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# Public services, environmental quality and subjective well-being in a European city: the case of Strasbourg metropolitan area

Strasbourg  
metropolitan  
area

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## Abstract

**Purpose** – This paper analyzes individual subjective well-being using a survey database from the Strasbourg metropolitan development council (France). The authors focus on the effects of externalities generated by public services (transport, culture and sport), environmental quality and feeling of security in the Strasbourg metropolitan area (Eurométropole de Strasbourg, EMS). Results show that EMS specificities (public facilities, environmental quality, safety and security) and individual features like opportunities to laugh or live with children significantly influence individual well-being. These findings are robust when using three subjective measures: feeling of well-being, environmental satisfaction and social life satisfaction. The authors also show that income may affect the perceived well-being of individuals belonging to a low-income group, while individuals belonging to a high-income group tend to be unsatisfied with environmental quality but satisfied

## JEL Classification — D62, I31

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**Data availability statement:** The data used in this paper comes from a survey conducted by EMS in 2017 to collect information on potential elements relative to individual well-being in the Strasbourg metropolitan area.

<https://www.strasbourg.eu/documents/976405/1086315/ContributionBienEtre1.pdf/8036d5c1-cd0f-eb38-5447-1d716b5fc51a>

Data may be available upon request only with the authorization of EMS.



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with their social life. Besides, social comparison in terms of income does not matter for individual well-being in the Strasbourg metropolitan area.

**Design/methodology/approach** – Theoretical and empirical paper —Utility theory in economics— Econometric modeling using an ordered probit model.

**Findings** – Specificities of the Strasbourg metropolitan area-France (public services related to transport, culture and sport, environmental quality perceived as convenient for individual health, sense of security) significantly impact individual subjective well-being. Income does not substantially impact the individual subjective perception of happiness: income may matter for the feeling of well-being only for individuals belonging to a low-income group. Wealthy individuals tend to be unsatisfied with environmental quality but satisfied with their social life. Social comparison in terms of income does not matter for individual well-being in the Strasbourg metropolitan area.

**Research limitations/implications** – Cross-sectional data, but it is the only available database from a survey conducted by EMS in 2017 to collect information on potential elements relative to individual well-being in the Strasbourg metropolitan area.

**Practical implications** – Results shed light on the role of territorial policies in improving individual well-being and might provide some guidelines for policy-makers concerned about the population's welfare. Policy-makers should give strong attention to public facilities (an essential element of local public action) and improve environmental quality. If they care about the population's happiness, they have to reorient current policies in this direction. Of course, through the inquiry in 2017 giving this database, the Strasbourg agglomeration development council aimed to provide such evidence to the local administration. Nevertheless, the results were a bit upsetting for many people in the administrative and political circles, who generally prioritize economic and demographic development, while the citizens' responses to the inquiry have revealed a strong focus on the quality of everyday life in their neighborhood.

**Originality/value** – The present study contributes to the literature on subjective well-being, with a focus on the role of local characteristics and living environment. The authors' starting point is related to the standard utility theory, indicating that environmental quality and public services are positive externalities. The authors investigate whether the local living environment and public facilities are crucial elements explaining individual well-being. To do this, we consider three subjective measures: feeling of well-being, environmental satisfaction and social life satisfaction, which are used as proxies of individual utility. The authors consider different explicative variables representing specificities of EMS in terms of public services (transport, culture and sport), environmental quality perceived as convenient for individual health, safety and security, etc. The authors also provide a test for relative standing by including the median monthly household income at the municipality level.

**Keywords** Environmental satisfaction, Externalities, Feeling of well-being, Local living environment, Public services, Social life satisfaction

**Paper type** Research paper

## 1. Introduction

Numerous investigations in the literature on subjective well-being offer interesting hints about the socioeconomic determinants of individual well-being. In most studies, the effects of income, age, health and unemployment status are significant, while education does not significantly affect individual well-being (Senik, 2005). Using these subjective indicators allows economists to investigate the effects of material conditions and socioeconomic characteristics and discuss the phenomenon of social comparison, which suggests that having a higher income and consuming more goods will lead to greater well-being. Individual income always represents one of the most important factors explaining well-being. However, this income effect may be mediated by social comparison (e.g. Carlsson, Johansson-Stenman, & Martisson, 2007; Clark, Yamada, & Senik, 2017). Some other studies have focused on external factors, such as economic and environmental risks, geographical location and environmental quality, as potential determinants of individual well-being (Ferrer-i-Carbonell & Gowdy, 2007; Brereton, Clinch, & Ferreira, 2008; Rehdanz & Maddison, 2005, 2008; Pham, Nguyen-Van, Nguyen, Tran, & Noukignon, 2019).

This paper fits into the literature on subjective well-being using the data from a survey carried out in 2017 in the Strasbourg metropolitan area (Eurométropole de Strasbourg, EMS). The latter is located in the north-east of France (*Grand Est* region), in Alsace, on the river Rhine. The study concerns 33 municipalities (Strasbourg and 32 smaller towns and villages).

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This survey includes three questions on individuals' subjective feelings: about their well-being, their social life and the environmental quality in EMS, giving us three different proxies of individual well-being. We focus on the influence of externalities generated by local public services and local environmental quality. Our starting point is related to the standard utility theory, indicating that environmental quality and public services are positive externalities. We investigate whether the local living environment and public facilities are crucial elements explaining individual well-being. To do this, we consider three subjective measures: feeling of well-being, environmental satisfaction and social life satisfaction, which are used as proxies of individual utility. We consider different explicative variables representing specificities of EMS in terms of public services (transport, culture and sport), environmental quality perceived as convenient for individual health, safety and security, etc. We also provide a test for relative standing by including the median monthly household income at the municipality level. A negative effect of this variable on individual well-being implies that the individual compares her household income to this reference level, confirming that social comparison and status-seeking do matter [1].

Our econometric estimation is done with an ordered probit model taking into account the potential issue of endogenous regressors. To fix this issue in the ordered probit model, we use the "variable addition test" based on the control function approach proposed by [Wooldridge \(2014\)](#) to test for the exogeneity of explanatory variables in nonlinear models. Our results are as follows: First, public facilities and environmental externalities do matter for individual subjective well-being. Indeed, our findings show that the equipment and programming in sports and culture in the individuals' neighborhood (urban district or village) positively affect their subjective well-being. The fact that public transport in EMS satisfies individuals' needs also increases their subjective well-being. These findings are robust for three subjective measures: feeling of well-being, environmental satisfaction and social life satisfaction. Results also indicate that environmental quality (perceived as convenient for individual health) significantly impacts the individuals' feeling of well-being and their environmental satisfaction. Second, individuals' lifestyle does affect their well-being. This result is relatively intuitive: opportunities to laugh increase the feeling of well-being and social life satisfaction, while a committed life with participation in collective activities (organization of elections, volunteer activity, civic service, etc.) positively affects individuals' social life satisfaction and negatively affects their environmental satisfaction.

Third, when analyzing socioeconomic characteristics, we observe that, compared to house tenants, house owners are more satisfied with their social life but less satisfied with environmental quality, suggesting that they are more demanding of environmental quality. The number of children significantly affects individual well-being, and this effect is not linear. Concerning income effect, it is different following income group. Indeed, an increase in income may make individuals feel better off, if individuals belong to a low-income group. However, individuals belonging to a high-income group tend to be unsatisfied with environmental quality but satisfied with their social life. Besides, social comparison regarding income does not matter for individual well-being in EMS. The latter result is opposite to that found in many analyses ([Clark \*et al.\*, 2017](#); [Alvarez-Cuadrado, Casado, & Labeaga, 2015](#), etc.), indicating individuals' preference for relative standing.

Our results confirm the assumption in economic analysis that environmental quality and public services are positive externalities in individual utility. Results also show that local policies and characteristics of where individuals live may be the key factors influencing their well-being. It sheds light on the role of territorial policies in improving individual well-being and might provide some guidelines for policy-makers concerned about the population's welfare. In other words, our results corroborate the assumption that improvement in well-being may be considered as a measure of local policies and helps us to understand how individual well-being is becoming more and more a public action concern. Some regions and

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cities in the world have adopted the concept and developed their indices of well-being, e.g. São Paulo (Brazil), Bristol (United Kingdom), Melbourne (Australia), Creston (Canada) and Vermont (United States) (Berejnoi, Cloutier, Colbert, Musikanski, & Polley, 2017).

The paper's remainder is organized as follows: Section 2 provides a survey on the link between local public action *via* public facilities, living environment and individual well-being. Section 3 presents the data and descriptive statistics. Section 4 presents the econometric specification. Estimation results are presented in Section 5. Section 6 concludes. Other details are given in Appendixes 1, 2, and 3.

