

Chapter 10

Labour Markets: Time and Income

Effects from Reducing Working Hours in Germany

Johannes Buhl and José Acosta

Abstract A reduction in working hours is being considered to tackle issues associated with ecological sustainability, social equity and enhanced life satisfaction—a so-called triple dividend. With respect to an environmental dividend, we analyse the time-use rebound effects of reducing working time. We explore how an increase in leisure time triggers a rearrangement of time and expenditure budgets, and thus the use of resources in private households. Does it hold true that time-intensive activities replace resource-intensive consumption when people have more free time at their disposal? In order to give an answer to the question, we estimate the marginal propensity to consume and the marginal propensity to time use in Germany. The findings from national surveys on time use and expenditure show composition effects of gains in leisure time and income loss. The results show that time savings due to a reduction in working time trigger relevant rebound effects in terms of resource use. However, the authors put the rebound effects following a reduction in working time into perspective. Time-use rebound effects lead to increased voluntary social engagement and greater life satisfaction, the second and third dividends.

Keywords Rebound effect · Time use · Resource use · Consumption

A significant reduction in working time in rich industrialised countries is being considered to tackle issues associated with ecological sustainability, social justice and individual quality of life (Schor 2005; Jackson and Victor 2011; Coote et al. 2013; Kallis et al. 2013; Pullinger 2014). However, as Kallis et al. (2013: 1564) recently noted, advocates of working time reductions in the degrowth discourse fail

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to take into account potential counterproductive “secondary and third level effects” of working time reductions—such as rebound effects.

The comprehension of rebound effects has evolved over time. More comprehensively, Sorrell (2010, p. 8) refers to rebound effects as “the unintended consequences of actions by households to reduce their energy consumption and/or greenhouse gas (GHG) emissions”. Every *action* that aims at promoting savings in resources is prone to rebound effects. With respect to time, Greening et al. (2000, p. 391) noted that “...many technological advances, in addition to fuel efficiency improvement, have resulted in changes in the allocation of time. This is reflected in a change in labour force participation rates and occupational structure”. Greening et al. (2000) paved the way for an introduction of time-use rebound effects such that later Jalas (2006, p. 51) classified the notion of time-use rebound effects as transformational rebound effects as well. They both argue that transformational effects respond to changes in consumer preferences, social institutions and in the organisation of labour—e.g. a reduction in working hours. In this regard, time-use rebound effects state that re-invested time savings may compensate for productivity gains in a similar way that re-invested monetary savings due to efficiency gains do. It would therefore be important to determine to what extent a reduction in working time is prone to time-use rebound effects.

Generally, Linder (1970) already stated that in modern industrialised societies, free time¹ decreases as productivity and wealth increase. More recently, Rosa (2013, p. 152f) corroborates Linder’s axiom by offering a more comprehensive understanding of social and technical acceleration and its implications for energy and resource requirements.

Wherever it is possible to save time through improved techniques—even in administrative processes, in legislation, in education, indeed in recreation or entertainment—there is great social pressure to develop and implement them in order to have newly available freed-up time resources. In addition to this, the holding open of future opportunities to accelerate, e.g., by acquiring more powerful hardware, wider streets, greater energy storage [...] likewise becomes an imperative of social action. The expectation of technical acceleration (and the corresponding quantitative growth of transportation, information processing, energy demand, etc.) is thus, as it were, always already “built in” to the social and material infrastructure. Technical acceleration is therefore a direct consequence of the scarcity of time resources and hence of the heightening of the pace of life.

Above all, technical acceleration is characterised by technological acceleration. However, technical acceleration is simultaneously characterised by an acceleration

¹Free time is usually seen “as the time resources that are not bound up in obligatory activities, and over which one may therefore dispose more or less at will.” As such, free time is “the time that remains left over after subtracting work time and housework (child care, errands, housework), and personal care time (eating, sleeping, body care)” (Rosa 2013, p. 133). However, free time is a deliberately subjective notion of the time people *consider* to have freely available after they have been at to work or have taken care of their children. Time use for eating, sleeping, resting or even time at voluntary work or time with children is often stressed as free time as well. Eventually, we distinguish between time at formal, paid work (labour) and time outside labour for the estimation of potential rebound effects after working time reduction.

of organisation, decision, administration, and control, i.e., the intentional acceleration of goal-directed processes through innovative techniques (Rosa 2013, p. 74). As such, we consider labour productivity gains, i.e. the increase in output (e.g. GDP) per (e.g. total) working hours a part of technical acceleration. With respect to an accelerating pace of life we follow Rosa's (2013, p. 121) definition of the same as the "increase of episodes of action and/or experience per unit of time as a result of a scarcity of time resources". Potential opportunities in terms of experiences (like trips, travels, going out, going to the movies, cooking, sports and so on) coming with technical acceleration emerge at an increasing pace. Likewise, the opportunity costs² of consumer decisions increase and the quest to decrease those by condensing actions and experiences over time (by means of increased energy and resource use) accelerates the pace of life in an experience-oriented society (Rosa 2013; Schulze 2013).

