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# Sickness absence, presenteeism and work-related characteristics

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## Abstract

This paper investigates how changes in work-related factors affect workers' absence and presenteeism behavior. Previous studies (implicitly) assume that there is a substitutive relationship – specifically, that a change in a work-related factor that decreases the level of absence 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 critical level of sickness that defines presenteeism. Our model shows that non-substitutive relationships between absence and presenteeism are also conceivable. Using European cross-sectional data, we find only one substitutive and few complementary relationships, while the bulk of the work-related characteristics are related only to one of the two sickness states.

*Keywords: Sickness absence, absenteeism, presenteeism, annual duration, work-related characteristics, health at work*

*JEL: J22 J28 I1 M50*

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# 1 Introduction

It is well established that sickness absence and presenteeism – that is, going to work while sick, have negative economic effects through reduced or less productive labour 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 the same factor might influence absence *and* presenteeism behavior at the same time is neglected.<sup>1</sup> Albeit of this lack of empirical evidence on the interrelationship between both sickness states with regards to their determinants, some studies suggest a substitutive relationship between both sickness states. This means that a determinant which reduces absence is assumed to increase presenteeism (and vice versa). This proposition is presented rather implicitly by describing both sickness states as the result of the same decision process (Aronsson and Gustafsson, 2005; Brown and Sessions, 2004) or by deducing hypotheses for determinants of presenteeism negatively from the literature on absence (Bierla et al., 2013). Hence, there is a vague consensus that absence and presenteeism have a substitutive relationship which is neither explicitly theoretically derived, nor comprehensively empirically investigated.

In this paper, we contribute to the existing literature by analyzing the interrelation between sickness absence and presenteeism in a more explicit and comprehensive manner. This topic is highly relevant for (personnel) managers and policy makers, since it clearly makes a difference whether a measure aimed at reducing absence days is associated with more, unchanged or even fewer presenteeism days. While a decline in absence 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 (see Schultz and Edington, 2007, for a survey on the productivity effects of presenteeism). 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 particular true for factors that managers and policy makers can directly influence. In our investigation, we therefore focus on work-related characteristics (e.g. contract type, workload, autonomy and others) which are at least partially under manager’s (and to a smaller degree under policy maker’s) control and analyze how they are related to absence and presenteeism behaviour.

When investigating the impact of work-related characteristics on sickness absence and presenteeism, we distinguish three possible interrelations between the two sickness states: (i) If a change in one work-related factor leads to a change in absence and presenteeism in the opposite direction, we find a substitutive relationship between both sickness states with respect to this work-related factor. (ii) If a change in one work-related factor implies a change

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<sup>1</sup>Only three studies investigate both sickness states at once, and these will be discussed in more detail below (Böckerman and Laukkanen, 2009, 2010; Johansson and Lundberg, 2004). In contrast there is a bulk of literature that investigates either sickness absence or presenteeism behaviour. While the former also includes economic studies (for an early survey article, see Brown and Sessions, 1996; for literature using European cross-country data, see Frick and Malo, 2008; Livanos and Zangelidis, 2013; Lusinyan and Bonato, 2007), the latter is mostly from social medicine (Arnold, 2014; Aronsson et al., 2000; Aronsson and Gustafsson, 2005; Böckerman and Laukkanen, 2009; Hansen and Andersen, 2008, 2009; Leineweber et al., 2011; Preisendörfer, 2010).

in absence and presenteeism in the same direction, we find a complementary relationship between both sickness states with respect to this work-related factor. (iii) If a change in one work-related factor affects only one of the sickness states while leaving the other constant, we find no relationship between them with respect to this work-related factor. Summing up, we ask whether work-related factors lead to a substitutive, a complementary or no relationship between absence and presenteeism. To find an answer to this question, we proceed with a two-step approach. First, we build a theoretical model that highlights mechanisms through which both sickness states can be affected at the same time. Second, we make use of a rich data set in which indicators for sickness absence and presenteeism are compiled in one survey. With these data at hand, we are able to *simultaneously* analyze determinants of sickness absence and presenteeism and hence take explicitly into account their interdependence.

In our theoretical model, the worker's utility of being attendant negatively depends on their sickness intensity. Accordingly, we can show that if the sickness level of an individual exceeds a certain threshold, s/he decides to stay at home. Hence, we call this threshold the individual critical level of sickness, which – and this is important – depends (among others) on work-related characteristics (see Brown and Sessions, 2004 for a similar approach). Moreover, we also present a formal definition of presenteeism. The crucial mechanism (which is not explicitly considered in the literature so far) behind this definition is that a worker's sickness level does not only negatively affect her/his utility level but also the firm's profit situation. If the worker's sickness level exceeds a certain threshold, it is profit-maximizing for the firm that the worker stays at home. We call this threshold the firm critical level of sickness. Then, presenteeism is defined as a situation where the worker decides to be attendant at the workplace despite the fact that her/his attendance reduces the firm's profit – in other words, her/his sickness level is higher than the firm critical level (compare Chatterji and Tilley (2002), for a similar definition).<sup>2</sup> Since work-related factors influence the impact of sickness on the firm's profit situation, the firm critical level of sickness and thus presenteeism are also functions of the work-related factors.

There are two benefits from our theoretical analysis. First, we find that the relationship between absence and presenteeism with regard to a work-related characteristic is not necessarily of a substitutive nature, as is commonly assumed in the literature. Indeed, the interrelation of both sickness states is more complex as work-related characteristics do not only affect the worker's absence decision but also the firm's costs of the worker's attendance while sick as stated above. Second, we derive conditions under which work-related factors lead to a substitutive, a complementary or no relationship between sickness absence and presenteeism. These conditions depend on the sign and the magnitude of the changes in the firm and/or the individual critical level of sickness brought about by changes in the work-related characteristics. With this at hand, we are able to identify the underlying mechanism for the variation in sickness absence and presenteeism behaviour, which in particular guides our understanding of the empirical findings.

In our empirical investigation, we estimate 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

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<sup>2</sup>Notably, we assume that the firm cannot observe the true sickness level of the individual. Hence, the firm is not able to prevent presenteeism in its workforce.

34 European countries. This allows us to relate in OLS regressions 16 different work-related characteristics of more than 18,000 employees to their sickness absence and presenteeism behaviour.<sup>3</sup> Since there is no panel data on presenteeism available, we cannot deliver causal analysis of the interrelation between absence and presenteeism behaviour, but our empirical investigation offers several improvements in other dimensions. First, we comprehensively cover work-related characteristics instead of only two as in Johansson and Lundberg (2004), which reduces omitted variable bias. Second, absence and presenteeism are measured more accurately in numbers of days per year instead of arbitrarily set frequency categories (Johansson and Lundberg, 2004) or incidence measures (Böckerman and Laukkanen, 2009, 2010). A (potentially) substitutive relationship between absence and presenteeism should be felt more strongly when measured in days than in frequency categories or in binary measures. Third, we use data that is representative for each European country and Europe as a whole instead of samples from Stockholm county (Johansson and Lundberg, 2004) or from Finnish trade union members (Böckerman and Laukkanen, 2009, 2010). Accordingly, our results have better external validity. Finally, covering relationships with both sickness states, we are able to see whether factors reducing absence days come at the price of more presenteeism. This is particularly an advantage over causal studies that investigate moral hazard effects in absence behaviour such as Puhani and Sonderhof (2010) and Ziebarth and Karlsson (2010), since they are not able to discern whether the changed moral hazard effect entails changes in presenteeism. Hence, their normative conclusions must be taken cautiously.

The main results are as follows: (i) We find that only one work-related factor (namely the supervisor status) leads 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. (ii) There are only two work-related factors (namely working conditions and tenure) which lead to a complementary relationship between absence and presenteeism. While an improvement of working condition is accompanied with a reduction of both absence and presenteeism, an increase in tenure is positively correlated with both sickness states. (iii) The bulk of the considered work-related characteristics is only related to one of the two sickness states while leaving the other unchanged. From a managerial and policy perspective, this shows that it is possible to reduce absence without negative side-effects on presenteeism or to reduce presenteeism without the threat of higher absence. The former case could be interpreted as a situation in which the absence is – at least partially – not due to health problems. According to our results, this can be observed in the public sector, in large firms and for employees with an open-ended contract. Our results are robust against count data models and in differently defined subsamples.

