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Application of Mathematical Induction in Teaching of Macro Economics: In Example of Teaching Based on IS Curve

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Abstract
Traditional macroeconomics is taught based on teacher-leaded explanation on theories, analysis and illustration on models and curves. Students are studying passively with low participation and poor efficiency in class. Our work explores mathematical induction in macroeconomics education aiming at abstractive theory and passively studying in economics class. In this paper, application of mathematical induction in teaching IS curve theory is used as an example to demonstrate issues existed in teaching IS curve. In addition, focusing on those issues, we design corresponding in-class questions and processes by following the concept of mathematical induction, as well as different education goals on different problems. And finally we discuss both pros and cons of such method applied to IS curve teaching.

Key words: Mathematical induction; Macro economics; Teaching; IS curve

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INTRODUCTION
Macroeconomics is a basic course in economics and management majors. It studies economic behavior of a whole society and its corresponding result. Tasks of it includes cause of economic growth and recession, reason of unemployment, its influence on the economy, and effect of government interference, and so on. By studying theories of macroeconomics, students' abilities of analyzing macreconomics and thinking are developed. It helps students understand normal phenomenon and variation laws in modern macroeconomics, which are the foundation of the following classes. In macroeconomic class, due to theoretical content, abstractive concepts and principles and large amount of mathematics models and graphs used in class, it is difficult for teachers to teach and students to understand. Especially in condition of college education is changing from "elite education" to "general education", teaching objects have changed as well as teaching goals. In case of practical colleges, comparing with a period of "elite education", students have obviously weaker mathematical foundation and capacity of logical analysis. In addition, their study and memorizing habits have changed remarkably. In current classes, students are shortly concentrated. Most of them prefer to memorize contents basing on understanding them, which cause poor enthusiasm. Thus in this condition, study object and more abstractive theoretical models are major properties of macroeconomics. Meanwhile, there are a series of hypotheses and premises involved in macroeconomics, which require teachers to consider how to help the student to build a detailed and subjective understanding in their preparation and teaching. Innovation of teaching method of macroeconomics, activation of students' motivation, exploring creative thinking, bringing students to participate in classes actively and developing students' subjective function is critical.

Thus teachers will consider using help of corresponding teaching methods in preparation and teaching progresses. However economics problem in the real world or life as examples hardly fits hypothesis in theory. In addition, lots of examples need tons of calculation, which barely fits

in-class teaching requirements. At the same time, those simple examples are able to help teachers make clear and detailed explanation, which involves students also. On one hand, it guides student to think actively and makes them completely participated. On the other hand, it deepens students' understanding of knowledge, which helps improve their abilities of analysis and solving problems. Mathematical induction does use simple mathematical examples to explain complicate economic theories. In addition, it let students to participate in the class with a higher motivation, which improves study efficiency and effect. Finally, resulted two-direction communication will further improve teaching quality.

In this paper, we summarized the application of mathematical induction teaching method in teaching macroeconomics in example of IS curve teaching practice.

1. PROBLEMS IN TEACHING OF IS CURVE

Currently, most of universities apply textbook edited by Hongye Gao in teaching macroeconomics. In this textbook, the IS-LM curve part contains extremely logical and complex formulas, models and graphs.

1.1 Large Amount of Algebraic Derivation and Complex Relationships of the Curve

IS curve is to describe an equilibrium product market and formed from various combinations of income and interest rates point. In other words, it describes the relationship between interest rates and national income sin two departments equilibrium product market, while $I = S$. Investment is a decay function of the interest rate, which is $i = e - dr$. Saving is an increasing function of income, which is $s = -\alpha + (1 - \beta)y$, where e is the spontaneous investment, r is the interest rate, d is the investment's sensitivity to interest rates, α is spontaneous consumption, β is marginal propensity to consume. By analyzing relationships between variables, it is easy to achieve function that relate y to r, which is $r = (\alpha + e) / d - (1 - \beta) / d * y$. However, it is difficult to master logic relationship between each variable, for example changes of IS curve, r and corresponding value of y when α and e decrease or increase, as well as changes of IS curve, r and corresponding value of y when d and β decrease or increase. Since in current in-class teaching, students' study character usually prefers to memorize base on understanding, change of values of variables and resulted changes of curve become difficulty of in-class teaching in this part.

1.2 Complicate Logic Relationship Between Four Quadrants in Quadrant Derivation of the Curve

Different from national income of fixed investment, when investment is a function of interest rate, it is not an external variable. Instead, it is expressed by function of interest rate. According to examples in Hongye Gao edited *Western Economics* (Macro Part), the 6th edition, one is able to derivate the relationship between y and r from function relationship of variables. For quadrant derivation, one should firstly get a random point on the investment curve from Figure 1 suggests that when the interest rate is $r1$, investment equals to $i1$. Then make the connection from A cross 45^o line in the Figure (2). In the next step, according to save function in Figure (3), when saving function is S1, national income is $y1$, Finally locate equilibrium point A' between saving and investment at which the interest rate is $y1$ and income is $y1$. By using the same method, B' is located in Figure (4). IS curve is achieved by connecting A' and B'.

