Evaluation of Teaching the IS-LM Model through a Simulation Program

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ABSTRACT

The IS-ML model is a basic tool used in the teaching of short-term macroeconomics. Teaching is essentially done through the use of graphs. However, the way these graphs are traditionally taught does not allow the learner to easily visualise changes in the curves. The IS-LM simulation program overcomes difficulties encountered in understanding the curves used in the model because, through it, the students can visualise the changes in these curves when the model's parameter values are modified. The IS-LM simulation program is presented and the effectiveness of its application to a group of macroeconomics students at the University of Seville during the 2009/10 academic year is evaluated. Analysis of variance (ANOVA) of all students' scores and some complementary statistical tests were applied, distinguishing between students who used the simulator and those who did not. The average score obtained by the former in a model comprehension test was significantly higher than that of the latter.

Introduction

The IS-LM model is a common and essential tool used in the teaching of macroeconomics. Despite criticisms of this model ever since the 1970s, it has persisted and survived through several modifications and the incorporation of new elements (Becker, 2000). The strange endurance of the model, as Colander (2004) describes it, is associated with its pedagogical use in intermediate macroeconomics courses and business schools. The IS-LM model is a framework which provides students with insights into some of the workings of macroeconomics and offers teachers the opportunity to show students the way in which economists think.

One benefit of learning the IS-LM model is that it provides a useful instrument to examine the determinants of the effectiveness of monetary and fiscal policies in generating a short-term change in the balance of the gross domestic product (GDP). This effectiveness may be analysed by using the tools of multivariate calculus, but these tools are too complicated for most students of intermediate-level macroeconomics. However, through the use of graphic techniques the students are much more easily able to understand the IS-LM framework, as Revier (2000) stated. The IS-LM model is then translated into a set of concatenated graphs which are representative of the model developed by Hicks (1937). As explained in Section 2, through the graphs it is possible to visualise the effects of economic policies. Therefore, graphical comprehension is fundamental to understanding economic interaction.

However, the use of traditional or static graphs to explain economic issues does not always benefit the students. As Cohn et al. (2001) stated: "If the graphs are relatively complicated and students have little time to absorb them, review the material, and have opportunities to ask questions about them, the use of graphs may not be helpful or may even be counterproductive." In fact, in a test given to students of Macroeconomics I at the Business Administration School of the University of Seville in 2008, it was observed that the students had difficulties in understanding changes in the slopes of the curves (Pablo-Romero et al., 2009). The difficulties in the comprehension of the mathematical functions and their graphical representation identified in the university context are not an isolated phenomenon; many research studies—mostly based on the contributions by Duval (1993, 2006) and Arcavi (2003)—illustrate these difficulties. For this reason, an improvement in the teaching of the graphs could contribute to a better understanding of the IS-LM model and, consequently, of macroeconomic relations.

The equipment used in teaching the graphs of the IS-LM model has traditionally been the black/whiteboard or, more recently, Power Point presentations. Such equipment/technology has also been traditionally used to teach economic

issues in undergraduate economics courses, although there is a noticeable shift towards the use of other teaching techniques (Watts & Becker, 2008). In Spain, the adaptation of the principles of the Higher Education European Space established in the Bologna Declaration (1988) is also promoting a revision of teaching methods in economics. The incorporation of the ECTS (European Credit Transfer System) credits as the measurement unit of the students' work aims to promote the student's involvement in the learning process beyond passive class attendance and the passing of the final test. It also means providing the students with learning material which should allow them to actively participate in learning the subject.

Traditional forms of graphical representations can be expanded thanks to the availability of new information technologies. In this way, as stated in Chen and Howard (2010), technology can help in the scientific learning process because of its potential to support activities such as visualization, meaningful thinking, problem solving and reflection. However, these graphs should satisfy certain requirements to help student learning, such as allowing the student to interact with them (Betrancourt, 2005). Also, the graphics must meet certain rules or principles, as indicated by Tufte (2001, 2006), Sweller (2005) and Mayer (2005a, 2005b), among others.

Following these principles, a software application has been developed which allows the students to interact with the model, offering the possibility of doing as many different exercises as there are different economic situations. Within the classification of learning objects considered by Churchill (2007), this application can be included within the group "contextual representations", in the sense that a realistic scenario can be explored for economic-specific policy.