How can we explain these results? Our theoretical model shows that if a change in a work-related factor only influences the absence/attendance decision of individuals and hence the individual critical level of sickness, absence and presenteeism are indeed substitutes with respect to the changing factor. To put it differently, both sickness states are then determined by the same decision process – as is also argued in the literature (see above). But since

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<sup>3</sup>Specifically, we look at supervisory and blue collar status, temporary contracts, tenure categories, weekly working hours, whether working in a second job and during evenings or weekends, net income, firm size, private sector employment, work interdependence, work autonomy, job insecurity, satisfaction with working conditions, support by coworkers and the management, and time pressure.

this substitutive relationship is rarely observed in the empirical investigation, there must be a second channel through which at least one sickness state is affected. Taking up the lessons from our model, this channel is given by the influence of work-related factors on the firm critical level of sickness which in turn defines presenteeism. Hence, our theoretical model is able to explain the none-substitutive relationships between sickness absence and presenteeism thanks to the endogenous firm critical level of sickness, which is its major innovation.

Regarding the related literature, there are few studies empirically looking at both sickness states and even fewer focusing on the interrelation between them. 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 and Laukkanen, 2009, 2010). In their first study, Böckerman and Laukkanen (2009) 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 (Böckerman and Laukkanen, 2010), while the other is only correlated with presenteeism. The match between desired and actual working hours are associated with less sickness absence and presenteeism, whereas a strong emphasis of efficiency in the work place increases presenteeism. However, the data set used is not representative for the Finish workforce since it comprises only a small sample of Finnish trade union members.

Johansson and 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 exclude all respondents that report neither absence nor presence behaviour since they want to investigate the decision between absence and presence behaviour (‘illness flexibility’). 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 convincingly address potential omitted variable bias.

In addition, our paper is also related to the theoretical analysis on sickness absence and presence behaviour by Brown and Sessions (2004). In this study, the authors enhance the Barmby et al. (1994) model of absenteeism by including sickness presenteeism into their shirking model. While our model is inspired by their model, we depart in three ways. We do not focus on shirking and detection technology since we cannot directly discern shirking from legitimate absence in our data. More importantly, we expand their model by defining presenteeism through the firm critical level of sickness. Finally, we focus on the interrelation between sickness absence and presenteeism, which is not done in their study.

The remainder of our paper is structured as follows. In section two, we present our

theoretical model and derive conditions for the existence of a substitutive, a complementary or no relationship between sickness absence and presenteeism. The empirical analysis is conducted in section three. Section four concludes.

## 2 Theoretical Model

### 2.1 Preliminaries

In this section, we build a model that formalizes the absence/attendance decision of individuals and shows under which conditions presenteeism is conceivable. There are three properties of our model. First, we consider the behaviour of individual  $i$  who is employed at firm  $j$ . By assumption, there is a contract between both which specifies the wage rate  $w_{ij} > 0$  and the working hours per day  $h_{ij} > 0$ . In addition to individual  $i$ , the firm employs an exogenously given number of individuals  $N_{-i,j}$ .

Second, we assume that the employment relationship between individual  $i$  and firm  $j$  is characterized by several work-related factors, such as tenure, contract type and others, which are the focus of our investigation. In order to keep our framework as general as possible, we use  $X_{ij}$  as a vector that subsumes all relevant work-related factors in the employment relationship between  $i$  and  $j$ .

Third, the individual is confronted with health shock  $\delta_i$ . We assume that  $\delta_i$  is randomly distributed over the interval  $[0, 1]$  with the density  $f(\delta_i)$  and increases in the severity of sickness (see Brown and Sessions, 2004, for a similar approach). Since the health state has an impact on the worker's utility, s/he decides conditional on  $\delta_i$  whether s/he will be absent from the workplace (absence) or attendant at the workplace (attendance). There is an individual critical level of sickness,  $\tilde{\delta}_{ij}$ , at which s/he is indifferent between absence and attendance. If the revealed health state exceeds (falls short of)  $\tilde{\delta}_{ij}$ , the individual is absent (attendant). Notably, we assume that  $\delta_i$  is private information to the individual  $i$ .

The timing structure of our model is as follows: First, individual  $i$  and firm  $j$  sign a contract by assumption. Second, the individual formulates a decision rule for being attendant or absent – that is, determines the threshold level  $\tilde{\delta}_{ij}$ . Third, the realization of the health shock is drawn, and the individual goes to work or stays at home in accordance with the formulated decision rule. We exclude the possibility of re-contracting after the state of health is revealed. Finally, production takes place. Note that the health shock recurs on a daily basis, implying that the individual renews her/his absence/attendance decision every day.

### 2.2 Absence/attendance decision

Under which conditions does individual  $i$  decide to be absent (attendant) from (at) the workplace? To find the answer to this question, we first have to introduce the individual's utility functions. For notational simplicity, we drop the indices  $i$  and  $j$  in the following.

The individual's realized utility can either be  $U^h$  in the case of attendance or  $U^a$  in the case of absence. Formally, we assume:

$$U^h = (1 - \delta) \cdot u^h(w, T - h, X), \quad (1)$$

$$U^a = u^a(s, T, X), \quad (2)$$

where  $T$  stands for the individual endowment in time and  $s$  ( $0 \leq s \leq w$ ) 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 concave in  $w$ ,  $(T - h)$ ,  $s$  and  $T$  with  $\partial u^h / \partial w > 0$ ,  $\partial u^h / \partial (T - h) > 0$ ,  $\partial u^a / \partial s > 0$  and  $\partial u^a / \partial T > 0$ . Note further that the higher the level of sickness  $\delta$ , the lower the utility of being attendant. Intuitively, an increasing  $\delta$  implies a rise in the worker's disutility of working, and thus the overall utility of being attendant drops.<sup>4</sup>

Regarding the vector  $X$ , the sign of the partial derivatives depends on the respective work-related factor. For example, if job insecurity increases,  $u^h$  might decline, while the reverse could be true in the case of an improvement in working conditions. In addition, we assume  $u^h \neq u^a$  so that work-related factors can influence the utility of being attendant and of being absent with different sign and intensity.

With this at hand, we can derive the individual critical level of sickness,  $\tilde{\delta}$ , at which the individual is indifferent between attendance or absence. Formally, this requires  $U^h(\delta = \tilde{\delta}) = U^a$ . Using (1) and (2), we obtain:

$$\tilde{\delta} = 1 - \frac{u^a(s, T, X)}{u^h(w, T - h, X)}, \quad (3)$$

where we assume that  $0 \leq u^a(s, T, X) \leq u^h(w, T - h, X)$  holds in order to ensure  $0 \leq \tilde{\delta} \leq 1$ . Intuitively, this condition should hold in any cases because otherwise the individual would never be attendant at the workplace and the contract would be thus misspecified. After the health state  $\delta$  of the individual is revealed, s/he chooses to be attendant on this day if  $\delta \leq \tilde{\delta}$  holds; otherwise ( $\delta > \tilde{\delta}$ ), s/he chooses to be absent. Recall that this decision is made on a daily basis since the health shock takes place every day. Note also the individual critical level of sickness  $\tilde{\delta}$  (and thus her/his attendance-absence decision) depends on  $X$ , implying that it is influenced by work-related factors.

