The commuters' burden : the relationship between commuting and wellbeing in Europe

THE COMMUTERS' BURDEN: THE RELATIONSHIP BETWEEN COMMUTING AND WELLBEING IN EUROPE

Toon Zijlstra

Researcher - University of Antwerp, Department of Transport and Regional Economics, Belgium;

Senior researcher - Netherlands Institute for Transport Policy Analysis, the Netherlands

toon.zijlstra@uantwerpen.be (corresponding author)

Ann Verhetsel

Professor - University of Antwerp, Department of Transport and Regional Economics, Belgium

ann.verhetsel@uantwerpen.be

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ABSTRACT

There is a growing body of scientific evidence that demonstrates a negative relationship between commuting and wellbeing. However, many of the existing studies have some limitations with respect to geographical scope, the control variables included, or the operationalisation of either wellbeing or commuting. In this contribution, we consider *weekly commuting hours* (WCH) per employed individual. Furthermore, we combined 13 variables on physical condition, weariness and mental condition in a new index for wellbeing. Thanks to the data from the large-scale European Working Conditions Survey from 2015, we were able to cover 35 European countries. A multilevel multiple linear regression model was developed with control variables for factors with a known influence on wellbeing, random intercepts per country, and random slopes for the estimated WCH effect per country. Our results confirm that more time spent on commuting is negatively associated with wellbeing, although the effect size of WCH on wellbeing is relatively small when compared to ageing, education level, frequently working overtime, and experiencing harassment or discrimination at work. The multilevel approach reveals relevant differences between European countries with respect to the general level of wellbeing and the effect of WCH. Nevertheless, in all the countries included in our analysis the relationship between WCH and wellbeing is slightly negative.

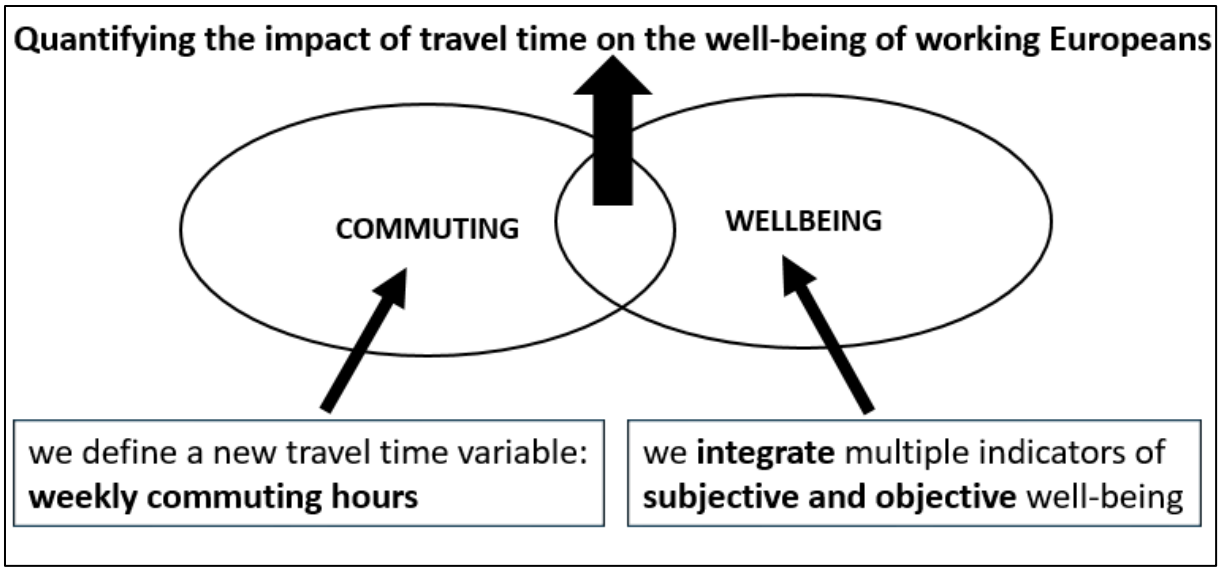
KEYWORDS

Commuting, Europe, Happiness, Mental Condition, Wellbeing, Working Conditions

HIGHLIGHTS

- Data from 30,000 employed individuals from 35 European countries.
- We use the weekly commuting hours
- Wellbeing consists of physical and mental health indicators and fatigue.
- Commuting has a small negative effect on wellbeing.
- Eliminating harassment and discrimination is far more important.

GRAPHICAL ABSTRACT


Quantifying the impact of travel time on the well-being of working Europeans
COMMUTING
WELLBEING
we define a new travel time variable: weekly commuting hours
we integrate multiple indicators of subjective and objective well-being

1 INTRODUCTION

Wellbeing research is on the rise. Academics from multiple research fields have reported on a broad range of issues that affect wellbeing. In this paper, we focus on the influence of commuting on wellbeing. With billions of people travelling to and from work daily, commuting is often mentioned as an important personal and societal burden. Many see commuting as a necessary evil while referring to traffic jams, overcrowded trains, and the necessity to travel to their place of work. Conversely, others experience commuting as pleasant due to the accompanying 'me-time' or the pleasure of walking, cycling, or driving. It is a complex issue that is interwoven with individual characteristics, family and work situation, and the relationship between family and work.

Although research on wellbeing research is on the rise, additional studies on the relationship between commuting and wellbeing are welcome. Within the broad field of welfare studies on family life and working conditions, attention for the effects of commuting is limited, and this topic often overlooked. Within the field of transport research, attention is often limited to comparing transport modes, travel experiences, and remembered utility. The present study examines the role of commuting in wellbeing while accounting for other known and relevant features of life.

There is a growing body of scientific evidence suggesting a negative relationship between the travel time for the daily commute and wellbeing. Chatterjee et al. (2019) have provided an excellent and critical overview of the highly heterogeneous literature on commuting and subjective wellbeing. They state that “satisfaction decreases with duration of commute” and that “a consistent link between commuting and life satisfaction overall has not been established” (Chatterjee et al., 2019, p. 1). We quantify this link between commuting and wellbeing in this paper. Furthermore, we aim to meet the plea by Mokhtarian (2019, p. 507), in another recent review paper, “for future research to pay attention to effect sizes as well as statistical significance […] whether it is meaningful in size”. The resulting research question of this paper is: to what extent does the time spent on commuting affect wellbeing?

Many of the existing studies have some limitations, such as sample size, the geographical area they cover, the control variables used, or the operationalisation of the abstract concept of wellbeing. In this contribution, we examine the relationship between commuting time and wellbeing thoroughly, on the basis of a carefully designed operationalisation of wellbeing, a wide range of relevant control variables, and a large and highly representative sample of employed individuals from 35 countries in Europe, home to 600 million people in 2015. By doing so, we hope to contribute and strengthen the available body of knowledge.

Our paper begins with an brief overview of the existing literature on wellbeing and commuting. In this section, various relevant variables for the regression model are introduced. For a more thorough and extensive review, we kindly refer to the excellent reviews by Mokhtarian (2019) and Chatterjee et al. (2019). In the next section, our research method and data are presented, after which we share our findings. Finally, the paper ends with a discussion and our conclusions.

2 WELLBEING AND COMMUTING

2.1 THE ABSTRACT CONCEPT OF WELLBEING

Wellbeing is conceived as thriving across multiple domains of life, integrating hedonic wellbeing (feeling good) and eudaemonic wellbeing (functioning well) (Adler & Seligman, 2016; Diener et al., 2003; Reardon & Abdallah, 2013). Therefore wellbeing must be approached in a multidimensional way: using both subjective and objective measures. Firstly, *subjective measures* of wellbeing are 'soft' measures of self-reported life domain assessment, like how 'happy' or 'satisfied with life' people are. Secondly, *objective measures* of wellbeing use statistics like income level, employment rate, housing quality (basic facilities, rooms per person), the average life expectancy, or the number of divorces (Smith & Reid, 2017; Reardon & Abdallah, 2013). The Better Life Index by the OECD is an interesting example of the latter (http://www.oecd.org/statistics/better-life-initiative.htm).. All dimensions mutually affect each other and provide a partial picture of an individual's wellbeing. Hence, combining these approaches provides a more complete view (Schueller & Seligman, 2010). Therefore, we include a multidimensional approach to wellbeing in this paper.

