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German Socio-Economic Panel Study (SOEP)
DIW Berlin
Mohrenstrasse 58
10117 Berlin, Germany

Contact: Uta Rahmann | soeppapers@diw.de

Self-Managed Working Time and Employee Effort: Theory and Evidence

Michael Beckmann[a], Thomas Cornelissen[b], Matthias Kräkel[c]

[a] University of Basel, Faculty of Business and Economics, Department of Human Resources and Organisation, Peter Merian-Weg 6, CH-4002 Basel, Switzerland
Phone: +41 61 267 32 24, fax: +41 61 267 27 58
E-mail: michael.beckmann@unibas.ch

[b] University College London, Department of Economics, Centre for Research and Analysis of Migration (CReAM), 30 Gordon Street, London WC1H 0AX, United Kingdom
Phone: +44 20 76 79 85 78, fax: +44 20 79 16 27 75
E-mail: t.cornelissen@ucl.ac.uk

[c] University of Bonn, Department of Economics, Institute for Applied Microeconomics (IAME), Adenauerallee 24-42, D-53113 Bonn, Germany
Phone: +49 228 73 3914, fax : +49 228 73 9211
E-mail: m.kraekel@uni-bonn.de

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Abstract: This paper theoretically and empirically examines the impact of self-managed working time (SMWT) on employee effort. As a means of increased worker autonomy, SMWT can theoretically increase effort via intrinsic motivation and reciprocal behaviour, but can lead to a decrease of effort due to a loss of control. Based on German individual-level panel data, we find that SMWT employees exert higher effort levels than employees with fixed working hours. Even after accounting for observed and unobserved characteristics there remains a modest positive effect. This effect is mainly driven by employees who are intrinsically motivated, suggesting that intrinsic motivation is complementary to SMWT. However, reciprocal work intensification does not seem to be an important channel of providing extra effort.

JEL Classification: J24; J81; M50
Keywords: Self-managed working time, worker autonomy, employee effort, reciprocity, intrinsic motivation, complementarity

1. Introduction

According to the social psychology literature, delegating authority to workers benefits employers, because authorised workers are highly motivated by feeling committed to their employers, leading to intrinsic motivation (Deci and Ryan, 1985, 2000) and reciprocal behaviour (Blau, 1964; Homans, 1958). In other words, received autonomy is likely to interact with the two personality traits intrinsic motivation and reciprocity. Recent work in behavioural economic theory yields similar results (Delgaauw and Dur, 2008; Dur et al. 2010). The economic literature, however, emphasises the following trade-off for employers when delegating authority to their workers (Aghion and Tirole, 1997; Aghion et al., 2013; Bloom and Van Reenen, 2011): On the one hand, increased motivation associated with higher worker authority may raise performance. On the other hand, workers can abuse their authority and this can reduce performance.

In our paper, we address this trade-off by focusing on one key component of delegated authority – workers' autonomy over their working time. In particular, we are interested in working time arrangements that allow workers to control the starting and finishing times of their workday, to set their breaks, vacation days and days off, and to freely distribute their workdays over the working week. Many of these regimes additionally include the decision right upon the place of work and thus allow working from home, at least occasionally (Kelly and Moen, 2007; Nijp et al., 2012; Shockley and Allen, 2012). We label such arrangements as self-managed working time (SMWT).

A natural consequence of SMWT is that employers no longer need to record actual working hours. While the omission of working hours registration enables the employer to save monitoring costs, it also harms his opportunities to control the workers' effort. This implies that the employer relies on his workers to abstain from exploiting their time sovereignty opportunistically by reducing effort.[1] SMWT is a widespread phenomenon. In the United States about 15% of employees are able to completely determine working hours on their own (Golden, 2012), while the corresponding percentage is about 17% for EU27 employees (Goudswaard et al., 2012). Yet, a theoretical analysis of SMWT does not exist and empirical evidence on the effects of this type of

[1] Probably, this is why SMWT is sometimes also called trust-based working time (e.g., Singe and Croucher, 2003; Godart et al., 2014). Other expressions used in the literature include work time control, schedule control, trust hours, or boundary-less work (Beckers et al., 2012; Kelly and Moen, 2007).

autonomy on worker performance is still scarce. As we document below, existing studies in this area typically analyse particular firms or occupations, or provide experimental evidence.

In the present paper, we study the effect of working time autonomy on worker performance in a closely linked theoretical and empirical analysis. We focus on those two personality traits that boost individual performance according to social psychology. In the theoretical analysis, we develop a modified moral-hazard model, which includes intrinsic motivation, reciprocal behaviour, and endogenous monitoring precision that depends on the chosen working time arrangement. The key contribution of the model is to analyse how working time autonomy interacts with the two personality traits, and to derive testable empirical implications. While there is qualitative and case-study evidence suggesting that personality traits moderate employee responses to working time arrangements (e.g., Kelliher and Anderson, 2010; Lambert, 2000), a rigorous theoretical analysis of how the interaction of personality traits and working time autonomy affects performance has not yet been provided in the literature.

Our empirical analysis builds on the theoretical model and draws on one of the most extensive household survey panel datasets in Europe, the German Socio-Economic Panel (SOEP), which includes information on individual workers and on the firms in which they are employed. The main contribution of using this database is twofold. First, the representativeness of the data set allows us to draw more generalisable conclusions than parts of the existing literature that have looked at non-random or selected samples. Second, the panel character of the data improves on the vast majority of the empirical literature in this field that is based on cross-sectional data. This allows us to address potential endogeneity problems and thus to derive managerial implications with regard to an effective use of SMWT. We do so by implementing a fixed effects estimation strategy that explicitly accounts for unobserved time-constant worker heterogeneity, which is an important source of endogeneity bias.

From a theoretical perspective, we find that the impact of working time autonomy on worker performance is ambiguous. On the one hand, due to high working time autonomy and low monitoring precision, the employer prefers low-powered extrinsic incentives. Consequently, workers choose low effort under the optimal incentive scheme. On the other hand, additional intrinsic motivation and incentives from reciprocating received autonomy can provide extra effort, so that the overall impact of working time autonomy on effort depends on which effect dominates. Our

empirical findings imply that SMWT has a moderate, positive net effect on extra working time measured as the difference between workers' actual and contractual working hours. Moreover, our results indicate that these extra working hours do not reflect an inefficient usage of working time, which supports our notion of extra working hours as extra effort. Finally, we show that the positive effort effect of SMWT is mainly driven by increased intrinsic worker motivation.

Our paper contributes to the existing empirical literature on the effect of working time autonomy on individual performance. Using data from seven biopharmaceutical firms in one US state, Eaton (2003) finds that employee control over time, pace and place of work has a positive impact on perceived productivity and organisational commitment. Analysing one cross-section of international survey data, Lyness et al. (2012) find that worker control over working time has a positive association with organisational commitment and job satisfaction. In a largely qualitative study covering workers from three private sector organisations in the UK, Kelliher and Anderson (2010) additionally find evidence for increased work intensification and conclude that employees reciprocate when given the opportunity to work flexibly by exerting additional effort. Based on personnel records of call centre employees from a large Chinese multinational firm, Bloom et al. (2013) conduct an intervention study on the effects of work from home (as an element of worker autonomy) on individual performance. Apart from a 13% productivity increase, the authors find an additional performance effect caused by employee self-selection. Based on experimental evidence and distinguishing between dull and creative tasks, Dutcher (2012) draws mixed conclusions. The author finds that while the autonomy to work from home is associated with an 11-20% productivity increase when workers deal with creative tasks, individual productivity declines by 6-10% when workers deal with dull tasks. This mixed evidence is confirmed by the field- and laboratory-based analyses of Leslie et al. (2012) who find that the effect of flexible work practices (including control over time and place of work) on a worker's career depends on whether management interprets the employees' choice of flexible work practices as a signal of high or low organisational commitment.

In sum, the current empirical evidence on the impact of working time flexibility and autonomy on employee performance is quite inconclusive. Moreover, existing studies differ substantially with respect to validity and representativeness, so that the generalisability of these findings is unclear. For example, Bloom et al. (2013), Dutcher (2012), and Leslie et al. (2012) identify causal effects and thus provide reliable evidence for the specific settings that they analyse. In

contrast, studies that look at a wider context by analysing more general survey data (e.g., Lyness et al., 2012) exploit cross-sectional data, and thus have only limited means of addressing endogeneity problems, which implies that management implications cannot be drawn from their results. In our study, we apply both representative panel data and an estimation strategy that accounts for unobserved worker characteristics.

The remainder of the paper is organised as follows: In section 2, we develop a theoretical model that analyses the consequences of SMWT on employee effort. Section 3 describes the data and variables and provides first empirical insights by discussing some descriptive statistics. The empirical analysis is split in two parts. In section 4, we investigate the overall impact of SMWT on employee effort, while section 5 is devoted to a supplementing complementarity analysis that explicitly focusses on the role of worker reciprocity and intrinsic motivation as potential mediating drivers of the SMWT effort effect. In section 6, we discuss the interpretation of our main variables and our baseline result. Finally, section 7 concludes.

2. Theoretical Model of Self-Managed Working Time and Effort Choice

We analyse the consequences of SMWT on workers' effort choices by modifying the principal-agent approach of Holmstrom and Milgrom (1987, 1990, 1991).[2] Our modifications allow workers to be intrinsically motivated and to reciprocate the employer's offered degree of working time autonomy. Furthermore, we pay attention to a loss of control by the employer due to the workers' higher discretion under SMWT. Finally, we take into account that the employer might compensate the loss of control by the use of alternative control instruments.

In our setting, we consider a risk-neutral, profit-maximizing employer who has to hire a worker in order to run a business. The worker is risk-averse. His utility function is given by $1 - \exp(-r \cdot y)$ with $r > 0$ denoting the Arrow-Pratt measure of constant absolute risk aversion and y the worker's income. This income may also include perceived income from intrinsic motivation. The worker has the reservation value $\bar{v} \geq 0$ in monetary terms, which indicates his best alternative job opportunity in the labour market.

[2] We do not build on the seminal paper by Aghion and Tirole (1997), because it does not include intrinsic motivation and reciprocity and considers the pure motivational effect of becoming authorised without including incentive contracts.

By choosing non-negative effort *e*, the worker contributes *e* units to the employer's profit. The employer cannot directly observe the worker's effort choice, but he can make use of the verifiable performance measure $m = e + \varepsilon$. Both *e* and ε are unobservable by the employer, which leads to a standard moral-hazard problem. The term ε describes a normally distributed error or noise component with $\varepsilon \sim N\left(0, \sigma_A^2 / \kappa\right)$. Thus, *m* is an unbiased estimator of the worker's true effort choice. The variance σ_A^2 / κ depends on the employer's decision whether to give the worker autonomy over his working time ($A = 1$) or not ($A = 0$). In other words, $A = 1$ indicates the choice of SMWT by the employer, whereas $A = 0$ describes a working time arrangement with less worker autonomy. We assume that $\sigma_1^2 > \sigma_0^2$, that is, the introduction of SMWT is accompanied by a higher discretion of a worker, which leads to a less precise monitoring of his daily work by the employer in terms of $1/\sigma_1^2 < 1/\sigma_0^2$ (e.g., by the worker's possibility of working at home). The parameter $\kappa > 0$ measures the intensity of chosen input and output control by the employer with $\kappa \in \{\kappa_L, \kappa_H\}$ and $\kappa_L < \kappa_H$. Exercising control is costly for the employer. We assume that the employer's costs for choosing κ amount to $K(\kappa) > 0$ with $K' > 0$. The performance measure *m* includes input-related indicators (e.g., control of working time, monitoring daily work) as well as output-related indicators (e.g., control of output quantity and quality). Whereas the introduction of SMWT leads to a loss of control since the employer foregoes an important input-related performance indicator, investment in additional control instruments via κ can compensate for this loss.