Since the individual knows her/his critical level of sickness  $\tilde{\delta}$  before the health state is revealed, it is possible to calculate the probability that the individual will be absent from the work-place on a given day. Formally, the probability of absence is given by  $A = \Pr(\tilde{\delta} < \delta < 1) = F(\tilde{\delta} < \delta < 1)$ , where  $F(\delta)$  denotes the distribution function of  $\delta$ . Using the simplifying assumption of a uniform distribution<sup>5</sup>  $F(\delta) = \delta$ , we obtain:

$$A = 1 - \tilde{\delta}. \quad (4)$$

Eq. (4) shows that if the individual critical level of sickness increases (decreases), the probability of being absent on a given day decreases (increases). Of course, the probability

<sup>4</sup>Since we are interested in explicitly deriving the individual critical level of sickness  $\tilde{\delta}$  (see below), we model the health state as an additive-separable argument in (1). The alternative approach – that is, using the implicit form  $u^h(\delta)$  with  $\partial u^h(\delta) / \partial \delta < 0$ , makes it impossible to calculate  $\tilde{\delta}$  in an explicit form.

<sup>5</sup>We use the uniform distribution in order to hold our model as simple as possible. Note that our qualitative results are not affected by this assumption. If we would use instead the general form of the distributional function  $F(\delta)$ , our qualitative findings would hold since we have  $\partial F / \partial \delta > 0$ .



of being attendant on a given day is simply given by  $H = 1 - A$ .

### 2.3 Presenteeism

So far, we have analyzed the consequences of the health shock on the individual's utility and derived her/his absence/attendance decision. One conclusion is that in the case of a relatively high individual critical sickness level  $\tilde{\delta}$ , it is possible that the individual chooses to be attendant at the workplace despite a relatively bad realization of the health shock – in other words, a high  $\delta$ . Such a scenario is described by presenteeism in the literature, where individuals work despite the fact that they are sick (see Arnold, 2014; Brown and Sessions, 2004; Chatterji and Tilley, 2002).

In this subsection, we use our model to give a formal definition of presenteeism. The crucial mechanism is that the health state of the individual also has an impact on the firm's profit situation. As we will show below, the firm's profit decreases in the level of the individual's sickness in the case of her/his attendance. This might be through the reduced productivity of the worker itself but also due to its effects on others – for example, team production or infection of co-workers. If the sickness level of the individual  $\delta$  exceeds a certain threshold denoted by  $\bar{\delta}$ , it is profit-maximizing for the firm that the individual is absent. Hence, we call the threshold  $\bar{\delta}$  firm critical level of sickness in the following. Importantly, this firm critical level of sickness depends on the work-related characteristics since the impact of sickness on profits differs between different jobs and is hence a function of the vector  $X$ .

To formally calculate  $\bar{\delta}$ , we have to specify the firm's profit function. We define  $\Pi^h$  as the firm's profit in the case of the individual's attendance, while  $\Pi^a$  stands for the profit in the case of the individual's absence. For both, we assume, respectively:

$$\Pi^h = (1 - \delta) \cdot \pi^h(h, w, X, Y) \geq 0, \quad (5)$$

$$\Pi^a = \pi^a(s, X, Y) > 0. \quad (6)$$

The variable  $Y > 0$  stands for the profit which the firm earns through the employment of the other  $N$  workers – that is, without the consideration of individual  $i$ . The sub-profit functions  $\pi^h$  and  $\pi^a$  are concave in their arguments with  $\partial\pi^h/\partial h > 0$ ,  $\partial\pi^h/\partial w < 0$ ,  $\partial\pi^h/\partial Y > 0$ ,  $\partial\pi^a/\partial s < 0$  and  $\partial\pi^a/\partial Y > 0$ . The sign of the partial derivatives of  $X$  depends (as for the utility functions) on the specific work-related factor considered. We also assume  $\pi^h \neq \pi^a$  to capture the fact that the same work-related factor might have a different impact on the firm's profit in the case of attendance than in the case of absence.

Importantly,  $\Pi^h$  is a negative function of the individual's sickness level  $\delta$ . One explanation is that an increasing sickness level has a negative effect on the individuals's productivity – particularly in the future due to a lack of recuperation (cf. Bergström et al., 2009) – which in turn decreases the firm's profit. It can also be the case that the sickness of individual  $i$  creates negative externalities either through infection of other employees (Barmby and Larguem, 2009) or through production interdependencies (team production), which also reduces the firm's profit (Pauly et al., 2008). Note that the formulation in (5) pushes this

argument to the extreme: If the individual has the highest level of sickness,  $\delta = 1$ , the firm's profit drops to zero.<sup>6</sup>

With this at hand, we can compute the firm critical level of sickness  $\bar{\delta}$  at which the firm is indifferent in regards to the individual's attendance or her/his absence. Formally, this requires  $\Pi^h(\delta = \bar{\delta}) = \Pi^a$ . Inserting (5) and (6) yields:

$$\bar{\delta} = 1 - \frac{\pi^a(s, X, Y)}{\pi^h(h, w, X, Y)}, \quad (7)$$

where we assume that  $\pi^a(s, X, Y) \leq \pi^h(h, w, X, Y)$  holds to ensure that  $0 < \bar{\delta} \leq 1$ . There is also an economic justification for this condition, since an employment contract should be specified in a way that attendance increases profits if the employee is healthy ( $\delta = 0$ ); otherwise, the contract would not have been concluded in the first place. Recall the interpretation of the firm critical level of sickness: If  $\delta \leq \bar{\delta}$  holds, the attendance of the individual is desired; otherwise ( $\delta > \bar{\delta}$ ), the firm prefers the absence of the individual. Note that the firm cannot observe  $\delta$  due to our assumption that this is the individual's private information.

Given the individual critical level of sickness  $\tilde{\delta}$  and the firm critical level of sickness  $\bar{\delta}$ , we are able to give a formal definition of presenteeism. Suppose that  $\tilde{\delta} > \bar{\delta}$  holds and that the realized health state of the individual lies in the interval  $\bar{\delta} < \delta < \tilde{\delta}$ . As a consequence, s/he chooses to be attendant at the workplace since  $\delta$  is smaller than her/his critical level of sickness. From the firm's perspective, the individual is sufficiently sick and should therefore stay at home. We define this situation ( $\bar{\delta} < \delta < \tilde{\delta}$ ) as *presenteeism* of the individual. 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  $P = \Pr(\bar{\delta} < \delta < \tilde{\delta}) = F(\bar{\delta} < \delta < \tilde{\delta})$ . Again using  $F(\delta) = \delta$ , we obtain:

$$P = \tilde{\delta} - \bar{\delta}. \quad (8)$$

Finally, suppose that instead  $\tilde{\delta} < \bar{\delta}$  holds. Then, a health shock realization of  $\tilde{\delta} < \delta < \bar{\delta}$  implies that the individual chooses to be absent, while s/he is not sufficiently sick from the firm's perspective and should therefore be attendant. We define this situation as *absenteeism* of the individual. Note, however, that in a situation where absenteeism is possible – that is  $\tilde{\delta} < \bar{\delta}$ , there is no presenteeism by definition.

## 2.4 Substitutes, complements or neither

Our model shows that the probabilities of absence and of presenteeism depend on the individual critical level of sickness  $\tilde{\delta}$  and on the firm critical level of sickness  $\bar{\delta}$  [see (4) and (8)]. In turn,  $\tilde{\delta}$  and  $\bar{\delta}$  are affected by variations in work-related factors which are summarized in the vector  $X$  [see (3) and (7)]. 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

<sup>6</sup>An alternative modeling approach would be to assume that  $\pi^h$  depends directly on  $\delta$ :  $\partial \pi^h / \partial \delta < 0$ . However, we then would not be able to find an explicit solution for  $\bar{\delta}$ . Thus, we use the formulation in (5) throughout.

