

ID 1742 | CHANGING MOBILITY BEHAVIOURS IN ACADEMIA UNDER AUSTERITY: THE CASE OF FEUP

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ABSTRACT: The purpose of this paper is to explore how commuting patterns of university students have changed, in face of the recent austerity that has been occurring in Portugal. Our findings based on two surveys carried out in 2006 and 2012 (before and during the austerity period) reveal that students have changed their travel patterns during economic crisis, becoming more multimodal, friendly of public transport and less dependent on private car. Interestingly, the results also indicate that this change on modal choice was particularly significant for distances longer than 8 km. Indeed, in 2012, students travelled longer distances taking advantage of the improvements in the public transport system, namely in the local Light Rail System that was not yet fully available in 2006. On the other hand, transport costs seemed to be able to explain, to a larger extent, the travel behaviour of those who did not use the individual car. In 2006, the main reason pointed out to move on foot was the time and comfort in short distances, whereas in 2012, the main reason was the overall cost of the journey. Although the overall evolution of the students' travel behaviour pointed towards greater sustainability patterns, the identified changes also reveal that the social contexts gained more importance. Keywords: University students, travel patterns, mode choice, private, public and non-motorized modes, austerity.

1 INTRODUCTION

The global financial crisis has had a strong impact, being in Europe particularly serious in peripheral countries such as Portugal, Ireland, Iceland, Greece and Spain (European Commission 2014; Frade & Coelho 2015). This crisis has exacerbated territorial differences between countries and social groups (Eurostat EU-SILC 2013, Martin 2011, Ulfarsson et al. 2015). According to Geels (2013), in political terms, it is understood as the right time to make profound changes in behaviours. It can be an opportunity to make transitions more sustainable, combined with green policies, and also, on a different perspective, the opportunity to introduce "structural" reforms with significant reductions in the welfare state and citizens' rights (Geels 2013). For this reason, one of the main issues associated with this theme is to understand why in some territories the effects of the crisis were felt more than in others (Hassink 2010).

Since mobility is part of the daily life of citizens, it is natural that it has undergone changes with the impact of the financial crisis. A financial reduction in family or personal life's budgets implies an adaptation to the new reality, which includes the need to reduce costs, including those associated to transport. It is recognized the difficulty of changing mobility habits, especially for individual transport users (Garcia-Sierra et al. 2015). One of the main differences in travel behaviour due to the financial crisis has been the reduction of travel frequency (Nielsen 2015), although the travel behaviour depends on the social groups under study (Marquet & Miralles-Guasch 2017). However, adaptations are complex and may include changing modal choice, destinations and residence, among many others. Some of these adaptations may be circumstantial, but others may lead to a change in daily mobility habits (Garcia-Sierra et al. 2015). In this sense, according to Marquet et al (2017), it is necessary to analyse with some caution their impacts not only in geographical terms but also in different social groups (Smith & Swain 2010).

Following the financial collapse in the US and shortly after the beginning of the Greek debt crisis in the first quarter of 2010, in April 2011, the government called in international institutions (the so-called troika, ECB, European Commission and IMF) to bailout Portugal¹. The long-term effects of the economic crisis and the

¹ While the European financial crisis is often presented as a contemporary product of the Eurozone and banking crises, Portugal's specific difficulties are also an outcome of recent and historical factors. According to Moury & Freire (2013) many political actors argue that both the government's right-wing coalition and the "troika" have gone beyond their mandate by imposing so-called "structural" reforms on the country, which severely reduced the welfare state and citizens' social rights.

austerity measures implemented in the recent years have had a strong impact on the economy (Cairns et al. 2014; Cairns 2011; Frade & Coelho 2015; Freire & Moury 2013), for example: growth stagnation, decrease of public and private consumption, the fall of 6.5% in Gross Domestic Product (GDP) between 2009 and 2012, a general reduction in State expenditure (in particular in health, education and social security), an increase of 8% of unemployment (17% in 2013), which most severely affected youth unemployment from 15 to 24 years of age, from 16.6% to 37.7% (Frade & Coelho 2015). As a result, families saw their incomes fall sharply (freezes and wage cuts, significant increases in taxes, rising unemployment), so they had to adjust their budgets and lifestyles and make significant cuts in spending, including the costs associated with transport and mobility habits. Besides the transport measures conducted by the Portuguese government, (e.g. introduction of tax fare on SCUT¹-motorway, introduction of new tariffs on fuel prices rising from 2005 - 1,15€/l to 2012 - 1,64€/l [DGEG]) and the rising price of oil in the world market also led to an abnormal increase in the price of public transport. Frade & Coelho (2015) report that 37.4% of the families surveyed say they have made cuts with transport and fuel (37,4% households who cut spending 2010-2014%).

The economic crisis also seems to have been the cause of the decrease of about 1/3 of the number of students enrolled in private university education in the period 2006 and 2012 (source INE 2014; Cairns et al. 2014) and the increase in the number of students in public universities. It also seems to have been felt in the emotional state of university students, who see the crisis as a disruptive factor for their future, in relation to several aspects such as the possibility of finding employment, of financial independence, of constituting a family and their sense of well being (Cairns et al. 2014, David et al. 2015). Although university students in Portugal are, still, a privileged group, it is possible that these measures had an impact on travel behaviour. Exploring university students' travel behaviour in two different times can reveal fundamental and valuable information to provide better guidance on future practice². Uncovering student's perception and travel mode choices behaviour changes may help us to make preliminary recommendations for university transport demand management in order to decrease car dependency among students.

