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**Does Commuting Matter to Subjective
Well-Being?**

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DOES COMMUTING MATTER TO SUBJECTIVE WELL-BEING?*

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Abstract: How and why commuting contributes to our well-being is of considerable importance for transportation policy and planning. This paper analyses the relation between commuting and subjective well-being by considering several cognitive (e.g., satisfaction with family life, leisure, income, work, health) and affective (e.g., happiness, anger, worry, sadness) components of subjective well-being. Fixed-effects models are estimated with German Socio-Economic Panel data for the period 2007 – 2013. In contrast to previous papers in the literature, according to which commuting is bad for overall life satisfaction, we find no evidence that commuting in general is associated with a lower life satisfaction. Rather, it appears that longer commutes are only related to lower satisfaction with particular life domains, especially family life and leisure time. Time spent on housework, child care as well as physical and leisure activities mediate the association between commuting and well-being.

Keywords: commuting distance, emotion, satisfaction, time use, well-being

JEL: I10, I31, R40

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1. Introduction

In the past decades, subjective well-being has become an important component of the agenda of governments and measures of subjective well-being are often used to assess the costs and benefits of policies (e.g., Blanchflower and Oswald 2004, Dolan et al. 2008, ONS 2015). According to the World Happiness Report 2015 of the United Nations, happier and more satisfied people are more likely to be healthier, productive and pro-social, resulting in benefits for the society as a whole, i.e. higher economic productivity, stronger social insurance, greater societal resilience to natural hazards, and greater mutual care (Helliwell 2015). Therefore, most governments and international organisations regard subjective well-being as the most comprehensive measure of wealth, replacing traditional measures like Gross Domestic Product (GDP) and some social indicators (OECD 2013). Partly as a result, economists are showing increasing interest in the “economics of happiness”, reflected by the large body of literature that considers subjective well-being as a proxy for individual welfare.¹ Thus, it is hardly surprising that subjectively experienced well-being has, especially recently, attracted more attention in transport and mobility studies, since transport is intricately linked to the well-being of the economy as well as communities and is seen as the blood of society (e.g., Banister et al. 2011, De Vos et al. 2013). In contemporary societies, the travel to work, in particular, plays a large role in the everyday life of individuals. With increasing suburban sprawl and subsequently longer commutes, the relationship between commuting and well-being is becoming a pressing concern (e.g., Pisarski 2006, Hilbrecht et al. 2014). This is compounded by the finding that commuting to work is found to be a stress factor and, hence, reflects one of the unpleasant sides of daily life (e.g., Kahneman et al. 2004, White and Dolan 2009, Mattisson et al. 2015). Understanding the relationship between commuting and well-being may offer insight into workers’ quality of life and contribute to programs and policies designed to better support population well-being. Further, understanding how commuting is related to how we feel offers insight into ways of improving existing transportation services, prioritising investments and theorising and modelling the costs and benefits of the travel to work.

Nevertheless, the relationship between travel and subjective well-being is largely “unexplored in travel behaviour research” (Ettema et al. 2010, p. 729). In the limited number

¹ Summaries and overviews of this rapidly expanding literature include: Frey and Stutzer (2000, 2002a, 2002b), Layard (2005), Kahneman and Krueger (2006), Di Tella and MacCulloch (2006), Clark et al. (2008), Dolan et al. (2008), Stutzer and Frey (2010), and MacKerron (2012).

of previous studies, subjective well-being has usually been assessed by judgements of overall life satisfaction.² Yet, as De Vos et al. (2013) point out, these studies are still in their infancy and many of the multifarious links between commuting and well-being are still under-examined since most studies focus mainly on life satisfaction, drawing mixed conclusions (Stutzer and Frey 2008, Dickerson et al. 2014, Hilbrecht et al. 2014, Wheatley 2014, Morris 2015). In classical urban and regional economic theory, individuals' commuting behaviour is determined by an equilibrium state of the housing and labour market, in which individuals' utility is equalised over all actual combinations of alternatives in these two markets. Accordingly, it is assumed that individuals freely optimise by changing job or residence and, hence, arbitrage away any utility differentials. If this is the case, no systematic relationship should be found between commuting behaviour and subjective well-being (respectively life satisfaction), which has been shown to be a satisfactory empirical approximation to individuals' utility (Kahneman and Krueger 2006).

However, subjective well-being covers a wider range of concepts than just life satisfaction. In fact, subjective well-being is defined as a person's cognitive and affective evaluation of his or her life, and encompasses different elements: the cognitive component consists of life satisfaction and satisfaction with specific life domains (e.g., satisfaction with family life, work satisfaction), while the affective component refers to positive emotions, moods and feelings (e.g., joy, pride) and negative ones (e.g., anger, worry) a person has (Diener 2000). In contrast to the above mentioned studies on the effect of commuting on overall life satisfaction, much less is known about the consequences of commuting on satisfaction with other life domains and emotions, although it has been shown that a distinction is important on both empirical and theoretical grounds (e.g., Kahneman et al. 1999, Kahneman and Deaton 2010, Deaton and Stone 2014). Our comprehensive investigation of this issue is intended to fill this gap and to gain further insights beyond those from the life satisfaction studies about the general consequences of commuting for well-being by adopting a more holistic view of well-being related to commuting.

Thus, this article aims to contribute to the understanding of the relationship between commuting distance and well-being by considering several components of subjective well-being, such as: cognitive evaluations of one's life and specific life domains (i.e., satisfaction with family life, leisure time, income, work, and health), positive emotions (i.e., happiness), and negative ones (i.e., anger, worry, sadness), and potential explanatory factors in links

² A detailed review of this literature is provided by De Vos et al. (2013).

between commuting and well-being. Since the aim of (transport) policies is to increase individuals' well-being, it is worthwhile to investigate how these different components of well-being depend on the travel to work (Ettema et al. 2010).

This paper uses data from the German Socio-Economic Panel (SOEP) for the years 2007 – 2013 to analyse the relation between commuting distance and various measures of subjective well-being. We aim not only to provide evidence on the effect of commuting on well-being, but also to shed some light on the mechanisms through which commuting might affect individual's well-being. We therefore apply, firstly, linear fixed-effects models in which time-invariant idiosyncratic effects are controlled for. All the different aspects of subjective well-being are measured separately to derive a more comprehensive measure of people's quality of life and to allow a better understanding of the relationship between subjective well-being and commuting distance.³ Second, we use a bootstrapping-based causal mediation analysis to analyse the extent to which several important daily activities (e.g., house work, caregiving, sleeping) serve as potential mediators in any association found between commuting and well-being.

We find that whereas affective well-being measures are hardly influenced by commuting, cognitive well-being measures are lower for people who commute longer. However, in contrast to previous papers in the literature, according to which commuting is bad for overall life satisfaction, we find no evidence that commuting is associated with lower levels of satisfaction with life in general. Our results suggest that longer commutes are rather related to lower satisfaction with family life and leisure time. These findings turn out to be robust against several specifications and sub-samples. Moreover, the multiple mediation analysis indicates that the relation between commuting and satisfaction with leisure and family life can largely be ascribed to changes in daily time use patterns, influenced by the work commute.

The structure of this paper is as follows: The next section reviews related literature. Section 3 presents the data used in the analysis. Section 4 describes the econometric methodology. Section 5 reports results, including several robustness checks, and discusses explanations for the findings. Section 6 concludes the study.

³ This approach is intended to meet the recommendation of the OECD guidelines on measuring subjective well-being (2013), according to which different aspects of subjective well-being should be measured separately.

2. Related literature

While the literature related to commuting and well-being is diverse, it may be grouped in two streams.⁴ The first stream of contributions analyses the association between commuting and cognitive measures of well-being. However, these studies focus almost entirely on life satisfaction and their findings are largely inconclusive.

Using data from the German Socio-Economic Panel (SOEP, 1985 – 2003), Stutzer and Frey (2008) show that greater commuting times lower self-reported life satisfaction (measured on a scale from 0 to 10). Further, in a robustness check, the authors also find a small negative effect of commuting distance on reported life satisfaction. Stutzer and Frey (2008) conclude that commuting is a stressful activity which does not pay off, a result which they refer to as the ‘commuting paradox’, as it does not correspond to the predictions from microeconomic theory according to which rational individuals would only choose to spend their time commuting if they are compensated, either in the form of improved job characteristics (including pay) or better housing prospects. Utilising cross-sectional data from the 2010 Canadian General Social Survey, Cycle 24, Hilbrecht et al. (2014) also find that commuting time is associated with lower levels of life satisfaction (measured on a scale from 1 to 10) and an increased sense of time pressure. Hilbrecht et al. (2014) argue that reduced time for physically active leisure and experiences of traffic congestion mediate the association of commute time with life satisfaction. Likewise, Nie and Sousa-Poza (2016), drawing on 2010 cross-sectional data from the China Family Studies, demonstrate that longer commuting times are associated with lower levels of life satisfaction and happiness, partially mediated through reduced sleep time. Analysing panel data from the British Household Panel Survey (BHPS, 1993 – 2009, subsumed by the Understanding Society Survey from 2009), Wheatley (2014) contributes to the understanding of the interaction between commuting time and levels of satisfaction with working hours, job, and leisure (measured on a scale from 1 to 7) among full-time working men and women in dual career households. Wheatley (2014) shows that only lengthier commutes lower satisfaction with working hours, job, and leisure for men,

⁴ Besides the small body of research which directly pertains to commuting and subjective well-being, the literature dealing with this relationship is also guided by research on mental and physical health, which are both critical contributors to well-being (Hilbrecht et al. 2014). Many studies address the relation between commuting and health outcomes, showing that commuting is related to increased pulse rate and blood pressure (e.g., White and Rotton 1998), musculoskeletal disorders (e.g., Koslowsky et al. 1995), fatigue symptoms (e.g., Kageyama et al. 1998), self-perceived stress (e.g., Gottholmseder et al. 2009), reduced sleep time (e.g., Costa et al. 1988), higher sickness absence (e.g., Goerke and Lorenz 2015) and lower physical and psychological health (measured via GHQ score) (e.g., Roberts et al. 2011, Humphreys et al. 2013, Martin et al. 2014).

whereas short and long commuting times reduce satisfaction with leisure for women. Using cross-sectional data from the American Time Use Survey (ATUS, 2012 – 2013), Morris (2015) indicate that travel time for the purpose of work is negatively correlated with life satisfaction.

Other studies, however, find no evidence that commuting has a negative effect on cognitive measures of well-being.⁵ Using data from the BHPS (1996 – 2008), Dickerson et al. (2014) revisit the debate surrounding the appropriate methodology for modelling subjective well-being data in the context of the relationship between commuting time and satisfaction with life or leisure and find no evidence that longer commutes are associated with lower levels of life satisfaction in general, but with lower satisfaction with leisure time. From a methodological point of view, the authors argue that ordered fixed-effects models are more appropriate than linear models, which are predominantly applied in the analysis of commuting and subjective well-being.

The second stream of contributions pertains to commuting and feelings and predominately focuses on experienced emotions during commutes. Morris et al. (2015), drawing on data from the American Time Use Survey's well-being module, report that commuting has basically no impact on how we feel because mood is not generally worse during travel than on average. Using cross-sectional data from the three largest urban areas of Sweden, Olsson et al. (2013) demonstrate that predominantly positive or neutral feelings (e.g., glad, active, joyful, awake, peppy, and pleased) dominate during the commute, so that work commute has a substantial influence on overall happiness, particularly due to the balance between positive and negative affect. Olsson et al. (2013) argue that, for longer work commutes, social and entertainment activities either increase positive affects or counteract stress and boredom. Jain and Lyons (2008) suggest that commuting provides transition time which allows mental shifting between different activity spheres. Thus, the way from work to home can serve as a decompression period for commuters. In several studies, Mokhtarian and colleagues (e.g., Redmond and Mokhtarian 2001, Mokhtarian et al. 2001, Ory and Mokhtarian 2005) have shown that the travel to work can also be utilised by the commuter for something positive. This could be pleasurable activities during the commute such as listening to music, enjoying the scenery or simply allowing for some coveted time alone.

⁵ Sweet and Kanaroglou (2016), drawing on cross-sectional data from the 2010 General Social Survey (GSS) of Time Use in Canada, find no evidence that total daily travel times are associated with levels of life satisfaction. However, it is unclear whether commuting to work is included in the daily travel time.

Moreover, especially active commuting, such as commuting by bicycle or walking, is reported to be more relaxing and exciting than passive commuting (by car or transit) and hence, might be related to increased well-being (e.g., Gatersleben and Uzzell 2007). Accordingly, commuting creates a time out from other responsibilities and commitments and may include leisurely moments for someone, which contributes to well-being even if commuting prevents participation in other activities. Those who derive positive utility from commuting are also found to experience the commute as less stressful (e.g., Gottholmseder et al. 2009) and experience less disutility of commuting (Ory and Mokhtarian 2005). Nevertheless, when commuting distances become too long, the willingness to commute decreases (Sandow and Westin 2010). There are also studies that show that commuters would like to decrease their commuting distance, regardless of mode used (e.g., Sandow and Westin 2010, Redmond and Mokhtarian 2001).