– influence *both* the probability of absence and the probability of presenteeism per day?<sup>7</sup>

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.<sup>8</sup>

To determine under which conditions a change in work-related factor  $x$  leads to a substitutive, a complementary or no relationship between absence and presenteeism, recall first that variations of  $x$  influence  $\tilde{\delta}$  and  $\bar{\delta}$ . Using (4), we can show that the probability of absence increases (decreases) when  $\tilde{\delta}$  decreases (increases):

$$dA = \underbrace{\frac{\partial A}{\partial \tilde{\delta}}}_{=-1} d\tilde{\delta} > (<) 0 \Leftrightarrow d\tilde{\delta} < (>) 0. \quad (9)$$

Regarding the probability of presenteeism, (8) indicates that changes in  $\tilde{\delta}$  and  $\bar{\delta}$  influence  $P$ . If  $d\tilde{\delta} < 0$  (and thus  $dA > 0$ ) holds, we get:

$$dP = \underbrace{\frac{\partial P}{\partial \tilde{\delta}}}_{=1} \underbrace{d\tilde{\delta}}_{<0} + \underbrace{\frac{\partial P}{\partial \bar{\delta}}}_{=-1} d\bar{\delta} < (>) 0 \Leftrightarrow d\bar{\delta} \geq 0 \text{ or } d\tilde{\delta} < d\bar{\delta} < 0 \text{ (} d\bar{\delta} \leq d\tilde{\delta} < 0 \text{)}. \quad (10)$$

If  $d\tilde{\delta} \geq 0$  (and thus  $dA \leq 0$ ) holds, we find:

$$dP = \underbrace{\frac{\partial P}{\partial \tilde{\delta}}}_{=1} \underbrace{d\tilde{\delta}}_{\geq 0} + \underbrace{\frac{\partial P}{\partial \bar{\delta}}}_{=-1} d\bar{\delta} > (<) 0 \Leftrightarrow d\bar{\delta} \leq 0 \text{ or } 0 < d\bar{\delta} < d\tilde{\delta} \text{ (} 0 < d\tilde{\delta} \leq d\bar{\delta} \text{)}. \quad (11)$$

With these conditions at hand, we obtain the following propositions.

**Proposition 1** *Presenteeism and absence are substitutes with respect to a work-related factor  $x$  (i) if the variations in  $\tilde{\delta}$  and  $\bar{\delta}$  are oppositional or (ii) if the changes of  $\tilde{\delta}$  and  $\bar{\delta}$  have the same sign but the (absolute) change in  $\bar{\delta}$  is sufficiently weak.*

**Proof.** A substitutional relationship requires  $dA > (<) 0$  and  $dP < (>) 0$ . From (9), we obtain  $dA > (<) 0 \Leftrightarrow d\tilde{\delta} < (>) 0$ . For  $d\bar{\delta} \geq (<) 0$ , (10) and (11) show that  $dP < (>) 0$  holds, which proves part (i) of the proposition. Eqs. (10) and (11) indicate that  $dP < (>) 0$  also holds if the absolute change in  $\bar{\delta}$  is lower than the absolute change in  $\tilde{\delta}$ :  $d\tilde{\delta} < d\bar{\delta} < 0$  ( $0 < d\bar{\delta} < d\tilde{\delta}$ ). This proves part (ii) of the proposition. ■

<sup>7</sup>Since we are not able to discern illegitimate absenteeism from legitimate absence in our empirical investigation, we do not analyze the effect of work-related factors on absenteeism.

<sup>8</sup>Note that we use the statement “absence and presenteeism are substitutes (complements) with respect to the changing work-related factor” as a synonym for case 1 (2). In the third case, we also formulate that “absence and presenteeism are neither substitutes nor complements with respect to the changing work-related factor”.

**Proposition 2** *Presenteeism and absence are complements with respect to a work-related factor  $x$  if the changes in  $\tilde{\delta}$  and  $\bar{\delta}$  have the same sign and the (absolute) change in  $\bar{\delta}$  is sufficiently strong.*

**Proof.** A complementary relationship requires  $dA > (<)0$  and  $dP > (<)0$ . Eq. (9) implies that  $dA > (<)0 \Leftrightarrow d\tilde{\delta} < (>)0$ . Observing (10) and (11), we find that  $dP > (<)0$  holds if the absolute change in  $\bar{\delta}$  is higher than the absolute change in  $\tilde{\delta}$ :  $d\bar{\delta} < d\tilde{\delta} < 0$  ( $0 < d\tilde{\delta} < d\bar{\delta}$ ).

■

**Proposition 3** *Presenteeism and absence are neither substitutes nor complements with respect to a work-related factor  $x$  (i) if  $\tilde{\delta}$  remains constant while  $\bar{\delta}$  changes or (ii) if the changes in  $\tilde{\delta}$  and  $\bar{\delta}$  are identical.*

**Proof.** There is no relationship between absence and presenteeism if  $dA = (\neq)0$  and  $dP \neq (=)0$  holds. From (9), we obtain  $dA = (\neq)0 \Leftrightarrow d\tilde{\delta} = (\neq)0$ . Given  $d\tilde{\delta} = 0$ , Eqs. (10) and (11) imply that  $dP \neq 0 \Leftrightarrow d\bar{\delta} \neq 0$ , which proves part (i) of the proposition. If  $d\tilde{\delta} \neq 0$  holds, we see from (10) and (11) that  $d\tilde{\delta} = d\bar{\delta}$  must hold in order to ensure  $dP = 0$ , which proves part (ii) of the proposition. ■

These findings are based on the assumption  $\tilde{\delta} > \bar{\delta}$ . However, it can be the case that the reverse relation is true:  $\tilde{\delta} < \bar{\delta}$ . As discussed in the previous subsection, there is then no presenteeism by definition, and we normalize its probability to zero:  $dP \equiv 0 \Leftrightarrow \tilde{\delta} < \bar{\delta}$ . Note that in this scenario, the probability of absenteeism is positive. Hence, we arrive at the following proposition:

**Proposition 4** *Presenteeism and absence are neither substitutes nor complements with respect to a work-related factor  $x$  if  $\tilde{\delta} < \bar{\delta}$  holds.*

Summing up, there are three lessons from our model. First, the absence/attendance decision is solely determined by the individual critical level of sickness. Second, we find that presenteeism is determined by both the individual- *and* the firm critical level of sickness since the health state of an individual also affects the firm's profit. Third, we show analytically under which conditions a change in work-related factor  $x$  implies a substitutional, a complementary or no relationship between absence and presenteeism. This result is particularly interesting since the literature on presenteeism (implicitly) assumes that the relationship between both is substitutional (see Aronsson and Gustafsson, 2005; Bierla et al., 2013; Brown and Sessions, 2004; Johansson and Lundberg, 2004). In our theoretical analysis, we have shown that it is not obvious whether a change in a work-related factor implies a substitutional, a complementary or no relationship between absence and presenteeism. In the end, such a classification is primarily an empirical question, to which we turn in the following section.

## 3 Empirical Analysis

### 3.1 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 behaviour. 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, and employees without work contracts.<sup>9</sup>

As the dependent variable in both sickness dimensions, we prefer the annual duration over incidence or frequency measures for two reasons. First, the impact of sickness on productivity depends much more on the annual duration than on the incidence or frequency of the two sickness states. Second, the substitutive and complementary impact of a work-related characteristic on absence and presenteeism is mostly felt at the intensity of both sickness dimensions.

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?*” These two items have major advantages compared to those which are widely used in the literature. On the one hand, asking for the number of sickness presenteeism and absence days in an open question is less prone to biased responses than offering predefined frequency categories as done by Johansson and Lundberg (2004). On the other hand, they fit well with our model where daily absence decisions can be explained. The annual number of days in our empirical investigation can be seen as the aggregated realization of daily absence decisions in the model. Since the aggregation has no influence on the decision of individuals per day due to the assumption of a daily health shock, we can use the derived proposition as the economic intuition behind our results from the empirical investigation.<sup>10</sup> Note that we disregard outliers – that is, those with either more than 50 sickness presenteeism or 100 absence days within 12 months, resulting in a loss of around 200 observations. However, the central results do not depend on this sample selection (see robustness checks). In total, the number of observations amounts to 18,447.

The descriptive statistics show that sickness absence and presenteeism is a widespread and quantitatively relevant phenomenon in Europe (Table 1). The average number of sickness presenteeism and absence days amounts to 2.4 and 5.3, respectively. The conditional means amount to almost seven presenteeism days and more than ten absence days. The distribution of the conditional sickness presenteeism and absence days is shown in Figure 1.

