IAE Nantes
Économie & Management
Pôle Sociétés

Master 1 : Econométrie appliquée

Econométrie Linéaire Avancée

A survey of meat consumption among college students : The case of Nantes Université in 2022

Ammour Gabriel, Bouedo Théo, Le Roux Noa

30 Novembre 2022

Nantes Université

Abstract

The purpose of this study was to appraise the environmental concerns, Food and Health behaviors as well as animal welfare concerns of Nantes Université students on their meat consumption. Using a questionnaire, we were able to collect information on their socio-economic environment, their consumption habits and their knowledge regarding meat industry externalities. After analyzing students' responses, we used the multiple component analysis as well as the cluster technique to group students according to their responses on each of the three themes mentioned above. We were able to identify three clusters gathering three types of individuals : the committed, the aware and the skeptical. Then, we used econometric methods - Ordinary Least Squares - to quantify the links between our clusters and MC. In accordance with the previous work, our results showed that being female, having vegetarian parents and not living alone had a negative impact on meat consumption. However, our study also showed that both health and environmental considerations were more important than animal considerations in shaping meat consumption.

Résumé

L'objectif de cette étude était d'évaluer les préoccupations environnementales, de santé alimentaire, ainsi que celles liées au bien-être animal des étudiants de l'Université de Nantes sur leur consommation de viande. A l'aide d'un questionnaire, nous avons pu recueillir des informations sur leur environnement socio-économique, leurs habitudes de consommation et leurs connaissances sur les externalités de l'industrie de la viande. Après avoir analysé les réponses des étudiants, nous nous sommes servis de l'analyse en composantes multiples ainsi que de la méthode des clusters pour regrouper les étudiants en fonction de leurs réponses sur chacun des trois thèmes mentionnés plus haut. Nous avons pu identifier trois clusters regroupant trois différents types d'individus : les engagés, les conscients et les sceptiques. Par la suite, nous avons utilisé des méthodes économétriques - Moindres Carrés Ordinaires - pour quantifier le degré de concordance entre nos clusters et le MC. Conformément aux recherches précédentes, nos résultats ont montré que le fait d'être une femme, d'avoir des parents végétariens et de ne pas vivre seul avait un impact négatif sur la consommation de viande. Cependant, notre étude a également révélé que les considérations liées à la santé et à l'environnement étaient plus importantes que les considérations liées aux animaux pour définir la consommation de viande.

Summary

Chapter 1

Introduction

Homini, our ancestor, began to include meat in his diet at least 2.6 million years ago. Indeed, until the development of agriculture, about 10,000 years ago, meat played an important role in the diet of our kind (Zink and Lieberman, 2016). For centuries, meat has been one of the most important sources of our development. However, meat has never been so much a part of our diet than it is today. On a global scale, meat consumption (MC) has almost tripled since the 90's[1]. In France, MC has experienced a significant increase in the middle of the 20th century. In fact, from 1950 to 1990, MC per capita has more than doubled going from 44 kg/year to 91 kg/year[2]. However, since the late 90, French MC has been decreasing. Today, if MC is still driven by some emerging countries - whose population and income are growing - its pace tends to slow down.

The human relationship towards other living beings is becoming more and more problematic. The best example that can be given is probably the epidemic of Covid-19 that we have just experienced. If our knowledge about the origin of this virus tends to evolve, the current state suggests its animal origin (Vilcek, 2020). Indeed, many practices such as intensive farming or wildlife trade would tend to facilitate the emergence of zoonosis[3]. Therefore, we can ask ourselves if our behavior towards animals - to ultimately consume meat - does not pose a certain number of risks, both for human and animal well-being. Moreover, MC also raises many environmental concerns. Indeed, MC - especially red meat - largely contributes to problems such as deforestation or the emission of greenhouse gases (GHG). We will come back to these points in more detail in the next chapter.

[1]M. Shahbande, *MC worldwide 1990-2021, by type*, Our World in Data,2022
[2]HCSP, *Pour une politique nutritionnelle de santé publique en France*, 1999
[3]Elsa Jourdain, *Facteurs de risque d'émergence des zoonoses*, 2022

In this study, we will use a survey to try to identify the determinants of the weekly MC of students at Nantes Université. In the limited amount of research done on MC among students, it seems that the three factors mentioned above - environment, health, and animal welfare - have an impact on MC (Arnaudova et al., 2022). Therefore, we will focus our study on the impact of these three components on MC. Thus, the objective is double, first, do we observe such sensitivities in students? And if so, are they a determining factor in MC? To answer these questions, we will begin by explaining the relevance of our subject. Then we will use the literature to determine the effects of various factors on MC. Next, we will conduct a descriptive analysis of our database. It is at this point that we will apply the cluster analysis to segment students based on their responses to the different considerations mentioned above. Finally, we will apply econometric methods - Ordinary Least Squares - to quantify the links between our clusters and MC.

Chapter 2

Externalities of the meat industry

2.1 The environnemental impact of meat production

2.1.1 Greenhouse gas emissions

According to the Cambridge dictionary, *someone's carbon footprint is a measurement of the amount of carbon dioxide that their activities produce*. The carbon footprint can be either computed individually or collectively. For instance, we can have the carbon footprint of a country like France, of a company like Total or of a citizen like Mr.Dupont. Each of those footprints are supposedly computed in the same way. Here, we will keep our focus mainly on the individual carbon footprint of Mr.Dupont. In France, every citizen has the opportunity to compute his carbon footprint. Let's assume that Mr.Dupont is the perfect match to represent the average French citizen. If Mr.Dupont had computed his footprint in 2019 he would have realized that his carbon footprint was almost 10tCO2-eq[1][2] and within these tons, we would have realized that right after the ways he uses to move his body into space (transport), the way he eats is the behavior that has the most impact on the environment. Indeed, for the average French person, food represents 2.3tCO2-eq and the meat itself is almost 1t. This means that on average, meat represents 10% of the individual footprint. It is quite huge considering that in order to comply with the Paris Agreement on climate change we must have a carbon footprint of 2tCO2-eq by 2050[3]. If MC is harmful to the environment, it's mainly due to red meat. The next subsection is going to try to provide us

[1]Note : CO2-eq includes all global warming potential gases.

[2]carbon4, *Empreinte carbone française moyenne, comment est-elle calculée ?*, 2022

[3]Le monde, *Combien de CO2 pourrez-vous émettre dans votre vie si le réchauffement est contenu à 1,5 °C ?*, 2019

some answers.

2.1.2 Land and water use

Livestock's land use is also one of the main concerns when we talk about MC. According to the Food and Agriculture Organization of the United Nations (FAO), livestock uses about 70% of all agricultural land and a third of all planet earth surface area (ice free). In the second part of the 20th century, more land has been converted to crops than ever before[4]. It corresponds well with the rapid increase in MC that we've talked about in the introduction. These observations are particularly true in South America where meat production is relatively high. During the last 30 years, we observed a significant decrease in forest mainly due by changes in land use for agricultural needs[5]. This land use change has many impacts on biodiversity. Earlier, we talked about zoonosis. Deforestation is one of the factors that can increase the risk of zoonosis. Forests are also one of the main elements of the carbon cycle, by storing carbon, they allow us to keep our carbon balance on track. When we are destroying them, we lose carbon sink capacity and let the carbon accumulate in the atmosphere which leads to an increase in global temperature. Forests also play a really important role in the water cycle. When we transform a forest into crop lands, rainfall infiltration is reduced to such an extent that the lands' demand for water increases a lot (FAO, 2006).

2.2 Human and Animal health concerns

2.2.1 Animal Welfare

The increase in MC discussed in the introduction has not been without consequences for animal welfare. Nowadays, there are around 4.5 billion chickens, laying hens and turkeys in the EU, and 330 million cattle, pigs, goats and sheep (Rigon, 2016). In France, about one billion land animals (chickens, pigs, cows, etc.) are killed in slaughterhouses every year, that is around three million per day. Most farm animals are raised under intensive farming conditions, i.e. in cages or in confined environments with no access to the outdoors. For example, more than one-half of the chickens produced in Europe are raised in cages, and up to 69% in France. It is important to note that most animals are slaughtered after a

[4]FAO, *The State of Food and Agriculture, 2006*

[5]ECLAC, *Forest loss in Latin America and the Caribbean from 1990 to 2020: the statistical evidence*, 2021

few weeks or months, i.e., they live only 2 to 20% of their normal life span. In addition to this, many painful practices within the industry, such as castration without anesthesia, dehorning, tail docking, teeth clipping, beak trimming and slaughter without stunning are legal and widespread in European countries.

Global species extinction has been accelerating sharply for several decades now with a global rate of species extinction that is now significantly higher (by several orders of magnitude) than the average rate over the past 10 million years (Benton et al., 2021). This is largely due to the conversion of natural ecosystems for crop or pasture production (thus largely related to meat production), causing the destruction of natural habitats for many species and thus drastically reducing biodiversity. Since 1970, the collective weight of wild mammals has decreased by 82%, and indicators of vertebrate abundance have shown a rapid decline (Bongaarts, 2019). According to the red list maintained by the International Union for Conservation of Nature (IUCN), agriculture is an identified threat to 24,000 of the 28,000 species so far listed as in danger of extinction (Ritchie and Roser, 2020). This overconsumption of meat, particularly in developed countries, is now putting global biodiversity at risk. Firstly, in the mistreatment of animals (simply reduced to resources to be consumed), and secondly, by destroying natural habitats, which leads to an increasing extinction of global biodiversity.

2.2.2 Human health

Overconsumption of meat is problematic for the climate, but it can also be problematic for health. While MC provides many essential nutrients, including protein and micronutrients - such as iron, zinc, and vitamin B12 - national health recommendations advise individuals to limit their consumption of processed meat, and especially processed red meat (PRM). By PRM, we mean any meat that has undergone salting, smoking, curing or other processes in order to enhance its taste or improve its preservation. PRM - which contains many toxic agents - is increasing the risk of death from heart disease, diabetes and other illnesses. It appears that mortality rates are slightly higher for individuals who consume a lot of red meat, particularly PRM (Godfray et al., 2018). The most important risk remains colorectal cancer, which seems to be most related to the overconsumption of red meat. Although it may also be related to the overconsumption of alcohol, tobacco or simply obesity. The World Health Organization (WHO) has recently classified the consumption of PRM as potentially carcinogenic. This is the result of studies conducted by the International Agency for Research on Cancer (IARC) on the consumption of red meat (beef, veal, pork, lamb, horse,

etc.) and PRM. The health risks are therefore mainly caused by processed meat, not meat in all its forms. In France, the most consumed animal is the pig. However, we know for a fact that most of the processed meats consumed are pork-based[6]. We can take the charcuterie as an example, one of the most popular meats in France. An important consumption of charcuterie can lead to an over-exposure to nitrites and nitrates. This exposure could eventually increase the risk of being affected by colorectal cancer[7].

If MC (especially PRM) can have a negative impact on health, it is relevant to consider the impact of its removal from the diet. We refer here to the benefits of a vegetarian diet. According to some research (Crowe et al., 2013), vegetarians have a lower Body mass index (BMI) and cholesterol level. In addition, the risk of developing certain cardiovascular diseases is also lower than for non-vegetarians. The list of benefits of such a diet is still long, here is a short excerpt: more favorable BMI, LDL-cholesterol and blood sugar levels (Appleby et al., 2016), benefits on cardiovascular health (Huang et al., 2012), as well as a reduction on the incidence of diabetes of nearly 40% for vegetarians and 60% for vegans (Yokoyama et al., 2014 / Pollakova et al., 2021). A vegetarian diet has few disadvantages in contrast to a vegan diet which brings several deficiencies - particularly and especially - in vitamin B12 (Pawlak et al., 2016). The vegetarian diet may also be deficient in vitamin B12, but this deficiency is less important than in the stricter diet imposed by veganism.

2.3 Interlinked impacts

Because of its impact on the environment, human health, animal welfare and the survival of the world's biodiversity, studying MC seems to us, in the current context, to be relevant. We can underline that these three impacts are interconnected. Indeed, the over-consumption of meat leads to an over-production of meat, which in turn leads to the destruction of the environment, which in turn destroys natural habitats and leads to a lack of respect for animal welfare. Three interconnected impacts, certainly, but which depend on only one variable: MC. We will see, later in this report, how these three variables can influence each other.

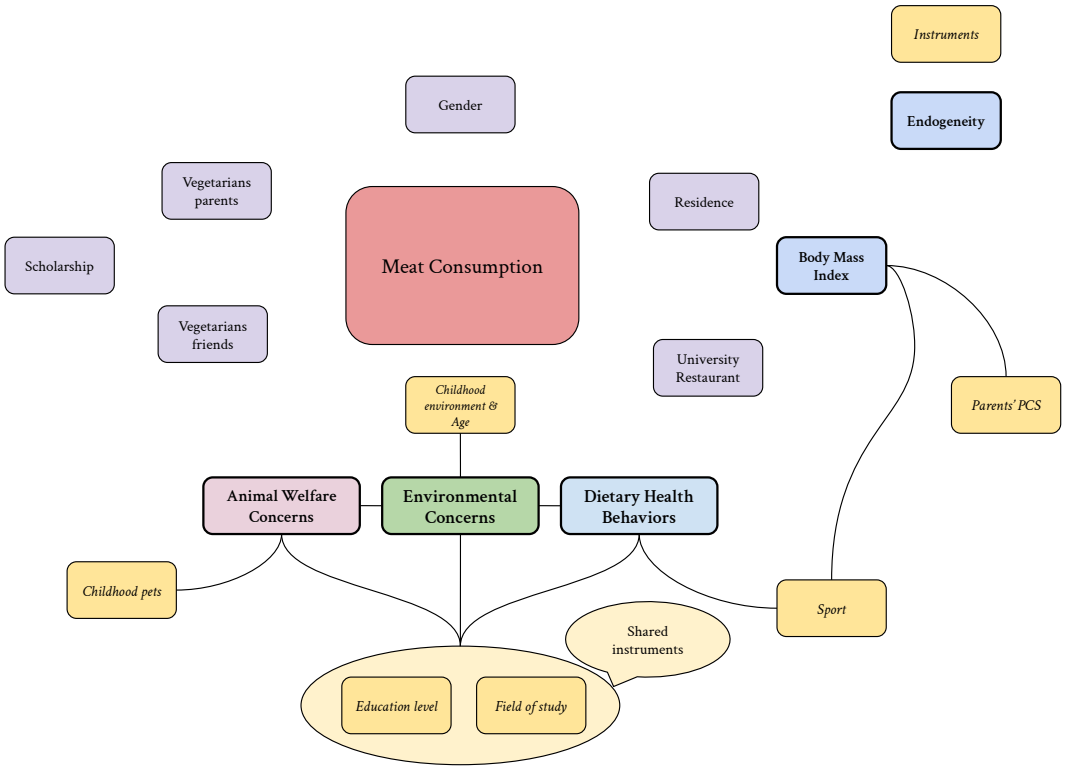
[6]OMS, FAQ sur la cancérogénicité de la consommation de viande rouge et de viande transformée, 2015
[7]Anses, Réduire l'exposition aux nitrites et nitrates dans l'alimentation, 2022

Chapter 3

Modelisation : Introduction and justification of variables

3.1 Modelisation

Figure 3.1: Graphic visualization of our model



3.2 Independent Variable

3.2.1 Meat Consumption

As mentioned in the first chapter, we believe that MC is an important matter. In this study, we've decided to study MC among college students. Studying meat consumption among students allows us to know if young people are aware of the potential externalities that MC can have, both on us and their environment. Each student was asked the following question : *Knowing that a week typically includes 14 meals, how often do you eat meat (on average)?*. We asked students for the frequency rather than the quantity out of fear that it would be too abstract for them. Similarly, they were asked about their weekly consumption and not monthly or annually in order to avoid non applicable (NA). We will discuss the answers in the next chapter but to give an idea, in France, on average, people belonging to the 18-24 age group are the biggest meat consumers. In fact, this age group would consume meat 10.6 times per week on average[1]. This is also one of the reasons why it is relevant to focus on students' MC. We will discuss in the next sections the variables that might influence students' MC.

3.3 Dependent Variables

3.3.1 Gender

For our study, we began by asking participants to specify their gender. We chose to introduce this variable for two reasons. First, we wanted to observe whether gender had a significant impact on MC. Second, we will use this variable to see if our sample can be representative of the population. We will detail this implication later in the section on the quota method. Our first intuition is that MC is gendered. We believe that being a man increases MC.

There is a link between gender and MC. In fact, many studies point to the fact that men consume more meat than women. One of the most known is Rothgerber, 2013 who concluded that on average, men eat more meat than women. Moreover, it seems that men have a particularly pronounced appetite for red meat, in fact, under a certain masculinity stress, the men's willingness to pay for red meat is increasing (Mesler et al., 2022). Indeed, it seems

[1]Crédoc, Consommation et mode de vie, 2018

like MC is a way for mens to assert their masculinity (*ibid*). We can also think that gender influences MC since women show a more positive green consumption intention. Women consume less carbon and purchase green products more frequently. On the other hand, men do better than women in terms of environmental knowledge and, in some regions, show more awareness regarding environmental issues (Zhao et al., 2021).

If gender can influence knowledge as well as behaviors around environmental sensitivity, we can wonder if there is not a strong correlation between these variables. The same observation can be made for involvement in health and in animal welfare. For example, it seems that women are more sensitive to animal welfare (María, 2006). For health and gender involvement, since we are dealing with a student population, we can assume that women are more involved in health since, on a national scale, 66% of health students are women[2].

3.3.2 Body mass index

In order to obtain the body mass index (BMI) we asked participants to specify their height and weight. The body mass index is a way of estimating the corpulence of an individual. This index is obtained as follow : $\frac{weight(kg)}{cm^2}$.