We assume that the employer induces extrinsic motivation by offering the linear incentive scheme $w(m) = \alpha + \beta m$, where α is a fixed wage component and βm incentive pay based on measured performance. In the following, we look for the optimal incentive scheme $w(m)$ and the corresponding implemented effort for a given working time regime $A \in \{0,1\}$ and a given control intensity $\kappa \in \{\kappa_L, \kappa_H\}$.

We further deviate from the Holmstrom-Milgrom framework by introducing intrinsic motivation and reciprocal behaviour. Intrinsic motivation is modelled as in Delgaauw and Dur (2008) via the worker's (perceived) income function[3]

$$y = w(m) + \gamma_A \cdot V(e) - c(e) \quad \text{with } V(0) = 0, V' > 0, V'' \leq 0 \text{ and } \gamma_A > 0. \tag{1}$$

The term $w(m) - c(e)$ describes the usual earned income minus effort costs. $\gamma_A \cdot V(e)$ characterises the perceived income from intrinsic motivation, which may depend on the employer's choice of the working time arrangement. Hence, our setup assumes that the worker directly benefits from exerting positive effort. Intrinsic motivation is an individual characteristic of the worker that may be independent of the employer's choice of A (i.e., $\gamma_1 = \gamma_0$ is possible). However, the modelling also allows intrinsic motivation being reinforced by SMWT (i.e., $\gamma_1 > \gamma_0$). Social psychological approaches argue that such reinforcement seems realistic. For example, empowered workers who obtain autonomy over their working time might feel committed to their task, which increases intrinsic motivation (Baron and Kreps, 1999). In addition, under SMWT workers might perceive a stronger internal locus of causality which leads to higher intrinsic motivation according to self-determination theory (Deci and Ryan, 1985, 2000; Turban et al., 2007). To allow for an explicit computation of the optimal incentive scheme, we assume that the perceived income function is linear: $V(e) = I \cdot e$ with $I > 0$.

Reciprocal behaviour by the worker can be motivated via social exchange theory, which was originally introduced by Blau (1964) and Homans (1958), or via the gift-exchange approach, suggested by Akerlof (1982). According to these approaches, a worker might feel obliged to reciprocate in a positive way to benefits provided by the employer. The worker interprets these benefits as signals of recognition for past performance, trust in his work morale or consideration for his work-life balance, and thus responds by exerting additional effort. In the present context, a worker might feel some basic reciprocity by getting a job offer with an interesting task from the employer. Depending on the individual type of worker, these reciprocal feelings can increase if a worker obtains autonomy over his working time, so that he exerts even more extra effort compared to a situation without SMWT. To model reciprocal behaviour in our moral-hazard con-

[3] Alternatively, intrinsic motivation could be modelled via realised output (e.g., Murdock, 2002). Such approach would have strong parallels to the modelling of feeling committed. A committed worker feels responsible for the produced output and obtains an extra utility when being successful (e.g., Francois, 2000; Besley and Ghatak, 2005; Friebel and Schnedler, 2011; Choe and Ishiguro, 2012).

text, we use the setup suggested by Dur et al. (2010), which focuses on the worker's effort cost function $c(e)$:

$$c(e) = \frac{e^2}{2} - \delta_A e \quad \text{with } A \in \{0,1\} \text{ and } \delta_1 \geq \delta_0 \geq 0\,. \tag{2}$$

According to (2), the worker feels non-negative reciprocity, indicated by $\delta_0 \geq 0$. If δ_0 takes its lower bound zero, the worker does not feel any basic reciprocity; otherwise the worker behaves even reciprocally without SMWT. If $\delta_1 = \delta_0$, reciprocity is a purely individualistic trait of the worker and insensitive to the employer's choice of working time arrangement. If $\delta_1 > \delta_0$, the worker positively reciprocates offered SMWT. Technically, in case of zero reciprocity, the worker has a standard quadratic effort cost function and is not willing to choose positive effort without compensation. However, if the worker is reciprocal, then he is willing to choose effort up to $\bar{e} = 2\delta_A$ even without being paid for it.

The timeline is the following. First, the employer offers a contract (α, β) to the worker, which specifies the details of the incentive scheme $w(m)$. Then, the worker decides whether to accept the contract or not. If the worker has accepted the contract, he will choose effort e, otherwise the game ends and the worker gets his reservation value $\bar{v}$. After the worker accepted the contract and chose effort, the performance measure m is realised and payments to the employer and the worker are made.

We solve the model by backward induction, starting with the last decision of the two players, i.e., the worker's effort choice. The worker maximises his expected utility or, equivalently, his certainty equivalent

$$CE = E[y] - \frac{r}{2}Var[y] = \alpha + \beta e + \gamma_A V(e) - \frac{e^2}{2} + \delta_A e - \frac{r}{2}\beta^2 \frac{\sigma_A^2}{\kappa}, \tag{3}$$

which follows from the worker's exponential utility function and noise being normally distributed.[4] Equation (3) shows that, in a technical sense, positive effects of SMWT (based on intrinsic

[4] See, similarly, Holmstrom and Milgrom (1990, p. 88), Holmstrom and Milgrom (1991, p. 29).

motivation and reciprocity) and effort are complements. The first-order condition yields the following description of the optimal effort choice, e^*:[5]

$$\beta + \gamma_A V'(e^*) - e^* + \delta_A = 0\,. \tag{4}$$

Implicit differentiation yields $\partial e^* / \partial \beta = \partial e^* / \partial \delta_A = 1 / [1 - \gamma_A V''(e^*)] > 0$ and $\partial e^* / \partial \gamma_A = V'(e^*) / [1 - \gamma_A V''(e^*)] > 0$. Thus, the worker's effort rises by an increase in extrinsic and intrinsic motivation, as well as in the degree of reciprocity.

At the first stage of the game, the employer chooses the optimal contract. He maximises expected profit $E[e^* - w(m)] = (1 - \beta)e^* - \alpha$ subject to the incentive constraint (4) and the participation constraint $CE \geq \bar{v}$. Since α does not influence incentives, but increases the employer's labour costs, under the optimal incentive scheme the employer chooses α to make the participation constraint just bind and, hence, to extract all rents from the worker. Inserting $CE = \bar{v}$ into the expected profit function shows that the employer chooses β to maximise

$$e^*(\beta) + \gamma_A V(e^*(\beta)) - \frac{e^*(\beta)^2}{2} + \delta_A e^*(\beta) - \frac{r}{2}\beta^2 \frac{\sigma_A^2}{\kappa} - \bar{v} \tag{5}$$

with the function $e^*(\beta)$ being implicitly described by (4). The first-order condition yields[6]

$$\left[1 + \gamma_A V'(e^*(\beta)) - e^*(\beta) + \delta_A\right] \cdot \frac{de^*}{d\beta} - r\beta \frac{\sigma_A^2}{\kappa} = 0. \tag{6}$$

By using the parametric specification for the perceived income introduced above, $V(e) = I \cdot e$, the incentive constraint (4) becomes $e^*(\beta) = \beta + \gamma_A I + \delta_A$ and the first-order condition (6) reduces to $\beta^* = 1 / [1 + (r\sigma_A^2 / \kappa)]$ as description of the optimal extrinsic incentives. The result for β^* shows that the following trade-off exists: The larger a worker's degree of risk aversion, *r*, and the smaller the overall precision of the performance measure, κ / σ_A^2, the lower powered will be optimal extrinsic incentives. This finding is not specific to linear incentive schemes but also holds qualitatively for non-linear schemes (see the incentive-intensity principle highlighted by Milgrom and Roberts, 1992). β^* also shows that extrinsic motivation crucially

[5] The second-order condition $\gamma_A V''(e) - 1 < 0$ is satisfied.
[6] The second-order condition is clearly satisfied for our specification of $V(e)$, see below.

depends on the chosen working time arrangement. Since SMWT leads to a loss of control in the sense of $\sigma_1^2 > \sigma_0^2$, for a given control intensity κ, optimal extrinsic incentives will be lower powered under SMWT compared to working time arrangements that allow less worker discretion. However, the employer might prefer to combine the different working time arrangements $A = 1$ and $A = 0$ with different control intensities. In particular, the employer might prefer to combine SMWT (i.e., A = 1) with a high control intensity $\kappa = \kappa_H$ to compensate for the loss of control due to higher worker discretion, and to combine A = 0 with $\kappa = \kappa_L$ because control of the working time already ensures a sufficiently precise performance measure *m*. To illustrate the possibility of such specific combinations of working time arrangement and control intensity, we replace κ by $\kappa(A)$ in the following.

Inserting β^* into $e^*(\beta)$, using the new notation $\kappa(A)$, and comparing the implemented optimal efforts under the two working time arrangements A = 0 and A = 1 shows that SMWT will imply higher effort if and only if

$$\delta_1 - \delta_0 + I(\gamma_1 - \gamma_0) > \frac{r\left(\frac{\sigma_1^2}{\kappa(1)} - \frac{\sigma_0^2}{\kappa(0)}\right)}{\left(1 + r\frac{\sigma_0^2}{\kappa(0)}\right)\left(1 + r\frac{\sigma_1^2}{\kappa(1)}\right)}. \tag{7}$$

In words, the introduction of SMWT will boost worker effort if and only if the effort increase via intrinsic motivation and reciprocal behaviour exceeds the possible effort decrease from lower powered extrinsic incentives. However, if the employer prefers $\kappa(1) = \kappa_H$ (but $\kappa(0) = \kappa_L$) to compensate for the loss of control under SMWT, it is even possible that $\sigma_1^2 / \kappa_H \leq \sigma_0^2 / \kappa_L$ so that extrinsic incentives are restored and condition (7) is satisfied for all levels of intrinsic motivation and reciprocity. This constellation will be optimal for the employer if the additional costs for the high control intensity, $K(\kappa_H) - K(\kappa_L)$, are relatively low compared to the impact of the additional control, $\kappa_H - \kappa_L$. We summarise our first result in the following hypothesis.

HYPOTHESIS 1. *Incentives from intrinsic motivation and reciprocity dominate the possible loss in extrinsic motivation so that SMWT leads to extra effort compared to other working time arrangements that give less discretion to workers.*

In contrast, if a worker's intrinsic motivation and reciprocity are not very strong, or if they are not context dependent but belong to the personal traits of a worker, extra incentives from the introduction of SMWT will be negligible. If, at the same time, the large autonomy over working time yields a considerable loss of control and the costs for additional control, $K(\kappa_H) - K(\kappa_L)$, are quite large, the overall incentive effect of SMWT will become negative.