In the university teaching context, the use of simulation programs is expanding in many areas of knowledge. While the use of computer- and non-computer-based simulations and games is undergoing significant levels of growth in education (Lean et al., 2006), few studies however have analysed their impact on students' levels of achievement (Jonassen, 2003; Kim & Reeves, 2007). In the context of economics teaching, different simulation programs have also been implemented, although in most cases, these programs are limited to quantitative methods and IT skills training (Hobbs & Judge, 1992). Among those who discuss different computer simulations used in teaching economics, Bolton (2005), Santos (2002), and Schmidt (2003) are worth mentioning. Porter et al. (2004) reviewed the use of simulation programs in this area and stated that the creators of these simulation programs consider that "simulation motivates students to learn, makes economics relevant and improves critical thinking."

Nevertheless, and despite the fact that the use of these simulation programs has grown continuously over the last 10 to 15 years (Schmidt, 2003), few controlled studies have been made of the effectiveness of simulations in this area. Porter et al. (2004) consider that the literature describing the impact of the use of simulations on learning remains very thin in the field of economics, particularly when we consider the small number of studies within a specific category. Therefore, as stated in Grimes and Willey (1990), it is important to determine the effectiveness of the use of simulations on student learning. As stated in Clark et al. (2009), researchers should take a pragmatic approach in applying findings from research done in the past, or in other contexts of their own situations, audiences, and settings. Therefore, more analyses of the effectiveness of the use of simulations on student learning in the field of economics may be convenient. In this sense, the introduction of e-learning methods and tools should be evaluated by controlled experiments and rigorous statistical analysis of the experimental data.

This paper contributes to the literature in relation to the impact of simulation use on student learning in the field of economics. The aim of this paper was thus to evaluate, using rigorous statistical analysis, if macroeconomics students at the Business Administration School of the University of Seville benefited from use of the IS-LM simulator as a learning tool to perform this evaluation, we carried out an analysis of variance of the scores obtained by two groups of students (one group taught using the simulator and the other in a traditional, classroom-based manner) in which the exam question was specifically relevant to theory that could be explained by invoking the IS-LM model.

In the second section of the paper, we discuss the operation of the simulation program and explain the learning process that students underwent. In the third section, we analyze the scores obtained by students who were taught to use the IS-LM model simulation program and who employed it to carry out their individual exercises, and compare them to the scores obtained by the students who did not have access to the program. Analysis of variance (ANOVA) of those scores and some complementary statistical tests using the R statistical program were applied. This is followed by a discussion section and finally we present the main conclusions.

The IS-LM simulation program

With the aim to facilitate the comprehension of the mathematical-graphical relations of the IS-LM model by students, an interactive simulation program was created in C++ language for the Windows operating system.

Essential of the IS-LM model

The IS-LM model shows the interaction between the real (IS curve) and monetary (LM curve) markets in the short term. The real market determines the level of income while the money market determines the interest rate. Both markets interact and influence each other. The income level will determine the demand for money and therefore the interest rate in the monetary market, while the interest rate influences investment demand and therefore income in the real market.

The IS curve shows the situation of balance between aggregate demand (D_A) and supply of goods and services (Y) in the short term for different values of income and interest rate. Graphically it is derived directly from income-expenditure model, which relates the aggregate demand with the supply (graph located above in Figure 1). The D_A and the *IS* curve are specified as follows:

$$D_A = \overline{A} + c(1-t)Y - bi \text{ , with } \overline{A} = \overline{C} + c\overline{TR} + \overline{I} + \overline{G}$$

where
c = marginal propensity to consume
t = tax rate
b = sensitivity of the investment to interest rate variations
i = interest rate
$\overline{C}$, $\overline{TR}, \overline{I}, \overline{G}$ = Autonomous consumption, state transfers, autonomous investment and public expenditure

The IS curve: $Y = \dfrac{1}{1-c(1-t)}\left(\overline{A} - bi\right)$

The LM curve shows the situation of balance between supply and demand for money in the money market. Graphically it is obtained from the balance between money supply and money demand (graph located at the bottom left in Figure 1). The function of the real money supply is: $\dfrac{M}{P}$

where
M = nominal money
P = price level

The function governing the demand for money is: $L = kY - hi$
where:
k = sensitivity of the demand for money to income variations
h = sensitivity of the demand for money to interest rate variations

The LM curve: $i = \dfrac{1}{h}\left(kY - \dfrac{M}{P}\right)$

The point at which the IS and LM cross shows the position of simultaneous equilibrium in both markets (graph located at the bottom right in Figure 1). This balance may be altered by variables other than interest rate that cause movements of the curves. The changes in effective demand (consumption, investment, government spending or the foreign sector) cause shifts in the IS curve. Moreover, changes in money supply, in the general level of prices and in demand for money cause shifts in the LM curve. Thus, economic policies affecting effective demand and / or the

money market affect the equilibrium. However, the new balance is not obtained immediately since the two markets (the real and monetary) interact with each other. Thus, a final equilibrium is reached after the two markets have undergone a process of adjustment that highlights the relationship that exists between them.