1.1 UNIVERSITY STUDENTS COMMUTING PATTERNS AND FACTORS AFFECTING THOSE PATTERNS

In recent years, the commuting patterns of university students have garnered increasing attention. The reason for this interest is not only because the study of university students' movements represents a high number of commuting hours in the city, but mainly because they are recognized to represent an important target group in the transformation of behaviours, because they are more prone to change (this is generally the time when they build their independence and begin to make their own decisions) and because they represent the future leaders (Zhou 2012; Zhou 2014; Zhou 2016). Several studies can be found which deal with different aspects of university students' travel behaviour. These include, among other issues, housing and commuting choices (Zhou 2014), use of GIS to visualize and assess travel behaviour (Rybarczyk & Gallagher 2014; Whalen et al. 2013), or promoting a proactive and sustainable university transportation (Zhou 2016; Kaplan 2015). Other studies focused on academic mobility and university policy (Hopkins et al. 2015), and others on the introduction of travel demand measures (TDM) in academia (Bleechmore et al. 2011; Bamberg et al. 2003; Fujii & Kitamura 2003), as well as promoting active mobility patterns (Bopp et al. 2016; Whalen et al. 2013; Shannon et al. 2006). More recently, some researchers focus on the individual, the habit and attitudinal travel behaviour - psychological characteristics (Klößner & Friedrichsmeier 2011; Lavery et al. 2013; Bamberg et al. 2003). Despite the emerging literature, most studies have failed to adequately specify relations of relevant explanatory variables (Zhou 2016).

Moreover, mobility patterns can vary with culture, technologies, characteristics of places, people and other external factors (Crane & Crepeau 1998)³.

1 SCUT – abbreviation of - 'without costs for the users' in its origin

2 For the definition of strategies and political measures it is essential first of all to begin with the knowledge and understanding of the reality that one intends to change

3 For example, Danaf (2014) in their study in Beirut Area, Lebanon, found that safety concerns and context are very important factors, as women university students tend to use more car or jitney, in that sense, cost differences among or

The mobility patterns of a given population are the reflection of this population in the territory, its social and economic-political organization. In the last decades, there have been profound changes in mobility patterns due to the continuous growth of the motorization rate, number of trips, distances travelled, urban dispersion and increased dependence on private transport, which has compromised the levels of sustainability of most urban areas and to become a central theme of the political debate (Banister et al. 2015; Pinho et al. 2015). It is consensual that to influence modal choice, it is necessary to know the factors that justify it. However the literature is not consensual on their identification. Zhou (2016) argues that little has been done to quantify the marginal effects of the factors, which are central when policy-makers design and prioritize efforts to promote alternative modes. An in-depth understanding of the factors influencing travel patterns and the extent to which these measures can change these conditions is therefore a main problem to address. To categorize the main exploratory factors influencing modal choice we will adapt the Cervero's model (2002) with Zhou (2016) and Paez (2004). In this sense, we chose to organize our explanatory model around three broad groups of factors: (i) individual characteristics (ii) characteristics of the trip and (iii) characteristics of the built environment with time contextual variables. The main factors that we used in our study are summarized on Table 1.

<p>Trip characteristics (quality and availability)</p> <ul style="list-style-type: none"> Travel time; Frequency; Costs <p>Individual characteristics (Students profile = traveller socio-demographic characteristics and attitudes/ motivation)</p> <ul style="list-style-type: none"> Age (Cervero 2002) Gender (Cullinane 2002) Car ownership (Sanchez and Arruda 2002; Ewing et al. 2005) and Driver's license for car (Naess 2005) Living arrangement (Zhou 2014; Zhou 2016; Alais et al. 1996) Main transport perceptions and degree of satisfaction (Cullinane 2002, Bamberg et al. 2003) Other external reasons (e.g. safety Danaf et al. 2014) <p>Characteristics of the Built Environment (factors related with campus profile)</p> <ul style="list-style-type: none"> Distance (Shannon et al 2006; Whalen et al. 2013) Pedestrian infrastructure and cycle quality (Rodriguez and Joo 2004) Road system (Balas 2003; Naess 2005) Network and public transport system (Naess 2005; Lavery et al. 2013) Accessibility (mixure and diversity, transport system available, road system available, information available...) <p>Factors related with Campus profile (basic campus characteristics)</p> <ul style="list-style-type: none"> Location (Mbars and Celliers, 2013; Ewing et al. 2005; Naess, 2006) Size (Ewing et al. 2005) Residence availability for students (on or off-campus) (Zhou 2016; Zhou 2016) Modal choice availability and quality (Naess 2005) Diversity on the activities (e.g. canteen, sports, leisure) (Zhou 2016) <p>Contextual variables (economic/political history and other indicator variables by country and presence of TDM)</p> <ul style="list-style-type: none"> at local level - presence of Travel Demand Measures and improvements on public transport system at national level and global level - economic crisis and important political / economic and historical measures, reforms changes 	Time constraints
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Table 1 - The main factors and variables explored in this study that influence mode choice Trip characteristics (quality and availability)

- i. Trip characteristics. The main factors usually included are time, frequency and associated costs. We also included information about multimodality. Lavery et al (2013) found that active travellers are seldom captive users of a single mode.
- ii. Individual characteristics. The individual characteristics of travellers that are used in the models are gender, age, income and car ownership (Zhou 2016; Zhan 2016; Cullinane 2002), the number of existing vehicles in the household (Danaf 2014) and socio-economic factors such as educational level and annual household income (Naess 2006), being the last two more common in European studies (Klößner & Friedrichsmeier 2011). Other individual variables explain heterogeneities among university students' transportation behaviour, higher socioeconomic or academic status is linked to a preference towards private transportation, whereas the use of public transport is more common among undergraduates of lower disposable income (Tezcan & Tanış 2011), mostly because of direct cost Barata et al. 2011). Younger students are also more

network grow on public transport may not have impact on mode choice. Although very scarce, data on the evolution of mobility of university students in two or more moments, seem to show a tendency of reduction of the use of the automobile and of the increase of the use of the public transports and the modes (French and Giles-Corti, 2010; Miralles-Guasch, Melo and Sarda, 2009; Marquet and Miralles-Guasch, 2017).

predisposed to alternative modes of transportation (Zhou 2012). Gender divides preferences and concerns, women tend to walk or share transportation (Zhou 2012) while men prefer their own car or bicycle (Delmelle & Delmelle 2012).