By introducing this variable, we initially assumed that MC could have an impact on BMI and *vice versa*. Our intuition was that there was a positive linear relationship between MC and BMI. In other words, the higher the MC is, the higher the BMI could be. Based on 13,602 American adults, Wang and Beydoun, 2009 confirmed our intuition by looking at the associations between MC and the prevalence of obesity. They found a positive association between MC and BMI. Indeed, the 20% of individuals who consume the most meat are 27% more likely to be obese than the 20% of individuals who consume the least meat.

On the other hand, we are aware of the ambiguous relationship between these BMIs and MC and we therefore considered a possible simultaneity bias[3]. In our case, this translates as follows: BMI could affect MC in the same way that MC could also affect BMI. Therefore, we introduced so-called instrumental variables to identify and estimate this causal link. In order to determine our instrumental variables, we relied on existing work. Danielzik et al.,

[2]Insee, *Effectifs d'élèves et d'étudiants*, 2021

[3]Le biais de simultanéité correspond aux situations où certaines variables explicatives sont déterminées en même temps que la variable à expliquer.

2004 argue that family SE status may have an impact on children's BMI. Also, a regular physical activity could play a role on BMI, however, this appears to be moderate (Cairney and Veldhuizen, 2017)

3.3.3 University restaurant

In our opinion, talking about the University's Restaurant (UR) is essential if we want to study the student's MC. Indeed, UR is the place dedicated to the students' catering. Even more popular since the implementation of the 1 euro meal for scholarship holders, we think that the UR frequentation is a relevant variable for our model. To obtain this data, we asked students how often they ate at the UR per week. Following the first feedback we had, we also included the university cafeteria in order to reach as many people as possible. Even before studying the data, we believe that the more a person eats at the UR, the more likely he/she is to eat meat. This assumption is based primarily on two points. First, an individual is more likely to eat a meatless meal if offered several alternatives. Second, when a student is in line to choose a meal, he/she will potentially be influenced by the choices of his/her peers. If they are eating with friends who choose a vegetarian meal, they are more likely to choose one as well. In addition, vegetarian meals require more preparation time than a simple cooking of meat (preparation of different vegetables, as well as different alternatives to compensate for the lack of meat, etc.). In other words, it is easier for a student to eat a vegetarian meal at the URsince he/she does not waste time preparing it, unlike at home. It is obvious that there is no literature dealing with queues in France's UR. Nevertheless, Sparkman and Walton, 2017 tried to measure the impact of social norms on MC. The results of this study showed that individuals exposed to dynamic norms tended to reduce their MC. Thus, we would expect to see a negative correlation between frequency of UR and MC.

3.3.4 Scholarship

Since our study focuses on students, it is not obvious to incorporate a variable related to income. Indeed, while the proportion of students with jobs is increasing, they remain a minority[4]. Nevertheless, we believe that incorporating information on income is necessary since we are trying to explain the consumption of a specific good. This is why we asked survey participants whether or not they were on a scholarship. For those on scholarship, we also ask them the level of the scholarship (echelon). This variable can be interesting since it defines

[4]Dares, *Les activités rémunérées des étudiants : quelles formes et quelle organisation ?*, 2017

both the student's income and indirectly the parents' income. However, this variable has some weaknesses. In fact, it is not because a student does not receive a scholarship that his or her parents are necessarily wealthy. Therefore, we can observe situations where scholarship students have a higher disposable income than non-scholarship students. Unfortunately, it is difficult to correct this default, which is why we will remain cautious in the interpretation of our results. In the current inflationary context, we believe that income may have an impact on MC. Indeed, a student with a low income might tend to reduce his MC to pay for housing, transportation or leisure activities. However, the data seem to indicate that in France MC is negatively correlated with income. On average, those belonging to the working class tend to consume more meat, and on the contrary, those belonging to the upper class consume less meat[5]. We note that for the other socio-professional categories, MC is located between the two extremes and is relatively close. According to the research literature, MC does not depend exclusively on income, and seems to be much more multifactorial. We will analyze in more detail the impact of income on the level of MC (within our data sample) later on.

3.3.5 Socioeconomic environment

The purpose of this is variable is to define the context of the individual's socio-economic (SE) environment. With these three variables, we seek to understand if the fact of having vegetarian parents and/or friends as well as the type of habitat in which the individual lives/evolves influences his personal convictions and therefore his MC. We believe that the SE environment in which the student grew up has a potential influence on his consumption. In this environment, parental and friendship connections can have a strong impact on the individual's beliefs and ideologies (which tend to evolve over time). In other words, we believe that the more the student is surrounded by relatives who follow a vegetarian diet, the more likely he or she is to be influenced and to become one (or to reduce consumption).

Parental and social ties are strong links, where individuals share a mutual affection, identify, recognize and influence each other. The human being is a social being, who builds himself from a very young age by imitating his close environment in every aspect. These hypotheses seem to be relevant according to the literature. Indeed, Norem-Hebeisen et al., 1984 have demonstrated that the number of friends using drugs is the most determining factor in the consumption of the individual. We can also refer to the theory of Bronfenbrenner, who in his ecological model of human development, identifies parents, friends and peer groups as part

[5]Crédoc, *Consommation et mode de vie*, Septembre 2018

of the so-called "immediate" environment of the individual, what he calls the "microsystem" (Absil et al., 2012). These have a very important role in the construction of an individual's thoughts, thus assuming that the close circle (including friends and relatives) strongly influences ideology and beliefs. Furthermore, Kenward, 2012 demonstrates that children reproduce their parents' actions from an early age in order to improve themselves. According to him *children do what adults do, and they think it is the right thing to do.* This mechanism of imitation allows the human being to follow the norm, and is part of natural learning. We can also point out that this mechanism follows us throughout our lives.

We took the liberty of a fiction parenthesis, with a quotation of Michel Tournier : *Autrui, pièce maîtresse de mon univers* in his book *Vendredi ou les limbes du Pacifique.* It also says that *man is an exclusively social being, his way of being is totally determined by his relations with others.* Those ideas suggest that man exists only because he communicates and has internalized social rules with others. We will end this literature review with Merlino et al., 2017 showing that households without children have higher weekly MC habits than those with children. In this same study, it was observed that households with children have a diet characterized by a greater variety of protein sources. To summarize, we believe that the environment (friends, relatives) as well as the habitat of an individual has a strong and significant impact on the level of MC.

3.3.6 Environmental concerns

The term *environmental concerns* reflects the intensity of an individual's concern about the current environmental situation. Our initial intuition was the existence of a negative relationship between the level of environmental commitment of an individual and his MC. In other words, the greater an individual's environmental commitment, the lower his level of MC. We also hypothesized that the most committed individuals would have on average more knowledge about the environment and pollution related to MC than the least committed individuals.

However, we have some doubts about the ability of each individual to reduce his or her consumption. It is possible that some individuals are concerned about the environment but do not take the "step" of eating without meat. They may also be more involved in other ways (reduction of water consumption, waste sorting, public transportation, etc.). Existing studies have confirmed our initial intuition. Indeed, the more an individual consumes meat,

the less he perceives the environmental benefits of not eating it (Tobler et al., 2011). Knowledge related to the impact of MC on the environment is relatively low, around 30% (Garnett et al., 2015).

The environmental awareness of individuals is determined by many factors and the introduction of this variable in our model may induce endogeneity. Therefore, we have introduced instrumental variables to estimate this bias. Education would be a significant component in environmental involvement. More educated people are generally more concerned about the environment (Arcury and Christianson, 1993);(Chanda, 1999) although one study found the opposite (Grendstad and Wollebaek, 1998). The field of study also appears to be influential. Students enrolled in a university environmental education (EE) program have significantly greater verbal and actual environmental knowledge engagement than similar students not enrolled in (Gifford et al., 1982). Age could also impact environmental engagement. Most research shows that younger people report being more environmentally conscious than older people, at least for the general environment (Arcury and Christianson, 1993). On the other hand, it is of interest to know whether people living in rural areas are more involved in the environment than their urban counterparts. Research in many countries has yielded conflicting results. In China, people living in large cities were more likely to engage in pro-environmental behavior activities than people living in smaller cities (Chen et al., 2011). Urban Germans reported greater verbal engagement with the environment than rural people (Bogner and Wiseman, 1997). However, UK students who grew up in rural areas report more positive and natural environment-oriented outcomes than students raised in urban areas (Hinds and Sparks, 2008).

3.3.7 Food and Health behaviors

The term *Food and Health behaviors* (FHB) refers to the level of attention individuals pay to their diet and the knowledge associated with it. We believe that this variable is important because, as previously explained, excessive MC can be detrimental to health. In doing so, we examined the prevalence of fast food consumption and knowledge about diet and the impact of meat consumption on health. Our initial hypothesis was the existence of a negative relationship between an individual's health involvement and MC. In other words, the more attention an individual pays to their diet, the less meat they consume.

Arnaudova et al., 2022 confirmed our initial intuition. Based on 500 individuals, they ana-

lyzed the results of a survey on MC. From these answers, several groups with different levels of consumption and knowledge emerged. The researchers identified a group called *curious consumers*, interested in changing their diet, but whose convictions were not fully formed. A second group is called *passive consumers* who consume meat regularly and have a positive perception of meat consumption on health. The penultimate group represents the informed consumers, who are aware of the impact of meat on their health, and more particularly of the benefits of a vegetarian diet. Their meat consumption is light and they are considering a complete change of diet. Finally, the last group, the *active consumers* are mostly flexitarians trying to reduce completely or have already completely reduced their meat consumption. Their attitude towards MC is completely defined and strongly influenced by health and environmental arguments.

As with environmental involvement, we may face the problem of endogeneity. To estimate this bias, we will use instrumental variables such as the practice of regular physical activity or the level of education. Indeed, the health benefits of physical activity are now well documented and demonstrated. Regular physical activity and sport, even of moderate intensity, reduces mortality, increases quality of life and improves mental health (Aquatias et al., 2008). Educational level has an influence on the health of individuals. It has been observed that the higher the level of education, the higher the life expectancy, the lower the smoking and the lower the risk of being obese[6]. As with EC, we believe that the study area can be correlated with FHB. Indeed, we can think that people studying health may have more tools to monitor their health. Therefore, field of study is also one of our instruments.

3.3.8 Animal welfare concerns

The qualification *animal welfare concerns* (AWC) reflects the attention that individuals pay to the impact of the meat industry on animal welfare. Respondents were asked to give their opinion on hunting, factory farming and the use of animals for scientific purposes. The initial idea was that the degree of involvement in the animal cause could induce MC i.e. the more involved a person is, the less meat he/she will consume. We had the intuition that at least two groups would emerge. The first group would not be particularly concerned about animal welfare and therefore consumed meat without moderation. Then, a second group, more committed and informed about this cause, would consume little or no meat because they care about the impact of the animal.

[6]OECD, Regards sur l'éducation, 2013

In 2018 on the basis of reports and other publications of the European Commission, a literature review, as well as field research conducted among Polish consumers, using an interview questionnaire, Gołębiewska et al., 2018 demonstrated that there are correlations between the respondent's level of education, place of residence and income and their decision to purchase meat from farms that care and protect animal welfare. However, it's interesting to note that no correlation was found between the age of the respondents and their decision to purchase meat from that type of ethic farms. The results also show that less than 50% of Polish society is aware of the concept of animal welfare. The main decision criteria for purchasing meat and meat products are price and ease of preparation. In addition, De Backer and Hudders, 2015 conducted a survey of 300 people to explore the relationship between morality and diet choice. Survey results show that animal health concerns - as measured by the Animal Attitude Scale - can predict diet choice. Vegetarians are the most concerned, while full-time meat eaters are the least concerned, and the contrast between flexitarians and vegetarians is greater than the contrast between flexitarians and full-time meat eaters.

As we discussed earlier, gender might be one of the variables that could have an impact on the AWC. Moreover, as we specified in 2.3 , tight connections can be made between EC and AWC. That is why we introduce instrumental variables in order to face those biases. We found it relevant to ask participants if they had one or several animals when they were children. The idea behind this instrument is to assume that if an individual had an animal when he or she was a child, he or she would be more concerned about animal welfare. We believe that the studies can be an instrument to help correct a potential endogeneity of AWC. Indeed, it might be expected that a more educated person would be better informed about the impact of MC on AWC and would therefore tend to be more sensitive to AWC. As for the field of study, we can make the assumption that people studying in fields like philosophy or biology could be more sensitive to the various forms of animal suffering.

Chapter 4

Statistical analysis

4.1 Survey

4.1.1 Methods

To conduct our study, we decided to set up a survey that we distributed to students at the University of Nantes (Appendix). We believe that surveys are the most efficient way to obtain relevant data on a student population. Moreover, it is entirely customizable, which allows us to target certain behaviors or characteristics. In this survey, apart from environmental awareness, Food and Health behaviors and animal welfare concerns, each variable had its own question. The question of environmental awareness is addressed through the questions (e1, e2, e2_bis, e3, e4, e5). The respondents were asked to give their opinion on the state of the planet, the introduction of a carbon pass and the impact of individual behavior on the environment. Involvement in the animal cause is addressed through questions (a1, a2, a3, a4). Respondents were asked to give their opinion on hunting, intensive farming and the use of animals for scientific purposes. Health implications are addressed through questions (s1, s2, s3, s4, s5). The frequency of fast food consumption, knowledge of diet and the impact of MC on health were examined. For each of these questions, we use the Likert scale. This scale is made of 5 levels which are : *Tout à fait d'accord*, *Plutôt d'accord*, *Plutôt pas d'accord*, *Ne sais pas / Ne se prononce pas* et *Pas du tout d'accord*. This allows us to categorize the students' opinions. At both ends of the scale, we might find very convinced individuals who would not be likely to change their mind. Those who answer *Je ne sais pas* might be people with neutral opinions on the subject. The others could be students with slight preferences but who could be convinced by a good argument. However, these

assumptions are only theoretical and may not be observed as described in our sample.

Some questions - not model variables' related - were introduced as control variables. We refer to the instrumental variables mentioned earlier. Additional questions (15) were added to enhance the analysis. The survey was online for a week and received 100 responses. Once the data were collected, we proceeded to a review of the database to see if there were any anomalies. We found two *troll*[1] individuals who were de facto removed. ,

4.1.2 Reallocation of variables' modalities

Except for binary and quantitative variables, we had to re-assign some of the students' responses in order to make it more exploitable for us. Indeed, some modalities did not have enough answers, that's why we sometimes had to group some of them together, otherwise, the data would have been unusable afterwards For instance, we had to group some *Totalement d'accord* with *Plutôt d'accord* or some *Plutôt pas d'accord* with *Pas du tout d'accord*. For some cases, we had to look into students' previous responses in order to reallocate appropriately responses. All the details will be in the R code provided with this work.

[1]Someone who leaves an intentionally annoying or offensive message on the internet (Cambridge Dict.)

4.2 Descriptive analysis

4.2.1 Qualitative analysis

Table 4.1: Descriptive analysis of our students' caracteristics

		Scholarship	
Variables	**Headcount**	*None*	*Yes*
		Headcount	
Scholarship			
None	75%	100%	0%
Yes	25%	0%	100%
Gender			
Female	57%	77%	23%
Male	43%	74%	26%
UR			
0	36%	42 %	17%
1	11%	12%	8%
2	0%	9%	8 %
3	10%	12%	4%
4	24%	15%	50%
5	10%	9%	12%
Residence			
Alone	40%	82%	18%
Apartment-share	22%	64%	36%
Parents	27%	77%	23%
Other	11%	73%	27%
Vegetarians parents			
Yes	16%	62%	38%
None	84%	78%	22%
Vegetarians friends			
Yes	78%	76%	24%
None	22%	73%	27%
PCS 1			
PCS+	67%	73%	27%
Other	33%	81%	19%
PCS 2			
PCS+	50%	80%	20%
Other	50%	71%	29%

Note : Results rounded to 10^{-2}

Since our study focuses on students, we expect a relatively young population. The Table 4.3 confirms our intuition since the average age of the students interviewed is 21.7 years. Moreover, half of the population is between 21 and 22 years old. The minimum age of 18 years old probably corresponds to one or several students who were recently admitted to the University. The maximum age of 28 years would likely correspond to individuals with a longer study program in the field of health, for example. Our population is 57% female (Table 4.1). Among these women, only 23% are on scholarship. This is not surprising since only a quarter of the students surveyed are on scholarship[2]. Regarding the gender distribution by age, we note that 67% of the women are 21 years old or younger and 62% of the men are 22 years old or older. Thus, the men in our student population are slightly older on average.Our individuals are predominantly studying in three broad areas (Table 4.2). Almost half of the individuals (46.9%) surveyed are studying in the field of Economics and Management. Next, we find health, which represents the field of study of almost a fifth of the respondents. Then, we have Law and Political Science, which account for 13.3% of our respondents. The remaining fields of study account for about 20% of our sample. For a more complete analysis, we can look at the gender distribution in the different fields of study. Among the students in Economics and Management, 64% of them are men. On the other hand, in the field of Health, we find a majority of women (68%). Finally, women are the only ones represented in Law and Political Science.

Table 4.2: Students' field of study

Gender	Field of study		
	Econ. & Management	Health	Law & Politic. Sciences
	Headcount		
Female	41%	68%	100%
Male	59%	32%	0%

Note : Results rounded to 10^{-2}.

In the 3.3.3, we pointed out that the introduction of the 1 euro meal had increased the number of people attending the RU. However, we know that only a quarter of our sample can benefit from this measure. Thus, we should observe a relatively high frequentation, particularly for scholarship students. Our data confirm our intuition. Indeed, while we observe that more than 50% of students go to the UR less than twice a week, more than 60% of scholarship students go at least four times a week. If we focus on the environment in which

[2]38,4% at the national scale

the students in our survey are living, we see that nearly 40% of them live alone (Table 4.1). We can notice that 36% of the people living in shared apartments are scholarship holders. We can make the hypothesis that shared apartments are more affordable residences that would tend to attract students, especially those with scholarships. As for the students' entourage, only 16% of the respondents have at least one vegetarian parent while the vast majority (78%) have at least one vegetarian friend (Table 4.1). Finally, all the persons having at least one vegetarian parent have at least one vegetarian friend (Appendix 7.2). This may possibly mark the influence of parents on children's behaviors that we discussed in the socio-economic environment of the previous chapter.