Therefore, the IS-LM model provides a useful instrument to examine the determinants of the effectiveness of monetary and fiscal policies in the short-term. Through the use of simple graphic techniques with no more than paper and pencil, it is able to understand the economic relations and their equilibriums in the short term.
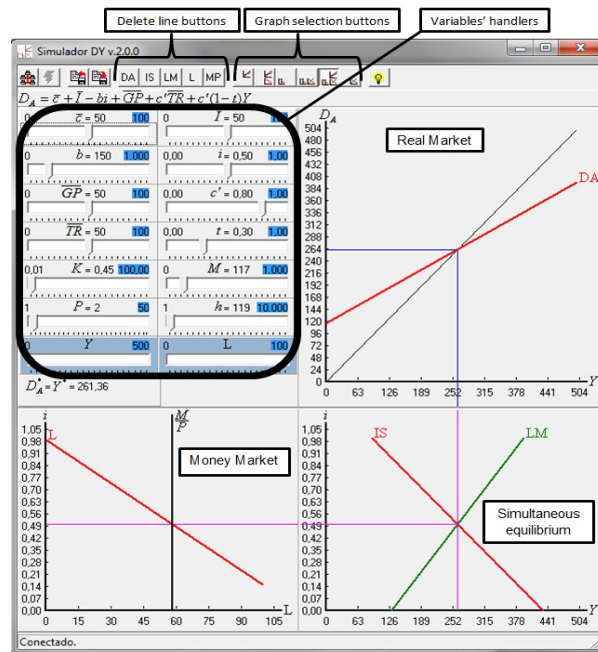

Figure 1. Initial screen of the IS-LM

Components

This computer program has two basic components. The first is the set of concatenated graphs which are representative of the model developed by Hicks (1937). The income-expenditure model (graph located above in Figure 1), the balance in the money market (graph located at the bottom left in Figure 1) and the IS-LM model (graph located at the bottom right in Figure 1). Visualization of single graphs at a time is also possible, following the principle of redundancy (Sweller, 2005), by clicking the appropriate button located at the top of the screen (Figure 1).

The second component of the computer program is a set of boxes on the left part of the screen which contain the values that may be taken by the variables ($t, i, c, \overline{C}, \overline{TR}, \overline{I}, \overline{G}, M, P$), defining the functions graphically represented and their different parameters (b, k, h). A change in the value of some of these economic variables will alter the position and/or the slope of the linear functions represented. Following Mayer (2005b), the signalling and temporal contiguity principles have been applied, highlighting the curve which is transformed when a parameter is modified, indicating its movement and ending position.

Also as described by Mayer (2005b), the spatial contiguity principle (data, their drivers and graphics are close to each other and visual cues linking the equilibrium of the graphs are added) and the coherence principle (only the formulas, variables and graphics needed have been included in the simulator window, with anything that might distract the student hidden from view) have been applied. Even though multimedia learning principles state that people learn more deeply from words and pictures than from words alone (Mayer, 2005a), it is important that not too much information is added to the graphs. Therefore, only graphs and variables are shown without explanatory text. Also, maximizing data-ink and erasing principle indicated by Tufte (2001) has been applied. Therefore graphics have not grid.

Program operation and student learning processes

The simulation program starts from an initial equilibrium shown on the first screen. The functions represented on this screen respond to pre-selected values of the different economic variables which define the IS-LM model and are specified on the upper left part of the screen (Figure 1).

