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External Economies and International Trade: A Quantitative Framework

External Economies and International Trade: A Quantitative Framework

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We have three completed papers: (1) "Grounded by Gravity: A Well-Behaved Trade Model with External Economies", (2) "Necessary and Sufficient Conditions for Uniqueness in Spatial Equilibria: The Case of Two Locations", and (3) "A Unified Model of International Business Cycles and Trade".

PAPER (1) already has 53 citations and builds theoretical foundations for empirical work. PAPER (2) fills a big gap in the new economic geography literature by providing a full mathematical characterization of the Krugman (1991) model. PAPER (3) closes a direction in the business cycles literature.

international trade

economies of scale economic geogrpahy dynamic trade models trade policy

The field of international trade has made great strides in the past decades by "mapping theory to data" in the new quantitative trade models (or so-called "gravity models"): Eaton and Kortum (2002), Anderson and van Wincoop (2003), Melitz (2003) with Pareto-distributed productivities as in Chaney (2008). More recently trade economists took gravity models to the next level by introducing multiple industries, labor markets, dynamics, and other realistic ingredients: Caliendo, Dvorkin and Parro (2015), Caliendo, Feenstra, Romalis and Taylor (2015), Galle, Yi and Rodríguez-Clare (2015). These more realistic gravity models allowed economists to address such important questions as, for example, the effects of Brexit on the countries around the world (Dhingra, Huang, Ottaviano, Pessoa, Sampson and Van Reenen, 2016) and the causes of trade collapse during the global financial crisis of 2007-2008 (Eaton, Kortum, Neiman and Romalis, 2016). Yet, modern gravity models are still lacking one ingredient: industry-level external economies of scale.

By definition, an industry is said to have external economies of scale if two things hold: (1) this industry exhibits increasing returns to scale, i.e., the more output is produced in this industry, the more productive firms in this industry become; (2) firms do not have full control over the improved production environment and technologies, i.e., firms cannot exclude other firms from benefitting from a larger scale of the industry.

A vast empirical and anecdotal evidence suggests that external economies of scale play an important role in the globalized world. A good example is Japanese car industry in which four smaller car producers – Mazda, Mitsubishi, Suzuki, and Subaru – continue to prosper alongside three giant car producers – Toyota, Nissan, and Honda. Moreover, the smaller four are more profitable than most firms in the car industry. This is a bit puzzling, because it seems that these four smaller car producers "should long ago have merged with rivals at home or abroad, or fallen by the wayside." (The Economist, "Lots of oomph", October 25th, 2014). A deeper look at this story suggests that the success of the smaller car manufacturers can equally be attributed to Japan's comparative advantage in the automobile industry and to the presence of external economies of scale in this industry. Speaking more broadly about the Japanese economy, Mitra and Sato (2006) analyze industry-prefecture level data on production and employment in Japan and find positive association between productivity and measures of external economies of scale.

On the theory side, trade and economic geography economists understand the consequences of external (as well as internal) economies of scale for trading economies only for a limited number of special cases: (i) multiple countries and one industry (Krugman 1979, 1980, and the literature that followed); (ii) two countries and two industries (Ethier, 1982; Fujita, Krugman and Venables, 1999); (iii) two countries and a continuum of industries under an exogenous assumption that both countries produce positive amounts of goods in all industries (Hanson and Xiang, 2004). The reason for this limitation is "a bewildering variety of [multiple] equilibria" which occur once one tries to generalize these cases (Krugman, 1995).

The main goal of this study was to develop a quantitative model of international trade which features multiple countries, multiple industries, and industry-level external economies of scale. This goal was being pursued in the paper "Grounded by Gravity: A Well-Behaved Trade Model with Industry-Level Economies of Scale". We aimed at developing a model in a such a way that it had a unique equilibrium under certain parameter restrictions. Uniqueness of equilibrium was needed to take the model to the data, which was our second goal. Namely, we were planning to use country-industry-level data on trade and production to quantitatively assess the role of external economies of scale for trading economies.

While pursuing our first goal, we acquired certain mathematical and economic modelling expertise. Endowed with this expertise, we saw a possibility to address two big gaps in the economics literature. Thus, we added two more goals. First, we aimed at building a model of international trade and real business cycles that featured external economies of scale and that was explaining certain puzzling features of other models used in the international business cycles literature. This goal was pursued in the paper "A Unified Model of International Business Cycles and Trade". The second additional goal was to establish mathematical properties (namely, conditions for uniqueness/multiplicity of equilibria) of a

class of economic geography models featuring external economies of scale. This goal was pursued in the paper "Necessary and Sufficient Conditions for Uniqueness in Spatial Equilibria: The Case of Two Locations".