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## 2. Individual well-being, public facilities and local characteristics

In numerous empirical investigations, individual well-being is measured by subjective indicators such as life satisfaction, job satisfaction and income satisfaction. These measurements are collected in household surveys such as the British Household Panel Survey (BHPS), the American General Social Survey, the German Socio-Economic Panel and the Eurobarometer. Other measurements of individual well-being, such as psychological health and the “Eudaimonia” score, have also been introduced in economic analyses. For example, Clark (2003) used the General Health Questionnaire (GHQ-12) from the BHPS to study questions related to unemployment (as a social norm) and psychological health (as a proxy of subjective well-being). Clark (2016) evoked the Eudaimonia score as a proxy of individual well-being and underlined a correlation between hedonic/life satisfaction and the Eudaimonia score, which refers to the idea of flourishing or developing human potential. This score is measured by answers to survey questions on autonomy, determination, aspiration, motivation, etc.

Using these subjective indicators allows economists to investigate the effects of material conditions and socioeconomic characteristics and discuss the influence of the phenomenon of social comparison on individual well-being. The issue of social comparison suggests that having a higher income and consuming more goods than others will lead to greater well-being. Indeed, individual income always represents one of the most important factors explaining well-being, but this income effect may be mediated by social comparison (e.g. Senik, 2005; Clark *et al.*, 2017; Pham *et al.*, 2019; Algan, Malgouyres, & Senik, 2020) [2]. In particular, the paper *What can we learn from subjective data? The case of income and well-being* (Senik, 2005) presents a survey on the link between income and well-being, underlying the effect of other people's income on individual well-being. It provides arguments in favor of using subjective data and illustrates how such data can offer information about aspects of utility and social interactions. Clark *et al.* (2017) prove that social comparison matters and individuals compare their income with a reference value. The latter study also shows a concordance of results using subjective well-being data and results based on hypothetical discrete-choice questions regarding income comparisons. Pham *et al.* (2019) use data from surveys on rural households in Vietnam and Thailand and show that income is one of the key determinants of households' subjective well-being. Moreover, households are sensitive to relative poverty. This study indicates that earning an income lower than the mean village level makes households feel worse than if compared in time (to the previous year or the previous five years).

Literature on individual well-being recently addressed the role of public facilities and factors other than individuals' socioeconomic situation. In a study prepared for the French Council of Economic Analysis, Algan *et al.* (2020) identify the five local living conditions as factors of dissatisfaction among the French population: employment, local taxation, private and public facilities, real estate and social links. This study measures the evolution of these five dimensions for each municipality over recent years. It assesses their influence on three aspects of dissatisfaction: the likelihood of a *Yellow Vest* event in the municipality, the

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variation in the abstention rate during presidential elections and citizens' self-reported well-being. This study also establishes a hierarchy among the five factors by applying the magnitude criterion. It is shown that the loss of health facilities and local shops (i.e. public and private facilities) appears to be the most strongly correlated with French dissatisfaction.

Some other studies have focused on external factors, such as economic and environmental risks, geographical location and environmental quality, as potential determinants of individual well-being (e.g., [Welsch, 2006](#); [Ferrer-i-Carbonell & Gowdy, 2007](#); [Brereton \*et al.\*, 2008](#); [Rehdanz & Maddison, 2005, 2008](#); [Pham \*et al.\*, 2019](#)). Using data from the German Socio-Economic Panel, [Rehdanz and Maddison \(2008\)](#) show that local air pollution and noise levels diminish individual well-being. Concerning [Ferrer-i-Carbonell and Gowdy \(2007\)](#), they examine the link between individual well-being and individual environmental attitudes using data from the BHPS. Their result shows that individuals' concern about ozone pollution and species extinction significantly influences their subjective well-being, implying a nexus between individual preferences and environmental factors. This result holds when the authors include objective indicators signaling whether individuals live in a polluted environment, whether individuals engage in outdoor leisure activities and dummies indicating the region where individuals live to capture the natural environment at the regional level.

[Brereton \*et al.\* \(2008\)](#) focus on the influence of geography and environment at the local level in their analysis using data from the Urban Institute Ireland National Survey on Quality of Life in 2001. It is shown that amenities such as climate and environmental conditions significantly affect individual life satisfaction. For instance, increases in January minimum temperature and in July maximum temperature have a positive effect, while wind speed negatively affects. Other variables indicating the location and geographic characteristics, such as proximity to the coast, airport and main road, also significantly impact individual life satisfaction. For the case of developing countries, such as Vietnam and Thailand, [Pham \*et al.\* \(2019\)](#) show that natural risks (drought, flooding and heavy ice rain) affect households' well-being, but differently in the two countries. More precisely, they find that environmental risks in the past have a positive effect on the fact that households feel better off than the previous year or the previous five years. In other words, when looking at natural disasters in the past, households feel better off in the present. Linked to natural risks, [Pham \*et al.\* \(2019\)](#) also show that households who are more willing to accept risk (i.e. lower risk aversion) feel better off in the present as compared to the previous year or the previous five years.

### 3. Data and descriptive statistics

The data used in this paper comes from a survey conducted by EMS in 2017 to collect information on potential elements relative to individual well-being in the Strasbourg metropolitan area [\[3\]](#). The online survey collected 2,405 responses from 33 municipalities (63% from the municipality of Strasbourg and 37% from 32 smaller-sized towns and villages in the rest of EMS).

Including the neighboring German town of Kehl [\[4\]](#), just across the Rhine, the agglomeration has 0.55 million inhabitants. More insights and data about this European metropolis are given in [Appendix 2 \(Table A1\)](#). Out of this database, we got 984 observations suitable for our study. On such a reduced number, it was possible to consider additional variables—on individual style life or some specificities of the EMS perimeter—to be introduced in our main econometric estimation.

[Table 1](#) summarizes the definition of variables concerning the socioeconomic conditions of the individuals as well as their lifestyle and the specificities of EMS. Three measures of individual subjective well-being were available in the data. First, *Feeling of Well-Being* is measured from a question to which individuals were asked to report their answers on an increasing scale from 1 to 10, where 0 indicates a negative feeling and 10 an excellent feeling

Variable	Definition	Type
SWB3	Individual feeling of well-being (1 if bad, 2 if medium, 3 if good)	Discrete
SWB3_SOCIAL	Individual social life satisfaction (=1 if unsatisfied, 2 if satisfied, 3 if very satisfied)	Discrete
SWB3_ENV	Environmental satisfaction (=1 if unsatisfied, 2 if satisfied, 3 if very satisfied)	Discrete
<i>Socioeconomic characteristics</i>		
Income group	Net monthly household income, 1(≤1150 euros), 2 (1151-1750 euros), 3 (1751-2300 euros), 4 (2304-3450 euros), 5 (≥3451 euros)	Discrete
# Children	Number of children in log value	Discrete
# Children squared	Squared value of the number of children	Discrete
Age group	Individuals' age in 4 groups, 1 (18–24 years old), 2 (25–39 years old), 3 (40–64 years old), 4 (≥65 years old)	Discrete
Female	Female (= 1 if female, = 0 otherwise)	Dummy
Couple	Living with a partner (1 if Yes, 0 if No)	Dummy
House ownership	House ownership (1 if owner, 0 otherwise)	Dummy
Profession_etu	Profession-student (1 if student, 0 otherwise)	Dummy
Profession_retraite	Profession-retirer (1 if retiree, 0 otherwise)	Dummy
Profession_libre	Profession-independent(1 if independent profession, 0 otherwise)	Dummy
Profession_employe	Profession-wage earner (1 if wage earner, 0 otherwise)	Dummy
Profession_autre	Profession-others (1 if other professions, 0 otherwise)	Dummy
<i>Lifestyle</i>		
Laugh	Opportunities to laugh (1 if Yes, 0 if No)	Dummy
Engagement	Participation in collective activities such as election organization, volunteer activity, civic service.	Dummy
SWB_indi_coll	Well-being perceived as individual or collective concept (1 if individual, 2 if collective, 3 if a balance between both)	Discrete
<i>Perception on the Strasbourg metropole characteristics</i>		
Service sport	The sports equipment and programming in village/district meet individual expectations (1 if No, 2 if Moderately, 3 if Yes)	Discrete
Service culture	The service culture and programming in village/district meet individual expectations (1 if No, 2 if Moderately, 3 if Yes)	Discrete
Service transport	Public transports satisfy individual needs (1 if No, 2 if Moderately, 3 if Yes)	Discrete
Environment	Environmental quality in EMS is convenient for individual health (1 if No, 2 if Moderately, 3 if Yes)	Discrete
Sense of security	Sense of security in the agglomeration (1 if No, 2 if Moderately, 3 if Yes)	Discrete
Median income	Monthly median household income, computed at municipal level in log value from the public agency INSEE data published in 2018	Discrete

**Table 1.**  
Definition of variables

**Source(s):** Table by the authors

(“Please indicate your feeling of well-being on a scale from 1 to 10”). Second, *Environmental Satisfaction* corresponds to the question “How satisfied are you with the environmental quality in EMS?” (on a scale where 1 indicates “not satisfied at all” and 10 “very satisfied”). The third subjective measure is *Social Life Satisfaction* corresponding to the question “How satisfied are you with your social life?” (on a scale where 1 indicates “not satisfied at all” and 10 “very satisfied”).