HYPOTHESIS 2. *The loss of control from larger worker autonomy dominates the incentives from intrinsic motivation and reciprocity so that SMWT leads to lower effort compared to other working time arrangements that give less discretion to workers.*

3. Data, Variables and Descriptive Statistics

Our empirical analysis is based on data from the German Socio-Economic Panel (SOEP). Starting in 1984, the SOEP is an annual longitudinal survey of about 22,000 individuals living in about 12,000 private households. The questionnaires cover a wide range of individual and job-related characteristics. Job-related characteristics, for example, include employment and occupational status, type of work contract, training, working conditions and working time arrangements, professional mobility, earnings, and job satisfaction. In addition, the SOEP contains a number of individual characteristics such as education, personality traits, living circumstances, health and individual well-being, family biographies, career history and household composition. The SOEP even includes some characteristics at the firm level, such as firm size, sector affiliation and works council presence. Some of the items are surveyed annually, while others are captured at more or less regular time intervals.[7] All in all, the SOEP is probably the most established and representative survey data set at the individual level in Germany, and one of the largest and longest running household panel studies in Europe.

In order to examine the relationship between SMWT and employee effort, we utilise the SOEP waves of 2003, 2005, 2007, 2009 and 2011. These five panel waves contain information about both the different forms of working time arrangements and measures of employee effort.

[7] For more comprehensive information about the SOEP, see Wagner et al. (2007).

We restrict the analysis to private and public sector employees and exclude self-employed persons, civil servants and apprentices.[8] Workers in the sample are aged between 17 and 65.

Workers are assigned to the respective working time regimes according to their answers to the following survey question: "*Which of the following working hours arrangements is most applicable to your work?*" Respondents could choose between four items.

- Fixed daily working hours
- Working hours fixed by employer, which may vary from day to day
- Flexitime within a working hours account and a certain degree of self-determination of daily working hours within this account
- Working hours fixed by employee, which may vary from day to day (SMWT).

Table 1 displays the incidence of the different working hours regimes between 2003 and 2011. The table demonstrates that fixed daily working time is still the most common form of working hours arrangements. It applies to about 43% of the employees in Germany. About 20% of the workers make use of flexitime within a working hours account. Furthermore, about 22.5% of employees work flexible hours that are determined by the employer. Finally, about 14.5% of employees report having the freedom to determine working time at their own discretion. Table 1 also indicates that the percentages for each of the working time regimes remained quite stable over the past decade.

[Insert table 1 and table 2 about here]

Table 2 provides some information about work effort in each of the four working time regimes. As a measure of extra effort, we use the difference between average actual working hours (WH^a) and contractual working hours (WH^c) per week, labelled $\Delta WH = WH^a - WH^c$. The first striking result is that workers provide some extra effort in each of the four working time arrangements, i.e., ΔWH is always positive. However, there are substantial differences between the categories with respect to the extent of extra effort. While, on average, ΔWH is relatively

[8] Self-employed individuals are excluded, because they are their own boss by definition. Thus, they are able to choose their working hours freely and may also lack a clear workplace definition (Eldridge and Pabilonia, 2010; Golden, 2009). In addition, we remove obvious outliers from our sample. Specifically, we eliminate individuals who reported unrealistically low monthly gross wages. Consequently, our sample includes workers who earn at least 400 Euros per month. In Germany, workers with a monthly gross wage of up to 400 Euros (450 Euros since 2012) are often called 'mini-jobbers'.

small in the fixed working time regime (2.2-2.7 hours per week), the largest amount of extra effort can be ascertained for employees with SMWT (6.9-8.1 hours per week). According to this finding, employees with SMWT provide, on average, an extra effort of up to one additional working day per week (in fulltime equivalents), which is about five hours more than workers in a fixed working time regime deliver.

Of course, these descriptive statistics only provide some first insights about average effort differences between the working time regimes. Conclusions regarding a meaningful effort effect of SMWT (and other working time arrangements) can only be drawn from multiple regression analyses that explicitly account for potential endogeneity bias.

4. Effort Effects of Self-Managed Working Time

This section is devoted to the question whether or not SMWT has an impact on worker effort, thus testing the general implications of condition (7) in our theoretical model that leads to the derivation of Hypotheses 1 and 2. We expect the overall incentive effect to be positive, if the effort increase induced by SMWT via reciprocal behaviour and intrinsic motivation is stronger than the potential effort decrease, which may result from the fact that SMWT is associated with a loss of employer control. Conversely, we expect a negative effect of SMWT on worker effort, if the reverse is true.

4.1. *Econometric Model and Estimation Strategy*

In order to measure the impact of SMWT on worker effort, we specify the following fixed effects model:

$$\Delta WH_{it} = \alpha_1 SM_{it} + \alpha_2 ED_{it} + \alpha_3 FT_{it} + X_{it}\beta + \mu_{i,o(it)} + u_{it} \ . \qquad (8)$$

The dependent variable ΔWH measures the amount of extra effort (as defined above) of employee i at time t. Our main explanatory variables are dummy variables for three of the four working hours regimes, i.e., SMWT (SM), flexible working time determined by the employer (ED), and flexitime (FT). The coefficients α_1, α_2 and α_3 must be interpreted relative to the excluded reference group of the fixed working time regime, where for our purpose α_1 is of par-

ticular interest. Furthermore, u is an idiosyncratic error term with zero mean and finite variance, and $\mu_{i,o(it)}$ is a worker-occupation specific spell fixed effect, where the index $o(it)$ stands for the occupation in which worker i is employed at time t. This is equivalent to the inclusion of dummy variables for all unique worker-occupation combinations, and it controls for worker fixed effects and occupation effects as well as their combination.[9]

Equation (8) contains a rich set of socio-economic control variables included in the vector X to ensure that our parameter estimates for α_1, α_2 and α_3 are not biased by factors that intrinsically must be attributed to other potential determinants of extra working time. In this regard, we assume that extra working time may additionally be affected by individual characteristics such as years of schooling, gender, nationality, marital status, the existence of children in the household, health status, satisfaction with health and household income, as well as the number of hours devoted to leisure-time activities. Furthermore, various job characteristics may influence a worker's extra effort, i.e., wage level, job tenure, job satisfaction, occupation, occupational status, employment status (full-time or part-time, permanent or fixed-term), employer changes, perceived job security, and previous experiences with full-time and part-time jobs as well as unemployment. We also add firm-level information (firm size class and sector affiliation of the respondent's company) to the vector of control variables. Moreover, X also includes a set of time dummies. Finally, in addition to the information provided by the survey, we match average annual unemployment rates of the different German Federal States as published by the German Federal Statistical Office to our data. Table S6 (see the supplemental material) provides the definitions and descriptive statistics of the complete set of variables used in this study.

By including occupation-specific worker fixed effects $\mu_{i,o(it)}$, equation (8) explicitly addresses the potential problem of time-invariant unobserved factors that may be correlated with both the explanatory variables (including the working time arrangements) and the worker's propensity to provide extra effort. Individual (occupation-specific) ability is a typical example of a

[9] The advantage of including worker-occupation spell fixed effects is twofold. First, as we have more than 10,000 workers and 1,000 occupations, this is a computationally simple way to control for two types of fixed effects when the number of units for each fixed effect is too high to generate and include dummy variables (Andrews et al., 2006). Second, this controls for unobserved heterogeneity even more flexibly than just including the worker and occupation effects separately. By including them in a combined way, we allow for unobserved worker heterogeneity that is constant as long as a worker is employed in the same occupation, but that is allowed to change when a worker switches his occupation. This controls not only for a worker's overall time-constant unobserved characteristics but also for some time-variant unobserved characteristics.

factor that may influence the choice of a certain working hours arrangement as well as employee effort. The bias of these unobserved characteristics on employee effort can be eliminated by applying the fixed effects within-estimator (FE) to equation (8).

4.2. *Empirical Results*

Table 3 displays the estimation results for the impact of SMWT on employee extra effort, as measured by ΔWH. Column (1) contains the conventional ordinary least squares (OLS) estimates of an unconditional specification, where the dependent variable is solely regressed on the working time regime dummies and a constant. Column (2) describes the OLS estimates of the working time regime dummies conditional on the complete set of covariates. These OLS estimates are unlikely to provide consistent estimates of α_1, α_2 and α_3, unless SM and the other working time variables are strictly exogenous, i.e., uncorrelated with both the unobserved individual effect, $\mu_{i,o(it)}$, and the idiosyncratic error term, u_{it}. Hence, column (3) displays the FE estimates of α_1, α_2 and α_3 from equation (8).[10] Applying the FE estimator allows us to eliminate an endogeneity bias that is caused by time-invariant unobserved factors.

[Insert table 3 about here]

The most striking result of our estimates is that throughout all specifications SMWT has a positive influence on employee extra effort, which confirms Hypothesis 1. However, the magnitude of the positive impact sharply declines when accounting for observed heterogeneity in column (2) and for time-constant occupation-specific unobserved heterogeneity in column (3). Starting with an initial estimate of about 5.1 hours per week in the unconditional specification, the effect on average extra effort reduces to 3.3 hours in the complete OLS model and finally ends up with a point estimate of 1.4 hours in the FE model. Put differently, from the initial 5.1 hours of extra effort obtained in the unconditional OLS estimation about 1.8 hours can be explained by observed individual, job or firm characteristics other than SMWT. From the remaining 3.3 hours, about 1.9 hours can be attributed to unobserved factors, leaving an effect of around

[10] All estimates that are not reported in the tables of subsections 4.2 and 5.2 are available from the authors upon request.

1.4 hours that can be ascribed to the policy of SMWT itself. This is about 27% of the initially estimated impact.

In sum, we conclude from these results that, although controlling for selection into SMWT reduces the positive effort effect of SMWT considerably, there remains a moderate positive effect. The 95% confidence interval from our preferred FE estimate ranges between 0.9 and 1.8 hours. Therefore, our findings document that Hypothesis 2 assuming a negative effect of SMWT on workers' effort choice can be clearly rejected. On the contrary, compared to the fixed working hours arrangement there remains a positive regime effect of about 90 minutes of excess working time per week, which supports Hypothesis 1.[11]

5. Complementarity Analysis

In this section, we go more into the details of our theoretical model derived in section 2. According to our empirical findings discussed in the previous section the overall incentive effect of SMWT is positive. This suggests that incentives from intrinsic motivation and worker reciprocity dominate the opposing incentive effect due to a loss of employer control associated with SMWT. In the following, we aim at disentangling this positive overall incentive effect by asking whether SMWT increases worker reciprocity, intrinsic motivation, or both. If SMWT indeed promotes the workers' intrinsic motivation or positive reciprocity, then these worker characteristics and SMWT are complements in producing effort. Identifying such complementarities enables us to refine the management implications to be drawn, because we can then establish under which circumstances the introduction of SMWT has the strongest effort effects.

5.1. *Econometric Modelling*

By definition, complementary items have a larger performance impact when utilised jointly rather than separately, and hence, their interaction effect on performance is positive. In this subsec-

[11] Additional instrumental variables estimates produce very similar results, and the associated endogeneity tests show that after controlling for fixed effects, there remains no further endogeneity, so we could, in principle, interpret the fixed effects results as causal. An extensive discussion can be found in the supplemental material. Furthermore, we conducted various sensitivity analyses, where we checked the robustness of our estimation results to changes in the definition of the dependent variable. Specifically, we measured employee effort by recent work overtime and the presence of non-standard working hours in the evenings, at night and at weekends. The results show a very uniform pattern and confirm our estimates discussed in this subsection (see the supplemental material).

tion, we therefore test for positive interaction effects by augmenting our preferred FE model (8) with interaction terms on SMWT and the worker characteristics of intrinsic motivation and reciprocity.