In sum, little consensus exists regarding the effect of commuting on subjective well-being. Considerable evidence suggests that individuals with lengthy commutes are more prone to experience lower levels of life satisfaction. Furthermore, it has also been shown that some individuals experience commuting (especially active commuting types) as activity that provides a time out from obligations and responsibilities, which could be beneficial to well-being.

While substantially enhancing our knowledge on the impact of commuting on well-being, there are a number of limitations in the existing literature: Many of the extant studies examine correlations of commuting time and satisfaction with life or feelings experienced during the commute, are mainly based on cross-sectional data, and do not investigate potential channels determining the relationship between commuting and well-being. Obviously, a shortcoming of measuring the well-being effects from the work commute using only life satisfaction is underestimating the effects on other areas of life. Since commuting increases the length of the total workday while simultaneously reducing time for private use, less time remains available for leisure time activities and home production, which might come at the expense of utility derived from e.g. family life or leisure time. Although often overlooked in discussions of commuting and well-being, time diaries have shown how daily behavioural patterns including the amount of time and timing of activities such as housework, leisure, caregiving and sleep may be shaped by the work commute (e.g., Kitamura et al. 1992). Lengthy commutes reduce time for leisure, family and friends and, hence, for maintaining family ties and social relationships such as going out for dinner with friends (e.g., Besser et al. 2008, van der Klis

and Karsten 2009, Sandow 2014). However, such activities have been shown to be associated with greater life satisfaction, happiness as well as mental well-being and can provide opportunities for coping with supposedly stressful situations (e.g., Hutchinson and Kleiber 2005, Sweet and Kanaroglou 2016).

Moreover, from a classical urban economic perspective, commuting is just one of numerous decisions rational individuals make. If commuting has extra monetary and non-monetary costs, then travelling longer distances to and from work is only chosen if it is either compensated (in order for the commuters' well-being or utility to be equalised) by lower rents or housing prices (e.g., Renkow and Hoover 2000), desired housing or neighbourhood characteristics (e.g., Plaut 2006) or an intrinsically or financially rewarding job (e.g., So et al. 2001). Based on the aforementioned literature, we, thus, could expect that individuals who commute longer are compensated by a better job or pleasant living environment, and hence report higher satisfaction with work, dwelling or income, whereas satisfaction with family life, leisure, or health could be lower. Consequently, on average commuters' utility, respectively life satisfaction might be the same regardless of their commuting distance.

Against this background, in this study we consider several components of subjective well-being to produce a more differentiated picture of the relation between travel to work and subjective well-being. We additionally examine whether several important daily activities – namely errands (e.g., shopping, trips to government agencies), housework and repairs (e.g., washing, cooking, cleaning, gardening), child care and support for persons in need of care, physical activities and other leisure activities (e.g., sports, fitness, gymnastic, hobbies) as well as sleeping – serve as potential mediators of the relationship between commuting and well-being. It is also worth stressing that our study differs from other recent studies since our key variable, and as such the proxy for the burden of commuting, is not commuting time but commuting distance. Although commute times and distances are strongly correlated (e.g., Small and Song 1992, Rietveld et al. 1999), we nowadays mainly observe an increase in distances travelled, driven by higher travel speeds and improvements in transportation, in turn fostering urban sprawl (e.g., Crozet and Joly 2004, Lyons and Chatterjee 2008). Since commuting distance appears to be increasing at a steady rate, it is important to see what impact longer distances have on individuals, when measured against a number of different proxies for subjective well-being. However, commuting distance is less closely related to the opportunity cost of commuting than commuting time.

3. Data and variables

The data used in this study is from the German Socio-Economic Panel (SOEP), which is representative for the entire population of Germany, aged 17 and older. The SOEP includes rich information on labour market status, wealth, incomes and standard of living, health and well-being as well as on family life and socio-economic variables.⁶ This paper focuses on the survey years 2007 – 2013 as these years contain data on commuting as well as on cognitive and affective components of subjective well-being.

We restrict the sample to working adults aged 18 to 65, and we exclude self-employed respondents, since they are more likely to work from home and generally have different commuting patterns than employees (Roberts et al. 2011).

As our dependent variables we use data from questions, where respondents are asked to cognitively evaluate one's life and certain life domains. The questions read as follows: "How satisfied are you today with the following areas of your life?: (a) health, (b) job, (c) household income, (d) personal income, (e) dwelling, (f) leisure time, (g) family life" and "How satisfied are you with your life, all things considered?" The respondents are asked to give a response on an 11-point scale, where the lowest value (0) is labelled "completely dissatisfied" and the highest value (10) is labelled "completely satisfied".

The SOEP, furthermore, requires respondents to report on their affective well-being. The question reads: "How often have you felt (i) angry, (ii) worried, (iii) happy, (iv) sad? Please indicate for each feeling how often or rarely did you experience this feeling in the last four weeks." Each response category has a choice of five options, where the lowest value (1) is labelled "very rarely" and the highest value (5) is labelled "very often". Figures A.1 and A.2 (see Appendix A) present the distributions of the cognitive and affective well-being measures. It can be seen that the distributions of the cognitive measures are highly skewed, with the majority of the respondents at the top end of each distribution. This is a common finding in the literature on subjective well-being (Dolan et al. 2008). The distributions of the affective well-being measures are less skewed, but again the majority of the respondents report either relatively high or low values.

The key explanatory variable is commuting distance derived from the question "How far (in kilometres) is it from where you live to where you work?". This is one way commuting

⁶ Further information about the SOEP is provided by Wagner et al. (2007) and can also be found at: <http://www.diw.de/english/soep/29012.html>. We use the SOEP long v30 dataset.

distance in kilometres and we treat it as a continuous variable.⁷ Figure A.3 (see Appendix A) presents the distribution of commuting distance.

Furthermore, the SOEP requires respondents to outline the time spent on the daily activities of errands (e.g., shopping, trips to government agencies), housework and repairs on and around the house (e.g., washing, cooking, cleaning, gardening), child care and support for persons in need of care, physical activities and other leisure activities (e.g., sports, fitness, gymnastic, hobbies) and sleeping. This time use information is captured by the question, “What is a typical weekday for you? How many hours per normal workday do you spend on the following activities?”.

Finally, the analyses include a number of control variables which the extant literature has shown to be relevant to subjective well-being: age, gender, number of children, marital status, health status, highest school qualification, unemployment experience, working hours, job tenure, household income, household size as well as regional and year dummies (e.g., Roberts et al. 2011, Frijters and Beaton 2012, Wheatley 2014, Dickerson et al. 2014).⁸

Table 1. Summary statistics.

	Mean	Standard deviation	Min.	Max.
Satisfaction with life	7.19	1.59	0	10
Satisfaction with work	7.01	1.99	0	10
Satisfaction with household income	6.61	2.10	0	10
Satisfaction with personal income	6.32	2.21	0	10
Satisfaction with dwelling	7.84	1.80	0	10
Satisfaction with leisure	6.69	2.08	0	10
Satisfaction with family life	7.81	1.88	0	10
Satisfaction with health	6.95	1.98	0	10
Angry	2.92	0.95	1	5
Worried	1.89	0.93	1	5
Happy	3.57	0.80	1	5
Sad	2.31	0.99	1	5
Commuting distance	21.69	54.64	0	999
Age	42.90	11.37	18	65
Female	0.50	0.49	0	1
Number of children	0.64	0.93	0	8
Marital status	0.63	0.48	0	1
Health status*	2.44	0.85	1	5
Education	0.33	0.47	0	1
Unemployment experience	0.36	0.48	0	1
Working hours	37.26	12.45	0.4	80
Tenure	11.29	10.34	0	50.9
Household income (log)	7.94	0.50	5.26	12.20
Household size	2.85	1.23	1	14
Urban area	0.65	0.47	0	1
Time (h) for errands	0.90	0.64	0	8
Time (h) for housework	1.94	1.46	0	16
Time (h) for caregiving	1.30	2.93	0	24
Time (h) for leisure activities	1.64	1.37	0	15
Time (h) for sleeping	6.84	1.00	1	16

Notes: Federal states and year dummies included. *For each possible value, a dummy variable is included in the analyses.

⁷ For the years we are observing, the SOEP does not provide information about commuting mode and commuting time. Given the travel patterns in Germany, passive commuting modes, such as commuting by car (65%) or public transport (14%) are very likely (Federal Statistical Office 2012).

⁸ We do not control for personality traits. Since personality traits are claimed to be time invariant, these factors would be absorbed into the fixed effect in our models and are thus irrelevant for the analysis.

Table 1 provides summary statistics on the subjective well-being and control variables. It can be seen that the average commuting distance is about 22 km (one way). The average age in the sample is 43 years, about two thirds live in urban regions, are married or cohabiting and the average number of children in the household is 0.6. One third has been unemployed at least once. For variable definitions, see Table A.1 of Appendix A.

4. Empirical strategy

4.1 Basic empirical model

The longitudinal characteristic of the SOEP allows the estimation of fixed-effects models in which idiosyncratic effects that are time-invariant can be controlled for. The effect of commuting distance on subjective well-being measures is then identified by the variation in commuting distance within observations for the same individual. In our sample, the mean (within) deviation of individual commuting experiences is 25.07 kilometres. Equation (1) summarises the empirical model:

$$SWB_{it} = \alpha_i + \beta CD_{it} + \gamma CD2_{it} + \lambda X_{it} + \varepsilon_{it} \quad (1)$$

where SWB_{it} denotes the individual's well-being,⁹ α_i denotes time-invariant idiosyncratic effects, β is the coefficient of commuting distance (CD), and γ is the coefficient of its squared term (CD^2).¹⁰ To evaluate the effect of commuting distance on subjective well-being measures, one needs to perform a test for joint significance. The vector X includes all the control variables.¹¹

⁹ In the main analyses, we treat the dependent variables as continuous. Thereby, the coefficients can be interpreted as marginal effects. In the robustness analyses, we apply a fixed-effect ordered logit (BUC) model as alternative specification.

¹⁰ A quadratic specification of the effect of commuting distance on life satisfaction is chosen because we hypothesise that the marginal burden of commuting is falling.

¹¹ In the main analyses, we use the same set of controls. Nevertheless, in order to see how sensitive the results are to the used controls, we also alter the control variables by, for example, including more variables on job characteristics (e.g., firm size, working hours mismatch) or residential aspects (e.g., sizes of dwelling, being owner of dwelling). If the results are affected by the modified set of controls, we report on these findings in body text.

4.2 Description of robustness checks

We perform several robustness analyses to test the sensitivity of the main results. They can be grouped into two categories.

First, we alter the methodology. We estimate a model in which we attempt to deal with possible measurement errors in reported commuting distances. Therefore, we have experimented with several functional forms of distance. We categorise commuting distance into ‘short’ (up to 24 km), ‘middle’ (25 – 49 km) and ‘long’ (50 km or more) commutes. This approach is less sensitive to minor reporting errors and allows for qualitatively different effects of, for example, shorter and longer commutes on well-being. We have also re-estimated models excluding observations that refer to changes in distance that are less than 3 km. In particular small distance changes will more likely refer to measurement error in the commuting distance.¹² Furthermore, we additionally log transformed commuting distance to see whether our results are sensitive to the chosen functional specification.

The next robustness check relates to the question whether different aspects of subjective well-being as measured in the SOEP can be taken to be cardinal measures or ordinal variables (Ferrer-i Carbonell and Frijters 2004). In our main approach we assume well-being to be cardinal, whereas we treat it as an ordinal variable in one robustness check. Therefore we estimate fixed-effects ordered logit models (“Blow-up and Cluster” (BUC) estimator) as proposed by Dickerson et al. (2014).¹³

The literature dealing with the health consequences of commuting is inconsistent in terms of including potential compensating factors such as income or working hours. Hansson et al. (2011) include proxies for job strain, financial stress, and variables related to income, overtime, and unemployment history. Roberts et al. (2011) consider housing quality, job satisfaction, and net household income. By including these potential compensating factors, these two studies investigate how commuting time affects (psychological) well-being alongside those compensating variables. Roberts et al. (2011) argue that an inclusion of

¹² As respondents in one year might, for example, report 22 km and in the next year 25 km without changing the actual commuting distance.