- iii. Characteristics of the built environment. The last three decades were rich in empirical studies focusing on the relationship between local physical environment and individual travel mode choice (Pinho et al. 2015). We chose to include in our study the DD of Ewing & Cervero (2010), which are the Population Density (number of inhabitants per km²); Diversity (mix of land uses); Design (connections and interconnectivity of the infrastructure and quality of the pedestrian environment - house vs. college). Distance and Accessibility (distance to destination, available transport system, diversity in route) (Ewing & Cervero 2010). The literature conclude that urban development can significantly influence the ways that people choose to travel (Cervero 2002; Zhou 2016) and the amount of travel by car is significantly higher in suburbs than in city centres (Naess 2005).

Within the characteristics of the built environment we can find in the literature some of the specific characteristics of university campuses. Most studies in the area concluded that the basic campus characteristics that influence students mobility patterns are, without a specific order, campus size, residence availability (on or off-campus), location (rural, suburban, urban), and diversity of activities. At local level we can also find other explanatory contextual factors such as presence of travel demand management (TDM) plans, strategies and programs, class schedules and telecommuting availability (Tomlinson 2014; Zhan et al. 2016; Zhou 2016).

The travel demand management (TDM) can include vehicular restrictions in some streets or parking cost (Shannon et al. 2006), introducing reserved bus lanes and signal priority at intersections, reducing public transport costs (subsidized fares, transit pass, others) operating an express bus service between campus and off-campus areas, and increasing student housing on or near the campus among others (Shannon et al. 2006).

Many of these exploratory factors influencing modal choice can be found in cross-sectional studies. However, in a study over time, there is still a need to include macro social contextual factors (economical/political and historical factors). For example, a war or a natural disaster will naturally generate different mobility patterns, in our study the crisis and the introduction of austerity measures had a great impact on the life of the Portuguese population and should be analyzed. These contextual factors - local, national and global factors, can be very important because cross-sectional data means that the analysis is essentially static, however, a study along time requires space-time changes should be considered (Paez 2004).

This article explores the main changes of commuting patterns of university students from before the financial crisis in 2006 to some years afterwards during the financial downturn and implementation of austerity policies in Portugal (2012). The purpose of this paper is to analyse the main factors that influence those patterns and ascertain their interrelations, as well as the main barriers and motivations affecting transport decision, focusing on the case of students from the Faculty of Engineering of the University of Porto (FEUP).

2 FEUP IN SPACE AND TIME

The Faculty of Engineering at University of Porto (FEUP) is part of the Asprela Campus (AC) and is located at the limits of Porto consolidated city, in the frontier line of three major municipalities of the Metropolitan Area of Porto, Porto, Maia and Gondomar and between three major motorways. This large university with 30,000 students is an important transport activity generator in Oporto Metropolitan Region¹. This university campus is relatively recent, conceived as a 'university city', after the relocation of the old university buildings spread from the urban centre of Porto to this area. The AC enrolls a large number of

¹ This Faculty have no transport policies or other travel management measures like parking costs, students until 23 years old have some subsidies to public transport costs from the Portuguese government.

public and private Institutions, lacking, however, diversity on commerce and housing. AC is one of the largest traffic generators in the Northern region, facing daily high levels of traffic congestion.

In Portugal, as in other southern European countries and some parts of the USA, most university students have no income and rely on their parents to pay for education fees, housing, travel and living costs (Cairns 2011; Cairns et al. 2014). Most students live off-campus¹. In Portugal there is no university accommodation policy and is common for students to live with their parents², which makes the problem of their mobility even more complex. Understand the commuting behaviour of FEUP students means to consider a larger region. The metropolitan area of Porto, the second largest in Portugal, contains a population of approximately 1.6 million people, with 1574 km² area, and a population density around 1016 (hab./km²), and has a polycentric urban structure (Pinho et al 2010:5). Like other metropolitan areas faces an increase in car use (INE, 2011). According to the 2011 Census, in a 10-year period, from 2001 to 2011, car journeys to work or school raised from 44,2% to 62,2% (INE 2011:35).

Big changes happened in the last years, in Porto. Several transport improvements and other planning measures were conducted: (a) at the local level, around FEUP's campus, new residential areas were built as well as new cycling paths, walking paths and a new road with sidewalks connecting with the eastern part of Porto; (b) at the metropolitan level, there were important changes on the public transport system (e.g. metro network improvements with more new lines, a unified ticket to public transport, Wi-Fi real time information at bus stops). We expected that both these measures and the Portuguese crisis would have an impact on student perception and mode travel choices.

3 METHODS

This article explores changes on modal choice, perceptions and barriers in a specific group. Our aim is to understand the explanatory factors that influence the modal choice along time. According to Anable (2005) if we want to built policy measures with effective results these should be designed in relation to specific target groups, which advises for the need of segmentation taking into account different attitudes and travel behaviours. In this way, policies should be oriented to those segments of the population that are more motivated to change and reduce the frequency of car use, thus justifying university students as an object of study.

The target population consisted of 5177 students in 2006 and of 4901 in 2012. Participants were 370 in 2006 and 352 in 2006 attending a University degree at Faculty of Engineering, University of Porto. Participants were randomly selected in order to set a representative sample. To determine sample size, we followed Krejci and Morgan proposal (1970, in Almeida & Freire 2007), that for an error probability less than 5% (with a confidence interval of 95%), for the population (N = 5000) the sample should include at least 360 subjects³ (Almeida & Freire 2007).

A personal survey was designed to provide information about commuting patterns, motivation and barriers for the university students. We designed an anonymous multiple-choice survey focusing on students' mobility mode choices and the reasons behind them, in reference to the day's trip to campus (Cervero 2002; Ewing and Cervero 2010). The survey was formulated considering the three groups of factors addressed⁴. In our study, it was necessary to introduce different contextual scales. It was included

¹ In this sense, it is expected to be verified that the economic crisis had an impact on the mobility patterns of Portuguese university students (Cairns et al. 2014).

² For example, the University of Porto (UP) has 9 University Residences with availability for 1192 individuals, equivalent to approximately 3.8% of the total UP students

³ Selected criteria were students attending the first to fourth years. After proper tuning with a pilot-survey, surveys were stratified among classes in various departments and colleges to get a heterogeneous distribution of degree and course in May of 2006 and after in May and June 2012. We used a sample size and the random process of selection of students for classes, year and course.