In order to be able to precisely estimate the interaction terms of interest, it is important to augment the econometric model not only with proxies for intrinsic motivation and worker reciprocity, but also with a measure that reflects the potential impact of extrinsic motivation on employee effort. Recall from our theoretical model in section 2 that the employer might be interested in choosing a high control intensity $\kappa = \kappa_H$ to compensate for the loss of control from SMWT. In practice, the introduction of SMWT may be accompanied by a measure for monitoring employee output as a substitute for the rescinded duty to register working hours.[12] In our econometric analysis, we address this idea by including a human resource policy measure aimed at increasing extrinsic motivation. Specifically, we add a dummy variable for performance evaluation, PE, which indicates whether or not an employee's performance is regularly evaluated by a supervisor.[13] Not controlling for extrinsic motivation involves the risk that an effort effect, which is effectively caused by extrinsic motivation, would falsely be attributed to intrinsic motivation or worker reciprocity.

Recall first that according to self-determination theory employees who perceive a stronger internal locus of causality are likely to exert a higher effort level due to increased intrinsic motivation. Working under an SMWT arrangement should strengthen the perception of an internal locus of causality, and this might be the reason for the positive effort effect of SMWT that was identified previously. Technically, in our model in section 2, the left-hand side of condition (7) increases in the intrinsic motivation parameter I, if $\gamma_1 > \gamma_0$, i.e., if intrinsic motivation under SMWT is higher than under a working time arrangement with less worker autonomy.

We test for such a complementary relationship by interacting our SMWT variable in the working hours regression with a measure for intrinsic motivation. For this purpose, we make use of a variable that gives information about an employee's work morale or work attitude, respec-

[12] Based on case studies, Moen et al. (2011a, 2011b) analyse such scenarios, which they call 'results only work environment (ROWE)'.

[13] The information about performance evaluations was originally only surveyed in 2004, 2008 and 2011. We replaced the missing values by imputing the 2004 observations to 2003 and 2005, and by imputing the 2008 observations to 2007 and 2009. Imputation might be inappropriate when workers switched employers. Our results are, however, virtually the same when we re-estimate equation (15) on a sample of workers who stayed with their employer.

tively. More precisely, we consider the responses of the surveyed individuals to the question: "*If you could choose your own number of working hours, taking into account that your income would change according to the number of hours: How many hours would you want to work*?" We compare the number of these desired working hours with the number of an employee's contractual working hours and consider workers, whose desired working hours equal or exceed their contractual obligation, as being intrinsically motivated. Consequently, we construct a binary measure IM to distinguish between employees with high and low levels of intrinsic motivation. We set $IM = 1$, if a worker's desired weekly working hours are equal or higher than his contractual weekly hours, while we set $IM = 0$, if the desired hours fall short of contractual working time.

In order to ensure that IM can, in fact, be interpreted as a measure for intrinsic motivation rather than a measure which simply reflects a worker's preference for longer working hours, we restrict our sample to full-time workers. The intuition behind this procedure is that part-time workers who prefer longer working hours may primarily wish to be promoted to a full-time job in order to earn more money. In this case, $IM = 1$ would indicate involuntary part-timers who are extrinsically rather than intrinsically motivated.

Furthermore, recall that according to social exchange theory and the gift-exchange approach, a worker may be encouraged to provide extra effort as an act of positive reciprocity in response to being granted SMWT. In our theoretical model discussed in section 2, this idea is explicitly considered as condition (7) will be more likely to be satisfied, if $\delta_1 > \delta_0$. Thus, we would expect the effort effect of reciprocity to be stronger for SMWT workers than for employees who do not work under an SMWT arrangement. We test this idea by interacting our SMWT variable with a binary measure R that distinguishes high-level from low-level reciprocators.[14] All in all, our regression model can therefore be written as

[14] The extent of positive reciprocity is obtained from the respondents' degree of approval to the following statements: (a) "*If someone does me a favour, I am prepared to return it.*" (b) "*I go out my way to help somebody who has been kind to me before.*" (c) "*I am ready to bear personal costs to help somebody who helped me before.*" All items were to be answered on a 7-point Likert scale ranging from 1 ("*does not apply to me at all*") to 7 ("*applies to me perfectly*"). The amount of positive reciprocity is then calculated by summing up the Likert scores and dividing the sum by 3. The median of this variable represents the splitting value for R, where individuals with scores lower than the median are assigned to the group with a low level of positive reciprocity. Information about reciprocity is originally surveyed only in 2005 and 2010. We therefore replaced the missing values by imputing the 2005 observations to the years 2003 and 2007, and by imputing the 2010 observations to the years 2009 and 2011. This procedure

$$\Delta WH_{it} = \alpha_{11} SM_{it} + \alpha_2 ED_{it} + \alpha_3 FT_{it} + \pi_1 IM_{it} + \pi_2 R_{it} + \pi_3 PE_{it} + \pi_4 IM_{it} \times SM_{it} + \pi_5 R_{it} \times SM_{it} + \pi_6 PE_{it} \times SM_{it} + X_{it}\beta + \mu_{i,o(it)} + u_{it} \; . \tag{9}$$

Here, π_1 indicates the effect of intrinsic motivation on ΔWH for workers without SMWT, while $\pi_1 + \pi_4$ captures the corresponding effect for SMWT workers. The term π_1 corresponds to γ_0 in our theoretical model, while $\pi_1 + \pi_4$ is the empirical analogue for γ_1. As a result, $\pi_4 > 0$ would support our theoretical prediction $\gamma_1 > \gamma_0$. In addition, $\pi_4 > 0$ would indicate complementarity between SMWT and intrinsic motivation implying that SMWT is particularly effective when targeted towards intrinsically motivated workers. This leads to the following hypothesis:

HYPOTHESIS 3. *The effort effect of intrinsic motivation is stronger for SMWT workers than for non-SMWT workers, so SMWT and intrinsic motivation are complements in producing worker effort.*

Moreover, π_2 measures the effect of positive reciprocity on ΔWH for workers without SMWT, while $\pi_2 + \pi_5$ indicates the corresponding effect for SMWT workers. Note that π_2 corresponds to δ_0 in our theoretical model, while $\pi_2 + \pi_5$ reflects δ_1. Hence, $\pi_5 > 0$ would confirm the theoretical prediction $\delta_1 > \delta_0$. Furthermore, $\pi_5 > 0$ would indicate a complementary association between SMWT and reciprocity implying that SMWT is particularly effective when targeted towards positively reciprocating workers. We can therefore state the following hypothesis:

HYPOTHESIS 4. *The effort effect of positive reciprocity is stronger for SMWT workers than for non-SMWT workers, so SMWT and reciprocity are complements in producing worker effort.*

Finally, $\pi_6 > 0$ would indicate complementarity between SMWT and performance evaluations implying that it is more effective to introduce SMWT jointly with measures of output control.

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should not be problematic, because personality traits are unlikely to change very quickly over time. For a short summary of the debate on whether personality traits can be assumed to be time-constant or time-varying, see Heineck and Anger (2010).

5.2. *Empirical Results*

Table 4 displays the parameter estimates of the SMWT variable (SM) as well as the intrinsic motivation (IM), reciprocity (R), and performance evaluation (PE) variables, and the corresponding interaction effects. Note that specification (8a) is restricted to a sample of full-time employees and extends equation (8) by IM, R, and PE. The primary aim of this specification is to check, whether our main results in subsection 4.2 are substantially affected by restricting the sample and including additional covariates. Comparing the first column of table 4 with our previous results demonstrates that this is not the case. Moreover, we find that both intrinsic motivation and reciprocity affect employee extra effort positively, but the effect of intrinsic motivation exceeds the reciprocity effect in terms of size and significance. On the contrary, performance evaluations do not contribute to increased worker effort significantly. The finding that the main SMWT effect remains virtually unaffected by the inclusion of the performance pay variable is important, because it suggests that the SMWT effect is not simply driven by the fact that firms have replaced their previous input monitoring activities (recorded working hours) by output monitoring via performance evaluation.

[Insert table 4 about here]

With regard to Hypothesis 3, our results demonstrate a distinct complementary relationship between intrinsic motivation and SMWT, so we can confirm our theoretical prediction $\gamma_1 > \gamma_0$. The interaction effect $\pi_4 = 1.245$ is highly significant, suggesting that intrinsically motivated workers with an SMWT arrangement provide about 75 minutes per week more extra effort than intrinsically motivated workers without an SMWT arrangement, who in turn exert extra effort of about 36 minutes per week compared to their less motivated counterparts ($\pi_1 = 0.602$).

Turning to Hypothesis 4, we note from table 4 that the interaction effect $\pi_5 = 0.128$ is not significantly different from zero, so we cannot find empirical support for our theoretical prediction $\delta_1 > \delta_0$. This suggests that SMWT does not amplify a worker's level of reciprocity, and thus, reciprocity is not found to be complementary to SMWT in producing extra effort. This finding is in line with Giardini and Kabst (2008) who argue that German employees might not perceive the employer's provision of work-family practices (such as SMWT) as a special benefit that would elicit a sense of obligation in them to reciprocate. Instead, due to Germany's long

tradition as a social market economy, German employees are assumed to expect a lot from their employers, which explains their lack of reciprocity. If indeed specific characteristics of the German labour market are responsible for the missing impact of reciprocity, this fact will even strengthen our general findings on the positive incentive effects of SMWT. In that case, the sole effect of intrinsic motivation complemented by SMWT already leads to extra incentives in the German labour market. Due to additional incentives from reciprocity, the positive incentive effect of SMWT must, therefore, be even larger in those labour markets that lack the German characteristic mentioned above.

Performance evaluations, however, do not increase the SMWT effect, with the interaction effect $\pi_6 = 0.141$ being statistically insignificant. Hence, we conclude that intrinsic motivation is strongly complementary to SMWT, but reciprocity and performance evaluations are not. From a management perspective, SMWT is therefore likely to boost worker effort the most, if it is targeted towards highly self-motivated workers, whereas accompanying performance evaluations do not seem to be necessary to keep worker effort high. Intrinsic motivation should therefore be a criterion for selecting employees into SMWT arrangements.

6. Discussion

In this section, we discuss the interpretation of some of our main variables and our empirical results obtained in sections 4 and 5. The objective of this discussion is to examine whether there are other interpretations in terms of variable choices and results that might harm the validity of our empirical analysis.

A first issue concerns our dependent variable ΔWH, which is defined as an employee's actual working time minus his contractual working time. Throughout the paper, we interpret positive values of ΔWH as an employee's extra effort that is found to be positively affected by SMWT. In this context, one may raise the question, whether a positive association is generally desirable by the employer, because what we call extra effort might perhaps simply reflect an inefficient usage of working time. Put differently, less monitoring might induce SMWT workers to work more but less efficiently. In order to address this concern we ran OLS and FE regressions according to (8), where we replaced our original dependent variable ΔWH by measures that shed light on this issue from a different perspective. Specifically, we regressed hourly wages

(measured as wage divided by actual working hours) and a dummy variable indicating whether or not the respondent sees himself as someone who completes tasks effectively and efficiently.[15] If these measures were negatively associated with SMWT, the argument that SMWT may involve an inefficient usage of working time could not be excluded.

[Insert table 5 about here]

As table 5 shows, our results are not in line with the interpretation that SMWT employees work inefficiently. Quite the contrary, in the OLS regressions we find a highly significant positive association between SMWT and hourly wages, which becomes insignificant in the FE specification. Similarly, we find an insignificant association between SMWT and a worker's self-assessment in terms of efficiently completing tasks. All in all, therefore, we see no indication for the consideration that SMWT might increase employee effort, thereby encouraging an inefficient usage of working time.