¹³ According to Dickerson et al. (2014) the BUC estimator is unbiased and the loss of efficiency relative to other methods (e.g., two step minimum distance, generalized method of moments) is very modest. In the fixed-effects ordered logit method, it is not possible to calculate the marginal effects relating to individual coefficients. However, it is possible to comment on the sign, statistical significance and the relative size of the coefficients. The BUC estimator is implemented in Stata using the *bucologit* command proposed by Dickerson et al. (2014). This approach has been used to analyse overall life satisfaction in a variety of studies, see for example Brown and Gray (2016), Mujic and Fritjers (2015) and Dickerson et al. (2014). A more detailed description on this method can be found in Baetschmann et al. (2015).

compensating factors is important, since the labour market is characterised by job search due to imperfections in the labour and housing markets and substantial residence relocation costs. Hence, controlling for compensating factors excludes, *inter alia*, on-the-job search imperfections. This (potential) compensating role is exactly the reason for Stutzer and Frey (2008) not to include household income, labour income, or working hours in their analysis on the relation between commuting and life satisfaction. They argue that the role of commuting could only be accurately predicted if all channels for compensation remain uncontrolled (Stutzer and Frey 2008). In our main analyses we follow Roberts et al. (2011) and Hansson et al. (2011). Nevertheless, in a robustness check we exclude variables with potentially compensating power (i.e., household income, working hours) to see whether those compensating factors are driving our results.

Finally, since we report results on many outcomes the probability is high to observe at least one significant result, even if it is actually not significant. One approach sometimes used to deal with multiple outcomes is to aggregate them into particular groupings to examine whether the impact of commuting on an overall outcome is different from zero. Thus, we accumulate the single dependent variables to overall well-being measures. This approach is useful to see whether the global impact of commuting distance is generally positive or negative (Gibson et al. 2011). Another way to address the issue of multiple outcomes is to consider the significance of individual coefficients when viewed as part of a family of n hypotheses. For example, we consider all outcomes related to cognitive well-being as a family. The family-wise error rate is then defined as the probability of at least one type 1 error in the family. Then we can maintain the family-wise error rate at some designated level α , such as 0.05 or 0.10, by adjusting the p-values used to test each individual null hypotheses in the family (Shaffer 1995). The simplest of such methods is the Bonferroni method, which uses as critical values α/n . Several refinements to the Bonferroni method offer greater power. Ranking the n outcomes in increasing order of their p-values for testing a null effect, so that $p_1 \leq p_2 \leq \dots \leq p_n$. Then, Holm's (1979) sequentially rejective Bonferroni method is applied as follows. In the first step, a null effect for outcome 1 is rejected if $p_1 \leq \alpha/n$. If we cannot reject this outcome, we cannot reject null effects for all other outcomes. Otherwise, reject a null effect for outcome 2 if $p_2 \leq \alpha/(n - 1)$, and at step j , reject a null effect for outcome j if and only if null effects have been rejected for all outcomes $i < j$, and $p_j \leq \alpha/(n - j + 1)$. Hochberg (1988) provides a step-up modification of this procedure, which

rejects null effects for all outcomes $i \leq j$ if $p_j \leq \alpha/(n - j + 1)$ for any $j = 1, 2, \dots, n$. The adjusted p-values are shown in Table A.2 of Appendix A.

In a second set of robustness checks, we analyse the relation between commuting distance and subjective well-being measures for several sub-groups. First, we estimate equation (1) separately for women and men, because it has been shown that commuting affects well-being for women, but not for men (Roberts et al. 2011).

With the second sub-sample, we follow Wheatley (2014), who argues that commutes for full-time workers have a particularly large impact on well-being, since a significant portion of time is devoted to work and necessary work-related activity. Moreover, for commuting full-time workers, the distribution of other elements of time-use (e.g., housework, caregiving) becomes especially relevant as time is particularly constrained.

Third, because commuting types (active vs. passive) could have opposing effects on well-being, we estimate a model that consists of individuals who report commuting more than 10 km to work. We do so since we do not have explicit information on commuting mode. But, short distances are more likely to be entirely covered on foot or by bicycle, and, including both active and passive types could result in their effects being cancelled out.

Fourth, since, by law, daily commutes of up to two and a half hours are considered to be reasonable, we restrict our sample to individuals who commute on a daily basis up to 100 km (one way), which could approximately be translated into a daily commute of two or two and a half hours. Daily commutes are expected to have a greater impact on subjective well-being than commutes on a weekly or less often basis (Ettema et al. 2010).

Fifth, we estimate the models for a subset of the sample whose employment was terminated involuntarily because of plant closure in the last year.¹⁴ For these individuals the impact of commuting distance is triggered by an exogenous event. Therefore, individuals might be locked into a disadvantaged situation, for example, experiencing a longer commute ex post than expected ex ante from re-optimising (Stutzer and Frey 2008). By including interactions between current commuting distance and involuntary job changes in the previous

¹⁴ Only 7% of individuals in our sample experienced an occupational change. Of these changes, a significant share was attributed to voluntary changes (e.g., approximately 42% were attributed to own resignation, 18% to expiry of temporary contracts, 11% to mutual termination) and only 6.5% were attributed to involuntary changes caused by plant closure (256 observations).

year, we check whether the impact of commuting is different for those individuals who were forced to re-arrange their commuting distance due to exogenous reasons.¹⁵

4.3 Assessment of mechanisms

In order to explore whether several important daily activities serve as potential mediators of the relationship between commuting and well-being, we first include additional time-use control variables in equation (1): errands, housework and repairs on and around the house, child care and support for persons in need of care, physical and other leisure activities and sleeping, to see how sensitive the results are to the inclusion of these variables.

Second, we apply a causal mediation analysis to account for the pathways by which one variable affects another and hence, to identify the extent to which the mediators explain the relation between commuting distance and well-being. The test of mediation uses bootstrapping to create a reference distribution used for significance testing and 95% confidence interval estimation.¹⁶ Figure A.4 of Appendix A illustrates the mediation design used in our study.

5. Results

5.1 Commuting distance and subjective well-being outcomes

Table 2 presents the results from the models with life satisfaction and satisfaction with specific life domains. Since commuting distance and the squared term of commuting distance are included, the table also reports the F-statistics and p-values of the joint significance. The F-statistic indicates whether there is a u-shaped relationship between commuting distance and the single subjective well-being measures.

¹⁵ The literature dealing with the consequences of commuting argues that analyses of individuals who neither change employer nor residence reveal the effect of exogenous changes in commuting distance (e.g., due to workplace relocation) on health outcomes (e.g., Roberts et al. 2011, Künn-Nelen 2016). We have also investigated this sub-sample, but did not find significant results. The most plausible explanation for this is that applying this strategy in our setting might result in endogeneity from the self-selection of employees in a group of workers who do not change residence or employer because they are willing to travel long distances. Strictly speaking, people who become so dissatisfied with their commutes are more likely to relocate closer to their place of work, and/or change employer. Further, we cannot exclude the possibility that individuals with unobserved positive attitudes towards life and certain life domains are more likely to accept exogenous distance changes and are also less likely to have lower levels of well-being.

¹⁶ A more detailed description on this method can be found in Preacher and Hayes (2008), MacKinnon et al. (2007) and Hicks et al. (2011).

It can be seen that people who commute longer distances report lower satisfaction with leisure time and lower satisfaction with family life. The relation between commuting distance and satisfaction with leisure is significant in a u-shaped manner, suggesting that the negative relation flattens out. However, the turning point for satisfaction with leisure time is around 470 kilometres of commuting distance. Because only 1% of the people in the sample have a commute longer than 470 kilometres, the negative linear relation between commuting distance and satisfaction with leisure holds for a substantial share of the sample. Whereas the effect is highly significant, its size is small. An increase in commuting distance of 20 kilometres with an initial commuting distance of 10 kilometres is, on average, associated with a 0.048-point lower satisfaction with leisure time (on an eleven-point scale).

Table 2. Estimation results on cognitive well-being outcomes.

	(1) Life	(2) Work	(3) HH-Income	(4) Income	(5) Dwelling	(6) Leisure	(7) Family life	(8) Health
Commuting distance	-0.0006 (-1.40)	-0.0006 (-0.95)	0.0005 (1.09)	0.0006 (1.13)	-0.0003 (-0.66)	-0.0025*** (-4.24)	-0.0014** (-2.45)	-0.0005 (-1.17)
Commuting distance squared	4.19e-07 (0.64)	7.08e-07 (0.72)	-9.23e-07 (-1.33)	-9.61e-07 (-1.06)	1.06e-06 (1.44)	2.61e-06*** (2.87)	7.82e-07 (0.92)	7.96e-07 (1.29)
F-statistic (p-value)	1.95 0.1427	0.51 0.5982	0.92 0.3975	0.64 0.5280	2.55 0.0784	10.92 0.0000	7.46 0.0006	0.84 0.4326
N	60,266	59,345	59,907	60,254	60,249	60,340	59,946	60,324
R ²	0.1676	0.0191	0.1518	0.0732	0.0129	0.0453	0.0344	0.5084

Notes: Fixed-effects ordinary least squares model. Only the coefficients for the commuting variables are reported. The following control variables are included: age, age squared, number of children, marital status, current health status, education, unemployment experience, actual working hours, tenure, tenure squared, household income (log), household size, urban area, federal states and year dummies. Appendix A shows the results for control variables in Table A.3. All models are estimated using robust standard errors. *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The relation between commuting distance and satisfaction with family life is significant at the 5% level, and the F-statistic indicates a u-shaped relation. Since the quadratic term of commuting distance is close to zero and not significant, this u-shaped relation is rather flat (linear). Hence, those commuting longer have lower levels of satisfaction with family life, but this negative relation flattens out with longer distances. Further, Table 2 indicates a jointly significant effect of commuting on satisfaction with dwelling, even though neither commuting distance nor the squared term by itself tests as statistically significant. Additional analyses show that this jointly significant relation between commuting and satisfaction with dwelling disappears when the model includes information on whether the rent is adequate or not and whether the respondent is owner or tenant of the dwelling. This indicates that commuting distance affects satisfaction with dwelling via residential amenities. This could indicate that

commuting enables individuals to select places to live and, hence, to freely choose the optimal residence location.¹⁷

Table 3 reports the regression results on affective well-being outcomes. The results indicate that commuting distance has no significant impact on individuals' moods and emotions. These findings are in line with Morris et al. (2015) who analyse the relationship between emotions and the travel to work for the United States.

Table 3. Estimation results on affective well-being outcomes.

	(1) Angry	(2) Worried	(3) Happy	(4) Sad
Commuting distance	-0.0001 (-0.32)	-0.0001 (-0.60)	-0.0002 (-1.19)	-0.0001 (-0.35)
Commuting distance squared	6.21e-08 (0.15)	4.05e-07 (1.05)	2.66e-07 (0.35)	4.44e-07 (0.98)
F-statistic (p-value)	0.11 0.8993	0.89 0.4109	0.86 0.4218	1.24 0.2892
N	57,166	57,112	57,142	57,136
R ²	0.0238	0.0473	0.0683	0.0429

Notes: Fixed-effects ordinary least squares model. Only the coefficients for the commuting variables are reported. The following control variables are included: age, age squared, number of children, marital status, current health status, education, unemployment experience, actual working hours, tenure, tenure squared, household income (log), household size, urban area, federal states and year dummies. Appendix A shows the results for control variables in Table A.4. All models are estimated using robust standard errors. *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.2 Robustness checks

As described in Section 4.2, we perform several robustness checks to show the sensitivity of the main results. Table 4 and Table A.5 (see Appendix A) report the results of the methodology-related analyses for cognitive (Table 4) and affective (Table A.5, Appendix A) well-being measures.

Panel (a) of Table 4 includes a categorical measure of commuting distance. Individuals who commute less than 10 km to work are treated as the reference group. In line with the results of Table 5.2, commuting distance decreases satisfaction with leisure and family life. When commuting distance increases from under 10 km to over 50 km, satisfaction with leisure (family life) decreases by about 0.32-points (0.15-points), on average. Although shorter distances do not seem to impact satisfaction with leisure and family life, all commuting dummies are jointly significant. Further, column (2) (Panel (a), Table 5.4) indicates that all commuting distance dummies together are significantly related to satisfaction with work at the 10% level. However, this finding is not robust to the inclusion of further working time (e.g., overtime, working hours mismatch) related controls. The findings reported in Table A.5 with respect to affective well-being outcomes are similar to the ones in

¹⁷ These results are available upon request.

Table 3, where no significant relations between commuting distance and affective well-being measures are observed.

Table 4. Robustness checks for cognitive well-being outcomes – methodology.