Given that low categories and very high categories have very few observations for these measures, we created a new scale by merging categories 1–4 into one group, 5–7 into a second group and 8–10 for the last group. The first variable *SWB3* is the *Feeling of Well-Being*: *SWB3* = 1 if the individual feels bad, *SWB3* = 2 if medium and *SWB3* = 3 if the individual feels good. [Table 2](#) reports the distribution of the *Feeling of Well-being* (*SWB3*). We note that most individuals (57.52%) feel satisfied (i.e. medium) with their situation.

The variable *Environmental Satisfaction* (*SWB3\_ENV*) is defined similarly. Its distribution is reported in [Table 3](#), indicating that 66.72% of individuals are satisfied with local environmental quality. The final dataset included 667 observations for this variable. *Social Life Satisfaction*, defined in the same way as the two other subjective variables, is presented in [Table 4](#). We observe that 58.63 % of the individuals are very satisfied with their social life. The final dataset included only 307 individuals for this subjective measure. However, those few observations may help us consolidate analyses using the two other subjective measures: *Feeling of Well-Being* and *Environmental Satisfaction*. Analysis results with *Social Life Satisfaction* are presented in [Appendix 2](#) ([Table A7](#)).

[Table A2](#) reports the distribution of a couple of subjective variables *Feeling of Well-Being–Social Life Satisfaction*. We note a consistency in the answers reported by individuals. For example, when they feel good, i.e. *SWB3* = 3, they also tend to be very satisfied with their social life, i.e. *SWB3\_SOCIAL* = 3. Concerning the distribution of the couple *Feeling of Well-Being–Environmental Satisfaction* ([Table A3](#)), we remark that when individuals feel good, they should be demanding a good environmental quality as they tend to be unsatisfied with the observed environmental quality.

[Figure 1](#) displays the distribution of net monthly household income for 984 individuals in the survey. The survey gives information about five household income groups but no

Feeling of well-being ( <i>SWB3</i> )	Frequency	Percent
Bad ( <i>SWB3</i> = 1)	67	6.81
Medium ( <i>SWB3</i> = 2)	566	57.52
Good ( <i>SWB3</i> = 3)	351	35.67

**Note(s):** Number of observations: 984

**Source(s):** Table by the authors

**Table 2.**  
Distribution of  
individuals' feeling of  
well-being

Environmental satisfaction	Frequency	Percent
Unsatisfied ( <i>SWB3_ENV</i> = 1)	153	22.94
Satisfied ( <i>SWB3_ENV</i> = 2)	445	66.72
Very satisfied ( <i>SWB3_ENV</i> = 3)	69	10.34

**Note(s):** Number of observations: 667

**Source(s):** Table by the authors

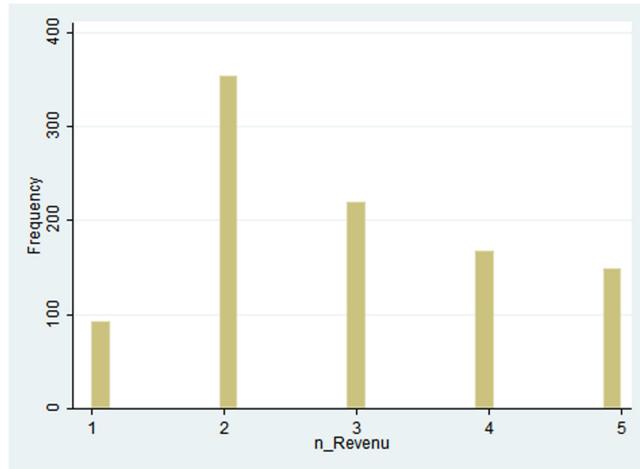
**Table 3.**  
Distribution of  
individuals'  
environmental  
satisfaction  
(*SWB3\_ENV*)

Social life satisfaction	Frequency	Percent
Unsatisfied ( <i>SWB3_SOCIAL</i> = 1)	21	6.84
Satisfied ( <i>SWB3_SOCIAL</i> = 2)	106	34.53
Very satisfied ( <i>SWB3_SOCIAL</i> = 3)	180	58.63

**Note(s):** Number of observations: 307

**Source(s):** Table by the authors

**Table 4.**  
Distribution of  
individuals' social life  
satisfaction (*SWB3\_*  
*SOCIAL*)



Source(s): Figure by authors

**Figure 1.**  
Distribution of *net monthly household income*. 1 ( $\leq 1,150$  euros), 2 (1,151–1,750 euros), 3 (1,751–2,300 euros), 4 (2,304–3,450 euros), 5 ( $\geq 3,451$  euros)

information about individual income. We observe that more than 30% of people belong to household income group 2 (between 1,151 and 1,750 euros). To estimate the effect of social comparison in terms of income, we use the median monthly household income as a reference to which individuals might compare their monthly household income. We consider that the individuals have a preference for relative standing (in terms of income) if the median monthly household income negatively affects the individual feeling of well-being. We get information on the median income of the French municipalities in 2015 from the public agency INSEE data published in 2018. This variable is measured in Euros per consumption unit (CU). By combining our family composition data, we define the variable “Median monthly household income” (*Median Income*) at the municipal level.

Table A1 provides descriptive statistics for three groups of variables: the socioeconomic characteristics of individuals, their lifestyle and EMS attributes. Regarding the socioeconomic factors, apart from income and reference income as suggested by the utility theory, we also consider other variables such as the number of children and number of children squared, age group of individuals, gender, living with a partner, housing ownership and profession. The second group of variables concerns individuals’ lifestyle, such as opportunities to laugh, participation in collective activities such as the organization of elections (e.g. polling stations), volunteer activity, civic services, etc. Finally, we consider EMS’s specificities as externalities in individual utility by using variables representing public services (sport, transport and culture), environmental quality perceived as convenient for individual health and feeling of security in the agglomeration. The five variables in this group take values on an increasing scale from 1 to 10. From initial variables, we create new three category-variables as indicated in Table 1. For example, to the question whether sports equipment and programming in village/district meet individual expectations, we will get three ordered values: 1 if no, 2 if moderately, 3 if yes.

#### 4. Econometric modeling

##### 4.1 Utility function and estimation specification

Let us consider the general utility function of individual  $i$ ,  $i = 1, \dots, N$ :

$$U_i = U(y_i, \bar{y}, Z_i, G, E) \quad (1)$$

where  $G$  represents public goods, considered as externalities, which may positively affect individual utility and  $E$  environmental externality.  $Z_i$  is the set of other control variables. The components of  $Z_i$  will be discussed below.  $y_i$  is individual income  $\bar{y}$  is a reference income level used for comparative purposes. This variable may be an average income in the individual  $i$ 's city or region, as mentioned in numerous studies in the subjective well-being literature (Luttmer, 2005; Alvarez-Cuadrado *et al.*, 2015; Clark *et al.*, 2017, etc.). It is important to examine this effect of  $\bar{y}$  on individual utility as a negative impact of  $\bar{y}$  on individual utility implies that there is an interpersonal comparison. In other words, such a result means that individual utility depends on relative income or relative wealth, which is a measure of social status. The dependence of an individual's utility positively on wealth (or income) and negatively on a reference level of wealth in the society has been used to explain many economic phenomena such as an absence of correlation between economic growth and individual well-being (Easterlin, 1974; Pham, 2005, 2019). Van Long and Shimomura (2004) show that the desire for wealth-enhanced social status can explain the process of catching up with the rich by the poor.

We note that the only information available in our data is a net monthly household income. For comparison, we consider the median net monthly household income as a reference level to which individuals may compare their household income. We use the median income of the French municipalities in 2018 from INSEE. This variable is measured in Euros per consumption unit (CU) [5]. By combining with data on family composition, we define the variable "median monthly household income" at the municipality level.