Finally, we can look at the socio-economic background of the students. Nearly 2/3 of "Parent 1" of the students surveyed belong to a CSP+[3]. Concerning "Parent 2", we observe a perfect parity between the CSP+ and the other social categories. At the national level, we know that around 50% of working people belong to the CSP+ category (age and gender combined)[4]. We can therefore make the assumption that we are dealing with a population coming from a relatively comfortable background. This may seem logical when we look at the relatively low proportion of scholarship students in our sample. We will come back later in this chapter to the possible influence of socio-economic background on MC.

4.2.2 Quantitative analysis

Our model contains only three quantitative variables. Two of them are explanatory - URand BMI - while the third - MC - represents our variable to be explained. We have already discussed the distribution of the UR above, so we will just add that by using a boxplot, we did not find any atypical values (Appendix 7.1). The method for computing BMI has already been described in the economics section. We performed the same method based on the students' weight and height. Unfortunately, three students did not wish to answer these questions. Therefore, we will remove these individuals to perform our statistical analyses.
Since our population is young, we would expect a relatively normal BMI. This is confirmed by the data as the average BMI of our sample is 21.27. As a comparison, the average BMI of a French person is around 24[5]. This difference can be explained by the age of our population since the BMI of a person would tend to increase continuously until the age of 50 years old.

[3]A regroupment of PCS N°2,3 et 4
[4]INSEE, *Catégorie socioprofessionnel selon le sexe en 2021*
[5]Le Monde, *Les Françaises et les Français champions d'Europe de la minceur*, 2009

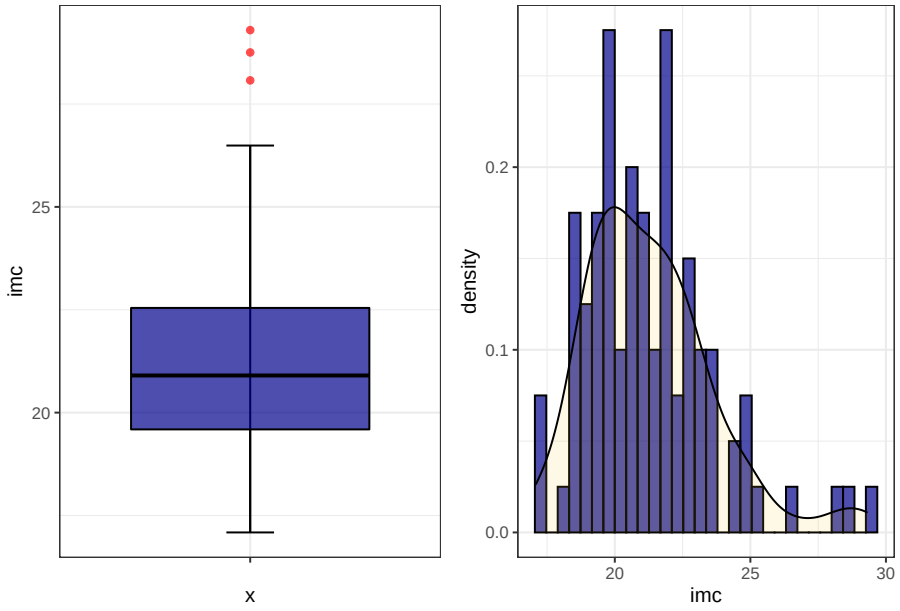
Table 4.3: Age and BMI of our individuals

Variables	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
Age	18	21	21	21.704	22	28
BMI	17.087	19.592	20.902	21.272	22.545	29.297

Note : BMI in kg and Age in years.

For the minimum value, we find an individual with a BMI of 17.09. This person could be considered - according to the WHO recommendations[6] - as being underweight since it is below 18.5. For the maximum value, we have a BMI of 29.3 which represents - according to WHO recommendations - a person in Pre-Obesity. Overall, our sample has a standard body weight since 50% of our sample has a BMI between 19.5 and 22.5.

Figure 4.1: Body Mass Index distribution : Boxplot and Histogram



The graphs in Figure 4.1 give us a better representation of what we have just said. On the left, the boxplot allows us to check if atypical values are present in the sample. We observe three points above the maximum value which means that we have potentially three atypical values in the top of the distribution. The histogram on the right allows us to have a better visualization of the individuals' distribution. It confirms what we said earlier since the

[6]WHO, *A healthy lifestyle - WHO recommendations*, 2010

skewness[7] seems to be positive.We now wish to know if the three individuals detected on the boxplot are really atypical. As there are less than ten individuals, we will use Rosner's test to verify a potential atypicality. The Rosner test (Appendix 7.3) confirms our observations since three individuals are atypical at a confidence level of 95%. These values correspond to the three individuals with the highest BMI - above 28 - in our sample. These three individuals will be removed from the sample for the remainder of the analysis. As only three individuals are atypical, the distribution of BMI remains essentially the same for the rest of the analysis (Appendix 7.1).

Now let's discuss of our illustrative variable, MC. For the entire sample, we observe that students consume meat an average of 6.5 times per week (Table 4.4). We can expect the distribution to be relatively homogeneous since the median is 7. Thus, we have half of the students surveyed who eat meat on average less than 7 times per week and the other half more than 7 times. As for the extremes, we observe that 9 people answered zero. These are people who practice a diet that excludes the consumption of meat products (vegetarians, vegans, etc...). The most extreme value is 14, which concerns only 4 people. We can probably identify these people as individuals who eat meat at every meal. As mentioned in 3.2.1, in France, on average, young people are the biggest meat consumers, they consume meat 10.6 times per week. If we compare our data to those observed nationally, we realize that our individuals consume significantly less meat. Many factors could explain this. For example, we said that MC was negatively correlated with income. And we know that our sample is composed of individuals coming from an educated background. However, there is no evidence to support this. We can also make the assumption that a certain number of individuals pull down the average by not consuming meat. The graphs that we are going to present will perhaps give us some answers.

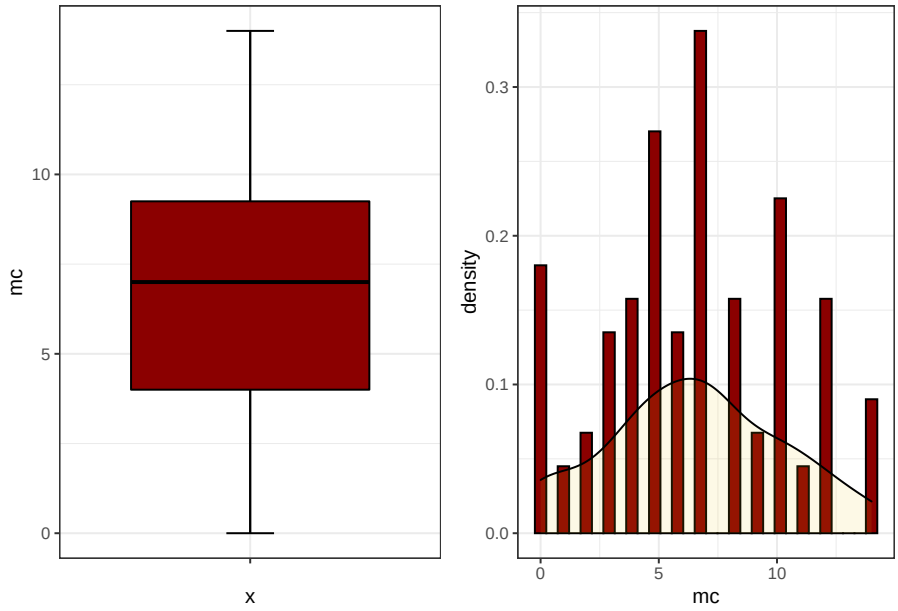
Table 4.4: Summary of meat consumption

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
0	4	7	6.522	9.250	14

As for the previous quantitative variables we will now use a boxplot to detect potential atypical values.

[7]Distribution asymmetry measurement

Figure 4.2: Meat consumption distribution : Boxplot and Histogram



The two graphs of Figure 4.2 do nothing more than to confirm the assumptions that we had formulated above. Indeed, no atypical value can be observed on the boxplot. Moreover, as we said, the distribution is rather homogeneous. We can nevertheless note that the vegetarians represent a rather important category of our sample. Around 10% of the sample do not eat meat. To take a point of comparison, on a national scale, only 2.2% of individuals declare to follow a diet excluding the consumption of meat products[8]. However, according to a CREDOC survey conducted in 4 different countries, the share of people declaring themselves as vegetarian, vegan or vegetarian increases to 12% among people aged between 18 and 24 years old[9]. In any case, the share of people not eating meat in our sample remains relatively high.

Here we are going to look into the correlation between our quantitative variables to see if they can be introduced in our model to explain MC. Since only two of our variables are quantitative, we will just have to illustrate the correlation between BMI and URparticipation.

[8]FranceAgriMer, *végétariens et flexitariens en France en 2020*, 2021
[9]FranceAgriMer, *Combien de vététariens en Europe ?*, 2018

Figure 4.3: Correlation between URand BMI

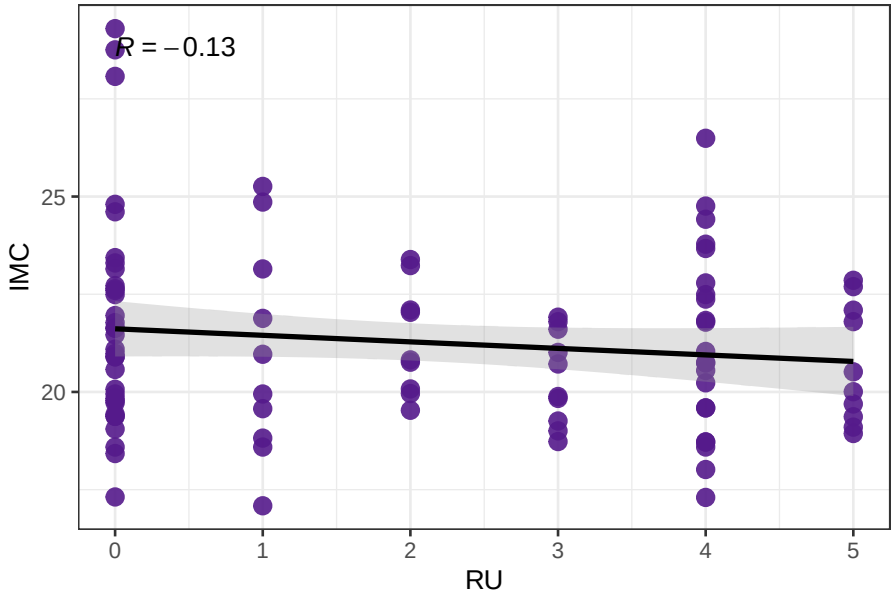


Figure 4.3 shows us the correlation between URand BMI. This graph is constructed from the Spearman correlation method (Appendix 7.4). As the graph shows us, the correlation is -0.096. Thus, there is no significant relationship between the URattendance of the students in our sample and their BMI. Therefore, we can incorporate these variables into our econometric model of the Chapter 5 .

4.2.3 Consumer typology

To complete the descriptive analysis of MC, we decided to segment MC into 4 consumer categories. Inactive consumers represent the population that does not eat meat. Occasional consumers are those who eat meat only occasionally, between 1 and 5 times a week. Then we have the regular consumers who eat meat on average 6-10 times per week, which is about once every two meals. Finally, we have the consumers who depend on the use of meat for their diet, eating between 11 and 14 times a week, at almost every meal. The Table 4.5 shows us the types of consumers according to certain social attributes of the students. To begin with, we notice that the two most extreme types of consumers - inactive and dependent - are predominantly represented by Men. If we refer to 3.3.1, this observation is more surprising for the inactive than for the dependent consumers. Regarding parents, we notice that inactive consumers are among those whose parents are the most vegetarian (38%). As far as social

Table 4.5: Consumer typology according to social characteristics

	Type of consumer			
	Inactive	*Occasional*	*Regular*	*Dependent*
Headcount	8	36	37	11
Gender				
Female	38%	61%	59%	36%
Male	63%	39%	41%	64%
Vegetarians parents				
Yes	38%	17%	16%	0%
No	63%	83%	84%	100%
Social environment				
PCS +	63%	69%	62%	82%
Other	38%	31%	38%	18%
Childhood environment				
Rural	50%	64%	51%	36%
Urban	50%	36%	49%	64%
Animals childhood				
Yes	88%	72%	76%	55%
None	13%	28%	24%	45%
Residence				
Alone	13%	28%	54%	36%
Not alone	88%	72%	46%	64%

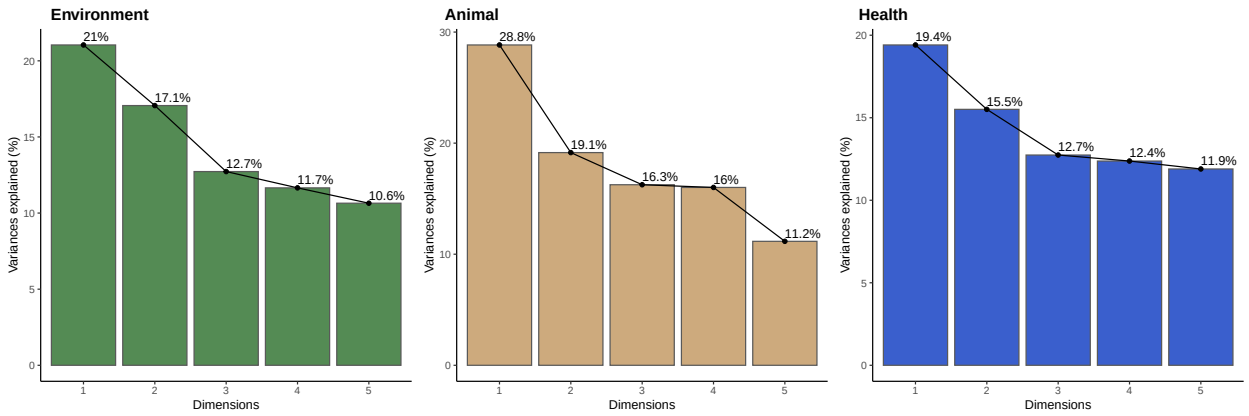
background is concerned, it is surprising to see that 82% of the parents of the dependents come from a CSP+. In fact, if we relate to 3.3.4, MC seems to be negatively correlated to income. However, our population is made up of students and there is no guarantee that every student will have the same status as their parents. Also, it should be noted that we have here considered only the Parent 1 since the Parent 2 distribution was perfectly equal (Table 4.1). For childhood environments and animals, we will simply note that in our sample, the people who consume the most meat seem to come from a rather urban environment while 88% of the people who do not eat meat had one or more animals as children. Finally, we note that almost all people who do not eat meat do not live alone (88%).

4.3 Clustering

4.3.1 Multiple correspondance analysis

To identify the different students' opinions on each of the 3 main parts of our questionnaire we will use the Multiple Correspondence Analysis (MCA) as well as a method of classification of individuals. For these two methods we will use the package called FactoMineR[10]. We can use MCA because we are dealing almost exclusively with qualitative data. The MCA allows us to identify the links between the modalities of these variables. The variables are projected in such a way that the majority of the variations are concentrated on a few axes, thus allowing us to explain the majority of the differences observed in the sample. As we have few variables, the percentages of inertia carried by the axes are sufficient. In fact, concerning axis 1 the inertia is 21%, 28.8% and 21.8% respectively for the AC, AWC and FHB (Figure 4.4). Although the percentages of inertia are of limited interest. To simplify the interpretation we will keep the first four axes that build between 60% and 70% of the inertia.

