Simulation games: an application to public economics

Maria Cubel and Cristina de Gispert*

Abstract: As part of a project to promote active learning we incorporated simulation games into our lectures on public economics at the University of Barcelona. This paper describes a game used to illustrate the main aspects of the Tiebout model of public sector decentralization. By means of a simple voting mechanism, students have to decide the level of social amenities they wish to have in their hall of residence. After the second year, the classroom splits in two and students are able to move. Hence, overall welfare increases with sorting. By linking preferences to income we then illustrate the equity implications of the model, since segregation by income increases the inequality between groups. The exercise is complemented with a brief questionnaire designed to gather information about students' perceptions of this sort of game. The results showed that students rated the exercise highly.

Key words: classroom games, simulations, public economics, fiscal federalism, Tiebout's model

JEL codes: A22, H73, H77

Creative play – seeking to see the world afresh
– is at times a fight against the fascination which familiar
associations and directions of thought exert on us.
Young people need to be encouraged to understand the
importance of this kind of play.
Professor Lewis Minkin

1. Introduction

Over the last ten years Spanish universities have seen a sharp rise in student absenteeism and an increasing lack of motivation with respect to traditional lectures. Large group sizes have usually been the main obstacle to implementing more

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participative means of teaching and learning[1]. Fortunately, this situation is gradually changing and lectures are now incorporating alternative teaching techniques such as case studies and practical exercises, etc. In our context we decided to address this issue by introducing classroom games into our lectures in order to foster student interest, creativity and participation[2]. This kind of practice is in accordance with current EU education policy and with the actual demands of students[3].

This paper describes our experience of using classroom games when teaching the subject of fiscal federalism, which is part of a standard course on public economics. Specifically, we present the results obtained from a game used to illustrate the economic implications of the Tiebout hypothesis of public sector decentralization.

The Tiebout model is one of the main theoretical topics in our course on local public finance. This is a compulsory course that forms part of the economics degree and which includes both theoretical and applied aspects. The number of students taking these compulsory subjects in the Faculty of Economics is high. Indeed, the course on local public finance is usually attended each semester by around 400 students, who are divided into two groups (morning and afternoon).

In the context of fiscal federalism theory the Tiebout model provides an efficiency argument for decentralizing the provision of public goods and services. Tiebout (1956) argues that under some assumptions individuals would move to the jurisdiction where they can best satisfy their preferences for public goods and services. Thus, *people do not vote at the polls, but with their feet*. Tiebout is suggesting a competitive market of

[1] See Exeter *et al* (2010).
[2] See Kumar and Lightner (2007) for an analysis of the perceptions of trainers, instructors and students on the use of games as an interactive teaching technique.
[3] These demands were expressed through questionnaires administered to students after conducting the experiment. The results of the questionnaires are discussed in Section 5.

jurisdictions in which every jurisdiction provides the efficient amount of public goods and services and people sort among jurisdictions efficiently[4].

After many years of teaching local public finance we observed that the Tiebout hypothesis was one of the topics that students find most difficult to understand. Furthermore, students generally question its usefulness and applicability to real life. We assume that this is due to the constrained assumptions which Tiebout uses to develop his argument for decentralization, as well as to the fact that, in order to assimilate the consequences of the model, students need to make a real effort in terms of abstraction and imagination. Consequently, we decided to try to encourage the students' attention and ability for abstraction by giving them the opportunity to apply Tiebout's model in an artificial setting. Specifically, we designed different scenarios in which they had to make various decisions regarding personal location, taxes payable and desired services, etc. On the assumption that students would behave rationally we expected that they would end the game by confirming the Tiebout hypothesis. We also predicted that the use of a game would enable students to feel closer to and more familiar with the model, internalizing all its assumptions and implications in an intuitive way.

In order to keep things simple we decided to focus on the efficiency and equity implications of the Tiebout hypothesis[5]. The design of the game was based predominantly on the work of Brouhle et al. (2005), although it departed from their work in two key aspects. First, we consider here that individuals are heterogeneous in two dimensions: income and preferences, whereas these authors only analyse the consequences of heterogeneous preferences. This is important, since having differences in income allows us to explore the equity aspects of the Tiebout hypothesis, which are

[4] See Oates (2006, 1981) for further reading on the Tiebout model.
[5] See Hewett et al. (2005) for an experiment to highlight the efficiency implications of the Tiebout hypothesis using a median voter approach.

not trivial. This point will be discussed later. Moreover, and this is the second main difference with respect to the work of Brouhle et al. (2005), we complement the game with a brief questionnaire designed to gather information about students' ratings of this kind of experience. The results obtained are described in the concluding section.

The paper is organized into five sections. Following this introduction, section two presents the main advantages and disadvantages of using games as an interactive classroom technique. Section three provides a brief description of the Tiebout model of public sector decentralization. Section four describes the procedure of the game and, finally, section five is dedicated to the discussion and concluding remarks.