We note that the utility of individual  $i$  is proxied by her self-reported subjective well-being in our data. Let  $U_i^*$  denote individual  $i$ 's unobserved (or latent) well-being at the time of the survey, and we consider the following conditional model:

$$U_i^* = X_i' \beta + \varepsilon_{i1}, \quad (2)$$

where  $\varepsilon_{i1}$  is an unobserved error term assumed normally distributed  $\mathbf{N}(0, \sigma_\varepsilon^2)$ . We can link  $U_i^*$  to the observed measures of individual self-reported subjective well-being by using the following formulation of the ordered probit model:

$$U_i = \begin{cases} 1 & \text{if } U_i^* \leq c_1 \\ 2 & \text{if } c_1 < U_i^* \leq c_2 \\ 3 & \text{if } c_2 < U_i^* \end{cases} \quad (3)$$

where  $U_i$  corresponds to the subjective well-being (either *Feeling of Well-Being SWB3*, *Environmental Satisfaction SWB3\_ENV* or *Social Life Satisfaction SWB3\_SOCIAL*) created from the reported answers by individual  $i$  on a scale of 1–10, and  $U_i^*$  is defined by equation (2). Two parameters  $c_1$  and  $c_2$ , to be estimated, are the cutoff values for the latent variable  $U_i^*$ .

In our estimation, the set of explanatory variables  $X_i$  encompasses all variables mentioned in utility function (1), including household income  $y_i$ , median monthly household income  $\bar{y}$  and externalities generated by public services  $G$  and environmental quality  $E$ . Other explanatory variables ( $Z_i$  in equation (1)) correspond to the number of children, the number of children squared, age, gender (female), opportunities to laugh, house ownership, participation in collective activities, perception of well-being as a collective or individual concern.

$Z_i$  also include other variables relative to the EMS specificities, such as the sense of security in the agglomeration. Including these variables in estimation reduces significantly the number of observations that varies from 984 to 307 if considering the sense of security in the agglomeration combined with two public services (sport and culture). The number of

observations is reduced to only 223 if considering the sense of security in the agglomeration and three public services (sport, culture and transport). We prefer then to present complementary estimations with more variables in [Appendix 2 \(Table A6\)](#). We remark that the effects of variables mentioned in the first estimation results ([Tables 5–8](#)) remain unchanged, showing our results' robustness.

*4.2 Endogenous regressors and specification tests*

The issue of endogenous regressors needs to be discussed as their existence can bias the results. More precisely, household income is potentially endogenous as it can be affected by unobserved factors. To fix this issue in the ordered probit model, we use the 'variable addition test' based on the control function approach proposed by [Wooldridge \(2014\)](#) to test for the exogeneity of explanatory variables in nonlinear models. This method can be implemented using the following two-step procedure. First, we made a linear regression of household income as it is a continuous variable in our model. Excluded instruments in the first regression correspond to *Profession* (student, retiree, independent, wage earner and others) and *Living with a partner*. These variables are assumed to be correlated with the endogenous regressor (i.e. household income) and uncorrelated with individual subjective well-being reported by individual *i*. Second, we computed the generalized residuals for these regressions of the first step and performed the ordered probit regression using these residuals

Variable	Model 1		Model 2		Model 3	
	Coef	Std.Err	Coef	Std.Err	Coef	Std.Err
Income group 2	0.460*	0.185	0.5266**	0.229	0.641**	0.305
Income group 3	0.215	0.180	0.3761*	0.220	0.275	0.279
Income group 4	0.153	0.180	0.161	0.219	0.223	0.302
Income group 5	0.143	0.172	0.393*	0.213	0.238	0.277
# Children	-0.878***	0.260	-1.085***	0.327	-0.593	0.390
# Children squared	0.510***	0.190	0.644***	0.236	0.405	0.288
Laugh	0.467***	0.088	0.354***	0.101	0.247*	0.133
Service sport 2	-0.327**	0.165	0.287	0.201	0.329	0.264
Service sport 3	0.688***	0.175	0.587***	0.215	0.509*	0.277
Service culture 2	0.651***	0.199	0.622**	0.2528	0.619*	0.329
Service culture 3	1.032***	0.208	0.912***	0.265	0.934***	0.340
Service transport 2	-	-	0.0896	0.146	-	-
Service transport 3	-	-	0.630***	0.151	-	-
Environment 2	-	-	-	-	0.424***	0.157
Environment 3	-	-	-	-	1.167***	0.213
# Observations	984		642		428	
# Parameters	27		30		30	
Log-likelihood	-751.067		-468.234		-314.255	
Pseudo R <sup>2</sup>	0.122		0.142		0.144	
AIC	1556.13		996.48		688.51	

**Note(s):** Model 1 corresponds to regression with socioeconomic, lifestyle variables and externalities from public services (*Sport, Culture*). Model 2 corresponds to regression with the same variables as in Model 1 and with an additional variable on public transport (*Transport*), reducing observations from 984 to 642. Model 3 corresponds to regression with the same variables as in Model 1 but with environmental externality (*Environment*). If we keep public transport (*Transport*) in Model 3, there are only 220 observations left. All explanatory variables are exogenous based on the variable addition test ([Wooldridge, 2014](#)). Significance levels: \*10%, \*\* 5% and \*\*\* 1%. Other nonsignificant variables used in the estimations are *Median income, Age, House Ownership, Female, Engagement, SWB\_indi\_coll*. The complete table with all variables is reported in [Appendix 2 \(Table A4\)](#)

**Source(s):** Table by the authors

**Table 5.** *Feeling of well-being (SWB3), environment and public services*

Variable	Model 1		Model 2		Model 3	
	Coef	Std.Err	Coef	Std.Err	Coef	Std.Err
Income group 2	-0.027	0.211	0.234	0.261	-0.560	0.352
Income group 3	-0.210	0.206	0.058	0.257	-0.536	0.360
Income group 4	-0.079	0.203	0.339	0.249	-0.686*	0.367
Income group 5	-0.526**	0.214	0.012	0.271	-0.862**	0.347
House ownership	-0.343***	0.115	-0.258*	0.149	-0.362*	0.194
Engagement	-0.199**	0.098	-0.235*	0.123	-0.181	0.167
Service sport 2	0.671***	0.187	0.645***	0.225	0.693**	0.301
Service sport 3	0.826***	0.197	0.704***	0.235	0.695**	0.310
Service culture 2	0.608***	0.226	0.744***	0.284	0.845*	0.453
Service culture 3	1.001***	0.234	1.118***	0.291	1.255***	0.456
Service transport 2	-	-	0.398**	0.190	-	-
Service transport 3	-	-	0.833***	0.197	-	-
Environment 2	-	-	-	-	1.478***	0.206
Environment 3	-	-	-	-	2.929***	0.311
# Observations	667		446		296	
# Parameters	27		30		30	
Log-likelihood	-509.152		-321.231		-168.813	
Pseudo R <sup>2</sup>	0.094		0.145		0.325	
AIC	1072.305		702.462		397.625	

**Note(s):** Model 1 corresponds to regression with socioeconomic, lifestyle variables and externalities from public services (*Sport, Culture*). Model 2 corresponds to regression with the same variables as in Model 1 and with an additional variable on public transport (*Transport*), reducing the number of observations from 667 to 446. Model 3 corresponds to regression with the same variables as in Model 1 and with environmental externality (*Environment*). If we keep public transport (*Transport*) in Model 3, there are only 205 observations left. All explanatory variables are exogenous based on the variable addition test (Wooldridge, 2014). Significance levels: \*10%, \*\* 5% and \*\*\* 1%. Other nonsignificant variables used in the estimations are *Median Income, Age, Female, SWB\_indi\_coll, Number of children, Number of children squared, Opportunities to laugh*. The complete table with all variables is reported in Appendix 2 (Table A5)

**Source(s):** Table by the authors

**Table 6.**  
*Environmental satisfaction (SWB3\_ENV) and environment and public services*

corresponding to Income. We made a robust *t*-test for the null hypothesis following to which the coefficients of residuals are zero, as recommended by Wooldridge (2014). The null hypothesis corresponds to the exogeneity of Income .

## 5. Estimation results

We run three models for each of the considered dependent variables *Feeling of Well-Being SWB3* and *Environmental Satisfaction SWB3\_ENV*. Models 1–3 have the same core group of explanatory variables (*Income, Number of children, Laugh, Service Sport, Service Culture* and other control variables). Models 2 and 3, different from Model 1, include different sets of additional regressors (*Service Transport* for Model 2 and *Environment* for Model 3) at the cost of decreasing the number of observations. We cannot include both sets in the same regression as the number of observations diminishes dramatically in this case.

Before presenting the estimation results, we discuss the specification tests, which lead us to the most appropriate econometric model for the data, i.e. regressions with *exogenous* Income. Indeed, the null hypothesis of *Income* exogeneity is not rejected by the variable-addition *t*-test for both dependent variables *SWB3* (*t* statistic = 0.98, 0.86 and 0.58 for Models 1, 2 and 3, respectively) and *SWB3\_ENV* (*t* statistic = 0.51, -0.12 and -0.49 for Models 1, 2 and 3, respectively).

