag{14}$$

$$\begin{aligned}\text{presenteeism days}_i = {} & \beta_0 + \mathbf{workcharacteristics}_i' \boldsymbol{\beta_1} + \mathbf{sociodemographics}_i' \boldsymbol{\beta_2} \\ & + \mathbf{healthstatus}_i' \boldsymbol{\beta_3} + \mathbf{country}_i' \boldsymbol{\beta_4} + \eta_i. \end{aligned} \tag{15}$$

Absence days$_i$ and presenteeism days$_i$ indicate the number of absence or presenteeism days during the last 12 months for individual i. Work characteristics$_i$, health status$_i$, and sociodemographics$_i$ represent the different vectors of independent variables. We include country dummies, while ε_i and η_i are the error terms.

Additionally to separate OLS regression models, we simultaneously estimate the equation system (14) and (15), which is called seemingly unrelated regression models (SUR) or system OLS (see Wooldridge, 2002, 143 ff.). SUR deliver by construction the same coefficient estimates as separate OLS estimates but allow for the correlation of the error terms between both equations with potential efficiency gains. This takes advantage of the fact that we observe absence and presenteeism behavior of the same individual i. Furthermore, SUR

allow to test for differences of coefficients across equations in a simple way, e.g., whether $\alpha_1 = \beta_1$ holds.

4.2 Results

The OLS regression outcomes are depicted in Table 3, in which we present the determinants of absence and presenteeism days in columns (1) and (2), respectively. Since the coefficients in the OLS models are the same as in the SUR models, the table contains the z-statistics in squared brackets for the SUR models in addition to the usual t-statistics in round brackets. The results from the SUR models will be discussed further below.

As our first result, we find that there are only *few* work-related variables that lead to a substitutive relationship. This is a very remarkable finding because it is at odds with the common view in the literature that employees' choice between absence and presenteeism is a zero-sum game. Furthermore, it suggests that the individual-specific definition of sickness – the main innovation of our theoretical model – plays an important role because non-substitutive relationships between both sickness states can only be explained by sufficiently large changes in the sickness definition, as explained in Section 3.3.2.

More specifically, being supervisor, working more than 45 hours per week and being autonomous about the working time are associated with less absence days at the expense of more presenteeism days. This group of individuals could be described as career-oriented employees because they work long hours and take responsibility for their firm as supervisor, but have also autonomy over their working time. Hence, one could argue that these employees have incentives to come to work at a more severe health shock but without adjusting their sickness definition. Consequently, absence days decline while presenteeism days increase.

The second result of our empirical investigation is that only a few complementary relationships exist between absence and presenteeism days with respect to work-related factors.[13] To be more specific, adverse working conditions and tenure are positive and significantly related to both sickness categories. Accordingly, longer tenure as well as worse working conditions give employees an incentive to stay at home even for less severe health shocks which raises absence days. At the same time, the employees' definition of sickness is widened by both factors such that more health shocks are considered as sick which raises presenteeism days.

[13] This lack in substitutes and complements is not a specific result for the work-related characteristics but does hold also true for the sociodemographics. Here, only sex leads to a complementary relationship between absence and presenteeism. Self-rated health status and some of the specific illness dummies are significantly related to both sickness states, too.