General wellbeing research, like that of Oguz et al. (2013) for the UK, shows that people view *their health as the most important factor for their personal wellbeing,* followed by employment status and relationship status. People's age, gender, ethnic background, migration status, religious affiliation, level of education, presence of children, reasons for inactivity, occupation, home ownership, and area of residence are other examples of factors which influence personal wellbeing (Oguz et al., 2013). The differences in life satisfaction between income classes are quite small, and improvements in financial situation hardly raise happiness, because the increase of income itself engenders a corresponding rise in material aspirations while experienced utility does not rise as expected (Frey & Stutzer, 1999; Easterlin, 2001). These observations inspired us to include a series of control variables in the analysis (Table 1).

Despite the growing presence of literature concerning the determinants of wellbeing and the established reasonably robust relationships between happiness, labour market status and health on the one hand and the extensive literature on the effects of specific working conditions on health outcomes on the other hand, *commuting is seldom part of such studies* (Roberts et al., 2009; Loscocco & Spitze, 1990). If mentioned at all, it is often only as one of the many objective state-level indicators (Adler & Seligman, 2016; Song, 2017).

Commuting involves distance and time, but it also leads to out-of-pocket costs, air pollution, greenhouse gas emissions, traffic congestion and urban sprawl. It intervenes in the relationship between work and family, and psychologists have long since recognised that commuting has potentially destructive effects, and that it leads to concerns about levels of stress and psychological problems among the working population (Roberts et al., 2009; Stutzer & Frey, 2008; Lyons & Chatterjee, 2008; Sandow 2014). However, there are also benefits, such as 20-minute commutes, which provide a buffer between work and private life, creating a moment for oneself. Mokhtarian and Salomon (2001) use the term "anti-activities", which they describe as "the ability to use the time for relaxing or thinking, including 'shifting gears' mentally between the origin and destination activities and roles" (p. 702). For longer work commutes, social and entertainment activities either increase positive effects or counteract stress and boredom (Lyons & Chatterjee, 2008; Ettema et al., 2012; Olsson et al., 2013; Mattisson et al., 2015).

From a neoclassical economics perspective, commuting is a rational decision determined by an equilibrium state of the housing and labour market (So et al., 2001; Novaco et al., 1990; Reardon & Abdallah, 2013). Not surprisingly, economic models emphasise the trade-off between commuting costs and housing costs and place this trade-off at the core of residential location models (Alonso, 1964; Muth 1969). Only recently has commuting been considered from the perspective of the 'new economics of wellbeing' (Roberts et al., 2009). Most attention has been paid to traffic congestion as the primary underlying factor leading to elevated stress from commuting (Wener et al., 2003). The studies by Kahneman et al. (2004) and White and Dolan (2009) state that commuting, compared to other daily activities, is neither pleasurable nor rewarding. A Swedish study by Olsson et al. (2013) shows another image, namely that people's feelings during commutes are predominantly positive or neutral. Possible explanatory factors include desirable physical exercise from walking and biking. However, many of the studies about commuting cover only the satisfaction with commuting, not wellbeing as a whole (Ettema et al., 2010). In this paper, we study wellbeing in general, and we focus on commuting time.

2.2 COMMUTE TO WORK

Much has been written about *commuting time* and the various factors that influence the duration of commuting. A 'commuting time paradox' has been observed, which states that the average commuting time on an aggregated level does not vary between different historical periods, while many other related aspects do (Van Ommeren & Rietveld, 2005; Kim, 2008). An increase in travel speed mainly results in longer distances covered. Indeed, the acceleration of the system results in an enlargement of geographical scope.

There are some patterns in commuting time in relation to social groups. In their study, using data from the European Working Conditions Survey (EWCS), Zijlstra et al. (2018) show that there are some key determinants to explain the differences in commuting time. For instance, the size of the organisation, expressed in the number of employees, is positively associated with travel time. In some sectors, like mining, construction and international organisations, there are relatively long commutes, while in retail, education and healthcare commutes are relatively short. The socio-economic class, based on education and income level, is also an important factor. Finally, this study shows that, on average, people who reside in non-urban peripheral regions need less time to travel to work. Levinson (1998), in turn, has found that residents who live in job-rich areas and work in housing-rich areas have shorter commuting times. Moreover, the travel mode, in addition to socio-economic and demographic characteristics, also influence commuting time (He & Zhao, 2017; Lee & McDonald, 2003). Clark et al. (2003) have demonstrated that both one- and two-worker households with a larger distance between the workplace and residence often decide to decrease commuting distance and time during their career.

Despite the number of studies about commuting time and the fact that context-specific factors like commuting time cause changes in subjective wellbeing (SWB), a link with overall wellbeing is less common. Our paper focuses on this connection. The following paragraph briefly discusses the existing literature on the relationship between commuting and both the subjective and objective measures of wellbeing.

2.3 THE COMPLEX RELATIONSHIP BETWEEN COMMUTING AND WELLBEING

Regarding the *subjective measures of wellbeing and commuting* there is already a small and interesting body of literature (Chatterjee et al., 2019). Contrary to the prediction of the equilibrium location theory, commuting time seems to have a (large) negative effect on self-reported SWB or

people's satisfaction with life (Stutzer & Frey, 2008; Olsson et al., 2013, Ettema et al.,2010; Crawley, 2014; Oguz et al., 2013). Moreover, Wener et al. (2003) have found that increased levels of stress and negatively affected satisfaction are not only caused by longer commuting times, but also by complicated (more stressful) trips, like public transportation trips with transfers. Olsson et al. (2013) have pointed out that for many people, being able to make their daily routines work may be important for their overall happiness due to positive feelings dominating over negative ones. Recent research, using the Travel Satisfaction Scale (STS), has concluded that subjective wellbeing is affected by travel mode, travel time, access to bus stops, and complexity of agendas that increase time pressure (De Vos et al., 2013; Eriksson et al., 2013; Ettema et al., 2011). Finally, Oguz et al. (2013) have found that the worst effects of commuting on personal wellbeing are experienced by people with journey times lasting between 61 and 90 minutes. These are (extremely) long commuting times for European standards (§3.2).

The vast majority of studies in the academic literature on the relationship between commuting and subjective wellbeing used cross-sectional data, though recently promising research was carried out with longitudinal data. These studies provide further analysis of the within-individual relationship between commuting behaviour and SWB based on multiple observations per individual (Chatterjee et al., 2019). A series of panel studies on data of workers in England was carried out by Clark et al. (2019). They analysed the impact of commuting (time and mode) on multiple aspects of SWB. They found that shorter commute times and walkable commutes can contribute to improved SWB, particularly through the release of leisure time, but life satisfaction overall will probably only be maintained if the benefits of undertaking the commute (earnings and satisfactory housing/employment) are not compromised.

With respect to the more *objective measures* of wellbeing in relation to commuting, findings can be grouped in four clusters. *The first cluster concerns the household of the commuter*. Sandow (2014) has found that longer travel times have a negative effect on marriages and cohabitations. Furthermore, Christian (2012) has demonstrated that more time spent on commuting results in less time spent on other activities like active leisure, social activities, household tasks, and political participation (Newman et al., 2014; Mattisson et al., 2015). The decreased time that can be spent with family or friends negatively impacts family life and social commitments in general, and it might (indirectly) influence the commuter's wellbeing (Denstadli et al., 2017). Concerning gender, most studies have found that women's greater sensitivity to commuting time appears to be a result of their greater responsibility for daily household tasks, including childcare (Roberts et al., 2009; Gimenez-Nadal & Molina, 2016; Lee & McDonald, 2003). After all, Swärdh and Algers (2016) have shown that estimated values of commuting time do not differ significantly between men and women, but when decisions affecting commuting time and wage of both spouses are analysed, both spouses value the commuting time of the wife highest. More time spent commuting also results in less time for sleeping and resting, which in turn belongs to *the second cluster: personal characteristics*. As early as 1978, Singer et al. concluded that commuting by train results in increased objective indicators of stress, such as blood pressure and neuroendocrine processes. Contrarily, active commuting by walking and cycling is associated with higher levels of physical wellbeing and reduced obesity (Hansson et al., 2011; Humphreys et al., 2013; Yang et al., 2012). Poor mental health is not significantly associated with commuting, whereas perceived poor sleep quality, exhaustion (low vitality) and poor self-rated health are. These results are in line with the findings of previous studies linking commuting to sleep disturbance (Gottholmseder et al., 2009; Walsleben et al., 1999; Costal, 1988), daily stress (Costal, 1988; Amponsah-Tawiah et al., 2016), exhaustion (Hämming et al., 2009), poor self-rated health (Stutzer & Frey, 2008), and the absence of sickness (Karlström & Isacsson, 2009). The *third cluster includes everything related to the work and employment situation,*

such as income (see above). Van Ommeren and Guitiérrez-i-Puigarnau (2011) have ascertained a positive and significant relationship between long distance commuting and absenteeism, considering that this last one is probably one of the best general indicators for the psychological and physical wellbeing of employees. *The fourth cluster concerns differences between countries and cultures*. This cluster is still underexposed due to insufficient attention to the bigger picture and the fact that studies often only focus one or a couple of countries.