For instance, the analysis of changing leisure time conducted by Aall et al. (2011, p. 453) showed that "leisure activities are to increasing extent based on material consumption". And when it comes to the re-allocation of working and leisure time Druckman et al. (2012) explained "that a simple transfer of time from paid work to the household may be employed in more or less carbon intensive ways". Knight et al. (2013) describe a time-use rebound effect due to the reduction in working as a compositional effect that may be triggered by a change in how households allocate their time spent and expenditure, also taking into account monetary and temporary budget constraints. They wonder (on p. 694) if "[h]ouseholds with more free time might take more vacations by auto or air, they may travel outside the home more, or have greater involvement in extra-mural community activities, leisure or shopping, as well as other energy consuming activities". Their results suggest that "the compositional effect of work hours on consumption patterns may be more consequential for non-energy resources" and noted that "this is an issue that could benefit from further study". In this respect, we investigate whether it holds true that significant time savings following a reduction in working hours lead to resource-intensive consumption being replaced by time-intensive, but low-resource activities—taking into account time-use rebound effects.

To this end, we adapt a model of time-use rebound effects from the literature in the next section. The fourth section contains a presentation of the findings gained from the statistical analysis. In the fifth section, we discuss the methodological issues mainly caused by mixing data. In the final section, we summarise the findings and briefly draw conclusions with respect to potential increase in voluntary engagement and an increase in life satisfaction—the second and third dividends of working time reductions.

²Opportunity costs is a basic concept in micro economics. It basically refers to the fact that a choice between opportunities leaves the foregone alternative as a cost, as an option that has not been realised. The more options foregone, the higher the opportunity costs. When it comes to working time reductions, opportunity costs are often given as the foregone wages. In this regard, opportunity costs are high in high-wage countries.

10.1 Method and Data

There are two main approaches for estimating time-use rebound effects in the literature. The first, explicitly referring to time-use rebound, was provided by Jalas (2002). He focused on how the use of resources is distributed between different activities besides working hours, leaving income effects aside. The second one and in line with Knight et al. (2013), Nässén and Larsson (2015) argue that consumers take decisions about their temporal and monetary budget constraints, taking into account both time and income effects of a reduction in working hours. The time-use rebound effect is then a composition or net effect of time gains and income loss due to a reduction in working hours. A composition effect takes into account the fact that people rearrange their time budgets and expenditure following a reduction in working hours. Nässén and Larsson (2015) conducted a marginal analysis of expenditure and time use in order to estimate a marginal net effect.

Our approach in this text adapts the second one from Nässén and Larsson (2015) in order to estimate the propensity to time use versus the marginal propensity to consume. Nässén and Larsson (2015) fit cross-sectional regressions on expenditure and time use. However, Gershuny (2003, p. 32) was right in stating that “[t]here is really only one way to see effects of change: to take repeated measures of the behaviour patterns of the same individuals. We can only ultimately identify change, by measuring changes”. We calculate the marginal propensity to time use by applying a regression analysis of time use. Data was taken from the longitudinal German Socio-Economic Panel³ (GSOEP) between 2008 and 2009. In order to derive a concise and equally differentiated picture of the substitution of expenditure, expenditure is estimated by a marginal analysis of the National Survey on Income and Expenditures in Germany for 2008. The data on resource use relies on calculations in an environmentally extended input output analysis of the total material requirements induced by the consumption of private households in Germany in 2005 (see Moll and Acosta 2006; Watson et al. 2013).