Figure 4.4: Histogram

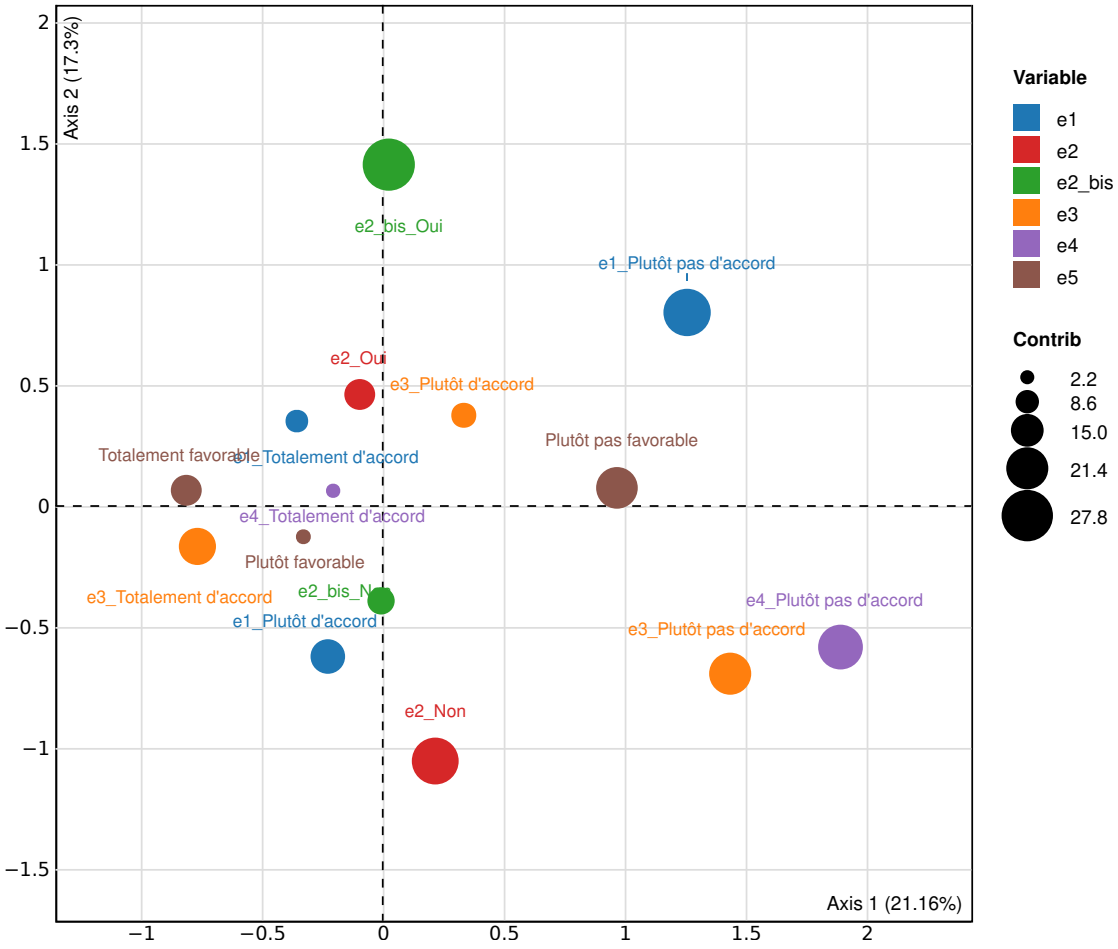


We will analyze each MCA on axes 1 and 2 and by theme (EC, AWC and FHB). As we said before, if this analysis is very succinct, it will be more developed in the clustering part. We are going to start by analyzing the MCA composed of the questions on EC. Here we reach a cumulative inertia of 38% (Figure 4.5). We can note an opposition on axis 1, with the left side of the answers attesting to a certain environmental awareness, while the more we move to the right, the more the latter diminishes or even disappears. In other words, the further

[10]https://CRAN.R-project.org/package=FactoMineR

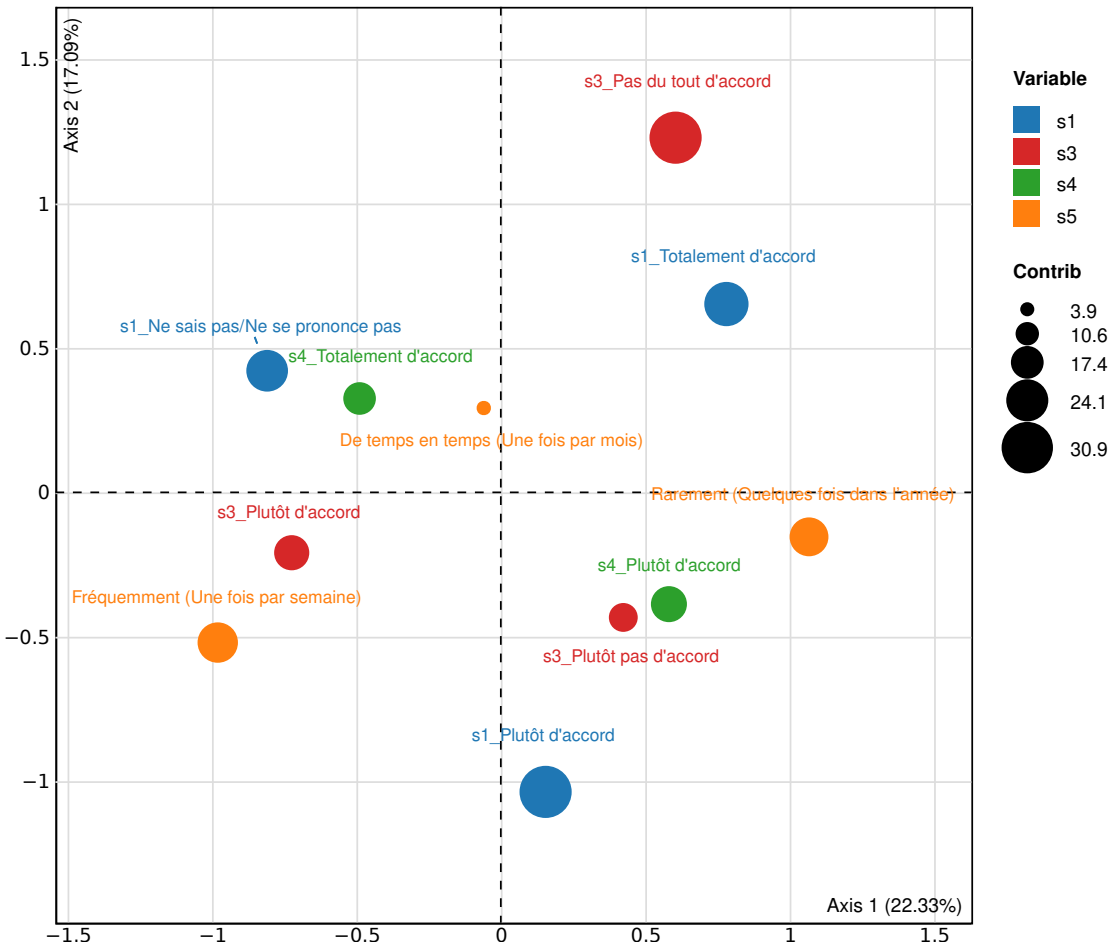
to the right we are, the more EC disappears.

Figure 4.5: Multiple Correspondence Analysis : Environmental concerns



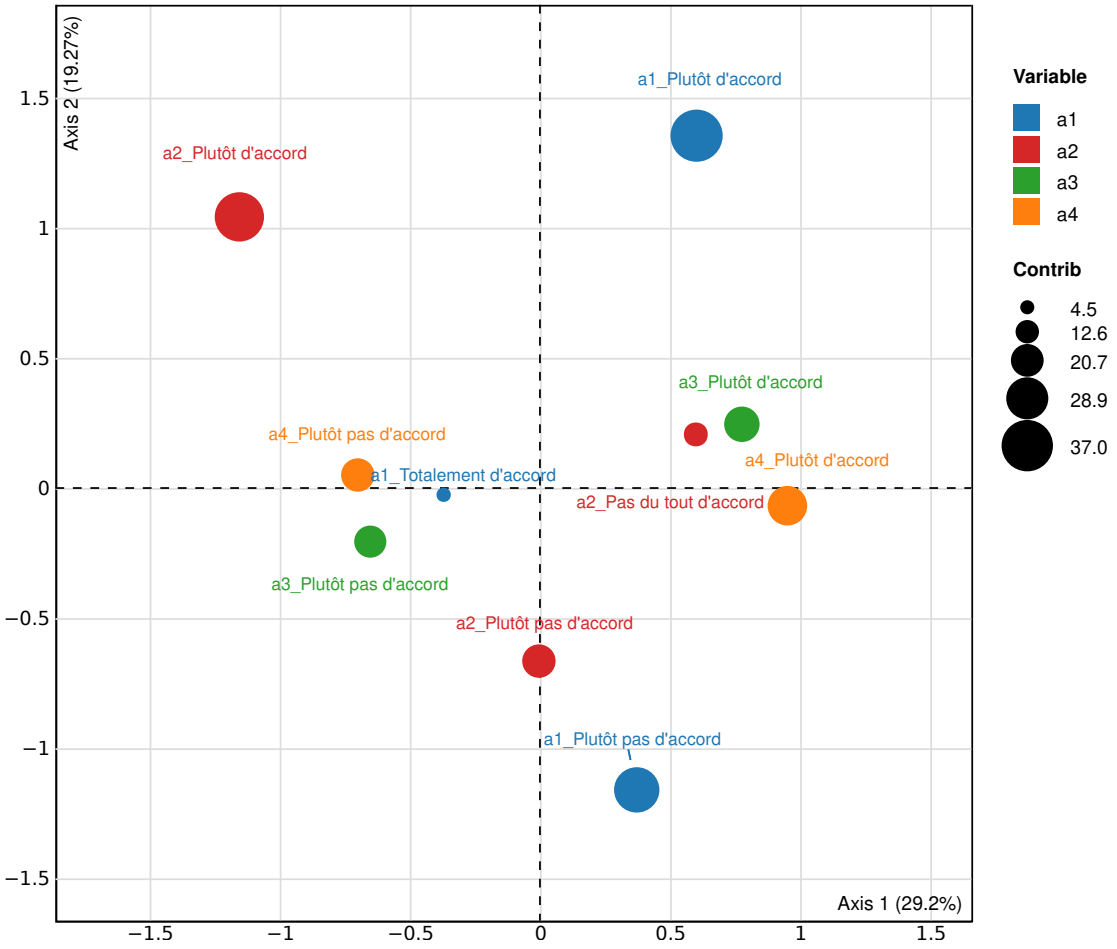
With the MCA composed of questions on FHB, we reach a cumulative inertia of 39% (Figure 4.6). Once again, the same mechanics seem to operate with the only difference that here it is in the opposite direction compared to the two previous cases. Indeed, the further to the left we are, the more we ignore the impact of the level of MC on health, and on the contrary, the further to the right we are, the more we are aware of it. We would like to precise that, when we are talking about the impact of MC on health, we refer to both negative and positive effects.

Figure 4.6: Multiple Correspondence Analysis : Dietary health concerns



For the MCA composed of questions on AWC, we reach a cumulative inertia of 48% (Figure 4.7). The same mechanism seems to operate here since the more one moves to the left the more the will to defend the well-being seems important, and the more we moves to the right the more it decreases or even becomes non-existent.

Figure 4.7: Multiple Correspondence Analysis : Animal welfare concerns

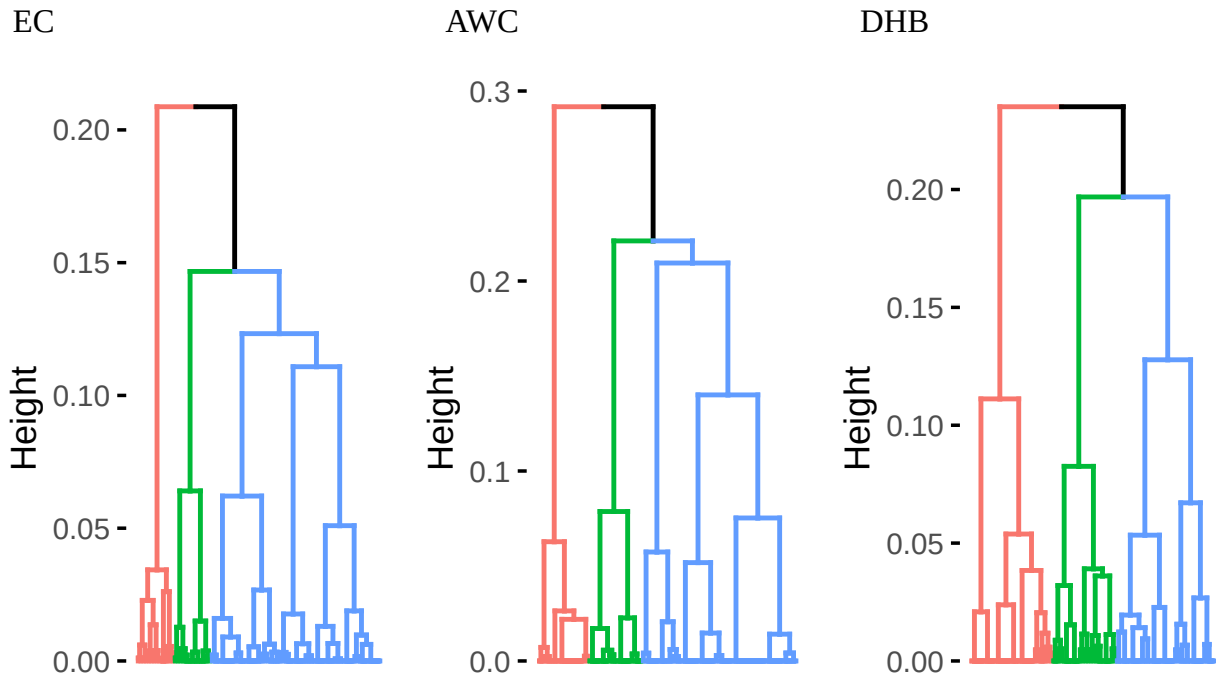


4.3.2 Dendrogram

In order to identify the different groups of students' opinions on the three themes of our questionnaire, we will use a method of hierarchical ascending classification (HAC). This statistical technique allows us to partition a population into different classes. To visualize and better understand the formation of classes, the hierarchical tree, or dendrogram, is an effective visual tool. The dendrogram resulting from this classification is represented on the Figure 4.8. Each class in the dendrogram represents a group of similar individuals, their similarity being established according to Ward's criterion. The objective is to make sure that the individuals grouped in the same class are the most similar as possible while the

individuals between classes are the most different as possible. As said before, we will perform this classification using the Euclidean distance and Ward's aggregation criterion (inertia). A dendrogram is considered to be of good quality when the individuals of the same class are close - people of the same group are similar, the intra-class inertia is low - and when the individuals of different class are different (between groups, student's opinions are not the same, inter-class inertia is high). The different classes are distinguished by a color code and by the height of the branches of the tree. In fact, classes aligned on the same height are similar while those of different heights are not. These dendrograms are respectively separated in 3,4,4 which suggests the use of the same number of classes. It can be seen that the red class appears to be different from the others for our three trees, since it is much higher.

Figure 4.8: Dendogram of our clusters



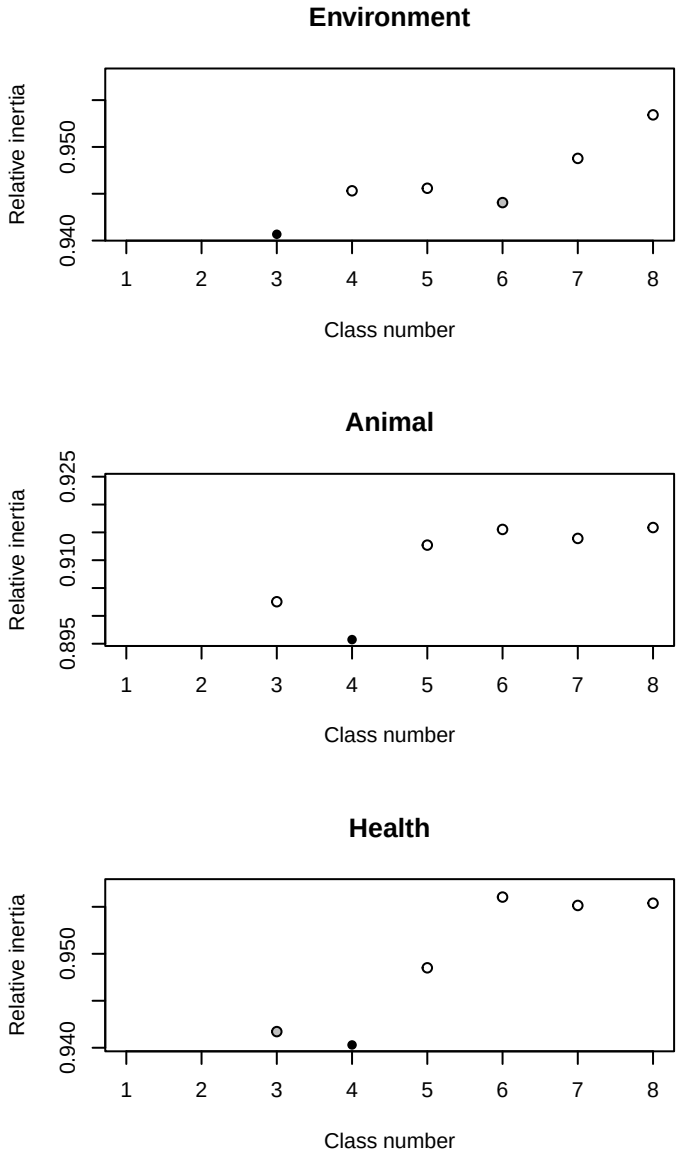
The Rpackage called *Jlutis*[11] computes the best partition to cut a hierarchical tree according to the relative inertia loss or (intraclass inertia gain[12]) criterion. The Figure 4.8 presents, according to the ward criterion, the best partition of the classes on the 3 main themes.

[11] http://larmarange.github.io/JLutils/

[12] This is the sum of the Euclidean distances between each point associated with the cluster and the newly calculated center of gravity

According to the dendrogram it appears that the optimal number of classes is 3 for EC and 4 for AWC and FHB. Nevertheless for AWC and FHB, the choice of 4 classes is questionable. The difference in intraclass inertia gain between 3 and 4 classes is very small (Figure 4.9). By analyzing the different cluster responses and in order to facilitate the interpretation of the econometric section, we considered it more appropriate to choose 3 clusters for each theme.