	(1) Life	(2) Work	(3) HH-Income	(4) Income	(5) Dwelling	(6) Leisure	(7) Family life	(8) Health
Panel a: Categorization of commuting distances								
Short:	-0.0214	-0.0763*	0.0152	-0.0154	0.0497	-0.0254	-0.0470	-0.0122
10-24 km	(-0.84)	(-1.88)	(0.46)	(-0.40)	(1.50)	(-0.70)	(-1.42)	(-0.47)
Middle:	0.0182	-0.0184	0.0585	0.0715	0.0683	-0.1005**	0.0184	0.0207
25-49 km	(0.52)	(-0.34)	(1.32)	(1.41)	(1.51)	(-2.07)	(0.42)	(0.62)
Long:	-0.0755	-0.1341*	0.0077	0.0344	0.0382	-0.3208***	-0.1522**	-0.0251
50 km +	(-1.60)	(-1.90)	(0.13)	(0.53)	(0.65)	(-4.91)	(-2.38)	(-0.56)
F-statistic	1.74	2.29	0.64	1.27	0.99	8.45	3.35	0.57
(p-value)	0.1573	0.0767	0.5870	0.2816	0.3956	0.0000	0.0181	0.6344
N	60,266	59,345	59,907	60,254	60,249	60,340	59,946	60,324
R ²	0.1671	0.0193	0.1517	0.0731	0.0128	0.0456	0.0336	0.5081
Panel b: Logarithm of commuting distance								
Log (CD)	-0.0075	-0.0410**	0.0133	0.0035	0.0251*	-0.0691***	-0.0310**	-0.0008
	(-0.69)	(-2.53)	(0.98)	(0.23)	(1.82)	(-4.68)	(-2.24)	(-0.09)
N	60,266	59,345	59,907	60,254	60,249	60,340	59,946	60,324
R ²	0.1670	0.0196	0.1517	0.0730	0.0128	0.0453	0.0337	0.5083
Panel c: Excluding small (up to 3km) distance changes								
CD	-0.0005	-0.0006	0.0006	0.0006	-0.0004	-0.0026***	-0.0014**	-0.0004
	(-1.30)	(-0.99)	(1.19)	(1.13)	(-0.79)	(-4.36)	(-2.36)	(-1.11)
CD squared	3.98e-07	7.96e-07	-1.03e-06	-1.04e-06	1.14e-06	2.77e-06***	7.14e-07	8.55e-07
	(0.59)	(0.80)	(-1.05)	(-1.16)	(1.55)	(2.98)	(0.83)	(1.34)
F-statistic	1.70	0.52	1.21	0.69	2.49	11.45	7.37	0.92
(p-value)	0.1820	0.5962	0.2978	0.5025	0.0826	0.0000	0.0006	0.3982
N	49,577	48,746	49,273	49,560	49,554	49,636	49,289	49,624
R ²	0.1549	0.0204	0.1566	0.0813	0.0112	0.0459	0.0305	0.5050
Panel d: FE ordered logit (BUC)								
CD	-0.0011	-0.0006	0.0006	0.0005	-0.0005	-0.0032***	-0.0020**	-0.0007
	(-1.40)	(-0.82)	(0.87)	(0.71)	(-0.62)	(-4.25)	(-2.48)	(-0.96)
CD squared	8.22e-07	7.63e-07	-1.11e-06	-7.89e-07	1.52e-06	3.23e-06***	1.14e-06	1.11e-06
	(0.72)	(0.67)	(-0.93)	(-0.53)	(1.40)	(2.77)	(0.96)	(1.09)
F-statistic	3.57	0.72	0.87	0.56	5.38	23.21	15.80	1.18
(p-value)	0.1679	0.6980	0.6460	0.7575	0.0679	0.0000	0.0004	0.5531
N	106,903	148,034	132,360	143,656	117,314	149,042	127,047	135,644
R ²	0.0564	0.0372	0.0599	0.0424	0.0093	0.0248	0.0177	0.2623
Panel e: Compensating factors excluded								
CD	-0.0005	-0.0005	0.0010**	0.0012**	-0.0002	-0.0030***	-0.0014***	-0.0004
	(-1.22)	(-0.89)	(1.92)	(2.09)	(-0.54)	(-4.91)	(-2.51)	(-1.06)
CD squared	3.92e-07	7.05e-07	-1.11e-06	-1.35e-06	1.03e-06	3.05e-06***	8.55e-07	7.68e-07
	(0.60)	(0.72)	(-1.53)	(-1.50)	(1.40)	(3.25)	(1.00)	(1.25)
F-statistic	1.38	0.42	2.00	2.62	1.74	15.04	7.46	0.79
(p-value)	0.2506	0.6591	0.1351	0.0729	0.1822	0.0000	0.0006	0.4539
N	60,266	59,345	59,907	60,254	60,249	60,340	59,946	60,324
R ²	0.1394	0.0156	0.0155	0.0111	0.0078	0.0254	0.0276	0.5138
Panel f: Accumulated cognitive well-being variables								
	(f1) Satisfaction with life and all life domains	(f2) Satisfaction with all life domains	(f3) Satisfaction with life and domains <i>without</i> leisure and family life	(f4) Satisfaction with domains <i>without</i> leisure and family life				
CD	-0.0051**	-0.0044**	-0.0011	-0.0004				
	(-2.15)	(-2.06)	(-0.58)	(-0.27)				
CD squared	4.36e-06	4.00e-06	1.34e-06	9.67e-07				
	(1.46)	(1.46)	(0.54)	(0.41)				
F-statistic	3.28	2.87	0.17	0.11				
(p-value)	0.0375	0.0569	0.8452	0.8924				
N	58,402	58,471	58,753	58,824				
R ²	0.2149	0.1999	0.2314	0.2134				

Notes: CD = commuting distance. Only the coefficients for the commuting variables are reported. Commutes with less than 10 km are treated as the reference category in Panel a. Same controls as in Table 2. All models are estimated using robust standard errors. *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Detailed regression results upon request.

Panel (b) of Table 4 includes a log transformed measure of commuting distance. The log transformed commuting distance clearly shows a significant relation with satisfaction with leisure and family life as well.¹⁸ Again, we observe a negative relationship between commuting distance and satisfaction with dwelling and work, which disappears when the model includes further information on residential-related variables and working time (e.g., overtime, working hours mismatch) indicating that commuting affects satisfaction with work and dwelling via residential amenities and working time-related aspects.¹⁹ This could point, *inter alia*, to potential benefits of increased flexibility resulting from the implementation of the flexible working regulations for individuals who commute long distances. With respect to affective well-being measures, no or a weak relation with the log transformed commuting distance is found (see Appendix A, Table A.5).

Panel (c) of Table 4 reports the results for models in which small distance changes are excluded, since small distance changes will more likely refer to measurement error in reported commuting distance. This robustness check produces findings similar to those of the main model: A u-shaped relation with commuting distance is found for both satisfaction with leisure and satisfaction with family life. With respect to the other subjective well-being measures, no relation with commuting distance is found (see Table A.5).

Panel (d) of Table 4 presents the results from the FE ordered logit (BUC) models. In line with the findings of Table 2, commuting distance is significantly related to lower levels of satisfaction with leisure and family life. Whereas the sizes of the coefficients increase, the signs and significance levels remain similar, indicating that our findings are robust to this type of methodology, in which the ordinal character of the well-being measures is taken into account.

In Panel (e) of Table 4, potentially compensating factors are excluded from the models. The relation between commuting distance and satisfaction with leisure time and family life is comparable to the main results. Hence, variables with potentially compensating factors are not driving these results. Further, we see that commuting distance is positively associated with satisfaction with (household) income, once income and working hours are excluded. Additionally, we find a significantly positive relationship between commuting and (household) income.²⁰ This suggests that the additional burden of commuting is compensated by a financially rewarding job so that commuters' utility is equalised. These results indicate

¹⁸ Results do not change when we include the logarithm of the squared commuting distance.

¹⁹ Additional analyses are available upon request.

²⁰ Additional analyses upon request.

that, on average, the positive effect of commuting on income could possibly offset the negative effect of commuting on family life and leisure so that overall life satisfaction is not affected.

Panel (f) addresses the issue of multiple hypothesis testing and reports the results for models in which the single dependent variables are added together to achieve overall well-being measures. In Panel (f) of Table 4 we use overall satisfaction with life and all life domains (f1), overall satisfaction with all life domains (f2), satisfaction with life and life domains but *without* leisure and family life (f3) and satisfaction with life domains but *without* leisure and family life (f4) as our dependent variables. This robustness check shows that commuting distance is significantly related to lower overall satisfaction with life and life domains and to lower overall domain satisfaction, but only in those models in which satisfaction with leisure and satisfaction with family life are taken into account (f1, f2). We observe no relationship between commuting and the aggregated well-being measures when satisfaction with family life and leisure are excluded (f3, f4). Thus we argue that the relationship between commuting and overall satisfaction with life and all life domains as well as overall domain satisfaction is driven by satisfaction with family life and leisure time. This is in line with Schwarz and Strack (1999), who argue that when people make a judgment about their general life satisfaction, particular life domains might be more salient than others. The adjusted p-values for multiple hypotheses testing (Table A.2 of Appendix A) do not reveal other results. If we were to consider all cognitive well-being measures as a family, the only outcomes that are significant are satisfaction with leisure and family life. With respect to the overall affective well-being measure (Panel (f), Table A.5), no relation with commuting distance is found.²¹ Since we do not find any significant effects, p-values were not adjusted.

Tables 5 and A.6 (see Appendix A for Table A.6) report the results for the models with different sub-samples. Panel (a) and (b) show differentiated effects across gender for several subjective well-being measures. For both men and women, a longer commuting distance is related to lower satisfaction with leisure time. We find no statistically significant differences between men's and women's satisfaction with leisure. Further, we find a hump-shaped relation between commuting distance and satisfaction with family life for women and a u-shaped relation for men. The difference is statistically significant.²² The results further

²¹ Since 'angry', 'worried', 'sad' can be assigned to negative emotions and 'happy' to positive ones, we first created a reverse scale of the frequency of being happy (a high value indicates a low frequency of feeling happy) before we summed up the single affective well-being variables.

²² For women, the turning point is around 95 km and for men around 560 km. Hence, the found relationship holds for a substantial share of women and men in the sample.

indicate that among women, longer commuting distances are significantly related to lower health satisfaction. Commuting distance squared is positive, suggesting that the negative relation flattens out. The turning point is around 206 km and, hence, the negative relation holds for a substantial share of women in the sample. This relation is not present among men. This is consistent with the findings of Künn-Nelen (2016) and Roberts et al. (2011). Further, as shown by the F-statistics for joint significance, commuting is only weakly related to lower life satisfaction and satisfaction with dwelling for men. With respect to the other subjective well-being outcomes, no or a weak significant relation with commuting distance is found.

In Panel (c), we restrict the sample to full-time workers. It turns out that the results are robust for this sub-sample. Shown by the F-statistics for joint significance, which are significant at the 1% level, commuting is related to lower satisfaction with family life and leisure. Further, we see that commuting is weakly related to satisfaction with dwelling which is again not robust to the inclusion of residential-related controls. Affective well-being measures are not affected.

In Panel (d), we restrict the sample to individuals who commute more than 10 km to work. It turns out that there are no large differences compared to the main model: A u-shaped relation is found between commuting and satisfaction with leisure and family life. For all other variables, results similar to those from our main models are found.

In Panel (e), we restrict our sample to individuals who commute on a daily basis up to 100 km each way. For this sub-sample, the u-shaped relation between commuting and satisfaction with family life is no longer significant, perhaps reflecting that satisfaction with family life is only affected by commuting when commuting trips are linked to longer periods of absence from family, which is typical for commuting on a weekly basis (e.g., staying away from home from Mondays to Fridays).²³ Since our data has a lot of missing information in the case of frequency of commuting (i.e., daily, weekly, less often) this finding has to be interpreted with caution.

²³ Moreover, we find no relationship between commuting and satisfaction with family life for individuals who have no children or who have no partner. These additional sub-sample analyses are available upon request.

Table 5. Robustness checks for cognitive well-being outcomes – sub-samples.