A relevant conclusion from this literature review is that a rigorous test of the hypothesis *there is a negative relationship between commuting time and wellbeing* demands the inclusion of both subjective and objective criteria for wellbeing. In both the definition and the interpretation of wellbeing, significant differences can be observed. Most of the studies include only one or a limited number of variables and have failed to bring findings for different countries together. We tackle this issue by incorporating the different dimensions of wellbeing. We also included a series of variables controlling for the many dimensions, other than commuting time, that influence wellbeing. This paper also covers 35 European countries, which makes our study unique in its genre. However, even if we are able to find an association, the question remains whether it is meaningful in size (Mokhtarian, 2019).

3 EWCS DATA AND MULTILEVEL MODELLING

3.1 DATA

To test our hypothesis, we used cross-sectional data from the sixth edition of the European Working Conditions Survey (EWCS, 2015), as obtained from the UK data archive. Nearly 44,000 workers – employees, self-employed and entrepreneurs - were interviewed in a similar manner in 35 countries . The random sample ranged from 1,000 to 3,300 people per country, depending on the number of inhabitants of the country and national arrangements. The original dataset also contains weights to approximate a more representative image of the working population per country. We applied these weights in our study.

From the EWCS data, we only used employees with ≥ 12 hours of paid work per week; other cases, such as employees with a limited number of working hours per week, the self-employed, volunteers, entrepreneurs or employers, were excluded from our analysis. Additionally, cases from respondents who cooperated poorly, as indicated by the interviewers, and cases with items missing regarding travel times were deleted. We used predictive mean matching as an imputation technique for missing items among the control variables. The final set contains 29,345 observations. This sample is larger and more heterogeneous than that of most other studies. It also enabled us to compare (cultural) differences between countries.

In the EWCS, a comprehensive list of 106 questions regarding working conditions was submitted to the respondents. The topics discussed included not only objective measures of job quality, but also the workers' own assessment of socio-economic aspects, working conditions, safety issues, work pressure, physical or mental strain, and collegiality. The EWCS data offers multiple benefits. Most important for the purpose of our paper is the availability of multiple indicators of wellbeing, covering both psycho-emotional (e.g. feeling cheerful) and more physical aspects (e.g. headaches) of wellbeing. Although the focus is on working conditions, the dataset contains multiple interesting potential control variables related to individual characteristics and household situation. Overall, the data gathering has been thorough, the sample size is excellent, and the data are publicly available.

3.2 To establish a causal relationship longitudinal data is preferred over cross-sectional data (Wunsch et al. 2010; Pearl, 2020). Models based on cross-sectional data have a higher risk of biased estimates (Maxwell & Cole, 2007; Pearl, 2020): they might under- or overestimate the effect. Since the EWCS contains cross-sectional data, we are cautious to make statements about causality in this paper. We demonstrate an association relationship between weekly commuting time and wellbeing and compare our findings with the findings in the literature.Main explanatory variable: weekly commuting hours

Unfortunately, the EWCS data only offers one variable directly related to commuting, which is the self-reported travel time: "In total, how many minutes per day do you usually spend travelling from home to work and back". Additional data on the transport mode, travel costs, the observed travel time and so on would offer interesting opportunities to further improve research. The self-reported travel time was converted to the main explanatory variable in this study, namely *weekly commuting hours (WCH)*. The WCH were calculated for each individual in the sample, using the self-reported travel minutes, number of workdays per week, and the locations where the work was carried out. People who never spent time at their workplace or who were always on the road (like taxi drivers, bus drivers, or UberEats bikers) were removed while cleaning the data. Moreover, working from home did not add any additional time to the WCH. The median WCH was 2.5, and the mean was 3.3. The histogram (Figure 1) shows that the commuting hours per week are heavily skewed. About 77% of the respondents commuted five hours or less per week to their respective workplaces, while the maximum was 20 hours per week.

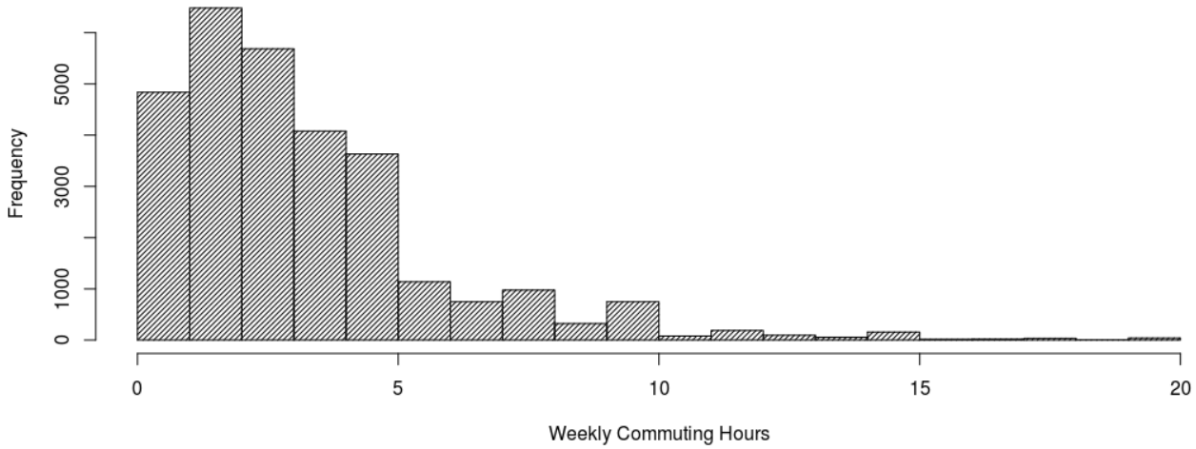


Figure 1: Histogram of the estimated WCH; our calculations with data from EWCS-2015

Multiple studies have made the 'mistake' of directly modelling daily travel time for commuting. This ignores day-to-day differences. For example, not everyone works at a fixed location every day. Also, quite some employees work part-time, so the burden of two or three commutes per week will be different from five times or even more. Additionally, people with longer travel times show more coping strategies, like working at home or from a more accessible hub on some days. In the EWCS subset we used, employees with > 12 hours per week, we found that 13% worked less than 30 hours per week and 6% worked more than 50 hours per week in their main paid job. Over 12% worked four days or less, and 18% worked more than five days a week. Approximately 80% of the people in our sample never worked at home. The remaining 20% did work from home occasionally or multiple days a week. Ultimately, only approximately 62% of the respondents in our sample commuted the

commonly assumed five days a week. 22% of the sample commutes less than five days. And 16% commutes more than five days a week. Our WCH are not perfect, as they do not account for having lunch at home, delays, or trip chaining. The WCH are the best guess based on the information available to us.

Figure 2 maps the average WCH per employee for all 35 displayed countries. The map hardly shows a distinct pattern. The average WCH in Turkey were relatively high, with 4.5 hours a week. The average WCH in Cyprus were relatively low, with an average of 1.9 hours per week. Figure 2 also shows which countries are included in the EWCS dataset.