Figure 4.9: Intraclass inertia of our clusters



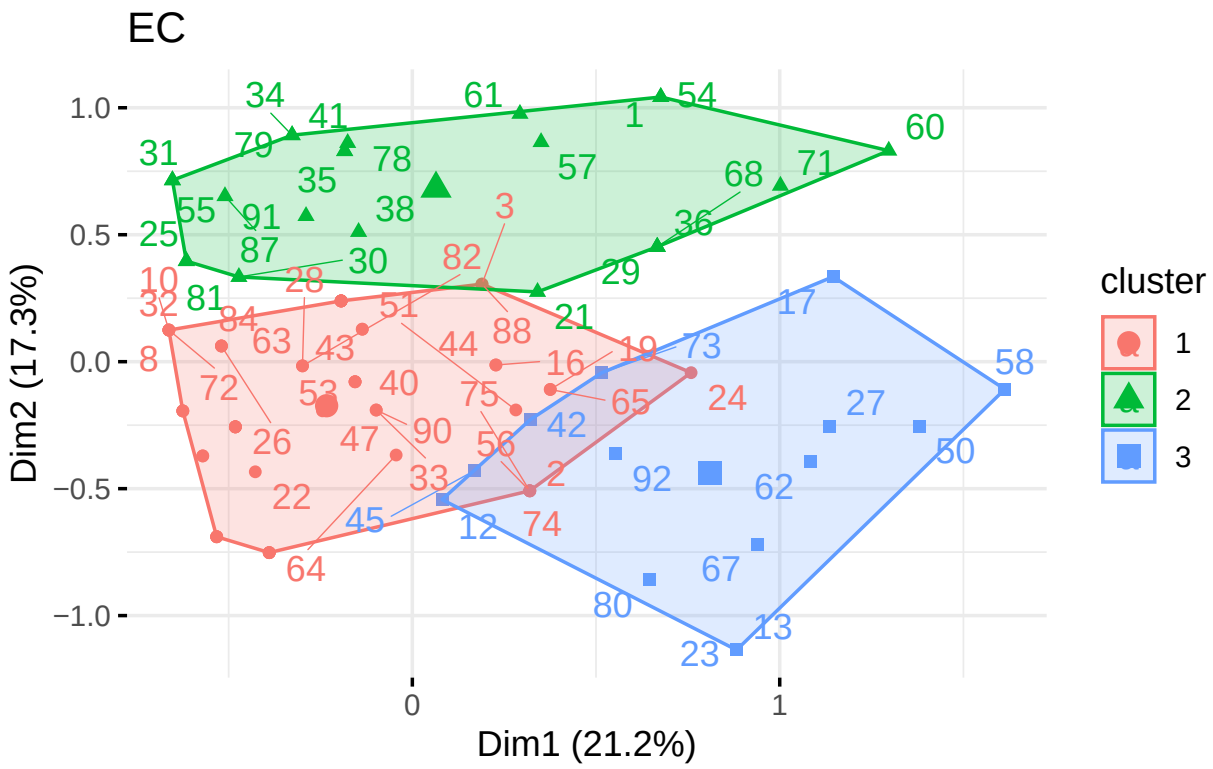
4.4 Cluster's definition

We will analyze the clusters on axes 1 and 2 for each theme. The full set of clusters on axes 1-2, 2-3 and 3-4 are available in the Appendix 7.5 and 7.6.

4.4.1 Environmental concerns

We will start with the cluster on the theme of EC (Figure 4.10). We have 3 distinct clusters, thanks to the previous projections of the AMC we know that the more an individual is projected to the right, the more he consumes meat and does not feel concerned by the impact of MC on the environment.

Figure 4.10: Environmental concerns clusters



First, we will use question E3 : *Que pensez-vous de cette affirmation : "La planète est dans un état dramatique"*. This question seems to be the one that drastically separates the students' opinions. We immediately notice that 79% of the individuals in cluster 3 do not agree with this statement, which may lead us to believe that cluster 3 comprises a majority

of individuals who are not particularly concerned about the environment (Table 4.6). In cluster 3 : 64% of the individuals do not agree with the introduction of a carbon passport, 57% of them think that states are doing enough to mitigate the effects of climate change, 50% of them are not familiar with the notion of carbon footprint and 93% of those who are familiar with it have never calculated their own. However, we can note that 79% of them think that individual behaviors can have a significant impact on the fight against climate change. Based on all these responses, those in cluster 3 will be considered *skeptical*. Indeed, these individuals do not seem particularly concerned and informed about climate change, although some of them seem to think they have a role to play.

On the other hand, a rather radical change of vision in cluster 2 : 96% of the individuals think that the planet is in a dramatic state, 52% think that they have a role to play in the fight against climate change, all of them are familiar with the notion of carbon footprint, among them 83% have calculated theirs (Table 4.6). Moreover, all of them think that governments are not doing enough and finally, 61% of them are in favor of setting up a carbon passport. We have therefore in the cluster 2 individuals who are very concerned about the environment and very knowledgeable on this subject. It is for these reasons that we consider these students as *committed* for EC.

This leaves cluster 1, composed of the majority of individuals, since it represents around 60% of our sample. In this cluster, all of the students think that the planet is in a dramatic state and that states are not doing enough, 95% think that they have a role to play in the fight against climate change, 73% are in favor of the introduction of a carbon passport (Table 4.6). On the other hand, only 62% are familiar with the notion of carbon footprint, and none of them, have never calculated it. In this last cluster, we have individuals who seem to be involved in the environmental cause but do not seem as well informed as cluster 2. We therefore decide to call students in this cluster *aware* of EC. We can notice that contrary to the previous cluster where only 52% of the individuals think that individual behaviors can have a significant impact on the fight against climate change, here 95% agree. We might think that maybe the individuals of cluster 2, better informed, are less disillusioned about their impact as individuals, although necessary, they might think that it will remain insufficient to fight against climate change.

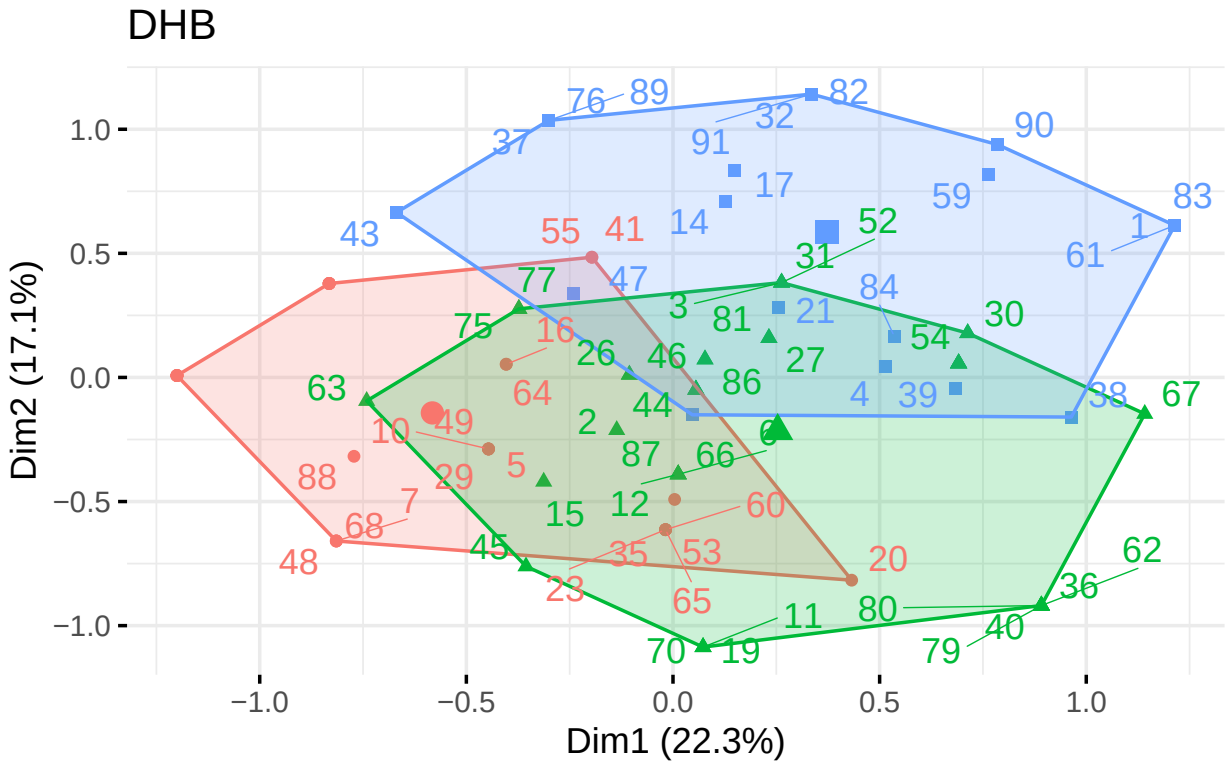
Table 4.6: Students' responses in relation to their clusters : Environmental concerns

	Environmental Concerns		
	Commited	*Aware*	*Skeptical*
Headcount	23	**55**	14
Comportements individuels			
Plutôt d'accord	22%	**53%**	50%
Plutôt pas d'accord	**48%**	5%	21%
Totalement d'accord	30%	**42%**	29%
Empreinte carbone			
Non	0%	38%	**50%**
Oui	**100%**	62%	50%
Calcul empreinte carbone			
Non	17%	**100%**	93%
Oui	**83%**	0%	7%
Planète dans un état dramatique			
Plutôt d'accord	**57%**	44%	21%
Plutôt pas d'accord	4%	0%	**79%**
Totalement d'accord	39%	**56%**	0%
Etats n'agissent pas suffisamment			
Plutôt pas d'accord	4%	0%	**57%**
Totalement d'accord	96%	**100%**	43%
Passeport carbone			
Plutôt favorable	26%	**44%**	21%
Plutôt pas favorable	39%	27%	**64%**
Totalement favorable	**35%**	29%	14%

4.4.2 Food and Health behaviors

We now move on to the second cluster, regarding the responses on FHB.

Figure 4.11: Food and Health behaviors clusters



We can start with the question concerning the frequency with which individuals go to fast food, which seems to be the one that divides our sample the most. We can see that 93% of the individuals in cluster 1 consume fast food at least once a month, moreover all of them think that it is necessary to eat meat to stay healthy and finally, half of them (48%) of them do not want to answer the question regarding the link between the consumption of red meat and the risk of developing cardiovascular diseases (Table 4.7). From the responses, it seems that the individuals in this cluster are less concerned about their health or simply do not seem to see a link between the impact of the level of meat consumption and health. We will call them *skeptical* regarding FHB.

Let's move on to cluster 2. In this cluster, we see that 74% of the individuals who compose it consume fast food at least once a month, which is a lower percentage than in cluster 1 (Table 4.7). Moreover, 74% think that there is a link between the consumption of red meat and the risk of developing cardiovascular diseases (against 41% for cluster 1) and finally 92% do not agree with the fact that they have to eat meat to stay healthy. This cluster seems to be composed of individuals who are *aware* of the link between the level of meat consumption

and health. Nevertheless, this group seems not to pay much attention to the fact that they frequently eat fast food.

Concerning the last cluster, only 54% of them eat fast food at least once a month, 63% think that there is a link between MC and the development of cardiovascular diseases and finally 86% do not agree at all with the fact that one should consume meat if he/she wants to remain in good health - against 92% of *Plutôt pas d'accord* for the previous cluster - (Table 4.7). In other words, this last cluster seems to be composed of individuals who are aware of the impact of meat consumption on health (in the same way as cluster n°2) except that this time the individuals seem to be much more *committed* than the previous cluster.

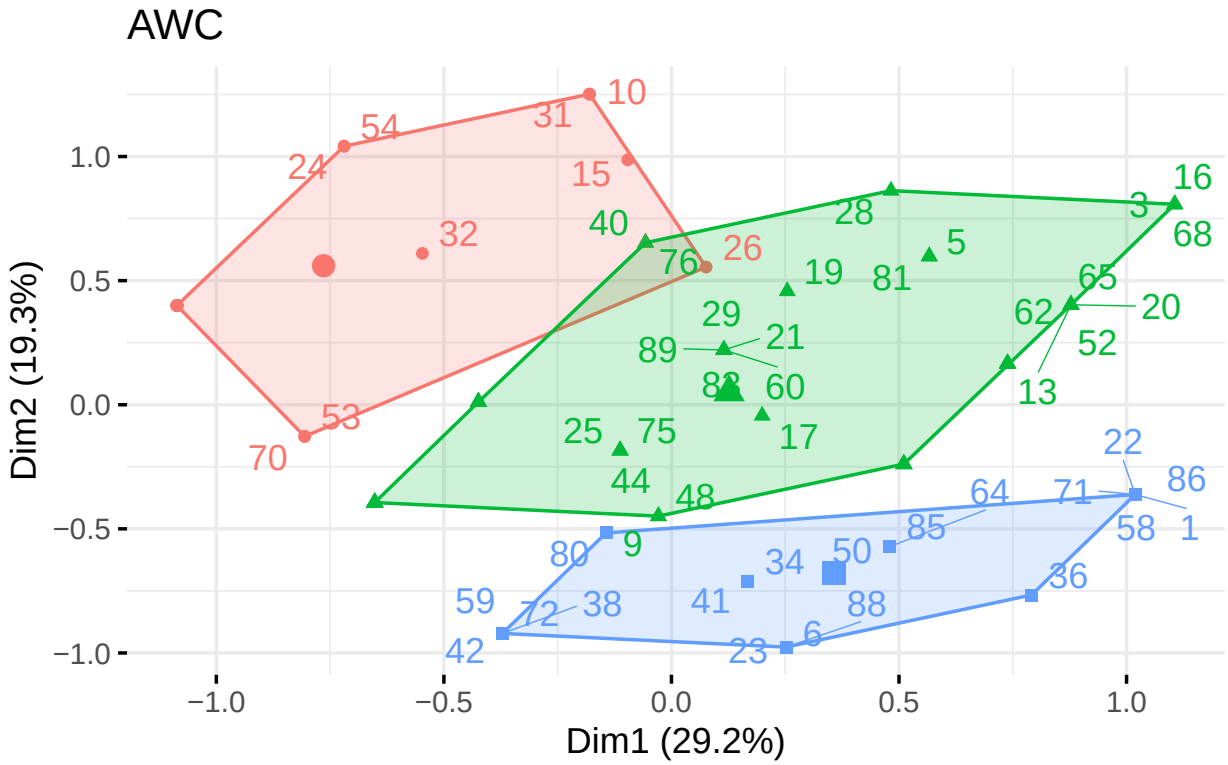
Table 4.7: Students' responses in relation to their clusters : Food and Health behaviors

	Food and Health behaviors		
	Commited	*Aware*	*Skeptical*
Headcount	22	**39**	31
Maladies cardio-vasculaire			
Ne sais pas/Ne se prononce pas	36%	26%	**48%**
Plutôt d'accord	18%	33%	**45%**
Totalement d'accord	**45%**	41%	6%
Attention à diversifier mon alimentation			
Plutôt d'accord	23%	**36%**	35%
Totalement d'accord	**77%**	64%	65%
Manger de la viande pour être en bonne santé			
Pas du tout d'accord	**86%**	0%	0%
Plutôt d'accord	14%	8%	**100%**
Plutôt pas d'accord	0%	**92%**	0%
Attention à la qualité des produits que j'achète			
Plutôt d'accord	50%	**56%**	29%
Totalement d'accord	50%	44%	**71%**
Fréquence Fast-Food			
De temps en temps (Une fois par mois)	45%	51%	**61%**
Fréquemment (Une fois par semaine)	9%	23%	**32%**
Rarement (Quelques fois dans l'année)	**45%**	26%	6%

4.4.3 Animal welfare concerns

We may end with the questions regarding AWC.

Figure 4.12: Animal welfare concerns clusters



We can start by analyzing the answers to question A2 : *Êtes-vous d'accord avec cette affirmation: "Il faut interdire toutes formes de chasses et pêches."* which seems to be the one that best divides our sample. We notice that in cluster 1, all of the students agree with this statement, 89% of them agree with the use of cameras in slaughterhouses, 78% disagree with the use of scientific experiments on animals, and 89% of them think that industrial breeding is not necessary (Table 4.8). Based on these responses, we can assume that cluster 1 is composed of individuals who are concerned and aware of the negative impact of the meat industry on animal welfare. We will call these individuals committed.

We will see that in the following clusters the answers are quite different, especially regarding the question on hunting and fishing. Indeed, 100% of the individuals in cluster 2 do not agree with the banning of all forms of hunting and fishing. On the other hand, 100% of them agree with the installation of cameras in slaughterhouses, 55% agree with scientific experiments on animals, and finally, 55% think that industrial breeding is not necessary (Table 4.8). This cluster seems to be more divided, since individuals seem to be partly concerned by animal welfare, but in a more passive way than individuals in cluster 1. We will therefore call the

individuals in cluster 2 *aware* by the AWC.

Concerning the last cluster, it seems to be opposed to cluster 1 in the answers. Indeed, all of them are against the banning of hunting and fishing and the installation of cameras in slaughterhouses. Less than a half (42%) are agree with scientific experiments, and 63% think that industrial breeding is necessary (Table 4.8). In other words, this group seems to be composed of individuals who are much less concerned about animal welfare. Similarly to the previous themes, we will consider them as *skeptical* to AWC.

