

Increasing the Effectiveness and Adoption of an International Trade Tutorial Simulation: A Quasi-Experiment

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International trade is a standard topic in principles of macroeconomics courses. It is a challenging topic for undergraduate students, specifically comparative advantage and the terms of trade. A tutorial simulation was previously created and validated as an effective aid to student understanding of the topic. Changes were made to the previous tutorial simulation both in content and the method of delivery. The effects of these changes on student adoption and tutorial efficacy were studied through a quasi-experimental design. The revised tutorial is shown to increase student use of the tutorial as a study aid and to increase student understanding of the topic.

INTRODUCTION

In academia, professors find that certain topics tend to be difficult for students. This is perhaps more likely in introductory courses, where students enter with dissimilar skill sets. For example, colleagues have suggested that logarithms are always challenging in an introductory Calculus class, linear programming in analytics, the statement of cash flows in financial accounting, and we add to the list the “terms of trade” problem in macroeconomic principles. Students have no difficulty understanding that a nation can use resources more efficiently if it produces a surplus of a good that it produces well and trades the surplus to another country for a good it does not produce well. It is the actual problem, which involves aspects of comparative advantage, production possibilities, and ratio analysis, which causes the difficulty. If we are conducting a review session for the relevant macro exam or a comprehensive final, a student can always be counted on to ask, “Will you do one of those terms of trade problems?”

We attempted to address this situation previously by designing a teaching aid called TradeSim (Repede and Burson, 2008), an interactive computer simulation, which was made available to students as a self-installing, stand-alone software application. Students could take given pre-trade information and work through a sample problem, with drop-down text boxes and graphs available to give the students step-by-step assistance. The program would randomly generate additional iterations, and the text boxes could be hidden once the student felt confident enough to work through an example on his/her own. One group of students was given access to TradeSim, while another group had only the standard classroom presentation. The TradeSim group performed at a significantly higher level on an exam. Students who were taught with the software and used it for out-of-class study had a 39% increase ($p < .01$) in average score over the group of students who did not use the simulation software (Repede and Burson, 2008).

While encouraged by those results, we did discover over the course of several semesters that TradeSim was not terribly user-friendly, and required a substantial investment of time on the part of the student to master the use of the program. Although students who used the software in the original study outscored those who did not, seventy percent of the students in the experimental group did not use the software.

The terms of trade problem continues to be a very relevant concept for business students to master (Table 1) and a challenge for students.

TABLE 1
TEXTBOOK COVERAGE OF INTERNATIONAL TRADE

	Baumol	Case	Frank	Mankiw	McConnell	Schiller	Taylor
Patterns of Trade						x	x
Comparative Adv.	x	x	x	x	x	x	x
Trade Barriers	x	x	x	x	x	x	x
Pro-trade Case	x	x	x	x	x	x	x
Anti-trade Case	x	x	x	x	x	x	x
Terms of Trade	x	x	x	x	x	x	x
Trade Agreements		x			x	x	x

We hypothesized that a new teaching aid geared more to the computer skills of today's students could be much more effective than TradeSim. The importance of spreadsheets in today's business practice, business education, and business research is readily apparent (e.g. Grossman, 1999; Hesse & Scerno, 2009; Johnson & Drougas, 2004; Markowski & Markowski, 2009; Ragsdale & Zoebel, 2010; Thin-Yin & Cheong, 2008). Among spreadsheet software, Microsoft Excel has a dominant share of the market. A 2010 INFORMS award given to Solver, the Excel add-in, stated "Solver has been included in every copy of Microsoft Excel, and currently enjoys an installed base of approximately half a billion users" (Frontline Systems, 2010, para. 5). With this in mind, we created a revised "terms of trade" simulation using Microsoft Excel.

EXPERIMENTAL DESIGN

Two sections of the undergraduate principles of macroeconomics class were selected for the study. One section served as the control group and the other section served as the experimental group. There was no evidence to suggest that the two sections were dissimilar in student demographics. Participation was voluntary and the experiment was approved by the university IRB. Students in both sections were given the same multi-part international trade questions on their respective course exams. Through this quasi-experiment, we sought to test three hypotheses:

Hypothesis 1

Students who study using the International trade simulation will score higher on international trade exam questions than those who do not use the simulation

Hypothesis 2

Student use of the Spreadsheet-based International Trade simulation will be greater than use of the stand-alone International trade simulation software

Hypothesis 3

Students who study using the spreadsheet-based International trade simulation will score higher on international trade exam questions than students who study using the stand-alone International trade simulation software

THE “TERMS OF TRADE” PROBLEM

The problem itself uses two countries which both produce the same two goods, and the student is initially given **pre-trade production possibilities** for the two countries (Table 2). Country A, for example, could produce 60 widgets if it devoted all of its resources to widget production or, similarly, 150 hammers.