2. Why games may be used as a teaching and learning technique

Classroom games and experiments are short, interactive exercises designed to facilitate the comprehension of key economic ideas. Some of the benefits attributable to experiences of active learning like this are: they are student-centred; they maximize participation; they are highly motivational; and they give life and immediacy to the subject matter by encouraging students to move beyond a superficial, fact-based approach to the material (McCarthy & Anderson, 2000). Moreover, classroom games are also a suitable instrument for promoting the intuitive understanding of abstract concepts, for connecting abstract and functional knowledge so that students are more aware of the utility and applicability of the learned materials, and for fostering the identification of students with the knowledge acquired.

Games can be a fun way not only to learn but also to teach. Classes develop in a more relaxed atmosphere than in the traditional lecture format and students have the opportunity to reveal more themselves, as do teachers. Furthermore, games provide an

easy way to engage students in discussions through the specific experience at hand[6], and the teacher can then guide their discussions towards abstract conceptualisations and the understanding of theoretical concepts. Another advantage of games is that they work for all levels of students. Indeed, games can introduce a topic in a friendly way to students from many different backgrounds and skills, in particular to those with low mathematical skills.

A number of recent studies have sought to demonstrate the benefits of using classroom games and simulations. The basic methodology is to keep the lecturer and module fixed, while randomly assigning students to two groups, one with games and one without games. Afterwards, one compares performance. The results show that the use of games increased scores, especially among females, and that they benefited the weaker students. However, those who tend to learn by reading and/or writing benefit less than those who prefer to learn by doing. More positively, games significantly improved the teaching evaluations of lecturers and the degree to which students found the course stimulating[7]. In this context, Lundy (1991) points out that the effectiveness of games in terms of enhancing cognitive learning depends on the students' approach. She remarks that competitiveness tends to have a negative impact on cognitive learning gains and that the involvement of the tutor during the game is important to secure active learning.

Lean et al. (2006) identify three broad barriers to teaching with games that instructors face: suitability, the resources required and the risks involved. Suitability implies ensuring that games are geared towards the achievement of intended learning outcomes, and clarifying whether they help to develop skills or knowledge. For

[6] An old Chinese proverb says, "I hear, and I forget; I see, and I remember; I do, and I understand".
[7] Ball, Eckel and Rojas (2006), Durham, McKinnon and Schulman (2007), Emerson and Taylor (2004).

instance, there is a danger that games may be misleading if they are too simple compared to reality (Davies, 2002). Thus, the choice of a particular game or simulation to explain a theoretical concept is a critical stage in developing active learning lectures. Second, games are usually more resource intensive than are other more traditional didactic methods of teaching, especially in terms of time expenditure. The latter includes time to prepare, execute and assess the game, and probably additional time to reinforce points that are covered in regular lectures. In our opinion, time restrictions mean that one has to be very selective in choosing the number of games and the subjects in which they might be carried out. Other costs derived from classroom games may be administrative, technical or related to additional staff costs (Sutcliffe, 2002).

In the context of classroom games and experiments the third potential barrier may be considered in terms of uncertainties about proper functioning. The range of risks includes, essentially, student resistance and negative reactions to learning with games, and a potential loss of control by the teacher over both experimental lectures and student learning. With respect to student reactions Kumar and Lightner (2007) reported that some students associated games and experiments with *childish* activities. Therefore, it may be necessary to provide incentives to encourage students to take games and experiments seriously (i.e. random payment). Another possible way of doing this is to have exam questions based upon the game.

From the teacher's point of view the main problem is the fear of losing control or of obtaining anomalous results that will be difficult to explain. Thus, the instructor of the game can always try to minimize the risk by defining behavioural rules to limit students' freedom. However, we agree with Holt (1999) that small variations in outcomes can provide interesting points for discussion.

3. A brief explanation of the Tiebout model

In common with a centralized approach the decentralized provision of public goods faces the problem of how to satisfy the unknown preferences of citizens. These preferences are revealed through an imperfect mechanism, namely the political process of elections. Therefore, to be in favour of public sector decentralization is only economically consistent if the political tools of local governments allow such an approach to be better in terms of efficiency.

The Tiebout hypothesis supports this view: allocation is better in a decentralized public sector context than in a centralized one. The mobility of citizens between jurisdictions allows them to show their preferences by moving to the community that provides their most desired bundle of public goods and taxes. Tiebout argues that if the number of communities is enough to accommodate the different types of preferences, then competition between them ensures that local public goods are provided at a lower cost. He also assumes an optimal community size for each pattern of tastes, as well as that there are no externalities or economies of scale, that residents have full information about available options, and that sorting is costless. Moreover, he excludes employment factors from the analysis. Once citizens sort themselves among communities, preferences are homogeneous within the communities and heterogeneous between them.

The Tiebout sorting equilibrium and the possibility of efficient provision of local public goods also depends on the principle of taxation being applied. Specifically, it is necessary that each community imposes a head tax equal to the cost of provision divided by the population of the community. If local governments established taxes according to the ability to pay, citizens could move to another community for fiscal reasons. Actually, citizens would move to the community where their net benefit from

public goods and taxes would be higher. By doing so, however, citizens would not reveal their preferences for public goods, and public provision would not be optimal.

These non-realistic assumptions hinder teaching of the Tiebout model, because students cannot visualize a real context where the hypothesis becomes true. This is why we believed it was a good idea to introduce a game into our teaching of this subject.