We start by defining the rebound effect according to Chitnis et al. (2014) as the percentage of offsetting actions ΔA in relation to expected savings ΔE .

$$\text{Rebound Effect} = \frac{\Delta E - \Delta A}{\Delta E} * 100 \quad (10.1)$$

For the estimation of potential rebound effects, we are in particular interested in the offsetting action ΔA . Simplifying, this could be expressed as the sum of the time effects ΔT and income effects ΔI . This means, more specifically, the total effect in

³The data used in this publication were made available to us by the German Socio-Economic Panel Study (GSOEP) at the German Institute for Economic Research (DIW), Berlin. Socio-Economic Panel (SOEP), data for years 1984–2012, version 29, SOEP, 2013, [10.5684/soep.v29](https://www.diw.de/en/soep) (see Wagner et al. 2007). We used the Panel Whiz-Addon for Stata v13.1 to compile and prepare the data (see Haisken-DeNew and Han 2010 for a documentation on Panel Whiz).

terms of resource use results from a new mix of activities and consumption patterns due to a changing disposability of time and income.

$$\Delta A = \Delta T + \Delta I \quad (10.2)$$

The income effect is defined as the product of marginal propensities to consume (MPC) and resource intensity r of consumption category k (in terms of kg/€).

$$\Delta I = \sum_{k=1}^n \text{MPC}_{ik} r_k \quad (10.3)$$

While the time effect results from the multiplication of the marginal propensities to time use MPT (in terms of h) with the resource intensity of time use category j (in terms of kg/h).

$$\Delta T = \sum_{j=1}^n \text{MPT}_{ij} r_j \quad (10.4)$$

In microeconomic terms, we derive Engel curves showing the relationship between a consumer's income and the goods bought.

$$\text{MPC}_{ik} = \frac{\partial c_{ik}}{\partial y_i} \quad (10.5)$$

The same propensities are defined for time use h along harmonised time use categories j depending on a marginal change of working hours l .

$$\text{MPT}_{ij} = \frac{\partial h_{ij}}{\partial l_i} \quad (10.6)$$

The resource intensities of consumption are defined as the ratio of total material requirement (TMR) per total expenditure C along Classification of Individual Consumption According to Purpose (COICOP) in Germany. The total material requirement induced by the German household consumption was calculated using the Environmentally Extended Input Output Analysis. For that a model that is based on the Leontief production function was applied. The applied model consists in the re-attribution of all materials globally extracted from the environment due to the global production for final consumption in Germany. By doing so the total direct and indirect material required along the whole production chain of each consumed product has been taken into account. Thus, each calculated value represents the resource footprint of the corresponding product group consumed by the households in Germany. The data on expenditure of the German households were extracted from the Eurostat database. For a detailed rationale of calculations of the total material requirement, please refer to Watson et al. (2013, annex A) and Moll and Acosta (2006) or Buhl (2014).

$$r_k = \frac{\text{TMR}_k}{C_k} \quad (10.7)$$

The definition of total material requirement per time use is more sophisticated. The total material requirement of time use is a re-allocation of the total material requirement of consumption along those harmonised time use categories. And the total time use H in category j is the average load of time use in Germany according to the National Survey on Time Use in Germany (see Buhl and Acosta 2016 for a more detailed description and Minx and Baiocchi (2010) for similar results on material intensities of activities).

$$r_j = \frac{\text{TMR}_j}{H_j} \quad (10.8)$$

The marginal propensity to consume in Eq. (10.5) is estimated using multi-variate OLS (ordinary least squares) regressions of expenditures c per category k on disposable income (as total expenditure budget) y and a vector of covariates X and an error term ϵ .

$$c_{ik} = y_i \beta_y + X_i \beta_X + \epsilon_i \quad (10.9)$$

The marginal propensity to time use in Eq. (10.6) is estimated using a panel regression according to Hausman-Taylor (1981) of time use h in category j on vector of time use X_1 , a vector of endogenous time-varying covariates X_2 , a vector of exogenous time-unvarying covariates Z_1 and a vector of endogenous, time-unvarying variables Z_2 . We follow Hausman and Taylors (1981) research rationale for defining the four subgroups of variables.

- X_{1it} exogenous, time-varying variables and potentially uncorrelated with μ_i such as time use for job, education, sleep etc.
- X_{2it} endogenous, time-varying variables and potentially uncorrelated with μ_i such as socio-economic characteristics like schooling years etc.
- Z_{1i} exogenous, time-unvarying variables and potentially uncorrelated with μ_i such as gender and birth cohorts
- Z_{2i} endogenous time-unvarying variables und potentially uncorrelated with μ_i are not identified.

Such an estimation fits well when benefits of instrumental variables and a within estimator (as in fixed effects models) are used, while time invariant characteristics are of interest. Theoretically, gender is crucial from a household production theory perspective. Druckman et al. (2012) considered time use and potential time-use rebound effects as a gender issue that is potentially disadvantageous to those who take care of potentially resource- and carbon-intensive reproduction activities.