Using the information on this screen, the students will be able to do the set exercises. They may, for instance, analyse the effect of an expansive monetary policy. The student increases *M*, which rises for example from 202 to 407. A series of changes in the curves will follow and students must interpret economically these changes and the market imbalances. First, because prices remain fixed, *M/P* increases and the *M/P* and LM curves move to the right. The student will notice that because the previous curves are now thinner (leftmost image of Figure 2). Also, the student will see that markets are not simultaneously in equilibrium. The new cutoff point between the IS curve and the new LM curve occurs at an interest rate which is inconsistent with equilibrium in the money market and an income level that does not correspond to the one shown in the upper graph of the leftmost image of Figure 2, i.e., equilibrium in the goods market. This can be easily observed because the lines linking the three graphs do not match. As the above image has not been modified, the student learns that following an increase in the amount of money, an imbalance in the money market occurs that affects the overall balance of system.
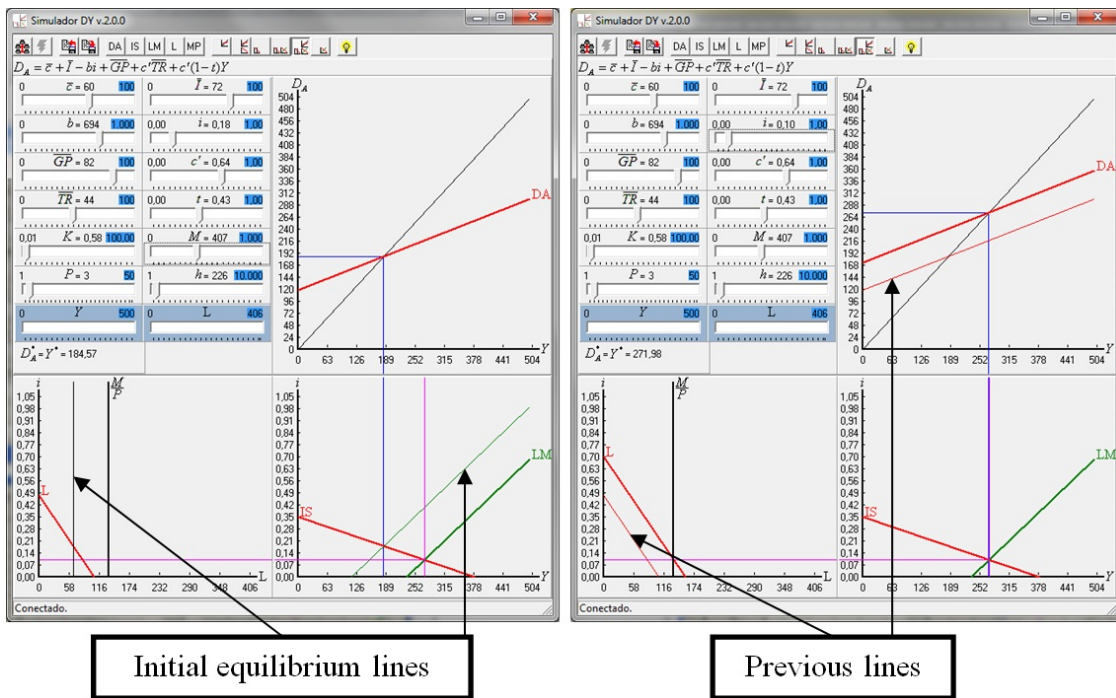

Figure 2. Increase in M

Now the student needs to find a way to enable the money market to re-establish its equilibrium. Before making any further change in the variables of the model, the student can erase the thin lines by clicking the DA, IS, LM, L and MP buttons in the menu at the top of the screen. If these lines are deleted, the student may more easily see the effects of new changes. Once the student reduces the interest rate by an appropriate amount, the investment expenditure will increase, and the student will see the upward movement of the aggregate demand as reflected on the upper right part of the third screen. The level of income will increase and reach 271.98 units. Also he will see, in the graphic located on the lower left, how this growth in production raises the demand for money, moving the curve to the right until the equilibrium in the money market is again achieved. All markets will again be in balance. This situation is shown in the rightmost image of Figure 2. The student will have learned that an expansionary monetary policy leads to higher production and a decrease in the rate of interest. Also, the student will have learned the economic mechanism through which this occurs. To facilitate this learning by stages, students can also view single graphs at a time. Thus, the student can learn direct effects that occur in each market in response to changes in certain variables. This learning will help the student to better understand how events happen throughout the process of economic adjustment.

Through the simulation program the student can observe in a similar way the effects of a change in fiscal policy by modifying *G, TR and/or t*. The student will be able to see as well what the effects are on the equilibrium of changes in the variables which define the characteristics of the market, such as the marginal propensity to consume, the sensitivity of the investment to interest rate variations, autonomous consumption or autonomous investment.

Likewise, the simulation program allows the student to analyse the effects of monetary and fiscal policies under special circumstances. For instance, the student may analyse a special case in which the demand for money is sparingly sensitive to the interest rate. This situation should be reflected by the student by assigning a value of 1 to the parameter h. By doing this, the student will find a screen similar to that shown in Figure 3. The student can easily observe that the money demand curve and the LM curve are vertical. Once the situation is known, the student is ready to analyze these effects using the IS-LM simulator.