⁴ The first section asked about the main transportation mode used on the journey residence-university, if they used more than one, with their used on first, second and third place, identifying how they combined this modes of transport; also were asked time and cost associated with these commuting (modal factors). In the second section, we analyzed accessibility in the residency area (e.g. modes of transportation available, quality of sidewalks, direct bus, main obstacles and other residential amenities), main barriers that students face up on their commuting to campus, and main reasons to choose that transport used. Students were also asked about their degree of satisfaction with the public

important contextual data about changes on the transport system and accessibility¹. In addition to the local context we had to include macro-social data, a more myopic view of reality allows us to consider relevant issues, which in this study is related to the economic crisis and the impacts of measures of austerity in the modal choice of students.

Data was collected and analysed using the Statistical Package for Social Sciences (SPSS). Frequencies and other descriptive statistics were used to describe the sample and identify the main differences between the groups. Thus, this paper uses a Bi-variate and a Multi-variate Analyses in order to examine the relationship between variables. In order to determine differences between stages, numeric variables were analysed using a T-test or ANOVA and categorical variables using X2-test. Estimates could then be calculated separately for 2006 and 2012. A non-parametric test Mann-Whitney was used to verify the degree of satisfaction with public transport, answers were rated by respondents on a scale of 1-5. Only variables that were significantly correlated ($p < .05$) were included in the models.

4 RESULTS AND DISCUSSION

4.1 CHARACTERISTICS OF FEUP STUDENTS CHANGES

The samples from 2006 and 2012 included similar respondents' profiles as shown in Table 2. The respondents are on average 21 years old, ranging from 18 to over 40, and have a gender ratio of 2:1. The majority of the respondents have driving license, (given that 18 is the Portuguese legal age to obtain it), and 40% owns a car, although in 2012 there is a reduction in this percentage. The tendency for owners of personal vehicle to use it is statistically significant ($\chi^2(2) = 80.612, p = .000$). The type of residence is not only important as the social context of the students' mobility patterns, but also because of distance to campus and network availability (Table 3). Regarding students' residence, approximately 2/3 live with family and 1/5 rented a house¹¹. The type of residence is associated with the travel distance – on average, students living with family travel 11 km to campus. The number of students living in a 4km radii is almost the same between 2006 and 2012 (137, 40% to 141, 41%),

However one of the main differences is the number of students living nearer, less than 1km, from university, which did double in 2012².

	2006	2012
age mean	21	21
range	18 - 46	18 - 51
male	67 %	69 %
female	33 %	31 %
with license to drive 79 %	78 %	
who own a car	42 %	40 %

Table 2 - respondents' profiles (valid responses)

transport, as prior research provides evidence that attitudinal variables may influence the perception of different modes and, therefore, affect the level of utility that individuals derive from certain aspects of travel (Whalen). Finally, in the third section, respondents were asked questions related to individual characteristics such as: age, gender, car access, driving license, type of residence, residence address and code (GIS)

¹ This is directly related to the characteristics of the local physical environment, and to the thesis that support the premise that a good public transport system brings users. ¹¹ In 2012 there was a slight increase of students living with their families and who rent, partly because the number of students that bought a house dropped (from 13% to 7%). This in part was expected during austerity period, when there were law changes, including in credit approval (Law N°58 and Law N°59/2012) being very difficult to get access to credit housing benefits.

² This can be explained in part because this campus is relatively recent and there is an adaptation period for housing construction and getting into the market rent (private investment) in and around the campus.

Location	2006	2012
< 1km	8%	16%
1 - 4 km	32%	25%
4 - 8 km	32%	25%
> 8 km	28%	35%
Type of residence		
With family	64 %	66 %
Rented to students	21 %	23 %
University residence	4 %	3 %
Own residence	13 %	7 %
Amenities in the area		
Wide and comfortable footpaths	41 %	54 %
Metro station	27 %	32 %
Bus station	79 %	76 %
Bus station (direct route)	35 %	24 %
Motorway	39 %	37 %

a Bird distance, calculated from respondents' postal code of weekday residence.

Table 3 – Demographic profile of respondents

4.2 MODAL BREAKDOWN OF ACCESS TO FEUP

Multimodality doubled from 2006 to 2012, as we can see in Figure 3. When it comes to Public Transportation, metro has gained popularity in 2012 doubling the number of students (16% to 33%), deposing bus (26%)¹. Train is also increasing popularity (10%), despite the fact that there is no train station in the vicinity.

Lavery and Paez (2013) found that people who use active commuting are seldom unimodal. In our study this is aided by the fact that the nearest metro station and the bus hub are at 7 to 10 minutes away from campus (900m from FEUP's main entrance). Thus, these results also confirm as it has been observed in other studies, that university students tend to have a unique travel behaviour, different from the general population and use more alternative modes (Whalen et al., 2013). In Portugal, from 2001 to 2011, car journeys raised from 44,2% to 62,2% (INE 2011:35).

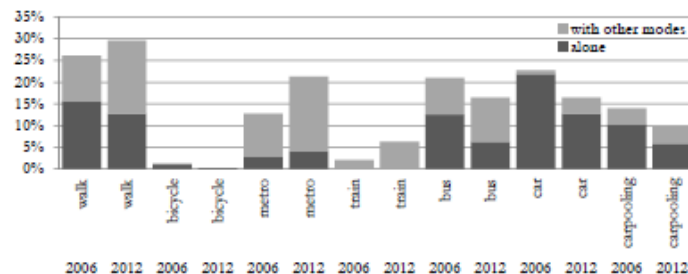


Figure 3 - Frequency of Mode choices when travelling to campus, in mono- and multi-modal trips (percentage of responses).

4.2.1 SHIFTING TIME AND MONTHLY COST

In 2006 home - college travel time was 30 minutes on average, but the high standard deviation (sd. 21,061) suggests a large dispersion around this reference value. In 2012 there was a slight increase in this value to 33 minutes (sd. 23.41). In 2006, students traveling by car were those who claimed to spend the most money on commuting, averaging 60€ per month (s. 50.62, 0-350€), the average travel time was around 23 minutes (sd. 14:27, 1-120 minutes), while in 2012 there is a decrease in the average value spent in the car 50€ (0-150€ N = 101) and travel time for students traveling by car 2012 varied from 2-60 minutes, with an average of 20 minutes (sd.10,43). Students traveling on public transport in 2006 spent an average of 40€ a month (29-150€), and took between 5-125 minutes (sd. 23.51), taking an average of 44 minutes. There was also an increase in the average amount spent on public transport 43€. Meanwhile, the average travel time for public transportation increased to 48 minutes (sd. 23.35, 10-120 minutes).