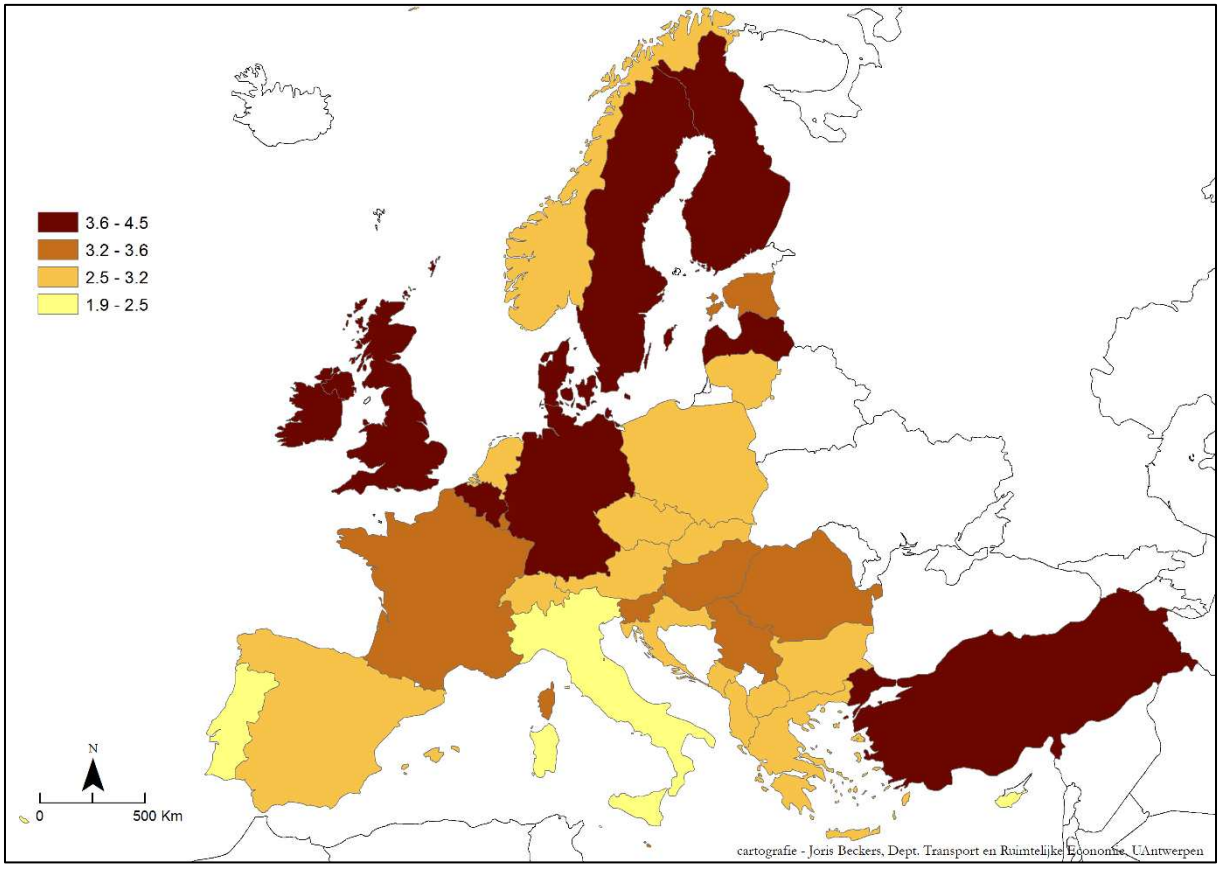


Figure 2: Average WCH per country, calculated with data from EWCS-2015.

3.3 AN INDEX FOR WELLBEING

The dependent variable in our main model is wellbeing. Again, this variable was not directly available in the EWCS dataset; it was derived from a number of other variables that were included. The technique used to obtain a single index for wellbeing is the confirmatory factor analysis (CFA). In contrast to an exploratory factor analysis, a CFA starts with a conceptual framework. It is up to the model to tell whether or not this framework makes sense. It is not a data-driven exercise to obtain the optimal fit for the data. The software used for the CFA is the *lavaan* package in R.

Our conceptualisation of wellbeing, inspired by the literature review, started with three main ingredients: the physical condition, mental condition, and fatigue. *Physical condition* was constructed using five dummy variables for the presence of backaches, headaches, muscular pain (upper and lower part of the body), and weariness. The *mental condition* relied on the frequency scores of five questions regarding the state of mind, namely feeling cheerful, feeling relaxed, feeling vigorous, feeling fresh and encountering interesting things. *Fatigue*, the third and final indicator for the

wellbeing index, can be regarded as an intermediary between physical and mental health. This indicator was fed by the question about weariness, as also used for physical condition, and three new questions regarding sleep issues (difficulties falling asleep, waking up repeatedly during the night, and waking up rested in the morning).

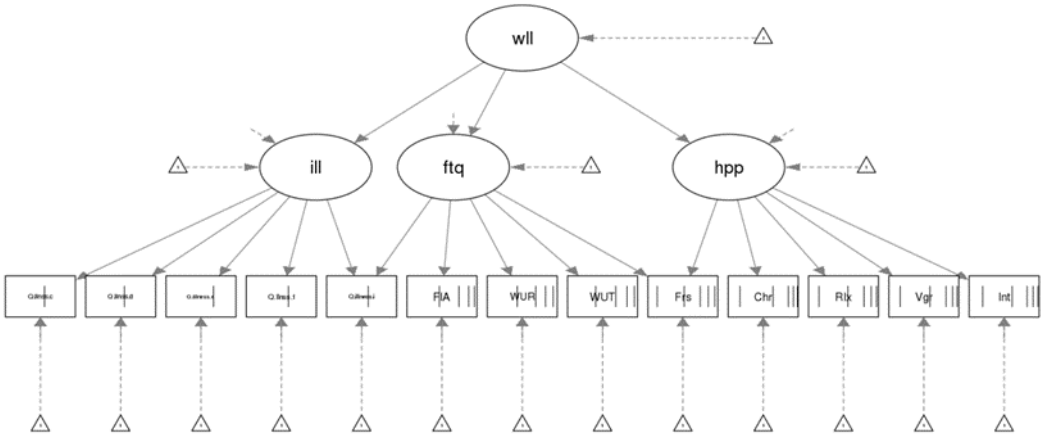


Figure 3: Wellbeing index: based on three indices and 13 survey questions

Our new conceptualisation of wellbeing combines more objective measures with more subjective measures of wellbeing into a single index. We did not apply a readily existing and tested index for wellbeing. The absence of the necessary standard building blocks in the dataset used is the main explanation here. We were simply unable to mirror known indices. In order to assess the importance of the underlying indicators in our index (mental condition, physical condition and fatigue), we looked for concordant and discordant results in three separate models with one of the indicators as dependent variable (appendix 3). We also carefully checked the output from the CFA.

The results of the CFA were satisfactory. All the details are provided in appendix 1. The CFA model fit was good according to standard rules of thumb (Harrington, 2009). The data-driven model improvement suggestions, called the modification indices, did not offer any logic lead for a better fit. Ultimately, there seemed to be little room for improvement. Hence, the output of the CFA revealed that our index for wellbeing is certainly plausible.

Figure 4 shows the histogram of the wellbeing index, the dependent variable in our model, as constructed by the CFA (appendix 1). By default, the result of a CFA approximates a standard normal distribution. In our study, the mean was zero and the standard deviation was 0.78. The distribution was somewhat abnormal in the right tail, which caused a standard deviation below one. The maximum (observed and practical) score on the wellbeing index was 1.64. People with a maximum score indicated that they did not have any physical issues, had no problems sleeping and felt cheerful, fresh, vigorous and so on all the time. Nearly 2.5% of the people in the sample obtained this maximum score. Note that a score of zero is not the same as neutral. Zero is the population average, with mainly (slightly) positive responses.