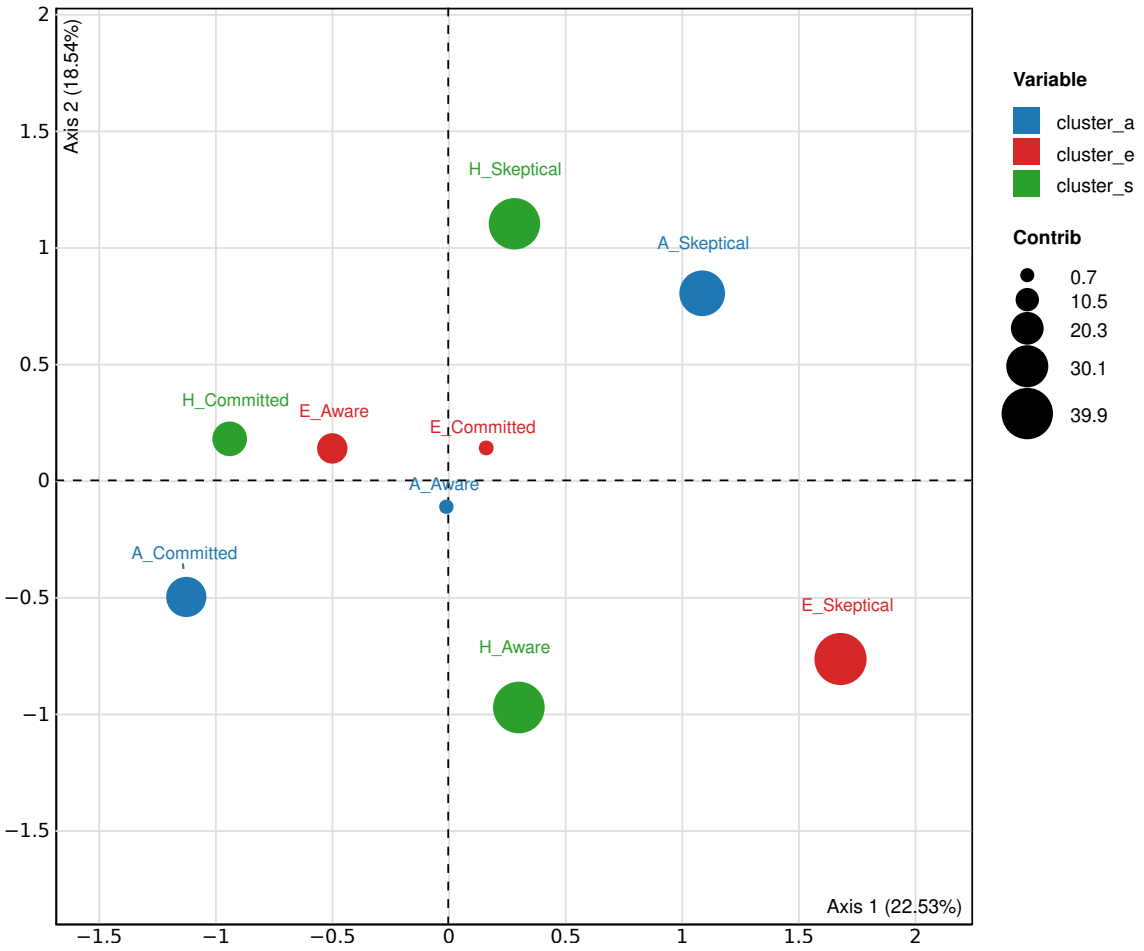
Table 4.8: Students' responses in relation to their clusters : Animal wefare concerns

	Animals Welfare Concerns		
	Commited	*Aware*	*Skeptical*
Headcount	18	**55**	19
Caméras de surveillance dans les abattoirs			
Plutôt d'accord	**28%**	25%	0%
Plutôt pas d'accord	11%	0%	**100%**
Totalement d'accord	61%	**75%**	0%
Interdire toutes formes de chasses et pêches			
Pas du tout d'accord	0%	**47%**	**47%**
Plutôt d'accord	**100%**	0%	0%
Plutôt pas d'accord	0%	**53%**	**53%**
Animaux utilisés à des fins scientifiques			
Plutôt d'accord	22%	**55%**	42%
Plutôt pas d'accord	**78%**	45%	58%
Élevage industriel est nécessaire			
Plutôt d'accord	11%	45%	**63%**
Plutôt pas d'accord	**89%**	55%	37%

4.4.4 Principal components analysis on our clusters

As an illustration we wanted to use our newly created clusters to perform an ACM (Figure 4.13. Once again, we find an opposition along axis 1. On the right side we find our skeptical individuals, in the middle and slightly overflowing on the left and right sides, our aware individuals and finally on the left side the committed individuals. This opposition follows our reasoning from our ACM part earlier in this report.

Figure 4.13: Multiple Correspondence Analysis : Clusters



4.4.5 Clusters' typology

As we did in above, we will now look at consumer typology. This time, we will use our cluster to see how students' involvement in EC, FHB and AWC can influence MC. We can see that 63% of inactive consumers are committed to EC (Table 4.9). In addition to this, we observe that 73% of dependent consumers are aware of the environmental externalities of MCs. This may indicate some form of myopia on the part of these students regarding MCs. Indeed, it is possible that these students feel concerned about the environmental cause but not enough to be aware of the externalities of MC. In addition, no inactive consumer is skeptical to EC. This observation confirms both our assumptions and scientific literature.

Table 4.9: Consumer typology according to clusters

	Type of consumer			
	Inactive	*Occasional*	*Regular*	*Dependent*
Headcount	8	36	37	11
Environment concerns				
Committed	**63%**	25%	22%	9%
Aware	37%	**64%**	**57%**	**73%**
Skeptical	0%	11%	22%	18%
Food and Health behaviors				
Committed	**63%**	25%	22%	0%
Aware	37%	**58%**	35%	18%
Skeptical	0%	17%	**43%**	**82%**
Animal welfare concerns				
Committed	**38%**	25%	11%	18%
Aware	**38%**	**64%**	**62%**	**55%**
Skepitcaled	25%	11%	27%	27%

Globally, we observe that non-meat eaters are mostly engaged in EC and FHB. As a matter of fact, 63% of inactive consumers are committed to both EC and FHB when only 38% of them are committed and 25% skeptical to AWC (Table 4.9). We can make the assumption that these people do not eat meat mainly because of health and environmental concerns. At the other end, we observe that 73% of dependent consumers are aware of the environmental externalities of MC. This may indicate some form of myopia for these students regarding MCs. Indeed, it is possible that these students feel concerned about the environmental cause but not enough to be aware of MC's externalities. As for DBH, 82% of them are skeptical which means that in our sample, people who eat the most meat tend to pay less attention

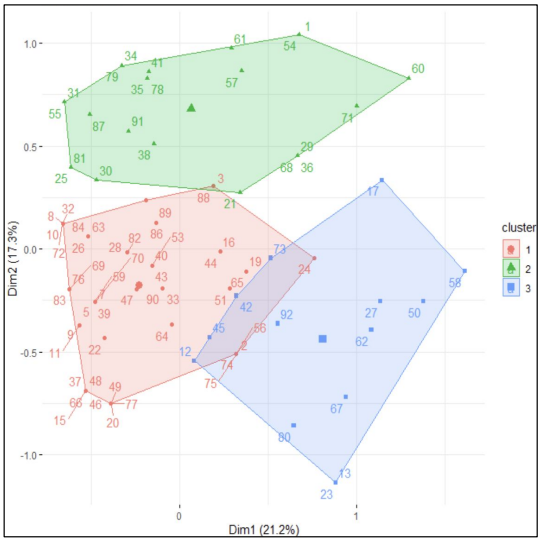
to their health. Finally, for AWC, we note that all types of consumers are mostly aware of animal concerns regarding MC.

4.4.6 Clusters' summary

Figure 4.14: Summary : EC's clsuter

CLUSTER 1 - AWARE

- ¾ of women are in this cluster ; only 40% of men are.
- ¾ of meat-dependent people are in this cluster .
- All of them think that countries are not doing enough and that the planet is in a dramatic condition.
- A large part is in favor of a carbon passport.
- About half of those are familiar with the concept of a carbon footprint, although none of them have ever calculated it.



CLUSTER 2 - COMMITTED

- 41% of men are in this cluster. Only 12% of women are.
- Half of those with vegetarian parents are in this cluster.
- Half believe that individual behavior can have a significant impact.
- All of them are familiar with the notion of carbon footprint and among them, almost all have already calculated theirs.
- More than a half agree with the idea of a carbon passport.

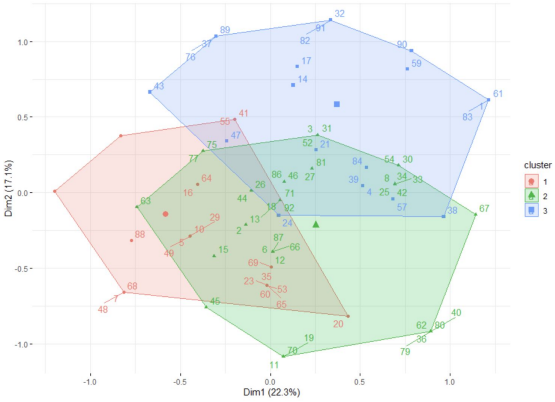
CLUSTER 3 - SKEPTICAL

- Proportionally, men are as present as women.
- There are no vegetarians in this cluster.
- Do not think that the planet is in a dramatic state.
- Do not agree with the introduction of the carbon passport.
- Thinks that states are doing enough to fight climate change.
- Half of them are not familiar with the concept of carbon footprint.

Figure 4.15: Summary : FHB's clsuter

CLUSTER 1 - SKEPTICAL

- 24% of women are in this cluster, 15% of men are.
- 82% meat-dependent students are in this cluster.
- Almost all of them go to a fast food restaurant at least once a month.
- All of them think that you have to eat meat to stay healthy.
- Half do not wish to comment on the impact of red meat consumption on health



CLUSTER 2 - AWARE

- 37% of women are in this cluster, 49% of men are.
- ¾ go to fast food at least once a month.
- ¾ believe that eating red meat negatively impacts health.
- Almost everyone thinks that it is not necessary to eat meat to stay healthy.

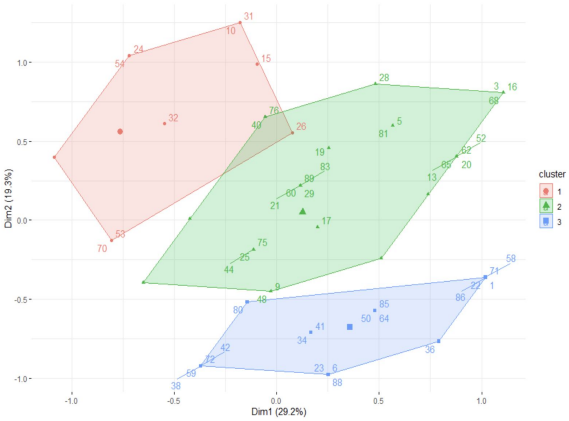
CLUSTER 2 - COMMITTED

- Proportionally, men are as present as women.
- 63% of vegetarians are in this cluster.
- Half of them go to a fast food restaurant only a few times a year.
- More than half believe that eating red meat has a negative impact on health.
- Almost everyone thinks that it is not necessary to eat meat to stay healthy.

Figure 4.16: Summary : AWC's clsuter

CLUSTER 1 - COMMITTED

- Among women, 24% are in this cluster against 15% of men.
- All of them are for the prohibition of all forms of hunting and fishing.
- Almost all are against the use of scientific experiments on animals.



CLUSTER 2 - AWARE

- 55% of women are in this cluster, 66% of men are.
- The totality is against the prohibition of all forms of hunting and fishing.
- All of them support the installation of cameras in slaughterhouses.
- A half of them support the use of scientific experiments on animals.
- A half think that industrial breeding is necessary.

CLUSTER 3 - SKEPTICAL

- Proportionally, men are as present as women.
- The totality is against the prohibition of all forms of hunting and fishing.
- The totality is against the installation of cameras in the slaughterhouses.
- Half support the use of scientific experiments on animals.
- More than half believe that factory farming is necessary.

Chapter 5

Econometrical analysis

5.1 Ordinary least squares method

In the previous section, using descriptive statistics, we were able to observe the existence of relationships between some variables, but without defining the extent of these relationships. The objective of this econometric section is to convert qualitative propositions such as "the relationship between two or more variables is positive" into quantitative propositions that provide useful indications of the strength of the relationships studied. In our case, we seek to define the magnitude of the relationship between the variables in our model and the level of MC (Figure 3.1). In this part, we will start by testing the different assumptions that will allow us to apply the Ordinary Least Squares (OLS) method. Then, we will deal with the endogeneity and we will finish by interpreting our results.

To use a linear regression model using the OLS method, basic assumptions must be met. Without this, it is possible for the model results to be biased. The model assumptions are as follows : The residuals of the estimated model must follow a normal distribution, the variance of the residuals must be constant for all individuals (assumption of homoscedasticity of the errors), the errors must be independent of each other (non-correlation of the errors), and finally the errors must be independent of the explanatory variables (assumption of exogeneity of the explanatory variables). All these assumptions are respected, and the detailed results are available in the Appendix 7.2. Nevertheless, we will deal with the endogeneity in the following section.

5.2 Endogeneity

Endogeneity is defined as a situation in which one of the explanatory variables is correlated with the error term. In the previous sections we indicated that we suspect endogeneity on the following variables: BMI, EC, AWC, FHB. For each of these variables, we have several so-called instrumental variables to estimate these biases. Therefore, we will use the Two Stage Least Squares (2SLS) method (Basmann, 1957). Modelisation in Figure 3.1 shows the instrumental variables corresponding to the endogenous variables. By applying the 2SLS method with the *ivreg* function of the AER[1] package on R, we obtained the following results (Appendix 7.2.6). None of the instrumental variables allows to correct efficiently the endogeneity. Nevertheless, the use of the 2SLS method is very questionable because the variables EC,AWC,FHB are categorical. It would have been better to estimate endogeneity in another way, perhaps in the same way as for the probit models. Endogeneity has therefore not been addressed, so the results we will interpret in the following sections are probably inaccurate.

5.3 Results

First of all, the Fisher test indicates that our model is worthwhile since it is globally significant at 1%. This means that we have one or more variables that have a significant impact on MC. The R^2 gives us the indication that our model seems to be of relatively good quality since about 41% of the variability (variance) of MC can be explained by our particular model.

Student's t test indicates that seven of our variables are significant. Concerning gender, we used females as a reference. The table shows us that gender has a significant influence - $p < 0.05$ - on MC. The dummy variable male indicates that in our sample, men consume on average 1.65 times more meat than women. This result confirms the scientific work mentioned in the economic section on the fact that women tend to consume less meat than men (Table 5.1). As far as the students' entourage is concerned, we notice that having vegetarian friends does not have a significant impact on meat consumption. On the other hand, having vegetarian parents has a positive influence - $p<0.05$ - on meat consumption. Indeed, students with vegetarian parents consumed on average 2.27 times less meat than students without vegetarian parents. Once again, this confirms the sociological work mentioned at the

[1] https://cran.r-project.org/web/packages/AER/AER.pdf

Table 5.1: Results of the ordinary least squares method

	Dependent variable
	mc
Constant	6.293*
Socioeconomic characteristics	
Gender (Male=1)	1.653**
Vegetarians friends (Yes=1)	0.069
Vegetarians parents (Yes=1)	−2.266**
BMI	−0.049
Residence (Alone=1)	1.893***
Scholarship (Yes=1)	1.429*
UR	−0.117
Environmental Concerns	
Committed	−1.781**
Skeptical	0.465
Food and Health behaviors	
Committed	−1.821**
Skeptical	2.518***
Animal Welfare Concerns	
Committed	−0.618
Skeptical	0.435
Observations	92
R^2	0.433
Adjusted R^2	0.338
Residual Std. Error	3.007 (df = 78)
F Statistic	4.575*** (df = 13; 78)
Note:	*p<0.1; **p<0.05; ***p<0.01

beginning of our report regarding the influence of parents on children's behaviors (**??**). As for the place of residence, we find a significantly positive relationship at the 1% confidence level. Students living alone consume 1.9 times more meat than other students, living with their parents, in a shared apartment or elsewhere. Finally, to end with the socio-economic variables, we notice that being a scholarship holder also has a significant influence - less important than the others since at p<0.10 - on MC. This influence is positive, here, a student with a scholarship consumes on average 1.4 times more meat than a student without a scholarship. In 3.3.4, we mentioned that in France, MC was negatively correlated with social class and thus ultimately with income. Since our study population is student, we cannot clearly make the link between these two observations. However, as we said above,

children tend to reproduce the behaviour of their parents. Thus, the fact that scholarship students eat more meat than non-scholarship students may be explained by the influence of non-scholarship parents on their children.

To interpret the clusters we had to define two dummy variables for each theme in order to be able to interpret them with respect to a third variable, this one being *aware*. Therefore, the interpretation of the *skeptical* and *committed* clusters is done in relation to the *aware* cluster. Among the clusters, there are three significant modalities. Indeed, being committed to FHB has a significantly negative impact - $p < 0.05$ - on MC. These committed students consumed on average 2 times less meat than the aware students. This result confirms the choice of our clusters by showing us that people committed to FHB have on average a more reasonable MC than the others. The second significant variable also concerns FHB. The fact of being skeptical to DBH positively influences - $p < 0.01$ - MC. In fact, skeptical students consume 2.5 times more meat than students aware to FHB. Finally, our last variable with a significant impact on MC is EC. Being a commited student to EC negatively affects MC ($p<0.05$). In our study, a commited to EC student consumes on average 1.78 times less meat than an aware student. Overall, dietary health behaviours seem to have a greater impact than environmental concerns and animal welfare concerns on meat consumption. This is surprising since when we asked the question *Why do you plan to reduce your meat consumption?* almost ¾ of the respondents answered : *to reduce my environmental impact.*

To summarize, we could picture an archetypal meat-eating student. This student would be male, live alone, have a scholarship and have parents who eat meat. In addition, he would not be very involved in healthy diet habits. On the other side, we would have a woman, living with her relatively wealthy vegetarian parents. She'd be very committed to the environment and would be very concerned about her health.

Chapter 6

Conclusion and discussion

6.1 Conclusion

In this report, we examined the drivers of the weekly meat consumption of students at the University of Nantes. First, we examined the negative externalities of the meat industry. We realized that this industry posed many issues, particularly for the environment, our health and animals' health. Therefore, we focused our analysis on the students' vision of these three problems. In order to do so, we distributed an online survey in order to evaluate the students' positions on these three causes. Using the results of the survey, we were able to analyze our population's characteristics in more detail. Through segmenting meat consumption, we were able to divide these same individuals according to their type of consumption. We determined 4 types of consumers : *inactive*, *occasional*, *regular* and *dependent*. Then, using the multiple component analysis and the clustering technique, we were able to determine three clusters corresponding to three different types of individuals: the *committed*, the *aware* and the *skeptical*. Using these clusters, we noticed that the student population was mostly aware of the three causes mentioned below. Using the same segmentations described above, we were able to see that being part of a particular cluster did have an impact on meat consumption. In fact, individuals who were skeptical about environmental, health and animal considerations tended to belong to the regular and dependent consumers. To quantify and measure the magnitude of these relationships, we used the ordinary least squares method. While our results are not robust because of an endogeneity problem, we found that food and health behaviors as well as environmental concerns were the two clusters with the most significant impact on meat consumption. Indeed, we found that students committed to these two causes consumed on average almost half as much meat as other students (aware ones). As for the

skeptical to food and health concerns, we found that they consumed on average 2.5 more meat than the aware students. Nevertheless, we still wish to point out that these results are likely to be wrong due to the sample we are working on and an unresolved endogeneity problem. In tomorrow's world, our diets will certainly require less meat. We believe that our public policies should be more specific and emphasize the hazards of meat - especially processed meat - on the health of all citizens. Indeed, given our results, the student population seems to be relatively well informed about animal and environmental issues, but we might tend to think that the health effects are largely underestimated.

