Environment and Planning C: Government and Policy 2015, volume 33, pages 726 – 745

doi:10.1068/c12239

Would shorter working time reduce greenhouse gas emissions? An analysis of time use and consumption in Swedish households

Jonas Nässén, Jörgen Larsson¶
Physical Resource Theory, Department of Energy and Environment, Chalmers University of Technology, SE-412 96 Gothenburg, Sweden; e-mail: jonas.nassen@chalmers.se, jorgen.larsson@chalmers.se
Received 14 September 2012; in revised form 9 September 2013; published online 20 April 2015

Abstract. This paper addresses the effect of working hours on energy use and greenhouse gas emissions from private consumption. Time use and consumption patterns of Swedish households are analysed to estimate the effects of changing income and availability of leisure time. The results indicate that a decrease in working time by 1% may reduce energy use and greenhouse gas emissions by about 0.7% and 0.8%, respectively. These results are mainly because of the effects of lower income and lower consumption. The partly offsetting effect of households having more time available for leisure activities is less than a tenth of the income effect. In a sketched scenario we also elaborate on the long-term impacts of a work time reduction. A gradual reduction towards a 30-hour working week in 2040 would result in a significantly slower growth of energy demand, which would also make it easier to reach climate targets.

Keywords: time use, working time, consumption, energy use, greenhouse gas emissions, work time reduction

1 Introduction

The current mainstream discourse on society's transformation towards long-term climate targets is dominated by strategies for increasing the ecological efficiency of the economy. This includes primarily technological changes such as the substitution of fuels, improvements in energy efficiency, and the development of carbon capture and storage technologies. In contrast to these efficiency strategies, others have proposed the need for sufficiency (Princen, 2005), which also includes questioning the amount of production and consumption in affluent societies. The idea that a reduction in working hours would be beneficial for the environment has been put forward primarily by the environmental movement (Coote et al, 2010; Kasser and Brown, 2003), but it has also been introduced in some policy-oriented contexts. A UNEP report (2008, page 81) stated that:

> "channelling productivity gains toward more leisure time instead of higher wages that can translate into ever rising consumption also increasingly makes sense from an ecological perspective."

Sharing the available work and improving the work–life balance was also included as one of twelve policy steps for a sustainable economy as pointed out by the UK Sustainable Development Commission (Jackson, 2009; Victor, 2008).

This idea is especially forceful because a shorter working time has the potential for enhancing well-being. Well-being research has shown that the benefits of having a job are fundamental, but also that a short work week is more beneficial for well-being than a long work week (Alesina et al, 2005; Pouwels et al, 2008). The vast majority of French

¶ Corresponding author.

employees who attained the 35-hour work week said that their overall quality of life improved (Hayden, 2006). Cross-sectional studies have also shown that a shorter work week is strongly linked with lower levels of time pressure (Larsson, 2012; van der Lippe, 2007), which in turn is closely correlated with a higher overall subjective well-being (Kasser and Sheldon, 2009). Shorter work times also make more time available for, for example, socialising, exercise, and volunteer work—activities that have been shown to be more important for subjective well-being than a high level of material consumption (Layard, 2005). A Swedish experiment where 400 employees reduced their working time to 6 hours per day, over 18 months, not only showed positive effects on life satisfaction, but also resulted in better self-reported health, as well as more gender-equal time-use patterns with regards household work and childcare (Bildt, 2007).

1.1 Previous research

Despite the widespread interest in the potential environmental benefits of changing time-use patterns, there is only a small amount of previous research on these issues. The large field of time-use research has been focused on social rather than ecological issues. Minx and Baiocchi (2009) proposed that the integration of time-use data with the more frequently utilised monetary and physical environmental data has the potential to improve the analysis of lifestyles in several different ways. Time-use data may extend the scope of quantitative analysis to cover all activities, not only purchasing behaviour, and allow for the understanding of economic decisions in a wider social context. Time-use data may also serve as a quantitative framework to incorporate other models and data sources.

One of the first examples of this type of research is Binswanger (2001; 2004), who used Becker's (1965) approach of a household production function to show that time-saving innovations lead to an increasing demand for that service; for example, when roads are built and transportation becomes faster, the demand for mobility (and energy) increases. In a similar way Jalas (2002) illustrated time-use rebound effects, by looking at examples of measures in the ecoefficiency literature. One such example is the delivery services of food, which have been claimed to save both time and energy (since several households can be served by the same delivery service). The total energy effect depends on which activity increases when less time is used for grocery shopping and which energy use this activity is causing.

Schipper et al (1989) and Druckman et al (2012) estimated energy and carbon intensities per hour for different types of time use and found large differences between different activities. This implies that the total effect of a work-time reduction is dependent on how this time is allocated to other activities.

There are also a few macrolevel studies that specifically address the link between work time and environmental impacts with the use of cross-country comparisons. Schor (2005) conducted a rudimentary analysis using data from eighteen OECD countries, linking national ecological footprints and average hours per employee, and found a significant positive correlation. This result has been supported by other studies applying multivariate analyses and datasets with more countries. Economists Rosnick and Weisbrot (2007) conducted multivariate analysis of energy use in forty-eight countries, distinguishing between the effects of hours per employee, workers per population, population, and GDP per hour (productivity). Their results indicate that an increase in work hours per employee by 1% corresponds to an increase in energy use by as much as 1.3%. The sociologists Hayden and Shandra (2009) carried out a similar cross-country analysis but with ecological footprint as the dependent variable. In their main estimates an increase of work hours per employee by 1% corresponds to an increase in ecological footprint by 1.2%. Finally, Knight et al (2013) conducted a panel analysis of carbon footprint [greenhouse gas (GHG) emissions from consumption] in twenty-nine OECD countries between 1970 and 2007 and found a response of 1.3% increase in carbon footprint for an increase in work hours by 1%.

In contrast to the studies mentioned above, in this paper we aim to contribute to the understanding of the links between work hours and sustainability by using a microlevel analysis. To our knowledge there are no previous studies of this issue at the household level. We have carried out a cross-sectional analysis—on Swedish households—to understand how a change in working time affects energy use and GHG emissions via changing income and time-use patterns. The methodology is described in section 2, followed by results in section 3. Section 4 contains a discussion, including a sketched scenario based on the results. Finally, conclusions are drawn in section 5.

2 Method

A change in the number of working hours can have many different consequences. In this paper we explore the effect on consumption through changing income and time-use patterns. Figure 1 illustrates these relationships.

Microdata, including both time use and expenditures in the same dataset, are not available. Instead, we have carried out an analysis in two steps. In the first step we use data from the Swedish Household Budget Survey to analyse how energy use and GHG emissions depend on the income level through the changing amount and composition of private consumption (section 2.1). In the second step we use data from the Swedish Time Use Survey to analyse how a change in the availability of leisure time may affect the composition of private consumption and hence energy use and emissions (section 2.2).