In the above explanation of the algebraic method, students are obviously having a better understanding in changes between y and r. However in graphic explanation of quadrants, it is difficult to understand relationships between quadrants and master logic relationships between graphs.

1.3 Difficult in Mastering I-S Relationship at Non-Equilibrium Point and Automatic Adjustment Mechanism in Product Market

Points that are off IS curve are non-equilibrium points. At those points, investment does not equal to save. On right hand side of IS curve, investment overcomes saving. On left hand side of IS curve, investment is less than saving. It is difficult to understand the magnitude of I and S. When saving and investment are not balanced, adjustment mechanism of product determines direction of adjustment in condition of non-equilibrium product market. In different non-equilibrium conditions, different change of income direction will alter non-equilibrium point to different directions. It is difficult to make students understand the adjust mechanism of the product market.

2. DESIGN ON IS CURVE TEACHING PROCESS BASED ON "MATHEMATICAL INDUCTION"

In teaching based on mathematics examples, teachers need to prepare some mathematics examples as teaching content. Teachers need to do proper guidance before teaching a new class. They need to introduce related knowledge and provide teaching requirements, clear obstacles for learning new knowledge, provide rich and emotional materials, and finally make a solid foundation for students' understanding. While teachers are guiding students in exploring, they can prepare some simple questions which match their acknowledgements for them to use their hands and brains to solve problems individually. To process it, it requires guaranteeing

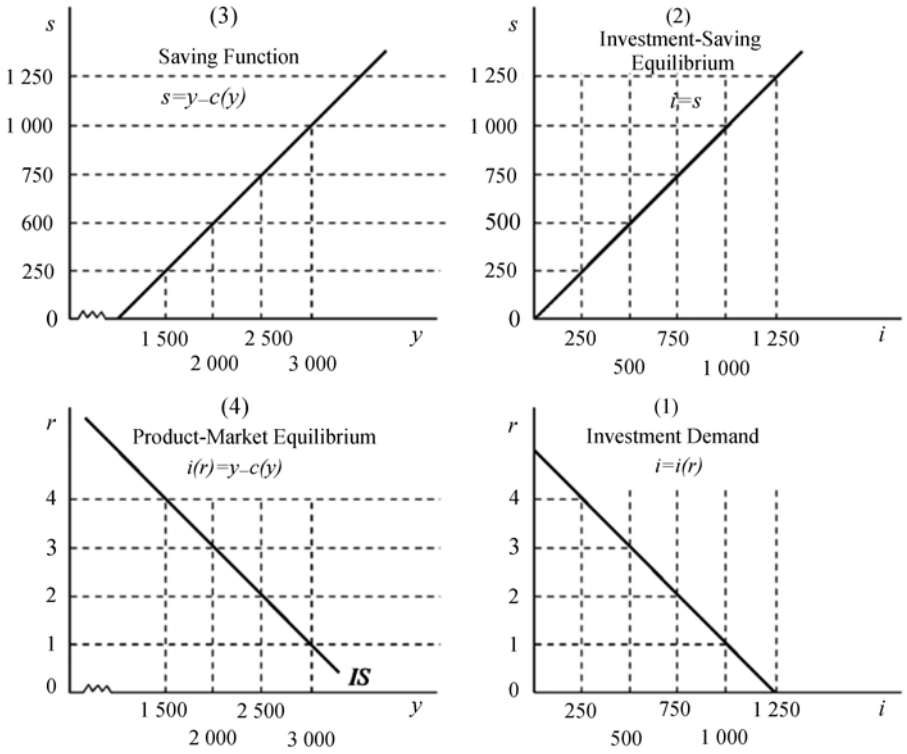

Figure 1
Derivation of IS Curve

students enough time to research. For different opinions and difficult problems during research, students will express themselves, cooperate with each other and improve themselves together. To unbury students' thinking processes, develop students' ability in expressing in mathematical language, encourage and guide students to bring up questions and finally let students to ask questions are difficult parts in teaching. It is necessary to tutor and guide and explore. Thus through teachers tutoring in person to expose students' failed ideas and let them understand the success path and total thinking process.

According to mathematical induction and teaching objects of IS curve, we developed several questions, as follow:

a) According to different r values, and relationship between given functions, calculate I, s and y in following table.