¹ For this, we present two possible factors – there was an adaptation period after the introduction of metro in the area, after which PT users shifted from bus to metro, and metro has a more regular and dependable service than bus.

4.2.2 GENDER, AGE, DRIVING LICENSE AND CAR OWNERSHIP

Our results revealed that female students tend to share a drive and use public transport more often than male students. This finding is consistent with Zhou (20012) and Delmelle and Delmelle (2012). However, data showing statistically significant differences found in 2006 are becoming only slight differences in 2012, mainly due to male student’s behavioural changes. The overwhelming majority of the surveyed students (80% of 370 and 78% of 350) have a driving license. Younger students tend to use more public transportation and older students tend to use more the private car. The tendency is similar in both years, in 2012 out of the 50% students who use public transport, 73% students have a license, as well as 75% students of the 19% students who usually travel on foot or by bicycle have driving license, which means that the vast majority of students who do not regularly use private transport has a driving license. Finally, in relation to possession of the vehicle itself, 42% and 40% responded positively. Access to car leads to its use (Limanond et al. 2011; Klöckner & Friedrichsmeier 2011). The tendency for owners of a personal vehicle to use it is statistically significant ($\chi^2(2) = 80.612, p = .000$).

4.2.3 RESIDENTIAL AREA AMENITIES

To analyse factors of physical environment of place of residence that may influence the mobility patterns of FEUP’s students, we asked students about some specific characteristics of their context, given that we had already some data on the destination. Indeed, the access to a metro station has increased, in 2006 23.9% of the students lived in a place with a Metro station less than 400 meters away and in 2012 29%¹. In fact, the number of students using the metro is now much higher, from 16% of respondents in 2006 to 33% in 2012 and from the students using metro only 30% use it as a first mode of transport, 27% go by car (17.4% solo, 15.7% carpooling), 17% catch a bus. From these 17% shifts himself to walk to get to the station and 10% use the train later combined with metro. If we think that sidewalks are one of the ways to get to a bus stop or underground station, we understand that most students have poor conditions either to move on foot or drive to a bus stop, which, as we have seen, were fundamental to the incentive of these two modes of transportation (Zhou 2012). Only 36% of respondents stated that they could use wide and comfortable sidewalks, however, of the respondents in 2012, 49% claimed to have access to these. On the other hand, a similar percentage of the studied population claims to have fast roads nearby. As high levels of accessibility, derived from highways, promote the use of private transportation (Cervero 2002), there is a greater incentive to use motor vehicles.

4.3 STUDENTS COMMUTING CHANGES AND MAIN FACTORS

The dominant modal choice is different from 2006 to 2012. In 2012 the preferred main mode choice was public transport (50%) but in 2006 it was the private transport (44%). Non-motorized modes maintained approximately the same average. The results indicate a statistically significant increase of public transport users and statistically significant reduction in car drivers (Chi-squared tests or Z-test - Montgonery). These results show a tendency of FEUP’s students modal choice to become more similar with other research results (Marquet & Miralles-Guasch 2017) and far away from others (e.g. Zhou 2016).

Dependent variables	2006 n=370		2012 n=352		X ²
	n	sample %	n	sample %	
Walk or Bicycle	73	20%	67	19%	
Public Transport*	142	38%	177	50%	*
Private transport	162	44%	108	31%	*

Table 4. Students commuting patterns

¹ The extension of the metro network reflected in the general population has increased the use of this transport. As we referred there were improvements on metro with more lines covering a larger area of influence (from 45 to 69 metro stations). Literature defends that improvements on network public service will increase their use (Shanon 2006). Pinho and Vilares (2009) point out that the introduction of metro helped to reshape the regression process of public transport, although metro also got some bus users.

TRAVEL DISTANCE BETWEEN HOME-FACULTY

The distance is one of the determinants of the choice of transport mode. For students who live at ranges less than 4 km from faculty walking is the preferred mode choice (Table 5). This result is similar to the majority of studies, which indicate that for distances less than 1 mile (1.6km) the preferred way is to walk, however our data show that this distance may be higher depending on other conditions. Distance is an explanatory factor in active commuting (Delmelle & Delmelle 2012). Closer locations (less than 10/20 min.) lead to trips made by foot or bike (Bopp et al. 2011). However, Whalen et al. (2013) found that distance may vary importance depending on distance travelled (Whalen et al., 2013). For distances between 4km and 8 km modal choice possibility is variable, it is distributed between public and private transport. These results, in conjunction with the maps illustrating the spatial distribution of residence, indicate that more than 50% of car use can be shifted by non-motorized or public transport modes, as argued in literature until 5 mile or 8 km is a biking zone (Shannon et al. 2006). In that sense, they are a feasible option for students, however the availability in and near campus free parking gives students comfort and time. In our study, we also observed that for trips over 8km there was a significant change in behaviours, from car use to the use of combined collective transportation. Our data also indicate statistically significant differences for distances over 8km. In 2006 the preferred mode of transport was car but in 2012 the number of students who failed to take the car went down to half, from the public transport clearly being the preferred way.

		travel distance			
		< 1 km	1 - 4 km	4 - 8km	> 8 km
<i>Walk or Bicycle</i>	2006	76,4%	25,6%	0,0%	,0%
	2012	67,9%	37,6%	6,0%	1,0%
<i>Public Transport*</i>	2006	7,3%	45,3%	59,1%	66,4%
	2012	14,3%	31,2%	45,7%	45,5%
<i>Private transport</i>	2006	16,4%	29,1%	40,9%	32,8%
	2012	17,9%	31,2%	48,3%	53,5%
				*	*

Table 5 – commute distance and modal choice

Our study also reveals that the average distances from students who walk are different between 2006 and 2012¹. Type of residence is related to distance of travel. Students living in rented housing live near campus and prefer non-motorized. The preferred transport mode for those who rent housing system is still walk, probably because there is more freedom among location choice and modal choice. This finding is consistent with the findings of Shannon et al. (2006) and Lavery et al. (2013). However, Lanzendorf (2002) found that living arrangements and household type were not significant.