4. Description of the game

The following classroom game is designed to explore the efficiency and equity implications of Tiebout's decentralization model, providing students with a relaxing and stimulating framework in which to discuss it.

In order to simulate the Tiebout world we established an artificial scenario in which students, as in the paper by Brouhle et al. (2005), are supposed to live in a hall of residence which offers entertainment amenities such as parties, music concerts or poetry readings, etc. In each period, every student has to indicate by a vote the amount of money that he or she is willing to pay to finance these social activities. Different levels of provision emerge from several voting rounds depending on the students' preferences, income and degrees of mobility, as will be described below.

The game takes about 45 minutes and can work with both small and large groups. However, after trying different group sizes we found that the ideal size is probably between 30 and 50 students; this number is large enough to ensure enriching discussions but means that the process of counting votes is still manageable. The game is structured around two phases. In the first phase, students are supposed to have equal income but different preferences for social activities. To simplify, students are classified into two types: those who obtain large utility from social activities (high valuers) and those who

do not (low valuers). In the second phase, students are heterogeneous in both income and preferences (see Table 1). Thus, students are also of two types as regards income: *relatively* rich students and *relatively* poor students. In order to ensure a voting equilibrium, we reduce the analysis to one dimension so that preferences for social activities are linked to income. Hence, assuming that social activities are normal goods, we impose the condition that *relatively* rich students present a stronger preference for social activities than do *relatively* poor students. Throughout the game, information about preferences and income remains private, such that students know their own type but not the characteristics of their peers.

Procedure

At the start of the game, students receive an envelope containing all the material they need to play[8], specifically: a coloured instruction sheet, two record sheets of different colours (one for each phase of the game) and a coloured mobility card. The information about students' preferences for social amenities and income is included on the instructions sheet. When students receive the envelope they are asked not to read the instruction sheet corresponding to the second phase of the game and not to exchange information with their colleagues.

The instruction sheet contains information about the rules of game, the functions they should use to calculate their individual utility and overall welfare, and some examples about how to use these functions. Colours play an important role in the preparation of the material. Hence, the colour of the instruction sheet relates to the preferences for social amenities. For example, we used a bright colour (orange) for the

[8] It is useful to prepare the classroom in advance so that students find the envelopes in their seats when they arrive.

high-valuation type and a softer colour (light green) for the low-valuation type. The record sheet is used by each student to write down the tax level that he/she wishes to vote for, as well as the overall tax chosen and the net welfare corresponding to each voting round. The record sheet also includes information about the student's income. Thus, in the second phase of the game, in which there are two levels of student income, we distinguished between the two types (*relatively* rich and *relatively* poor) by printing the record sheet (for this phase) in two different colours (violet and light yellow). By contrast, the record sheet for the first phase of the game was white for all the students since they did not have different incomes. Mobility cards were also of different colours, using blue for mobile students and red for immobile students.

As mentioned above, students were divided into two types in order to play the game. In the first phase of the game, types were defined according to their preferences. At the end of this phase they received new information about their income, such that their preferences were now linked to income while maintaining their previous type. Approximately half the students were of each type, although they were distributed unevenly around the class. Specifically, we divided the classroom into two parts (left and right), corresponding to two halls of residence from the first year onwards. We then distributed two-thirds of the envelopes with rich/high valuation types and one-third of the envelopes with poor/low valuation types around the left-hand part of the class. The remaining envelopes were distributed around the right-hand part of the class. This means that we had a majority of rich/high valuation types to the left and a majority of poor/low valuation types to the right. Mobility cards were distributed evenly among both parts of the class and between types. Thus, in each part of the class around 50% of the students in each type were mobile, while the remainder in each type were immobile.

The first phase of the game is organized into four years and four rounds of voting, one for each year. At the start of this phase each student is informed about the total amount of money (y) which he or she has to spend on social amenities per year. In the first year all students live together in the same hall of residence, and they have to decide collectively on the amount of social amenities they wish to have. In order to do so, they must vote for the amount of money they are willing to pay (T_i) in order to finance social amenities. However, they cannot freely decide the amount to vote for, but rather must choose between three possibilities: 0, 50 or 100.

The level of provision of social amenities (E) is determined by the total tax collected (T), such that E = T. Furthermore, the actual tax due to be paid by each student is the average voted tax, $T^* = n_0 \times 0 + n_{50} \times 50 + n_{100} \times 100$, where n_i is the proportion of students voting i, and i = 0, 50 or 100. By assumption, a unit of social amenities costs €1. Hence, e = T*, where e is the per capita amount of social amenities. Individual benefits obtained from social amenities depend on a student's preferences, which are referred to on the instructions sheet as a personal value multiplier (PVM). Thus, individual benefits are defined as 2e for high-valuation students and 0 for low valuers (low-valuation students have a zero personal value multiplier and they derive no benefit from social amenities). Hence, net welfare is defined as $W_H = Y + 2e - T^*$ and $W_L = Y - T^*$, where the lower case H and L refer to high valuation and low valuation types, respectively. Simplifying, net welfare can be written as $W_H = Y + T^*$ and $W_L = Y - T^*$. Finally, overall (net) welfare is calculated as $W = N_H W_H + N_L W_L$.