Estimation results for *SWB3* and *SWB3\_ENV*, where all explanatory variables are exogenous, are provided in Tables 5 and 6 (more details concerning all variables are

Variables	Model 2			Model 3		
	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>
Income group 2	-0.0671* (0.0376)	-0.0858** (0.0336)	0.153** (0.0604)	-0.0732 (0.0512)	-0.127*** (0.0463)	0.200** (0.0827)
Income group 3	-0.0531 (0.0368)	-0.0497* (0.0277)	0.103* (0.0559)	-0.0405 (0.0506)	-0.0348 (0.0318)	0.0754 (0.0763)
Income group 4	-0.0263 (0.0378)	-0.0137 (0.0179)	0.0400 (0.0529)	-0.0340 (0.0510)	-0.0257 (0.0319)	0.0597 (0.0777)
Income group 5	-0.0549 (0.0358)	-0.0534* (0.0303)	0.108* (0.0557)	-0.0358 (0.0482)	-0.0281 (0.0270)	0.0639 (0.0698)
Number of children	0.0313** (0.0131)	0.0612** (0.0245)	-0.0925*** (0.0345)	0.00994 (0.0133)	0.0220 (0.0291)	-0.0319 (0.0420)
Laugh	-0.0378*** (0.0131)	-0.0739*** (0.0266)	0.112*** (0.0354)	-0.0251* (0.0146)	-0.0556* (0.0320)	0.0807* (0.0443)
Service sport 2	-0.0440 (0.0359)	-0.0307* (0.0173)	0.0747 (0.0475)	-0.0467 (0.0453)	-0.0451 (0.0277)	0.0919 (0.0666)
Service sport 3	-0.0734** (0.0366)	-0.0992*** (0.0331)	0.173*** (0.0560)	-0.0639 (0.0459)	-0.0884** (0.0388)	0.152** (0.0730)
Service culture 2	-0.120* (0.0654)	-0.0160 (0.0387)	0.136*** (0.0431)	-0.119 (0.0846)	-0.0201 (0.0460)	0.140** (0.0582)
Service culture 3	-0.149** (0.0667)	-0.0812* (0.0444)	0.230*** (0.0489)	-0.150* (0.0855)	-0.0935* (0.0539)	0.244*** (0.0645)
Service transport 2	-0.0141 (0.0237)	-0.00873 (0.0137)	0.0228 (0.0366)	-	-	-
Service transport 3	-0.0678*** (0.0236)	-0.130*** (0.0314)	0.198*** (0.0430)	-	-	-
Environment 2	-	-	-	-0.0638** (0.0301)	-0.0505** (0.0228)	0.114*** (0.0387)
Environment 3	-	-	-	-0.108*** (0.0337)	-0.284*** (0.0675)	0.392*** (0.0707)
# Observations		642			428	

**Note(s):** P<sub>j</sub> is the probability that SWB3 = j, with j = 1,2,3. Model 2 with three variables representing public services (*Sport, Culture, Transport*). Model 3 with two variables representing public services (*Sport, Culture*) and environmental externality (*Environment*) Significance levels: \* 10%, \*\* 5% and \*\*\* 1%. Other nonsignificant variables used in the estimations are *Median income, Age, House Ownership, Female, Engagement and SWB\_indi\_coll*

**Source(s):** Table by the authors

**Table 7.** Marginal effects with feeling of well-being (SWB3) as the dependent variable

reported in Tables A4 and A5 in Appendix 2) and marginal effects are reported in Tables 7 and 8 Table A6 also provides estimations with *Feeling of Well-Being SWB3* with more variables but fewer observations. We observe in Table 5 for *Feeling of Well-Being SWB3* that Models 2 and 3 have higher explanatory power than Model 1 following the pseudo  $R^2$  (0.142 and 0.144 compared to 0.122). The AIC criterion is also favorable to Models 2 and 3 (its value is much lower than in Model 1). The same observation is obtained for *Environmental Satisfaction SWB3\_ENV*, where Models 2 and 3 have much more explanatory power than Model 1 (pseudo  $R^2 = 0.145$  and 0.325 compared to 0.094).

Let us first consider the effects of variables in the group of *socioeconomic characteristics*. We can observe that household income may matter, but in different ways, for individuals' feelings of well-being and environmental satisfaction. Indeed, *income* has a positive effect on subjective well-being only for individuals belonging to a low-income group, while individuals belonging to a high-income group tend to be unsatisfied with environmental quality. The marginal effects of income reported in Tables 7 and 8 justify this observation. The results show that a higher income is conducive to a higher probability of feeling "Good" and a lower

Variables	Model 2			Model 3		
	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>
Income group 2	-0.0710 (0.0832)	0.0452 (0.0582)	0.0258 (0.0266)	0.0814* (0.0443)	-0.00934 (0.0387)	-0.0721 (0.0618)
Income group 3	-0.0189 (0.0842)	0.0134 (0.0603)	0.00559 (0.0240)	0.0767 (0.0491)	-0.00653 (0.0434)	-0.0702 (0.0610)
Income group 4	-0.0992 (0.0777)	0.0582 (0.0545)	0.0410 (0.0287)	0.109* (0.0612)	-0.0283 (0.0573)	-0.0811 (0.0608)
Income group 5	-0.00408 (0.0892)	0.00294 (0.0644)	0.00114 (0.0248)	0.155** (0.0621)	-0.0643 (0.0701)	-0.0904 (0.0597)
House ownership	0.0758* (0.0436)	-0.0452* (0.0272)	-0.0306 (0.0192)	0.0760* (0.0411)	-0.0479 (0.0302)	-0.0281 (0.0174)
Engagement	0.0691* (0.0366)	-0.0412* (0.0238)	-0.0279* (0.0155)	0.0379 (0.0362)	-0.0239 (0.0248)	-0.0140 (0.0132)
Service sport 2	-0.224*** (0.0865)	0.175** (0.0779)	0.0492*** (0.0152)	-0.192* (0.101)	0.160* (0.0953)	0.0326** (0.0148)
Service sport 3	-0.241*** (0.0876)	0.184** (0.0780)	0.0571*** (0.0201)	-0.193* (0.102)	0.160* (0.0955)	0.0328** (0.0167)
Service culture 2	-0.280** (0.111)	0.243** (0.106)	0.0375*** (0.0127)	-0.283 (0.175)	0.261 (0.172)	0.0220** (0.0107)
Service culture 3	-0.386*** (0.113)	0.300*** (0.108)	0.0856*** (0.0214)	-0.365** (0.175)	0.308* (0.173)	0.0570*** (0.0218)
Service transport 2	-0.142** (0.0706)	0.114* (0.0615)	0.0278** (0.0127)	-	-	-
Service transport 3	-0.259*** (0.0702)	0.171*** (0.0646)	0.0883*** (0.0216)	-	-	-
Environment 2	-	-	-	-0.483*** (0.0729)	0.438*** (0.0774)	0.0451*** (0.0171)
Environment 3	-	-	-	-0.584*** (0.0778)	0.177 (0.133)	0.406*** (0.0900)
# Observations		446			296	

**Note(s):** P<sub>j</sub> is the probability that  $SWB3\_ENV = j$ , with  $j = 1, 2, 3$ . Model 2 with three variables representing public services (*Sport*, *Culture*, *Transport*). Model 3 with two variables representing on public services (*Sport*, *Culture*) and environmental externality (*Environment*) Significance levels: \* 10%, \*\* 5% and \*\*\* 1%. Other nonsignificant variables used in the estimations are median income, age, female, SWB\_indi\_coll, number of children, number of children squared and opportunities to laugh

**Source(s):** Table by the authors

**Table 8.** Marginal effects with environmental satisfaction ( $SWB3\_ENV$ ) as the dependent variable

probability of feeling “Bad” and “Medium” (Table 7, Model 2). When introducing a supplementary variable relative to the environment and individual health (*Environment*), this result concerns only individuals having a low household income (Table 7, Model 3). Concerning the individuals’ environmental satisfaction, we observe that a higher income may conduce to a higher probability of low satisfaction (Table 8, Model 3) [6].

Still concerning income effect, Table A7 in Appendix 2 provides complementary estimations using another subjective indicator, *Social Life Satisfaction*. We show that income positively affects individuals’ social life satisfaction only for individuals belonging to group 5 (i.e. when monthly household income is higher than 3,451 euros). These different estimations show that the income effect is heterogeneous following subjective measures and income group. Its effect is not strong for individuals’ subjective perception in our data concerning the Strasbourg metropolitan area. Besides, no social comparison in terms of income is detected: median income does not affect different estimations using the three different subjective measures.

The number of children is another variable in this group of socioeconomic characteristics deserving attention. We note that it has a significant and nonlinear effect on the individuals’

feelings of well-being. More precisely, results show a convex relationship between the number of children and individuals' feelings of well-being. This convex curve is found in two models presented in [Table 5](#) (or B4) and three additional models in [Table A6](#).