6.2 Discussion

As we began to say in the conclusion, our study is subject to many biases. First, due to lack of time and resources, we were not able to distribute our survey as widely as we would have liked. This has led to observations such as the fact that half of our population is doing the same type of study. In addition, because the authors sent the questionnaire to their peers, there is a risk of over-representation of students with the same opinions as them. Secondly, with hindsight, we could have had a better questionnaire. Indeed, our questionnaire did not rely enough on the review of the scientific literature that was done ex post before writing the report. Thus, many hypotheses or variables were introduced by intuition and not with the support of solid evidence. This led to a problem of endogeneity at the end of our paper, particularly with the choice of instruments. However, in the end, we are satisfied with our work because it has allowed us to acquire experience and new tools that we will be able to use with more adequacy in our future work.

Chapter 7

Appendix

7.1 Additional figures

7.1.1 Statistics

Figure 7.1: University Restaurant distribution : Boxplot and Histogram

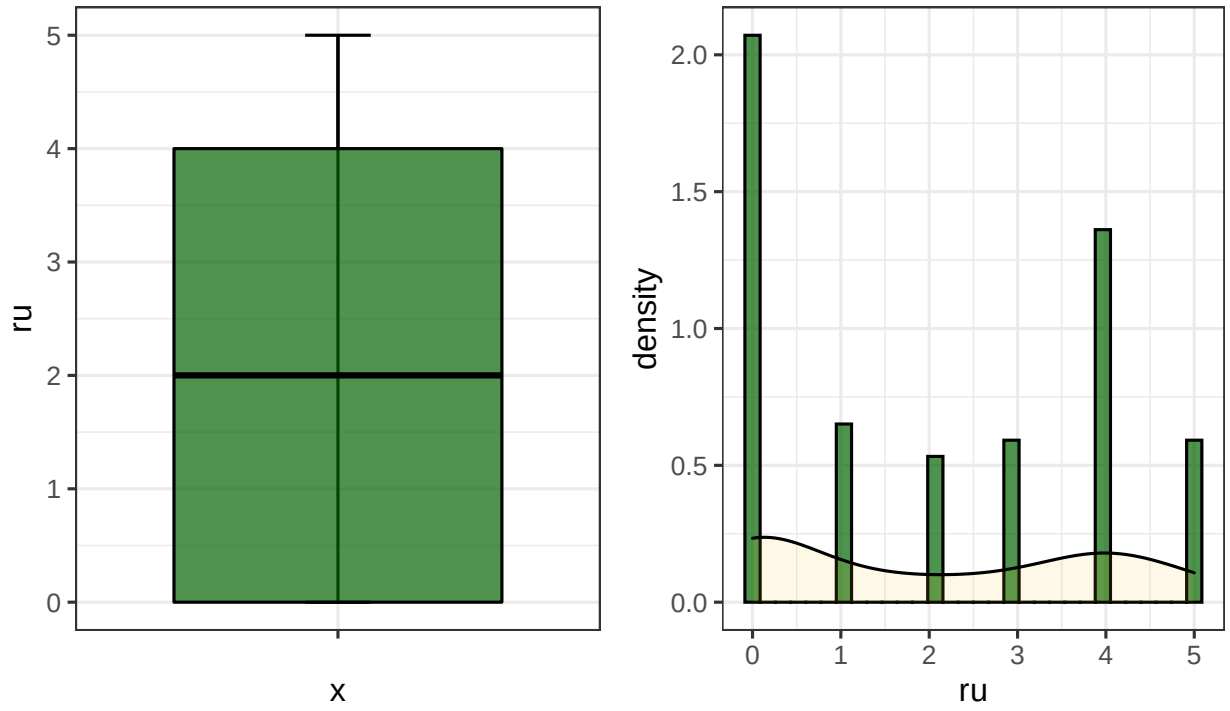


Figure 7.2: Vegetarians : Parents and friends

```
> tab_entourage_vege= table(base$parents_vege, base$amis_vege, deparse.level = 2)
> round(prop.table(tab_entourage_vege,1),2)
                 base$amis_vege
base$parents_vege  Non  Oui
            Non 0.27 0.73
            Oui 0.00 1.00
```

Figure 7.3: Rosner test : BMC

```
$all.stats
  i   Mean.i     SD.i    Value Obs.Num    R.i+1 lambda.i+1 Outlier
1 0 21.27161 2.348778 29.29688      35 3.416784   3.366490    TRUE
2 1 21.18623 2.208209 28.75434      36 3.427261   3.362836    TRUE
3 2 21.10486 2.073626 28.07504      19 3.361352   3.359136    TRUE
4 3 21.02909 1.951279 26.49151      46 2.799403   3.355387   FALSE
5 4 20.96907 1.874732 25.25952      92 2.288568   3.351588   FALSE
```

Table 7.1: Summary BMI : Without atypical values

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
17.087	19.587	20.859	21.029	22.405	26.492

Figure 7.4: Spearman test : URand BMI

```
> cor(base$imc, base$ru, use="complete.obs", method ="pearson")
[1] -0.1340288
```

Figure 7.5: Clusters : 2 / 3

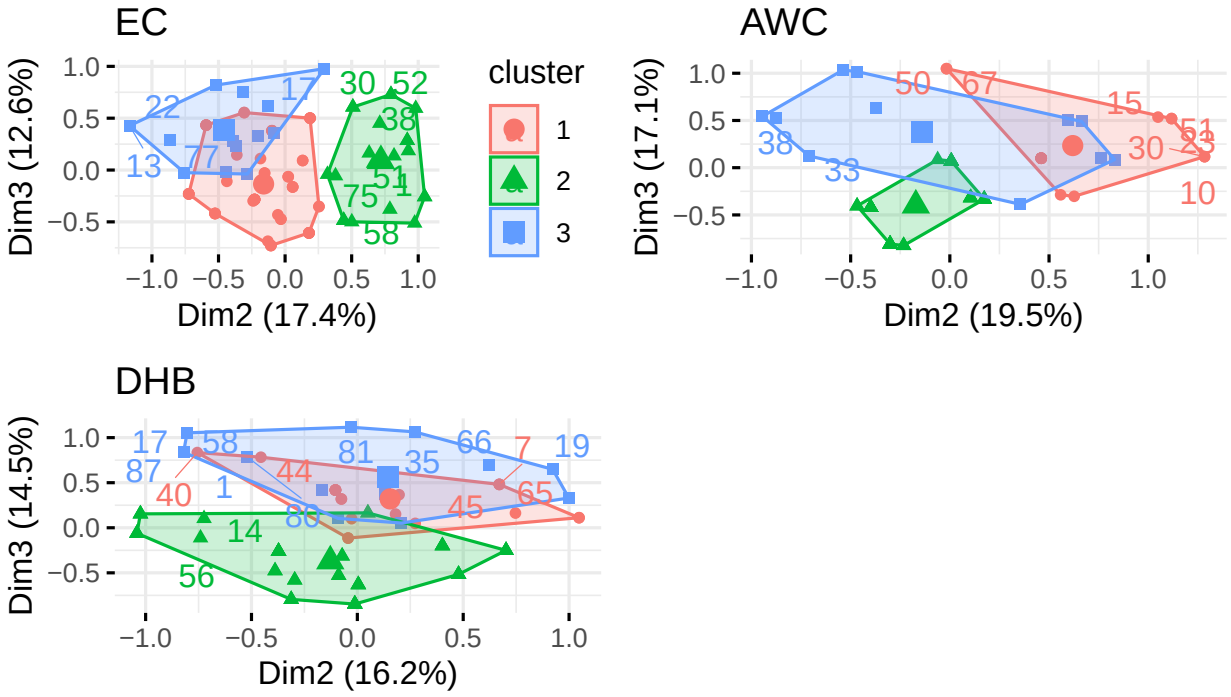


Figure 7.6: Clusters : 3 / 4

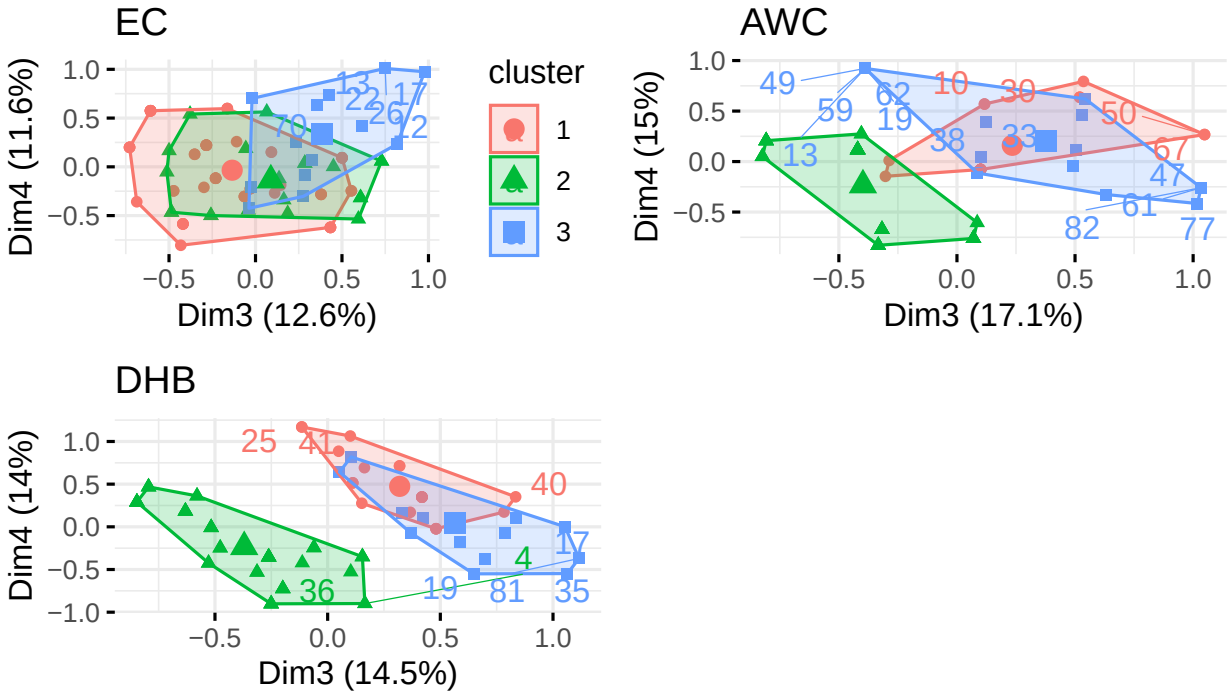


Table 7.2: Clusters : Fullset table

	E_Committed	E_Aware	E_Skeptical	H_Committed	H_Aware	H_Skeptical	A_Committed	A_Awared	A_Skeptical	
Headcount	23	55	14	22	39	31	18	55	19	
Female	12%	75%	14%	25%	37%	37%	24%	55%	22%	
Male	41%	41%	17%	22%	49%	29%	15%	66%	20%	
MC (0)	63%	38%	0%	63%	38%	0%	38%	38%	25%	
MC (1-5)	25%	64%	11%	25%	58%	17%	25%	64%	11%	
MC (6-10)	22%	57%	22%	22%	35%	43%	11%	62%	27%	
MC (11-14)	9%	73%	18%	0%	18%	82%	18%	55%	27%	
Regu_Sport (Yes)	26%	57%	17%	22%	46%	31%	19%	65%	17%	
Regu_Sport (No)	24%	63%	13%	26%	37%	37%	21%	53%	26%	
Animals childhood (No)	28%	48%	24%	20%	32%	48%	20%	56%	24%	
Animals childhood (Yes)	24%	64%	12%	25%	46%	28%	19%	61%	19%	
Childhood env (Rural)	22%	66%	12%	22%	46%	32%	16%	64%	20%	
Childhood env (Urban)	29%	52%	19%	26%	38%	36%	24%	55%	21%	
Residence (Not Alone)	28%	58%	14%	21%	46%	33%	21%	60%	19%	
Residence (Alone)	20%	63%	17%	29%	37%	34%	17%	60%	23%	
Vegetarians parents (Yes)	21%	64%	16%	25%	40%	35%	22%	61%	17%	
Vegetarians parents (No)	47%	40%	13%	20%	53%	27%	7%	53%	40%	
Diet (No)	28%	56%	16%	23%	44%	33%	16%	64%	20%	
Diet (Yes)	18%	68%	14%	25%	39%	36%	29%	50%	21%	
SPC1_Other	17%	77%	7%	30%	33%	37%	17%	60%	23%	
SPC1 +	29%	52%	19%	21%	47%	32%	21%	60%	19%	
SPC2_Other	26%	61%	13%	24%	43%	33%	15%	63%	22%	
SPC2 +	24%	59%	17%	24%	41%	35%	24%	57%	20%	
UR(0)	23%	65%	13%	26%	23%	52%	29%	55%	16%	
UR(1-3)	10%	72%	17%	34%	41%	24%	14%	66%	21%	
UR(4-5)	41%	44%	16%	13%	63%	25%	16%	59%	25%	

7.2 Econometrics test

7.2.1 Residuals normality

In order to interpret the OLS results, we need to know if the errors are following a normal distribution. To confirm this, we will use the Shapiro-Wilk (SW) test. The rules of the SW

test are the following :

$$H_0 : \text{The errors follow a normal distribution}$$
$$H_1 : \text{The errors do not follow a normal distribution}$$

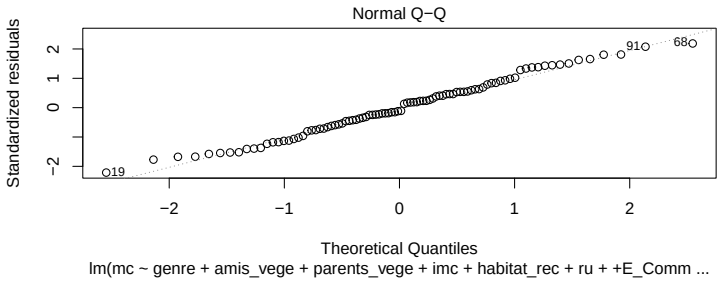
If the the p-value given by the test is superior to 0.05, we will not the refuse the H_0 which stipulates the normality of the errors.

Figure 7.7: R results : Shapiro-Wilk

```
        Shapiro-Wilk normality test

data:  residuals(mco)
W = 0.99038, p-value = 0.7456
```

We can use a quantile-quantile plot to support the SW test (Figure 7.8).

Figure 7.8: QQ-plot



7.2.2 Residuals Homoscedasticity

Homoscedasticity of residuals occurs when the variance of residuals is constant for all individuals : $V(\varepsilon_i) = \sigma^2 \ \forall_i$. If this assumption is not respected, then the estimators are no longer the Best Linear Unbiased Estimator (BLUE). To detect heteroscedasticity, we can use the Breush-Pagan (BP) test. The two hypotheses of this test are the following :

$$\mathrm{H}_0 : y_i = \alpha + \beta x_i + \gamma z_i + \varepsilon_i \ ; \ V(\varepsilon_i) = \sigma^2 \ \ ; \ \ i = 1, \ldots, N$$

$$\mathrm{H}_1 : y_i = \alpha + \beta x_i + \gamma z_i + \varepsilon_i \ ; V(\varepsilon_i) = \sigma_i^2 = \eta_1 + \eta_2 x_i + \eta_3 z_i + \omega_i$$

Where η_1, η_2, η_3 are coefficients and ω_i a white noise.

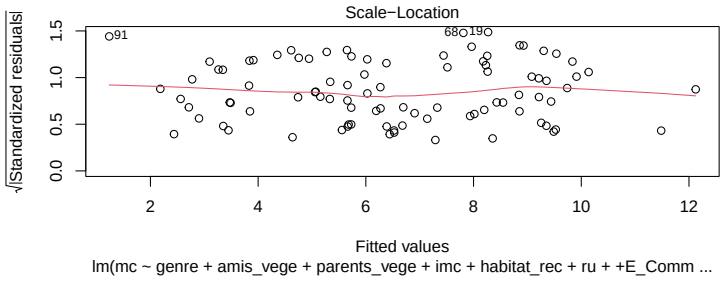
To perform this test, we will use R. If the p-value given by the test is superior to 0.05, we will not refuse the homoscedasticiy assumption H_0.

Figure 7.9: R results : BP test

```
        studentized Breusch-Pagan test

data:  mco
BP = 15.288, df = 13, p-value = 0.2897
```

Our BP test is giving us a p-value of 0.29. Thus, we do not refuse the homoscedasticiy assumption H_0. The variance of our residuals is constant.

Figure 7.10: Scale-location plot



The scale-location diagram confirms the results of the BP test. Moreover, it gives us an intuition about the functional form of the model (probably linear). We will see in the next section if this observation is confirmed.

7.2.3 Functional form

Now we wish to know if the functional form of our model is linear. In order to know that, we will perform the Ramsey Regression Equation Specification Error Test (RESET). The assumptions are the following.

$$H_0 : \text{The functional form of the model is linear}$$
$$H_1 : \text{The functional form of the model is not linear}$$

To verify this test, we will use R. If the p-value given by the test is superior to 0.05, we will not refuse the linear functional form assumption of H_0.

Figure 7.11: R results : RESET

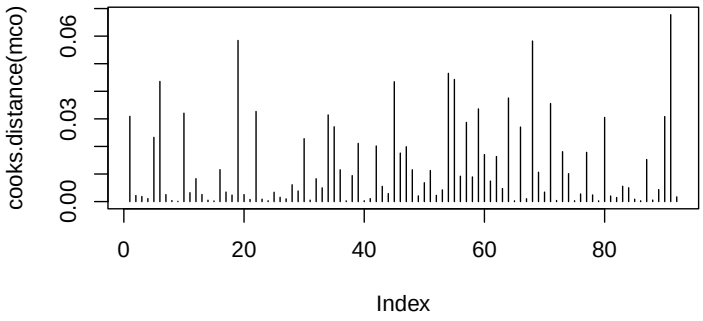
```
        RESET test

data:  mco
RESET = 0.010575, df1 = 2, df2 = 76, p-value =
0.9895
```

Here, we see that the p-value is superior to 0.05. The linear form of our model is not rejected.