MAIN REASONS TO CHOOSE ONE MODE OF TRANSPORT AMONG OTHERS

Cost was statistically the most significant factor between 2006 and 2012 (statistically significant increase), which somehow seems to be associated with the economic crisis (Table 6). Like the research of Delmelle and Delmelle (2012) our results also reveal that male students are more cost sensitive than female students. Public transport is known as cheaper than car, although cost may not be a key factor for changing to public transport and other factors may have greater impact, such as time and comfort. In accordance with literature our results revealed that time is an important reason for mode choice. In both samples time is the most perceived reason to car users. In 2006 for non-motorized was the most important reason too. Journey time by car is perceived to be much less than it may actually be (Beirao & Cabral 2007). Driving is also associated with a sense of control, freedom and accomplishment, is a necessity to maintain the accessibility sprawling urban areas (Lavery et al. 2013; Whalen et al. 2013). Cost and health are usually associated with active modes (Bopp et al. 2011; Shannon et al. 2006), time and comfort with car use (Beirao & Cabral 2007). Conversely, concerns with safety, time and comfort act as barriers to

¹ Naturally, for walking, the percentage decreases sharply with the increase of travel distance, for distances greater than 4km the use of this transportation is virtually nil. The number of students living in a 4km radii is almost the same between 2006 and 2012 (137, 40% to 141, 41%), however one of the main differences is the number of students living near, less than 1km, from university, doubled in 2012. This can be explained in part because this campus is relatively recent and there is an adaptation period for housing construction and getting into the market rent (private investment) in and around the campus.

active modes (Shannon et al. 2006), time and comfort are usually incompatible with public transport and, finally, cost is the main complaint among car users (Tezcan & Tanış, 2011).

We found out in our study that people who do not use public transport seem to have a worse opinion of them than those who use them. In order to verify if the degree of satisfaction differed in both groups (users of public transport and non-users), we used the non-parametric Mann-Whitney test, at a level of statistical significance 5 given that the scale used was ordinal. We found that the differences between the two groups were statistically significant, with the group that did not often use public transportation having a worse opinion ($z = -2,2006$, $p = 0.03$).

	2006			2012			χ ²
	Walk or Bicycle %	Public Transport* %	Private transport %	Walk or Bicycle %	Public Transport* %	Private transport %	
<i>there is no other option</i>	13,7%	28,8%	7,1%	10,4%	28,8%	13,0%	
<i>cost</i>	28,8%	26,1%	7,1%	56,7%	26,4%	25,0%	*
<i>comfort</i>	12,3%	23,2%	39,0%	32,8%	24,8%	48,1%	
<i>time</i>	46,6%	20,4%	53,2%	46,3%	23,2%	63,9%	
<i>schedules</i>	2,7%	5,6%	18,8%	10,4%	13,0%	32,4%	

(Students could respond more than one reason)

Table 6. Main reasons to choose one mode among others

5 FINDINGS AND CONCLUSIONS

In this paper, we have explored how commuting patterns of university students have changed in face of the recent austerity period in Portugal. We aimed to gain some understanding about the explanatory factors that influence those patterns for that specific group. The crisis may explain changes on mobility needs and created a strong incentive to cut some spending costs on most expensive modes of transport, in particular for longer distances. However, socioeconomic changes alone are not sufficient to explain differences in travel behaviour. Despite the presence of other explanatory factors, the trends seem to indicate a better use of the transportation system available, students are more multimodal and the results give us significant differences among car users. The differences of modal choice have repercussions upon several aspects of mobility, such as cost, travel time and distance to/from residence. This study compares two points in time and cannot support an effective analysis of the financial crisis. However, our results seem to reflect that even if not all groups of students were affected by the financial crisis in Portugal, our research identifies a group of students that have changed their behaviours. This group is characterized by male students living with their families at distances greater than 8km. Cost is pointed out as the main reason for this option.

In summary, our results highlight some relevant findings: we verified that for trips over 8km there was a significant change in behaviour, from car use to the use of combined public transportation. In 2006 students who lived farther than 8km travelled mostly by car with monthly expenses that reached 350 euros. In 2012 these values decreased substantially. Taking into account the large number of Portuguese families who suffered from the impacts of the crisis, forced to make adaptations and changes in their daily behaviour, including mobility, it was expected that some of these impacts would be reflected in part by university students. In our study, a change in the attitudes of male students living with their families at distances greater than 8km is evident. Effectively, there is an increase in the number of students living with their family farther than 8km away from FEUP, which seems to explain a family management option. Other plausible interpretation is that, after the improvement of the metropolitan light rail, students tend to use it (> 8 km: 8% in 2006 had access to metro and in 2012 increase to 15%).

For trips that are not very long between 4km and 8km, car continues to be widely used, which suggests that at these distances the associated cost variation did not justify a change in behaviour. Thus the collective transportation system seems to benefit users on long journeys, but not for shorter journeys. This should allow us to question how we can increase the cost difference between car use and the use of public transport within urban centres, following the general trend in Europe. In our study, we can verify that within the urban zone, the car tends to be faster, and to have similar costs for those who use public transport,

since (at that time) there were no paid parking policies near the Faculty nor other type of 'penalties' for car users, nor, on the other hand, effective networks of BUS lanes¹.

We therefore reaffirm the urgency of implementing such measures. It should be noted that the economic crisis does not affect all users in the same way, the distance for those who live close remains as a consistent explanatory factor, those who live near the Faculty tend to move on foot. However, when questioned about why they are moving on foot, the response changes from reasons of 'speed' in 2006, to 'cost' in 2012, which demonstrates a change in attitude and priorities. Our study also shows that those who opt for a house renting scheme, seek to make it closer to the Faculty, substantially reducing transport costs, not only financial but also time related. However, there is no relevant difference in the size of the group between the two samples. In Portugal, there are no policies regarding the accommodation of university students, so we believe it would be imperative to introduce policies to encourage university students to a leasing system close to universities. Students who normally use public transport on their commuting most of the times combine it with other modes. Furthermore, our study also reveals that people who use active commuting (walking or biking) are more sensitive to the local physical environment. In this way, we should give special emphasis to the attributes of the local physical environment.