	(1) Life	(2) Work	(3) HH-Income	(4) Income	(5) Dwelling	(6) Leisure	(7) Family life	(8) Health
Panel a: Women								
CD	0.0004 (0.52)	-0.0013 (-1.01)	0.0014 (1.30)	0.0017 (1.46)	0.0005 (0.50)	-0.0028** (-2.40)	0.0009 (0.79)	-0.0015* (-1.78)
CD squared	-1.62e-06 (-1.03)	6.39e-07 (0.27)	-2.56e-06 (-1.23)	-3.79e-06 (-1.75)	-5.79e-07 (-0.28)	2.97e-06 (1.44)	-4.69e-06* (-1.95)	3.63e-06** (2.24)
F-statistic (p-value)	0.87 0.4187	1.54 0.2136	0.86 0.4240	1.60 0.2019	0.20 0.8220	3.91 0.0201	4.14 0.0160	2.73 0.0653
N	30,716	30,130	30,510	30,699	30,704	30,749	30,575	30,740
R ²	0.1300	0.0096	0.1851	0.0582	0.0016	0.0487	0.0214	0.5067
Panel b: Men								
CD	-0.0009* (-1.94)	-0.0001 (-0.07)	0.0001 (0.28)	0.0004 (0.73)	-0.0007 (-1.23)	-0.0025*** (-3.56)	-0.0020*** (-2.90)	-0.0003 (-0.66)
CD squared	9.31e-07 (1.30)	1.97e-07 (0.18)	-3.17e-07 (-0.41)	-5.70e-07 (-0.56)	1.62e-06** (1.96)	2.57e-06** (2.54)	1.78e-06* (1.84)	4.10e-07 (0.59)
F-statistic (p-value)	2.45 0.0861	0.05 0.9552	0.12 0.8903	0.30 0.7445	3.14 0.0434	7.32 0.0007	6.06 0.0023	0.22 0.8043
N	29,550	29,215	29,397	29,555	29,545	29,591	29,371	29,584
R ²	0.1650	0.0306	0.0972	0.0795	0.0236	0.0367	0.0299	0.4927
Panel c: Full-time worker								
CD	-0.0007 (-1.56)	-0.0007 (-1.08)	0.0003 (0.63)	0.0006 (1.01)	-0.0004 (-0.83)	-0.0025*** (-4.00)	-0.0015 (-2.46)	-0.0004 (-1.05)
CD squared	6.17e-07 (0.91)	1.06e-06 (1.04)	-5.93e-07 (-0.83)	-8.00e-07 (-0.87)	1.20e-06 (1.58)	2.70e-06*** (2.86)	9.69e-07 (1.11)	7.13e-07 (1.13)
F-statistic (p-value)	1.87 0.1540	0.59 0.5547	0.38 0.6848	0.52 0.5974	2.51 0.0810	9.20 0.0001	6.35 0.0017	0.64 0.5276
N	47,652	47,427	47,364	47,675	47,636	47,717	47,374	47,703
R ²	0.1577	0.0260	0.1276	0.0739	0.0086	0.0412	0.0379	0.5002
Panel d: Leaving out distances ≤ 10 km								
CD	-0.0012 (-1.22)	0.0001 (0.07)	-0.0011 (-0.85)	0.0004 (0.34)	-0.0020 (-1.51)	-0.0030* (-1.82)	-0.0017** (-2.14)	0.0002 (0.28)
CD squared	1.43e-06 (0.53)	-7.47e-07 (-0.21)	4.32e-06 (1.15)	1.62e-06 (0.42)	4.86e-06 (1.39)	5.76e-06 (1.21)	1.02e-06 (0.90)	1.78e-06 (-0.69)
F-statistic (p-value)	2.23 0.1079	0.09 0.9100	0.82 0.4411	1.80 0.1658	1.14 0.3198	2.78 0.0619	5.13 0.0059	0.59 0.5563
N	28,972	28,729	28,814	28,982	28,964	29,015	29,085	29,013
R ²	0.1020	0.0249	0.0928	0.0643	0.0014	0.0213	0.0115	0.4788
Panel e: Daily commutes up to 100 km								
CD	-0.0008 (-0.26)	-0.0014 (-0.25)	0.0016 (0.36)	-0.0002 (-0.05)	-0.0010 (-0.23)	-0.0089* (-1.80)	0.0015 (0.36)	0.0008 (0.25)
CD squared	1.65e-06 (0.04)	-6.04e-06 (-0.08)	-0.00002 (-0.45)	0.00002 (0.49)	0.00001 (0.24)	0.00003 (0.56)	-0.00003 (-0.68)	-0.00002 (-0.56)
F-statistic (p-value)	0.18 0.8376	0.36 0.6979	0.11 0.8915	0.77 0.4615	0.03 0.9718	6.14 0.0022	0.47 0.6233	0.40 0.6699
N	29,489	29,313	29,324	29,504	29,481	29,532	29,353	29,529
R ²	0.0928	0.0153	0.1028	0.0565	0.0010	0.0153	0.0109	0.4962
Panel f: 'Involuntary' terminated employment because of plant closure (last year) ⁺								
CD	-0.0005 (-1.26)	-0.0005 (-0.88)	0.0006 (1.19)	0.0007 (1.21)	-0.0003 (-0.61)	-0.0025*** (4.14)	-0.0013** (-2.31)	-0.0004 (-1.11)
CD squared	3.47e-07 (0.53)	6.61e-07 (0.67)	-9.08e-07 (-1.41)	-1.02e-06 (-1.12)	1.04e-06 (1.41)	2.55e-06*** (2.79)	6.79e-07 (0.80)	7.74e-07 (1.26)
PC	0.1992* (1.84)	-0.2198 (-1.21)	0.2001 (1.33)	0.1117 (0.71)	-0.0584 (-0.45)	0.0583 (0.40)	0.1260 (0.364)	-0.0264 (-0.21)
PC × CD	-0.0095*** (-3.11)	-0.0053 (-0.75)	-0.0078* (-1.80)	-0.0072 (-1.61)	-0.0030 (-0.85)	-0.0079 (-1.59)	-0.0129*** (-2.44)	-0.0028 (-0.67)
PC × CD ²	0.00001*** (3.25)	8.36e-06 (0.76)	0.00001* (1.74)	0.00001 (1.60)	4.86e-06 (0.88)	0.00001* (1.798)	0.00002*** (2.78)	3.87e-06 (-0.67)
F-statistic and p-value								
all CD	4.16	1.53	1.05	0.79	1.57	5.41	8.03	0.86
variables & interactions	0.0009	0.1759	0.3854	0.5536	0.1658	0.0001	0.0000	0.4849
CD, CD ²	1.73	0.44	1.02	0.73	2.53	10.47	7.07	0.79
N	60,266	59,345	59,907	60,254	60,249	60,340	59,946	60,324
R ²	0.1675	0.0189	0.1519	0.0731	0.0127	0.0453	0.0343	0.5083

Notes: CD = commuting distance. PC= plant closure. Only the coefficients for the commuting variables are reported. Same controls as in Table 2. ⁺Interaction term is included since the number of observations in the cases of plant closures is very small. All models are estimated using robust standard errors. *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Detailed regression results upon request.

In Panel (f), we analyse whether the impact of commuting distance on subjective well-being is different for individuals whose employment was terminated involuntary in the previous year due to plant closure.²⁴ Since the number of employment terminations due to plant closures (n=256) is small, we include interaction terms rather doing the analyses separately. Again we see that commuting distance has a significant adverse effect on satisfaction with leisure time and family life; both the commuting distance variables and the interaction terms are jointly significant. Further, we do observe a significantly negative relation between commuting distances and satisfaction with life for those individuals whose employment was terminated involuntary one year before. The resulting F-statistic is 4.16, which has a p-value of 0.0009 and thus is significant at the 1% significance level. In sum, individuals who changed their job *involuntary* experience reduced life satisfaction if their new arrangements involve longer commuting distances.²⁵ Commuting distance has no impact on reported life satisfaction if the individual *voluntary* changed job or did not change job compared with one year before. With respect to the other subjective well-being outcomes no jointly significant relation with commuting distance is found.

Overall, the robustness checks confirm our finding that affective well-being measures are barely influenced by commuting distance. One possible explanation for the non-relationship between affective well-being and commuting across individuals is that intrinsically happier people tend to engage in more out-of-home activities (Morris et al. 2015). Intrinsic happiness is a characteristic we fail to directly observe, and a significant omission from the OLS models, since recent studies find that perhaps one-third or even 50% of the observed variance in moods or feelings is genetic and inherited (De Neve et al. 2012, Nes et al. 2006). Another possible explanation is that people who travel may adapt to negative effects of their work commute. Some research has demonstrated adaptation to adverse conditions (Frederick and Loewenstein 1999), which the self-report measures in the present study do not fully capture.

²⁴ Therefore, we create a dummy variable that takes the value ‘1’ if employment was terminated involuntary due to plant closure in the last year and ‘0’ if individual did not change job or if the change in employment was voluntary (e.g., own resignation). Following Stock and Watson (2012) we also consider the interaction of plant closure with the cubic commuting distance.

²⁵ We also estimated models where we take into account that residence location is endogenously chosen. Thus, we keep residence location constant. We find that the effect of commuting distance on life satisfaction seems larger for people who do not change their residence compared with one year before ($\beta_{PC \times CD} = -0.0112, p = 0.000$; $\beta_{PC \times CD^2} = 0.00002; p = 0.000$; $\chi^2(5) = 4.79, p = 0.0002$).

Moreover, the robustness checks uncover a robust negative impact of commuting longer distances on satisfaction with leisure time and family life.²⁶ Nevertheless, the first observation that flows from our findings is that commuting distance is a significant but small contributor to satisfaction with leisure time and family life. Thus in one sense our findings might be interpreted to mean that the effects of commuting is indeed quite limited. However, we also find that the impact of travel on well-being is not trivial, and in many cases and various robustness checks our findings suggest that commuting distance is statistically distinguishable from zero. Hence, provided the caveats in the previous paragraph are kept in mind, commuting distance does measurably impact satisfaction with leisure time and family life. Furthermore, we find no relationship between commuting distance and life satisfaction, in general.²⁷ This is in line with the strong notion of equilibrium in location theory. A relation between commuting distance and satisfaction with life is only observed for individuals who were forced to re-arrange their commuting distance due to exogenous reasons.

We argue that these findings can be interpreted as causal effects because, first, FE specification controls for correlated unobservable effects on commuting distance and satisfaction with leisure time as well as family life. Second, endogenous selection, namely that (for example) only those commute who have strong family ties, can only bias the relation between commuting and satisfaction with family life downward. This is confirmed by an OLS analysis in which ‘commuting distance’ is estimated on lagged satisfaction with family life and a set of control variables. This analysis yields no relationship between satisfaction with family and commuting. Hence, good or bad family life does not seem to contribute to individual decision to commute. The same applies to satisfaction with leisure time.²⁸

5.3 Mechanisms

The previous analyses have revealed robust relationships between commuting and satisfaction with leisure time and family life. This is not surprising since commuting involves

²⁶ Since the survey years 2007 – 2013 are to a large extent crises years, which might affect the relation between commuting and life as well as domain satisfaction we performed supplementary analyses using more survey years. However, due to data limitations this is only possible for the cognitive well-being outcomes. We do not find evidence in our data supporting this conjecture. Table A.7 reports the results of the additional analyses for cognitive well-being outcomes.

²⁷ Since we use commuting distance as our key variable, any change in distance, must come from the individual either changing job, workplace or residence location. Both of these events could have an effect on well-being. Our results remain robust, when we restrict our sample to individuals who either did not change job or residence.

²⁸ These findings are available upon request.

much more than just covering the distance between home and work. Commuting prolongs the total workday, whilst reducing time that could be spent with family or on spare time activities.

As outlined in Section 5.2, it has been shown that commuting shapes the amount of time and timing of activities such as housework, leisure, caregiving and sleep, which in turn are linked with life satisfaction, happiness as well as mental well-being. Therefore, in this subsection, we analyse whether several important daily activities serve as potential explanatory factors in the connection between the travel to work and satisfaction with leisure and family life. We especially focus on the average daily time spent on errands (e.g., shopping, trips to government agencies), housework and repairs on and around the house (e.g., washing, cooking, cleaning, gardening), child care and support for persons in need of care, physical activities and other leisure activities (e.g., sports, fitness, gymnastic, hobbies) and sleeping. Since not all of these time use controls are available in every wave, we have to affirm that our results do not depend on the smaller sample size by estimating the main models based on this restricted sample. Further, in order to perform the mediation analysis properly and to be able to calculate correctly the extent to which the time use controls mediate the relationship between commuting distance and well-being, we only consider commuting distance without the quadratic term. Since the negative relation between commuting distance and satisfaction with family life and leisure holds for a substantial share of the sample and the u-shaped relation is found to be rather flat (linear) (see Table 2) our estimates are hardly sensitive to the exclusion of the quadratic term.

As a first step, we include the additional time-use control variables in the modified version of equation (1). The results in Table 6 reveal that more time spent on caregiving is significantly related to both lower satisfaction with leisure as well as family life, whereas more time spent on spare time activities and sleeping is related to higher satisfaction levels. The effect of commuting distance on satisfaction with leisure time and family life is still significant. Moreover, we see that the magnitudes of the estimated coefficients of the distance variables decline to some extent once potential mediators are included, at least in column (2). Therefore, commuting may reduce individual's time devoted to such activities. However, this effect does not explain the observed impact of commuting on satisfaction with leisure and family life.

Table 6. Contribution of time use controls to satisfaction with leisure and family life.