Table 3

Regression Results

	(1) Absence (OLS)[SUR]		(2) Presenteeism (OLS)[SUR]	
		Substitutes		
Supervisor	**–0.503****	(–2.19) [–2.12]	**0.314*****	(3.12) [2.91]
Over time (≥ 45 h)	**–0.831*****	(–3.30) [–3.19]	**0.485*****	(4.43) [4.09]
Flexibel time arr.	**–1.225*****	(–3.90) [–2.79]	**0.223****	(2.11) [1.12]
		Complements		
Adverse working condit.	**0.233*****	(4.63) [6.04]	**0.058****	(2.45) [3.30]
Tenure (<1 years)		(base)		(base)
Tenure (1–2 years)	1.085***	(3.54) [2.98]	0.597***	(3.28) [3.61]
Tenure (3–14 years)	**1.728*****	(4.29) [4.96]	**0.702*****	(3.52) [4.41]
Tenure (≥ 15 years)	1.671***	(3.46) [4.26]	1.047***	(4.66) [5.88]
		Only absence		
Private sector	**–0.928*****	(–4.99) [–4.19]	**0.014**	(0.18) [0.14]
Temporary contract	**–0.960*****	(–3.61) [–3.46]	**–0.069**	(–0.57) [–0.54]
Part time (10–30h)	–0.685*	(–1.80) [–2.44]	–0.146	(–0.78) [–1.15]
Size (<10 employees)	(base)		(base)	
Size (10–49 employees)	**0.719*****	(3.57) [3.43]	**0.084**	(0.76) [0.88]
Size (50–99 employees)	**0.655****	(2.39) [2.35]	**0.007**	(0.06) [0.06]
Size (100–249 employees)	**1.045*****	(3.20) [3.51]	**0.287***	(1.95) [2.12]
Size (>250 employees)	**1.418*****	(4.19) [4.95]	**0.135**	(1.14) [1.03]
		Only presenteeism		
Work autonomy	**–0.083**	(–0.99) [–1.11]	**0.156*****	(3.16) [4.62]
Lack of time	**–0.106**	(–0.89) [–1.20]	**0.157*****	(3.04) [3.92]
Production targets	–0.013	(–0.07) [–0.07]	0.198***	(2.90) [2.43]
Performance assessment	0.065	(0.28) [0.38]	0.218**	(2.25) [2.79]
Social support	–0.025	(–0.39) [–0.53]	–0.085***	(–3.69) [–4.03]
Blue collar	0.224	(0.92) [0.95]	–0.186*	(–1.92) [–1.75]
		Insignificant		
Piece or product. rate	0.116	(0.46) [0.45]	–0.079	(–0.75) [–0.68]
Control variables	Yes		Yes	
N	18804		18804	
R^2	0.12		0.14	

Source: 2010-EWCS, own calculations.

Notes: Coeffcient estimates are from OLS regressions. The dependent variables are the number of sickness absence days in columns (1) and the number of sickness presenteeism days in column (2), including those with zero days. All variables shown in the table except *adverse working conditions, lack of time, work autonomy* and *social support* are dummies (see Table 1 for descriptive statistics). Sociodemographic variables as well as country and industry dummies are included as control variables but are not shown. The sociodemographic controls comprise sex, having children, partnership status, age categories, Financial problems and educational status. The health control variables include self rated health status (3 dummies), 14 different symptoms and diseases from which the respondent suffered during the last 12 months as well as an index measuring mental health. T-statistics based on

standard errors clustered on the country level are in parentheses, z-statistics from SUR regression in squared brackets. Bold coeficients indicate significant differences across equations in the SUR model (five per cent level). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

As shown in Table 3, the majority of the work-related factors is either related to sickness absence days or to presenteeism days while being uncorrelated with the other. Let us first look at the case in which absence behavior changes while presenteeism remains unaffected. Working under a temporary contract and in the private sector are associated with significantly less absence days (part time only at the ten per cent significance level), while working in a larger plant is positively related to the number of absence days.

In our theoretical model, this pattern can be explained if there is illegitimate absence instead of presenteeism. Individuals then decide to be absent from the workplace without considering the respective health shock as sick. Accordingly, temporary contracts, employment in the private sector and in smaller firms make illegitimate absence more costly. This might be explained by less employment protection in these jobs which has been shown to affect absence behavior (cf. Riphahn, 2004; Ichino / Riphahn, 2005). Although there is a reduction of absence, these characteristics do not, in this case, come at the cost of increased presenteeism. With data collected in 2010, at the peak of the economic crisis in Europe with its increasing unemployment and general economic insecurity, which should increase effort in form of presenteeism particularly among those with low employment protection, it is a strong result that we find only differences in absence but none in presenteeism. This suggests that it is rather the case that protected employees shirk but that the unprotected do not supply additional effort in form of presenteeism to keep their jobs.

Finally, we consider the case where presenteeism changes while absence is unaffected. As shown in Table 3, subjective work load (lack of time), work autonomy and two of the HRM measures (production target and formal performance assessment) are highly significantly associated with more sickness presenteeism days, while support by colleagues and management is highly significantly associated with less (blue collar only at the ten per cent level). As our theoretical model explains this pattern by differences in the individual sickness definition, these results suggest that pressure on the employee (work load and performance assessment) and support of the employee affect perceived sickness in an oppositional way. From the perspective of a manager, the existence of this category is interesting because it highlights possibilities to reduce presenteeism without the threat of higher absence.

Regarding economic significance, tenure and firm size are the most relevant determinants for absence days where specific discrete changes can each make a difference of up to 1.5 absence days, directly followed by flexible time arrangements with a difference of still 1.2 absence days.[14] Private sector, temporary

contract and working over time are still relevant with a difference of less than one absence day for a discrete change in each variable. Although being highly statistically significant, a standard variation in adverse working conditions comes only with 0.6 additional absence days.