Other variables such as *house ownership*, *age* or *gender* do not affect the individual feeling of well-being. However, it is interesting to note that *house ownership* has an opposite effect on environmental satisfaction and social life satisfaction. Indeed, [Table 6](#) (or B5) shows that house owners are more demanding of environmental quality than house tenants, as they tend to be less satisfied with environmental quality than the first group (i.e. house tenants). When considering the marginal effect of house ownership, it positively affects the probability of being "unsatisfied" with environmental quality ([Table 8](#)). When estimating social life satisfaction as a dependent variable ([Table A7](#)), we can observe that house owners appear to be more satisfied than house tenants, all things considered unchanged.

Let us now consider the effects of two variables in the lifestyle group. We observe that Laugh's opportunities make people more satisfied with their social life ([Table A7](#)) and make people feel good ([Tables 5 and 7](#)). In other words, if using the feeling of well-being and social life satisfaction as two proxies of happiness, this result shows, not surprisingly, the significant impact of a joyous life with opportunities to laugh on our feeling of happiness. A lifestyle with *Engagement*, i.e. participation in collective activities such as organizing elections, volunteer activity, civic service, etc., can make people more satisfied with their social life ([Table A7](#)) but unsatisfied with environmental quality ([Table 6](#) or B5). At the same time, it does not affect the feeling of well-being ([Table A4](#)).

We focus on the last group of variables representing the Strasbourg metropolis' specificities *via* individuals' perception of public services (in sport, culture and transport), their sense of safety in the agglomeration and their perception of whether the environmental quality is convenient to health. All variables in this group contribute significantly to explaining individuals' feelings of well-being, environmental satisfaction and social life satisfaction. For instance, looking at [Table 5](#) for estimation results using the feeling of well-being and [Table 7](#) for marginal effects of explicative variables, we remark that if the sports equipment and programming (*Service Sport*) and the culture equipment and programming (*Service Culture*) meet individual expectations, then the feeling of well-being will be better off. The same observation is found for variable *Service Transport*, which indicates whether the public transport in the agglomeration of Strasbourg satisfies individual needs. When public transport *satisfies moderately* (i.e. *Service Transport* = 2) or *satisfies* (i.e. *Service Transport* = 3) individual needs, this contributes to increasing the individual feeling of well-being, all things remaining unchanged. Note that the reference case with *Service Transport* = 1 corresponds to the situation where *Service Transport* does not satisfy individual needs. Analyses of marginal effect clarify this observation. Results from Model 2 presented in [Table 7](#) precise that if public transport *satisfies* individual needs, this hurts the probability of being "unsatisfied" (i.e.  $P_1$ ) and "satisfied" (i.e.,  $P_2$ ) and has a positive effect on the likelihood to be "very satisfied" (i.e.,  $P_3$ ). Likewise, if the culture (*Service Culture* = 2 or = 3) or sport (*Service Sport* = 2 or = 3) equipment and programming meet individual expectations, then this reduces the probability of being "unsatisfied" ( $SWB3 = 1$ , i.e.  $P_1$ ) and "satisfied" ( $SWB3 = 2$ , i.e.  $P_2$ ), and increases the probability of being "very satisfied" ( $SWB3 = 3$ , i.e.  $P_3$ ).

The above findings confirm the hypothesis that public services are positive externalities and affect individual utility. Likewise, let's consider the individual perception of whether environmental quality in the Strasbourg agglomeration is convenient for health as a proxy of environmental quality (Environment). Observations regarding the impact of the variable *Environment* show that this variable is also a positive externality present in the utility function as it has a positive effect on the individual feeling of well-being ([Tables 5 and 7](#), Model 3).

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When using environmental satisfaction as a dependent variable, the same observations are made: the effects of public services (i.e. *Culture, Sport and Transport*) on environmental satisfaction is positive (Tables 6 and 8). The variable Environment has, unsurprisingly, a positive effect on individuals' environmental satisfaction (Tables 6 and 8, Model 3), but no impact on social life satisfaction (Table A7, Model 3).

The last variable representing specificities of Strasbourg agglomeration concerns the sense of safety. From answers to the question "*What is the level of your sense of safety in the agglomeration,*" we create a three-category-variable indicating the *Sense of security*. This variable takes 1 if the answer is *No*, 2 if *moderately* and 3 if *Yes*. Introducing *Sense of security* in the estimations reduces the number of observations; however, results clearly show that the sense of security increases the feeling of well-being (Models 4, 5 and 6 in Table A6, Appendix 2). Note that variables representing public services and environmental quality remain significant in this specification. We do not introduce this variable in estimations using environmental satisfaction and social life satisfaction as the number of observations is considerably reduced to less than 100.

## 6. Conclusions

This paper aims to analyze determinants of individual subjective well-being using data from the Strasbourg metropolitan area (France). We focus on the effects of externalities generated by public services (transport, culture and sport), environmental quality and the sense of security in the metropolitan area. Results show that specificities of this urban area (public services, environmental quality perceived as convenient for individual health, sense of security), opportunities to laugh and living with children significantly impact individual subjective well-being. These findings are robust when using three subjective measures: feeling of well-being, environmental satisfaction and social life satisfaction.

Concerning the effect of income, this variable does not substantially impact the individual subjective perception of happiness. We show that income may matter for the feeling of well-being only for individuals belonging to a low-income group. Wealthy individuals tend to be unsatisfied with environmental quality but satisfied with their social life. Our analyses, contrasting with the expected result in subjective well-being literature, show that the difference between household income and median household income does not affect the personal perception of happiness. This result indicates then social comparison in terms of income does not matter for individual well-being in the Strasbourg metropolitan area.

The present study contributes to the literature on subjective well-being, with a focus on the role of local characteristics and living environment. Results shed light on the role of territorial policies in improving individual well-being and might provide some guidelines for policy-makers concerned about the population's welfare. Policy-makers should give strong attention to public facilities (an essential element of local public action) and improve environmental quality. If they care about the population's happiness, they have to reorient current policies in this direction. Of course, through the inquiry in 2017 giving this database, the Strasbourg agglomeration development council aimed to provide such evidence to the local administration. Nevertheless, the results were a bit upsetting for many people in the administrative and political circles, who generally prioritize economic and demographic development, while the citizens' responses to the inquiry have revealed a strong focus on the quality of everyday life in their neighborhood.

## Notes

1. Most studies on subjective well-being underscore a phenomenon of relative standing (Luttmer, 2005; Senik, 2005; Clark *et al.*, 2017; Algan *et al.*, 2020, etc.), contrary to the absolute utility hypothesis which is usually postulated in standard economic modeling. Individuals may compare their income (or

consumption) to an external reference (others) or an internal reference (one's past income or expected future income).

2. Individual preference for a social status is then modeled under the form of a utility depending on relative wealth (Van Long & Shimomura, 2004; Pham, 2005) or relative consumption (Fisher & Hof, 2000; Cooper, Garcia-Peñalosa, & Funk, 2001; Pham, 2019), etc.
3. The survey area is illustrated in Figure A1.
4. Kehl is part of the agglomeration and has been interviewed in 2017, but the methodology and the sampling were not very coherent with the main enquiry— on the French side. We therefore decided not to use this additional statistical information in our econometrical analysis of the data base. We hope to design a specific cross-border enquiry in the near future.
5. Note that following INSEE's measure, 1 Adult = 1 consumption unit (CU), 1 person >14 years old = 0.5 CU, 1 child  $\leq$  14 years old = 0.5 CU.
6. The marginal effect of an explanatory variable is calculated by maintaining other variables at their average - values. For more details in the formulas of marginal effect, see Appendix 3.