	(1) Leisure	(2) Leisure	(3) Family life	(4) Family life
Commuting distance	-0.00107*** (-3.26)	-0.00105*** (-3.38)	-0.000973*** (-2.97)	-0.000939*** (-2.99)
Time (h) for errands		0.0138 (0.79)		-0.0067 (-0.40)
Time (h) for housework		0.0017 (0.11)		0.0081 (0.87)
Time (h) for caregiving		-0.0275*** (-4.31)		-0.0113** (-2.13)
Time (h) for leisure activities		0.1246*** (13.88)		0.0240*** (2.95)
Time (h) for sleeping		0.1110*** (8.31)		0.0725*** (5.81)
N	47,319	47,319	47,072	47,072
R ²	0.0444	0.581	0.0342	0.0313

Notes: Fixed-effects OLS. Information on time (h) for sleeping is not available for the year 2007. Only coefficients for commuting distance and time use variables are reported. Detailed results are available upon request. The following control variables are included: age, age squared, # of children, marital status, health status, education, unemployment experience, actual working hours, tenure, tenure squared, household income (log), household size, urban area, federal states and year dummies. All models are estimated using robust standard errors. *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

As second step, mediation analysis allows an examination of the contribution of the mediators to the relationship between commuting distance and satisfaction with leisure. The results, presented in Table A.8 of Appendix A, indicate that the total indirect effect is significant ($\beta_{\text{total indirect effect}} = -0.00009, p < 0.01$), suggesting that the model was partially mediated by the addition of the respective time-use controls, which is in line with the results shown in Table 6. So, the multiple mediation analysis confirms that the impact of commuting distance on satisfaction with leisure is relatively robust. The mediation ratio (P_M), which denotes the proportion of the total effect of commuting on satisfaction with leisure (see Table 6, column (1): $\beta_{CD} = -0.00107, p < 0.01$) that is mediated by the included intervening variables, is around 91.6% ($P_M = 1 - \frac{-0.00009}{-0.00107}$). In other words, an appropriate part of the impact of commuting on satisfaction with leisure may be explained through the significant indirect effects of time spent on housework, child care and support for persons in need of care, as well as physical activities and other leisure activities.

Mediation analysis of the relationship between commuting distance and satisfaction with family life reveals a significant indirect effect of commuting (see Appendix, Table A.9: $\beta_{\text{total indirect effect}} = -0.00005, p < 0.01$), indicating that the model was also partially mediated. This supports our findings presented in Table 6. Again, the multiple mediation analysis confirms that the impact of commuting distance on satisfaction with family life is relatively robust. 94.9% of the total effect of commuting on satisfaction with family life (see Table 6, column (3): $\beta_{CD} = -0.000973, p < 0.01$) is mediated by the included intervening variables

$(P_M = 1 - \frac{-0.00005}{-0.000973})$. As depicted in Table A.9 of Appendix A, we find significant indirect effects of time spent on housework as well as physical activities and other leisure activities.

6. Conclusion

In this paper, we analyse the relation between commuting and subjective well-being for employed workers in Germany. In contrast to most of the earlier research, our analyses focus on different affective and cognitive measures of subjective well-being. We find that whereas affective well-being is barely influenced by commuting distance, cognitive well-being is lower for people who commute longer distances. Particularly, our results suggest that commuting is related to lower levels of satisfaction with certain life domains, especially with family life and leisure time. These findings turn out to be robust against several specifications and sub-samples. Moreover, we find that the relation between commuting and satisfaction with family life and leisure can largely be explained by time scarcity. Since commuting increases the length of the total workday while simultaneously reducing time for private use, less time remains available for leisure time activities and home production, which obviously come at the expense of utility derived from family life and hobbies.

However, contrary to the common perception that commuting to work is an onerous activity which is bad for overall life satisfaction, we find no evidence that commuting distance is associated with lower levels of satisfaction with life. This finding is in line with the prediction of equilibrium location theory, according to which individuals are expected to freely optimise and, hence, maximise their utility. Consequently, travelling longer distances to and from work is only chosen if it is compensated. We find evidence that individuals are compensated for their commute by residential amenities (e.g., sizes of dwelling, adequacy of rent) and financially rewarding jobs. We conclude that the benefits related to the labour and housing markets could potentially offset the costs related to family life and leisure, so that overall life satisfaction is not affected.

In sum, individuals' decision concerning commuting cannot be fully understood within the traditional economics framework. On the one hand, we demonstrate that individuals may generally be capable of correctly assessing the true costs of commuting for their overall well-being, whereas on the other hand, they may not be able to accurately forecast the outcome of their choices with respect to particular life domains. Our favoured interpretation is that particular life domains and experiences might be more salient than others, when people make

a decision on whether to commute or not and when people make a judgement about their well-being. In particular, we do not know what people exactly include in their (life) evaluations and what they do not (see Schwarz and Strack 1999). Individuals might rely on inadequate intuitive theories when they predict how certain life domains are affected by commuting. In particular, they may make mistakes when they predict their adaptation to travel-related stress. Consequently, decision utility, inferred from choices, and experienced utility would not be identical (Ettema et al. 2010). Our results suggest that individuals tend to underestimate time constraints related to commuting and its possible consequences for family life and leisure time.

Since the aim of transport policies is to increase individuals' well-being, it is worthwhile to pay more attention to domain specific well-being. Yet, transport policies primarily tend to focus on overall life satisfaction, which might be an insufficient indicator of the effectiveness of policies. Thus, in order to develop tools that allow a complementary evaluation, the effects of policies on different domain specific requirements and aspects of life should be taken into account. Furthermore, since part of the effect of commuting arises through time scarcity caused by the commute, the relationship between the distance travelled, time-use and subjective well-being deserve more attention in transport policy and planning. Much transport policy and planning is currently fostering enlarged job regions to create more opportunities for work and strengthen the economy for both individuals and society. Thus, a more flexible and accessible labour market for companies is created by making the workforce available over larger geographical areas. For these reasons, there is the political will in many countries to expand labour market areas and transportation systems, resulting in an increase in overall commuting. Regardless, when we plan, build and manage our transport network or even the labour market, we should not lose sight of the fact that increased mobility in society is increasing the geographical spread of individuals and thereby reducing their well-being. This does not remain without consequences for social welfare.

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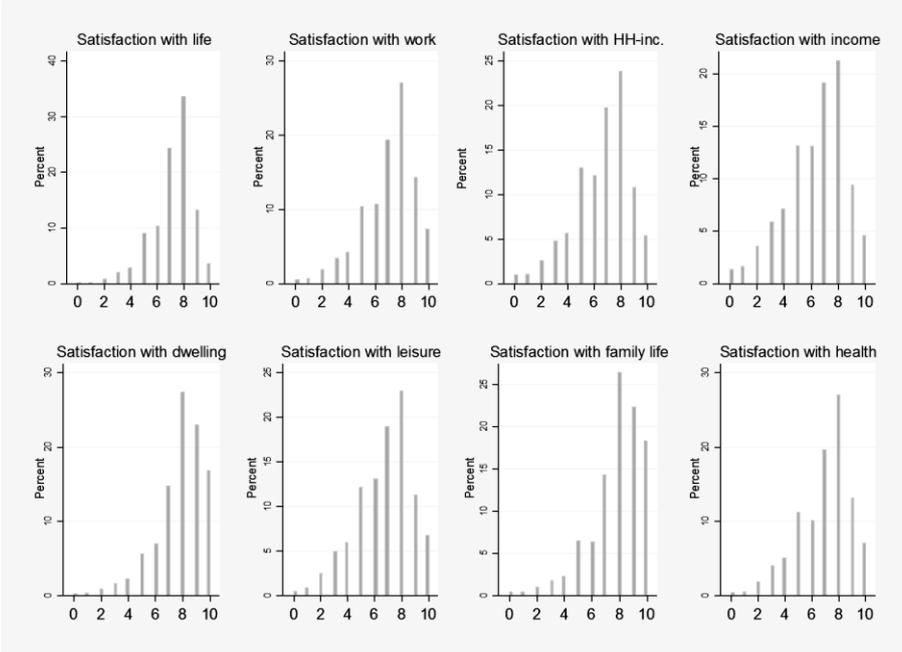
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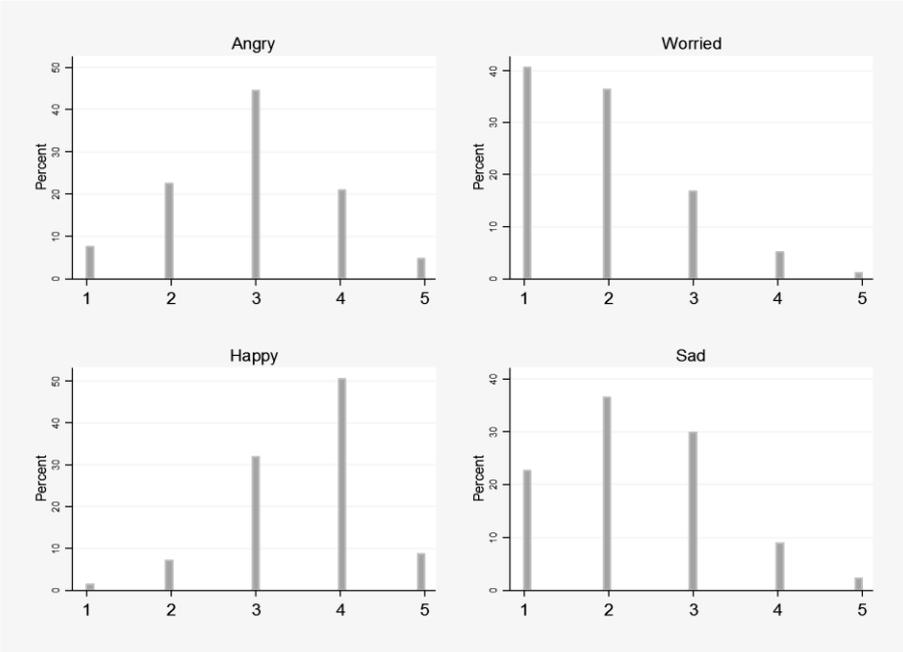
Appendix A

Figure A.1. Distributions of cognitive well-being measures.



Notes: Cognitive well-being measures on an 11-point scale, where the lowest value (0) is labelled “completely dissatisfied” and the highest value (10) is labelled “completely satisfied”.

Figure A.2. Distributions of affective well-being measures.



Notes: Affective well-being measures on a 5-point scale, where the lowest value (1) is labelled “very rarely” and the highest value (5) is labelled “very often”.

Figure A.3. Distribution of commuting distance in km.

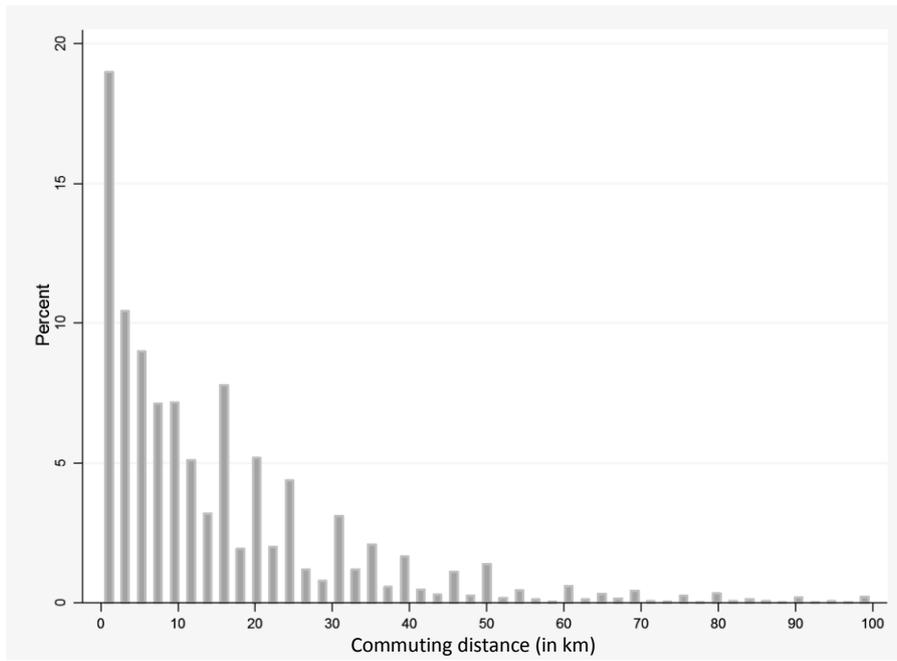
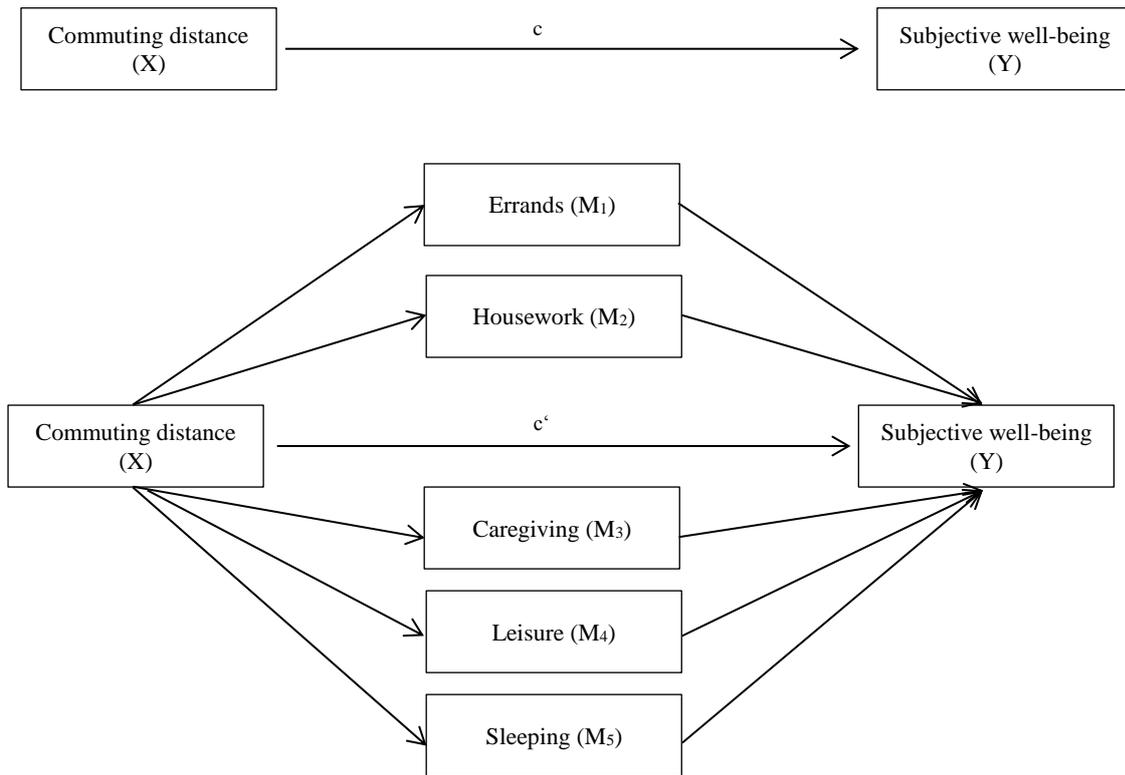


Figure A.4. Schematic of the multiple mediation model.