Synthesizing, the commuting patterns of FEUP's student are different. Our results revealed (i) Individual characteristics – gender differences have faded, mainly due to male student's behavioural changes, age is still an explanatory factor as well as car ownership². (ii) Trip characteristics - in general students are spending less money on transport, mainly because for longer and more expensive trips students changed from car use to public transport use, although this change was territorial, differences between social contexts gained importance. (iii) Characteristics of the built environment - our results reveal that an improvement on transport system can lead to an increase in its use and distance is an important factor to non-motorized modes of transport. Explanatory factors may vary depending on the mode of transport. Car users seem to favour time and comfort to cost, but our results suggest this may be not true for longer distances when cost became significant. This finding may open a window to introduce some new measures at shorter distances.

We have verified that the factors that justify the use of a mode of transport in a certain period may be different in another period. This variation of explanatory factors over time is important as policy makers must take into account their dynamics in the construction of analysis and decision models. Our study also reveals the importance of taking into account fundamental contextual macro social factors - political-economic, historic and socio cultural. In practical terms this could mean raising awareness of time and different scales of context for policy design, taking into account not only local contextual data but also macro-social ones. Lastly, the crucial question is to know, whether these changes towards more sustainable modes of transport are intrinsic and natural, accompanied by a change of mentalities that incorporates associated advantages such as savings, health, time and quality of life, or whether it is only a direct reflection of the economic situation of the country. In this sense, we consider it particularly pertinent to carry out a new study to investigate, in the current context, if there is a deflection on the use of public transport and a gain in private transportation, or if a more sustainable trend is maintained, embracing the thesis that it is important to test the transport system and improve its image in the public opinion.

¹ In general, the students improved their accessibility conditions to the metro system. Although the proximity to a metro station has increased, this improvement alone is not enough to explain the great adherence to the metro in 2012, especially for distances of more than 8km. It should be noted that the financial crisis had several impacts on the transport system. If buses were penalized by price increases and the reduction of some access lines and schedules, which may partly explain the decline in their use, so did private transport with the introduction of tolls and fuel prices. As a result, they may have contributed to the change to public transport, justifying the change in behavior and benefiting the use of the metro in particular.

² Public Transportation is relatively more used by women, but the differences between sexes are fading. Between 2006 and 2012, female student's mode shares were virtually unchanged and the mode shift is explained entirely by male behaviour.

BIBLIOGRAPHIC REFERENCES

- Almeida, S. and Teresa Freire. 2007. *Metodologia Da Investigação Em Psicologia E Educação*. 4a. edited by P. Edições. Braga: Psiquilíbrios edições.
- Anable, Jillian. 2005. "Complacent Car Addicts'; or 'Aspiring Environmentalists'? Identifying Travel Behaviour Segments Using Attitude Theory." *Transport Policy* 12(1):65–78.
- Balsas, Carlos J. ... L. 2003. "Sustainable Transportation Planning on College Campuses." *Transport Policy* 10(1):35–49.
- Bamberg, Sebastian, Icek Ajzen, and Peter Schmidt. 2003. "Choice of Travel Mode in the Theory of Planned Behavior: The Roles of Past Behavior, Habit, and Reasoned Action." *Basic and Applied Social Psychology* 25(May):175–87.
- Banister, D., P. Crist, and S. Perkins. 2015. "Land Transport and How to Unlock Investment in Support of 'Green Growth.'" *OECD Green Growth Papers* (1):1–35.
- Barata, E., Cruz, L., & Ferreira, J. P. (2011). Parking at the UC campus: Problems and solutions. *Cities*, 28(5), 406-413.
- Bleechmore, Regan, Billie Giles-corti, Sarah French, and Doina Olaru. 2011. "University U-Pass Programs: Projecting Potential Quantitative Impacts at UWA." 34th Australasian Transport Research Forum (ATRF) September.:1–17.
- Bopp, Melissa, Andrew Kaczynski, and Pamela Wittman. 2011. "Active Commuting Patterns at a Large, Midwestern College Campus." *Journal of American College Health* 57(7):605–11.
- Boyd, Brent et al. 2002. "An Analysis of the Effects of UCLA's Fare-Free Transit Program (BruinGo) on Student Commuting Mode Shares." *Transportation Research Record: Journal of the Transportation Research Board* 101–10.
- Cairns, David. 2011. "Youth, Precarity and the Future: Undergraduate Housing Transitions in Portugal during the Economic Crisis." *Sociologia, Problemas e Praticas* 66:9–25.
- Cairns, David, Katarzyna Growiec, and Nuno De Almeida Alves. 2014. "Another 'Missing Middle'? The Marginalised Majority of Tertiary-Educated Youth in Portugal during the Economic Crisis." *Journal of Youth Studies* 17(8):1046– 1060.
- Cervero, Robert. 2002. "Built Environments and Mode Choice: Toward a Normative Framework." *Transportation Research Part D: Transport and Environment* 7(4):265–84.
- Crane, Randall and Richard Crepeau. 1998. "Does Neighborhood Design Influence Travel?: A Behavioral Analysis of Travel Diary and GIS Data." *Transportation Research Part D: Transport and Environment* 3(4):225–38.
- David, F., Abreu, R., Segura, L., Formigoni, H., & Mantovani, F. (2015). Impact of the economic crisis on the higher education: The case of Portugal.
- Delmelle, Eric M. and Elizabeth Cahill Delmelle. 2012. "Exploring Spatio-Temporal Commuting Patterns in a University Environment." *Transport Policy* 21:1–9.
- Eom, Jin Ki, Kwang Sub Lee, Dae Seop Moon, Duckshin Park, and Keun Yul Yang. 2014. "Investigating Activity Patterns and Time Spent for Exposure Assessment of College Buildings in Korea." *Procedia Computer Science* 32:756–61.
- European Commission. 2014. "Consultation of the Horizon 2020 Advisory Groups Response of the Transport Advisory Group June 2014." (June).
- Ewing, Reid and Robert Cervero. 2010. "Travel and the Built Environment: A Synthesis." *Transportation Research Record: Journal of the Transportation Research Board* 1780(917422348):87–114.
- Frade, Catarina and Lina Coelho. 2015. "Surviving the Crisis and Austerity: The Coping Strategies of Portuguese Households
- Freire, André and Cathrine Moury. 2013. "Austerity Policies and Politics: The Case of Portugal The Case of Portugal." *Pôle Sud* 39(October):35–56.
- Fujii, Satoshi and Ryuichi Kitamura. 2003. "What Does a One-Month Free Bus Ticket Do to Habitual Drivers? An Experimental Analysis of Habit and Attitude Change." *Transportation* 30(1):81–95.
- Garcia-Sierra, Marta, Jeroen C. J. M. van den Bergh, and Carme Miralles-Guasch. 2015. "Behavioural Economics, Travel Behaviour and Environmental-Transport Policy." *Transportation Research Part D: Transport and Environment* 41(November):288–305.