[Figure 1 about here.]

<sup>9</sup>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 either those working less than 10 or more than 80 hours per week.

<sup>10</sup>One remark: In our model, presenteeism was defined by a situation where the individual chooses to be attendant despite the fact that her/his sickness level exceeds the firm critical level of sickness. If we adopt our model to the EWCS presenteeism item, “work when you were sick” means that the individual worked despite the fact that s/he was sufficiently sick from the firm’s perspective.

Since we are interested in the relationship between work-related characteristics and absence/presenteeism, we have to select specific work-related characteristics and cover them empirically. In our cross-sectional model, this selection of explanatory variables is key and must be done as comprehensively as possible. Therefore, we guide our choice by the literature on sickness absence behaviour (Frick and Malo, 2008; Livanos and Zangelidis, 2013; Puhani and Sonderhof, 2010; Ziebarth and Karlsson, 2010) and by the literature on sickness presenteeism (Arnold, 2014; Aronsson et al., 2000; Aronsson and Gustafsson, 2005; Böckerman and Laukkanen, 2009, 2010; Hansen and Andersen, 2008; Leineweber et al., 2011; Preisendörfer, 2010).

Among the work-related variables, 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), weekly working hours, whether working in a second job and during evenings or weekends (unusual working time), net income (21 ordinal categories), firm size, industry (modified NACE-17 classification) and sector information (private sector). Additionally, we take the more subjective properties of a job into account such as work interdependence, work autonomy, job insecurity, satisfaction with working conditions, support by co-workers and the management, and time pressure (lack of time to get work done).<sup>11</sup> The corresponding descriptive statistics are provided in Table 1.

[Table 1 about here.]

Besides the work-related characteristics, we control for sociodemographic variables and health status. 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), and educational status (primary, secondary and higher education status). The health status is taken into account by four subjective categories (very good, good, fair and, finally, bad and very bad in one category) and an objective index measuring the number of different kinds of health problems from which the respondent has suffered during the last 12 months.<sup>12</sup> Although the generosity of sick pay entitlements is crucial for absence behaviour (Frick and Malo, 2008; Puhani and Sonderhof, 2010; Ziebarth and Karlsson, 2010), we prefer including country dummies, which is a better way to account for aggregated country differences (labor market institutions, social norms, health care and other country-specific effects) in cross-sectional data sets.

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

<sup>11</sup>Work interdependence indicates whether work speed depends on other employees, and job insecurity measures the likelihood of losing one's job within six months on a five point Likert scale. Work autonomy is captured by an index measuring the number of autonomy dimensions in which the employee has control – specifically, work order, methods and speed. The other subjective variables are measured on different Likert scales.

<sup>12</sup>Regarding the subjective measure, we integrated the two worst categories into one single category since only 0.2 percent of the sample claimed to have a very bad health status. The health problems 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 and insomnia or general sleeping problems. Using dummy variables for each of these health problems instead of the their number did not improve the fit of the model while leaving the main results unchanged and was hence discarded. The corresponding results are available upon request.

how they are related to the number of presenteeism 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.

For that purpose, we investigate the relationship between the work-related characteristics and the number of presenteeism and absence days by estimating 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 with excess zeros, 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. 59ff.). 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 zero-inflated negative binomial regression model (ZINB) as a robustness check.

The econometric model reads as follows:

$$\text{absence/presenteeism days}_i = \alpha_0 + \text{workcharacteristics}'_i \alpha_1 + \text{sociodemographics}'_i \alpha_2 + \text{healthstatus}'_i \alpha_3 + \text{country}'_i \alpha_4 + \epsilon_i.$$

Here, presenteeism/absence days<sub>*i*</sub> indicate the number of days either spent at work while being sick or absent during 12 months for individual *i*. Work characteristics<sub>*i*</sub>, health status<sub>*i*</sub>, and sociodemographics<sub>*i*</sub> represent the different vectors of independent variables. In order to account for country-specific effects, we include country dummies, and  $\epsilon_i$  is the error term.

### 3.2 Predictions

Before we turn to the results of our empirical investigation, let us look at some expectations regarding the relationship between sickness presenteeism and absence with respect to the considered work-related characteristics. As stated above, the literature on sickness presenteeism often argues that changes in work-related factors lead to a substitutive relationship between presenteeism and absence (Aronsson and Gustafsson, 2005; Bierla et al., 2013; Brown and Sessions, 2004; Johansson and Lundberg, 2004). In an extreme interpretation of this, the choice between both sickness states is simply a zero-sum game. However, the results of our theoretical model (Propositions 1-4) are at odds with this view. There is clear theoretical evidence that, for example, a change in a work-related factor can also increase both sickness states at the same time. Whether the relationship is substitutive, complementary or simply non-existing depends on the relative changes of the individual critical level of sickness  $\tilde{\delta}$  and the firm critical level of sickness  $\bar{\delta}$ .

This conclusion establishes a second way to find predictions, which consists of two steps: (i) Derive expectations for the sign and the magnitude of changes in  $\tilde{\delta}$  and  $\bar{\delta}$  for each covered work-related factor. (ii) Adopt the results summarized in Propositions 1-4 to formulate a prediction as to whether this variation is associated with a substitutive, a complementary or no relationship between absence and presenteeism.

Concerning step 1, we make use of the fact that changes in the individual critical level  $\tilde{\delta}$  determine individuals' absence behaviour [see (4)]. Hence, the sign of changes in  $\tilde{\delta}$  can be deduced from the empirical literature on absence behaviour with regards to the considered work-related characteristics.<sup>13</sup> In contrast, changes in the firm critical level of sickness  $\bar{\delta}$  are driven by the relation between the profit in the case of the employee's absence and the profit in the case of his or her attendance. According to the literature (Pauly et al., 2008; Nicholson et al., 2006), the cost of absence ( $\pi^a - \pi^h$  in our model) depends on three characteristics: the degree of team-oriented production versus individual-oriented production, costs and availability of substitutes and the magnitude of penalty associated with output shortfalls. Following these criteria, we categorize the work-related factors as favourable (implying an increase in  $\bar{\delta}$ ) or unfavourable (implying a decrease in  $\bar{\delta}$ ) to the worker's attendance.<sup>14</sup> Unfortunately, the literature does not provide any indicators to derive the magnitude of the changes in  $\tilde{\delta}$  and  $\bar{\delta}$ . In addition, even the sign of these changes remains unclear in some cases. Table 2 summarizes our predictions.

[Table 2 about here.]

Without knowing the magnitude of the changes in  $\tilde{\delta}$  and  $\bar{\delta}$ , step 2 – the adoption of our model – implies that we cannot predict whether or not absence and presenteeism are complements with respect to the changing work-related factor. However, as stated in Proposition 1, it is nevertheless possible to predict a substitutive relationship. The sufficient condition for this is that the changes in  $\tilde{\delta}$  and  $\bar{\delta}$  are oppositional, irrespective of their magnitude. Therefore, we expect a variation in job insecurity and temporary contracts to lead to a substitutive relationship between both sickness states.

### 3.3 Econometric Results

The regression outcomes are depicted in Table 3, in which we present the determinants of absence and presenteeism days in columns (1) and (2), respectively. As our first result, we find that the supervisor is the *only* work-related variable that leads to a substitutive relationship, with more presenteeism days at the expense of absence days. This is a very remarkable finding because it is at odds with the common view in the literature that employees' choice

<sup>13</sup>We consulted Frick and Malo (2008) regarding firm size, private sector, and income; Puhani and Sonderhof (2010) regarding tenure, firm size, income and blue collar; Goerke and Pannenberg (2012) regarding work autonomy, firm size, blue collar and income; Störmer and Fahr (2012) regarding firm size, tenure and temporary contract and Livanos and Zangelidis (2013) regarding second job. Finally, with regard to some work-related characteristics, we do not find a clear expectation from the literature. This is the case for tenure, work load (weekly hours and lack of time), social support, income, work interdependence and unusual working time.