Table 1
Variable Relation in IS Curve

r	i	s	y
	i=1250-250r	s=i	s=- α+(1-β)y=-500+0.5y
1	1000	1000	3000
2	750	750	2500
3	500	500	2000
4	250	250	1500
5	0	0	1000

b) As r changes, how do i, s and y change?

c) As r changes, how do i, s and y change? In addition, illustrate function relationship of r and i, i and s, s and y, and r and y in Cartesian coordinate system, considering corresponding relationships between images.

d) While r is increased, why do i and y are decreased. Clear practical meaning of change in i and y resulted from interest rate change;

e) If other conditions are not changed, when i and s are changing as followed: i = 1500 -250r, i = 1500- 125r, s = -α + (1 - β)y = -1000 + 0.5y与s= -α + (1 - β)y= -1000 + 0.75y. How does IS curve change?

f) Compare i-s relationships on top-right side and bottom-left side of IS curve;

3. TEACHING REQUEST ACCOMPLISHED BY QUESTION-DESIGNING

Designing question majorly guides students to complete certain content and to participate classes, which help them explore theories.

Object 1: By solving question A, question B, question C and question D, make student notice change of i and y that resulted from change of r, as well as illustrating how do r, i and y change;

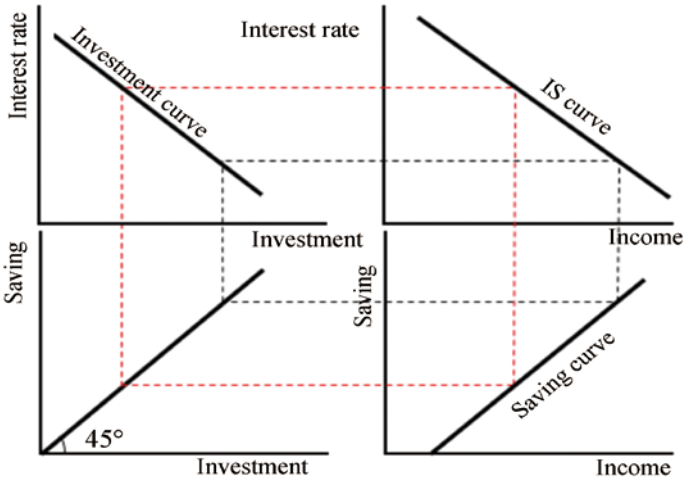

Figure 2
Geometric Derivation of IS Curve

Thus when $i = s$, relationship curve of interest rate and income is called IS curve. Any point on the left side of the curve represents exceed demand, on the right side represents exceed supply.

Object 2: By solving question E and make students to research changes of spontaneously consumption [α] and spontaneously investment [e] and corresponding moving direction and value of IS curve, students are able to understand how does r determine y and what is property of IS curve.

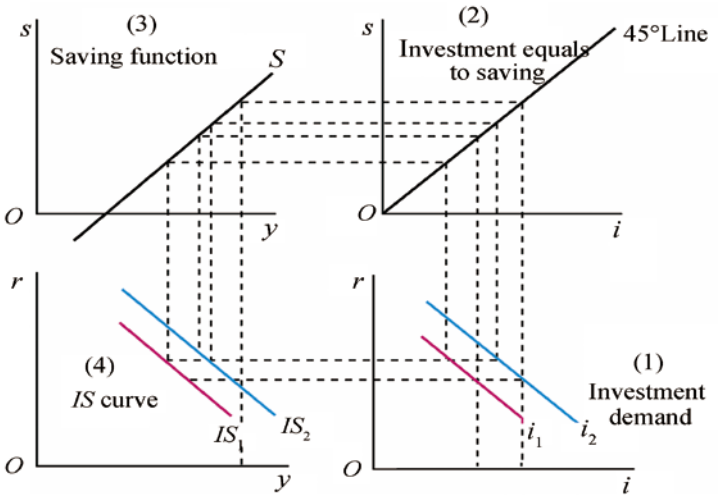

Figure 3
Change of IS Curve Resulted From Increasing Spontaneously Investment [e]

While investment demand curve is moving to the top-right direction, IS will also move to top-right. Moving distance of y is proportional to it for i. Thus if other conditions keep unchanged, when e increases by Δe, then Δy equals to $\Delta e/(1 - \beta)$, *vice versa*.

Change of α and function value in saving function. When α decreases, saving is increased. With other condition constant, when α is increased by $\Delta\alpha$, moving distance of IS curve to left equals to distance that saving function moves to left (increased saving) multiplied by investment multiplier $1/(1 - \beta)$.

Object 3: By solving question E, make students study variation of d and β, slope change of IS curve, r and corresponding change of y value.

According to d in IS curve function, one can derivate that increasing d represents sensitivity of investment to interest rate. Thus same change of r will lead to different variation of i, which further resulting a larger change on y value. Thus IS curve will be flat, *vice versa*.