After the first year, students are told that there are now two halls of residence which coincide with the two parts of the class into which they have been divided (left and right). During the second year, no student is able to move from their original hall of

residence, but mobility is gradually increased during the course of the game. Thus, in the third year some students can move (partial mobility), and finally, in the fourth year, all students are completely mobile (perfect mobility). In each year, students repeat the same voting procedure, and an individual's utilities and overall welfare are calculated after each voting round as described above. After this, the instructor asks the students to state who has made a gain/loss in welfare with respect to the previous year, so that they are able to value the effect of sorting when mobility is allowed (see Table 1 for an outline of the game).

When concluding the first phase of the game students have almost perfectly split between high valuation types on the right-hand part of the class, and low valuation types on the left-hand part of the class. To visualize this result the instructor may ask the students to hold up their coloured instructions sheet.

The objective of this phase of the game is to show that when individuals are homogeneous in income but heterogeneous in their preferences for the level of public goods provision (in this case, social amenities), overall welfare increases with mobility, since jurisdictions (halls of residence) gradually become more homogenous (in preferences) as individuals are able to move freely. The exercise makes it clear that the individuals who suffer the most are those who are not mobile and who are in the *wrong* residence, i.e. where their preferences are in the minority. For example, in the second year, when students are not mobile, the ones who lose the most are the low-valuation students who live in the high-valuation hall of residence. Then, in the third year, some students are mobile and some are not. Hence, those low-valuation students who are immobile and live in the high-valuation residence are the ones who lose the most. Through this process, students also become aware that perfect mobility is a key

assumption in order to obtain efficiency gains through the decentralization of public goods provision, since overall welfare increases with sorting.

In the second phase of the game, students are assumed to be heterogeneous in both preferences and income. To avoid excessive repetition we made this phase of the experiment shorter, it being organized into two years and two rounds of voting. During this second phase there are always two halls of residence, although the degree of mobility between them changes over time. Specifically, during the first year, students are not mobile at all, but after this, during the second year, there is complete mobility. As in the first phase, students have to choose, each year, the head tax they are willing to pay in order to provide social amenities at their hall of residence. Also as before, the implemented tax is the average tax resultant from the round of voting. After knowing the tax to pay, students are able to calculate their individual net welfare and the instructor calculates the overall welfare. The instructor then asks the students if they are better or worse off than the previous year, so that they can see who is gaining and losing through decentralization and sorting.

The main goal of the second phase of the game is to reveal and stimulate discussion regarding the equity consequences of the Tiebout hypothesis. The exercise is similar to that of the first phase in the sense that students eventually divide into two almost perfectly homogenous halls of residence. Again, to visualize this result it is useful to ask the students to hold up their coloured record sheet. However, in this second phase, halls of residence are not only homogeneous in preferences but also in income. Therefore, at the end of the game all the *relatively rich* individuals are located in one hall of residence and can afford a high level of social activities, while all the *relatively poor* individuals are located in the other hall of residence and can afford a

much lower level of social activities. The result is that overall welfare increases with people sorting, but at the cost of introducing inequality between groups. When students become aware of the income segregation derived from the Tiebout hypothesis, discussion about the possible effects in terms of equality of opportunity emerges spontaneously.

[Table 1 here]

5. Discussion and ratings

The Tiebout model was addressed through two sessions: the execution of the simulation game in the classroom and, subsequently, a lecture to relate the game with the theoretical model, the aim being to interpret and reinforce the assumptions used.

In addition, participants were asked to complete a questionnaire so as to gather their main impressions regarding the interest and utility of the experiment. The students could also check their degree of assimilation and understanding of the Tiebout model through an online questionnaire which was made available after running the experiment (see Appendix C).

The experiment was carried out with two groups (morning group and afternoon group). The morning group was further divided in two so that we could work with groups of approximately 50 students in each case. There were two principal advantages to avoiding very ‘large’ groups: it facilitated the counting of votes and it enabled the physical action of mobility without the situation becoming chaotic. In our opinion, around 50 people is the optimal number for conducting the experiment in a more pleasant environment and for bringing a discussion alive. In very small groups the discussion could become less interesting.

Although, when running the experiments, students behaved as expected we detected two repeated practices that deserve some further comment. First, the most common mistake, that a few students made, was to use their own real preferences, instead of using the given preferences (according to their type, *high* or *low valuation*) when required to make a decision. Second, when voting for the head tax to finance social amenities, students had to choose among three options: 0, 50 and 100 m.u. According to their preferences we distinguished between individuals who attached high and low value to social amenities. Thus, assuming rationality, students belonging to the *high value* type should vote 100, while students designated as *low value* should vote for a zero tax. Nevertheless, in every trial there were students who voted 50. We can think of three possible explanations for this behaviour. First, these students are altruistic; second, they did not understand the instructions of the game; and third, they are risk averse. Since students did not have complete information about the objective and development of the game, they chose the value in the middle (50) to avoid a possible big loss. We therefore believe that voting for a tax of 50 could be a sign of risk aversion. In this regard, it would be interesting at some point in the experiment, preferably not at the beginning, to let the students discuss this sort of behaviour and offer possible interpretations.