The student's learning process is then performed over several stages. The teacher presents an economically realistic case, similar to that proposed to the students who do not use the simulator, which is solved in stages by the student. At each stage, the graphics are modified automatically by the program once the student makes a change of variables. The modification of the graphics allows the student to identify what has happened, and the imbalances that have arisen. This allows the student to identify what would happen in a real economy. This leads the student to make new changes in the variables, resulting in new graphs which can also be explained by observing what it seen. After several modifications, the student will come to a screen where all the graphics are balanced. The case has been resolved and the student can easily see the final solution and can understand what has happened in the economy. However, as the process has been addressed in stages, the student will also have learned the process of market adjustment that has taken place.

The possibilities of the simulation program are as many as the teacher and the student can imagine, and it is possible to combine more than one policy or change at a time. For this reason, the simulation program is a very helpful tool for the student to work autonomously. In addition, it allows the students to do individual and personalised tasks or exercises, thus avoiding the possibility of copying their results from other students, and not doing the practice on their own. This option can generate significant academic benefits.
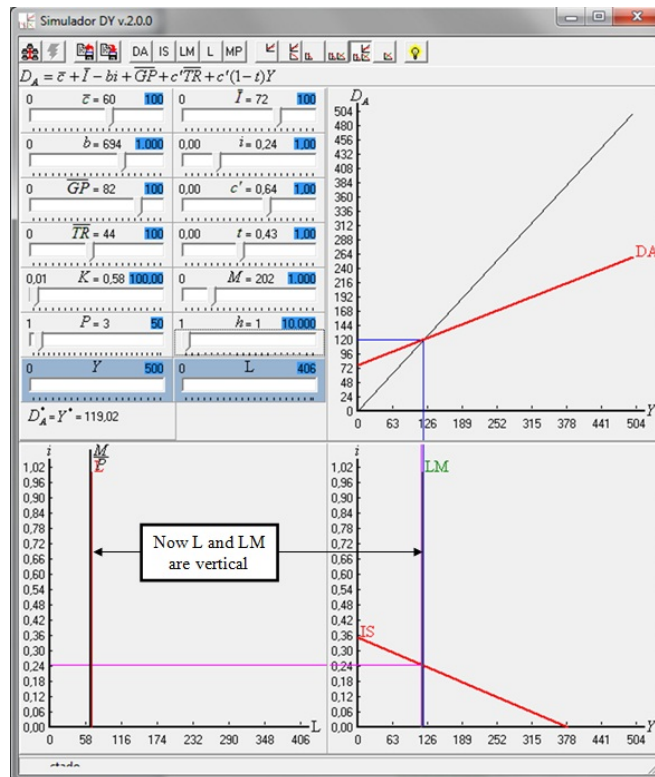

Figure 3. Money demand that is insensitive to interest rate

Basic for evaluation of simulation program IS-LM

At the University of Seville, the teaching of macroeconomics within Business Administration Studies is divided into two courses. The first one (Macroeconomics I) analyses National Accounting in the short term. The second course (Macroeconomics II) refers to medium- and long-term analyses. Teaching in the first course is organised in traditional lectures and tasks or exercises which the students must do individually. Some of these exercises aim to facilitate the learning and understanding of the functioning of the IS-LM model.

To test the usefulness of the IS-LM simulator for teaching and learning, it has been conducted an evaluation of it, by comparing the knowledge and skills learned by students which have used the simulator and those who did not. It is considered that students which use the simulator are able to better understand the model performance, as they have the advantage of much faster exploration of causes and effects and the opportunity to do thus many more case studies and to play around with the model, and not to just copy the studies from fellow students. Also they have the advantage of do not to depend on the teacher explanations, so much.

With this aim, during the 2009-2010 academic years, the teaching method was modified for one group of students. The teacher in this group taught the IS-LM model through the above described simulation program. In addition, the students used the simulation program to perform different tasks on the IS-LM model. The students selected for this test were those registered in Group 3 of the subject, with this choice of the group made randomly. Theoretically, therefore, this group of students had no differentiating characteristics from the rest of groups in terms of their abilities or past performance. However, it must be said that students enroll in groups according to what is most convenient for them, so this may occasionally cause differences in the level between them. This circumstance is taken into account in the analysis.