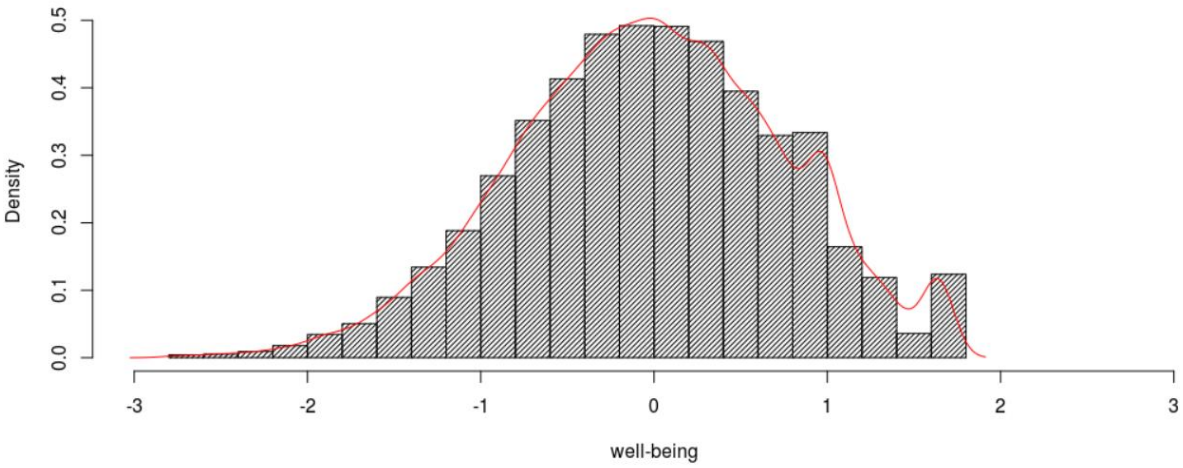


Figure 4: Histogram of the wellbeing index

3.4 MULTILEVEL MODELLING

To estimate the effect of travel time on wellbeing, we used a mixed-effects linear regression model (Hox, 2010). This popular model is also known as a hierarchical or multilevel model. We considered *two* levels in the analysis. Firstly, the responses of the participants were the base level (level 0). On this level we had data from 29.345 cases. Secondly, on level 1, we differentiated between the 35 countries present in the EWCS dataset. We added this level, because one of the well-known phenomena in 'happiness' studies are the considerable differences in self-reported wellbeing between countries (Kahneman et al., 2004). Moreover, we needed to differentiate between the countries in our data because of the considerable differences in the cultural, social, economic and political conditions, which were not all accounted for by the control variables. Our assumption was that the travel conditions for commuters vary between countries. Therefore, we allowed this effect to differ between countries by adding a random slope for WCH to the model.

The literature review and the model output from other researchers made clear that individual characteristics, household circumstances and employment context greatly influence wellbeing. Therefore, we introduced a balanced set of control variables to account for these effects in our model. Luckily, the rich EWCS data gave us the opportunity to do so (Table 1). Nevertheless, not all relevant factors, with a known effect on wellbeing, are available to us. For instance, the EWCS lacks details about living conditions and the social life of the individual.

Table 1: Control variables used in the model

Statistic	Ref. level	Mean	St. Dev.	Min.	Median	Max.
Female	Male	0.515	0.500	0	1	1
Age (group)[1]	15-29 y/a	42.155	11.656	15	42	86
Immigrant	No	0.09	0.286	0	0	1
Partner at home	No	0.651	0.477	0	1	1
Kids at home	No	0.482	0.500	0	0	1

Single parent	No	0.071	0.256	0	0	1
No and low education level	Mid - high education	0.032	0.177	0	0	1
Low to mid education level	Mid - high education	0.604	0.489	0	1	1
Higher education level	Mid - high education	0.115	0.319	0	0	1
Rurban / semi-urban	Urban	0.305	0.460	0	0	1
Rural	Urban	0.267	0.442	0	0	1
Restructure at workplace	No	0.253	0.435	0	0	1
Work at night	No	0.113	0.317	0	0	1
Work overtime	No	0.147	0.354	0	0	1
Business size (2-9 people)	1 person	0.192	0.394	0	0	1
Business size (10-249 people)	1 person	0.426	0.495	0	0	1
Business size (250+ people)	1 person	0.340	0.474	0	0	1
Main breadwinner	No	0.633	0.482	0	1	1
Wanting to change working hours	No	0.119	0.324	0	0	1
Second job	No	0.079	0.269	0	0	1
Flexible working hours	No	0.224	0.417	0	0	1
Permanent contract	No	0.802	0.398	0	1	1
Years at current workplace	0	9.878	9.688	0	7	64
Discrimination (number of issues)	0	0.121	0.548	0	0	7
Harassment (number of issues)	0	0.335	0.898	0	0	7
Net wage per month	0	0.16	1.081	-1	-0.15	6.796
Change of wage level (+ or -)	0	0.211	0.59	-1	0	1
Weights		1.003	1.372	0.004	0.493	18.535

Notes: the summary statistics displayed in the table are unweighted. [1] Age was converted into five age groups in the models: 15-29 (n=5073), 30-39 (n=7339), 40-49 (n=7945), 50-59 (n=7131), and 60 years and older (n=1875). This was done to account for non-linearity and to reduce correlation with other independent variables.

4 MAIN RESULTS: SMALL IMPACT OF WEEKLY COMMUTING HOURS ON WELLBEING

In this section, we first report the results regarding the fixed effects of the WCH and of the included control variables on wellbeing. Subsequently, we explore the random intercept and random slope to study the relevant differences between countries.

4.1 FIXED EFFECTS

With respect to the fixed effects (figure 5, appendix 2), WCH were found to have a statistically significant and negative effect on the overall wellbeing while controlling for other known determinants that affect wellbeing. The coefficient for one hour of weekly commuting time was -

0.014, with a 95% confidence interval ranging from -0.019 to -0.009. Hence, the estimated effect of the average commuting time of 3.3 hours was -0.046. Motivated by the skewed distribution of the WCH (Figure 1) and the potential decisive effect of outliers, we also tested a log-transformed or square root effect of travel time in the model. This did not yield alternative conclusions in terms of significance or direction of the effect. All findings support our main hypothesis: commuting time is significantly negatively associated with wellbeing. However, the statistical significance is hardly surprising given the number of observations in our model. Meanwhile, the size of the effect is modest in comparison to many other coefficients. Therefore, the importance of WCH and their negative effect on wellbeing should not be overestimated.

When looking at the underlying indicators of our wellbeing index, we also a found significant negative effect of WCH on fatigue, mental condition or physical condition (Appendix 3). The effect size was somewhat larger (range -0.022 to -0.018) , when compared to the main model (-0.014). The parameters for the main explanatory variable from these three models were highly consistent with each other. Hence, the negative effect in the main model cannot be attributed to just one of these indicators. Some of the (less consistent) control variables mitigate the effect of WCH in the main model.

With respect to these control variables in our model, we found that women clearly reported lower levels of overall wellbeing. Additionally, the wellbeing dropped as age increased, although the age group of 60 years and older did not differ from the group of 50 to 60 years. In contrast with the expectations, we did not find a lower level of wellbeing for immigrants, as they actually reported a higher level of wellbeing than native employees. This might also be related to the added value of other control variables (discrimination, income, and so on) or the lack of information, as we could not differentiate between European and non-European migration, voluntary of non-voluntary migration, and other possible relevant details. Moreover, we found small effects for the presence of a partner or children at home. Having children at home slightly increased the level of wellbeing, whereas having a partner at home resulted, on average, in a slightly lower wellbeing. However, we found that not having a partner while having children at home (being a single parent) had a much stronger negative effect on wellbeing. Furthermore, as education levels rose, so did the wellbeing. We did not find a significant positive effect of income level, which is probably because of the presence of education level, age, and other correlated variables. We did find an effect in the expected direction of a recent rise or fall in income levels.

The number of different issues with harassment in the workplace turned out to be one of the key determinants in wellbeing. Being confronted with one type of harassment resulted in a 0.16 drop. The linear relationship suggests that being confronted with four forms of harassment would result in a drop of 0.62. Approximately 17% of the respondents reported at least one form of harassment; over 2% reported four types or harassment or more.

Looking at the working conditions, we learned that working in a small company contributes to wellbeing, while a recent restructuring of the workplace, frequently working overtime and frequently working at night goes hand in hand with a relatively lower overall wellbeing. Additionally, we found a positive association between the years of employment at a particular workplace and the wellbeing, although at least ten years at the same workplace are required for a noticeable difference. Finally, a negative effect was found for people who indicated they wanted to alter their current working hours.