<sup>14</sup>For some variables, these three dimensions point to counteracting effects with regard to the profit situation in the case of attendance (good working conditions, private sector, social support, firm size, blue collar and work autonomy), or their impact on profits is a priori not clear (weekly hours, tenure and second job).



between absence and presenteeism is a zero-sum game. Furthermore, it contradicts our expectations that sickness absence and presenteeism are substitutes with respect to perceived job security and temporary contracts.

What are the consequences of the observed lack of substitutive relationships between both sickness states with respect to work-related factors? To answer this question, we use our model presented in the previous section. On the one hand, we see from Proposition 1 that a substitutive relationship requires a sufficiently weak or no change in the firm critical level of sickness  $\bar{\delta}$ . On the other hand, we see from Propositions 2 and 3 that a complementary or no relationship crucially depends on the change in  $\bar{\delta}$ . If this variation is sufficiently strong, we obtain a complementary relationship. If this change is identical to the variation in the individual critical level of sickness  $\tilde{\delta}$ , there is no relationship. This is also true if  $\tilde{\delta}$  remains constant while  $\bar{\delta}$  changes.

Therefore, the combination of our model's results and the first empirical finding – that is, only one substitutive relationship between absence and presenteeism suggests that the firm critical level of sickness plays an important role for the interdependence between sickness absence and presenteeism. This also implies that the idea of a fixed-sized pie of sickness that can be differently shared between absence and presenteeism is too simple and that the size of the pie itself, here the definition of sickness via the firm critical level of sickness, can be influenced by work-related factors as well. The endogenous firm critical level of sickness is, thus, the major innovation of our model compared to that of Brown and Sessions (2004). Regarding the work-related factor of supervisor, our model allows another corollary: Proposition 1 in connection with the empirical result suggests that the difference between supervisors and non-supervisors with regards to their individual critical level of sickness  $\tilde{\delta}$  is positive and larger than that with regard to their firm critical levels  $\bar{\delta}$ . This implies that supervisors differ more strongly in their absence decision than in their impact on profits from non-supervisors.

[Table 3 about here.]

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.<sup>15</sup> To be more specific, working conditions and tenure are significantly related to both sickness categories in the same direction. Good working conditions reduce the number of absence and presenteeism days. In contrast, longer tenure is related to more days in both sickness states, with a stronger effect on absence days. We can interpret this finding by observing Proposition 2: Working conditions and tenure more strongly affect the impact of sickness on profitability ( $\bar{\delta}$ ) than the individual absence decision ( $\tilde{\delta}$ ). So, they primarily change the effect of sickness for the firm and less so for the employee. From a managerial perspective, these two results are particularly interesting. On one hand, offering good working conditions does not lead to more presenteeism as one may have expected; it even is associated with less presenteeism and also reduces absence. On the other hand, experienced and trustful employees – that is, those with long tenure – are not only less often attendant but also

<sup>15</sup>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 has a complementary relationship with absence and presenteeism. Health status is of course significantly related to both.

more often inhibited in their productivity through sickness when attendant. Whether the productivity increasing experience effect of tenure or the negative sickness effect prevails is an open question for further research.

As shown in Table 3, the majority of the work-related factors has either an impact on sickness absence days or on presenteeism days while leaving the other unaffected. Let us first look at the case in which absence behaviour changes while presenteeism remains unaffected. Working under a temporary contract, in the private sector, in a larger plant or as a blue collar worker and being dependent on the work speed of one's coworkers (interdependence) are only significantly related to the number of absence days, while they are statistically insignificant in the presenteeism regression. Working under a temporary contract and in the private sector are associated with significantly less absence days, while working in a larger plant, as a blue collar worker and being dependent on the work speed of one's coworkers are positively related to the number of absence days.

Again, we can use our model to find an explanation for this result. There are two possible constellations: On the one hand, Proposition 3(ii) states that both the individual- and firm critical level of sickness must change by the same magnitude (and sign) in order to ensure that only absence varies with a change in a work-related factor. On the other hand, Proposition 4 shows that a variation in absence without a change in presenteeism is the result of a change in  $\bar{\delta}$  if  $\tilde{\delta} < \bar{\delta}$  since then the probability of presenteeism is zero by definition. Note that in this situation, a health shock which lies in the interval  $[\tilde{\delta}, \bar{\delta}]$  implies that the individual chooses to be absent, while s/he is not sufficiently sick from the firm's perspective. We have defined this scenario as absenteeism where individuals absent themselves illegitimately from work. Since the latter case is more likely, we conclude that the above-mentioned work-related factors do not only leave presenteeism unaffected but might also be associated with a change in absenteeism behaviour.

For temporary contracts, employment in the private sector and in smaller firms, this conclusion fits very well with the literature that suggests that these factors make illegitimate absence more costly (probably due to less employment protection, cf. Riphahn, 2004; Ichino and Riphahn, 2005). Albeit reducing absence, these characteristics do not come at the cost of increased presenteeism here. With data collected in 2010, the peak of the economic crisis in Europe with its increasing unemployment and general economic insecurity, this is a rather hard test since we would expect to find strong effects that might have appeared in this situation also at the cost of increased presenteeism.

Next, let us turn to the other case where presenteeism changes while absence is unaffected. As shown in Table 3, work load and autonomy are associated with more sickness presenteeism days, while support by colleagues and management is associated with less. Hence, there are no strong signs that those who are overworked try to cope with their work load an increase in presenteeism. Proposition 3(i) shows that a simple change in the firm critical level ( $\bar{\delta}$ ) and a constant individual critical level of sickness can explain this outcome. This suggests that the work load of an employee (lack of time, usually worked hours per week and second job), social support and work autonomy affect only the impact of sickness on the firm's profit situation while leaving the individual's utility trade off between absence and attendance unchanged.

### 3.4 Robustness Checks

As robustness checks, we present in Table 4 count data models as well as OLS models in differently defined (sub)samples. Estimating zero-inflated negative binomial regression models largely confirms our results (columns 1 and 2). Unusual working times – such as working weekends or evenings, and working in two jobs – gain significance in the presenteeism model.

[Table 4 about here.]

Restricting our sample to EU member states which are characterized by a more homogeneous institutional setting (columns 3 and 4) does not alter our results, either. In fact, the results are quite similar to those obtained in the count data model. Accordingly, unusual working time and second job are significantly related to presenteeism. As a further robustness check, we restrict our sample to employees that have been sick during the last 12 months, since one can only substitute between sickness states when being sick at all (columns 5 and 6). Here, work autonomy turns out to also lead to a substitutive relationship between sickness absence and presenteeism, while the qualitative findings for the other controls remain mostly stable. Even here we find only two substitutes which – additionally – measure quite similar things. Hence, this is only a small caveat since supervisors are, among others, characterized by more work autonomy.

Finally, including (some) of the outliers – that is, those with up to 150 absence or presenteeism days in 12 months, does not fundamentally change our results either (not shown in Table 4 but available upon request). The absence model is more affected than the presenteeism model, where the significance is reduced to the 10 percent level for the coefficients of the supervisor, job insecurity and work interdependence variables, while the only weakly significant second job effect becomes insignificant in the presenteeism model.

## 4 Conclusion

In this paper, we ask whether certain work-related factors lead to a substitutive, a complementary or no relationship between the two sickness states of absence and presenteeism. Using cross-sectional data from the EWCS, we show in OLS regressions that only one out of 16 work-related factors, namely the supervisor status, implies a substitutive relationship between absence and presenteeism. This finding is at odds with the predominant view in the literature that presenteeism behaviour 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 is possible to reduce either absence or presenteeism without shifting the negative productivity effect of sickness to the other sickness state, hence raising the overall number of unimpaired working days. Our results are remarkably robust against count data models and in differently defined subsamples.