Notes: Figure A.4 depicts the framework for our mediation model. X represents the independent variable (commuting distance), Y the dependent variable (subjective well-being) and M the mediation variables (time-use). The top portion of the figure represents the *total effect* of X on Y, denoted by c. The bottom portion represents the introduction of the mediators. In this figure c' represents the *total indirect effect* after controlling for the proposed mediators. c' is the coefficient we are interested in. A measure that is relevant for the mediation models is the ratio of the indirect effect to the total effect, $P_M = 1 - \frac{c'}{c}$. P_M is also known as the validation ratio and is often interpreted as the proportion of the total effect that is mediated (Preacher and Kelley 2011). A significant c can be viewed as a necessary condition for testing mediation. If c' remains significant, one can say that the model is partially mediated. If c' is not significant, the model is fully mediated.

Table A.1. Variable definitions.

Variable	Definition
Satisfaction with life	Satisfaction with life on an 11-point scale.
Satisfaction with work	Satisfaction with work on an 11-point scale.
Satisfaction with household income	Satisfaction with household income on an 11-point scale.
Satisfaction with personal income	Satisfaction with personal income on an 11-point scale.
Satisfaction with dwelling	Satisfaction with dwelling on an 11-point scale.
Satisfaction with leisure	Satisfaction with leisure on an 11-point scale.
Satisfaction with family life	Satisfaction with family life on an 11-point scale.
Satisfaction with health	Satisfaction with health on an 11-point scale.
Angry	A five point indicator of frequency of feeling angry in the last four weeks.
Worried	A five point indicator of frequency of feeling worried in the last four weeks.
Happy	A five point indicator of frequency of feeling happy in the last four weeks.
Sad	A five point indicator of frequency of feeling sad in the last four weeks.
Commuting distance	Self-reported one-way commuting distance measured in kilometres.
Age	Age in years.
Female	Dummy equals 1 for women.
Number of children	Number of children in household.
Marital status	Dummy equals 1 if the individual is living together with partner (either married or unmarried couple).
Health status	A five point indicator of self-reported health status: 1 = "very good", 2 = "good", 3 = "acceptable", 4 = "less good", 5 = "bad".
Education	Dummy equals 1 if individual has a school degree higher than intermediate.
Unemployment experience	Dummy variable indicating whether respondent has ever been unemployed.
Working hours	Actual weekly working time.
Tenure	Number of years in present job.
Household income (log)	Logarithm of current gross labour household income.
Household size	Number of persons in household.
Urban area	Dummy equals 1 if individual lives in an urban region.
Time (h) for errands	Time in hours spent for errands on an average workday.
Time (h) for housework	Time in hours spent housework and gardening on an average workday.
Time (h) for caregiving	Time in hours spent for childcare and support for persons in need of care on an average workday.
Time (h) for leisure	Time in hours spent for leisure and hobbies on an average workday.
Time (h) for sleeping	Hours of sleep on an average workday.
Federal states	Dummy variables for the 16 federal states of Germany.
Year	Dummy variables for each year covered by the sample.

Table A.2. P-values and adjusted p-values for multiple hypothesis testing.

Dependent variables	Unadjusted p-values (Table 2)	Adjusted p-values		
		Bonferroni	Holm	Hochberg
Satisfaction with life	0.162	1.000	0.972	0.510
Satisfaction with work	0.340	1.000	1.000	0.510
Satisfaction with household income	0.275	1.000	1.000	0.510
Satisfaction with personal income	0.260	1.000	1.000	0.510
Satisfaction with dwelling	0.510	1.000	1.000	0.510
Satisfaction with leisure	0.000	0.000	0.000	0.000
Satisfaction with family life	0.014	0.112	0.098	0.098
Satisfaction with health	0.240	1.000	1.000	0.510

Table A.3. Complete estimation results on cognitive well-being outcomes.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Life	Work	HH-Inc.	Income	Dwelling	Leisure	Fam. life	Health
CD	-0.0006 (-1.40)	-0.0006 (-0.95)	0.0005 (1.09)	0.0006 (1.13)	-0.0003 (-0.66)	-0.0025*** (-4.24)	-0.0014** (-2.45)	-0.0005 (-1.17)
CD ²	4.19e-07 (0.64)	7.08e-07 (0.72)	-9.23e-07 (-1.33)	-9.61e-07 (-1.06)	1.06e-06 (1.44)	2.61e-06*** (2.87)	7.82e-07 (0.92)	7.96e-07 (1.29)
Age	-0.0544*** (-3.55)	-0.0354 (-1.53)	-0.0396* (-1.95)	0.0307 (1.34)	-0.0813*** (-4.15)	-0.0258 (-1.27)	-0.0401** (-2.06)	-0.0864*** (5.70)
Age ²	0.0007*** (4.40)	0.0005** (2.17)	0.0010*** (4.64)	0.0004* (1.83)	0.0008*** (4.26)	0.0007*** (3.29)	0.0005** (2.43)	0.0006*** (3.92)
Number of children	0.0382* (1.88)	-0.0095 (-0.35)	0.0583** (2.36)	0.0652** (2.41)	0.0710*** (2.94)	-0.1194*** (-4.34)	0.0171 (0.63)	0.0037 (0.19)
Marital status	-0.0099 (-0.25)	0.0637 (1.23)	0.0024 (0.06)	0.0358 (0.72)	-0.0078 (-0.16)	-0.0367 (-0.73)	0.0426 (0.79)	0.0210 (0.57)
Health status (ref.= very good)								
good	-0.2297*** (-10.00)	-0.2273*** (-6.89)	-0.1232*** (-4.12)	-0.1331*** (-4.06)	-0.1121*** (-3.98)	-0.2522*** (-7.82)	-0.2144*** (-7.39)	-0.8266*** (-34.25)
acceptable	-0.6136*** (-22.54)	-0.5689*** (-14.72)	-0.3035*** (-8.88)	-0.3272*** (-8.71)	-0.2390 (-7.35)	-0.5384*** (-14.55)	-0.4407*** (-12.98)	-1.9474*** (-64.07)
less good	-1.0924*** (-29.62)	-0.9512*** (-18.76)	-0.4765*** (-11.24)	-0.4584*** (-9.95)	-0.3540*** (-8.82)	-0.7830*** (-16.52)	-0.6396*** (-14.34)	-3.5278*** (-82.80)
bad	-2.0794*** (-22.09)	-1.3997*** (-11.65)	-0.8462*** (-9.45)	-0.8337*** (-8.59)	-0.5283*** (-5.75)	-0.9069*** (-8.52)	-0.8648*** (-8.28)	-5.2529*** (-51.32)
Education	0.1821 (1.34)	0.1276 (0.35)	0.1595 (0.83)	0.0106 (0.04)	-0.0485 (-0.27)	-0.0546 (-0.22)	-0.0836 (-0.41)	0.0332 (0.20)
Unemployment experience	-0.0566 (-0.76)	0.2181* (1.87)	-0.1447 (-1.52)	-0.1285 (-1.06)	-0.0513 (-0.55)	-0.1571* (-1.68)	-0.1534 (-1.55)	-0.0377 (-0.55)
Working hours	0.0011 (1.00)	-0.0006 (-0.36)	0.0120*** (8.06)	0.0217*** (12.84)	0.0017 (1.32)	-0.0255*** (-15.84)	-0.0047*** (-3.26)	0.0014 (1.37)
Tenure	-0.0076 (-1.57)	-0.1231*** (-15.93)	-0.0156** (-2.56)	-0.0316*** (-4.59)	0.0103** (1.99)	0.0172*** (2.78)	0.0116* (1.94)	-0.0113** (-2.43)
Tenure ²	-0.00002 (-0.18)	0.0020*** (7.93)	0.00004 (0.19)	0.0004* (1.84)	-0.0002 (-1.22)	-0.0005*** (-2.79)	-0.0001 (-0.59)	0.0001 (1.04)
Household income (log)	0.2722*** (8.45)	0.2420*** (5.85)	1.2553*** (28.36)	0.8664*** (19.38)	0.1676*** (4.35)	0.0818** (1.96)	0.2578*** (4.65)	0.1128*** (3.78)
Household size	-0.0394** (-2.46)	-0.0030 (-0.13)	-0.1806*** (-8.13)	-0.1363*** (-5.98)	-0.0823*** (-4.03)	-0.0596*** (-2.65)	0.1052*** (4.65)	-0.0401** (-2.47)
Urban area	0.0175 (1.17)	0.2572** (1.96)	0.0387 (0.33)	0.1127 (0.92)	-0.0655 (-0.45)	-0.0281 (-0.24)	0.2294* (1.65)	0.0799 (0.94)
_cons	6.4049*** (15.11)	6.5100*** (10.56)	-3.2258*** (-5.90)	-2.5274*** (-4.04)	8.5248*** (14.98)	7.2844*** (12.71)	6.5584*** (11.41)	10.1860*** (25.45)
State dummies	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>
Year dummies	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>
F-statistic	1.95	0.51	0.92	0.64	2.55	10.92	7.46	0.84
(p-value)	0.1427	0.5982	0.3975	0.5280	0.0784	0.0000	0.0006	0.4326
N	60,266	59,345	59,907	60,254	60,249	60,340	59,946	60,324

Notes: Fixed-effects ordinary least squares model. CD = commuting distance. All models are estimated using robust standard errors. *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4. Complete estimation results on affective well-being outcomes.

	(1)	(2)	(3)	(4)
	Angry	Worried	Happy	Sad
Commuting distance	-0.0001 (-0.32)	-0.0001 (-0.60)	-0.0002 (-1.19)	-0.0001 (-0.35)
Commuting distance squared	6.21e-08 (0.15)	4.05e-07 (1.05)	2.66e-07 (0.35)	4.44e-07 (0.98)
Age	-0.0328*** (-3.28)	-0.0036 (-0.38)	-0.0295*** (-3.55)	-0.0240** (-2.24)
Age ²	-0.00005 (-0.49)	7.25e-07 (0.01)	0.0002*** (2.95)	0.0001 (1.19)
Number of children	0.0232* (1.69)	-0.0339** (-2.57)	0.0096 (0.83)	-0.0035 (-0.24)
Marital status	0.0187 (0.75)	0.0086 (0.36)	-0.0237 (-1.07)	-0.0229 (-0.86)
Health status (ref.= very good)				
good	0.0982*** (5.27)	0.0848*** (5.79)	-0.0931*** (-7.00)	0.1190*** (6.98)
acceptable	0.2400*** (12.31)	0.2163*** (12.49)	-0.2220*** (-14.39)	0.2851*** (14.38)
less good	0.3727*** (15.45)	0.4608*** (20.00)	-0.3934*** (-19.57)	0.5297*** (20.90)
bad	0.5105*** (9.85)	0.8838*** (15.12)	-0.6993*** (-15.40)	0.8709*** (16.45)
Education	-0.0332 (-0.27)	0.1301 (1.04)	0.1676 (1.39)	-0.0268 (-0.23)
Unemployment experience	0.0194 (0.41)	0.0575 (1.26)	0.0124 (0.33)	0.0889* (1.82)
Working hours	0.0030*** (4.21)	-0.0010 (-1.41)	-0.0002 (-0.46)	0.0020*** (2.66)
Tenure	0.0240*** (7.26)	-0.0031 (-1.04)	0.0004 (0.18)	-0.0050 (-1.48)
Tenure ²	-0.0005*** (-4.89)	0.0001 (1.54)	-0.00006 (-0.73)	0.0002** (2.33)
Household income (log)	-0.0461** (-2.32)	-0.0849*** (-4.42)	0.0674*** (3.89)	-0.0857*** (-3.96)
Household size	0.0169 (1.55)	0.0059 (0.59)	-0.0126 (-1.34)	-0.0440*** (-3.86)
Urban area	-0.0944 (-1.62)	-0.1286** (-2.46)	0.0798 (1.60)	-0.1498** (-2.52)
_cons	4.6090*** (16.58)	2.7021*** (10.22)	3.8433*** (16.12)	3.6676*** (12.59)
State dummies	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>
Year dummies	<i>included</i>	<i>included</i>	<i>included</i>	<i>included</i>
F-statistic	0.11	0.89	0.86	1.24
(p-value)	0.8993	0.4109	0.4218	0.2892
N	57,166	57,112	57,142	57,136

Notes: Fixed-effects ordinary least squares model. All models are estimated using robust standard errors. *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5. Robustness checks for affective well-being outcomes – methodology.

