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Introduction

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Over the last half-century, the gravity model has become the workhorse of the applied international trade literature. Starting with Tinbergen (1962),[1] the gravity model has given rise to literally thousands of publications and working papers covering a wide variety of regions, time periods, and sectors. For example, Disdier and Head (2008) in their meta-analysis of the effect of distance on trade cover 1,052 separate estimates in 78 papers. By linking trade flows directly with economic size and inversely with trade costs, usually proxied by geographical distance as an indicator of transport costs, the gravity model captures some deep regularities in the pattern of international trade and production. Indeed, Leamer and Levinsohn (1995) have argued that the gravity model has produced "some of the clearest and most robust findings in empirical economics".

The gravity model is a key tool for researchers interested in the effects of trade-related policies. It provides a convenient testing bed on which to assess the trade impacts of different policies. Gravity models now routinely include variables far beyond those such as tariffs, which are imposed at the border, to cover behind-the-border barriers as well. Regulatory policies, as well as deep political and institutional characteristics of countries, have been shown to influence trade as modeled in the gravity framework. Moreover, the gravity model is no longer concerned only with trade in goods, but has recently been applied with success to trade in services (e.g., Kimura and Lee, 2006). Indeed, the exercises presented in this user guide will concentrate on the emerging area of trade in services, where increased data availability is making it increasingly feasible to apply the most up-to-date estimation methods and models.

Although the gravity model is an attractive platform for applied international trade researchers, its use does not come without some potential pitfalls. Chief among these is the choice of exactly which model to estimate (specification). Traditionally, gravity models have been based largely on intuitive ideas as to which variables are likely to influence trade. More recently, however, a number of "theoretical" gravity models have been developed, which use various micro-founded theories of international trade to develop gravity-like models. Indeed, Deardorff (1995) has argued that an equation that looks something like gravity must emerge from "just about any sensible trade model".

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[1] See De Benedictis and Taglioni (2011) for a review of the development of the gravity model and its early implementations. That paper also contains information on many examples of the successful application of gravity models in policy contexts, and is strongly recommended as complementary reading for this User Guide.

At the same time, econometricians have set out a number of alternative methodologies for estimating the models themselves. The challenge for applied researchers in the current environment is to make best use of these recent theoretical and empirical advances in answering interesting and relevant policy questions. This user guide is envisaged with that challenge in mind.

The purpose of this user guide is to provide policy researchers with an applied introduction to the gravity model and its applications. With the exception of the worked Stata examples, all the material presented here draws on published papers and existing research. The user guide thus serves as a kind of compendium – at an introductory level – of recent advances in gravity model practice. The material is presented in a largely non-technical way that should be accessible to anyone with a grounding in graduate-level microeconomics and econometrics. To keep the presentation simple and uncluttered, proofs of basic propositions are generally omitted, and readers are referred to standard sources – particularly econometrics textbooks – for more detailed information.

In light of its purpose and intended audience, this user guide is a complement to existing sources on the gravity model, its foundations, and its applications. Applied policy researchers can use it as a starting point for their own research, or as a ready reference for Stata code and other technical details. However, each research application of the gravity model is highly specific, and needs to be careful crafted and related to the previous literature. Moreover, the literature in this area is changing rapidly, and is currently unsettled in a number of areas, particularly when it comes to econometric methods for gravity. Researchers therefore need to ensure that they are up to date with the latest developments in the field when putting together their own applications of the model.

With these points in mind, the user guide proceeds as follows. Section 2 first presents the traditional gravity model, which we refer to as the "intuitive" model. It also introduces the dataset used throughout the guide, and shows how we can use Stata to calculate descriptive statistics and produce graphs that allow us to analyze the way in which the model captures some important stylized facts of international trade. In the second part of Section 2, we move on to consider "theoretical" gravity models, namely those with sound microeconomic foundations. We focus in particular on the famous "gravity with gravitas" model of Anderson and Van Wincoop (2003), which has become one of the standard formulations used in applied work. The Appendix provides a full derivation of the model, whereas the text of the section focuses on a general description of its features. In Section 3, our attention turns to estimation of the gravity model using econometric methods. We discuss estimation and testing of the intuitive model using ordinary least squares, and the limitations of that approach. We then discuss two approaches for estimating the theoretical gravity model, including the use of fixed effects panel data methods. Section 4 continues with the econometric analysis by introducing two recent advances in methodology that account for potential problems with the ordinary least squares estimator. In both cases, the presentation is intuitive and application-focused. Readers are referred to the original research for

full technical details of the two new estimators we consider, namely Poisson and the Heckman sample selection model. Sections 3 and 4 make extensive use of the sample dataset provided with this user guide, and include all Stata code necessary for producing the results discussed in the text. Finally, Section 5 concludes with a summary of current issues in gravity modeling practice. It also discusses the ways in which applied policy researchers can best make use of the gravity model in producing relevant and technically-sound research.