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(The Appendix follows overleaf)

**L'Eurométropole de Strasbourg comme terrain d'enquête**



**Figure A1.**  
Area of survey,  
Strasbourg  
Eurométropole, France

Source(s): GeoRhena, Open Data Strasbourg | Realisation : Julien Guerard, Avril 2020

**Appendix 2**  
**Data description and additional results**

Strasbourg  
metropolitan  
area

Variable	Obs	Mean	Std. Dev	Min	Max
Individual feeling of well-being (SWB3)	984	2.28	0.58	1	3
Individual social life satisfaction(SWB3_SOCIAL)	307	2.51	0.62	1	3
Environmental satisfaction (SWB3_ENV)	667	1.87	0.56	1	3
Net monthly household income ( <i>Income Group</i> )	984	2.92	1.22	1	5
Median household income in log ( <i>Median Income</i> )	984	7.88	0.341	7.28	8.51
Number of children in log (# <i>Children</i> )	984	0.61	0.56	0	1.61
Number of children squared (# <i>Children squared</i> )	984	0.69	0.74	0	3.21
Individuals' age in 4 groups ( <i>Age Group</i> )	984	2.59	0.77	1	4
Female ( <i>Female</i> )	984	0.68	0.47	0	1
Living with a partner ( <i>Couple</i> )*	984	0.72	0.45	0	1
House Ownership ( <i>House Ownership</i> )	984	0.55	0.49	0	1
Profession-student ( <i>Profession_etu</i> )*	984	0.05	0.22	0	1
Profession-retireer ( <i>Profession_retraite</i> )*	984	0.14	0.35	0	1
Profession-independent ( <i>Profession_libre</i> )*	984	0.11	0.31	0	1
Profession-wage earner ( <i>Profession_employe</i> )*	984	0.21	0.41	0	1
Profession-others ( <i>Profession_autre</i> )*	984	0.49	0.50	0	1
Opportunities to laugh ( <i>Laugh</i> )	984	0.69	0.45	0	1
Participation in collective activities ( <i>Engagement</i> )	984	0.27	0.44	0	1
Well-being perceived as individual or collective concern (SWB_indi_coll)	984	2.018	0.44	1	3
Sports equipment and programming in community meets individual expectations ( <i>Service Sport</i> )	984	2.32	0.64	1	3
Cultural equipment and programming in community meets individual expectations ( <i>Service Culture</i> )	984	2.44	0.63	1	3
Public transport satisfying individual needs ( <i>Service Transport</i> )	642	0.24	0.74	1	3
Environmental quality in Euro metropole perceived as convenient for individual health ( <i>Environment</i> )	428	1.95	0.63	1	3
Sense of safety in the agglomeration ( <i>Sense of Security</i> )	307	2.04	0.629	1	3

**Note(s):** To test the endogeneity of household income, stated variables are used as excluded instruments in the first regression of a two-step procedure estimation. These variables are assumed to be correlated with the endogenous regressor (i.e. *household income*) and uncorrelated with individual *subjective well-being* reported by individual *i*.

**Source(s):** Table by the authors

**Table A1.**  
Descriptive statistics

Feeling of Well-being	Social Life Satisfaction			Total
	Unsatisfied	Satisfied	Very satisfied	
Bad	10	3	4	17
Medium	10	82	83	175
Good	1	21	93	115
Total	21	106	180	307

**Source(s):** Table by the authors

**Table A2.**  
Distribution of feeling of well-being (SWB3) and social life satisfaction (SWB3\_SOCIAL)

**Table A3.**  
Distribution of feeling of well-being (SWB3) and environmental satisfaction (SWB3\_ENV)

Feeling of Well-being	Environmental Satisfaction			Total
	Unsatisfied	Satisfied	Very satisfied	
Bad	25	18	1	44
Medium	103	260	19	382
Good	167	21	49	241
Total	153	445	69	667

**Source(s):** Table by the authors

Variable	Model 1		Model 2		Model 3	
	Coef	Std.Err	Coef	Std.Err	Coef	Std.Err
Income group 2	0.460*	0.185	0.5266**	0.229	0.641**	0.305
Income group 3	0.215	0.180	0.3761*	0.220	0.275	0.279
Income group 4	0.153	0.180	0.161	0.219	0.223	0.302
Income group 5	0.143	0.172	0.393*	0.213	0.238	0.277
Median income	0.103	0.131	0.249	0.167	0.175	0.209
# Children	-0.878***	0.260	-1.085***	0.327	-0.593	0.390
# Children squared	0.510***	0.190	0.644***	0.236	0.405	0.288
Age group 2	0.108	0.171	0.321	0.213	-0.293	0.254
Age group 3	-0.035	0.185	0.155	0.225	-0.394	0.273
Age group 4	-0.004	0.211	0.186	0.265	-0.372	0.303
House ownership	0.113	0.092	0.093	0.120	0.021	0.141
Female	0.002	0.086	0.014	0.105	0.029	0.139
Laugh	0.467***	0.088	0.354***	0.101	0.247*	0.133
Engagement	0.019	0.084	0.072	0.101	0.158	0.125
Service sport 2	-0.327**	0.165	0.287	0.201	0.329	0.264
Service sport 3	0.688***	0.175	0.587***	0.215	0.509*	0.277
Service culture 2	0.651***	0.199	0.622**	0.2528	0.619*	0.329
Service culture 3	1.032***	0.208	0.912***	0.265	0.934***	0.340
Swb_indi_coll 2	0.131	0.132	0.058	0.163	0.022	0.209
Swb_indi_coll 3	0.061	0.176	-0.272	0.229	-0.081	0.293
Service transport 2	-	-	0.0896	0.146	-	-
Service transport 3	-	-	0.630***	0.151	-	-
Environment 2	-	-	-	-	0.424***	0.157
Environment 3	-	-	-	-	1.167***	0.213
c <sub>1</sub>	0.919	1.063	2.256*	1.363	1.414	1.704
c <sub>2</sub>	3.098***	1.068	4.568***	1.376	3.369**	1.716
# Observations	984		642		428	
# Parameters	27		30		30	
Log-likelihood	-751.067		-468.234		-314.254	
Pseudo R <sup>2</sup>	0.122		0.142		0.144	
AIC	1556.13		996.48		688.51	

**Note(s):** Model 1 corresponds to regression with socioeconomic, lifestyle variables and externalities from public services (*Sport*, *Culture*). Model 2 corresponds to regression with the same variables as in Model 1 and with an additional variable on public transport (*Transport*), reducing observations from 984 to 642. Model 3 corresponds to regression with the same variables as in Model 1 and environmental externality (*Environment*). If we keep public transport (*Transport*) in Model 2, there are only 220 observations left. All explanatory variables are exogenous based on the variable addition test (Wooldridge, 2014). Significance levels: \*10%, \*\* 5% and \*\*\* 1%

**Table A4.**  
Estimation results for feeling of well-being (SWB3)

**Source(s):** Table by the authors

Strasbourg  
metropolitan  
area

Variable	Model 1		Model 2		Model 3	
	Coef	Std.Err	Coef	Std.Err	Coef	Std.Err
Income group 2	-0.027	0.211	0.234	0.261	-0.560	0.352
Income group 3	-0.210	0.206	0.058	0.257	-0.536	0.360
Income group 4	-0.079	0.203	0.339	0.249	-0.686*	0.367
Income group 5	-0.526**	0.214	0.012	0.271	-0.862**	0.347
Median income	0.026	0.153	0.149	0.186	0.065	0.269
# Children	0.161	0.339	-0.049	0.319	0.588	0.510
# Children squared	-0.086	0.245	0.027	0.280	-0.172	0.364
Age group 2	0.147	0.207	-0.071	0.278	-0.035	0.354
Age group 3	-0.021	0.227	-0.299	0.304	0.004	0.395
Age group 4	0.037	0.262	-0.236	0.327	-0.174	0.434
House ownership	-0.343***	0.115	-0.258*	0.149	-0.362*	0.194
Female	-0.004	0.105	0.048	0.126	-0.089	0.185
Laugh	0.139	0.106	0.174	0.129	0.256	0.176
Engagement	-0.199**	0.098	-0.235*	0.123	-0.181	0.167
Swb_indi_coll 2	-0.094	0.163	-0.185	0.209	-0.364*	0.219
Swb_indi_coll 3	-0.216	0.221	-0.395	0.301	-0.583	0.359
Service culture 2	0.608***	0.226	0.744***	0.284	0.845*	0.453
Service culture 3	1.001***	0.234	1.118***	0.291	1.255***	0.456
Service sport 2	0.671***	0.187	0.645***	0.225	0.693**	0.301
Service sport 3	0.826***	0.197	0.704***	0.235	0.695**	0.310
Service transport 2	-	-	0.398**	0.190	-	-
Service transport 3	-	-	0.833***	0.197	-	-
Environment 2	-	-	-	-	1.478***	0.206
Environment 3	-	-	-	-	2.929***	0.311
c <sub>1</sub>	0.530	1.219	2.086	1.474	1.541	2.117
c <sub>2</sub>	2.747**	1.219	4.426***	1.475	4.486**	2.103
# Observations	667		446		296	
# Parameters	27		30		30	
Log-likelihood	-509		-321		-168	
Pseudo R <sup>2</sup>	0.094		0.145		0.325	
AIC	1072.305		702.462		397.625	

**Note(s):** Model 1 corresponds to regression with socioeconomic, lifestyle variables and externalities from public services (*Sport, Culture*). Model 2 corresponds to regression with the same variables as in Model 1 and with an additional variable on public transport (*Transport*), reducing the number of observations from 667 to 446. Model 3 corresponds to regression with the same variables as in Model 1 and with environmental externality (*Environment*). If we keep public transport (*Transport*) in Model 3, there are only 205 observations left. All explanatory variables are exogenous based on the variable addition test (Wooldridge, 2014). Significance levels: \*10%, \*\* 5% and \*\*\* 1%