The result is an Hausman-Taylor estimator (HT estimator) of marginal propensities to time use as a function of working hours l , exogenous time use X_1 , endogenous, time-varying socio-economics X_{2it} and time-unvarying, exogenous socio-demographics Z_i .

$$h_{it} = l_{it}\beta_l + X_{1it}\beta_1 + X_{2it}\beta_2 + Z_i\delta_i + \epsilon_{it} + \mu_i \quad (10.10)$$

The unknown parameters β_y and β_l are estimates of MPC and MPT. By substituting MPC and MPT in (10.3) and (10.4) with β_y and β_l in Eqs. (10.9) and (10.10), as well as substituting r_k and r_j from Eqs. (10.7) and (10.8) in Eqs. (10.3) and (10.4), we derive

$$\Delta I = \sum_{k=1}^n \beta_y \frac{\text{tmr}_k}{C_k} / \sum_{k=1}^n \frac{x_{ik}}{y_i} \frac{\text{tmr}_k}{C_k} \quad (10.11)$$

And for ΔT

$$\Delta T = \sum_{j=1}^n \beta_l \frac{\text{tmr}_j}{H_j} / \sum_{j=1}^n \frac{h_{ij}}{H_i} \frac{\text{tmr}_j}{H_j} \quad (10.12)$$

With average budget shares defined as the ratio of expenditures x_i in consumption category k and time use h_i in time use category j with respect to total expenditures C_i and total time H_i , respectively.

Replacing ΔI and ΔT in Eq. (10.2) of the offsetting action ΔA with Eq. (10.11) and (10.12) as well as substituting the expected savings ΔE with income effect ΔI and offsetting action ΔA , the rebound effect in Eq. (10.1) is thus

$$\text{Rebound Effect} = \frac{\sum_{k=1}^n \beta_y \frac{\text{tmr}_k}{C_k} / \sum_{k=1}^n \frac{x_{ik}}{y_i} \frac{\text{tmr}_k}{C_k}}{\sum_{j=1}^n \beta_l \frac{\text{tmr}_j}{H_j} / \sum_{j=1}^n \frac{h_{ij}}{H_i} \frac{\text{tmr}_j}{H_j}} * 100 \quad (10.13)$$

In this sense, the estimation considering time-use rebound effects does not differ from conventional rebound studies on energy efficiency rebound effects. For the latter, it is assumed that gains in energy efficiency lead to monetary savings by consumers, who then rearrange their expenditure due to income and substitution effects. Depending on the energy or greenhouse gas intensities of the new expenditure, rebound effects occur (see Sorrell 2010). For time-use rebound effects, it is assumed that gains in (labour) productivity may just as well be translated into time savings in terms of increased free time via a reduction in working time.

10.2 Results

First, the effect of a change in working hours on the allocation of time use is analysed (time effects). Second, the effect of a change in working hours on income and consumption patterns is analysed (income effects). Both time and income effects are then integrated in order to derive the net effect. The net effect of time and income effects constitutes the time-use rebound effect.

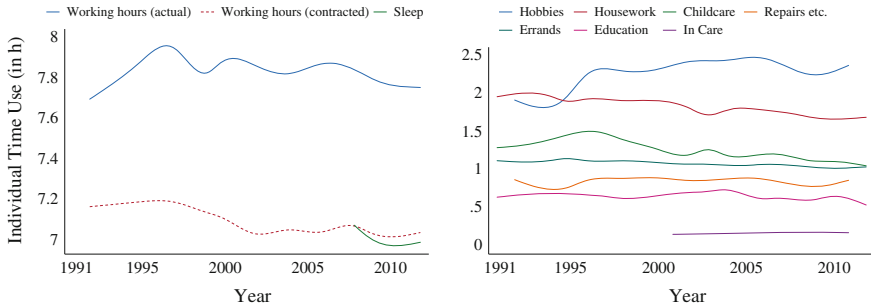


Fig. 10.1 Working hours and sleep (*left trends*) and other unpaid time use (*right trends*) in Germany between 1991 and 2012. *Data* German Socio-Economic Panel, v29

10.2.1 Time Effects

For the statistical description of time use we expand the analysis of time use in the German Socio-Economic Panel from 1991 to 2012. This enables us to show historical patterns of time use. In the following estimation of time and income effects, we focus on the years 2008 and 2009 in order to provide a consistent estimation of time and income effects alike.

