
A Simulation Experiment of a Customs Union

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Abstract

Here a numerical simulation model, implemented in *Excel*, that can be used to expand student understanding of the theory of customs unions is presented. The model allows examination of core customs union issues including trade creation, trade diversion, and the Kemp–Wan theorem. By responding to an experimental assignment that guides them through the simulation, students are able to learn the theory in a hands-on manner. We also attempt to measure the effectiveness of our approach, and find evidence to suggest exposure to simulation improves student outcomes.

Introduction

Excel has recently become a widely used tool in business and economics education. Many authors have considered its use in the context of model development (see, for example, Cahill and Kosicki, 2000; Mixon and Tohamy, 2000), while others have used the program to help build skills useful in the business world (Wight, 1999). More recently, Tohamy and Mixon (2003) and Gilbert (2004, 2005) have used *Excel* in the context of a number of applications in international economics.

Using *Excel* has several pedagogical advantages. It is almost universally available, and most business/economics students receive training in the program as part of their general education courses. Hence it is familiar. Moreover, it is flexible for the instructor in that models built in the environment can be easily modified, and the information can be presented in a wide variety of formats, since *Excel* allows both tabular and graphical presentation of data.

The current paper contributes to the trade policy simulation strand of the literature by demonstrating the application of an *Excel*-based model designed to assist student learning of the theory of customs unions. This is a

classic topic for international trade economists, and a topic that, given current changes in the attitudes towards regional economic integration in the United States and elsewhere, is of considerable practical importance.

In the following section we outline our motivation for this paper. We then briefly present the theoretical background going on to describe the *Excel* implementation of the model, followed by our simulation experiment. Our statistical analysis of the effect of the model on student outcomes is then followed by the conclusion.

Motivation

Economic integration in its various forms has attracted the attention of numerous academics as well as policy makers over the past half a century. Increased attention has recently been paid to regional economic integration following the various problems that multilateral liberalisation under the World Trade Organization (WTO) has faced. In particular, several countries that have previously eschewed regional trade reform in favour of multilateral reform have now begun to pursue regional agreements vigorously (especially Japan and Korea, see Scollay and Gilbert, 2001). Other countries that have had limited interest in regional arrangements, such as the United States, have also begun to negotiate numerous bilateral agreements (see Schott, 2004). Hence, it seems likely that our students will have to evaluate the implications of this type of agreement with increasing frequency. Therefore, as educators, it is important that we expand student understanding of the issue. This belief motivated us to explore the impact of using *Excel* in the classroom as an aid to discussion of the theory of customs unions (Viner, 1950).

In order to achieve our goal, we designed an experimental simulation model that allows students to explore the impact of the formation of a customs union, under various possible economic conditions, for themselves. This simulated experiment allows students to consider not only the important Vinerian concepts of trade creation and trade diversion, and the factors that influence the magnitude of these effects, but also to consider the more advanced concepts of the Kemp–Wan Theorem (Kemp and Wan, 1976). The latter concepts are rarely touched upon in undergraduate classes. However, our simulation provides

an undergraduate audience with the learning opportunity in a simple simulation.

Theoretical background

In this section we demonstrate the basic partial equilibrium analysis used in our simulated model. Assume that two small countries, A and B, contemplate forming a customs union. The domestic supply and demand curves for commodity X in country A (B) are shown in panel A (B) in Figure 1. P_w denotes the given world price and t_i is the pre-union tariff on X imposed by country i , where $i = A, B$. Both countries are importers of X prior to the formation of the union, in the volumes denoted by M_A and M_B , respectively. Now assume that countries A and B form a customs union. There are two possible post-union prices. If the common external tariff is set such that competing imports from the rest of the world would be priced above P_U in Figure 1, then P_U must be the union price (the external tariff is prohibitive with respect to the union, and B imports only from A in this case). One way to find the union price is then to derive the total demand that country A faces after the formation of the union. This is simply the domestic demand for X plus the excess demand of country B (i.e. the demand for imports from country A). This total demand curve is denoted by $D_A D_0 A$ in panel A of Figure 1. The intersection of $D_A D_0 A$ and supply curve $S_A S_A$ reveals the union price. If on the other hand the common external tariff is set such that competing imports from the rest of the world would be priced below P_U then the world price plus the common tariff would prevail. In Figure 1 we have assumed the former case.