7.2.4 Influential observations

We can use a Cook's distance to check if there are individuals who have too much influence in our sample.

Figure 7.12: Cook's plot



All of the individuals are under 1, meaning there is no problem.

7.2.5 Multicolinearity

After estimating the OLS, we need to check if there is no collinearity between the different explanatory variables. To know this, we will perform the Variance inflation factor test (VIF). The VIF is calculated based on the following expression :

$$\text{VIF}_i = \frac{1}{1 - R_i^2}$$

If $\text{VIF}(\hat{\beta}_i) > 10$, we can say that the collinearity is strong. By performing the test on R, we get the following results.

Figure 7.13: R results : VIF

```
      genre     boursier    amis_vege parents_vege
   1.378375     1.282443     1.421688     1.290327
        imc  habitat_rec           ru  E_Committed
   1.085827     1.147305     1.623462     1.380344
 E_Skeptical  H_Committed  H_Skeptical  A_Committed
   1.303201     1.520767     1.501187     1.215072
 A_Skeptical
   1.223748
```

All our variables have a VIF close to 1, there is no multicolinearity.

7.2.6 Endogeneity

For each of the endogenous p-values associated with the *weak instruments* test is greater than 0.1 : consequently, the instruments chosen to verify endogeneity are not relevant. These instruments are not correlated with the residual (p-value associated with the Sargan test > 0.05).

Figure 7.14: R results : Endogeneity

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)   -4.2277    27.0200  -0.156   0.8761
genre1         1.8218     1.0241   1.779   0.0792 .
amis_vege1     0.5227     2.5379   0.206   0.8374
parents_vege1 -3.0395     2.1237  -1.431   0.1564
boursier1      1.8750     1.7809   1.053   0.2957
habitat_rec1   2.1612     2.0372   1.061   0.2920
ru            -0.2948     1.1943  -0.247   0.8057
imc            0.4666     1.3861   0.337   0.7373
H_Committed1  -2.6544     7.4873  -0.355   0.7239
H_Skeptical1   1.0196    13.6751   0.075   0.9408
E_Skeptical1  -0.1582     6.9124  -0.023   0.9818
E_Committed1  -1.9822     1.4329  -1.383   0.1705
A_Skeptical1   2.3711     5.7355   0.413   0.6804
A_Committed1  -0.6335     3.5419  -0.179   0.8585

Diagnostic tests:
                                df1 df2 statistic p-value
Weak instruments (imc)            5  77     0.350   0.880
Weak instruments (H_Skeptical1)   5  77     0.252   0.938
Weak instruments (E_Skeptical1)   5  77     1.779   0.127
Weak instruments (A_Skeptical1)   5  77     0.475   0.794
Wu-Hausman                        4  74     0.092   0.985
Sargan                            1  NA     0.682   0.409

Residual standard error: 3.346 on 78 degrees of freedom
Multiple R-Squared: 0.2976,     Adjusted R-squared: 0.1805
Wald test:  3.07 on 13 and 78 DF,  p-value: 0.001049
```

7.2.7 Step-wise

Stepwise regression is a method of fitting regression models where the choice of predictor variables is made automatically at each step. A variable is considered to be added to or subtracted from the set of explanatory variables according to a given criterion. Here we will use

the Akaike criterion (AIC) which is like an extension of the maximum likelihood principle[1]. The *leaps*[2] package on R allows you to perform a stepwise regression according to this same criterion. The results are published below on Table X. Compared to the initial model, we notice that the R^2 has decreased slightly but the adjusted R^2 has increased slightly. Overall, this model incorporates all the significant components of the other model. Both models are very similar, the difference between them is almost negligible.

Nevertheless we have decided to put this part in the appendix because the trouble with stepwise regression is that, at any given step, the model is fit using unconstrained least squares which can give inconsistent results.

Figure 7.15: R results : Stepwise

```
Call:
lm(formula = cons ~ H_Skeptical + habitat_rec + H_Committed +
    parents_vege + genre + E_Committed + boursier, data = base_e)

Residuals:
    Min      1Q  Median      3Q     Max
-6.4790 -2.1801  0.0764  2.0286  6.5864

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)     5.0328     0.6697   7.515 5.62e-11 ***
H_Skeptical1    2.7543     0.7138   3.859 0.000223 ***
habitat_rec1    1.8564     0.6395   2.903 0.004722 **
H_Committed1   -1.7151     0.8092  -2.120 0.036991 *
parents_vege1  -2.0391     0.8574  -2.378 0.019667 *
genre1          1.5898     0.6588   2.413 0.017990 *
E_Committed1   -1.9633     0.7828  -2.508 0.014070 *
boursier1       1.5182     0.7468   2.033 0.045197 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.928 on 84 degrees of freedom
Multiple R-squared:  0.4206,    Adjusted R-squared:  0.3723
F-statistic:  8.71 on 7 and 84 DF,  p-value: 5.261e-08
```

All our variables have a VIF close to 1, there is no multicolinearity.

7.2.8 Quotas' method

Due to the size of our sample, we are restricted to applying the quota method only for the gender of the students. The most recent statistics on the subject indicate that women represent 55.9% of students in higher education in France[3].

$\chi^2_{obs} = \frac{(41-40,572)^2}{40,572} + \frac{(51-51,428)^2}{51,428} = 0,00807699$

[1]Maximum likelihood is conventionally applied to estimate the parameters of a model once the structure and dimension of the model have been formulated (https://doi.org/10.1002/wics.1460)

[2]https://cran.r-project.org/web/packages/leaps/leaps.pdf

[3]INSEE, *Femmes et hommes, l'égalité en question*,2022

	Male	Female	Sum
Observed population	41	51	92
Theoretical population	$0,441 * 92 = 40,572$	51,428	92
Distribution in the total population	0,441	0,559	1

$\chi^2_{thoretical}$ (for a 5% risk threshold) at : *Chi2* (1)=3.84

The calculated value is inferior to the theoretical value of the sample is then representative.

Bibliography

Absil, G., Vandoorne, C., & Demarteau, M. (2012). Bronfenbrenner, écologie du développement humain. réflexion et action pour la promotion de la santé.

Appleby, P. N., Crowe, F. L., Bradbury, K. E., Travis, R. C., & Key, T. J. (2016). Mortality in vegetarians and comparable nonvegetarians in the United Kingdom. *The American Journal of Clinical Nutrition*, *103*(1), 218–230. https://doi.org/10.3945/ajcn.115.119461

Aquatias, S., Arnal, J.-F., Rivière, D., Bilard, J., Callède, J.-P., Casillas, J.-M., Choquet, M., Cohen-Salmon, C., Courteix, D., Duclos, M., et al. (2008). *Activité physique: contextes et effets sur la santé-synthèse et recommandations* (Doctoral dissertation). Institut national de la santé et de la recherche médicale (INSERM).

Arcury, T. A., & Christianson, E. H. (1993). Rural-urban differences in environmental knowledge and actions. *The Journal of Environmental Education*, *25*(1), 19–25.

Arnaudova, M., Brunner, T. A., & Götze, F. (2022). Examination of students' willingness to change behaviour regarding meat consumption. *Meat Science*, *184*, 108695. https://doi.org/10.1016/j.meatsci.2021.108695

Basmann, R. L. (1957). A generalized classical method of linear estimation of coefficients in a structural equation. *Econometrica: Journal of the Econometric Society*, 77–83.

Benton, T. G., Bieg, C., Harwatt, H., Pudasaini, R., & Wellesley, L. (2021). Food system impacts on biodiversity loss. *Three levers for food system transformation in support of nature. Chatham House, London.*

Bogner, F. X., & Wiseman, M. (1997). Environmental perception of rural and urban pupils. *Journal of Environmental Psychology*, *17*(2), 111–122.

Bongaarts, J. (2019). IPBES, 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. *Population and Development Re-*

view, *45*(3), 680–681. https://doi.org/10.1111/padr.12283
_eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/padr.12283

Bouvard, V., Loomis, D., Guyton, K. Z., Grosse, Y., Ghissassi, F. E., Benbrahim-Tallaa, L., Guha, N., Mattock, H., & Straif, K. (2015). Carcinogenicity of consumption of red and processed meat. *The Lancet Oncology*, *16*(16), 1599–1600. https://doi.org/10.1016/S1470-2045(15)00444-1

Cairney, J., & Veldhuizen, S. (2017). Organized sport and physical activity participation and body mass index in children and youth: a longitudinal study. *Preventive Medicine Reports*, *6*, 336–338.

Chanda, R. (1999). Correlates and dimensions of environmental quality concern among residents of an african subtropical city: gaborone, botswana. *The Journal of Environmental Education*, *30*(2), 31–39.

Cheah, I., Sadat Shimul, A., Liang, J., & Phau, I. (2020). Drivers and barriers toward reducing meat consumption. *Appetite*, *149*, 104636. https://doi.org/10.1016/j.appet.2020.104636

Chen, X., Peterson, M. N., Hull, V., Lu, C., Lee, G. D., Hong, D., & Liu, J. (2011). Effects of attitudinal and sociodemographic factors on pro-environmental behaviour in urban china. *Environmental Conservation*, *38*(1), 45–52.

Crowe, F. L., Appleby, P. N., Travis, R. C., & Key, T. J. (2013). Risk of hospitalization or death from ischemic heart disease among British vegetarians and nonvegetarians: results from the EPIC-Oxford cohort study. *The American Journal of Clinical Nutrition*, *97*(3), 597–603. https://doi.org/10.3945/ajcn.112.044073

Danielzik, S., Czerwinski-Mast, M., Langnäse, K., Dilba, B., & Müller, M. (2004). Parental overweight, socioeconomic status and high birth weight are the major determinants of overweight and obesity in 5–7 y-old children: baseline data of the kiel obesity prevention study (kops). *International journal of obesity*, *28*(11), 1494–1502.

De Backer, C. J., & Hudders, L. (2015). Meat morals: relationship between meat consumption consumer attitudes towards human and animal welfare and moral behavior. *Meat science*, *99*, 68–74.

Deckers, J. (2009). Vegetarianism, Sentimental or Ethical? *Journal of Agricultural and Environmental Ethics*, *22*(6), 573. https://doi.org/10.1007/s10806-009-9176-3

The Evolution of Diet. (n.d.). National Geographic.

Food system impacts on biodiversity loss. (2021, February 3). Chatham House – International Affairs Think Tank.

Garnett, T., Mathewson, S., Angelides, P., & Borthwick, F. (2015). Policies and actions to shift eating patterns: What works? *What works*, 85.

Gifford, R., Hay, R., & Boros, K. (1982). Individual differences in environmental attitudes. *The Journal of Environmental Education*, *14*(2), 19–23.

Godfray, H. C. J., Aveyard, P., Garnett, T., Hall, J. W., Key, T. J., Lorimer, J., Pierrehumbert, R. T., Scarborough, P., Springmann, M., & Jebb, S. A. (2018). Meat consumption, health, and the environment. *Science (New York, N.Y.)*, *361*(6399), eaam5324. https://doi.org/10.1126/science.aam5324

Gołębiewska, B., Gębska, M., & Stefańczyk, J. (2018). Animal welfare as one of the criterion determining polish consumers'decisions regarding their purchase of meat. *Acta Scientiarum Polonorum. Oeconomia*, *17*(3), 13–21.

Goodale, C. L., Apps, M. J., Birdsey, R. A., Field, C. B., Heath, L. S., Houghton, R. A., Jenkins, J. C., Kohlmaier, G. H., Kurz, W., Liu, S., Nabuurs, G.-J., Nilsson, S., & Shvidenko, A. Z. (2002). Forest Carbon Sinks in the Northern Hemisphere. *Ecological Applications*, *12*(3), 891–899. https://doi.org/10.1890/1051-0761(2002)012[0891:FCSITN]2.0.CO;2

Grendstad, G., & Wollebaek, D. (1998). Greener still? an empirical examination of eckersley's ecocentric approach. *Environment and behavior*, *30*(5), 653–675.

Harguess, J. M., Crespo, N. C., & Hong, M. Y. (2020). Strategies to reduce meat consumption: A systematic literature review of experimental studies. *Appetite*, *144*, 104478. https://doi.org/10.1016/j.appet.2019.104478

Hinds, J., & Sparks, P. (2008). Engaging with the natural environment: the role of affective connection and identity. *Journal of environmental psychology*, *28*(2), 109–120.

Hoekstra, A. Y. (2012). The hidden water resource use behind meat and dairy. *Animal Frontiers*, *2*(2), 3–8. https://doi.org/10.2527/af.2012-0038

Huang, T., Yang, B., Zheng, J., Li, G., Wahlqvist, M. L., & Li, D. (2012). Cardiovascular disease mortality and cancer incidence in vegetarians: a meta-analysis and systematic review. *Annals of Nutrition & Metabolism*, *60*(4), 233–240. https://doi.org/10.1159/000337301

Impact of meat and Lower Palaeolithic food processing techniques on chewing in humans | Nature. (n.d.).

Kenward, B. (2012). Over-imitating preschoolers believe unnecessary actions are normative and enforce their performance by a third party. *Journal of experimental child psychology*, *112*(2), 195–207.

María, G. A. (2006). Public perception of farm animal welfare in Spain. *Livestock Science*, *103*(3), 250–256. https://doi.org/10.1016/j.livsci.2006.05.011

Meat consumption, health, and the environment - PubMed. (n.d.).

Merlino, V. M., Borra, D., Verduna, T., & Massaglia, S. (2017). Household behavior with respect to meat consumption: differences between households with and without children. *Veterinary sciences*, *4*(4), 53.

Mesler, R. M., Leary, R. B., & Montford, W. J. (2022). The impact of masculinity stress on preferences and willingness-to-pay for red meat. *Appetite*, *171*, 105729. https://doi.org/10.1016/j.appet.2021.105729

Norem-Hebeisen, A., Johnson, D. W., Anderson, D., & Johnson, R. (1984). Predictors and concomitants of changes in drug use patterns among teenagers. *The Journal of Social Psychology*, *124*(1), 43–50.

Pawlak, R., Lester, S. E., & Babatunde, T. (2016). The prevalence of cobalamin deficiency among vegetarians assessed by serum vitamin B12: a review of literature. *European Journal of Clinical Nutrition*, *70*(7), 866. https://doi.org/10.1038/ejcn.2016.81

Pollakova, D., Andreadi, A., Pacifici, F., Della-Morte, D., Lauro, D., & Tubili, C. (2021). The Impact of Vegan Diet in the Prevention and Treatment of Type 2 Diabetes: A Systematic Review. *Nutrients*, *13*(6), 2123. https://doi.org/10.3390/nu13062123

Rigon, D. N. a. A. (2016). Briefing POLICY DEPARTMENT FOR CITIZENS' RIGHTS AND CONSTITUTIONAL AFFAIRS.

Ritchie, H., & Roser, M. (2020). Environmental impacts of food production. *Our world in data*.

Rosenfeld, D. L., Rothgerber, H., & Janet Tomiyama, A. (2020). From mostly vegetarian to fully vegetarian: Meat avoidance and the expression of social identity. *Food Quality and Preference*, *85*, 103963. https://doi.org/10.1016/j.foodqual.2020.103963

Rothgerber, H. (2013). Real men don't eat (vegetable) quiche: Masculinity and the justification of meat consumption. *Psychology of Men & Masculinity*, *14*(4), 363–375. https://doi.org/10.1037/a0030379

Slingenbergh, J., Gilbert, M., BALOGH de, K., & Wint, W. (2004). Ecological sources of zoonotic diseases: -EN- -FR- -ES-. *Revue Scientifique et Technique de l'OIE*, *23*(2), 467–484. https://doi.org/10.20506/rst.23.2.1492

Sparkman, G., & Walton, G. M. (2017). Dynamic Norms Promote Sustainable Behavior, Even if It Is Counternormative. *Psychological Science*, *28*(11), 1663–1674. https://doi.org/10.1177/0956797617719950

Stoll-Kleemann, S., & Schmidt, U. J. (2017). Reducing meat consumption in developed and transition countries to counter climate change and biodiversity loss: a review of influence factors. *Regional Environmental Change*, *17*(5), 1261–1277. https://doi.org/10.1007/s10113-016-1057-5

Sumpter, K. C. (2015). Masculinity and Meat Consumption: An Analysis Through the Theoretical Lens of Hegemonic Masculinity and Alternative Masculinity Theories. *Sociology Compass*, *9*(2), 104–114. https://doi.org/10.1111/soc4.12241

Tobler, C., Visschers, V. H. M., & Siegrist, M. (2011). Eating green. Consumers' willingness to adopt ecological food consumption behaviors. *Appetite*, *57*(3), 674–682. https://doi.org/10.1016/j.appet.2011.08.010

Vilcek, S. (2020). SARS-CoV-2: Zoonotic origin of pandemic coronavirus. *Acta Virologica*, *64*(3), 281–287. https://doi.org/10.4149/av_2020_302

Wang, Y., & Beydoun, M. A. (2009). Meat consumption is associated with obesity and central obesity among us adults. *International journal of obesity*, *33*(6), 621–628.

Yokoyama, Y., Barnard, N. D., Levin, S. M., & Watanabe, M. (2014). Vegetarian diets and glycemic control in diabetes: a systematic review and meta-analysis. *Cardiovascular Diagnosis and Therapy*, *4*(5), 373–382. https://doi.org/10.3978/j.issn.2223-3652.2014.10.04

Zhao, Z., Gong, Y., Li, Y., Zhang, L., & Sun, Y. (2021). Gender-Related Beliefs, Norms, and the Link With Green Consumption. *Frontiers in Psychology*, *12*.

Zink, K. D., & Lieberman, D. E. (2016). Impact of meat and Lower Palaeolithic food processing techniques on chewing in humans. *Nature*, *531*(7595), 500–503. https://doi.org/10.1038/nature16990

Contents

List of Figures

List of Tables