Turning to the presenteeism regression, tenure is the most relevant determinant accounting for a difference of up to one presenteeism day, followed by over time with almost half a presenteeism day difference and supervisors with 0.3 days.[15] Varying the non-binary variables (adverse working conditions, work autonomy, lack of time and social support) by one standard deviation does not come with more than 0.2 days variation in presenteeism days. Hence, the variables that are only related to presenteeism are quantitatively less relevant determinants of presenteeism days than those that imply a substitutive or complementary relationship between absence and presenteeism. Overall, work-related characteristics account for more variation in absence than in presenteeism days.

As stated above, we also present the SUR model in Table 3. The residuals in the two SUR equations correlate at 0.0977, which is substantially reduced when compared to the raw correlation between absence and presenteeism days amounting to 0.1817. Our previously discussed results remain qualitatively unchanged with one exception: the flexible time variable becomes insignificant in the presenteeism regression.

Additionally, we use the SUR model to test whether coefficients are statistically different across both regression equations. In Table 3, bold coefficients indicate significant differences at the five per cent level. Looking at the three work-related factors which imply a substitutive relationship between absence and presenteeism, the sign of the coefficients is not only opposed but also statistically different in both equations. This strengthens our result that absence and presenteeism change in opposite directions. For work-related characteristics that influence both sickness states in the same way (complements), different coefficients across equations indicate only different effect sizes, such that their quality as complements is not affected.

For the remaining work-related factors, we have assumed that they are neither substitutes nor complements because they are significantly related to one of the two sickness states but insignificant to the other. With the SUR model at hands, we can use a stricter definition for this situation, i.e., work-related factors do not lead to a substitutive or a complementary relationship between absence and presenteeism if the former assumption holds *and* if the coefficients

[14] These discrete changes in tenure, firm size category or flexible working time can account each for more than 20 per cent of the average number of absence days (5.39) and more than 10 per cent of its variation (11.6).

[15] Discrete changes in tenure, over time or supervisory status account each for more than ten per cent of the average number of presenteeism days (2.67) and for more than 3 per cent of its variation (5.35).

are significantly different across equations. As shown in Table 3, work-related characteristics that are only significantly related to absence days all have statistically different coefficients across equations and thus fit the new definition (except for the part time variable). In contrast, those that are only significant in the presenteeism model do not have statistically different coefficients across equations (except for the work autonomy and lack of time variables). Accordingly, production targets, performance assessment, social support and blue collar status do not fulfill the narrower definition, which might cast some doubt as to whether these factors affect both sickness states differentially.

4.3 Robustness Checks

As robustness checks, we use count data models as well as OLS models in differently defined (sub)samples and provide the respective estimation results in Table 4. Estimating a Poisson regression model confirms our results from the OLS regressions (see columns 1 and 2 in Table 4). Restricting our sample to EU member states which are characterized by a more homogeneous institutional setting (columns 3 and 4 in Table 4) does not fundamentally alter our results, either. Only the part time variable becomes insignificant in this sample.

As a further robustness check, we restrict our sample to employees that have been sick during the last 12 months because one can only substitute between sickness states when being sick at all (columns 5 and 6 in Table 4). In this sample, we find one additional substitutive relationship, namely work autonomy. Here, work autonomy is associated with less absence and more presenteeism days, while the qualitative findings for the other controls remain mostly stable. Being associated with responsibility and intrinsic motivation, work autonomy fits quite well into the group of the other substitutes.

Moreover, we do some further sensitivity checks that are not presented in Table 4.[16] Including (some) of the outliers, i.e., those with up to 150 absence or presenteeism days in 12 months, does not fundamentally change our results. Specifically, flexible working time becomes insignificant in the presenteeism regression, while supervisor is only significant at the ten per cent level in both regressions. In contrast, blue collar status becomes highly statistically significant in the presenteeism regression. Hence, only over time and supervisor status – albeit less significantly – remain substitutes in these models. This could be seen as a sign that substitution plays rather a role in a sample of employees with less severe health issues which allows them to actually reduce absence at the cost of presenteeism.

To see whether our results are sensible to the exclusion of employees with particularly severe health issues, we rerun our models excluding employees

[16] The respective estimation results are available upon request from the authors.

having suffered during the last twelve months from a.) injuries (around eight per cent of the sample) or b.) other (non listed) health problems (around three per cent).[17] Again, the results are virtually unchanged in these two sub-samples. Only flexible working time becomes insignificant in both presenteeism models.