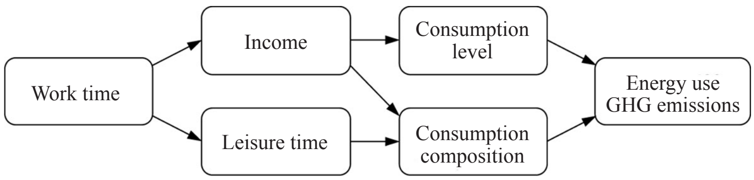

Figure 1. Model of links between working time, consumption, energy use, and greenhouse gas (GHG) emissions. Arrows should be read as ‘affects’.

2.1 Income effect

A general reduction in working hours in the future would limit the income gains that otherwise would be possible because of the productivity improvements in the economy. Here, we assume that a change in working hours results in a proportional change in income; that is, a reduction of working time by 1% would also reduce income by 1%. This may not be the case for the individual. Overtime pay may, for example, be higher than the average salary, while marginal tax rates may also be higher. However, unless working time affects productivity, an increase or decrease of the amount of hours worked in the economy should, at least in the long term, correspond to approximately the same change in private income. Studies on the potential effects of working time on productivity are inconclusive and indicate the effects could go either way. Positive effects may be that a decreased working time can trigger more efficient work procedures, and that workers may be more thoroughly rested and therefore more effective; whereas a negative effect is that capital utilisation might go down (Anxo and Bigsten, 1989). Therefore, we have assumed that work-time reductions do not affect productivity.

In this part of the analysis we estimate the relationship between income, energy use, and GHG emissions for Swedish households. The regression model is described in section 2.1.1, and the datasets in section 2.1.2.

2.1.1 *Regression model of income effect*

The estimation of the income effect is based on a multivariate linear regression (ordinary least squares) modelling of energy use and GHG emissions from Swedish households according to equation (1):

$$\ln E = C + a_1 \ln Y + a_2 S + a_3 K_{0-6} + a_4 K_{7-19} + a_5 A + a_6 U + a_7 H + a_8 L\,, \qquad (1)$$

where E represents energy use and Y represents income. Hence, the regression coefficient a_1 is the elasticity of energy use with respect to income. If Y increases by 1%, E increases by a_1%. C is a constant. The variables for cohabitation (S) and children in different ages (K_{0-6}, K_{7-19}) are included to control for the fact that large households consume more (and earn more) than smaller households. We do not want to allocate this effect to the income effect from a change in working time. We also include a number of other control variables that may affect consumption patterns in different ways and that may therefore impact the estimate of the income effect: age (A), education level (U), house type (H), and living in a large city (L) (see table 1). Similar models have been used previously to explain the energy use of households in other countries. For example, Lenzen et al (2006) found significant positive coefficients for the variables 'single-family house' and 'age', and significant negative coefficients for 'urbanity' and 'level of education'.

Because we use the logarithmic form of E and Y, the regression coefficient a_1 is the elasticity of energy use with respect to income. If Y increases by 1%, E increases by a_1%. The same model is also used but replacing energy use with GHG emissions as the response variable. In order to interpret the results from the aggregated level, the model is also run for seven different categories of consumption: direct energy use, housing, food, transport services, other services, durable goods, and nondurable goods (these categories are described in the appendix).

Table 1. Description of variables used in the regression model.

Variables		
Response variable		
E	energy use	total annual energy use per household, including both the direct use of fuels and the indirect energy use embedded in consumed products and services
G	GHG emissions	total annual CO_2-equivalent emissions (CO_2, CH_4, N_2O) per household; includes direct and indirect emissions from energy use, agriculture, and industrial processes, but not from deforestation
Explanatory variable		
Y	income	approximated by total annual expenditures
S	cohabitation	two or more adults living in the household (reference: single household)
K_{0-6}	child 0–6 years	at least one child of preschool age (0 to 6 years old)
K_{7-19}	child 7–19 years	at least one child of primary or secondary school age (7 to 19 years old)
A	age	average age of adults in the household
U	high education	at least one adult with an education from college or university
H	single-family house	household live in a single-family (detached or row) house (reference: apartment)
L	large city	household live in Stockholm, Göteborg, or Malmö (>250 000 inhabitants)

Note: GHG = greenhouse gas; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide.

2.1.2 *Datasets on consumption, energy use, and GHG emissions*

This analysis is based on data from the Swedish Household Budget Survey for 2006 (Statistics Sweden). Both consumption and time-use patterns for a person are heavily influenced by the income and time use of his or her partner. If someone has a partner who is not working at all, this effect is subsequently much stronger than if one has a working partner. Thus households with one or more unemployed or retired adult(s) were excluded from the set, leaving 1492 households in the sample. This dataset contains expenditure data on ~800 different goods and services. In this study, however, we use an aggregation level of 104 types of goods and services because these can be matched with available intensities of energy use and GHG emissions. These categories include direct energy use, housing, food, transport services, other services, durable goods, and nondurable goods, as listed in the appendix.

Energy use and GHG emission data are taken from an input–output analysis from Statistics Sweden's Environmental Accounts.[1] In this methodology primary energy use and carbon dioxide (CO_2) equivalents [global warming potential (GWP) over a hundred years for CO_2, methane, and nitrous oxide] per unit of final consumption are calculated with the use of monetary transactions between sectors, together with multipliers of direct energy use and emissions in each sector. Thus the method reallocates energy use and emissions from production sectors where they occur to the final consumption of goods and services, including indirect contributions from an unlimited number of upstream sectors. In addition to the convenience of matching expenditures with emissions, the main strength of input–output analysis is that it avoids double counting and omission of upstream emissions, which may occur in process-based life-cycle analysis (Nässén et al, 2007). This makes it a suitable approach when the purpose is to analyse the total budget of emissions. However, for the allocation of production emissions between different products and services, errors may occur from the assumptions of homogeneity (only one product per sector) and proportionality (a fixed relationship between energy use and expenditures).

The energy use and GHG emissions for imported goods and services have been calculated as if they have been produced domestically. Because the Swedish energy system, particularly the electricity sector, is relatively low in CO_2 emissions,[2] this results in an underestimation of the emissions for imported goods (Carlsson-Kanyama et al, 2007). These errors may be significant in absolute terms, but less important for comparisons between households or for relative changes over time. The underlying method for the compilation and analysis of input–output matrices is well described in a publication by the United Nations (1999).

The database used from Statistics Sweden's Environmental Accounts contains only primary inputs of fossil fuels and bioenergy and the final demand of electricity and district heating. Inputs of nuclear, hydro, and wind power have been added in accordance with their respective shares of electricity generation in Sweden.[3]

(1) Available from http://www.mir.scb.se

(2) The Swedish electricity mix provided from the Mirdata database is 24 $gCO_2e\ kWh^{-1}$, which can be compared with ~400 $gCO_2e\ kWh^{-1}$ for average electricity production in the EU-27 (Gode et al, 2009).

(3) Primary energy for electricity has been calculated with efficiencies of 0.37 for nuclear and thermal power. For hydro and wind, primary energy is calculated as produced electricity plus internal energy use. This gives a total weighted average conversion efficiency of 0.52 from primary energy to electricity. The partial substitution method, in which all electricity is calculated as if it had been produced in thermal power plants, would have resulted in higher estimates of primary energy.