TABLE 2
PRE-TRADE PRODUCTION POSSIBILITIES

	Widgets	Hammers
Country A	60	150
Country B	120	40

In the absence of trade, it is assumed that citizens of both countries are demanding both goods, so each country has to divide its resources (we always assume a 50-50 resource split) in order to produce both goods. From that resource allocation, the student can find the **pre-trade actual production levels** (Table 3).

TABLE 3
PRE-TRADE ACTUAL PRODUCTION LEVELS

	Widgets	Hammers
Country A	30	75
Country B	60	20

Assuming the countries then decide to become trading partners, the student then needs to find which country has the **comparative advantage** in the production of which good. This is accomplished by finding the relative “opportunity costs”; the country that gives up the fewest hammers to make an additional unit of widgets has the comparative advantage in production of hammers, and should specialize in the production of that product. By determining the ratios of widgets-to-hammers for the two countries, we see that Country A gives up 2.5 hammers for each additional unit of widgets produced, while Country B only sacrifices .33 units of hammers for each additional widget produced. Country B, then, has the comparative advantage in the production of widgets. The ratios invert when we consider hammers-to-widgets, with Country A having comparative advantage in the production of hammers.

Now that comparative advantage has been identified, we assume that the two countries decide to trade, and they **re-allocate resources** with trade in mind. If the two countries were to maximize their relative comparative advantages, Country A would change its production to 100% hammers (150 units) and Country B would change to 100% widgets (120 units).

The final step, and the most difficult for the students, is to **develop a trade that would be mutually beneficial to each country**. In this particular example, there are many trade combinations that would satisfy the criteria, but we suggest that our students use the method explained below.

We now have 120 widgets to divide, and we assume that each country would, at minimum, want the amount of widgets that they had at pre-trade production levels. So we give each country the amount of

widgets they previously had, 30 for Country A and 60 for Country B. There are 30 widgets left, representing net gain; we divide the gain equally (and equitably) between the two countries, with each receiving an additional 15 widgets. Repeating the process for hammers shows a net gain of 55 hammers, so each country would receive their pre-trade allocation of hammers plus their share of the gain (27.5 units). The post-trade production levels would be as shown in Table 4, with each country receiving more of each good than the pre-trade levels:

**TABLE 4
POST-TRADE PRODUCTION LEVELS**

	Widgets	Hammers
Country A	45	102.5
Country B	75	47.5

SPREADSHEET SIMULATION

TradeSim2 is an Excel spreadsheet which allows students to simulate multiple international trade scenarios. TradeSim2 provides the student with a trade problem and allows the student to perform sensitivity analyses on the parameters of the problem. In the first panel (Figure 1), the student uses sliders to select production possibilities for each of the two goods in each of the two countries. Opportunity costs are automatically calculated and displayed. The student then selects from sliders the pre-trade production levels for each good in each country.

**FIGURE 1
PRODUCTION POSSIBILITIES PANEL**

Country A				Country B			
Production Possibilities (Type a number in the box or use the slider to set the production possibilities for Country A)				Production Possibilities (Type a number in the box or use the slider to set the production possibilities for Country B)			
Amount if only hammers are produced	<input type="text" value="150"/>			Amount if only hammers are produced	<input type="text" value="40"/>		
Amount if only widgets are produced	<input type="text" value="60"/>			Amount if only widgets are produced	<input type="text" value="120"/>		
Opportunity Costs				Opportunity Costs			
For each unit of hammers, Country A must give up $60/150 = 0.40$ units of widgets				For each unit of hammers, Country B must give up $120/40 = 3.00$ units of widgets			
For each unit of widgets, Country A must give up $150/60 = 2.50$ units of hammers				For each unit of widgets, Country B must give up $40/120 = 0.33$ units of hammers			
Pre-Trade Production Levels (Use slider to set the relative % of resources that are devoted to each good) (start at 50/50)				Pre-Trade Production Levels (Use slider to set the relative % of resources that are devoted to each good) (start at 50/50)			
	Widgets		Hammers		Widgets		Hammers
% Resources	50		50	% Resources	50		50
Production Amount	30		75	Production Amount	60		20

In the second panel (Figure 2), the opportunity costs and resulting comparative advantages calculated from the inputs selected in panel 1 are displayed.