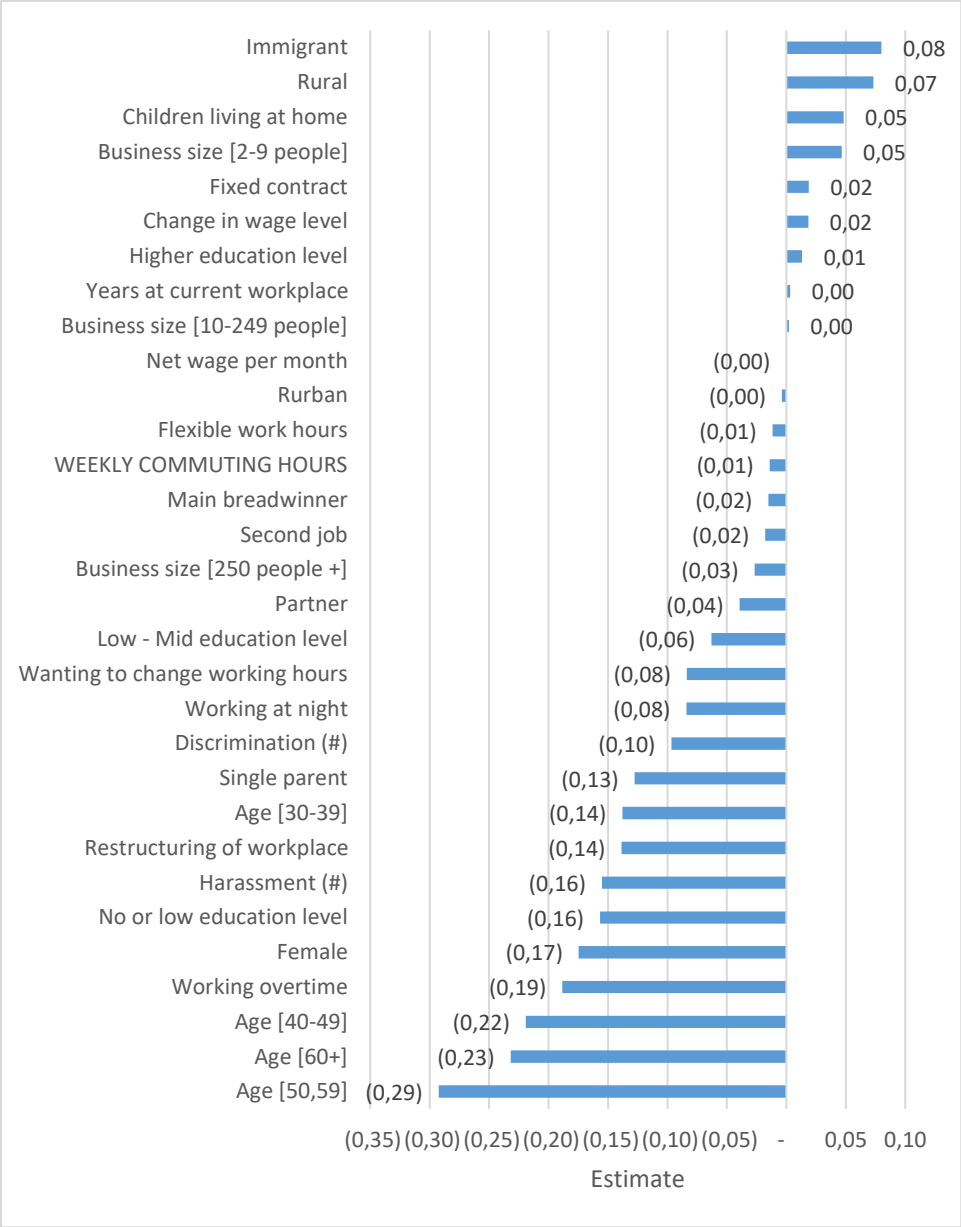


Figure 5: Fixed effects on wellbeing

4.2 RANDOM EFFECTS

The random intercepts for wellbeing per country showed relevant differences between countries, with a range from -0.268 to 0.255 . The estimates were nicely normally distributed, with a mean of zero and a standard deviation of 0.13 (Figure 6). On average, and for the same reference level of the random effects, the level of self-reported wellbeing among employed people was highest in the Czech Republic. Austria and the Netherlands also performed well. We found lower levels of wellbeing among the employed population in France, Albania and Serbia. It is difficult to see clear geographical patterns in these random intercepts. The idea that Northern Europe outperforms Southern Europe certainly does not hold. Additionally, there is no clear divide between Eastern and Western European countries.

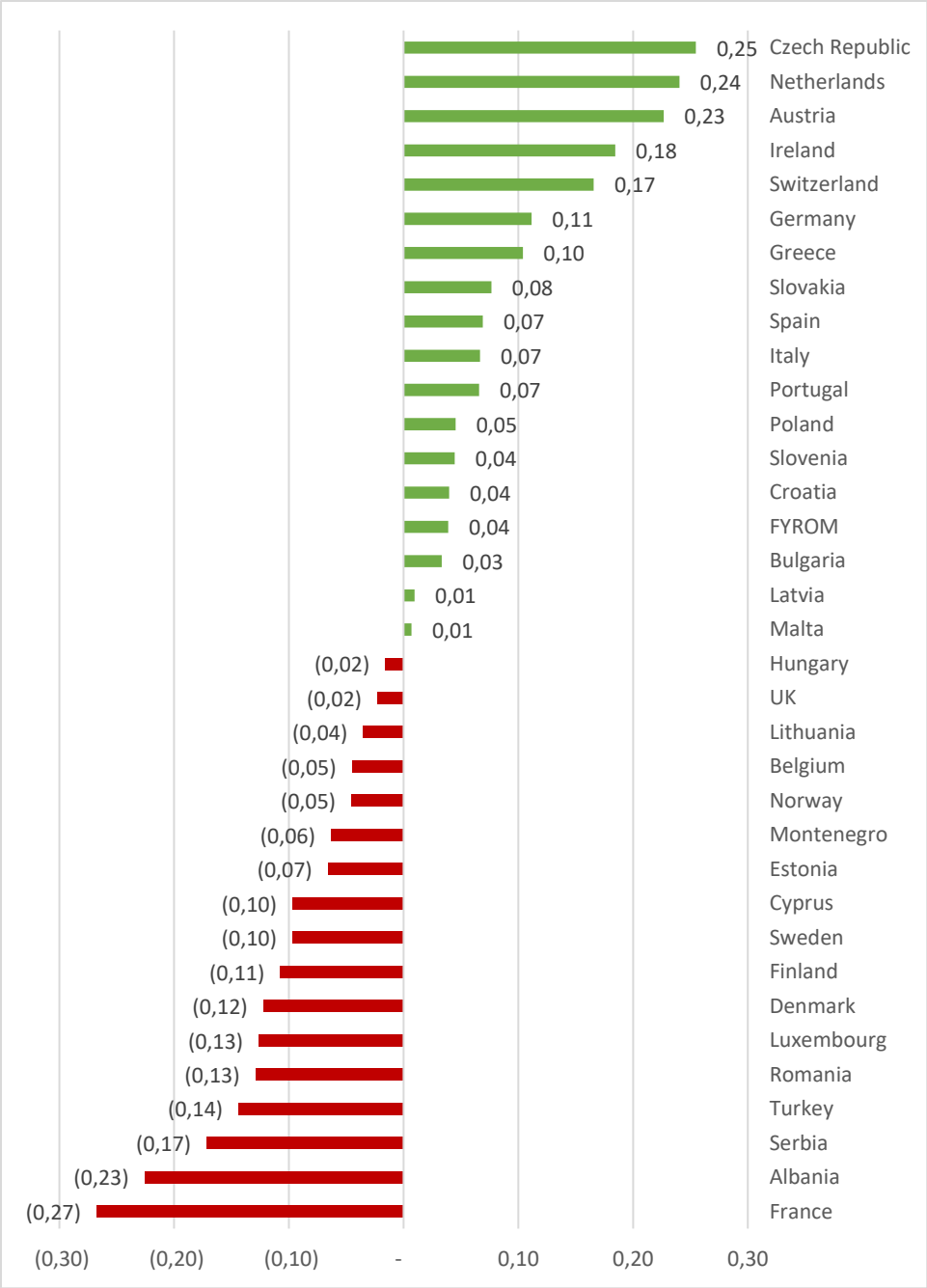


Figure 6: Random intercept for wellbeing by country

The random slopes for WCH per country indicated the estimated difference in the impact of one extra hour of commuting per week on wellbeing. Again, the differences between countries were relevant, and they resulted in an improved model fit, although the standard deviation was small (0.005). We identified a relatively big impact of an extra hour of weekly commuting time on wellbeing in Poland, Turkey, Switzerland, and France. It was nearly twice the overall average of -0.014. Conversely, in Hungary, Romania, and Germany, hardly any impact on wellbeing was found, with estimates ranging from -0.0028 to -0.0041, all close to zero. Nevertheless, all combinations of the random slopes and the fixed effect were negative.