2.2 Time effect

As shown in figure 1, in addition to affecting the budget for consumption (section 2.1), a change in working time also affects the available leisure time for other activities, which may in itself affect the relative composition of consumption and by that also energy use and GHG emissions. The time effect can be calculated according to equation (2):

$$\text{time effect} = \frac{\sum_{i=1}^{10} e_{i,1} T_{i,1}}{\sum_{i=1}^{10} e_{i,0} T_{i,0}}, \qquad (2)$$

where $T_{i,0}$ and $T_{i,1}$ are the time use on categories i before (0) and after (1) a change in time use, and e_i is the energy intensity of the different activities.

To calculate this effect, we need to estimate first how a reduction in working time is converted to increases in other categories of time use. The regression model used for this purpose is presented in section 2.2.1. Second, in order to evaluate the effects of these changes in time use, we also need to estimate values of energy use and GHG emissions per unit of time. The method of allocation energy and GHG emissions to different activities is described in section 2.2.2.

2.2.1 *Time-use regression model*

The time effect is analysed with data from the Swedish Time Use Survey 2000/01 (Statistics Sweden). In this survey the time use was described for every ten minutes and coded into 134 types of activities. In this study we have aggregated this into ten time-use categories: work, domestic work, childcare, personal care (including sleep), sports or outdoor activities, entertainment and culture, socialising, TV/radio/reading, hobbies, and travel. As in the analysis of the income effect, we have excluded households where one or more of the adults were unemployed or retired. We have also excluded households where all adults did not participate in the study because one partner's working time may also affect the time-use patterns of the other partner (eg, if one partner works more, then the other does more of the domestic work). In order to capture such effects, we have aggregated the time use of the adults living within the same household. In total, the time-use analysis is based on data from 636 households, covering data from 872 individuals. Of these individuals, 474 are cohabiting, and data from both adults are included. In addition to this, the analysis includes 398 individuals living as the only adult in the household.

The regressions are run with the time use of i different time-use categories T_i as the response variables.

$$T_i = \mathrm{C} + b_1 T_{\text{work}} + b_2 Y + b_3 S + b_4 K_{0-6} + b_5 K_{7-19} + b_6 A + b_7 U + b_8 H + b_9 L\,. \qquad (3)$$

For the aims of this paper, the most important explanatory variable in equation (3) is working time T_{work}, but we also control for the same set of parameters used in the income regression [see equation (1) and table 1]. The model establishes a linear relationship between working time and the other time-use categories, where the change in working time equals the sum of the change in the other time-use categories.

2.2.2 *Calculating energy use and GHG emissions from time use*

In a similar way to previous attempts to estimate the energy or carbon intensities per hour for different activities (Druckman et al, 2012; Jalas, 2002; 2005; Schipper et al, 1989), we constructed an allocation matrix where expenditures, energy use, and GHG emissions of

104 different items (the data used to calculate the income effect) are allocated to ten categories of time use.[4] The allocation is based on the following assumptions:

- A large number of expenditure items have been assumed to be independent of time use: housing, heating fuels, food, clothes, furniture, package holidays, day care, insurances, and other services. For example, we do not expect people to eat more because they spend more time eating.
- Vehicles, transport fuels, and travel tickets are allocated to travel time.
- Electricity consumption is first divided on end use based on energy statistics (SEA, 2008):
  - Electric heating is assumed to be independent of time use (as for other types of heating).
  - Lighting is allocated on the basis of the time of activities at home and awake.
  - Electricity for household appliances is allocated to time for domestic work.
  - Electricity for computers is allocated to time for hobbies or other leisure time.
  - Electricity for radio and TV is allocated to time for TV/radio/reading.
- Household appliances and tools are allocated to time for domestic work.
- Telephone and telephone services are allocated to time for socialising.
- Major durables for outdoor recreation (eg, boats), sports equipment, and services are allocated to time for sports or outdoor activities.
- TVs, radios, books, and papers are allocated to time for TV/radio/reading.
- Photographic equipment, computers, music instruments, games, toys, and gardening equipment are allocated to time for hobbies or other leisure time.
- Appliances and products for personal care are allocated to time for personal care.
- Coffee, tea, cocoa, soft drinks, and alcohol are assumed to be partly independent of time use (as for the assumption for food) and partly allocated to time for socialising.

The above allocation of expenditures and energy use to different categories of time provides fixed intensities of expenditure per hour (SEK h^{-1}) and energy per hour (MJ h^{-1}). This would imply that $e_{i,1}$ equals $e_{i,0}$ in equation (2). However, fixed intensities would imply that expenditures (and with it energy use) would always increase with more available leisure time, which is not possible because of the income constraint (expenditure should not exceed income)

In reality, the expenditure and energy intensities for some activities are not necessarily fixed. With more time available, some types of activities may be 'dematerialised' by a more extensive use of equipment (more frequent tennis playing with the same racquet, or a longer night's sleep in the same bed), while the expenditures and energy use of other activities are proportional to time use. Therefore, we have divided the activities into two types:

Type 1: activities where expenditures and energy use are directly linked to the time spent: travel; entertainment and culture; TV/radio/reading; domestic work. With this assumption, two hours of, for example, car travel or lawn mowing always results in twice as much energy use as one hour.

Type 2: activities where expenditures and energy use do not have to increase in proportion to the time spent on them: childcare; personal care; sports or outdoor activities; socialising; hobbies. Compared with type-1 activities, these activities depend less on the total amount of time spent and more on *how* they are performed.

In order to ensure that the total expenditures do not exceed income, the expenditure intensities (SEK h^{-1}) related to the type-2 activities are scaled down by multiplication of an

[4] In the input–output methodology (section 2.1.2) energy use and GHG emissions in the production sectors are allocated to the final consumption of the goods and services. Energy use and GHG emissions from a person's activities at work—for example, business flights—are considered as production and are therefore not included in his or her personal energy use and GHG emissions. Including them would lead to double counting because these emissions are allocated to the people that buy products from this company.

adjustment factor. The same factor is used to adjust the energy intensities of these activities so that $e_{i,1} < e_{i,0}$ as used in equation (2).

3 Results

Following the order of the method section, the results are presented with the income effect in section 3.1 and the time effect in section 3.2. In section 3.3 these results are summed together into the total effect of changing working hours.

3.1 Income effect

The relationship between income level, energy use, and GHG emissions is presented in table 2. Model 1 contains only income and variables representing the size of the households, whereas model 2 also contains a set of control variables as described in table 1. Because the regressions are estimated by means of the logarithmic form [equation (1)], the coefficients in the first row of the table represent the elasticities of energy use and GHG emissions with respect to income. Hence, using model 1, an increase in income (approximated by total expenditure; see table 1) by 1% corresponds to an increase in both energy use and GHG emissions by 0.84%. Adding the control variables reduces these estimates to 0.80% for energy use and 0.82% for GHG emissions. In particular, the binary variable for dwelling type adds to the explanatory power of the model and a part of the income effect appears to be mediated through this variable. This effect is stronger for energy use than for GHG emissions, probably because a lot of the extra energy use from households living in single-family houses is heating and electricity with low carbon emissions (see section 2.1.2). The resulting elasticities as well as the overall fit of the model are similar to findings from previous studies on household consumption in other countries (Kerkhof et al, 2009; Lenzen et al, 2006; Roca and Serrano, 2007).