Since the use of games is not a widespread practice in our faculty of economics we have found that students are quite keen to play and try a different way of approaching lectures. Hence, monetary compensation is generally not needed to motivate them to participate. However, we have occasionally found that some students are reluctant to play the game or are too shy to feel comfortable with it.

Further issues

The experiment was used to reveal the main efficiency and equity aspects of the Tiebout hypothesis. Additionally, after the experiment, we developed in detail the assumptions and implications of the model and showed the interrelationship between the theoretical model and the simulation game. Special emphasis was placed on three aspects: clarifying the relationship between individual mobility and efficiency; analysing the principle of taxation implied by the Tiebout setting; and discussing further the segregation consequences and applicability of the Tiebout hypothesis to the real world.

More specifically, during the explanation we argued that the gains in efficiency derived from the Tiebout hypothesis appear when public services are financed by head taxes. This means that in the Tiebout setting there is no room for progressive taxation and redistribution of income. In the case of taxes being defined under the principle of ability to pay, people could move among jurisdictions for fiscal reasons and, consequently, preferences for public services would not be revealed.

The second phase of the experiment allowed us to discuss the implications of the Tiebout hypothesis in terms of equality of opportunity.[9] If people are heterogeneous in income and segregate by it, the result is the formation of perfectly homogeneous jurisdictions which are, however, unequal with respect to one another. This leads to different supplies of public goods and services and to horizontal inequity. If this affects the supply of essential public services, such as education, for instance, then equality of opportunities among individuals of different jurisdictions is not secure. Furthermore, income segregation can also induce a reduction of growth and efficiency in the long run. Benabou (1996, 2000) argues that the future productivity of a region depends on its

[9] Oates (2006).

human and social capital over time. Under income segregation, social capital in poor regions will be low and, consequently, the expected productivity and growth in those regions will also be low. Segregation avoids peer effects and the sharing of social capital which is favourable to economic growth. Consequently, if we consider the long-term effects of the Tiebout hypothesis, then the gains in terms of efficiency are not so clear.

Additionally, and taking into account the equity implications of the Tiebout hypothesis, one can introduce the next topic of the course: central government intervention through equalisation grants in order to secure a minimum level of public goods and services in all jurisdictions. Equalisation among jurisdictions will not eliminate differences in social capital due to segregation, but it will at least diminish inequalities in the provision of public services.

Student perceptions (results of the questionnaire)

Above all the questionnaire sought to measure the success or appropriateness of the experiment with respect to the following areas: as a complement to traditional lectures (question 1), in facilitating understanding of the subject (question 2), in encouraging student participation (question 3), and its usefulness in terms of preparing for the exam (question 4) (for results, see Appendix A)[10].

Responses to question 1 revealed that 50% of all students perceived the experiment as a very good complement to the traditional lecture, and 44% as quite a good complement. The best results were those of the afternoon group, where 79% of students felt that the experiment was a very good complement (41% in the morning

[10] Appendix A presents the results obtained from both the morning and the afternoon group. However, the aggregated results, derived from considering the two groups together, and which are described in the text, are not included in the appendix.

group). It is likely that in question 1, students are implicitly appraising the change in didactic methodology.

As regards question 2, 96% of all students thought that the experiment facilitated their understanding of the subject (50% a lot, and 46% considerably), with the afternoon group being more optimistic (71% a lot and 29% considerably).

In response to question 3, 45% of all students felt that the experiment very much favoured their participation, and 37% that its effect was considerable. The incentive to participate could be related to the size of the group and a more relaxed environment.

Responses to question 4 revealed that 25% of all students saw the experiment as being very useful in terms of preparing for the exam, while 60% thought it was quite useful. One would expect a lower percentage of "very useful" responses here due to uncertainty about the exam.

Finally, the questionnaires reveal that students rated the experience positively. On a scale from 1 to 10, 72% of all students gave it the highest rating (A^+ and A), while 20% awarded a B. Once again, the best ratings corresponded to the afternoon group, where 42% gave an A^+ (20% in the morning group) (Figure 5). Higher ratings among the afternoon group could be related to the student profile: in general, students in the afternoon group are older, they usually combine work with studies, and they are supposed to be more responsible and mature.

In addition to answering the questions, some students wrote a general comment about the experience on the questionnaire sheet. Two examples of such comments are:

…This sort of lecture where you "live" the model and you have a leading role facilitates our learning. There should be more experimental lectures during the course.

…it allows an intuitive understanding of theoretical abstract concepts.

Kumar and Lightner (2007) obtained similar results in the context of adult learning. In their case study, students responded positively to active learning exercises (including games) that replaced traditional lectures, indicating that the activity was enjoyable and that it achieved its goal. These authors also point out that student perceptions about the interest and usefulness of a game are very sensitive to the way in which it is presented. In other words, the instructor must be sure that the instructions of the game are clear, that the material is well prepared, and that the contents and objectives of the game are well matched to the subject being taught.

As mentioned above, we gave students the opportunity to fill in an online questionnaire to self-test their understanding of the Tiebout model. Around 50% of the participants in the game responded to the questionnaire and the total average score obtained (related to true or false questions) was an A^- rating (7.6 out of 10). Notwithstanding, further research is needed to address the impact of the simulation game on final marks.