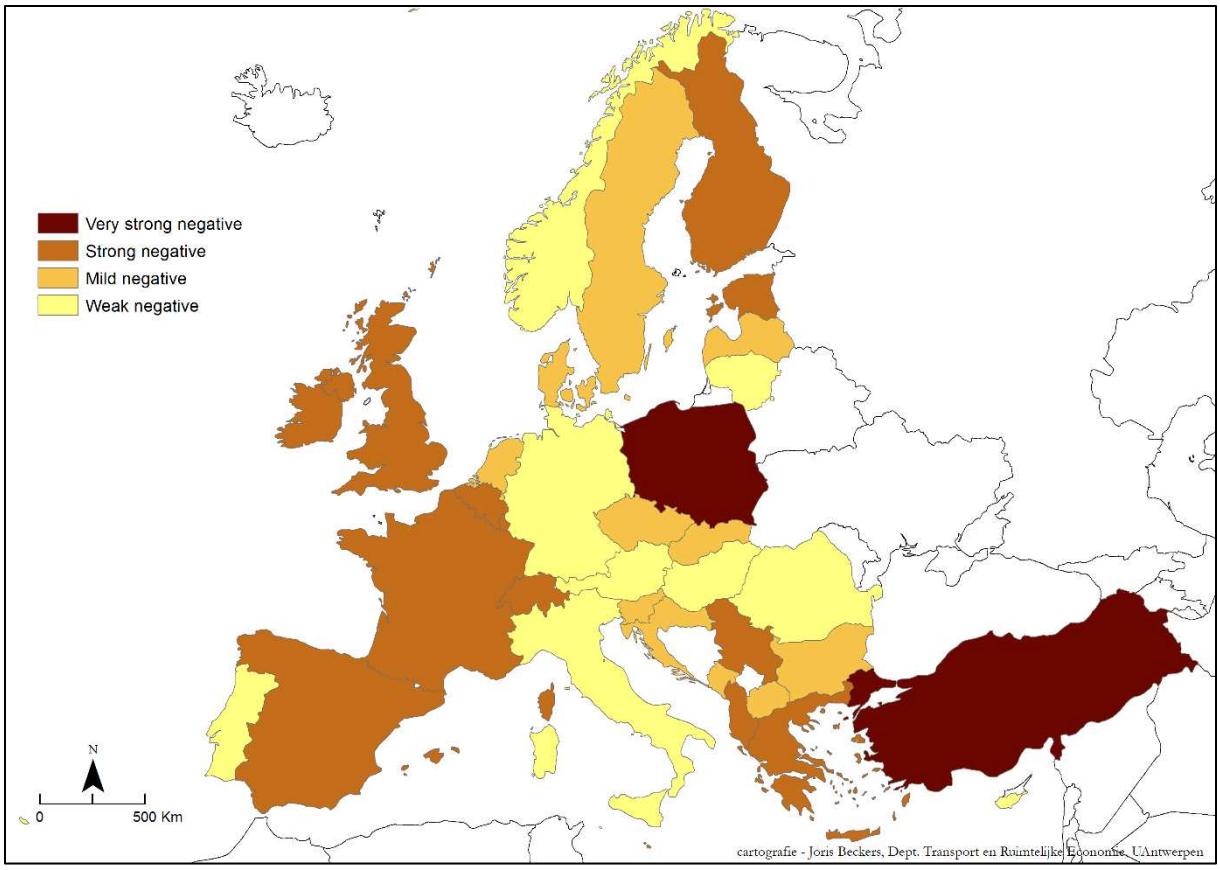


Figure 7: Impact of one extra hour of commuting time per week on wellbeing (= fixed effect plus random slope)

5 DISCUSSION AND CONCLUSIONS

In recent publications a negative relationship between commuting and wellbeing has been established, although some studies have reported positive effects. Since the scope of these studies is sometimes limited, we tested this assumed relationship on the basis of a dataset of 35 European countries (the EWCS) by means of a multilevel linear regression model. We constructed a rich index for wellbeing consisting of three main indicators and 13 underlying variables on physical condition, fatigue, and mental condition. In addition, we controlled for many other possible reasons for a reduced or increased level of wellbeing in our model. Moreover, by adding country of residence in an extra layer, we corrected for known differences in wellbeing between European countries. As a key explanatory variable, we introduced weekly commuting hours (WCH), which accounts for telecommuting, working overtime, and part-time jobs, and is preferable to commonly used travel time or distance of a single commute trip. We allowed the effect of WCH on wellbeing to vary between countries.

The results of the regression model were satisfactory. We found a significant negative effect of WCH on wellbeing. This effect is also consistent over the three underlying indicators (Appendix 3). These results are in line with most previous findings. The size of the effect per additional hour of commuting was modest, not to say small, compared to many other effects established in the model. The small effect we found is consistent with the contrasting effects of travel time on wellbeing found in several former studies. The strongest negative effects of WCH were found in Poland, Turkey, and Switzerland. The effect of WCH was close to zero in Germany, Romania, and Hungary. This suggests that in the latter countries, time spent on commuting hardly affects wellbeing, according to our study. We identified major differences in the general level of wellbeing between countries. These differences were established in the aggregated overall average level of wellbeing and the random intercepts provided by the regression model. The question remains whether these differences are indeed directly related to wellbeing or if they actually reflect cultural differences in answering a questionnaire, as the interviewees in some countries might perhaps be more eager to complain than others. At any rate, the effects of age, gender, level of education, and irregular working hours on wellbeing seem to be more important than the effect of commuting. More importantly, being confronted with discrimination or harassment in the workplace has a clear and striking negative effect on wellbeing. When talking about working conditions and wellbeing, commuting issues are not the first priority. Nevertheless, on the basis of these results and other sustainable development goals, we propose to implement a deterrence policy to prevent travel times from increasing further. The findings call for a discussion on the current mobility and recruitment policies of companies and the related transport policy of the governmental authorities involved.

With respect to research on commuting and wellbeing, we recommend additional efforts in four areas. Firstly, in our research we were able to control for many variables that affect wellbeing. Many of the variables used proved their added value. However, since the dataset we used is strongly oriented towards the workplace, it mainly contains aspects related to working conditions. An extension with aspects related to living conditions and social network is desirable.. Secondly, in contrast to excessively long travel times, extremely short travel times may also be conceivable. When home and the workplace become synonyms, like during the COVID-19 lockdowns all over the world, it can become more difficult to mentally distance oneself from work. If the phenomenon of ‘minimal needed’ travel times exists, this is not captured by our model, as we excluded people who only work at home from our dataset. Thirdly, this study is limited to the estimated travel times for commuting to and from work. Additional information about distances, departure times, transfers, modes of transport, and information concerning activities during the commute can sharpen the research.

Fourthly, longitudinal data is strongly preferred over cross-sectional data when it comes to causality. Longitudinal data also has a lower risk of biased estimates. Hence, it would be wonderful to have an international longitudinal survey covering both commuting and wellbeing. The challenge is that all these suggestions require additional databases.

Considering mobility research in general, we return to the thoughts on the impacts of travel on social wellbeing given by Mokhtarian (2019, p. 507-508): “that one reason we have neglected to report effect sizes in the past is that they are so often disappointing small . . . several other factors, such as health and social relationships, could be expected to have larger impacts on wellbeing”. The present research has confirmed that the effect of commuting on wellbeing is small and that several other factors have a larger impact. This conclusion puts many recent studies into perspective: where one searches for the influence of modal choice on wellbeing, one will eventually measure very small differences from a small impact. Other research questions remain, such as what about other travel trips than commuting, what about the indirect role of travel in relation to the more important factors (De Vos et al., 2013), and which characteristics of travel have an impact (Mokhtarian, 2019).

Although much research awaits, we want to present some ideas on the current mobility and recruitment policies of companies and the related transport policy of authorities. Due to the small effect of commuting on wellbeing, people will not easily change their behaviour. To change behaviour, pricing policy would be a good measure. However, in many companies we see the opposite: reimbursing part of or all of the commuting costs reduces the incentive for the employee to live closer to work. On the contrary, such practices support the wishes of many Europeans to live on the outskirts and thus subsidise the urban sprawl. Moreover, compensating for commuting is often supported and even stimulated by, often fiscal, government policies. The results of this research argue in favour of a deterrence policy with regard to long commuting times. This could be done by reducing the compensation culture while maintaining or developing arrangements for relocation allowances. This way not only will the 'super commuters' be protected against themselves, but economic and ecological objectives can be achieved as well. Shorter travel distances mean less infrastructure and fewer traffic jams, fewer accidents, and less pollution, thus improving the overall sustainability of the transport system.