Secondly, one might ask whether the fact that a (full-time) worker desires to work more hours than he is contractually obliged to work, really proxies some kind of intrinsic motivation. Recall that we interpret intrinsic motivation in terms of an employee's aspiration level concerning his work attitude or work morale. An alternative interpretation of our variable *IM* may be that the worker faces a high level of workload and would prefer to work longer hours to cope with this kind of strain. In order to test this alternative interpretation we regressed our *IM* variable on measures that are related to the concept of intrinsic motivation or workload, respectively. We use an ordinally scaled variable on job satisfaction and a dummy variable indicating an employee's sacrifice on the job[16] as measures that express whether an employee experiences some joy at work or whether he is exceedingly committed in his job. Our measures for workload are also dummy variables capturing approval to the following statements: (a) "*The amount of work has increased steadily over the last two years*", (b) "*Because of the high volume of work there is often high time pressure*". The results are displayed in table 6.

[Insert table 6 about here]

[15] The original variable is ordinally scaled between 1 and 7. The dummy variable has been set to 1, if the ordinal variable takes the values 6 or 7. The definitions of all additional variables applied in this section can be found in table S6 (see the supplemental material).

[16] Precisely, the dummy variable is constructed on approval to the statement "*Those closest to me say I sacrifice myself too much for my job*".

Conditional on the complete set of covariates we find a positive and highly significant association with *IM* for both the job satisfaction variable and the sacrifice on the job variable. On the other hand, the conditional correlation between *IM* and our workload measures is negative (insignificant for (a), significant at the 5% level for (b)). These results should invalidate the idea that *IM* might to some extent capture workload rather than intrinsic motivation.

Finally, one might be concerned about substantial work intensification following the introduction of SMWT.[17] In some European countries, such as Germany and Switzerland, there is an ongoing political debate on this question (e.g., Lehndorff, 2007; Singe and Croucher, 2003).[18] Some practitioners, such as employer and employee representatives, seem to be split on this question. While employer representatives typically emphasise the positive effect that SMWT is expected to have on employees' job autonomy and work-life balance, unions often tend to oppose SMWT. One of their main arguments is that recording working hours protects workers from being exploited by the employer. Consequently, the omission of working hours registration in SMWT arrangements would pressurise workers to intensify effort in order to meet the employer's expectations. The claim is that work intensification might reach a level that could even harm the workers' physical and mental health.[19] SMWT is also controversially discussed among managers, as was recently demonstrated by the cancelation of working from home (which is often a component of SMWT) at Yahoo enacted by CEO Marissa Mayer. In particular, Mrs. Mayer raised concerns that work from home would undermine the employees' work morale (Miller and Perlroth, 2013). However, our results show that neither the concerns in terms of unhealthy work intensification nor the shirking conjecture appear to be appropriate. On the contrary, we find a moderate positive effect of SMWT on employee extra effort. This moderate effort increase induced by SMWT clearly contradicts the shirking hypothesis and is presumably too small to justify the claim of unhealthy work intensification. Moreover, we find no indication for reciprocal work intensification as presumed, for example, in Kelliher and Anderson (2010).

[17] For a general discussion on the impact of decentralisation practices on worker stress see, e.g., Azkenazy (2001).
[18] For the Swiss debate see, e.g., http://www.seco.admin.ch/dokumentation/publikation/00008/00022/04951/index.html?lang=de. Additionally, in Switzerland SMWT arrangements even come into conflict with current labour legislation.
[19] Another argument is that due to the omission of working hours registration, SMWT allows employers to deprive their employees of paying overtime premiums.

7. Conclusion

In this paper, we examine the impact of self-managed working time (SMWT), which provides employees with autonomy over scheduling their own working hours, on employee effort. Our theoretical model shows that SMWT will lead to an overall positive effect on effort, if intrinsic motivation and reciprocal behaviour dominate a possible decline of extrinsic incentives due to a loss of control. Using a large representative individual-level panel data set, the German Socio-Economic Panel (SOEP), we empirically examine the effect of SMWT on employee effort, as measured by the difference of employees' actual working time and their contractual obligation.

Without controlling for selection into SMWT based on observable and unobservable characteristics, we find a large and significant association between SMWT and extra working time, which sharply declines when accounting for observed and unobserved characteristics. Our preferred fixed effects estimates imply the following decomposition of the raw difference of five hours of extra work between workers with SMWT and workers with fixed working time. About one hour and 45 minutes of the initial five weekly hours of extra working time can be attributed to selection on observable individual, job or firm characteristics. Roughly another two hours can be attributed to unobserved factors, leaving an effect of less than 90 minutes that can be ascribed to the policy of SMWT itself. We present additional evidence that SMWT does not reduce productivity per hour worked as proxied by hourly wages and self-reported efficiency. These results justify our interpretation of the SMWT effect on extra working time as an effect on worker effort.

After showing that SMWT employees, on average, exert extra effort rather than reducing effort, we conduct additional analyses, in order to obtain some information about complementarities between SMWT, intrinsic motivation and worker reciprocity. First of all, we find that SMWT amplifies the positive effort effect of an employee's intrinsic motivation. Specifically, self-motivated workers with an SMWT arrangement are found to exert extra effort of somewhat less than two hours per week (111 minutes), which exceeds the amount of extra work provided by self-motivated employees without SMWT by about 75 minutes. However, we find no complementarity between SMWT and employee reciprocity, which rules out reciprocity as a potential channel of the SMWT effect. Perhaps surprisingly, we also find no complementarity between SMWT and performance evaluations as an indicator of extrinsic motivation. This suggests that it

is particularly effective to select intrinsically motivated workers into SMWT, while additional performance evaluations do not boost the effort effect of SMWT.

The results of our study provide some important policy implications that are relevant for both management and employee representatives. While the latter may be concerned about a potential work intensification following the introduction of SMWT, managers might consider adopting SMWT (e.g., in the context of fringe benefits or work-life balance programs) and wonder whether SMWT is associated with increased employee effort or shirking. According to our empirical results, the extra effort effect induced by SMWT is positive but modest, so both employers and employees should benefit from the use of SMWT. Employers can benefit from introducing SMWT, because, on average, SMWT arrangements do not encourage employee shirking, but instead tend to elicit positive effort effects. The largest effort effect can be achieved, if managers select intrinsically motivated employees for working under SMWT. On the other hand, employees should also benefit from SMWT, because the modest effort effect could probably be compensated by the increased time autonomy coming along with SMWT. Consistent with this idea is our finding that the effort increasing effect caused by SMWT is more a matter of improved employee motivation than of reciprocal work intensification.

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Table 1: Incidence of Different Working Time Arrangements

Working time arrangement	2003	2005	2007	2009	2011	Total
Fixed daily working hours	44.8	43.8	42.3	41.7	41.3	42.9
Working hours fixed by employer	22.4	22.0	22.6	23.6	21.9	22.5
Flexitime within a working hours account	18.9	19.9	20.3	20.4	21.8	20.2
Working hours fixed by employee (SMWT)	13.9	14.3	14.8	14.3	15.0	14.4
N	9,583	8,755	8,785	8,752	6,915	42,790

Note: The means are displayed in percent. N is sample size.

Table 2: Actual and Contractual Working Hours per Week

Working time arrangement		2003	2005	2007	2009	2011	Total
Fixed daily working hours	WH^a	35.8	35.9	36.5	35.9	35.9	36.0
	WH^c	33.6	33.6	33.8	33.5	33.3	33.6
	ΔWH	2.2	2.3	2.7	2.4	2.6	2.4
Working hours fixed by employer	WH^a	37.6	37.9	37.9	37.6	38.0	37.8
	WH^c	33.7	33.7	33.5	33.3	33.5	33.5
	ΔWH	3.9	4.2	4.4	4.3	4.5	4.3
Flexitime within a working hours account	WH^a	39.8	40.1	39.7	39.6	40.0	39.8
	WH^c	35.8	36.1	35.8	35.8	36.1	35.9
	ΔWH	4.0	4.0	3.9	3.8	3.9	3.9
Working hours fixed by employee (SMWT)	WH^a	38.2	40.2	41.1	41.0	39.1	39.9
	WH^c	31.1	33.0	33.0	33.3	32.2	32.5
	ΔWH	7.1	7.2	8.1	7.7	6.9	7.4
Difference between SMWT and fixed daily working hours	ΔWH^{SM}	4.9	4.9	5.4	5.3	4.3	5.0

Note: The displayed values are average weekly working hours. WH^a is average actual working hours per week, WH^c is contractual working hours per week and $\Delta WH = WH^a - WH^c$. ΔWH^{SM} is the difference in ΔWH between workers with SMWT and workers with fixed daily working hours. The calculations are based on 37,486 observations.

Table 3: Effects of Self-Managed Working Time on Employee Extra Effort

Estimation strategy	OLS	OLS	FE
	(1)	(2)	(3)
Self-managed working time (SM)	5.054***	3.320***	1.382***
	(0.148)	(0.162)	(0.217)
Employer-determined working time (ED)	1.843***	1.402***	0.818***
	(0.083)	(0.090)	(0.126)
Flexitime (FT)	1.471***	0.748***	0.756***
	(0.071)	(0.087)	(0.143)
R^2 / R^2-within	0.080	0.306	0.025
N	37,486	30,699	31,367

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The dependent variable is ΔWH . The values in parentheses represent robust standard errors clustered at the individual level. The specification displayed in column (1) includes no control variables. The specifications in columns (2) and (3) contain a set of covariates described in table S6 (see the supplemental material). Moreover, the specification in column (2) includes occupation and occupational status dummies, industry dummies, firm size dummies, and time dummies. The specifications in column (3) also include all these dummies, except for the occupation dummies which are replaced by individual-occupation spell fixed effects.

Table 4: Complementarity Analyses

Estimation strategy	FE	FE
Specification	(8a)	(9)
Self-managed working time (SM)	1.752***	0.731*
	(0.270)	(0.425)
Intrinsic motivation (IM)	0.707***	0.602***
	(0.114)	(0.115)
Positive reciprocity (R)	0.229*	0.218*
	(0.130)	(0.130)
Performance evaluation (PE)	0.113	0.100
	(0.139)	(0.138)
Interaction ($IM \times SM$)		1.245***
		(0.413)
Interaction ($R \times SM$)		0.128
		(0.398)
Interaction ($PE \times SM$)		0.141
		(0.416)
R^2 -within	0.037	0.038
N	20,490	20,490

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The dependent variable is ΔWH . The values in parentheses represent robust standard errors clustered at the individual level. The specifications in this table are restricted to a sample of full-time employees and extend equation (8) by the covariates displayed. Both FE models additionally contain the same control variables as the regression models displayed in table 3, column (3).

Table 5: Does ΔWH measure inefficient usage of working time?

Dependent variable	Hourly wage		Efficient work	
Estimation strategy	OLS	FE	OLS	FE
SM	1.226***	-0.000	-0.006	-0.037
	(0.204)	(0.228)	(0.015)	(0.045)
ED	-0.096	-0.287***	0.017	0.005
	(0.081)	(0.096)	(0.011)	(0.028)
FT	0.632***	-0.085	-0.015	-0.036
	(0.115)	(0.189)	(0.013)	(0.038)
R^2 / R^2-within	0.517	0.068	0.123	0.029
N	32,880	33,600	13,300	13,575

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The values in parentheses represent robust standard errors clustered at the individual level. The specifications include the same control variables as the corresponding regression models displayed in table 3.