**Source(s):** Table by the authors

**Table A5.**  
Estimation results for  
*environmental*  
*satisfaction*  
(SWB3\_ENV)

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Variable	Model 4		Model 5		Model 6	
	Coef	Std.Err	Coef	Std.Err	Coef	Std.Err
Income group 2	0.177	0.369	0.226	0.486	0.350	0.479
Income group 3	0.086	0.348	0.142	0.445	0.175	0.452
Income group 4	-0.204	0.349	-0.278	0.462	-0.101	0.435
Income group 5	0.080	0.333	0.232	0.434	0.115	0.404
Median income	0.192	0.244	0.346	0.286	0.276	0.357
# Children	-1.401***	0.531	-1.583**	0.947	-1.344*	0.768
# Children squared	0.821**	0.415	0.947*	0.487	1.005*	0.587
Age group 2	0.264	0.322	0.483	0.389	0.102	0.355
Age group 3	0.077	0.340	0.281	0.400	-0.008	0.405
Age group 4	0.155	0.397	0.355	0.475	-0.190	0.466
House ownership	0.060	0.170	0.047	0.209	-0.038	0.248
Female	-0.043	0.165	-0.053	0.181	0.073	0.224
Laugh	0.386*	0.162	0.416**	0.197	0.512***	0.229
Engagement	-0.141	0.148	-0.035	0.172	-0.045	0.194
Swb_indi_coll 2	0.316	0.254	0.119	0.270	0.773***	0.352
Swb_indi_coll 3	0.286	0.345	-0.186	0.404	0.412	0.544
Service culture 2	0.797**	0.373	0.796*	0.439	1.313**	0.549
Service culture 3	0.927**	0.402	0.741	0.465	1.287**	0.571
Service sport 2	0.586*	0.314	0.385	0.366	0.455	0.376
Service sport 3	0.978***	0.336	0.694*	0.387	0.678*	0.411
Service transport 2	-	-	0.207	0.273	-	-
Service transport 3	-	-	0.541*	0.290	-	-
Environment 2	-	-	-	-	0.169	0.274
Environment 3	-	-	-	-	1.1165***	0.348
Sense of security 2	0.561**	0.228	0.587**	0.277	0.755**	0.361
Sense of security 3	0.998***	0.265	0.930***	0.321	1.209***	0.390
c <sub>1</sub>	2.131	1.945	3.510	2.303	3.954	2.083
c <sub>2</sub>	4.654**	1.950	5.998***	2.323	6.707**	2.844
# Observations		307		223		177
# Parameters		30		33		33
Log-likelihood		-212.670		-155.433		-111.289
Pseudo R <sup>2</sup>		0.182		0.185		0.229
AIC		485.339		376.865		288.578

**Note(s):** Model 4 corresponds to regression with socioeconomic, lifestyle variables and externalities from public services (*Sport, Culture*) with a sense of safety in EMS (*Sense of security*) representing a specificity of the Strasbourg metropolitan area. Model 5 corresponds to regression with the same variables as in Model 2 (i.e. three public services *Sport, Culture and Transport*) and with the sense of security in EMS (*Sense of security*), this reduces the number of observations from 307 to 223. Model 6, with only 177 observations, considers two public services (*Sport, Culture*), environmental externality (*Environment*) and *Sense of Security* in the agglomeration. All explanatory variables are exogenous based on the variable addition test (Wooldridge, 2014). Significance levels: \*10%, \*\* 5% and \*\*\* 1%

**Table A6.** Estimation results for *feeling of well-being (SWB3)* with additional variables

**Source(s):** Table by the authors

Variable	Model 1		Model 2		Model 3	
	Coef	Std.Err	Coef	Std.Err	Coef	
Income group 2	0.311	0.351	0.015	0.492	0.029	0.488
Income group 3	0.447	0.344	-0.049	0.470	-0.169	0.524
Income group 4	0.429	0.318	0.123	0.456	0.174	0.448
Income group 5	0.516*	0.301	0.460	0.443	0.054	0.431
Median income	0.024	0.253	0.133	0.321	0.169	0.374
# Children	0.037	0.496	0.461	0.738	-0.923	0.727
# Children squared	-0.111	0.364	-0.506	0.531	0.477	0.526
Age group 2	0.041	0.277	0.657	0.404	0.287	0.387
Age group 3	-0.155	0.339	0.542	0.485	0.203	0.521
Age group 4	0.238	0.404	1.076*	0.532	-0.229	0.665
House ownership	0.367*	0.182	0.332	0.259	0.701**	0.301
Female	-0.019	0.163	0.179	0.210	0.283	0.253
Laugh	0.809***	0.234	0.993***	0.209	1.086***	0.233
Engagement	0.254	0.158	0.488**	0.205	0.595**	0.237
Swb_indi_coll 2	0.465***	0.179	0.811**	0.378	1.474***	0.377
Swb_indi_coll 3	0.957***	0.322	0.854*	0.504	2.034***	0.582
Service culture 2	0.431	0.417	0.355	0.478	0.976	0.672
Service culture 3	0.655	0.431	1.025*	0.494	1.488**	0.680
Service sport 2	0.369	0.317	0.195	0.396	0.523	0.450
Service sport 3	0.681**	0.338	0.588	0.434	0.760	0.483
Service transport 2	-	-	0.258	0.307	-	-
Service transport 3	-	-	0.123	0.313	-	-
Environment 2	-	-	-	-	-0.059	0.306
Environment 3	-	-	-	-	-0.066	0.404
c <sub>1</sub>	1.312	2.023	2.951	2.590	3.979	3.006
c <sub>2</sub>	2.871	2.031	4.643*	2.591	5.725**	3.014
# Observations	307		177		162	
# Parameters	27		30		30	
Log-likelihood	-227.673		-130.908		-106.709	
Pseudo R <sup>2</sup>	0.141		0.189		0.234	
AIC	509.347		321.816		162	

**Note(s):** Model 1 corresponds to regression with socioeconomic, lifestyle variables and externalities from public services (*Sport, Culture*). Model 2 corresponds to regression with the same variables as in Model 1 and with an additional variable on public transport (*Transport*), reducing observations from 307 to 177. Model 3 corresponds to regression with the same variables as in Model 1 and environmental externality (*Environment*). If we keep public transport (*Transport*) in Model 3, only 99 observations remain. All explanatory variables are exogenous based on the variable addition test (Wooldridge, 2014). Significance levels: \*10%, \*\*5% and \*\*\*1%

**Source(s):** Table by the authors

**Table A7.**  
Estimation results for  
social life satisfaction  
(SWB3\_SOCIAL)

**Appendix 3****Marginal effects in an ordered probit model**

Our estimation provides marginal effects of household income and that of all other explanatory variables. In the ordered probit model, three probabilities of our specification are written as:

$$P(U_i = 1) = \Phi(c_1 - X_i'\beta)$$

$$P(U_i = 2) = \Phi(c_2 - X_i'\beta) - \Phi(c_1 - X_i'\beta)$$

$$P(U_i = 3) = 1 - \Phi(c_2 - X_i'\beta)$$

where  $\Phi(\cdot)$  is the standard normal cumulative distribution function. The marginal effects of a regressor  $x_i$  on probabilities are not represented by the estimated coefficients associated with  $x_i$ , but they are calculated as follows:

$$\frac{\partial P(U_i = 1)}{\partial x_i} = -\phi(c_1 - x_i\beta)\beta$$

$$\frac{\partial P(U_i = 2)}{\partial x_i} = -\phi(c_2 - x_i\beta)\beta + \phi(c_1 - x_i\beta)\beta$$

$$\frac{\partial P(U_i = 3)}{\partial x_i} = \phi(c_2 - x_i\beta)\beta$$

where  $\phi(\cdot)$  is the standard normal density. We note the opposite sign of  $\partial P(U_i = 1)/\partial x_i$  and  $\partial P(U_i = 3)/\partial x_i$ . However, the sign of  $\partial P(U_i = 2)/\partial x_i$  may be either positive or negative. We also remark that the sum of the three probabilities is equal to unity, i.e.  $P(U_i = 1) + P(U_i = 2) + P(U_i = 3) = 1$ , and the sum of the three marginal effects is equal to 0:

$$\frac{\partial P(U_i = 1)}{\partial x_i} + \frac{\partial P(U_i = 2)}{\partial x_i} + \frac{\partial P(U_i = 3)}{\partial x_i} = 0.$$

We note that  $U_i$  corresponds to the subjective well-being created on a scale of 1–3 from the observed well-being reported by an individual  $i$  on a scale of 1–10: either *Feeling of Well-being (SWB3)*, *Environmental Satisfaction (SWB3\_ENV)* or *Social Life Satisfaction (SWB3\_SOCIAL)*.

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