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Appendix A. Student ratings

Figure 1

Do you think that the experiment is a good complement to traditional lectures?

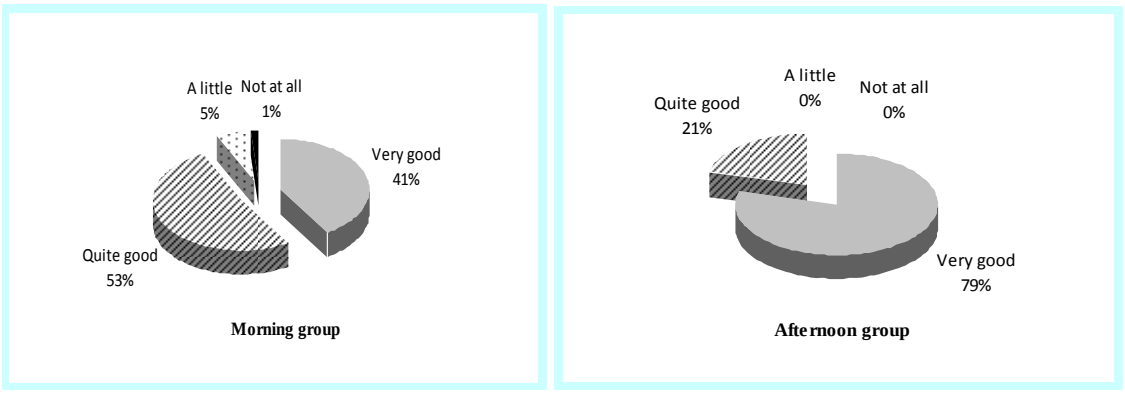


Figure 2

Do you think that the experiment helps in understanding the subject?

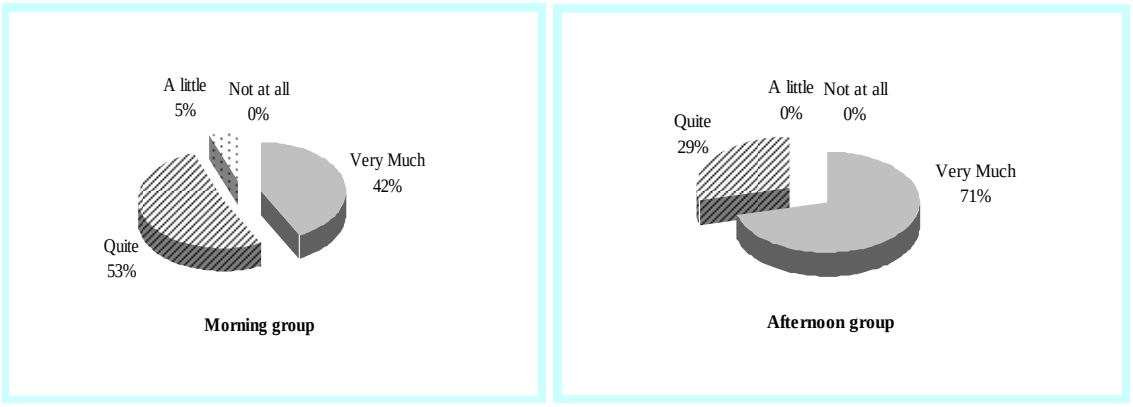


Figure 3

Do you think that the experiment favours student participation?

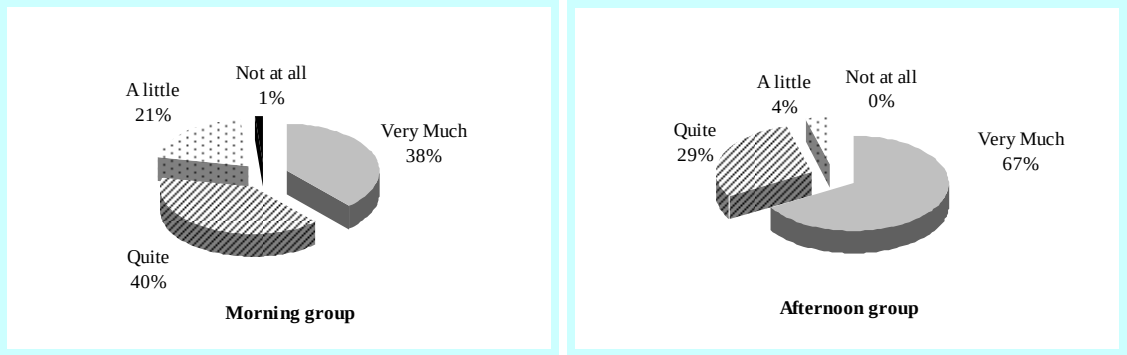


Figure 4

Do you think that the experiment is useful in terms of preparing for the exam?