But before, the descriptive statistics show that working hours (contracted as well as actual working hours) decreased during the past two decades. The same accounts for informal work and household production such as housework or child care. At the same time, time use for hobbies increased (Fig. 10.1). The historical trend thus suggests a shift from working hours in favour of hobbies.

Then, the question arises how those gains in free time are re-allocated and to what extent does this mean a shift from resource intensive to resource light time use. Based on the descriptive analysis (see Fig. 10.1), we hypothesise that time-use rebound effects play a major role when explaining (an observed increase in) intensive resource use in daily life despite relevant gains in free time. The following results from the stochastic estimations test the hypotheses at stake following the method described in 10.2 to estimate the marginal propensities to time use.

The coefficients in Table 10.1 show the marginal propensity for spending time in eight time use categories depending on working hours and socio-economic covariates that improve the fit of the model. All of the models derived demonstrate negatively correlated and highly significant effects of working hours on the time use categories. This result supports the predicted relationship between working hours and time use. A marginal increase in working hours leads to a reduction in all other time use categories outside labour, suggesting a potential for time-use rebound effects. Free time following a reduction in working hours is re-invested in the major time use categories. The greatest effects of re-allocation are visible in hobbies and child care, followed by housework, educational activities and sleep. A higher household net income leads to a significant reduction in time spent on child care

Table 10.1 Marginal propensity to time use in Germany from 2008 to 2009

	Sleep	Hobbies	Housework	Errands	Childcare	Repairs etc.	Education	In care
Job	-0.052*** (0.004)	-0.131*** (0.006)	-0.078*** (0.004)	-0.012*** (0.003)	-0.105*** (0.008)	-0.019*** (0.004)	-0.066*** (0.004)	-0.013*** (0.002)
Household net income	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000* (0.000)	-0.000** (0.000)	0.000 (0.000)	0.000 (0.000)
Household size	0.013 (0.028)	-0.096** (0.042)	0.007 (0.026)	-0.004 (0.020)	0.078 (0.054)	0.064** (0.025)	-0.029 (0.021)	0.029 (0.018)
With partner in hh	-0.074 (0.070)	-0.423*** (0.104)	0.008 (0.066)	-0.000 (0.051)	0.174 (0.136)	0.001 (0.062)	-0.082 (0.053)	-0.038 (0.044)
Children under 16 in hh	-0.062 (0.054)	-0.216*** (0.082)	0.104** (0.052)	-0.012 (0.040)	1.306*** (0.108)	0.018 (0.049)	-0.166*** (0.043)	-0.022 (0.035)
Schooling (in years)	0.039 (0.027)	0.087* (0.047)	-0.124*** (0.027)	-0.059*** (0.019)	-0.028 (0.057)	0.021 (0.024)	-0.505*** (0.026)	-0.005 (0.017)
Year of birth	0.001 (0.004)	-0.006 (0.007)	-0.012*** (0.004)	0.001 (0.003)	-0.040*** (0.011)	-0.029*** (0.004)	0.057*** (0.006)	-0.003 (0.003)
Male	-0.073*** (0.024)	0.303*** (0.034)	-0.890*** (0.020)	-0.139*** (0.015)	-0.695*** (0.056)	0.372*** (0.020)	0.105*** (0.045)	-0.031** (0.014)
<i>n</i>	16,590	16,590	16,590	16,590	16,590	16,590	16,590	16,590

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ *Note* Hausman-Taylor estimates, constant suppressed, standard errors in parentheses*Data* German Socio-Economic Panel v29 (waves 2008 and 2009)*Reading examples*A marginal increase of the time use for the job (one actual working hour) decreases the time use for hobbies by 0.13 (hour)
Males spend 0.3 h more for hobbies than females on an average

and repairs (see negative sign of effects), suggesting that higher income levels tend to outsource these household services. Once again, family status has a major influence. In particular, if children are still living in households, the parents have less time for hobbies and leisure activities, but more time for household production, such as household chores and child care. Gender exhibits highly significant effects in all of the time use categories, suggesting a major influence of gender on time use patterns. Females spend more time on household production such as errands, household chores and child care, whereas males spend more time on leisure, doing repairs and pursuing hobbies. The roles still tend to be traditionally distributed between men and women in Germany when it comes to household production. However, this finding is consistent with Druckman et al. (2012), who reported significant differences in resource implications between men and women for the United Kingdom.