To check whether the hypothesis is true, at the end of the course, all students took the same examination in which one question referred to the IS-LM model. Specifically, we asked students to compare the effects of an expansionary monetary policy and show the transmission mechanism when the economy has different sensitivities of investment depending on interest rates, in the short term. To do this, they must use the IS-LM model. However, they must not only draw the curves and demonstrate how these changed in the situations described, but also associate these changes to the behavior of the economy, and explain them in the order they occur in reality. Thus, the score obtained on this question assesses the degree of student learning and understanding of the IS-LM model, and therefore their understanding of the behavior of the economy to economic policies in different situations. And lets compare if there are significant differences between the scores of those who used the simulator and those who did not and thus if there are significant differences between the learning of them. To make this comparison between the scores of the students, it has been used an analysis of variance (ANOVA). Thus, from the analysis of the scores obtained by the students on that particular question, we assessed then the advantage of using an IS-LM simulation program in class.

With this aim in mind, the student sample (which includes all students who took the exam) was divided into three subgroups: those students who used the simulation program (S), those who attended the course but did not have access to the simulation program (A) and, finally, those who neither came to class nor did the assigned tasks (N) but, nevertheless, took the examination. Some of these students (N) attended classes in the previous year, so it was decided to include them in the study also, but as a separate group. The total sample included 324 students, of which 45 used the simulation program, 221 came to class and did their tasks but never used the simulation program, and 58 that did not attend the course regularly in that academic year and did not do the individual exercises either. The scores ranged from 0 to 10, 10 being the highest grade.

Results

Table 1 summarizes the main statistical results of the three groups. It may be observed that the higher means were obtained by group S (5.2), followed by group A (3.21) and finally group N (2.06). The scores in the first and third quartiles also show important differences between groups.

Histograms of the scores obtained in the answer to the question on the IS-LM model were elaborated for each group of students (shown in Figure 4). The scores of the students in group S have a more uniform distribution and their lower scores are not the most frequent ones. Groups A and N show greater frequencies of their lower scores.

However, group A presents a better score distribution in its histogram than group N, because even if lower scores are the most frequent ones, the proportion of students with higher scores is greater than in group N.

Table 1. Summary statistics. IS-LM question by groups.

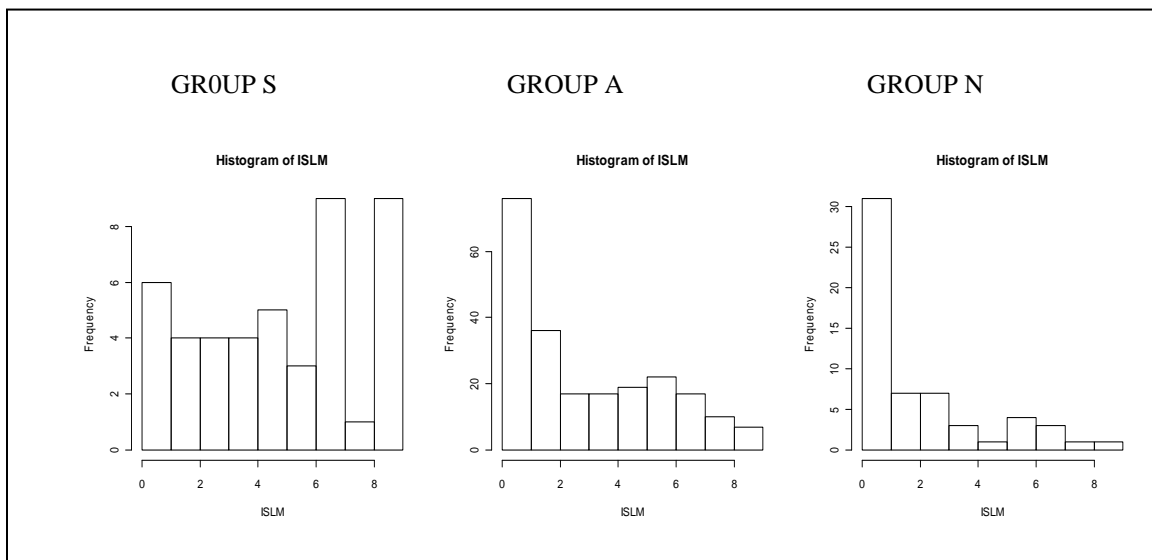|	GROUP S	GROUP A	GROUP N
Minimum	0.0	0.0	0.0
1st Quartile	3.0	1.0	0.0
Median	5.0	2.0	1.0
Mean	5.2	3.21	2.06
3rd Quartile	7.0	6.0	3.0
Maximum	9.0	9.0	9.0
Observations	45	221	58

Figure 4. Histograms of scores obtained on the IS-LM question

In order to contrast these results, a variance analysis (ANOVA) has been done which allows us to study the effect of the use of the IS-LM simulation program on the scores obtained by checking for the equality of the means of the three analysed populations. The rejection of the null hypothesis of the equality of the means implies that the teaching method and attendance in class affect the obtained scores. In order for the results of the ANOVA analysis to be robust, the sample needs to be normal and homoscedastic. The Shapiro-Wilk normality test and various variance homogeneity tests have also been done in order to check those conditions. Given that the null normality hypothesis is rejected, the data is transformed to mitigate the problem through a Box-Cox potency transformation (with the parameter of 0.28).