Table 6: Does *IM* measure intrinsic motivation or workload?

Indicators	Explanatory variables	OLS	Probit ML
Intrinsic motivation indicators	Job satisfaction	0.030***	0.099***
		(0.005)	(0.015)
	Those closest to me say I sacrifice myself too much for my job	0.065***	0.208***
		(0.019)	(0.055)
Workload indicators	The amount of work has increased steadily over the last two years	-0.011	-0.032
		(0.020)	(0.059)
	Because of the high volume of work there is often high time pressure	-0.040**	-0.131**
		(0.020)	(0.058)
R^2 / Pseudo-R^2		0.238	0.110
N		3,769	3,236

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The dependent variable is *IM*. The values in parentheses represent robust standard errors clustered at the individual level. The sample is restricted to full-time employees and the panel wave of 2011. The specifications include the same control variables as the regression models displayed in table 3, column (2).

Supplemental material (not intended to be published)

Section S1 examines whether our FE estimations discussed in subsection 4.2 suffer from potentially remaining endogeneity biases caused by unobserved time-varying heterogeneity. Section S2 provides estimation results for indicators of employee extra effort other than $\Delta WH = WH^a - WH^c$. Here, measures of unusual working hours, i.e., work in the evening or at night and work at weekends, serve as dependent variables. In section S3, we check the robustness of our estimation results from the main specification (subsection 4.2 in the paper) to changes in the definition of the dependent variable. Finally, section S4 contains the first-stage regressions from the FEIV and the ECFE estimation approach derived in section S1 as well as the description and the descriptive statistics of the entire set of variables used in this study.

S1. Instrumental Variables Approaches

After controlling for fixed effects according to equation (8), there may be additional bias due to a potential correlation between SM and u_{it}, which may result from the omission of time-varying characteristics that drive selection into a particular work time regime, or from reverse causality. In the latter case, an employee's decision in favour of SMWT may depend on his actual working hours. Moreover, employees may sort into different working time regimes based on time-varying unobserved characteristics which also affect their effort choices. Examples include personality traits that may change over time, or unobserved changes to an individual's life circumstances. If not addressed, both reverse causality and selection based on time-varying unobservable characteristics might cause estimation biases.

To address these issues, we combine equation (8) with instrumental variables (IV) approaches. Specifically, we use two related two-step identification strategies, where the first is based on predictor substitution and the second relies on residual inclusion. Both approaches require the estimation of reduced form equations for each of the three flexible working time regimes in the first stage. For the first approach these equations are

$$SM_{it} = \varphi_{11} ED_{it} + \varphi_{12} FT_{it} + X_{it}\vartheta_1 + Z_{1it-2}\omega_{11} + \omega_{12} Z_{2it} + \nu^{SM}_{i,o(it)} + \varepsilon_{1it} \quad \text{(S1)}$$

$$ED_{it} = \varphi_{21} SM_{it} + \varphi_{22} FT_{it} + X_{it}\vartheta_2 + Z_{1it-2}\omega_{21} + \omega_{22} Z_{2it} + \nu^{ED}_{i,o(it)} + \varepsilon_{2it} \quad \text{(S2)}$$

$$FT_{it} = \varphi_{31} SM_{it} + \varphi_{32} ED_{it} + X_{it}\vartheta_3 + Z_{1it-2}\omega_{31} + \omega_{32} Z_{2it} + \nu^{FT}_{i,o(it)} + \varepsilon_{3it} \ . \quad \text{(S3)}$$

Here, $\nu_{i,o(it)}$ and ε_{it} represent the occupation-specific worker effects and the idiosyncratic error terms. The vector X contains the same control variables as in equation (8). Altogether, Z_1 and Z_2 comprise four identifying instrumental variables that are excluded from the primary equation (8). For instrumental variables to be valid, they must be relevant, i.e., significant predictors of the working time arrangements in the first stage, and exogenous, i.e., uncorrelated with the idiosyncratic error term u_{it} in equation (8).

Our first three exclusion restrictions, included in Z_1, follow a standard procedure of IV estimations with panel data (e.g., Fernandez-Val and Vella, 2011; Vella and Verbeek, 1998). Specifically, we instrument each of the working hours arrangements with its corresponding lagged variable, i.e., SM_{it} is instrumented by SM_{it-2}, ED_{it} is instrumented by ED_{it-2}, and FT_{it} is instrumented by FT_{it-2}. These instruments are relevant, because a worker's past choices are likely to affect his current choice. At first glance, it appears natural that the experience of previous work under a certain working time regime increases the likelihood of future work under that regime; therefore, we would expect positive coefficients ω_{j1}, ($j = 1,2,3$), on the corresponding lagged working time regime variables. Note, however, that in a fixed effects within-estimation also negative coefficients on the lagged working time regime variables can occur, if changes between regimes occur relatively frequent and the observation period is relatively short. As our panel is relatively short and changes between working time regimes may be caused by a number of events such as employer changes, promotions, relocations or management policy changes, negative signs of the coefficients on the lagged variables would not be surprising. With respect to the exogeneity requirement, we have to assume that a worker's working time regime in the past (lagged by two periods) has no direct effect on a worker's current work effort; i.e., that it is uncorrelated with the idiosyncratic error u_{it} in equation (8). In our application, this assumption seems credible, the more so as it only needs to hold conditional on our large set of covariates, which includes the contemporary working time regime, a large set of observed characteristics, and the worker's unobserved time-constant propensity to provide extra effort (the fixed effect).

After holding all these factors constant, it is hard to see how the lagged working time regime could have a direct effect on the worker's current effort.

As a further instrument for our focus variable, SM_{it}, Z_2 represents the share of workers with SMWT among all workers in the same occupational status group, firm size category, sector, region, and time period.[20] This group-specific mean is positively correlated with the SMWT dummy SM by construction and should consequently be negatively correlated with the remaining working hours arrangement dummies ED and FT. On the other hand, there is no reason to expect that the average demand for SMWT employees within each of these cells has an influence on an employee's propensity to provide extra effort in any other way than through its effect on the individual choice of SMWT.[21] This should especially hold true, because we group the observations mainly according to firm characteristics rather than employee characteristics.

In our first approach, we estimate the parameters of the triangular four-equation structure (8), (S1)-(S3) by the two-stage least squares (2SLS) within estimator, where at the second stage SM, ED and FT in the primary equation (8) are replaced by their predicted values. We refer to this estimator as the fixed effects instrumental variables estimator (FEIV). Since the model (8), (S1)-(S3) is over-identified with four instruments for three endogenous explanatory variables, we can test the exogeneity of the overidentifying restrictions, conditional on the validity of at least as many instruments as are required for exact identification.

The 2SLS approach has the strength that it allows the inclusion of fixed effects, because the first stages are estimated as linear probability models. It has the drawback, however, that the binary nature of the endogenous regressors is not explicitly accounted for. We therefore implement a second IV approach to address this issue by estimating the first-stage equations (S1)-(S3) as probit models. Since the fixed effects probit model leads to inconsistent parameter estimates (e.g., Baltagi, 2008), we estimate random effects probit models, but proxy for time-constant occupation-specific unobserved worker heterogeneity that may be correlated with the error term by

[20] For each of the five years we defined two groups of occupational status (jobs with managerial or non-managerial tasks), four firm size classes, 10 industries and the 16 federal states of Germany. Cells with just one observation do not provide real means and are therefore merged. By proceeding in this way, we prevent the instrument for these observations being identical to the endogenous SMWT variable and thus avoid potential endogeneity of the instrument.

[21] The idea to use group-specific means as exclusion restrictions is not unusual and has been applied, for example, in Woessmann and West (2006).

additionally including the person-occupation mean values of all the time-varying covariates of (S1), (S2), and (S3), respectively. This proceeding is also known as Mundlak's approach (e.g., Greene, 2008). The first-stage equations (S1)-(S3) can then be written as

$$D_{it}^{*} = W_{it}^{D}\eta_{1}^{D} + \overline{W_{i,o(it)}^{D}}\eta_{2}^{D} + \theta_{i,o(it)}^{D} + \varepsilon_{it}^{D} \tag{S4}$$

$$D_{it} = \begin{cases} 1 & \text{if } D_{it}^{*} > 0 \\ 0 & \text{otherwise}, \end{cases} \tag{S5}$$

where D represents SM, ED or FT, respectively. Here, D_{it}^{*} denotes the latent propensity to choose working time regime D_{it}, and ε_{it}^{D} is a normally distributed error term. The vector W^{D} includes each of the right-hand-side variables of equations (S1), (S2), and (S3), while $\overline{W_{i,o(it)}^{D}}$ contains the person-occupation mean values of all time-varying covariates of (S1), (S2), and (S3). Finally, $\theta_{i,o(it)}^{D}$ is that part of the original unobserved effect $\nu_{i,o(it)}^{D}$ which remains after controlling for the person-occupation means of the time-varying covariates, i.e., $\theta_{i,o(it)}^{D} = \nu_{i,o(it)}^{D} - \overline{W_{i,o(it)}^{D}}\eta_{2}^{D}$. Mundlak's approach relies on the assumption that after controlling for the person-occupation mean values, $\theta_{i,o(it)}^{D}$ is uncorrelated with the original regressors in W^{D} and can hence be treated as a random effect.

From the random effects probit estimates of (S4) and (S5), we extract the generalised residuals $s_{it}^{D} = \left(D_{it} - \Phi_{it}\right)\phi_{it} / \left[\Phi_{it}\left(1-\Phi_{it}\right)\right]$, where ϕ_{it} and Φ_{it} denote the PDF and CDF of the standard normal distribution evaluated at $W_{it}^{D}\eta_{1}^{D} + \overline{W_{i,o(it)}^{D}}\eta_{2}^{D} + \theta_{i,o(it)}^{D}$. In the second stage, these generalised residuals are added as correction terms to equation (8) in order to control for remaining time-varying unobserved heterogeneity, i.e.,

$$\Delta WH_{it} = \alpha_{1}SM_{it} + \alpha_{2}ED_{it} + \alpha_{3}FT_{it} + X_{it}\beta + \tau_{1}s_{it}^{SM} + \tau_{2}s_{it}^{ED} + \tau_{3}s_{it}^{FT} + \mu_{i,o(it)} + u_{it}\,. \tag{S6}$$

Intuitively, the generalised residuals embody time-varying characteristics that drive the selection into the working time regimes, and explicitly controlling for them in the second stage removes the endogeneity bias from the coefficients of the working time regime variables. Just as

for equation (8), equation (S6) is estimated by the fixed effects estimator.[22] We refer to this second approach as the endogeneity-corrected fixed effects estimator (ECFE).

The coefficients resulting from our FEIV estimation of equations (8), (S1)-(S3) and our ECFE estimator according to (S6) can be found in table S1. It can be asserted that the parameter estimates are in line with our FE estimates. According to the FEIV model the point estimate is 1.1 hours (not statistically significant), while in the ECFE model we obtain a point estimate of about 1.0 hours (statistically significant at the 5% level).