In addition to our empirical investigation, we present a theoretical model which is able to explain the aforementioned results. Our theory shows that if a work-related factor changes

only the individual's utility trade-off regarding their absence decisions, then we always obtain a substitutive relationship between absence and presenteeism. However, if a work-related factor also implies a change in the firm's profit, the firm critical level adjusts and – depending on the sign and magnitude of this change – there can also be a complementary or no relationship between both sickness states. Hence, the new endogenous firm critical level is crucial in so far as it allows us to obtain a non-substitutive relationship between absence and presenteeism, which is the dominant empirical finding. This also implies that the idea of a fixed-sized “pie” of sickness that can be differently shared between absence and presenteeism is too simple and that the size of the pie itself, here the definition of sickness via the firm critical level, can be influenced by work-related factors as well.

Although our results are based on cross-sectional correlations only, and hence causal interpretations should be taken cautiously, our investigation offers advantages in other dimensions. Particularly, we are able to identify situations which are associated with absenteeism – that is, illegitimate absence, 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.

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## Appendix

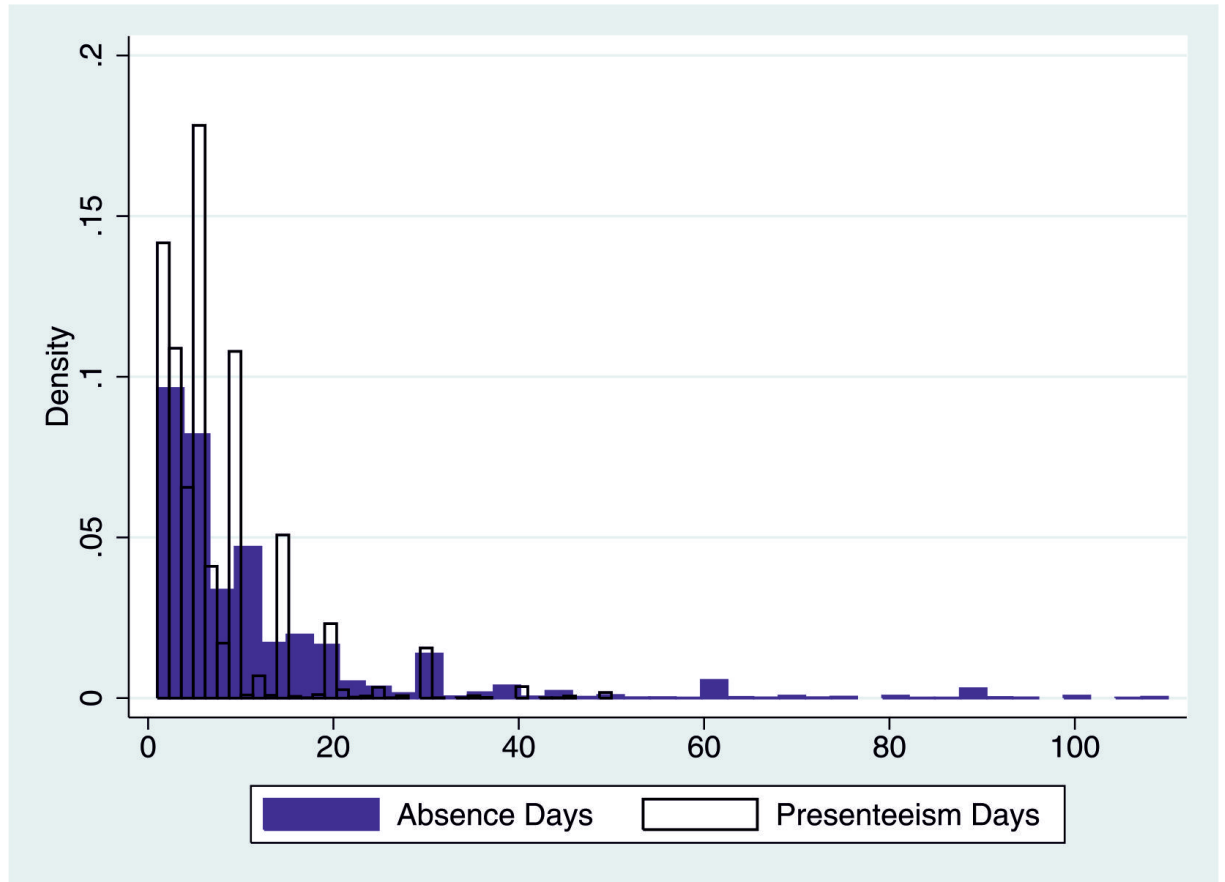


Figure 1: Distribution of sickness absence and presenteeism days conditional on absence and presenteeism. Observations with zero sickness absence and presenteeism days not shown but included in analysis (49 and 64 % of the full sample, respectively). Source: 2010-EWCS. Own calculations, survey weights used.

Table 1: Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Sickness presenteeism days	18,447	2.37	4.9	0	50
Sickness absence days	18,447	5.30	4.9	0	100
Work-related characteristics					
Tenure (<1 years)	18,447	0.08	0.27	0	1
Tenure (1-2 years)	18,447	0.17	0.38	0	1
Tenure (3-14 years)	18,447	0.20	0.5	0	1
Tenure ( $\geq 15$ years)	18,447	0.25	0.43	0	1
Work autonomy index	18,447	1.92	1.19	0	3
Supervisor	18,447	0.15	0.36	0	1
Usual weekly working hours	18,447	38.0	9.1	10	80
Lack of time to get work done	18,447	2.11	0.99	1	5
Unusual working time	18,447	0.58	0.49	0	1
Second job	18,447	0.07	0.26	0	1
Good working conditions	18,447	3.04	0.68	1	4
Social support	18,447	5.58	1.94	1	8
Job insecurity	18,447	2.18	1.19	1	5
Blue collar worker	18,447	0.34	0.47	0	1
Temporary contract	18,447	0.13	0.33	0	1
Net income category	18,447	11.37	3.84	1	21
Work interdependence	18,447	0.46	0.50	0	1
Size (<10 employees)	18,447	0.27	0.45	0	1
Size (10-49 employees)	18,447	0.34	0.47	0	1
Size (50-99 employees)	18,447	0.13	0.34	0	1
Size (100-249 employees)	18,447	0.11	0.31	0	1
Size ( $\geq 250$ employees)	18,447	0.15	0.36	0	1
Private sector	18,447	0.67	0.47	0	1
Socio-demographic controls					
Sex (female=1)	18,447	0.46	0.50	0	1
Children	18,447	0.54	0.50	0	1
Partnership	18,447	0.74	0.44	0	1
Age (18-24 years)	18,447	0.07	0.26	0	1
Age (25-34 years)	18,447	0.26	0.44	0	1
Age (35-44 years)	18,447	0.29	0.46	0	1
Age (45-54 years)	18,447	0.26	0.44	0	1
Age (55-65 years)	18,447	0.11	0.32	0	1
Primary education	18,447	0.31	0.46	0	1
Secondary education	18,447	0.34	0.47	0	1
Higher education	18,447	0.36	0.48	0	1
Health status					
Very good health	18,447	0.26	0.44	0	1
Good health	18,447	0.55	0.50	0	1
Fair health	18,447	0.18	0.39	0	1
Bad and very bad health	18,447	0.02	0.13	0	1
# of health problems	18,389	2.69	2.36	0	14

Source: 2010-EWCS. Own calculations, survey weights used.