The Vinerian concepts of trade creation and trade diversion effects can easily be shown in our simple two-country set up. In B the volume of imports rises to $M_U (= EU, \text{ the exports of A})$, but the source switches from the rest of the world to country A. The trade diversion effect for country B is indicated by the shaded area c in Figure 1, panel B. This effect is associated with the lost welfare due

to diversion of trade from a cheaper source of trade (outside the union) to a more expensive source within the union, and is composed of lost tariff revenue. On the other hand, the trade creation effect for country B is indicated by the shaded areas $a + b$ in Figure 1, panel B. These areas are, in effect, deadweight loss from the original tariff that is 'reclaimed' by allowing imports from A.

For Country A, the net welfare effect of the customs union is given by the area $d + (e + f)$. The area d represents an expansion of net producer surplus due to preferential access to the market of B. The area e represents lost consumer surplus and f lost tariff revenue, both as a consequence of eliminating imports from the rest of the world.

The net impact of union formation on country B depends on whether or not the positive trade creation effect outweighs the negative trade diversion effect, and similarly for A. In general, this is an empirical question. However, there are several economic conditions that can make a net welfare gain more likely for a union. The larger the initial tariffs in the members, the more likely it is that trade creation will outweigh trade diversion (consider the limiting case of a prohibitive initial tariff). The more efficient members are relative to the world, the lower the trade diversion effect. Finally, the lower the common external tariff chosen after integration, the greater trade creation effect and the lower trade diversion effect.

This last point leads us to the core concept of the Kemp–Wan theorem (Kemp and Wan, 1976), which states that members of a customs union can choose a level of common external tariff that makes the member countries better off and leaves the welfare of the non-member countries unchanged. The essence of the result is that there is always a price at which the volume of imports from outside the union remains unchanged, and yet imports from inside the union rise. This means that aggregate welfare must rise.

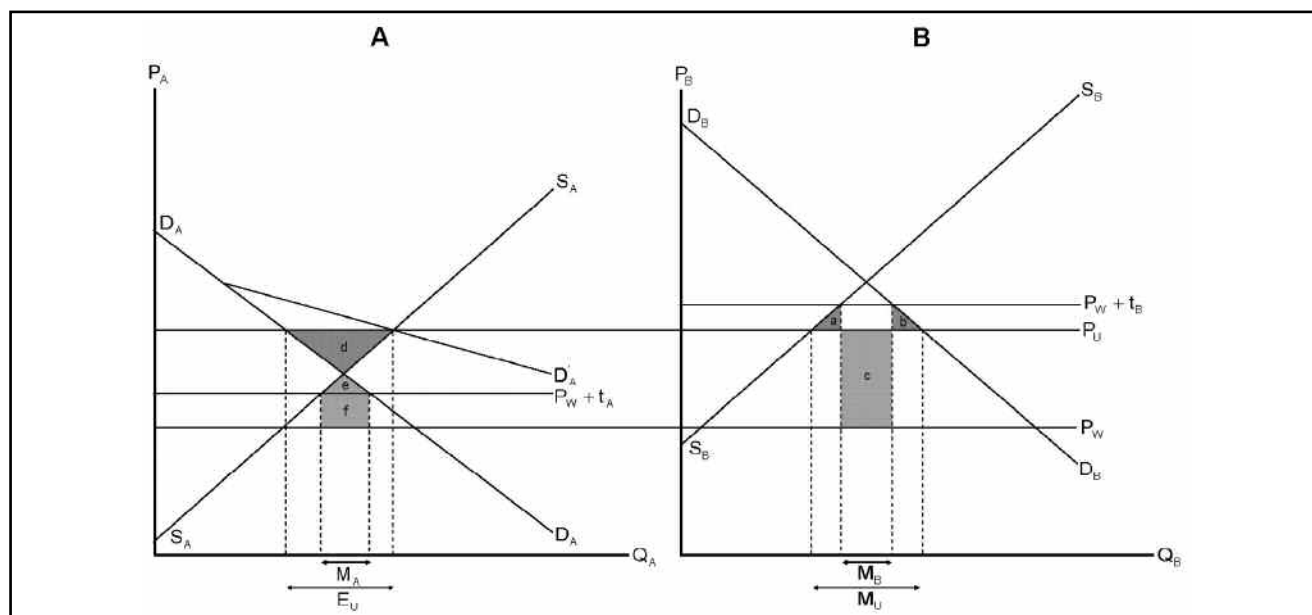


Figure 1.

Implementing the model in *Excel*

A model of this type can be implemented in *Excel* in a variety of ways.¹ The Solver add-in can be used to solve the problem, and this may be the easiest approach if non-linear functions are used. With linear functions for demand and supply, it is a simple matter to enter the solutions to the model directly. Since *Excel* automatically recalculates cell values on any change in an underlying cell, this approach has the advantage of providing instant feedback to students. Hence, it is the approach taken here.

The basic interface is shown in Figure 2. In the top two panels in Figure 2 we place the parameters of the (inverse) demand and supply functions for the two countries, A and B. Here we also place the exogenous world price, and the initial tariffs of the two economies. We adopt the convention of using a white cell background to indicate those cells that contain parameters of the model (those cells that can be changed by the user) and grey to indicate variables of the model (those cells the values of which are determined by the logic of the model, given the parameters). In the middle two panels we depict the tariff-ridden equilibrium of the two economies. Here we calculate the equilibrium prices and quantities, but also the economic surplus of the agents in the partial equilibrium model (i.e. consumers, producers and the government).

The third panel describes the integrated equilibrium. In this part the user can set the common external tariff, and the equilibrium prices and quantities are displayed. The economic surplus is also calculated, and can be compared directly to the corresponding value for the initial equilibrium. We make liberal use of comments to provide information on the meaning of the information contained in the cells.

At the top of the sheet, we have created graphics representing the two economies, and corresponding directly to the diagram in Figure 1. Because the figures are based directly on the values in the underlying cells, as students change those values the figure responds directly, providing a visual description of the changes in the outcome.

Two further points on the implementation are worth noting. The first is the use of forms. *Excel* provides a variety of pre-built interfacing devices (checkboxes, scroll wheels and others). These can be used to make the implementation more user-friendly by allowing users to vary key parameters smoothly (scroll wheels), and by allowing the user to select the information that is displayed on the graphs (checkboxes).² Second is the use of shading on the graphs. Mixon and Tohamy (2000) have shown how layers can be created using area graphs and transparent fills. However, this approach limits a model to

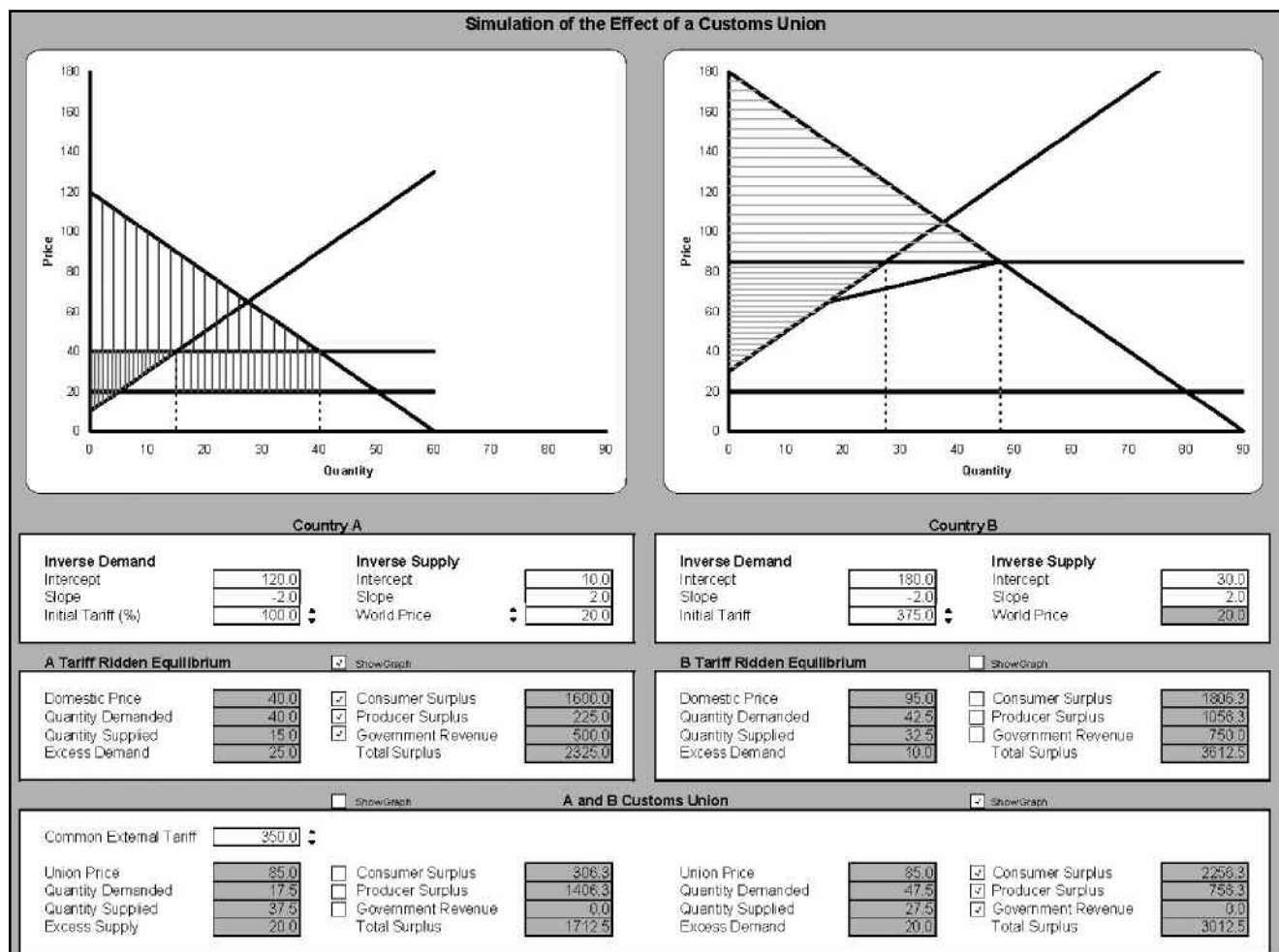


Figure 2.

integer solutions. We have used an alternative method of shading, using coloured lines in alternating directions. Then, by selecting consumer surplus under the integrated equilibrium and under the initial equilibrium, for example, the change in consumer welfare can be visualised.

Simulation experiment

We conducted our simulation experiment in international economics for business students, in the Fall of 2004, following the pattern of introduction that we have used with other simulation models in the past. Students were introduced to the model in class, using in-class technology. The simulation was first used as a support to a standard teaching approach, using static geometry and classroom discussion. The model was used to introduce the basic results of trade diversion/creation. The purpose of the classroom introduction to the tool is to familiarise students with the mechanics of the model and its usage.

The second part of our approach was to provide students with access to the model itself, through class websites, along with a graded assignment containing instructions on the nature of the simulated experiment (see the Appendix). Their task was to simulate various scenarios in which the two countries form a customs union. The objective of the assignment was to provide students with the opportunity to discover some features of pre and post-union economies that can help them to understand whether the outcome of integration will be positive or negative from the net social welfare perspective. We did not tell the students what to expect. In order to conduct the experiment methodically, we asked the students to record their findings throughout the experiment. At the end we ask them to explain their recorded results in a short essay. Our premise is that students will retain ownership of results that they discover for themselves, and that this will improve learning outcomes.

The experimental assignment is as follows. First students are asked to simulate a scenario by selecting certain pre-union tariffs and a world price using spinner. Under this scenario both countries would be worse off by formation of the union. We expect the students to realise that the exporting member of the union may be worse off by formation of the union even though exports expand. Students also notice that the trade diversion effect of this simulated union outweighs the trade creation effect.

Next we ask student to simulate a second scenario by choosing higher levels of pre-union tariffs. In this scenario the trade creation effect dominates the trade diversion effect, making the formation of the union beneficial to both countries. Hence, students are expected to find that an important factor in determining the benefits of a customs union is the pre-union barriers to trade.

In a third scenario students are asked to select a higher world price, making the (partner) member country to which trade is diverted less inefficient relative to non-member sources. Again, the formation of a customs union benefits both countries. The expected conclusion by students is that the less inefficient the partner country within the union is, compared to non-member sources, the higher is the likelihood of benefiting from formation of a union.

Finally, we try to simulate a situation by which students are guided toward the outcome anticipated by the Kemp–Wan theorem. Students are asked to choose an external tariff that leaves the welfare of the non-member countries unchanged while making both union member countries better off. Since the union consists of two small countries and the formation of a customs union does not affect the world price, the impact on the welfare of the non-member countries is measured by the level of union trade with these countries.

Statistical analysis

Several computer simulations of trade and trade policy related issues now exist, and numerous arguments can be made for the pedagogical value of the approach. Many of the students find the approach fun, and overall classroom reaction has been very positive. However, there is relatively little quantitative evidence that using simulations is effective in the sense of actually improving student performance. Because the material that formed the basis of this experiment was covered using traditional chalkboard techniques in the previous semester, by using a common final examination we had the opportunity to use exam results from the previous semester as a control to test the effectiveness of our treatment. A similar approach is used in Tohamy (2004) to test the effectiveness of non-computerised classroom games. The course material covered in both semesters was identical in all respects other than the simulation assignment. The textbook, instructor and approximate time of the class (in the afternoon) did not change, nor did the class notes or access to practice problem questions.

The final exam contained a total of seven multiple choice questions concerning the effect of customs unions. These questions required students to correctly define trade creation and diversion, to calculate the extent of trade creation/diversion for an algebraic example (using linear demand and supply functions), and to identify factors that would alter the extent of trade creation/diversion. In the semester in which the simulation model was used as part of the instruction on customs unions, the total number of students was 56, while 59 students took the course in the preceding semester. The mean score on these questions (which were among the most challenging in the exam) was 51.3% in the control group, and 66.3% in the treatment group. Hence, the average improvement in the score on this section was 15 percentage points (a 29.2% improvement). The t-value of the test for an equal mean was 3.056, with a probability of 0.28%. Hence, the difference in performance on this material is strongly statistically significant. This suggests that using the experimental simulation was an effective method of improving student understanding of customs union issues.

It is possible that the group of students in the treatment group were, for some reason, outside of our control or, by chance, better able than the students in the preceding semester. However, if this hypothesis was true, then we would expect the performance on the remaining questions in the exam to be superior (the final was comprehensive). The average score on the remaining questions in the control group was 75.1%, while for the treatment group

the average was 78.6%, an improvement of 3.5%. However, the t-value of the test for an equal mean was 1.588 with a probability of 11.51%. Hence, at any conventional level we cannot reject the null hypothesis that the mean score on the remaining questions was the same across both groups.

Concluding remarks

We used an *Excel*-based simulated experiment to enhance student learning of the theory of customs unions. The issues of customs unions and regional economic integration in general have gained increasing importance over the past few decades partly due to the problems that multilateral liberalisation under WTO has faced. Therefore, student understanding of these issues is crucial.

Through our simulated experiment we guide students to explore the Vinerian concepts of trade creation and trade diversion. In addition, within our simple framework, we provide students with the opportunity to learn the Kemp–Wan theorem (Kemp and Wan, 1976). Classroom response to the simulation was positive. Finally, we attempted to measure the impact of our simulation on student learning by comparing the average exam performance on questions relating to customs unions between the treatment group and a control group from the preceding semester. Our results indicate a statistically significant improvement in performance in the treatment group.

Notes

- ¹ A copy of the Excel sheet described in this section is available from the author on request.
- ² Figure 2 demonstrates the display of the tariff ridden equilibrium for country A, and the display of the integrated equilibrium for country B. Total surplus is shaded in both diagrams.

References

- Cahill, M. and Kosicki, G. (2000) 'Exploring Economic Models Using Excel', *Southern Economic Journal*, 66(3), 770–792.
- Gilbert, J. (2004) 'Using Nonlinear Programming in International Trade Theory: The Factor-Proportions Model', *Journal of Economic Education*, 35(4), 343–359.
- Gilbert, J. (2005) 'A Trade War Simulation/Experiment in Excel', *Computers in Higher Education Economics Review*, 17.
- Kemp, M. and Wan, H. (1976) 'An Elementary Proposition Concerning the Formation of Customs Unions', *Journal of International Economics*, 6(1), 95–97.
- Mixon, J.W. and Tohamy, S. (2000) 'Using Microsoft Excel in Principles of Economics', *Computers in Higher Education Economics Review*, 14.
- Schott, J. (ed) (2004) *Free Trade Agreements and US Trade Policy*, Institute for International Economics: Washington, DC.
- Scollay, R. and Gilbert, J. (2001) 'New Regional Trading Arrangements in the Asia-Pacific', Washington, DC: Institute for International Economics.
- Tohamy, S. (2004) 'Combining Fun and Learning in Principles of Economics Courses', *Computers in Higher Education Economics Review*, 16.

- Tohamy, S. and Mixon, J. W. (2003) 'Lessons from the Specific Factors Model of International Trade', *Journal of Economic Education*, 34(2), 139–150.
- Viner, J. (1950) *The Customs Union Issue*, New York: Carnegie Endowment for International Peace.
- Wight, J. B. (1999) 'Using Electronic Data Tools in Writing Assignments', *Journal of Economic Education*, 30, 21–27.

Appendix

Assignment instructions for customs unions experiment

Download the *Excel* file entitled 'Customs Unions' from the class website. This *Excel* sheet helps you simulate different situations where two countries contemplate forming a customs union.

Assume that the pre-union tariff rates on commodity X are 100% and 375% in countries A and B, respectively. (These values should be the defaults.) Let the world price be \$20. Note that both countries at this point import X from the rest of the world.

Now assume that A and B form a customs union with an external tariff of 350%, resulting in Country A being an exporter of X to B.

1. What is the impact of formation of this union on the welfare of A? Explain the result. How does the formation of the union impact on B?
2. Now assume that the pre-union tariff rates in A and B are 205% and 420% respectively. How does this assumption affect your answer to question 1?
3. Assume the original pre-union tariff rates of 100% and 375% in countries A and B, respectively, and instead let the world price be \$40. What is the impact of the formation of a customs union on the welfare of A and B? How does this compare to question 1? What do you conclude?
4. Assume that the world price of X is \$20 and pre-union tariff rates are 210% and 420% in A and B, respectively. A and B form a union but, due to their obligations under the WTO, they want to choose a level of external tariff that leaves the welfare of the rest of the world unchanged when compared with the pre-union level. Find such a rate of external tariff.

Summarise your findings from this experiment. Include your answers to all stages of the experiment in your explanation. Use the concepts you learned in class regarding the formation of customs unions, in particular trade creation and trade diversion. What are the implications of your findings for the likely effects of a formation of customs unions in the real world? Your summary should be approximately 300 words and typed.

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