Table S1: Effects of Self-Managed Working Time on Employee Extra Effort

Estimation strategy	FEIV		ECFE	
	(4)		(5)	
Self-managed working time (SM)	1.146	(0.885)	1.029**	(0.504)
Employer-determined working time (ED)	0.520	(0.661)	0.748*	(0.420)
Flexitime (FT)	1.574*	(0.925)	0.794	(0.567)
Correction term s^{SM}			0.166	(0.313)
Correction term s^{ED}			0.013	(0.247)
Correction term s^{FT}			0.013	(0.329)
Endogeneity test (p -value)	0.59		0.80	
Test on instrument relevance (test statistic)				
SM equation	81.1***		454.8***	
ED equation	70.0***		569.2***	
FT equation	45.9***		331.9***	
Hansen J -test (p -value)	0.46			
R^2 / R^2 -within	0.024		0.027	
N	19,824		19,504	

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The dependent variable is ΔWH . The values in parentheses represent robust standard errors clustered at the individual level. The endogeneity test for the FEIV model is a C -test, while the endogeneity test for the ECFE model is an F -test on $\tau_1 = \tau_2 = \tau_3 = 0$ in (S6). Analogously, the test on instrument relevance for the FEIV (ECFE) model is an F -test (χ^2 -test). The Hansen J -test is a test on overidentifying exclusion restrictions. The specifications contain a set of covariates described in table S6. The specifications also include occupational status dummies, industry dummies, firm size dummies, time dummies, and individual-occupation spell fixed effects.

[22] See Fernandez-Val and Vella (2011) for a similar two-step estimation strategy.

Table S1 also includes information about the validity of the exclusion restrictions applied in the FEIV and the ECFE approach. First, relevance of the instruments is indicated by F - or χ^2 -tests on joint significance in the respective first-stage regressions. Each of the test statistics by far exceeds the rule-of-thumb value of 10, indicating strong instruments. Instrument relevance is additionally confirmed by the corresponding parameter estimates of the first-stage equations, which are displayed in table S5. In each of the first-stage equations both the respective lagged working time variable and the group-specific mean variable are significant at the 5% or 1% level, respectively. The group-specific mean variable exhibits the expected positive sign in the SM equations and a likewise unsurprising negative sign in the ED and FT equations. Moreover, all lagged working time variables exhibit a negative sign in the corresponding reduced form equation. Finally, Hansen's J -test documents that the overidentification restrictions can be considered as exogenous ($p = 0.46$).[23] All in all, therefore, the diagnostic tests support the validity of the overidentifying restrictions and thus emphasise the confidence in our FEIV and ECFE approaches.

Note, however, that neither the C -test for endogeneity nor an F -test on joint significance of the endogeneity correction terms s^{SM} , s^{ED} and s^{FT} in equation (S6), i.e., $\tau_1 = \tau_2 = \tau_3 = 0$, rejects the null hypothesis of exogenous working time regime dummies ($p = 0.59$ or $p = 0.80$). This indicates that the FE estimates displayed in table 3 can already be interpreted as causal, and that there is no necessity to additionally account for unobserved time-varying heterogeneity. As a result, the FE, FEIV and ECFE models all provide consistent estimates for the SMWT effect, where the FE model is the most efficient of the three models, producing the smallest standard

[23] We conducted additional tests with regard to the exogeneity assumption of our exclusion restrictions. Specifically, we ran FEIV regressions, where only three of the four instrumental variables served as exclusion restrictions, while the remaining instrument was added to the vector of control variables in the primary equation. A simple t -test on significance of the estimated coefficient then provides information in terms of the exogeneity assumption of this particular instrument. Each of our instruments proved to be insignificant in the primary equation which is consistent with the result of Hansen's J -test of overidentification. Furthermore, we simply added the instruments to equation (8) in order to test the exogeneity assumption. Neither of the instruments turned out to be significant in this specification.

errors. Therefore, the FE model is our preferred model, but its results are confirmed by the FEIV and ECFE models.[24]

S2. Self-Managed Working Time and Non-Standard Working Hours

This section extends our analysis by considering further measures of extra effort. Specifically, we investigate whether or not employees with SMWT work more non-standard hours than employees with fixed working hours. Non-standard working hours include work in the evening or at night as well as work at weekends. This investigation aims at expanding our previous insights with respect to the impact of SMWT on employee extra effort. The results are displayed in table S2 and table S3.

Table S2 contains the estimates for evening work and night work. The original question in the questionnaire is "*Do you sometimes have to work in the evenings (after 7 p.m.) or at night (after 10 p.m.)?*" From the respondents' information we generate dummy variables indicating whether or not employees are used to working in the evenings or at night at least occasionally and use these dummies as dependent variables. We maintain our previous estimation strategies, focusing on the FEIV approach for the endogeneity correction, because this approach provides us with more detailed information about instrument validity (namely the overidentificaton test) than the ECFE estimation strategy. This implies that both the outcome and first-stage equations are linear probability models, which produce consistent estimates for our SMWT effect and the remaining covariates.[25]

The estimations in table S2 show a quite uniform pattern. While the positive OLS estimate for SM is highly significant and quite substantial in terms of size, the corresponding FE estimate remains significant but the size of the coefficient declines considerably. Finally, in the FEIV specification, α_1 continues to decline in size and becomes insignificant. For example, in the model for evening work the FE estimate (0.078) declines by about 70% compared to the OLS

[24] Another way to verify that the FEIV and ECFE models confirm the estimates of the FE model is to note that its SMWT effect of 1.4 hours lies within the 95% confidence intervals for the SMWT effect resulting from the FEIV and ECFE models.

[25] See Angrist and Pischke (2009, section 3.4.2) for a justification of applying linear IV methods to limited dependent variables, and Angrist and Evans (1998) for a well-known application of linear IV estimation in a context where both the outcome and the endogenous variable are binary.

estimate in a model without control variables (0.263). The coefficient continues to decline by an additional 19% in the FEIV specification.

Table S2: Effects of Self-Managed Working Time on Employee Effort (Evening and Night Work)

Estimation strategy	OLS	FE	FEIV	OLS	FE	FEIV
Dependent variable	Evening work			Night work		
Self-managed working time (*SM*)	0.263*** (0.009)	0.078*** (0.020)	0.029 (0.070)	0.058*** (0.009)	0.037** (0.019)	-0.006 (0.063)
Employer-determined working time (*ED*)	0.275*** (0.008)	0.076*** (0.013)	-0.023 (0.056)	0.154*** (0.008)	0.032*** (0.011)	-0.016 (0.048)
Flexitime (*FT*)	0.037*** (0.009)	0.045** (0.018)	0.026 (0.088)	-0.076*** (0.007)	0.014 (0.014)	0.008 (0.080)
C -test on endogeneity (p -value)			0.35			0.65
F -test on instrument relevance (F -statistic)						
Equation (2)			99.9***			91.1***
Equation (3)			77.4***			70.9***
Equation (4)			49.8***			44.3***
Hansen J -test (p -value)			0.31			0.16
R^2 / R^2 -within	0.063	0.017	0.010	0.032	0.009	0.007
N	32,270	25,950	20,998	31,099	25,142	20,334

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The values in parentheses represent robust standard errors clustered at the individual level. The OLS models include no control variables. The FE and FEIV models contain a set of covariates described in table S6. Furthermore, the FE and FEIV models include occupational status dummies, industry dummies, firm size dummies, time dummies, and individual-occupation spell fixed effects.

Analogously, table S3 displays the estimates for work on Saturdays and Sundays. Hence, our dependent variables in these cases are dummy variables that indicate whether or not an employee at least occasionally works on Saturdays or Sundays, respectively. The estimation results follow the same pattern as before. Starting with a highly significant positive coefficient in the unconditioned OLS model, the effect of SMWT on the propensity to work at weekends decreases sub-

stantially in size and significance when accounting for time-constant and time-varying unobserved characteristics in our FEIV specification.

Table S3: Effects of Self-Managed Working Time on Employee Effort (Work at Weekends)

Estimation strategy	OLS	FE	FEIV	OLS	FE	FEIV
Dependent variable	Work on Saturday			Work on Sunday		
Self-managed working time (SM)	0.148*** (0.009)	0.061*** (0.018)	0.027 (0.067)	0.177*** (0.010)	0.044** (0.021)	-0.108 (0.075)
Employer-determined working time (ED)	0.238*** (0.007)	0.074*** (0.012)	-0.035 (0.050)	0.210*** (0.008)	0.031*** (0.012)	-0.163*** (0.054)
Flexitime (FT)	-0.083*** (0.009)	0.037** (0.017)	0.003 (0.093)	-0.043*** (0.008)	0.027* (0.016)	-0.027 (0.089)
C -test on endogeneity (p -value)			0.23			0.00
F -test on instrument relevance (F -statistic)						
Equation (2)			99.5***			93.1***
Equation (3)			74.6***			70.8***
Equation (4)			50.1***			45.0***
Hansen J -test (p -value)			0.37			0.68
R^2 / R^2 -within	0.059	0.014	0.008	0.047	0.009	-0.026
N	32,412	26,057	21,083	31,206	25,228	20,405

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The values in parentheses represent robust standard errors clustered at the individual level. The OLS models include no control variables. The FE and FEIV models contain a set of covariates described in table S6. Furthermore, the FE and FEIV models include occupational status dummies, industry dummies, firm size dummies, time dummies, and individual-occupation spell fixed effects.

The diagnostic tests again confirm the validity of our exclusion restrictions. Also, in three of four FEIV specifications, the C -test does not reject the exogeneity hypothesis. In these cases, as in our previous results, the point estimates resulting from the FE approach can already be interpreted as causal effects. In sum, our previously obtained main finding, according to which an employee's exertion of extra effort can only to a minor extent be attributed to the arrangement of SMWT, remains unchanged. For example, for the evening work specification we conclude that

only about 30% of the original impact of SMWT on the probability of working in the evenings can be ascribed to this particular working time arrangement. In contrast, the predominant part of this positive impact can be explained by observed and unobserved time-invariant heterogeneity.

Another example supporting our main finding is that, in the 'work on Sundays' specification only about 25% (0.044/0.177) of the original impact of SMWT on the probability of working on Sundays can be explained by this human resource practice. Presumably, the causal effect is even weaker because for this specification the C-test emphasises the necessity to additionally account for time-varying unobserved heterogeneity, which in the end decreases the causal effect to zero. In both cases, we can thus conclude that the causal effect of SMWT on employee extra effort is rather small. Apart from other observed characteristics, the positive effect is largely driven by unobserved heterogeneity such as selection issues. Also, note that similar to subsection 4.2, we find no evidence that SMWT encourages shirking.

S3. Applying Alternative Measures for Employee Extra Effort

In this section we examine whether the result of a positive effort effect of SMWT, which declines when gradually controlling for observed and unobserved factors, also holds when we replace our dependent variable used in subsection 4.2 by two alternatively defined measures of extra effort. The first variable measures the amount of self-reported overtime work in the respective month prior to the survey (OT). Just as with our dependent variable in subsection 4.2, the second alternative variable is defined as actual minus contractual working time. The difference between these two variables, however, is the definition of actual working hours. While the dependent variable that we used in subsection 4.2 is restricted to the average actual working hours that employees spend doing their main job, the alternative measure additionally includes commuting times as well as the number of working hours, if any, committed to a second job ($\Delta WH2$).[26] As before, we focus on our OLS, FE and FEIV estimation strategies. Table S4 displays the corresponding estimation results.

[26] In order to calculate the actual working hours in this case, we analysed the responses to the following question: "*How many hours do you spend on job, apprenticeship, and second job on a typical weekday, Saturday, and Sunday (including commuting times)?*" Actual working hours are then calculated as the number of working hours on a typical workday times 5 plus the number of working hours on typical Saturdays and Sundays.