It is worth noting some of the other results of the regressions in table 2—for example, that households living in single-family houses cause significantly higher energy use and GHG emissions than households living in apartments. Moreover, households in large cities are

Table 2. Results from the multivariate ordinary least squares regressions, with energy use and carbon dioxide equivalents [greenhouse gases (GHGs)] as the response variables. Regression coefficients are presented together with significance levels. Model 1 contains only income and variables as representing the size of the households. Model 2 also contains a set of control variables as described in table 1.

Variable	Energy use (log)		GHG emissions (log)	
	model 1	model 2	model 1	model 2
Income (log)	0.844***	0.797***	0.842***	0.818***
Cohabitation	0.317***	0.136***	0.267***	0.183***
Child 0–6	−0.053**	−0.008	−0.095***	−0.062***
Child 7–19	0.092***	0.018	0.066***	0.033**
Age		0.005***		0.004***
Higher education		−0.027		−0.010
Large city		−0.036*		−0.018
Single-family house		0.422***		0.188***
N	1492	1492	1492	1492
Adjusted R^2	0.727	0.838	0.813	0.845

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed test).

found to use less energy than other households while, for example, the level of education is not significant in the regressions.

Table 3 provides the results for income elasticities for different consumption categories. Compared with the average consumption, the marginal consumption has a relatively small share of direct energy use (elasticity of 0.47) and a large share of durable goods—for example, vehicles, furniture, and electronics (elasticity of 1.95). As is shown by the right column of the table, direct energy use has, by far, the highest energy intensity while all other categories have energy intensities below the total energy intensity of consumption. Hence, this relative shift in consumption from fuels to other things is the reason why the total income elasticity is below 1.

The explanatory variables of the regressions have been tested for multicollinearity by means of variance inflation factors (VIFs). The VIFs are low for all variables, with the highest value of 1.5, indicating no problem with multicollinearity.

Table 3. Elasticities of energy use in different consumption categories with respect to total expenditures together with energy intensities. The model used to estimate elasticities is the same as in table 2. The products and services included in each category are listed in the appendix.

Category	Income elasticity	Energy intensity, MJ/SEK
Total energy use	0.80***	1.10
Direct energy use	0.47***	5.73
Housing (excluding direct energy use)	0.51***	0.40
Food	0.69***	0.84
Transport services	1.02***	0.97
Other services	0.78***	0.32
Durable goods	1.95***	0.51
Nondurable goods	0.98***	0.69

*** $p < 0.001$ (two-tailed test).

3.2 Time effect

Table 4 gives the results of the time-use regression analysis for nine time-use categories as described in section 2.2.1. The main results of interest, within the scope of this paper, is how these time-use categories depend upon work time, after controlling for the other explanatory variables. These results are presented in the upper row of table 4.

The regression coefficients of work time for the nine regressions can be used to divide a ‘marginal hour’ into different activities. This is presented in table 5, along with average time use and intensities of energy use and GHG emissions.

The column with marginal time use illustrates how one hour of less work is divided between the other activities (calculated from the results in table 4). When one type of time use decreases, other types of time use will increase. About 18 minutes are used for personal care (sleep, eating, and hygiene) and 12 minutes are used for domestic work. Together, these two categories account for half of the marginal time. A further 8 minutes are used for TV/radio/reading, 7 minutes for socialising, and 6 minutes for hobbies. The 3 minutes for childcare is an average number, being much higher for parents. From an energy point of view, the most interesting finding is that the marginal travel time of 3.5 minutes per hour is almost identical to the average share. These results are well in line with the results of Gershuny (2003), which are based on similar cross-sectional calculations of marginal time use.

The figures in the columns with energy intensities and time use for different activities are illustrated in figure 2. The area below the broken line represents energy use, which we have

Table 4. Results from the multivariate ordinary least squares regressions with different time-use categories as the response variables. Regression coefficients presented together with significance levels and *t*-values in parenthesis. The regressions are estimated using heteroscedasticity-robust standard errors. The explanatory parameters are described in table 1.

Category	Domestic work	Childcare	Personal care	Sports etc	Entertainment and culture	Socialising	TV/radio/ reading	Hobbies	Travel
Work time	−0.183***	−0.039***	−0.281***	−0.032*	−0.020***	−0.101***	−0.129***	−0.091***	−0.054***
	(−8.56)	(−3.86)	(−10.0)	(−2.34)	(−3.27)	(−4.40)	(−5.58)	(−4.69)	(−3.48)
Income	−0.005	−0.002	−0.002	0.002	0.001	0.002	−0.007*	0.004	0.001
	(−1.73)	(−1.52)	(−0.46)	(1.31)	(0.77)	(0.65)	(−2.22)	(1.44)	(0.44)
Cohabitation	−21.4	−8.11	150	83.0	−8.55	−87.0	249**	−148**	119
	(−0.26)	(−0.20)	(1.65)	(1.41)	(−0.42)	(−1.11)	(2.92)	(−2.76)	(1.95)
Child 0–6	568***	939***	-446***	−291***	−25	−176	−367***	−181**	73.0
	(6.08)	(15.0)	(−3.48)	(−5.11)	(−1.02)	(−1.75)	(−3.85)	(-2.74)	(1.04)
Child 7–19	467***	424***	−238**	−106*	20.8	−250**	−217*	−171***	88
	(5.70)	(9.36)	(−2.69)	(−2.23)	(0.83)	(−2.93)	(−2.56)	(−3.62)	(1.61)
Age	28.0***	1.030	−15.1***	-3.90	−2.09*	−4.27	5.39	0.058	−8.9***
	(8.50)	(0.90)	(−4.12)	(−1.87)	(−2.32)	(−1.31)	(1.57)	(0.02)	(−3.85)
Higher education	−87.3	32.4	31.0	117*	27.8	63.5	−152*	−47.3	−14.9
	(−1.26)	(0.91)	(0.38)	(2.32)	(1.37)	(0.84)	(−1.96)	(−1.11)	(−0.29)
Large city	−138	5.71	84.8	−81.7	−9.69	30.2	13.8	−94.5*	193***
	(−2.00)	(0.16)	(1.01)	(−1.77)	(−0.45)	(0.39)	(0.17)	(−2.26)	(3.73)
Single-family house	217*	42.4	−62.9	−65.4	4.2	−186*	14.8	22.1	31.3
	(2.34)	(0.89)	(−0.65)	(−1.19)	(0.18)	(−2.25)	(0.17)	(0.37)	(0.54)
Adjusted R^2	0.296	0.395	0.186	0.043	0.016	0.051	0.081	0.086	0.063
N	636	636	636	636	636	636	636	636	636

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed test).

Table 5. Average and marginal time use, together with energy intensities and carbon-dioxide (CO_2) equivalent intensities.