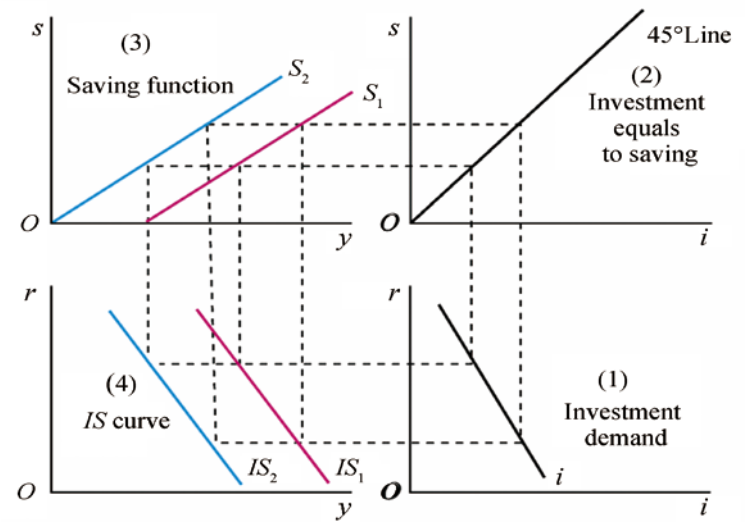

Figure 4
The Effects of *d* Changes on *y*

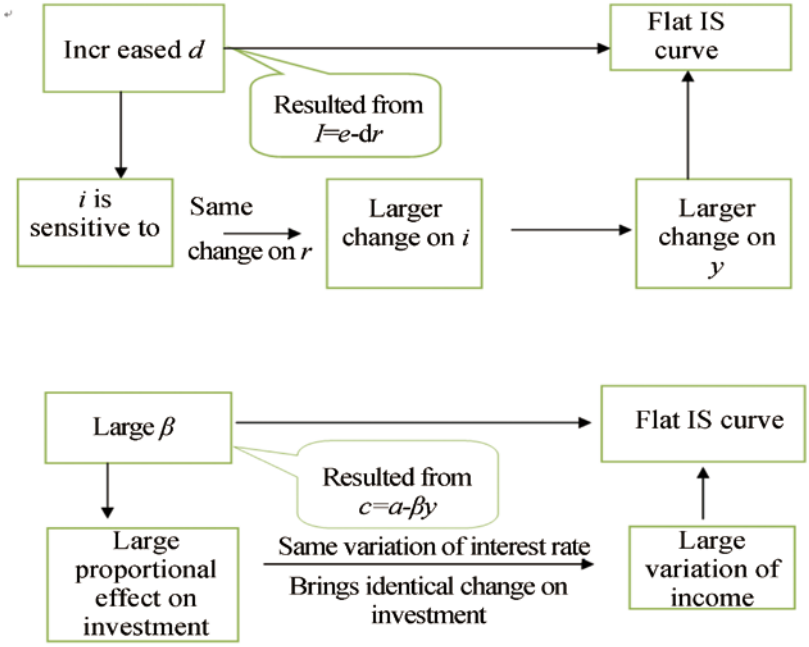

Figure 5
The Effect of *β* Changes on *y*

Object 4: Political meaning and mechanisms of coefficients and variables.

Increasing fiscal cost and decreasing tax on a constant interest rate (expansionary fiscal policy) will move IS curve to right, which leads to a higher income level. Decreasing fiscal cost and increasing the tax on a constant interest rate (tight fiscal policy) will move IS curve to left, which will lower income.

SUMMARY

"Mathematical Induction" method follows process of "mathematical induction comparison—pattern searching—summary and conclusion". Teacher is in a leading role in designing problems. It is clarified that students should master derivation of IS curve, variation of spontaneous consumption [α] and spontaneous investment [e], variation of d and β, movement of IS curve and slop change, corresponding change of y at fixed r. In in-class teaching, students are major. They are asked to calculate IS curve with different α, e, d and β values. After that, by comparing with the original function, discuss their effect on national income before and after change of α, e, d and β. Finally, students and teachers need to summarize and conclude together, to supply each other and summarize logical relationships between every variable. By letting

students to solve designed problems, it is conducive to promote students' motivation and improve their participation. By thinking and reviewing knowledge, they learn and complete study objects during their participation. Meanwhile, it worth noticed that due to uncertainty in depth and width of the students' problem, in conclusion of teaching content, one-sidedness will make students frustrated. That's why teacher needs to encourage students properly to avoid affecting their motivation and enthusiasm.

Mathematical induction teaching is an equal, free and open method. The key point to success is to use simple mathematical example to organize class, which is able to motivate students and offer them direct feeling. In addition, this method does not equal to simply ask a question in-class, not to mention tutoring in spare time. It sets a new concept from teach and learn, and participation together. It improves teaching quality by improving students' participation and releasing students' power in exploring knowledge.

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