Table S4: Effects of Self-Managed Working Time on Employee Effort (sensitivity check)

Estimation strategy	OLS	FE	FEIV	OLS	FE	FEIV
Dependent variable	Overtime last month (OT)			$\Delta WH2$		
Self-managed working time (SM)	2.311*** (0.085)	0.704*** (0.150)	0.511 (0.616)	2.693*** (0.204)	0.711** (0.336)	1.022 (1.381)
Employer-determined working time (ED)	0.732*** (0.047)	0.192** (0.081)	0.049 (0.416)	2.754*** (0.160)	0.260 (0.224)	1.633 (1.200)
Flexitime (FT)	1.063*** (0.048)	0.341*** (0.110)	1.136 (0.736)	0.813*** (0.136)	0.193 (0.255)	-0.104 (1.435)
C-test on endogeneity (p-value)			0.54			0.56
F-test on instrument relevance (F-statistic)						
Equation (2)			100.1***			80.1***
Equation (3)			76.2***			66.7***
Equation (4)			51.2***			48.3***
Hansen J-test (p-value)			0.60			0.79
R^2 / R^2-within	0.046	0.019	0.016	0.016	0.020	0.019
N	40,637	32,948	20,762	35,012	30,050	19,024

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. $\Delta WH2$ is defined as total working hours in a typical week (including commuting times and working hours devoted to a potential second job) minus contractual working time. The values in parentheses represent robust standard errors clustered at the individual level. The OLS models include no control variables. The FE and FEIV models contain a set of covariates described in table S6. Furthermore, the FE and FEIV models include occupational status dummies, industry dummies, firm size dummies, time dummies, and individual-occupation spell fixed effects.

The results confirm our previous estimates. In both specifications, the unconditioned OLS effect is positive and highly significant. The coefficients resulting from the FE model are also significant, but decline substantially from about 2.3 to 0.7 hours or from about 2.7 to 0.7 hours, respectively. Again, the FEIV point estimates lose their significance. The validity of our exclusion restrictions is confirmed by the diagnostic test statistics. For both FEIV specifications, the C-test does not reject the hypothesis of exogenous working hours-arrangement variables, and we can again interpret the FE point estimates as causal effects. Based on the initial OLS effects, therefore, about 70% (or 1.6 weekly hours in absolute terms) in the OT-specification and 74% (or about 2 weekly hours in absolute terms) in the $\Delta WH2$-specification must be ascribed to (ob-

served and time-constant unobserved) factors other than SMWT, which is very much in line with our estimates in subsection 4.2.

S4. First-Stage Regressions and Description of the Variables

Table S5: First-Stage Estimates of the Exclusion Restrictions According to Equations (S1)-(S3)

Estimation strategy	FEIV			ECFE		
Explanatory variable to be instrumented	*SM*	*ED*	*FT*	*SM*	*ED*	*FT*
SM_{t-2}	-0.224*** (0.022)	0.004 (0.017)	0.021 (0.019)	-1.403*** (0.110)	0.127 (0.107)	0.014 (0.109)
ED_{t-2}	0.003 (0.006)	-0.243*** (0.015)	0.022** (0.009)	0.169 (0.119)	-1.285*** (0.057)	0.149 (0.094)
FT_{t-2}	-0.006 (0.012)	0.002 (0.014)	-0.184*** (0.018)	-0.090 (0.119)	0.094 (0.096)	-1.126*** (0.084)
Group-specific mean for employees with SMWT	0.426*** (0.031)	-0.068** (0.031)	-0.195*** (0.030)	3.359*** (0.226)	-0.558*** (0.190)	-1.469*** (0.204)

Note: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The values in parentheses represent robust standard errors clustered at the individual level. The same sets of control variables as in table S1 are included, but not reported to save space.

Table S6: Definition and Descriptive Statistics of the Variables

Variable	Definition	*N*	Mean	Std	Min-Max
Dependent variable					
ΔWH	Difference between average actual and contractual working time per week	38,312	3.68	5.44	-38-42
Main explanatory variables					
Self-managed working time (*SM*)	Dummy variable indicating whether or not an employee has extensive decision-making authority in terms of scheduling individual working hours (reference group: fixed working time)	42,790	0.14	0.35	0-1
Employer-determined working time (*ED*)	Dummy variable indicating whether or not an employee faces flexible working hours determined by the employer (reference group: fixed working time)	42,790	0.23	0.42	0-1
Flexitime within a working hours account (*FT*)	Dummy variable indicating whether or not an employee is allowed to vary daily working hours, where daily attendance is restricted to a defined time interval (working hours account) (reference group: fixed working time)	42,790	0.20	0.40	0-1
Positive reciprocity (*R*)	See footnote 14.	38,890	0.41	0.49	0-1
Intrinsic motivation (*IM*)	Difference between desired and contractual working time per week	27,659	0.68	0.46	0.1
Performance evaluation (*PE*)	Dummy variable indicating whether or not an employee's performance is regularly evaluated by a supervisor	37,276	0.30	0.46	0-1
Control variables					
Monthly gross wage	Gross wage of the employee in the month before the survey (in 1,000 Euros)	42,790	2.42	1.85	0.40-80.0
Job satisfaction (Intrinsic motivation indicator 1)	Ordinal variable ranging from 0 to 10, indicating an employee's job satisfaction (0: completely unsatisfied, 10: completely satisfied)	41,935	6.95	2.00	0-10
Satisfaction with household income	Ordinal variable ranging from 0 to 10, indicating an employee's satisfaction with household income (0: completely unsatisfied, 10: completely satisfied)	42,411	6.41	2.12	0-10
Living with partner	Dummy variable indicating whether or not an employee has a settled living partner	42,568	0.84	0.37	0-1
Children aged under 16	Dummy variable indicating whether or not an employee has one or more children aged under 16 who currently live in the household	42,751	0.36	0.48	0-1
Full-time employed	Dummy variable indicating whether or not an employee is employed full-time	39,274	0.77	0.42	0-1
Fixed-term contract	Dummy variable indicating whether or not an employee has a fixed-term contract	40,317	0.09	0.29	0-1
Employer change	Dummy variable indicating whether or not an employee has changed their employer in the year before the survey	42,790	0.09	0.28	0-1

Variable	Definition	*N*	Mean	Std	Min-Max
Male	Dummy variable indicating whether or not an employee is male	42,790	0.50	0.50	0-1
Foreign nationality	Dummy variable indicating whether or not an employee is of non-German nationality	42,790	0.07	0.25	0-1
Job tenure	Years of an employee's job tenure	42,733	10.51	9.64	0-50.9
Schooling	Years of schooling an employee has had	41,516	12.41	2.55	7-18
Full-time experience	Years of an employee's experience in a full-time job	42,403	15.61	11.38	0-49
Part-time experience	Years of an employee's experience in a part-time job	42,403	3.01	5.51	0-45
Unemployment experience	Years of a worker's unemployment experience	42,403	0.62	1.58	0-24.1
Hobbies and other leisure activities	Number of hours devoted to hobbies and other leisure activities on a typical working day	41,356	1.60	1.40	0-15
Satisfaction with health	Ordinal variable ranging from 0 to 10 that indicates the degree of satisfaction with an employee's health (0: completely unsatisfied, 10: completely satisfied)	42,714	6.93	1.98	0-10
Current health: good	Dummy variable indicating whether or not an employee assesses his current health status as good (reference group: very good)	42,720	0.48	0.50	0-1
Current health: satisfactory	Dummy variable indicating whether or not an employee assesses his current health status as satisfactory (reference group: very good)	42,720	0.32	0.47	0-1
Current health: poor	Dummy variable indicating whether or not an employee assesses his current health status as poor (reference group: very good)	42,720	0.10	0.30	0-1
Current health: bad	Dummy variable indicating whether or not an employee assesses his current health status as bad (reference group: very good)	42,720	0.01	0.11	0-1
Strong worries about job security	Dummy variable indicating whether or not an employee is strongly concerned about his job security (reference group: no worries)	41,544	0.16	0.37	0-1
Some worries about job security	Dummy variable indicating whether or not an employee is somewhat concerned about his job security (reference group: no worries)	41,544	0.43	0.50	0-1
Firm size 20-200	Dummy variable indicating whether or not an employee works in a firm that employs between 20 and 200 employees (reference group: < 20)	41,453	0.30	0.46	0-1
Firm size 201-2000	Dummy variable indicating whether or not an employee works in a firm that employs between 201 and 2000 employees (reference group: < 20)	41,453	0.22	0.42	0-1
Firm size >2000	Dummy variable indicating whether or not an employee works in a firm that employs more than 2000 employees (reference group: < 20)	41,453	0.22	0.41	0-1

Variable	Definition	*N*	Mean	Std	Min-Max
Regional unemployment rate	Average unemployment rate of the German federal state, where the employee lives (%)	42,751	10.75	4.49	4.3-22.1
Exclusion restrictions					
SM_{t-2}	Two years lagged observations of *SM*	25,494	0.14	0.34	0-1
ED_{t-2}	Two years lagged observations of *ED*	25,494	0.22	0.41	0-1
FT_{t-2}	Two years lagged observations of *FT*	25,494	0.21	0.41	0-1
Group-specific mean for employees with SMWT	Average share of *SM* in groups separated by 2 occupational status classes, 4 firm size classes, 10 industry classes, 16 regional classes, and 5 time periods	40,541	0.14	0.18	0-1
Additional variables applied in section 6					
Hourly wage	Gross monthly wage of the employee divided by actual monthly working hours (in Euros)	33,600	15.25	8.54	1.5- 263.7
Efficient work	Dummy variable indicating whether or not an employee approves to the statement: "*I see myself as someone who does things effectively and efficiently*" (original variable is ordinal ranging between 1: does not apply to me at all and 7: applies to me perfectly; threshold: 6)	13,575	0.73	0.44	0-1
Intrinsic motivation indicator 2	Dummy variable indicating whether or not an employee approves to the statement: "*Those closest to me say I sacrifice myself too much for my job*" (original variable is ordinal ranging between 1: strongly disagree and 4: strongly agree; threshold: 3)	3,769	0.41	0.49	0-1
Workload indicator 1	Dummy variable indicating whether or not an employee approves to the statement: "*The amount of work has increased steadily over the last two years*"	3,769	0.66	0.47	0-1
Workload indicator 2	Dummy variable indicating whether or not an employee approves to the statement : "*Because of the high volume of work there is often high time pressure*"	3,769	0.65	0.48	0-1
Alternative dependent variables applied in the supplemental material sections					
Evening work	Dummy variable indicating whether or not an employee at least occasionally works in the evening	32,750	0.52	0.50	0-1
Night work	Dummy variable indicating whether or not an employee at least occasionally works at night	31,551	0.26	0.44	0-1
Work on Saturday	Dummy variable indicating whether or not an employee at least occasionally works on Saturdays	32,896	0.61	0.49	0-1
Work on Sunday	Dummy variable indicating whether or not an employee at least occasionally works on Sundays	31,649	0.36	0.48	0-1
OT	Number of overtime hours an employee has executed in the recent month before the survey	41.642	2.21	3.60	0-22.8

Variable	Definition	*N*	Mean	Std	Min-Max
$\Delta WH2$	Difference between the number of working hours in a typical week (including commuting times as well as working hours devoted to a potential second job, as well as work at Saturdays and Sundays) and the weekly contractual working hours	35,728	10.51	9.49	-59.5-108

Note: *N* is the number of observations. Std is standard deviation. In order to save space the information for 11 occupational status dummies, 62 industry dummies, 16 regional dummies and five time dummies are not displayed.

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