	Time use		Energy intensity, MJ per capita per hour	GHG intensity, $kgCO_2$ equivalent per capita per hour
	average min h^{-1}	marginal min h^{-1}		
Work (energy intensity: home heating, etc, while at work)	15.1	−60.0	8.9	0.41
Domestic work	5.5	11.8***	34.3	0.72
Child care	1.2		10.2	0.42
Personal care (sleep, eating, hygiene)	24.6	18.1***	11.5	0.48
Sports, outdoor, and participatory activities	1.4	2.1*	19.4	0.98
Entertainment, and culture	0.2		54.8	2.57
Socialising	2.4		24.1	1.16
TV/radio/reading	5.0		19.4	0.54
Hobbies	1.1		43.0	1.95
Travel	3.4		91.9	5.10

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed test).
Note: GHG = greenhouse gas.

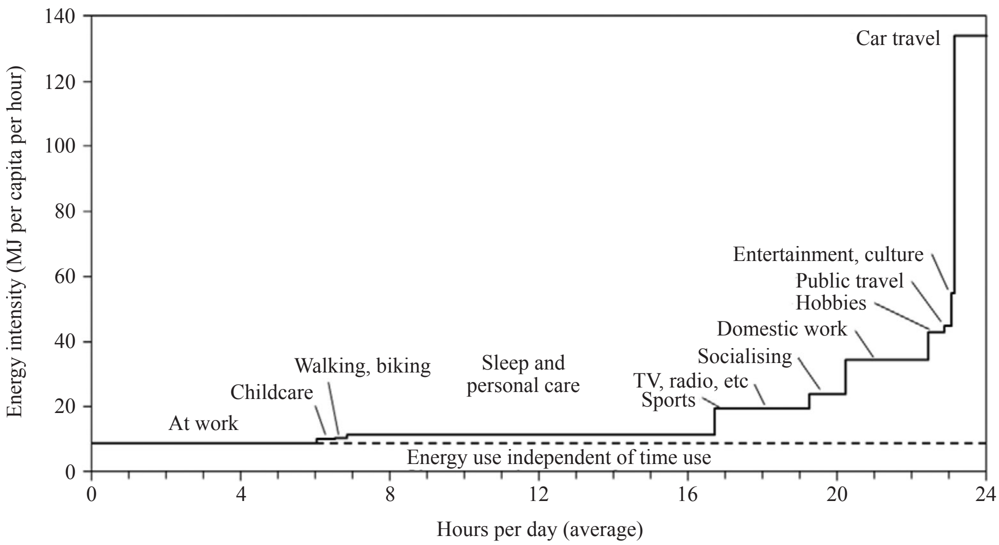

Figure 2. The energy use of different activities during an average day. Energy use below the broken line is considered to be independent of how time is spent (eg, space heating). This is the level of private energy use while at work.

assumed to be independent of time use (8.9 MJ per capita per hour); for example, energy for the heating of one's home (see section 2.2.2). For example, energy use for domestic work is made up by energy use, which is independent of time use plus energy for cooking, washing, etc (a total of 34.3 MJ per capita per hour). Energy use coupled to the work itself (production) is not included here as this would lead to double counting (energy use from production activities is included indirectly in the energy intensities of consumption).

What does this mean for the time effect on energy use? A direct use of the energy and CO_2-equivalent intensities from table 5 would imply that a reduction of work time by 1%

would increase energy use by 0.23% and GHG emissions by 0.21%. But this is unrealistic because this way of using the new spare time would mean that the total expenditure would exceed income. Therefore, with the method described in section 2.2.2, the expenditure intensities (SEK h^{-1}) for type-2 activities (those where energy use is not directly proportional to time use), and with that the energy and GHG intensities, have been adjusted so that the total expenditures do not exceed income. The resulting isolated time effect (the income effect is analysed separately in section 3.1) is that a decrease in work time by 1% causes an increase in energy use by 0.06% and an increase in GHG emissions by 0.02%.

3.3 Total effect of a change in working hours

The results from section 3.1 and 3.2 are summarised in table 6. It is assumed that an increment in working time by 1% is associated with a proportional increment in disposable income. The total effect on energy use and GHG emissions is estimated as the sum of the income and time effects.

Table 6. Summary of results on income and time effects. The total effect is the sum of these effects for energy use and greenhouse gas emissions, respectively. The numbers show the outcome of a decrease in work time by 1%.

Effect type	Effect of shorter working hours by 1% on:	
	energy use (%)	CO_2 equivalents (%)
Income	−0.80	−0.82
Time	0.06	0.02
Total	−0.74	−0.80

Note: CO_2 = carbon dioxide.

4 Discussion

The results from this analysis of Swedish households indicate that people who work less also cause less energy use and fewer GHG emissions. This points in the same direction as previous studies that use cross-country comparisons (Hayden and Shandra, 2009; Knight et al, 2013; Rosnick and Weisbrot, 2007). However, the estimated effect from our microlevel analysis is that a decrease in working time by 1% corresponds to 0.7%–0.8% less energy use and GHG emissions, which can be compared with effects of more than 1% in all of the macrolevel analysis: 1.3% for energy use in Rosnick and Weisbrot (2007); 1.2% for ecological footprint in Hayden and Shandra (2009); and 1.3% for carbon footprint (consumption-based GHG emissions) in Knight et al (2013).

It is difficult to give a simple explanation to why the results of the microlevel and macrolevel analyses differ. We see no obvious mechanisms that would imply effects as high as those found in the macrolevel analysis. Cross-country estimates of the elasticities of CO_2 emissions with respect to expenditures have been estimated to be around 0.8% (Hertwich and Peters, 2009), which is more in line with our microlevel results. We expect that a gradual reduction in working hours over time would have smaller effects than our cross-sectional estimate. We discuss this further in the sketched scenario presented in section 4.2.

4.1 Limitations

The empirical analyses conducted in this paper are highly constrained by the availability of data. Statistics Sweden conducts detailed surveys on both consumption and time use, but not for the same sample of individuals. Because consumption is not available in the time-use survey, we had to rely to a large extent on the household budget survey from which it is relatively straightforward to estimate energy use and emissions. The time-use survey was then used to assess to what degree changes in the time budget itself could cause effects beyond those through income. This is what we term the time effect. This second step of the analysis relies on a large number of assumptions about how different consumption categories are allocated to different time-use categories (section 2.2.2).

Because the income effect is handled separately, a large time effect may occur only if the marginal time use was to differ significantly from the average time use with respect to activities with high energy intensities (high MJ h^{-1}). This implies that the most sensitive assumptions concern the time used for car transport. The time-use regressions show that the share of travel time is about the same for marginal time use as it is for average time use. However, the available microdata do not contain different modes of travel, and hence the energy intensity was based on the average times for travel (62% by car, 15% by public transport, 23% by bicycle or on foot). If all of the marginal travel time had been by car, the total time effect would then have been 0.07% for energy and 0.04% for GHG emissions; and if all of the marginal time use had been by foot, then it would have been 0.03% for energy and −0.03% for GHG emissions. These changes are still small in relation to the income effect.

The analysis is also limited by the data to a constant five-day working week. It is likely that a change in working hours, in some cases, would also mean a change in the number of work days. A four-day working week would decrease the time spent on commuting, but three-day weekends may also result in longer weekend trips. Hence, the effect of the number of work days needs further research.