- Klößner, Christian A. and Thomas Friedrichsmeier. 2011. "A Multi-Level Approach to Travel Mode Choice - How Person Characteristics and Situation Specific Aspects Determine Car Use in a Student Sample." *Transportation Research Part F: Traffic Psychology and Behaviour* 14(4):261–77.
- Lanzendorf, M. (2003, August). Mobility biographies. A new perspective for understanding travel behaviour. In 10th international conference on travel behaviour research (Vol. 10, p. 15).
- Lavery, T. A. A. et al. 2013. "Driving out of Choices: An Investigation of Transport Modality in a University Sample." *Transportation Research Part A: Policy and Practice* 57:37–46. Retrieved March 15, 2016
- Limanond, Thirayoot, Tanissara Butsingkorn, and Chutima Chermkhunthod. 2011. "Travel Behavior of University Students Who Live on Campus: A Case Study of a Rural University in Asia." *Transport Policy* 18(1):163–71. Retrieved (<http://dx.doi.org/10.1016/j.tranpol.2010.07.006>).
- Marquet, Oriol and Carme Miralles-Guasch. 2017. "Resilient Territories and Mobility Adaptation Strategies in Times of Economic Recession. Evidence from the Metropolitan Region of Barcelona, Spain 2004-2012." *European Urban and Regional Studies* (April):forthcoming.
- Miralles-Guasch, Carme, Montserrat Martínez Melo, and Oriol Marquet Sarda. 2014. "On User Perception of Private Transport in Barcelona Metropolitan Area: An Experience in an Academic Suburban Space." *Journal of Transport Geography* 36:24–31.
- Molina-Garcia, Javier, Isabel Castillo, and James F. Sallis. 2010. "Psychosocial and Environmental Correlates of Active Commuting for University Students." *Preventive Medicine* 51(2):136–38.
- Naess, Petter. 2005 Residential location affects travel behavior—but how and why? The case of Copenhagen metropolitan area. *Progress in Planning*, 63(2), 167-257.
- Nielsen, Thomas Alexander Sick. 2015. "Changes in Transport Behavior during the Financial Crisis. An Analysis of Urban Form, Location and Transport Behavior in the Greater Copenhagen Area 2006-2011." *Research in Transportation Economics* 51:10–19. Retrieved (<http://dx.doi.org/10.1016/j.retrec.2015.07.003>).
- Paez, A. (2004). Network accessibility and the spatial distribution of economic activity in Eastern Asia. *Urban Studies*, 41(11), 2211-2230.
- Pinho, P., & Silva, C. (Eds.). (2015). *Mobility patterns and urban structure*. Ashgate Publishing, Ltd.
- Rybarczyk, Greg and Laura Gallagher. 2014. "Measuring the Potential for Bicycling and Walking at a Metropolitan Commuter University." *Journal of Transport Geography* 39:1–10.
- Shannon, Tya et al. 2006. "Active Commuting in a University Setting: Assessing Commuting Habits and Potential for Modal Change." *Transport Policy*.
- Tezcan, Hüseyin Onur and Mustafa Tanış. 2011. "Does the Academic Rank Matter? Study on the Trip Preferences of Academicians from Different Ranks Employed at Istanbul Technical University." *Journal of Urban Planning and Development* 137(3):272–80.
- Tomlinson, Andrew Mark. 2014. "Using the Academic Timetable to Influence Student Trip- Making Behaviour." thesis PhD (February).
- Ulfarsson, Gudmundur F., Anne Steinbrenner, Trausti Valsson, and Sungyop Kim. 2015. "Urban Household Travel Behavior in a Time of Economic Crisis: Changes in Trip Making and Transit Importance." *Journal of Transport Geography* 49:68–75.
- Whalen, Kate E., Antonio Paez, and Juan A. Carrasco. 2013. "Mode Choice of University Students Commuting to School and the Role of Active Travel." *Journal of Transport Geography* 31:132–42.
- Zhan, Guangjun, Xuedong Yan, Shanjiang Zhu, and Yun Wang. 2016. "Using Hierarchical Tree-Based Regression Model to Examine University Student Travel Frequency and Mode Choice Patterns in China." *Transport Policy* 45:55–65. Retrieved (<http://dx.doi.org/10.1016/j.tranpol.2015.09.006>).
- Zhou, Jiangping. 2012. "Sustainable Commute in a Car-Dominant City: Factors Affecting Alternative Mode Choices among University Students." *Transportation Research Part A: Policy and Practice* 46(7):1013–29.
- Zhou, Jiangping. 2014. "From Better Understandings to Proactive Actions: Housing Location and Commuting Mode Choices among University Students." *Transport Policy* 33:166–75.
- Zhou, Jiangping. 2016. "Proactive Sustainable University Transportation? Marginal Effects, Intrinsic Values and University Students' Mode Choice." *International Journal of Sustainable Transportation* 8318(9):0.