FIGURE 2 COMPARATIVE ADVANTAGE PANEL

Opportunity cost of Widgets (In units of Hammers)		Opportunity cost of Hammers (In units of Widgets)	
Country A	2.50	Country A	0.40
Country B	0.33	Country B	3.00

Country B has an advantage in Widget production Country A has an advantage in Hammer production

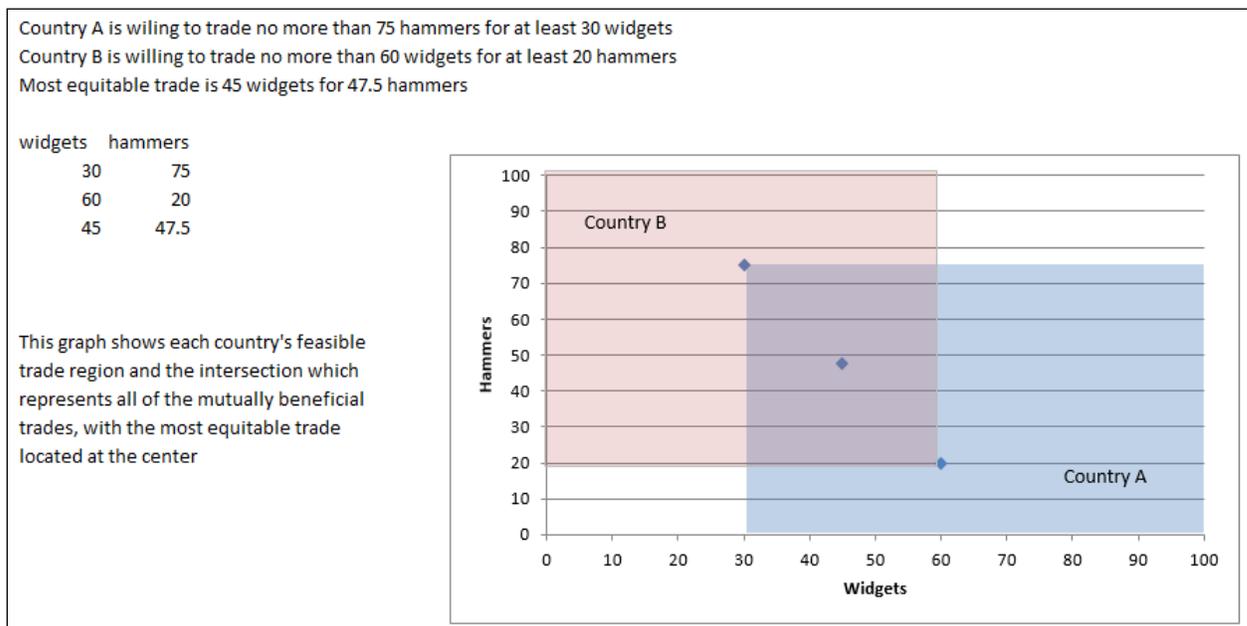
In the third panel (Figure 3), revised production levels, based on 100% of resources devoted to the comparative advantage, are displayed with upper and lower bounds on the terms of trade for each country.

FIGURE 3 TRADE PANEL

Most Equitable Trade								
Pre-Trade			Specialized Production		Post-Trade (Pre-trade + equal share)			
	Widgets	Hammers	Widgets	Hammers		Widgets	Hammers	
Country A pre-trade	30	75	Country A	0	150	Country A post-trade	45	102.5
Country B pre-trade	60	20	Country B	120	0	Country B post-trade	75	47.5
Pre-trade total	90	95	Most Equitable Trade:					
New production	120	150	45	Widgets	47.5	Hammers		
Increase to share	30	55						
Equal share	15	27.5						

The final panel (Figure 4) summarizes the feasible trades and graphs each country's feasible trade region, showing the area of mutually beneficial trades and the location of the most equitable trade.

FIGURE 4 FEASIBLE TRADE PANEL



It is hypothesized that the interactive nature of using sliders to set input values combined with the immediate updating of the outputs and the graphical display allows students to visualize the relationships in a way that manual calculations cannot, and thereby increases understanding.