Another apparent weakness of the study is that the results for both income effects and time effects are based on cross-sectional datasets that analyse differences between households and not actual changes. Real changes in individuals' time use and consumption may give different results. However, such analyses would require panel data of households, which are currently not available.

Finally, the two different surveys we employ here are for different years (2006 for the household budget survey and 2001 for the time-use survey). However, because time-use and consumption patterns develop relatively slowly and because no major economic fluctuations occurred in this period, we do not expect this to be any serious limitation of the study.

4.2 Scenario discussion

Because work time appears to have such a large impact on energy use and GHG emissions, it is interesting to dwell on the development over time. In this section we will sketch two scenarios of work time and energy use (scenarios for GHG emissions would require assumptions regarding future changes in the mix of energy supply, and that is outside the scope of the current study). These scenarios are simplified—they are based on our microlevel results without taking into account the dynamic effects on labour markets or prices.

In the first scenario (the baseline scenario) all of the expected productivity improvements are channelled into increased income and consumption. In the second scenario half of the productivity improvement is used to reduce the length of the working week, resulting in a slower growth in consumption. This differs from proposals to shorten work hours with unaffected salaries, where the reduction in work time would be financed by the company owners and through higher productivity levels (Kallis et al, 2013).

We also assume that, because of a slower exchange of products, the second scenario suffers from a slightly slower improvement in technical energy efficiency. Another important aspect is whether work time reductions lead to lower unemployment—something which is often called work sharing. Some economists have argued that this is not possible (Fitzgerald, 1996; Konjukturinstitutet, 2002) and that the 35-hour work week in France did not lower unemployment (Estevão and Sá, 2008; Hayden, 2006). However, a research overview of the effects of work hour reductions on employment in different European countries found that "most studies conclude that working time reductions have positive employment effects of 25–70 percent of the arithmetically possible effect", while only a few studies found zero or negative effects (Bosch, 2000, page 180). On the basis of this, we assume that 30% of the reduced hours are carried out by someone else. Although this is a socially desirable effect, it reduces the ecological benefits of a shorter working week. The scenarios are for the year 2040 starting at 2010. The two scenarios are described in table 7.

In these rather simple scenarios a reduction of the working week from 40 to 30 hours would result in a significantly slower growth of energy demand, when compared with the scenario with a constant working week (9% instead of 25%). The results are in line with a similar scenario analysis by Rosnick (2013). Another possible benefit with this scenario is reduced unemployment as the result of the work sharing component. Total private consumption increases by only 45% in the 30-hour working week scenario, as opposed to 78% in the 40-hour working week scenario. However, there are several uncertainties in these scenarios. For example, if the 'technological penalty' in terms of slower energy efficiency improvements was to be higher than in our scenarios, then energy savings would be smaller. Another uncertainty is the work sharing parameter. If shorter working weeks do not reduce unemployment at all [which is argued for in Konjukturinstitutet (2002)], then the positive environmental effect would be larger.

Table 7. Scenarios of working time and energy use.

Scenario	Baseline	Shorter work time	Comments
Inputs			
Productivity improvement (% per year)	2.0	2.0	the historical rate in Sweden 1980–2005
Length of standard working week (% per year)	0.0	−1.0	
Work sharing (%)		30	the extent to which a shorter working time leads to new employment
Energy efficiency improvement (% per year)	0.9	0.8	from IIASA A and B scenarios (Nakićenović et al, 1998)
Energy to consumption change ratio	0.80	0.80	'income effect' (see section 3.1)
Energy to work time change ratio		−0.06	'time effect' (see section 3.2)
Intermediate calculations			
Total work time (% per year)	0.0	−0.7	the result of a shorter working week and work sharing
Total private consumption (% per year)	2.0	1.3	productivity, working week, and work sharing
Outcome 2040			
Standard working week (hours)	40	30	
Total private consumption increase (%)	78	45	
Energy use increase (%)	25	9	energy use in Sweden and abroad related to Swedish consumption (see section 2.1.2)

4.3 Policy discussion

Since the mid-19th century, work hours have declined drastically in industrialised countries (Ausubel and Grübler, 1995). However, this decline ended some decades ago in many countries; for example, in Sweden the average amount of work hours per working-age person decreased by only ~0.1% per year during the period of 1980–2005 (SOU, 2008, page 105). The increase in productivity (production per work hour) during the same time has been 2.0% per year (page 105). During the same period, private consumption increased by 55% in real terms;(5) that is, on average, by 1.8% per year. This shows that the vast majority of the productivity gains have been transformed into private consumption, and not into reductions in work time.

Some economists argue that Europeans have to work more in order to enhance competitiveness in the increasingly globalised economy. Politicians tend to argue for more work to ensure the financing of the public sector, especially towards the increasing costs of the ageing population. Subsequently, there are compelling reasons for longer working hours in the EU. However, if we consider a long-term perspective, a reduction in working hours is hardly impossible. Historically, Europeans, to a larger extent than Americans, tend collectively to choose leisure time instead of income (Schor, 1991). This trend might continue, and it could even accelerate if postmaterial values become more common, along with a feeling of saturation regarding having ‘stuff’, thus resulting in the work–life balance becoming relatively more prioritised.

As well as collective forms of work time reduction, such as a shorter standard working week or a longer vacation, there are also individualised forms such as part-time work or temporary leaves of absence (Bosch, 2000). One example is the Dutch law that gives all full-time employees the right to request shorter hours, along with a subsequent cut in pay (Moss and Korintus, 2008). Individual, voluntary downshifting of work and consumption can be appealing for some people, but deviating from full-time norms and consumption norms in one’s reference group can be difficult. This probably explains why the public is more positive towards future, collective work time reductions (instead of higher salaries) than towards taking the individual step of reducing work time and income (Sanne, 1995).

For policy makers, the benefits of shorter work hours has to be weighed against drawbacks such as decreased tax revenues that may impair the financing of welfare services and pensions. There are various ideas on how a tax-financed welfare society could be combined with shorter working hours (Holmberg et al, 2012). Perhaps changes in the tax system can be made—for example, climate taxes on household consumption (eg, fuels, electricity, aviation, and meat)—but it is also possible that people would become healthier as a result of not working so much, thereby resulting in lower costs for health insurances and care. Another idea is that the voluntary sector would be able to play a greater role in a society where people do not work as much.

5 Conclusions

The transformation of affluent societies towards long-term climate targets, such as the 2ºC target adopted by the European Union and Sweden, will require radical reductions in GHG emissions. Today’s climate policy is driven almost exclusively with the aim of improving the ecoefficiency of the economy. This approach has been partly successful and has resulted in significant changes—for example, in the energy system—but the effects on total GHG emissions have been offset by the general increase in private consumption. There is therefore reason to question whether ecoefficiency alone can achieve the emissions reductions that

(5) Statistics Sweden National Accounts 1950–2008. Available from http://www.scb.se/Pages/ProductTables____38450.aspx

the climate targets require, and to consider broader climate strategies which also address the actual need for continued increases in consumption. One possible component of such a strategy would be a return to the gradual reduction of working hours that have occurred during the 1900s but which have levelled off in the last decades.