The transformation of the data improves normality, although it would still be possible to reject the data normality hypothesis. Nevertheless, the robustness of the ANOVA analysis is high even if data normality is not fully achieved but homoscedasticity is. The homoscedasticity test values of the transformed sample are shown in Table 2. Neither of these tests allows us to reject the null variance homogeneity hypothesis in the transformed sample. Thus, the ANOVA results can be considered quite robust.

Table 2. Homoscedasticity test and ANOVA test (score on the IS-LM question)

	Statistics	*p*-value
Bartlett test	0.90 (K-squares)	0.637
Levene's test	1.80 (F value)	0.166
Fligner-Killeen test	3.04 (med chi-squared)	0.218
ANOVA	16.77 (F value)	1.174

Considering that the *F*-value of the ANOVA analysis is 16.778, with a *p*-value of 1.174, the hypothesis of the equality of means is rejected, meaning that the differences between the means by group are significant.

However, the ANOVA analysis only allows us to state that belonging to one group or another has an influence on the score obtained but it does not allow us to link the difference in the means with any group in particular. In order to determine between which groups the difference in the means is significant, a Tukey multi-comparison test is done. The results of the test are reproduced in Table 3.

The results indicate that the differences in the means are significant between the three groups. The mean of group S is significantly higher than the means of groups A and N; the mean of group A is significantly higher than the mean of group N. This shows the advantage of using a simulation program in the teaching-learning process, not only because the students came to class and did their tasks, but because of the use of the simulation program itself.

Table 3. Tukey multi-comparison test

	Differences of means	Confidence interval- lower result	Confidence interval- upper result	*p* adj
N-S	-2.752728	-3.8719872	-1.6334689	0.00000
A-S	-1.589848	-2.5112960	-0.6684005	0.00018
A-N	1.162880	0.3316440	1.9941157	0.00314

Due to the weakness of the assumption of normality, in order to provide greater robustness to the results obtained, a non-parametric Kruskal-Wallis rank sum test has been applied to the original data. The Kruskal-Wallis chi-squared statistic equals 30.6762 (*p*-value = 2.181) and therefore the null hypothesis of the equality of means is once again rejected, supporting our previous conclusions.

The previous results might be attributed to the groups' own characteristics rather than to the use of the simulation program or to attendance in class and task accomplishment. In other words, they might be related to a difference in the capacities of the students in each group. In order to find out if this is true, the same comparative study was made on the average scores obtained by each group of students on the examination question which was not related at all to the knowledge or comprehension of the IS-LM model. In this case, the question was a theoretical-practical one. All the students had the same material available to allow them to answer this question successfully.

Table 4 summarises the main statistical results of the scores obtained on this question by the three groups. There are no relevant differences between the means and score distributions for the groups are more alike.

Table 4. Summary statistics. Control question by groups

	GROUP S	GROUP A	GROUP N
Minimum	2.0	0.0	1.0
1st Quartile	5.0	5.0	5.0
Median	6.0	6.0	5.5
Mean	6.2	6.14	5.74
3rd Quartile	7.0	8.0	7.0
Maximum	10	10	10
Observations	45	221	58

Due to the fact that the hypothesis of data normality is rejected, we work on transformed data. On the other hand, given that the hypothesis of the sample's homoscedasticity cannot be rejected, the ANOVA results may be considered robust enough. In this case, the F-value of the ANOVA analysis equals 1.073. Therefore, the hypothesis of the equality of means between the groups cannot be rejected. In addition, by applying the non-parametric Kruskal-Wallis rank sum test to the original data, the Kruskal-Wallis chi-squared statistic shows a value equal to 2.51 with a *p*-value equal to 0.285 that again does not allow us to reject the hypothesis of the equality of means. We can thus conclude that the average scores obtained on the theoretical question do not diverge between the different groups. This means that the groups of students are homogeneous and their particular characteristics do not affect the conclusions drawn from the previous analysis.

Thus, we can confirm the advantages of using the IS-LM simulation program for a better learning and comprehension of the IS-LM model. Therefore, the use of this simulation program in class – and its availability to the students to work on it – facilitates the teaching, learning and understanding of the IS-LM model and, through it, of the functioning of economic relations and the effects of fiscal and monetary policies in the short term.