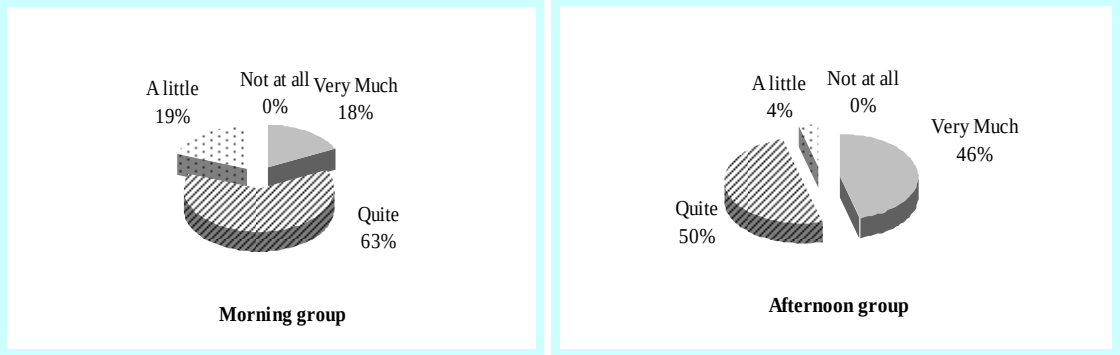
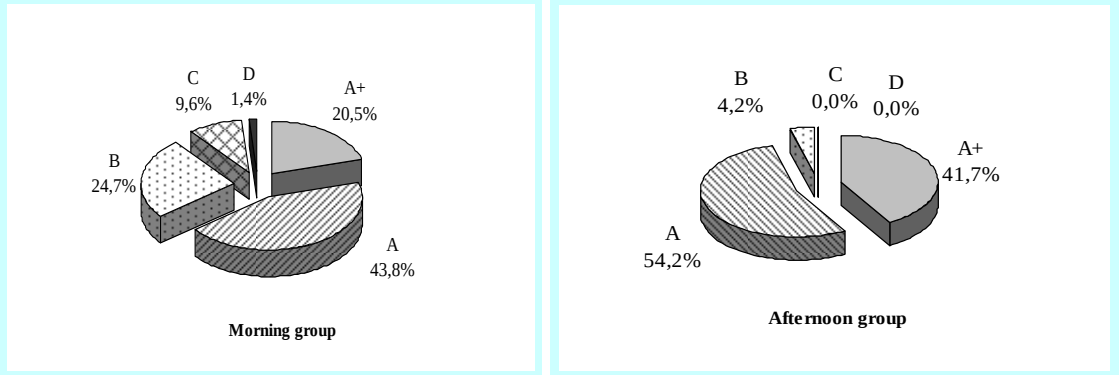


Figure 5

Rate the experience from 1 to 10



Appendix B1. Instructions for High-Value Residents[11]

Suppose you live in a hall of residence that's deciding how much money to raise for a collective fund that will be spent on parties and social events for your hall of residence. Your hall of residence is voting on the amount of money that each resident will equally contribute to the fund for the current school year.
Your room, board, and tuition are already paid for, and you have a spending allowance of €1000 at the beginning of each year that you may use freely for entertainment, books, etc.
The hall of residence will decide on a level of per-capita taxation, *T*, between 0 and 100, which will be paid out of your €1000 spending account. The level of taxation will represent the number of Euros in taxes that you and everyone else in your dorm must each pay. These taxes will be used to sponsor social events in your dorm. Residents of your hypothetical hall of residence enjoy these social events differently. As a result, you have each been assigned a personal value multiplier.

Your personal value multiplier is 2.

To calculate the value you derive from your dorm's parties and social events, take your personal value multiplier times T. In your case, the value you derive would be (2 x T). As other people may have different values, we ask that you keep your value private.
In addition to these instructions, you have received a record sheet. You will be using this sheet to record the level of taxes, T, imposed by the hall of residence, as well as the value that you receive from the parties that are funded by these taxes. You will also calculate your after-tax welfare: that is, the value of your spending account (€ 1000), minus the taxes you pay, plus your own personal value of the social events. Here's the way your record sheet will look:

Level of taxation chosen (*T*): _____

Your spending account	€1,000
PLUS	
Your value of the social events (= 2 x *T*)	_____
MINUS	
Your tax payment for the social events (= *T*)	_____
EQUALS	
Your after-tax welfare	_____

To determine the taxation level, the hall of residence's governing committee will survey its residents. They will ask which of three possible taxation levels you prefer: 0, 50, or 100.
They will then calculate the average of your choices and impose that average as the taxation level.

[11] The design of the instructions and record sheets is based on Brouhle et al. (2005). We only included the instructions related to high valuation individuals. In order to obtain the instructions belonging to low valuation individuals, the personal value multiplier should be changed to zero. We used colours to distinguish types. Hence, we print the instructions of high valuation individuals in orange and the instructions of low valuation individuals in green.

Are there any questions so far?

Let's work through an example.

Imagine that there are 10 residents in your dorm, and that 2 of them vote for a level of €0 taxes, none vote for 50, and 8 vote for 100. The average choice is then

$$\frac{(2 \times €0) + (0 \times €50) + (8 \times €100)}{10}$$

so the taxation level will be €80 for everyone in the hall of residence. We have used this information to calculate your after-tax welfare on the following practice worksheet:

Level of taxation chosen (*T*): €80

Your spending account	€1,000
PLUS	
Your value of the social events (= 2 x *T*)	€160
MINUS	
Your tax payment for the social events (= *T*)	€80
EQUALS	
Your after-tax welfare	€1080

Are there any final questions before we begin?