Since females and males might differ in terms of their health status and behaviour, we separately estimate models for both groups. The results are qualitatively more robust in the absence than in the presenteeism models with largely unchanged coefficients. Specifically, over time (temporary contract) is only significantly linked to absence days in the male (female) sample. Moreover, we find that the significant results in the presenteeism model for lack of time, supervisory and blue collar status are driven by the females, while those for flexible working time and social support are driven by the males.[18]

Since we present a parsimonious model as our preferred specification, we finally check whether our results change when including those insignificant work-related characteristics that were excluded before. Controlling in addition for work interdependence (whether work speed depends on others), whether working during evenings or weekends, a categorical income measure (21 categories) and perceived job insecurity (5 point Likert scale) does not qualitatively vary our results.

[17] These are the two least prevalent illness categories that are particularly strongly related to both sickness states. Excluding those with cardiovascular or respiratory disease does not qualitatively change our results either.

[18] Besides these straightforward cases with clearly different coefficients across the subsamples, there are several cases where the coefficients remain unchanged but turn insignificant at conventional levels – probably due to the reduced sample size. This is the case in the absence models for supervisory status (females) and part time (both subsamples), in the presenteeism models for adverse working conditions (males), production targets (males) and performance evaluation (both subsamples).

Table 4

Robustness Checks

	(1) Absence		(2) Presenteeism		(3) Absence		(4) Presenteeism		(5) Absence		(6) Presenteeism	
	Poisson				EU-27				Conditional on sickness			
Supervisor	–0.539**	(–2.19)	0.300***	(3.20)	–0.618**	(–2.58)	0.267**	(2.39)	–0.677*	(–1.91)	0.525***	(3.74)
Over time (≥ 45h)	–0.813***	(–2.91)	0.457***	(5.06)	–0.807**	(–2.76)	0.610***	(5.00)	–1.405***	(–3.53)	0.826***	(5.20)
Flexibel time arr.	–1.439***	(–3.19)	0.252***	(2.60)	–1.073***	(–4.32)	0.230**	(2.13)	–1.467***	(–3.52)	0.417***	(2.97)
Adverse working condit.	0.198***	(4.76)	0.055**	(2.57)	0.255***	(4.72)	0.066**	(2.59)	0.328***	(4.17)	0.080**	(2.26)
Tenure (1 – 2 years)	1.505***	(3.03)	0.668***	(3.09)	1.280***	(3.79)	0.614***	(3.11)	0.754	(1.34)	0.444*	(1.70)
Tenure (3 – 14 years)	2.271***	(3.66)	0.830***	(3.61)	2.006***	(4.84)	0.679***	(3.26)	1.482**	(2.10)	0.490*	(1.86)
Tenure (≥ 15 years)	2.152***	(3.04)	1.153***	(4.81)	1.996***	(4.00)	0.980***	(4.20)	0.991	(1.25)	0.916***	(2.80)
Private sector	–0.919***	(–4.96)	0.036	(0.49)	–0.903***	(–4.84)	0.058	(0.69)	–1.432***	(–6.30)	0.055	(0.51)
Temporary contract	–1.045***	(–2.95)	0.003	(0.02)	–0.771***	(–2.99)	–0.062	(–0.48)	–1.631***	(–4.06)	0.030	(0.15)
Part time (10 – 30h)	–0.908**	(–2.23)	–0.174	(–0.84)	–0.658	(–1.64)	–0.050	(–0.25)	–0.712	(–1.33)	0.025	(0.08)
Size (10 – 49 employees)	0.760***	(3.54)	0.102	(0.86)	0.813***	(3.68)	0.175	(1.46)	1.161***	(3.93)	0.124	(0.74)
Size (50 – 99 employees)	0.696**	(2.37)	0.071	(0.54)	0.621**	(2.22)	0.027	(0.22)	0.669*	(1.70)	–0.059	(–0.33)
Size (100 – 249 employees)	1.058***	(3.29)	0.326**	(2.11)	1.146***	(3.19)	0.348**	(2.09)	1.347***	(3.03)	0.269	(1.27)
Size (>250 employees)	1.332***	(3.98)	0.171	(1.40)	1.413***	(4.02)	0.181	(1.42)	1.726***	(3.93)	0.002	(0.01)
Work autonomy	–0.089	(–1.07)	0.185***	(3.90)	–0.056	(–0.65)	0.211***	(4.65)	–0.247**	(–2.05)	0.236***	(3.95)
Lack of time	–0.114	(–1.03)	0.114***	(3.24)	–0.123	(–0.97)	0.144**	(2.62)	–0.240	(–1.50)	0.181***	(3.04)
Production targets	–0.106	(–0.59)	0.173***	(2.66)	0.087	(0.41)	0.205**	(2.71)	–0.290	(–1.19)	0.209**	(2.17)
Performance assessment	0.062	(0.27)	0.200***	(2.66)	0.062	(0.24)	0.236**	(2.17)	–0.299	(–0.87)	0.175	(1.41)