In this study we have shown that a decrease in working hours may have a large impact on both energy use and GHG emissions. On the basis of a novel microanalysis approach of time use and consumption in Swedish households, we find that a decrease in work time by 1% corresponds to reductions in energy use and GHG emissions by about 0.7% and 0.8%, respectively. This estimate is, however, lower than previous results from cross-country analyses which have shown corresponding effects of 1.2–1.3%, for energy use (Rosnick and Weisbrot, 2007), GHG emissions (Knight et al, 2013), as well as for ecological footprint (Hayden and Shandra, 2009).

The increase in energy use with work hours is dominated by the effect of increasing income and consumption. The opposing effect of having more time available for leisure activities is found to be less than a tenth of the income effect. Although the Swedish energy system has some clearly country-specific traits, such as the very low emissions intensities of the heat and power sectors, the estimated income effect of 0.8% is very close to results from previous studies of consumption patterns and energy use in other industrialised countries. Previous estimates from Western European countries include 0.84% in the Netherlands, 0.86% in Denmark, and 0.91% in Spain, whereas results from other parts of the world have a larger spread—for example, 0.57% in the USA, 0.64% in Japan, and 1.0% in Brazil (Kerkhof et al, 2009; Lenzen et al, 2006; Roca and Serrano, 2007; Shammin et al, 2010). Hence, we expect the results of this study to be fairly generalisable, at least to European countries with similar income levels.

The results of this study indicate that a reduction of working hours could be an important complement to ecoefficiency strategies for reaching long-term climate targets. However, there are also major difficulties and policy issues that require further scrutiny. One such issue concerns whether one should pursue a joint reduction of normal working hours or whether to offer individualised opportunities for reductions. Other very important issues concern the extent and pace with which work time reductions may be implemented, and what other changes (for example, to the tax system) would be required in order not to jeopardise the financing of the welfare system.

Acknowledgement. Funding from the AES programme of the Swedish National Energy Administration is gratefully acknowledged.

References

Alesina A F, Glaeser E L, Sacerdote B, 2005, "Work and leisure in the US and Europe: why so different?", in *NBER Macroeconomics Annual 2005* Eds M Gertler, K Rogoff (MIT Press, Cambridge, MA) pp 1–100

Anxo D, Bigsten A, 1989, "Working hours and productivity in Swedish manufacturing" *Scandinavian Journal of Economics* **91** 613–619

Ausubel J H, Grübler A, 1995, "Working less and living longer: long-term trends in working time and time budgets" *Technological Forecasting and Social Change* **50** 113–131

Becker G, 1965, "A theory of the allocation of time" *Economic Journal* **75** 493–517

Bildt C, 2007 *Arbetstidsförkortning och hälsa. Försök med sex timmars arbetsdag inom offentlig sektor* Arbetslivsinstitutet, Stockholm

Binswanger M, 2001, "Technological progress and sustainable development: what about the rebound effect?" *Ecological Economics* **36** 119–132

Binswanger M, 2004, "Time-saving innovations and their impact on energy use: some lessons from a household-production-function approach" *International Journal of Energy Technology and Policy* **2** 209–218

Bosch G, 2000, "Working time reductions, employment consequences and lessons from Europe", in *Working Time: International Trends, Theory and Policy Perspectives* Eds L Golden, D Figart (Routledge, London) pp 177–195

Carlsson-Kanyama A, Assefa G, Peters G, Wadeskog A, 2007, "Koldioxidutsläpp till följd av Sveriges import och konsumtion: beräkningar med olika metoder, TRITA-IM: 2007:1", KTH, Royal Institute of Technology, Stockholm

Coote A, Franklin J, Simms A, Murphy M, 2010, "21 hours: why a shorter working week can help us all to flourish in the 21st century", New Economics Foundation, London

Druckman A, Buck I, Hayward B, Jackson T, 2012, "Time, gender and carbon: a study of the carbon implications of British adults' use of time" *Ecological Economics* **84** 153–163

Estevão M, Sá F, 2008, "The 35-hour workweek in France: straightjacket or welfare improvement?" *Economic Policy* **23** 417–463

European Commission, OECD, 2006, "Methodological manual on purchasing power parities", working paper, Publications Office of the European Union, Luxembourg

Fitzgerald T J, 1996, "Reducing working hours" *Economic Review—Federal Reserve Bank of Cleveland* **32** 13–22

Gershuny J, 2003, "Web use and net nerds: a neofunctionalist analysis of the impact of information technologyin the home" *Social Forces* **82** 141–168

Gode J, Byman K, Persson A, Trygg L, 2009, "Miljövärdering av el ur systemperspektiv", IVL Svenska Miljöinstitutet, Stockholm

Hayden A, 2006, "France's 35-hour week: attack on business? Win–win reform? Or betrayal of disadvantaged workers?" *Politics and Society* **34** 503–542

Hayden A, Shandra J M, 2009, "Hours of work and the ecological footprint of nations: an exploratory analysis" *Local Environment* **14** 575–600

Hertwich E G, Peters G P, 2009, "Carbon footprint of nations: a global, trade-linked analysis" *Environmental Science and Technology* **43** 6414–6420

Holmberg J, Larsson J, Nässén J, Svenberg S, Andersson D, 2012, "Low-carbon transitions and the good life", Naturvårdsverket, Stockholm

Jackson T, 2009, "Prosperity without growth? The transition to a sustainable economy", Sustainable Development Commission, London

Jalas M, 2002, "A time use perspective on the materials intensity of consumption" *Ecological Economics* **41** 109–123

Jalas M, 2005, "The everyday life context of increasing energy demands—time use survey data in a decomposition analysis" *Journal of Industrial Ecology* **9** 129–145

Kallis G, Kalush M, O'Flynn H, Rossiter J, Ashford N, 2013, " 'Friday off': reducing working hours in Europe" *Sustainability* **5** 1545–1567

Kasser T, Brown K W, 2003, "On time, happiness, and ecological footprints", in *Take Back Your Time: Fighting Overwork and Time Poverty in America* Ed. J De Graaf (Berrett-Koehler, San Fransisco, CA) pp 107–112

Kasser T, Sheldon K M, 2009, "Time affluence as a path towards personal happiness and ethical business practices: empirical evidence from four studies" *Journal of Business Ethics* **84** 243–255

Kerkhof A C, Nonhebel S, Moll H C, 2009, "Relating the environmental impact of consumption to household expenditures: an input–output analysis" *Ecological Economics* **68** 1160–1170

Knight K W, Rosa E A, Schor J B, 2013, "Could working less reduce pressures on the environment? A cross-national panel analysis of OECD countries, 1970–2007" *Global Environmental Change* **23** 691–700

Konjukturinstitutet, 2002, "Samhällsekonomiska effekter av en allmän arbetstidsförkortning", Stockholm

Larsson J, 2012 *Studier i tidsmässig välfärd–med fokus på tidsstrategier och tidspolitik för småbarnsfamiljer* PhD dissertation, Department of Sociology, University of Gothenburg