As the aggregation of time use in main time use categories like hobbies does not indicate, time savings following a reduction in working time are diversely re-invested in leisure activities. It makes sense to take a closer look at the kind of hobbies for which time is spent. People spend more time with their friends and neighbours, followed by time spent for media, TV, radio and going out, eating and sports. It is worth mentioning that spending more time on hobbies does not lead to more trips being undertaken or family and relatives being visited more often.⁴

10.2.2 Income Effects

According to both Nässén and Larsson (2015) and Knight et al. (2013), account has to be taken not only of potential time effects, but also of potential income effects following a reduction in working time. The assumption that a reduction in working time only results in a re-allocation of time use does not hold true when the reduction in working time is accompanied by a loss of income. More realistically, a relevant and voluntary reduction in working time is associated with income loss, which potentially alters the consumption patterns of such households. Households re-allocate both monetary and temporal savings. Income and time effects are most probably correlated, i.e. the change in income affects the way time is spent. In our analysis of time effects, we control for income effects, meaning that a change in time use refers exclusively to a change in working hours, and explicitly not to an associated change in income. However, we do not know exactly how consumption patterns change due to a change in income.

The cross-sectional analysis shows that a marginal rise in income is associated with greater expenditure in all consumption categories along the internationally

⁴Since no time units are given for differentiated leisure activities in the data (GSOEP), the coefficients help us to differentiate and deal with the heterogeneous leisure activities of respondents and thus resource implications of time use (see Buhl and Acosta (2015) for a full presentation of the estimation results and respective coefficients).

harmonised Classification of Individual Consumption According to Purpose (COICOP) (see Table 10.2). Most income gains are spent on transport goods and services, followed by consumption in recreation and culture (including leisure and entertainment).

10.2.3 *Time-Use Rebound Effect*

The net effect of time savings and income loss following a reduction in working hours constitutes the rebound effect as described in Sect. 10.3 and noted in formula (10.13). The time-use rebound effect is basically the relation of the change in time use to the change in expenditures after a reduction in working hours. The bottom row in Fig. 10.2 shows Engel curves, presenting the relationship between a consumer's income and the goods bought. The slope of the Engel curve at any point is known as the marginal propensity to consume, and measures for a marginal change in income the ratio of the resulting change in the consumption of goods. The very same is calculated for a change in daily working hours (see top row in Fig. 10.2 and method in Sect. 10.3). Based on the concept of Engel curves and the corresponding marginal propensity to consume, we call the effect of a marginal change in working hours on time use the marginal propensity to time use. Fellner (2014) suggests to name the depiction of interdependent changes in time use T-Curves, referring to Engel curves as well.

We assume that a reduction in working hours is accompanied by a proportional drop in income. The drop in income then suggests a drop in expenditure. In contrast, a reduction in working hours leads to an increase in time use. Basically, a marginal decrease in the propensity to consume due to a loss of income is then cancelled out by a marginal increase in the propensity to time use due to time savings.

Finally, we add the triggered resource use of the marginal propensity to consume to the triggered resource use of the marginal propensity to time use. A marginal increase in time use due to a marginal decrease in working hours is responsible for a rise of 1.37 kg of resources used per hour. A marginal decrease in expenditure due to a marginal decrease in working hours is responsible for a decrease of 1.67 kg of resources used per Euro spent. In relative terms, this equals a marginal increase of 0.48 of resource use in relation to average time shares and a marginal reduction of 0.80 of resource use in relation to average expenditure shares. In other words, a marginal reduction in working hours is accompanied by a rebound effect of 59 %. Ultimately, a reduction in working hours is associated with relevant rebound effects, but still environmentally beneficial compositional effects, i.e. no backfire.