In the project "Grounded by Gravity: A Well-Behaved Trade Model with Industry-Level Economies of Scale", we developed a quantitative model of international trade which features multiple countries, multiple industries, and industry-level external economies of scale. We put significant effort into numerical simulations of the model. This entailed development of new computational algorithms using cutting-edge knowledge from computer science (namely, interval analysis). Our numerical simulations demonstrated that the model possessed desired properties that allowed us to take the model to the data, which we did next. Using country-industry-level data on trade and production, we have quantitatively assessed the role of external economies of scale for trading economies. Simultaneously with the empirical work, we worked on establishing mathematical properties of our model. This work was done in collaboration with two recognized specialists in matrix algebra: Charles R. Johnson of College of William and Mary, and Michael Tsatsomeros of the Washington State University.

In the project "A Unified Model of International Business Cycles and Trade", we proved a theorem that several popular models in the international trade and business cycles literature are equivalent in their aggregate economic predictions despite having very different setups. Our proof was constructive in the sense that we build a unifying model that has the same aggregate predictions as any of the other models in the literature that we considered. We next estimated key parameters of our model by brute force grid search in the parameter space (7 dimensions). We could not apply any of the Newton-based methods for the estimation due to high nonlinearity of our model and lack of concavity properties of the objective function. The estimation part took about one year and required substantial computational resources. In addition to that, we spent about six months setting up the estimation and then analyzing its results. For the estimation, we used: (i) the workstation acquired by Konstantin Kucheryavyy with the current research grant; (ii) the computational cluster at the economics department in the University of California at Berkeley; (iii) the high-performance cluster at the University of Texas at Austin.

In the project "Necessary and Sufficient Conditions for Uniqueness in Spatial Equilibria: The Case of Two Locations" we proved several theorems that established mathematical properties of a class of economic geography models featuring external economies of scale. Proving the theorems did not require any advanced knowledge of mathematics. Instead, it involved creative thinking and skillful use of standard methods of analysis of non-linear equations.

Our research results were presented at almost all prestigious conferences in our field (The NBER Summer Institutes, Society of Economic Dynamics, Meetings Econometrics Society at different regions; American Economic Association meetings, and others) as well as at about 30 universities in Asia, Europe, and North America. Our first project "Grounded by Gravity: A Well-Behaved Trade Model with Industry-Level Economies of Scale" is at the second round of revision at "The American Economic Journal: Macroeconomics". Our second project "A Unified Model of International Business Cycles and Trade" is the revision at "The Review of Economic Studies". We are now preparing our third project "Necessary and Sufficient Conditions for Uniqueness in Spatial Equilibria: The Case of Two Locations" for a publication at a top-5 economic journal.

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A Unified Model of International Business Cycles and Trade
18th Society for the Advancement of Economic Theory in Taiwan
2018

Konstantin Kucheryavyy
A Unified Model of International Business Cycles and Trade
2018 Society for Economic Dynamics in Mexico
2018

Konstantin Kucheryavyy
A Unified Model of International Business Cycles and Trade
2018 North American Summer Meeting in the US
2018

Konstantin Kucheryavyy
A Unified Model of International Business Cycles and Trade
NBER Summer Institute in Boston
2018

Konstantin Kucheryavyy	
A Unified Model of International Business Cycles and Trade	
34th Annual Congress of the European Economic Association	
2018	

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A Unified Model of International Business Cycles and Trade	
Hitotsubashi University, Japan	
2018	

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A Unified Model of International Business Cycles and Trade	
Columbia University, USA	
2018	

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A Unified Model of International Business Cycles and Trade	
UC Berkeley	
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A Unified Model of International Business Cycles and Trade	
University of Wisconsin-Maddison	
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A Unified Model of International Business Cycles and Trade	
Michigan University	
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Rochester University	
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Copenhagen Business School, Denmark	
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Konstantin Kucheryavyy	
Unified Model of International Business Cycles and Trade	
18th Society for the Advancement of Economic Theory	
2018	

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Unified Model of International Business Cycles and Trade	
2018 Society for Economic Dynamics	
2018	

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Unified Model of International Business Cycles and Trade	
2018 North American Summer Meeting	
2018	

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Unified Model of International Business Cycles and Trade

71st European Meeting of the Econometric Society

2018

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National Research University Higher School of Economics in St Petersburg, Russia

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