Layard R, 2005 *Happiness: Lessons From a New Science* (Penguin, London)

Lenzen M, Wier M, Cohen C, Hayami H, Pachauri S, Schaeffer R, 2006, "A comparative multivariate analysis of household energy requirements in Australia, Brazil, Denmark, India and Japan" *Energy* **31** 181–207

Minx J C M, Baiocchi G, 2009, “Time use and sustainability: an input–output approach in mixed units”, in *Handbook of Input–Output Economics in Industrial Ecology* Ed. S Suh (Springer, Netherlands) pp 819–846
Moss P, Korintus M, 2008 *International Review of Leave Policies and Related Research 2008* Department for Business, Innovation and Skills, London
Nakićenović N, Grübler A, McDonald A, 1998 *Global Energy Perspectives* (Cambridge University Press, Cambridge)
Nässén J, Holmberg J, Wadeskog A, Nyman M, 2007, “Direct and indirect energy use and carbon emissions in the production phase of buildings: an input–output analysis” *Energy* **32** 1593–1602
Pouwels B, Siegers J, Vlasblom J D, 2008, “Income, working hours, and happiness” *Economics Letters* **99** 72–74
Princen T, 2005 *The Logic of Sufficiency* (MIT Press, Cambridge, MA)
Roca J, Serrano M, 2007, “Income growth and atmospheric pollution in Spain: an input–output approach” *Ecological Economics* **63** 230–242
Rosnick D, 2013, “Reduced work hours as a means of slowing climate change”, The Center for Economic and Policy Research, Washington, DC
Rosnick D, Weisbrot M, 2007, “Are shorter work hours good for the environment? A comparison of U.S. and European energy consumption” *International Journal of Health Services* **37** 405–417
Sanne C, 1995 *Arbetets tid. Om arbetstidsreformer och konsumtion i välfärdsstaten* (Carlsson bokförlag, Stockholm)
Schipper L, Bartlett S, Hawk S, Vine E, 1989, “Linking life-styles and energy use: a matter of time?” *Annual Review of Energy* **14** 273–320
Schor J, 1991 *The Overworked American: The Unexpected Decline of Leisure* (Basic Books, New York)
Schor J, 2005, “Sustainable consumption and worktime reduction” *Journal of Industrial Ecology* **9** 37–50
SEA, 2008, “Mätningar av hushållsel: preliminära resultat. Energimyndigheten”, Forskningsarena 2008–08–25, Swedish Energy Agency, Katrineholm
Shammin M R, Herendeen R A, Hanson M J, Wilson E J H, 2010, “A multivariate analysis of the energy intensity of sprawl versus compact living in the U.S. for 2003” *Ecological Economics* **69** 2363–2373
SOU, 2008, “Långtidsutredningen 2008. Huvudbetänkande”, Finansdepartementet, Stockholm, page 105
UNEP, 2008, “Green jobs. Towards decent work in a sustainable, low-carbon world”, United Nations Environment Programme, Nairobi
United Nations, 1999, “Handbook of input–output table compilation and analysis: studies in methods Series F, No 74”, United Nations Statistics Division, New York
van der Lippe T, 2007, “Dutch workers and time pressure: household and workplace characteristics” *Work, Employment and Society* **21** 693–711
Victor P, 2008 *Managing Without Growth: Slower by Design not Disaster* (Edward Elgar, Cheltenham, Glos)

Appendix

Classification of consumption categories

The table provides the classification of final expenditures in 104 categories used in the paper. See Eurostat-OECD (European Commission and OECD, 2006) for further description of this classification. Energy and GHG emissions data for these categories are available from http://www.mirdata.scb.se/

Table A1. The 104 consumption categories divided into seven groups together by COICOP code.

Code	Consumption category	Code	Consumption category
	Direct energy use		*Nondurable goods*
0451	Electricity	0561	Nondurable household goods
0452	Gas	0611	Pharmaceutical products
0453	Liquid fuels	0612	Other medical products
0454	Solid fuels	0933	Gardens, plants and flowers
0455	District heating	0934	Pets and related products
0722	Fuels for personal transport	0952	Newspapers, periodicals
	Food	0953	Miscellaneous printed matter
0111	Bread, cereals	0954	Drawing materials
0112	Meat	1213	Other appliances for personal care
0113	Fish, seafood		*Housing (excluding direct energy)*
0114	Milk, cheese, eggs	0411	Rentals paid by tenant
0115	Oils, fats	0412	Rentals paid in cooperative building
0116	Fruit	0421	Owned house excluding maintenance and energy
0117	Vegetables	0422	Summer house
0118	Sugar, jam etc	043	Maintenance and repair of dwelling
0119	Salt, spices etc		*Travel services*
0121	Coffee, tea, cocoa	07245	Vehicle rental and taxable benefits
0122	Mineral water, soft drinks, juices	0731	Passenger transport by railway
0211	Spirits	0732	Passenger transport by road
0212	Wine	0733	Passenger transport by air
0213101	Light beer	0734	Passenger transport by sea and waterways
0213102	Beer	0735	Combined passenger transport
022	Tobacco	0736	Other transport services
111	Restaurants, cafés	096	Package holidays
	Durable goods (including semidurable goods)		*Other services*
0311	Clothing materials	0314	Cleaning, repair, and hire of clothing
0312	Garments	0322	Repair of footwear
0313	Clothing accessories	0513	Repair of furniture
0321	Footwear	0533	Repair of household appliances
0511	Furniture and furnishings	0562	Household services
0512	Carpets and other floor coverings	0621	Medical services
052	Household textiles	0622	Dental services
0531	Major household appliances	0623	Paramedical services
0532	Small electric household appliances	063	Hospital services
054	Glassware, tableware, and household utensils	0723	Maintenance and repair of vehicles
0551	Major tools and equipment	07241-4	Parking, driving lessons, vehicle tests, etc

Table A1 (continued).

Code	Consumption category	Code	Consumption category
	Durable goods (including semidurable goods) (continued)		*Other services* (continued)
0552	Small tools and accessories	0811	Postal services
0613	Therapeutic equipment	0813	Telephone and telefax services
0711	Cars	0915	Repair of audiovisual, photographic, information equipment
0712	Motor cycles	0923	Repair of major durables for recreation
0713	Bicycles	0935	Veterinary services
0721	Spare parts for vehicles	0941	Recreational and sporting services
0812	Telephone and telefax equipment	0942	Cultural services
0911	TV sets, radios, gramophones, etc	0943	Games of chance
0912	Photographic and cinematographic equipment	10	Education
0913	Information processing equipment	112	Accommodation services
0914	Recording media	1211	Hairdressing, personal grooming
0921	Major durables for outdoor recreation	12401	Daycare, kindergarten
0922	Music instruments, durables for indoor recreation	12402	Old age care
0931	Games, toys, and hobbies	12403	Personal assistant
0932	Equipment for sport, and outdoor recreation	12404	General care
0951	Books	125	Insurance
1212	Electric appliances for personal care	126	Financial services
1231	Jewelry, watches	127	Other services
1232	Other personal effects		