Discussion

To understand macroeconomic relationships, it is necessary to make an abstraction and simplification of complex economic relations that occur between economic agents. These relationships are often portrayed as causal processes, which can often best be explained by making use of graphics given that students learn these relationships in a more intuitive manner by using them. As stated in Mayer (2005a), we learn best by using words and pictures than from words alone. However, as Cohn et al. (2001) stated, the use of traditional or static graphs to explain economic issues does not always benefit the students. A graph in itself does not improve the understanding of a subject; rather, it is necessary that students learn how to formulate these graphs, and how they vary when the circumstances are different. In this sense, it is necessary to include controls which allow students to interact with the graphs because, as indicated by the animation and interactive principles in multimedia learning (Betrancourt, 2005), the static display of formulas, data and curves is not sufficient for the proper assimilation of training. In the field of macroeconomics, these controls, which allow the graphics and therefore the market balances to be changed are particularly important because the cause and effect relationships are made easily visible. This ensures that the student can understand and assimilate these relationships.

Often in the field of macroeconomics, the graphs which define markets are not isolated from other markets and therefore from other graphics. Thus, simulators should allow not only that the effects of actions are displayed in all markets, but also that the student can assimilate these effects step by step. Therefore, according to Sweller (2005), it is appropriate that the programs enable the student to see the effects on just one chart initially, and then on all graphics at once when this change is assimilated.

In this sense, the evaluation of the effectiveness of the IS-LM simulator has been very positive. This can be associated to the fact that the principles outlined above have been taken into account for its construction. It therefore seems appropriate to relate this experience to other areas of teaching of economic relations, particularly when these involve processes of cause and effect. While the results of such studies are not always transferable, as stated in Clark et al. (2009), it is necessary to accompany the use of these simulators in teaching with objective analyses for measuring their effectiveness.

Nevertheless, the advantage of using this simulation program may be due not to the program itself, but the fact that the availability of this program allows students to carry out more practical work, since the completion of each practice requires less time, and also allows viewing of each practice in stages, generating a greater understanding of the dynamics behind each particular case. In that sense, as Thompson (1999) pointed, the potential of computer mediation to foster knowledge depends less on what learners use, than on how they use it. Thus, maybe the advantage of using this program is to provide students with a tool that allows them to perform more practical work in a more autonomous way. In this sense, it seems appropriate to conduct further analysis to look for causes behind the success of this study.

Conclusions

The IS-LM model remains a useful tool for teaching and learning short-term economic relations in intermediate macroeconomics courses. While the graphical methods underlying this model improve its understanding, students sometimes nonetheless encounter difficulties in interpreting those graphs, particularly when it comes to visualising changes that affect the slopes and positions of the curves in the IS-LM model.

The interactive simulation computer program presented here allows students to overcome basic difficulties in the visual comprehension of the curves used in the model. With this program, the students can thus visualise the changes in these curves when the values of the parameters in the model are modified. It also permits students to associate the

changes in those values with their effects on the economy and to understand the effects of fiscal and monetary policies in the short term under different circumstances.

The analysis of the scores obtained by the students of Macroeconomics I at the Business Administration School shows the advantages of using the simulation program both for class explanations and in doing individual work. The results of this analysis demonstrate that the average score of the students who used the simulation program was significantly higher than that of the rest of the students. These results could not be attributed to a lack of homogeneity among the students of the different groups.

It is therefore possible to conclude that the use of the simulation program in class – and its availability to the students to work on it – facilitates the teaching, learning and understanding of the IS-LM model and, through it, of the functioning of economic relations and the effects of fiscal and monetary policies in the short term. In this way, students are able to do more practical work and to view each case in stages, generating a greater understanding of the dynamics behind each particular scenario. In this sense, it is desirable to pose specific questions to guide the tasks undertaken by students, and to facilitate their learning in a stage by stage manner. It is also desirable that the teacher demonstrates some exercises to the students and teaches the students how to go about solving other problems.

Indeed, perhaps the success of this program has been that students were able to do more practical exercises and in an autonomous way. In this sense, it may be worthwhile for more studies to be performed to examine the reasons behind the success of such simulators for teaching. Thus, it may be worthwhile to accompany evaluations of simulators with surveys to students who use them, and to identify what aspects of the simulators not only provide the greatest benefits to learning, but also what their weaknesses may be.

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Note

The copyright of the IS-LM simulator belongs to the authors Pablo-Romero and Del-Pozo. Readers can access the program by contacting Dr. Pozo-Barajas by email (pozo@us.es).

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