	(1) Angry	(2) Worried	(3) Happy	(4) Sad
Panel a: Categorization of commuting distances				
Short:	0.0246	-0.0004	-0.0183	-0.0099
10-24 km	(1.41)	(-0.03)	(-1.33)	(-0.55)
Middle:	0.0296	-0.0174	-0.0195	-0.0398
25-49 km	(1.25)	(-0.80)	(-1.01)	(-1.63)
Long:	-0.0214	-0.0095	-0.0281	-0.0296
50 km +	(-0.69)	(-0.35)	(-1.09)	(-0.97)
F-statistic	1.51	0.28	0.79	0.98
(p-value)	0.2090	0.8416	0.5005	0.4008
N	57,166	57,112	57,142	57,136
Panel b: Logarithm of commuting distance				
Log (CD)	0.004	0.0016	-0.0106*	-0.0001
	(0.67)	(0.26)	(-1.84)	(-0.02)
N	57,166	57,112	57,142	57,136
Panel c: Excluding small (up to 3km) distance changes				
Commuting distance	-0.00002	-0.0001	-0.0003	-0.00004
	(-0.08)	(-0.60)	(-1.47)	(-0.14)
Commuting distance squared	-2.86e-08	3.88e-07	3.29e-07	3.50e-07
	(-0.07)	(1.01)	(1.04)	(0.76)
F-statistic for joint significance	0.05	0.79	1.32	1.07
(p-value)	0.9487	0.4523	0.2677	0.3443
N	46,473	46,430	46,458	46,452
Panel d: FE ordered logit (BUC)				
Commuting distance	-0.0001	-0.0005	-0.0009	-0.0002
	(-0.13)	(-0.63)	(-1.16)	(-0.35)
Commuting distance squared	1.42e-08	1.26e-06	9.81e-07	1.27e-06
	(0.01)	(1.05)	(0.94)	(0.94)
F-statistic for joint significance	0.08	1.78	1.44	2.29
(p-value)	0.9620	0.4114	0.4876	0.3182
N	76,812	66,278	56,352	78,927
Panel e: Compensating factors excluded				
Commuting distance	-0.00003	-0.0001	-0.0001	-0.00008
	(-0.14)	(-0.74)	(-1.16)	(-0.28)
Commuting distance squared	1.07e-08	4.24e-07	2.70e-07	4.11e-07
	(0.03)	(0.10)	(0.86)	(0.91)
F-statistic for joint significance	0.04	0.79	0.77	1.19
(p-value)	0.9637	0.4544	0.4626	0.3031
N	57,166	57,112	57,142	57,136
Panel f: Accumulated affective well-being variables				
Commuting distance		-0.00008		
		(-0.13)		
Commuting distance squared		6.71e-07		
		(0.70)		
F-statistic for joint significance		1.05		
(p-value)		0.3486		
N		57,061		

Notes: CD = commuting distance. Only the coefficients for the commuting variables are reported. Commutes with less than 10 km are treated as the reference category in Panel a. Same controls as in Table 3. All models are estimated using robust standard errors. t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Detailed regression results upon request.

Table A.6. Robustness checks for affective well-being outcomes – sub-samples.

	(1) Angry	(2) Worried	(3) Happy	(4) Sad
Panel a: Women				
Commuting distance	-0.0006 (-1.33)	-0.0004 (-0.94)	0.0003 (0.67)	-0.0004 (-0.64)
Commuting distance squared	1.29e-06 (1.36)	1.18e-06 (1.31)	-1.25e-06* (-1.71)	1.32e-06 (1.03)
F-statistic for joint significance (p-value)	0.94 0.3893	1.00 0.3683	3.75 0.0235	0.74 0.4772
N	29,242	29,213	29,231	29,231
Panel b: Men				
Commuting distance	0.0001 (0.30)	-0.0001 (-0.32)	-0.0003 (-1.38)	-0.0001 (-0.26)
Commuting distance squared	-2.24e-07 (-0.47)	3.13e-07 (0.71)	4.92e-07 (1.46)	3.94e-07 (0.78)
F-statistic for joint significance (p-value)	0.15 (0.8599)	0.57 0.5647	1.07 0.3436	0.87 0.4184
N	27,924	27,899	27,911	27,905
Panel c: Full-time worker				
Commuting distance	-0.0001 (-0.33)	-0.0001 (-0.67)	-0.0002 (-1.17)	-0.0001 (-0.38)
Commuting distance squared	-3.04e-08 (-0.07)	4.01e-07 (1.00)	3.51e-07 (1.10)	4.41e-07 (0.93)
F-statistic for joint significance (p-value)	0.44 0.6450	0.66 0.5159	0.69 0.5038	1.05 0.3508
N	45,468	45,425	45,445	45,438
Panel d: Leaving out distances ≤ 10 km				
Commuting distance	-0.0011* (-1.76)	-0.0001 (-0.32)	0.0002 (0.54)	-0.0001 (-0.20)
Commuting distance squared	2.45e-06 (0.46)	2.26e-07 (0.16)	-1.19e-06 (-0.89)	1.16e-06 (0.59)
F-statistic for joint significance (p-value)	1.68 0.1860	0.10 0.9082	0.68 0.5086	0.59 0.5524
N	27,555	27,532	27,545	27,538
Panel e: Daily commutes up to 100 km				
Commuting distance	-0.0034 (-1.40)	-0.0033 (-1.51)	-0.0017 (-0.92)	-0.0035 (-1.44)
Commuting distance squared	0.00001 (0.48)	0.00002 (0.94)	0.00003 (0.92)	0.00001 (0.66)
F-statistic for joint significance (p-value)	3.24 0.0392	1.88 0.1526	1.66 0.1895	2.77 0.0630
N	28,030	28,000	28,017	28,012
Panel f: 'Involuntary' terminated employment because of plant closure (last year) ⁺				
Commuting distance	-0.00009 (-0.33)	-0.0001 (-0.70)	-0.0002 (-1.11)	-0.0001 (-0.44)
Commuting distance squared	5.91e-08 (0.14)	4.38e-07 (1.13)	2.48e-07 (0.79)	4.79e-07 (1.06)
Plant closure	0.0214 (0.26)	-0.0503 (0.488)	0.0393 (0.62)	-0.0285 (-0.03)
PC \times CD	-0.0002 (-0.09)	0.0043* (1.74)	-0.0024 (-1.13)	0.0044 (1.03)
PC \times CD ²	1.17e-06 (0.26)	-7.01e-06* (-1.69)	3.64e-06 (1.04)	-7.63e-06 (-1.10)
F-statistic (p-value)				
all CD variables & interactions	0.26 0.9373	0.99 0.4205	0.63 0.6756	0.80 0.5507
CD, CD ²	0.12 0.8888	0.93 0.3932	0.77 0.4651	1.26 0.2848
N	57,166	57,112	57,142	57,136

Notes: CD = commuting distance. PC = plant closure. Only the coefficients for the commuting variables are reported. Same controls as in Table 3. ⁺Interaction term is included since the number of observations in the cases of plant closures is very small. All models are estimated using robust standard errors. *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Detailed regression results upon request.

Table A.7. Estimation results on cognitive well-being outcomes using more survey years.

	(1) Life	(2) Work	(3) HH- Income	(4) Income	(5) Dwelling	(6) Leisure	(7) Family life	(8) Health
Commuting distance	-0.0027 (-1.59)	0.00001 (0.05)	0.0004 (1.33)	0.0004 (0.90)	0.0002 (0.54)	-0.0032*** (8.19)	-0.0018*** (-3.72)	-0.0003 (-1.54)
Commuting distance squared	0.00002 (0.67)	2.08e-07 (0.37)	-2.16e-07 (-0.47)	-4.06e-07 (-0.60)	-1.19e-06 (-0.24)	3.34e-06*** (5.69)	1.32e-06* (1.88)	4.98e-07 (1.33)
F-statistic	3.71	0.47	2.26	0.53	0.30	39.70	12.93	1.19
(p-value)	0.0246	0.6281	0.1042	0.5914	0.7416	0.0000	0.0000	0.3055
N	161,143	157,567	159,946	99,670	160,823	141,263	81,443	161,128
R ²	0.1730	0.0495	0.2255	0.1323	0.0266	0.0451	0.0488	0.5307

Notes: Fixed-effects ordinary least squares models. Models (1) – (3), (5), (6) and (8) are based on survey years 1992 – 2013 (with gaps). Model (4) is based on the years 2004 – 2013. Model (7) is based on the years 2006 – 2013. Only the coefficients for the commuting variables are reported. The following control variables are included: age, age squared, number of children, marital status, current health status, education, unemployment experience, actual working hours, tenure, tenure squared, household income (log), household size, urban area, federal states and year dummies. *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.8. Mediation of the effect of commuting on satisfaction with leisure time.

	Observed Coefficient.	Bootstrap S.E.	95% CI		
Time (h) for errands			-0.0000108	2.19e-06	(P)
			-0.0000118	1.62e-06	(BC)
			-0.0000113	1.95e-06	(BCa)
Time (h) for housework	0.00001687**	7.021e-06	4.09e-06	0.0000318	(P)
			4.33e-06	0.000032	(BC)
			4.33e-06	0.000032	(BCa)
Time (h) for caregiving	0.00001865***	5.089e-06	9.53e-06	0.0000291	(P)
			9.84e-06	0.0000294	(BC)
			9.76e-06	0.0000293	(BCa)
Time (h) for leisure activities	-0.00011709***	0.00002588	-0.000168	-0.0000665	(P)
			-0.0001681	-0.0000667	(BC)
			-0.0001668	-0.0000647	(BCa)
Time (h) for sleeping	-7.168e-06	0.00001429	-0.0000359	0.0000199	(P)
			-0.0000365	0.0000195	(BC)
			-0.0000362	0.0000198	(BCa)
Total indirect effect of commuting distance	-0.00009217***	0.00003058	-0.0001541	-0.0000337	(P)
			-0.000155	-0.0000347	(BC)
			-0.0001542	-0.0000338	(BCa)
N		47,319			
Replications		5,000			

Notes: Multiple mediation analysis. Same controls as in Table 2 (without CD squared). S.E. = Standard error, CI = Confidence interval, (P) = Percentile confidence interval, (BC) = Bias-corrected confidence interval, (BCa) = Bias-corrected and accelerated confidence interval. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.9. Mediation of the effect of commuting on satisfaction with family life.

	Observed Coefficient	Bootstrap S.E.	95% CI		
Time (h) for errands			-1.81e-06	8.17e-06	(P)
			-1.22e-06	9.32e-06	(BC)
			-1.40e-06	8.70e-06	(BCa)
Time (h) for housework	-0.0000144**	6.171e-06	-0.0000276	-3.13e06	(P)
			-0.0000279	-3.25e06	(BC)
			-0.0000278	-3.22e06	(BCa)
Time (h) for caregiving	-2.300e-06	2.283e-06	-7.23e-06	2.08e-06	(P)
			-7.40e-06	1.94e-06	(BC)
			-7.40e-06	1.95e-06	(BCa)
Time (h) for leisure activities	-0.00003659***	8.735e-06	-0.0000546	-0.0000204	(P)
			-0.0000549	-0.0000207	(BC)
			-0.0000545	-0.0000203	(BCa)
Time (h) for sleeping	-3.310e-06	7.591e-06	-0.0000184	0.0000116	(P)
			-0.0000184	0.0000116	(BC)
			-0.0000182	0.0000117	(BCa)
Total indirect effect of commuting distance	-0.00005423***	0.00001301	-0.0000805	-0.000029	(P)
			-0.0000802	-0.0000286	(BC)
			-0.0000798	-0.0000284	(BCa)
N		47,072			
Replications		5,000			

Notes: Multiple mediation analysis. Same controls as in Table 2 (without CD squared). S.E. = Standard error, CI = Confidence interval, (P) = Percentile confidence interval, (BC) = Bias-corrected confidence interval, (BCa) = Bias-corrected and accelerated confidence interval. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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