RESEARCH RESULTS

Two sections of the undergraduate macroeconomic principles course were introduced to the international trade topic. Approximately fifty percent of students in each section were sophomore business majors. A control section received the material in the same way the topic had been taught previously. An experimental section was introduced to the topic by the instructor using the TradeSim2 software. The software was made available to students in the experimental section for practice outside of the classroom.

The same multi-part exam questions were used in both sections to measure student's understanding of the topic. There was a 32% improvement in the experimental group's average score on the international trade exam questions over the control group's average score ($p = .012$). Hypothesis 1 was confirmed.

In the original study, 30% of the students in the experimental group self-reported using the TradeSim software for out-of-class study. In this experiment, 50% of the experimental group self-reported that they used the TradeSim2 spreadsheet for out-of-class study. These proportions are significantly different ($p < .05$). Hypothesis 2 was confirmed.

There was a 12% improvement in the TradeSim2 (spreadsheet) experimental group's average score on the international trade exam questions over the TradeSim (stand-alone application) experimental group's average score ($p < .05$). Hypothesis 3 was confirmed.

CONCLUSIONS

TradeSim2 has been shown to be an effective study supplement for undergraduate business students in a principles of macroeconomics course. This study showed a significant increase in student use of a spreadsheet-based simulation over a stand-alone software application. Additionally, the changes in the TradeSim simulation and its interface increased students' understanding over the previous version.

REFERENCES

- Baumol, William J., & Blinder, Alan S. (2012). *Macroeconomics: Principles and Policy*, (12th ed.). Mason, OH: South-Western.
- Burson, T., & Repede, J., Extending The Use Of Simulation Software, *Journal of Applied Business and Economics*, 6(3), 57-64.
- Case, Karl E., Fair, Ray C., & Oster, Sharon (2013), *Principles of Macroeconomics*, (11th ed.). Upper Saddle River, NJ: Prentice Hall.
- Frank, Robert H., & Bernanke, Ben S. (2012), *Principles of Macroeconomics*, (4th ed.). Boston, MA: McGraw-Hill.
- Frontline Systems. (2010). Frontline Systems Wins 2010 INFORMS Impact Prize for Excel Solver. Retrieved from <http://www.solver.com/press201008.htm>
- Goldwater, E. (2007). Using Excel for Statistical Data Analysis – Caveats. Retrieved from <http://www-unix.oit.umass.edu/~evagold/Excel.html>
- Grossman, T. (1999). Why spreadsheets should be in OR/MS practitioners' tool kits, *ORMS Today*, 26(2), 20-21.
- Hesse, R., & Scerno, D. (2009). How electronic spreadsheets changed the world. *Interfaces*, 39(2), 159-167.
- Johnson, A. C., & Drougas, A. M. (2004). Illustrating type I and type II errors via spreadsheet simulation in the business statistics course. *Decision Sciences Journal of Innovative Education*, 2(1), 89-95.
- Mankiw, N. Gregory (2012), *Principles of Macroeconomics*, (6th ed.). Mason, OH: South-Western.

- Markowski, E. P., & Markowski, C. A. (2009). A systematic method for teaching post hoc analysis of chi-square tests. *Decision Sciences Journal of Innovative Education*, 7(1), 59-65.
- McConnell, Campbell R., Brue, Stanley L., & Flynn, Sean M. (2012), *Macroeconomics*, (4th ed.). Boston, MA: McGraw-Hill.
- Ragsdale, C. & Zobel, C. (2010). A simple approach to implementing and training neural networks in excel, *Decision Sciences Journal of Innovative Education*, 8(1), 143-149.
- Repede, J., & Burson, T., Improving Students' Understanding Of International Trade, *Decision Sciences Journal of Innovative Education*, 7(1), 265-269.
- Schiller, Bradley R., Hill, Cynthia, & Wall, Sherri (2013), *The Macro Economy Today*, (13th ed.). Boston, MA: McGraw-Hill.
- Taylor, John B. & Weerapana, Akila (2013), *Principles of Macroeconomics*, (6th ed.). Mason, OH: South-Western.
- Thin-Yin, L., & Cheong, M. F. (2008). Spreadsheet modeling of equipment acquisition plans. *Decision Sciences Journal of Innovative Education*, 6(2), 365-373.