Your local government will now conduct its first survey. Take a moment to think about which of the following three options you prefer:

- Taxation of €0
- Taxation of €50
- Taxation of €100

After the vote is taken, we will announce the results and will then proceed to the next year.
At the beginning of each year, you will be given verbal instructions related to that particular year. Please listen carefully and do not hesitate to ask questions if you have them.

Appendix B2. Record sheet for the first phase of the experiment[12]

AVAILABLE RESOURCES TO SPEND = €1000

Year 1		
	Tax level voted individually (T_i):	_____
	Tax level chosen collectively (T*):	_____
	Available to spend	**€1000**
	PLUS	
	Assessment of parties (= PVM[13] x T*)	_____
	LESS	
	Tax payment (T*)	_____
	EQUAL TO	
	Net Welfare	_____
Year 2	Tax level voted individually (T_i):	_____
	Tax level chosen collectively (T*):	_____
	Available to spend	**€1000**
	PLUS	
	Assessment of parties (= PVM x T*)	_____
	LESS	
	Tax payment (T*)	_____
	EQUAL TO	
	Net Welfare	_____
Year 3	Tax level voted individually (T_i):	_____
	Tax level chosen collectively (T*):	_____
	Available to spend	**€1000**
	PLUS	
	Assessment of parties (= PVM x T*)	_____
	LESS	
	Tax payment (T*)	_____
	EQUAL TO	
	Net Welfare	_____
Year 4	Tax level voted individually (T_i):	_____
	Tax level chosen collectively (T*):	_____
	Available to spend	**€1000**
	PLUS	
	Assessment of parties (= PVM x T*)	_____
	LESS	
	Tax payment (T*)	_____
	EQUAL TO	
	Net Welfare	_____

[12] Since in this phase of the game students have equal income we print all record sheets in white. However, in the second phase of the game we used different colours to distinguish rich and poor individuals (see note 13).

[13] *PVM* refers to Personal Value Multiplier, which is the parameter used to indicate whether a student is a high valuation (H) or a low valuation (L) type. In other words, *PVM* determines the utility derived from social amenities and, therefore, it provides information about an individual's preferences for social amenities. We defined $PVM_H = 2$, and $PVM_L = 0$.

Year 1

Which of these three tax levels would you prefer?

	€0
	€50
	€100

Year 2

Which of these three tax levels would you prefer?

	€0
	€50
	€100

Year 3

Which of these three tax levels would you prefer?

	€0
	€50
	€100

Year 4

Which of these three tax levels would you prefer?

	€0
	€50
	€100

Appendix B3. Record sheet for the second phase of the experiment

(RELATIVELY RICH INDIVIDUALS)[14]

AVAILABLE RESOURCES TO SPEND = €2000

Year 1

Tax level voted individually (T_i):	_____
Tax level chosen collectively (T*):	_____
Available to spend	€2**000**
PLUS	
Assessment of parties (= PVM[15] x T*)	_____
LESS	
Tax payment (T*)	_____
EQUAL TO	
Net Welfare	_____

Year 2

Tax level voted individually (T_i):	_____
Tax level chosen collectively (T*):	_____
Available to spend	€2**000**
PLUS	
Assessment of parties (= PVM x T*)	_____
LESS	
Tax payment (T*)	_____
EQUAL TO	
Net Welfare	_____

[14] We only included the instructions related to *relatively rich* individuals. In order to obtain the instructions belonging to *relatively poor* individuals, the initial income (resources available to spend) should be changed from €2000 to any smaller value. Specifically, we used the value of €500. We used colours to distinguish types. Hence, we print the record sheet of *relatively* rich individuals in violet and the record sheet of *relatively* poor individuals in light yellow.

[15] *PVM* refers to Personal Value Multiplier (see note 11 for details).

Year 1

Which of these three tax levels would you prefer?

	€0
	€50
	€100

Year 2

Which of these three tax levels would you prefer?

	€0
	€50
	€100

Appendix C. Online questionnaire

1. The argument of Tiebout is viable only if there is a real and feasible possibility (bearable costs) of moving between jurisdictions. True or False?
2. The central argument of the Tiebout hypothesis is related to equity issues. True or False?
3. In year 3, some of you were able to change your hall of residence. How do we analyse the situation of people who were not able to move? What are the most probable reasons for not changing jurisdiction?
4. According to the utility function used in the classroom experiment, it is rational to choose a 50 m.u. tax. True or False?
5. How might we interpret that a person votes for a 50 c.u. tax?
6. When applying Tiebout's model with heterogeneous incomes, people's sorting causes income polarisation. True or False?
7. Tiebout's model only works if the tax burden is distributed according to the benefit principle. True or False?
8. In the equilibrium solution from Tiebout's model there is redistribution of income. True or False?
9. Under the Tiebout setting, if public goods are financed through progressive taxation, Tiebout's model will work efficiently. True or False?
10. In the exercise, two kinds of people have been considered:
    a. Rich people (income: 2000) with a high valuation of public goods, PMV:2
    b. Poor people (income: 500) with a low valuation of public goods, PMV: 0

    From this information, could you deduce the relationship between people's income and their preferences for public goods?