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Appendix 1: output from the confirmatory factor analysis

Physical condition	est. (s.e.)
Backache	0.570 (0.006)***
Muscular pain (upper)	0.622 (0.006)***
Muscular pain (lower)	0.563 (0.006)***
Headache	0.498 (0.007)***
Tiredness	0.403 (0.007)***
Fatigue	est. (s.e.)
Difficulties falling asleep	0.479 (0.008)***
Waking up repeatedly during night	0.475 (0.008)***
Waking up tired	0.528 (0.009)***
Illness: fatigue	0.159 (0.006)***
Feeling fresh	0.166 (0.004)***
Mental condition	est. (s.e.)
Cheerful	0.652 (0.005)***
Relaxed	0.648 (0.005)***
Vigorous	0.668 (0.005)***
Feeling fresh	0.519 (0.004)***
Interesting	0.550 (0.004)***
Wellbeing index	est. (s.e.)
Physical condition	0.861 (0.017)***
Fatigue	1315 (0.034)***
Mental condition	0.808 (0.014)***

Model fit statistics

Optimisation method	NLMINB
Number of free parameters	60
Number of observations	29345
Iterations	42
Estimator	DWLS
Model fit test statistic	4810.436
Degrees of freedom	60
P-value (Chi-square)	0
Minimum function test statistic	818919.964
Degrees of freedom	78
P-value	0
Comparative fit index	0.994
Tucker-Lewis index	0.992
RMSEA (90% CI)	0.052 (0.051 - 0.053)
P-value RMSEA <= 0.05	0.005
SRMR	0.042

The number for the degrees of freedom was found to be positive. The chi-square test's p-value was highly significant, partly due to the high number of observations. The comparative fit index (0.994) and Tucker-Lewis index (0.992) were perfect, with the common rule of thumb prescribing a value of 0.950 or higher. Moreover, the root mean squared error of approximation (RMSEA = 0.052) and standardised root mean square residual (SRMR = 0.042) were well below the common rule of thumb's maximum of 0.10.

Appendix 2: model estimates from the main model

Variable	Coef. (95%-ci)
WCH	-0.014*** (-0.019; -0.009)
Female	-0.175*** (-0.194; -0.155)
Age Group [30,40)	-0.138*** (-0.165; -0.110)
Age Group [40,50)	-0.219*** (-0.248; -0.190)
Age Group [50,60)	-0.292*** (-0.324; -0.261)
Age Group [60+)	-0.232*** (-0.278; -0.186)
Immigrant	0.080*** (0.048; 0.112)
Partner at home	-0.039*** (-0.064; -0.015)
Kids at home	0.048*** (0.026; 0.070)
Single parent	-0.128*** (-0.174; -0.081)
No and low education level	-0.157*** (-0.208; -0.105)
Low to mid education level	-0.063*** (-0.085; -0.041)
Higher education level	0.013 (-0.018; 0.045)
Rurban / Semi-urban	-0.004 (-0.024; 0.016)
Rural	0.073*** (0.051; 0.095)
Restructuring of the workplace	-0.139*** (-0.159; -0.118)
Working at night	-0.084*** (-0.111; -0.057)
Working overtime	-0.188*** (-0.213; -0.163)
Main breadwinner	-0.015 (-0.035; 0.005)
Wanting to change working hours	-0.084*** (-0.111; -0.057)
Second job	-0.018 (-0.050; 0.015)
Flexible hours	-0.012 (-0.033; 0.010)
Permanent contract	0.019 (-0.005; 0.043)
Years at current workplace	0.003*** (0.002; 0.004)
Business size (2-9 people)	0.047** (0.000; 0.093)
Business size (10-249 people)	0.002 (-0.043; 0.047)
Business size (250+ people)	-0.027 (-0.073; 0.019)
Discrimination (number of issues)	-0.097*** (-0.112; -0.082)
Harassment (number of issues)	-0.155*** (-0.165; -0.146)
Net wage per month	0.000 (-0.010; 0.010)
Change in wage level (+ or -)	0.019** (0.003; 0.034)
Constant	0.430*** (0.355; 0.505)
Observations	29345
Log-likelihood	-44365
AIC	88803
BIC	89101

Note: levels of significance *** p<0.001 ** p<0.01 * p<0.05

Appendix 3: Output from three multilevel models based on one of the indicators

Variable	Physical condition Coef. (95%-ci)	Fatigue Coef. (95%-ci)	Mental condition Coef. (95%-ci)
WCH	-.021*** (-.029; -.014)	-.018*** (-.025; -.011)	-.022*** (-.033; -.011)
Female	-.188*** (-.214; -.163)	-.319*** (-.355; -.284)	-.171*** (-.201; -.141)
Age Group [30,40)	-.164*** (-.199; -.128)	-.225*** (-.276; -.174)	-.164*** (-.208; -.121)
Age Group [40,50)	-.298*** (-.335; -.260)	-.333*** (-.386; -.279)	-.260*** (-.306; -.215)
Age Group [50,60)	-.432*** (-.473; -.391)	-.469*** (-.527; -.411)	-.270*** (-.319; -.221)
Age Group [60+)	-.356*** (-.416; -.297)	-.381*** (-.465; -.297)	-.184*** (-.256; -.112)
Immigrant	.017 (-.024; .058)	.173*** (.115; .232)	.107*** (.057; .157)
Partner at home	-.042*** (-.074; -.010)	-.046** (-.091; -.001)	-.081*** (-.120; -.043)
Kids at home	.024* (-.004; .052)	.081*** (.041; .121)	.088*** (.054; .122)
Single parent	-.127*** (-.187; -.067)	-.176*** (-.261; -.091)	-.230*** (-.303; -.158)
No and low education level	-.321*** (-.388; -.254)	-.232*** (-.328; -.137)	-.080* (-.161; .002)
Low to mid education level	-.186*** (-.214; -.157)	-.031 (-.071; .008)	-.073*** (-.107; -.039)
Higher education level	.057*** (.016; .097)	.009 (-.048; .067)	-.008 (-.057; .041)
Rurban / Semi-urban	-.002 (-.028; .024)	-.025 (-.062; .012)	.023 (-.009; .054)
Rural	.068*** (.040; .097)	.129*** (.088; .170)	.091*** (.056; .125)
Restructuring of the workplace	-.152*** (-.179; -.125)	-.261*** (-.299; -.223)	-.121*** (-.153; -.088)
Working at night	-.036** (-.071; -.000)	-.195*** (-.245; -.144)	-.074*** (-.117; -.031)
Working overtime	-.246*** (-.278; -.213)	-.319*** (-.365; -.273)	-.182*** (-.221; -.142)
Main breadwinner	.030** (.004; .056)	-.032* (-.069; .005)	-.056*** (-.088; -.025)
Wanting to change working hours	-.126*** (-.161; -.091)	-.134*** (-.184; -.085)	-.075*** (-.117; -.033)
Second job	-.034 (-.077; .008)	-.036 (-.096; .024)	.006 (-.046; .057)
Flexible hours	.013 (-.015; .040)	-.019 (-.059; .020)	-.041** (-.074; -.007)
Permanent contract	.053*** (.022; .084)	.025 (-.019; .069)	-.002 (-.039; .035)
Years at current workplace	.001 (-.000; .003)	.006*** (.004; .008)	.007*** (.005; .008)
Business size (2-9 people)	.081*** (.021; .141)	.009 (-.076; .095)	.136*** (.063; .209)
Business size (10-249 people)	.028 (-.030; .086)	-.045 (-.128; .037)	.056 (-.015; .126)
Business size (250+ people)	.039 (-.021; .099)	-.116*** (-.201; -.031)	.012 (-.061; .084)
Discrimination (number of issues)	-.095*** (-.114; -.076)	-.171*** (-.198; -.144)	-.114*** (-.138; -.091)
Harassment (number of issues)	-.190*** (-.202; -.177)	-.247*** (-.265; -.229)	-.187*** (-.203; -.172)
Net wage per month	-.019*** (-.031; -.006)	.007 (-.011; .025)	.007 (-.008; .022)
Change in wage level (+ or -)	-.007 (-.027; .013)	.030** (.002; .058)	.054*** (.030; .077)
Constant	.570*** (.463; .678)	.715*** (.576; .854)	.426*** (.312; .541)
Observations	29345	29345	29345
Log-likelihood	-52016	-62305	-57622
AIC	104103	124682	115315
BIC	104402	12498	115614

Note: levels of significance *** p<0.001 ** p<0.01 * p<0.05