Social support	–0.020	(–0.35)	–0.086***	(–3.91)	–0.055	(–0.87)	–0.107***	(–4.94)	0.012	(0.13)	–0.128***	(–3.65)
Blue collar	0.253	(1.05)	–0.200**	(–2.26)	0.273	(1.00)	–0.177*	(–1.77)	0.673*	(1.76)	–0.193	(–1.22)
Piece rate	0.090	(0.38)	–0.090	(–0.92)	0.070	(0.25)	–0.089	(–0.88)	0.252	(0.57)	–0.067	(–0.38)
Control variables	Yes		Yes		Yes		Yes		Yes		Yes	
N	18804		18804		16585		16585		11656		11656	
*R*2					0.12		0.14		0.11		0.12	

Source: 2010-EWCS, own calculations.

Notes: Average marginal eects from Poisson regression in Columns (1) and (2), coeficient estimates from OLS regressions in Columns (3)-(6). The dependent variables are the number of sickness absence days in columns (1), (3) and (5) and the number of sickness presenteeism days in column (2), (4) and (6), both including those with zero days. All variables shown in the table except *adverse working conditions, lack of time, work autonomy, social support* are dummies (see Table 1 for descriptive statistics). Sociodemographic variables as well as country and industry dummies are included as control variables but are not shown. The sociodemographic controls comprise sex, having children, partnership status, age categories, financial problems and educational status. The health control variables include self rated health status (3 dummies), 14 dierent symptoms and diseases from which the respondent suffered during the last 12 months as well as an index measuring mental health. The first two estimations rely on the full sample of 18,804 observations. Columns (3) and (4) rely on the observations from the EU-27 countries, i.e. 16,585 observations, and columns (5) and (6) rely only on observations that have at least one sickness day, be it absence or presenteeism (11,656 observations). T-statistics based on standard errors clustered on the country level are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$

5. Conclusion

How are work-related factors simultaneously related to sickness absence and presenteeism? To address this question, we explore a theoretical and empirical analysis. Using cross-sectional data from the EWCS, we find in OLS regressions that only three out of 17 work-related factors, namely supervisor status, over time and flexible working time, show a substitutive relationship between absence and presenteeism. This finding is at odds with the predominant view in the literature that presenteeism behavior is simply the residuum of sickness absence. In addition, there are also only two work-related factors, namely working conditions and tenure, for which a complementary relationship between both sickness states can be observed.

The bulk of work-related factors is only related to one of the sickness states while leaving the other unaffected. This finding shows that it might be possible to reduce either absence or presenteeism without shifting the negative productivity effect of sickness to the other sickness state, hence possibly raising the overall number of unimpaired working days. Finally, we are able to identify situations which are associated with absenteeism and that would benefit from according measures. This is the case for employees in the public sector, in larger firms and with open-ended contracts who are associated with more absence but not fewer presenteeism days. Our results are remarkably robust against SUR models, count data models and in differently defined subsamples.

In our theoretical model, we show that non-substitutive relationships between absences and presenteeism (with respect to work-related factors) can be explained by shifts in the individual-specific definition of sickness. If, for instance, a change in one work-related factor implies more absence days, this would, c.p., be combined with reduction of presenteeism days. This effect interacts, however, with a change in the sickness definition. If the same work-related factor implies that individuals consider more health shocks as sick, presenteeism days would, c.p., increase. If the latter effect is strong enough, absence and presenteeism days could simultaneously rise with respect to the work-related factor. Presenteeism days remain unchanged if the aforementioned effects cancel out or if there is absenteeism. If, in turn, the sickness definition changes but the individuals' absence decision does not vary, only presenteeism days will adjust. The fact that the non-substitutive relationship between absence and presenteeism is the dominant empirical finding thus indicates the importance of the individual-specific sickness definition.