Table 10.2 Marginal propensity to consume along COICOP in Germany for 2008

	Food	Housing etc.	Transport	Clothing	Furnishing etc.	Health	Communi- cation	Education	Recreation and culture	Restaurants and hotels	Miscellaneous
Income	0.030*** (41.23)	0.125*** (36.17)	0.425*** (40.18)	0.036*** (40.85)	0.081*** (19.50)	0.074*** (24.51)	0.008*** (36.62)	0.006*** (8.89)	0.120*** (24.99)	0.048*** (39.65)	0.039*** (22.61)
HH size	247.155*** (118.19)	239.581*** (36.34)	-422.542*** (23.11)	54.413*** (27.30)	-44.987*** (5.81)	-93.651*** (16.34)	26.828*** (39.57)	41.977*** (27.52)	-23.680*** (2.77)	-30.010*** (10.93)	-1.729 (0.49)
Schooling	-3.189*** (7.15)	16.069*** (12.35)	-21.346*** (8.06)	7.011*** (16.73)	-3.644*** (2.96)	-18.644*** (16.48)	9.092*** (54.79)	1.973*** (5.70)	0.870 (0.65)	7.887*** (13.27)	2.017*** (3.06)
Age	3.451*** (38.67)	12.401*** (48.40)	-15.758*** (29.90)	-1.779*** (21.65)	-1.242*** (5.54)	4.312*** (20.75)	-0.525*** (17.24)	-1.624*** (27.06)	0.767*** (3.11)	-0.928*** (7.46)	0.562*** (3.84)
Male	34.128*** (9.35)	70.001*** (6.57)	-147.478*** (7.40)	-24.972*** (7.35)	-15.950* (1.88)	14.499* (1.85)	-4.292*** (3.21)	-14.347*** (5.78)	-0.910 (0.08)	91.386*** (19.44)	-28.838*** (5.56)
R ²	0.89	0.87	0.58	0.63	0.28	0.25	0.76	0.15	0.56	0.49	0.38
n	44,088	44,088	44,088	44,088	44,088	44,088	44,088	44,088	44,088	44,088	44,088

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Note OLS estimator, robust standard errors in parentheses
Data National Survey on Income and Expenditures 2008

Reading example A marginal increase in income (one Euro) increases spending on transport by 0.43 (Euro)

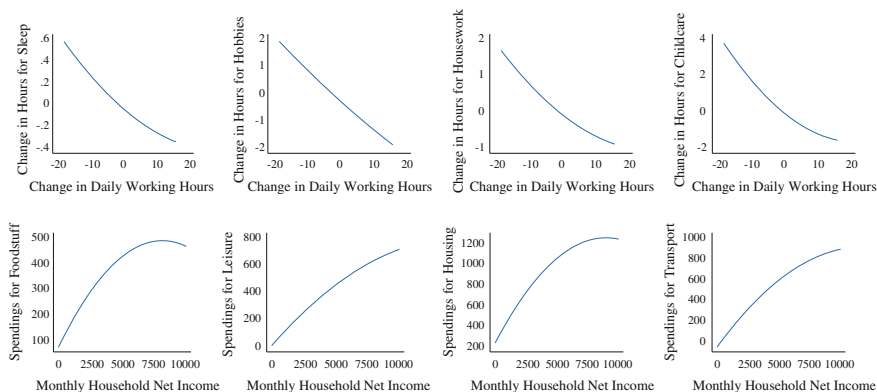


Fig. 10.2 Selection of predictions of the marginal propensity to time use (*top row*) and the marginal propensity to consume (*bottom row*). *Note* Quadratic prediction plots without confidence intervals. *Data* German Socio-Economic Panel v29, National Survey on Income and Expenditures 2008

10.3 Discussion

A comprehensive analysis across dimensions in terms of time use, expenditures and resource use naturally involves compromises and limitations. In order to integrate income and time effects, we had to rely on different data sets. In order to introduce leisure activities such as voluntary work in the stochastic analysis, we had to deal with different types of information, from ordinal to cardinal data. Leisure activities are only differentiated by frequency, not by time use. The analysis of time use is again restricted to 9 aggregated time use categories. Data on resource use is restricted to 12 main consumption categories along COICOP. For future research, consistent resource use and time use data with differentiated information, particularly about leisure activities, should be favoured. With respect to time use, we focus on everyday time use like hobbies. The national time budget surveys in Germany do not take irregular time use like vacations and longer holiday trips into account. But with respect to resource use, we take the complete resource use induced by private consumption into account and differentiate between main consumption categories like transport or leisure and recreation. On the one hand, this leads to overestimated resource use of the specific everyday time use due to overestimated resource intensities of the same. On the other hand, the unspecific data on resource use includes the rather irregular but environmentally relevant consumption like holiday trips and as such balances out the missing time use data to some extent. Still, information on both, regular, everyday time use and irregular time use would thus yield more consistent and differentiated estimates of time-use rebound effects. Furthermore, the estimation of the marginal propensity to consume relied on a cross-sectional analysis. However, a panel analysis would result in more efficient estimates of income effects, and event history data would yield more accurate

results of the effects of a reduction in working time on time budget reallocations. Moreover, the identification of resource intensities is static. In the wake of relevant shifts in time use patterns, a dynamic identification of the relationship between resource use and time use to corresponding intensities would result in an appropriate dynamic interpretation of time use shifts. Changing time use for practices that merely rely on durables (such as outdoor sports) is unlikely to exhibit a proportional increase in resource use.