Table 2: Predictions from the literature

Variable	$\tilde{d\delta}$	$\bar{d\delta}$
Temporary contract	$> 0$	$< 0$
Job insecurity	$> 0$	$< 0$
Supervisor	$> 0$	$> 0$
Private sector	$> 0$	$?$
Good working conditions	$> 0$	$?$
Work autonomy index	$> 0$	$?$
Blue collar worker	$< 0$	$?$
Firm size	$< 0$	$?$
Second job	$> 0$	$?$
Lack of time to get work done	$?$	$> 0$
Unusual working time	$?$	$> 0$
Social support	$?$	$?$
Net income category	$?$	$> 0$
Work interdependence	$?$	$> 0$
Tenure	$?$	$?$
Usual weekly working hours	$?$	$?$

Table 3: Regression results

	(1)		(2)	
	Absence		Presenteeism	
Substitutes				
Supervisor	-0.764***	(-3.15)	0.332***	(3.23)
Complements				
Good working condit.	-0.527***	(-3.38)	-0.271***	(-3.09)
Tenure (<1 years)	(base)		(base)	
Tenure (1-2 years)	1.114***	(3.90)	0.696***	(4.57)
Tenure (3-14 years)	1.876***	(5.21)	0.776***	(5.31)
Tenure ( $\geq 15$ years)	1.916***	(4.20)	1.093***	(6.66)
Only absence				
Private sector	-1.305***	(-6.07)	-0.070	(-0.66)
Temporary contract	-1.106***	(-3.85)	0.010	(0.08)
Work interdependence	0.400**	(2.51)	0.026	(0.41)
Blue collar	0.635**	(2.47)	-0.089	(-1.18)
Size (<10 employees)	(base)		(base)	
Size (10-49 employees)	0.786***	(3.27)	0.111	(0.99)
Size (50-99 employees)	0.427	(1.54)	0.126	(1.06)
Size (100-249 employees)	1.114***	(3.20)	0.193	(1.16)
Size (>250 employees)	1.341***	(3.59)	0.084	(0.60)
Only presenteeism				
Lack of time	-0.101	(-0.95)	0.168***	(2.90)
Usual weekly hours	-0.008	(-0.53)	0.027***	(3.98)
Work autonomy	-0.070	(-0.84)	0.205***	(3.85)
Second job	-0.429	(-1.53)	0.308*	(1.79)
Social support	-0.058	(-1.11)	-0.073***	(-2.90)
Insignificant				
Net income	0.013	(0.30)	-0.021	(-0.96)
Job insecurity	0.111	(1.30)	0.021	(0.46)
Unusual working time	-0.136	(-0.96)	0.124	(1.55)
Control variables	Yes		Yes	
N	18447		18447	
R <sup>2</sup>	0.11		0.14	

Source: 2010-EWCS, own calculations. Notes: Coefficient estimates are from OLS regressions. The dependent variables are the number of sickness absence days in column (1) and the number of sickness presenteeism days in column (2), both including those with zero days. All variables shown in the table except *good working conditions*, *lack of time*, *usual weekly hours*, *work autonomy*, *social support*, *net income* and *job insecurity* are dummies (see Table 1 for descriptive statistics). Sociodemographic and health variables as well as country and industry dummies (modified NACE 17) are included as control variables but are not shown. The sociodemographic controls comprise sex, having children, partnership status, age categories and educational status. The health status comprises a subjective and an objective measure of health measuring the number of different health problems during the last 12 months. T-statistics based on standard errors clustered on the country level are in parentheses. \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table 4: Robustness checks

	(1) Absence Count data model		(2) Presenteeism Count data model		(3) Absence EU-27		(4) Presenteeism EU-27		(5) Absence Conditional on sickness		(6) Presenteeism Conditional on sickness	
Supervisor	-0.808***	(-3.43)	0.212**	(2.30)	-0.907***	(-3.60)	0.323**	(2.75)	-1.005***	(-2.76)	0.520***	(3.62)
Good working condit.	-0.476***	(-3.39)	-0.203***	(-2.87)	-0.602***	(-3.39)	-0.276***	(-2.87)	-0.408*	(-1.80)	-0.227*	(-1.85)
Tenure (<1 years)	(base)		(base)		(base)		(base)		(base)		(base)	
Tenure (1-2 years)	1.180***	(3.21)	0.667***	(4.08)	1.195***	(3.69)	0.721***	(4.16)	0.736	(1.43)	0.527**	(2.57)
Tenure (3-14 years)	1.953***	(4.43)	0.745***	(4.95)	2.073***	(5.25)	0.754***	(4.60)	1.613**	(2.56)	0.519**	(2.71)
Tenure ( $\geq 15$ years)	1.933***	(3.70)	1.038***	(6.28)	2.215***	(4.60)	1.041***	(5.77)	1.284	(1.69)	0.890***	(3.79)
Private sector	-1.403***	(-6.41)	-0.097	(-0.97)	-1.285***	(-5.93)	-0.061	(-0.51)	-1.892***	(-6.71)	-0.042	(-0.30)
Temporary contract	-1.286***	(-3.89)	-0.026	(-0.21)	-0.943***	(-3.06)	-0.042	(-0.30)	-1.907***	(-4.62)	0.042	(0.20)
Work interdependence	0.332**	(2.02)	0.055	(0.98)	0.411**	(2.39)	0.011	(0.17)	0.433*	(1.72)	-0.041	(-0.49)
Blue collar	0.622**	(2.32)	-0.051	(-0.63)	0.720**	(2.42)	-0.074	(-0.94)	1.295***	(3.08)	-0.025	(-0.19)
Size (<10 employees)	(base)		(base)		(base)		(base)		(base)		(base)	
Size (10-49 employees)	0.683***	(2.91)	0.091	(0.83)	0.793***	(2.96)	0.223*	(1.97)	1.238***	(3.68)	0.152	(0.91)
Size (50-99 employees)	0.301	(1.10)	0.116	(0.93)	0.363	(1.25)	0.165	(1.24)	0.363	(0.97)	0.088	(0.52)
Size (100-249 employees)	0.741**	(2.32)	0.185	(1.13)	1.154***	(2.94)	0.254	(1.37)	1.312***	(2.85)	0.103	(0.46)
Size (>250 employees)	0.947**	(2.50)	0.055	(0.42)	1.363***	(3.38)	0.132	(0.92)	1.598***	(3.29)	-0.055	(-0.32)
Work autonomy	-0.067	(-0.68)	0.225***	(4.26)	-0.026	(-0.29)	0.262***	(5.22)	-0.261**	(-2.19)	0.282***	(4.34)
Lack of time	-0.017	(-0.16)	0.124**	(2.53)	-0.125	(-1.07)	0.158**	(2.49)	-0.223	(-1.53)	0.196***	(2.93)
Usual weekly hours	0.008	(0.53)	0.028***	(4.91)	-0.006	(-0.37)	0.028***	(3.76)	-0.021	(-0.97)	0.038***	(3.86)
Unusual working time	-0.186	(-1.48)	0.183**	(2.46)	-0.158	(-1.00)	0.182**	(2.22)	-0.391*	(-1.86)	0.100	(0.76)
Second job	-0.333	(-1.09)	0.284**	(2.23)	-0.246	(-0.88)	0.398**	(2.62)	-0.936***	(-2.87)	0.253	(1.18)
Social support	-0.009	(-0.20)	-0.059**	(-2.46)	-0.057	(-1.04)	-0.086***	(-3.29)	-0.039	(-0.60)	-0.095**	(-2.58)
Net income	-0.009	(-0.19)	-0.012	(-0.55)	0.016	(0.32)	-0.030	(-1.23)	-0.006	(-0.11)	-0.048	(-1.54)
Job Insecurity	0.056	(0.77)	0.031	(0.87)	0.140	(1.57)	0.046	(0.99)	0.161	(1.37)	0.033	(0.55)
Control variables	Yes		Yes		Yes		Yes		Yes		Yes	
N	18447		18447		16065		16065		11713		11713	
R <sup>2</sup>					0.11		0.14		0.10		0.12	

Source: 2010-EWCS, own calculations. Notes: Average marginal effects from zero-inflated negative binomial regression in Columns (1) and (2), coefficient 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 *good working conditions*, *lack of time*, *usual weekly hours*, *work autonomy*, *social support*, *net income* and *job insecurity* are dummies (see Table 1 for descriptive statistics). Sociodemographic and health variables as well as country and industry dummies (modified NACE 17) are included as control variables but not shown. The health status comprises a subjective (4 dummies) and an objective measure of health measuring the number of different health problems during the last 12 months. The first two estimations rely on the full sample of 18,447 observations. Columns (3) and (4) rely on the observations from the EU-27 countries, i.e. 16,065 observations, and columns (5) and (6) rely only on observations that have at least one sickness day, be it absence or presenteeism (11,713 observations). T-statistics based on standard errors clustered on the country level are in parentheses. \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .