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Theme Day Summary

Recent Advances in Applied General Equilibrium Modeling: Relevance and Application to Agricultural Trade Analysis

Organizers: Ian Sheldon (The Ohio State University), Kari Heerman (Office of the U.S. Trade Representative), and Jason Grant (Virginia Tech)

Introduction

The International Agriculture Trade Research Consortium (IATRC) is an international association of agricultural trade researchers and policy practitioners. The objective of the consortium is to enhance the quality of agricultural trade research by encouraging collaboration among international researchers to improve public understanding of international trade and trade policy issues through various activities such as its flagship annual conference, organized symposia, and outreach activities.

Each year, the consortium holds its annual meeting where members including academics, government representatives and business researchers discuss research priorities and plans as well as report on on-going research during the theme day discussions. The first day of this meeting is called the Theme Day, which is devoted to a topic such as a policy issue, an area of research, or a research methodology. The focus is on innovative trade analysis and research with potential applications for agriculture. The Theme Day also helps to facilitate the exchange of ideas and foster collaboration.

This year the Theme Day discussions focused on the latest research and analysis regarding the evolution and advancement of Applied General Equilibrium (AGE) models, their merits and demerits, as well as their applications to agricultural trade issues. AGE models are becoming increasingly relevant as the policy debate moves beyond agriculture towards food systems. These models are well equipped to provide a comprehensive approach to tackle important issues such as environmental sustainability, climate change, trade, productivity, rural poverty and nutrition. This makes AGE models an important addition in applied agricultural trade analysis, which is often carried through Partial Equilibrium models in government agencies, focusing on the implications of new trade agreements on the agriculture sector. Both tools can tackle similar problems, such as those listed above, but with a different lens thus providing different types of results for analysis.

The Theme Day was organized as follows: it started with a retrospective discussion of AGE models followed by analysis of some of the recent applications of AGE models to agricultural trade. We then examined some of the challenges in measuring trade elasticities as well as looking at how other models could complement AGE models. The day concluded with a critical assessment of recent AGE model developments and a panel discussion reflecting on their current state.

Session 1: Retrospective Discussion of AGE Models

Timothy Kehoe (University of Minnesota) -Discussant: Munisamy Gopinath (University of Georgia)

AGE models have been in place since the 1980s

This session's speaker noted that we have come a long way in the past forty years, or so we thought. Looking back, Applied General Equilibrium models have evolved in many different ways leading to a variety of agriculture and trade analysis. The introduction of features like Armington elasticities and how to measure them, among others, have been important additions to these models.

AGE models are often static models, meaning that they do not have a time component; they transition from one equilibrium state to another. Thus, they perform well in predicting trade volumes and include fairly disaggregated sectors of the economy. However, they face a number of challenges that could make their predictions imprecise when compared to the actual data. AGE models are spatial and lack intra-industry heterogeneity. In other words, representative agents trade homogenous goods and services between themselves through countries rather than heterogeneous goods through industries. These models do not explain well the dynamics during the transition from one equilibrium to another, so it is very difficult to assess which agents of the economy are affected during the transition.

In addition, assuming full employment in AGE models is problematic since there is always unemployment in the economy. Trade policy uncertainty, which is more relevant today than before, is not captured in AGE models. Uncertainty is difficult to measure and this feature would undoubtedly affect trade analysis. These challenges render AGE analysis inexact most of the times when the projected results were retrospectively compared to the data.

Elasticities drive most of the results in AGE models

The introduction of Armington elasticities in AGE models have been a great addition as they help determine the use of inputs through substitution between domestic and imported products, ultimately affecting trade flows. However, they are unobserved in the data and hence researchers rely on estimates. There are many different types of elasticities in AGE models and getting an accurate estimate of each of them has been a challenge.

Another challenge with elasticities in AGE models is that they are fairly aggregated i.e. one import elasticity is estimated for all sectors and regions. This simplifies the analysis but makes the results less accurate. Disaggregating elasticities has been the focus of many researchers. In fact, it is shown that estimating not just sector specific elasticities but bilateral specific elasticities will enhance the results of AGE models.

The treatment of the "small share" or "zero trade" in Armington-based models is another problem. It assumes that products with no trade or small trade will remain so post-simulation. This is problematic since trade in some of the least traded products grow after trade liberalization. To avoid this issue, it was suggested that dividing the sectors into least traded and highly traded products, and enhancing the elasticities of least traded products by adding a booster term, will greatly enhance the results of AGE models. The booster term essentially scales up the factor term for least traded products reflecting the faster growth in this category and aligning the results with what actually occurs.

Despite the challenges, AGE models continue to evolve and remain important

Despite the aforementioned challenges, AGE models continue to be important in analyzing the implications of trade policies. The fact that they use fairly disaggregated data for all sectors of the economy and for all regions of the world makes them better suited in analyzing the overall effects of trade policies. In addition, the models keep evolving and improving as we learn from the past, and come with new ways of addressing some of the structural challenges facing the models.

Session 2: Recent Applications of AGE Models to Agricultural and Other Trade Settings
Edward Balistreri (Iowa State University) - Discussant: Dominique van der Mensbrugghe (Purdue University)

U.S.-China trade dispute

Recent applications of AGE models include the U.S.-China trade dispute. One of the main themes in this session was trade theories, such as Armington/E-K, Krugman, Melitz etc., which form the building blocks of different AGE models. Research has shown that these trade theories are complements and not necessarily substitutes, and no matter which trade theory AGE models are based on, they tend to perform in a similar manner. It was also pointed out that the use of gravity equations has also become more common in recent AGE applications.

The symmetry of bilateral trade relations was also discussed. The assumption is that exports from country A to B are equal to imports of country B from A. Symmetry leads to simplicity but less completeness. Symmetry could be adjusted through trade elasticities and focusing on heterogeneity but this is not trivial.

Session 3: Measuring Trade Elasticities
Michael Waugh (New York University) - Discussant: Shawn Arita (USDA Office of Chief Economist)

Estimating trade elasticities is challenging

Trade disputes have shown us the importance of trade elasticities as countries have started shifting their import sources. For example, since the China-U.S. trade war, many industries have begun sourcing their parts or resources from different countries. Switching between countries demonstrates the importance and use of trade elasticities. However, trade elasticities are unobserved, leading researchers to develop methods to estimate the size of the elasticities. Nevertheless, the more that sectors are disaggregated, the higher the trade elasticities. It has also been shown that substitution elasticities tend to be higher in the presence of trade disputes. More work is needed to better measure elasticities.

Session 4: Taking AGE Models to the Data
Yoto Yotov (Drexel University) - Discussant: Nelson Villoria (Kansas State University)

Bringing gravity models to AGE models

Gravity models are trade models that help predict bilateral trade flows based on the size of countries' economies and the distance between them. Thus, much of the discussion focused around how gravity models and gravity equations can be used to complement AGE models. It was shown that gravity equations can be malleable enough to form the basic building blocks of AGE models, hence making the two models complements. It was highlighted that gravity models/equations tend to fit well with all

models, without the extensive theory. In other words, with a few basic assumptions and equations the gravity model/equations can be integrated with larger AGE models and generate similar results.

Session 5: Critical Assessment of Recent AGE Models

Katheryn Russ (University of California Davis) – Discussant: Jeff Reimer (Oregon State University)

AGE Models will continue to be the main tools used in analysing policy changes

AGE models have many critics, as the output or results are often incorrect (as with any long-term projecting model) when compared with actual results. Nevertheless, these models remain the workhorse for trade analysis and are the go-to models when trade agreements or trade disputes take place. Issues that critics of AGE models have pointed out include the fact that uncertainties are generally discounted, missing or inaccurate elasticities, full employment assumption, and lack of firm heterogeneity. These shortcomings have provided ammunition for critics to question the usefulness of AGE models. Nevertheless, they will continue to be the main framework used to analyse policy changes in part because of their richness and completeness. While improvements in addressing some of the challenges have been made, such as work on elasticities and research into booster terms, there is still work to be done in addressing these challenges.

Session 6: Panel Discussion - Reflections on the Current State of GE Modelling

Amanda Countryman (Colorado State University), Tom Hertel (Purdue University), Will Martin (IFPRI), William Powers (U.S. International Trade Commission), Panel Chair: Kari Heerman (Office of U.S. Trade Representative)

The panel spent some time discussing where the models have failed in the past in order to move forward and improve them. The main insight was to be transparent in communicating model results to the public and policy makers. It was stressed that how you communicate the results of the models is as vital as getting your assumptions right.

It was noted that sensitivity analysis should be conducted to test the results especially around elasticities since they drive most of the results. Figuring out how to deal with the “small share” and “zero trade” problem and improving asymmetries remain important.

Improving AGE models by continuously adding more equations may not be the best strategy, as it makes the models “bulky”. This may mean they are more complete but much less simple. This implies greater difficulty in understanding them, running them and fixing problems that may arise. Instead, it was suggested that modules could be incorporated and could be turned on or off to enable specific features or components. The importance of further disaggregating sectors, incorporating trade uncertainties, measuring non-tariff measures, as well as aggregating tariffs were also discussed.

Conclusion

The Theme Day discussions focussed on understanding how general equilibrium models have been used in the past, how they are currently utilized as well as some of the challenges they face. In particular, the evolution of AGE models including the introduction of Armington elasticities, their predictive performance, as well as challenges and opportunities facing the models were discussed. Despite AGE

models possessing a number of shortcomings, including measurement of elasticities, lack of firm heterogeneity, full employment assumptions and at times inaccurate predictions, AGE models remain the workhorse for trade analysis.

Their richness and power come when analysing policy changes that have wide implications for the whole economy (e.g., free trade agreements or trade disputes). AGE models are far better equipped than Partial Equilibrium (PE) models in analysing the implications of such a change in policy since they have a structural framework that links not only whole sectors in the economy but also all regions in the world. Furthermore, the increasingly stronger linkages throughout the global value chains require a comprehensive view of agriculture that is connected with other sectors in the domestic and global context. Hence, AGE models, unlike PE models, provide a modelling approach that captures those inter-industry linkages as well as inter-country linkages. This is not to discount the importance of PE models that provide agricultural sector specific modelling and have far more disaggregated sector specific data. PE models can also best estimate a wide range of measures including the agronomic details of production at the local scale while AGE models look at the broader, more complete picture.