It is worth mentioning that the time composition effect does not take into account the overall scale effect of working time reductions as a policy. A comprehensive reduction in working time may affect overall production and resource use in addition to domestic consumption. Knight et al. (2013) argue that a combination of scale and composition effects may result in more beneficial effects of reduced working hours.

We did not differentiate between a voluntary and forced reduction in working hours, e.g. as a result of a corporate policy dealing with demand shocks. As a result, we assumed mixed motives for reducing working hours in the sample. For the analysis of rebound effects, a differentiation of motives is not essential. Working less in favour of the environment is therefore not a condition for analysing rebound effects after a reduction in working time. People opt to reduce their working time in order to gain free time, just as consumers opt for energy-efficient (product) solutions to save money (among other motives). However, an interesting strand of future research would be to differentiate rebound effects according to motives. Ultimately, the findings fail to fully provide a deeper understanding of working time reduction as an extensive policy. The findings rely on individual and rather voluntary reductions in working hours. Moreover, we assumed a proportional drop in income due to the reduction in working hours. In a progressive wage taxation system, a reduction in working hours would reduce income loss disproportionately.

Considering the shortcomings, our analysis overestimates the magnitude of time-use rebound effects. Nevertheless, the analysis suggests that time-use rebound needs to be taken into account when evaluating environmentally driven policies involving a change in the working hours regime.

10.4 Summary and Conclusions

In our study, we analysed the widely promoted benefits of reducing working time in terms of environmental aspects. The literature on working hours within the scope of degrowth policies suggests reducing working hours to tackle environmentally unfriendly consumption patterns and job-related stress, and to achieve a satisfactory work-life balance. Hence, a reduction in working hours is expected to enhance social equity by redistributing working hours to informal social engagement. We opted to analyse micro data from national surveys on income, expenditure and time use. An analysis of micro data is suitable for comprehensively understanding

potential substitutions of daily practices and activities following a reduction in working hours.

We primarily analysed whether it holds true that—for the case of a rich industrialised country like Germany—a reduction in working hours leads to more low-resource activities in everyday life by applying an integrated model of time-use rebound effects. In this respect, the aim of the study was to account for both time and income effects. It is hypothesised that a gain in free time fosters a change in consumption patterns, in time use and expenditure towards more time-intensive but low-resource daily life.

A marginal estimation of the propensity to time use and to consume supports the findings that time effects may compensate for income effects to a relevant extent due to a reduction in working hours. The composition effect reveals relevant time-use rebound effects. The respondents reported shifts in time use in favour of hobbies, media consumption, going out as well as active sports. In addition and more strikingly, time use is re-allocated in favour of caring activities and household production, supporting the hypotheses that hours of paid work were substituted by informal work. The analysis revealed that a reduction in working hours leads to more informal work, care and intensified social relationships with friends and neighbours. However, taking leisure substitutions into account, the substitutions are in sum rather ambiguous from an environmental point of view. Substitutions in favour of resource-intensive hobbies and sports may lead to relevant time-use rebound effects in terms of the use of resources. Overall, the analysis showed that the environmental implications are not as clearly beneficial as expected when time-use rebound effects are taken into consideration. The analysis revealed environmentally ambiguous effects due to time-use rebound effects. Shifts in time use are still associated with resource-intensive consumption patterns. Nonetheless, in spite of non-trivial rebound effects, substitutions result in environmentally beneficial net effects due to reduced working hours.

The analysis shows that a reduction in working time could have positive effects on the environment. More time is typically spent pursuing leisure activities and in favour of informal work and social engagement, which is indeed associated with a triple dividend—low-resource, socially beneficial and individually satisfying activities. The effects suggested that a “smart” recomposition of time use may be associated with greater life satisfaction (see Knabe et al. 2010; Dunn and Norton 2013 on the subject and Buhl and Acosta 2016 for a detailed analysis). The co-benefits of rebound effects are an increase in life satisfaction since people have more time for their hobbies and leisure activities. More importantly, a reduction in working hours results in increasing social engagement (again, the detailed analysis can be found in Buhl and Acosta 2016). In this regard, the paper found evidence suggesting that it led to a more “amateur economy” (Nørgård 2013). Time-use rebound effects show that even amateurs are unlikely to live idly.

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revised according to helpful suggestions from the editors. The theoretical background on social acceleration and time-use rebound effects has been largely extended. The method and model to estimate time and income effects is given in full detail in the text. The empirical results have been extended by presenting historical trends of time use in Germany. The discussion of strengths and weaknesses of the underlying method and data has been elaborated to great extent as well.

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