From a management perspective, our results indicate that a policy which aims to reduce absence days of the workforce can but may not necessarily increase presenteeism days at the same time. According to our findings, an improvement of working conditions, for example, reduces absence and presenteeism days such that an increase in the productivity of the workforce is

quite likely. In contrast, longer tenure is correlated with both higher absence and presenteeism days which could incur a negative productivity effect. From this perspective, higher turnover might be beneficial for the firm. However, these implications must be taken cautiously because we cannot identify causal effects with the data at hands. This shortcoming should be addressed in future work.

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Appendix

As in the main text, we assume that δ is randomly distributed over the interval $[0, 1]$ with the density $f(\delta)$, where we suppress the index i for notational simplification. The distribution function is denoted by $F(\delta)$, with $F(0) = 0$, $F(1) = 1$ and $\partial F / \partial \delta > 0$. The probability of absence reads:

$$A = F(\theta < \delta < 1) = 1 - F(\theta),$$

which implies:

$$(A.1) \qquad \frac{\partial A}{\partial \theta} = -\frac{\partial F}{\partial \theta} < 0.$$

The probability of presenteeism is given by:

$$P = F(\phi < \delta < \theta) = F(\theta) - F(\phi),$$

which leads to:

$$(A.2) \qquad \frac{\partial P}{\partial \theta} = \frac{\partial F}{\partial \theta} > 0 \quad \text{and} \quad \frac{\partial P}{\partial \phi} = -\frac{\partial F}{\partial \phi} < 0.$$

With (A.1) and (A.2) at hand, we can rewrite (11) as:

$$(A.3) \qquad dA = \underbrace{\frac{\partial A}{\partial \theta}}_{<0} d\theta > (\leq)\, 0 \Leftrightarrow d\theta < (\geq)\, 0.$$

If $d\theta < 0$ (and thus $dA > 0$) holds, we get from (12):

$$(A.4) \qquad dP = \underbrace{\frac{\partial P}{\partial \theta}}_{>0} \underbrace{d\theta}_{<0} + \underbrace{\frac{\partial P}{\partial \phi}}_{<0} d\phi < 0 \Leftrightarrow d\phi \geq 0 \text{ or } d\phi < 0 \text{ and } |\Gamma_1| > |\Gamma_2|,$$

$$(A.5) \qquad dP = \underbrace{\frac{\partial P}{\partial \theta}}_{>0} \underbrace{d\theta}_{<0} + \underbrace{\frac{\partial P}{\partial \phi}}_{<0} d\phi \geq 0 \Leftrightarrow d\phi < 0 \text{ and } |\Gamma_1| \leq |\Gamma_2|,$$

with $\Gamma_1 \equiv (\partial P/\partial \theta)d\theta$ and $\Gamma_2 \equiv (\partial P/\partial \phi)d\phi$. If instead $d\theta \geq 0$ (and thus $dA \leq 0$) holds, we find [see (13)]:

$$(A.6) \qquad dP = \underbrace{\frac{\partial P}{\partial \theta}}_{>0} \underbrace{d\theta}_{\geq 0} + \underbrace{\frac{\partial P}{\partial \phi}}_{<0} d\phi > 0 \Leftrightarrow d\phi \leq 0 \text{ or } d\phi > 0 \text{ and } |\Gamma_1| > |\Gamma_2|,$$

$$(A.7) \qquad dP = \underbrace{\frac{\partial P}{\partial \theta}}_{>0} \underbrace{d\theta}_{\geq 0} + \underbrace{\frac{\partial P}{\partial \phi}}_{<0} d\phi \leq 0 \Leftrightarrow d\phi > 0 \text{ and } |\Gamma_1| \leq |\Gamma_2|.$$

Observing (A.4) and (A.6), we find that presenteeism and absnce are substitutes (i) if the variations in θ and ϕ are oppositional or (ii) if the changes of θ and ϕ have the same sign but the weighted (absolute) change in ϕ is sufficiently weak. This finding corresponds with Proposition 1. In addition, (A.5) and (A.7) imply that presenteeism and absence are complements if the changes in θ and ϕ have the same sign and the weighted (absolute) change in ϕ is sufficiently strong. This confirms Proposition 2. Finally, (A.5) and (A.7) also show that presenteeism and absence are neither substitutes nor complements (i) if θ remains constant while ϕ changes or (ii) if the weighted changes in θ and ϕ are identical, which is equivalent to Proposition 3.