

The Gravity Model in International Trade

ADVANCES AND APPLICATIONS

Edited by

Peter A. G. van Bergeijk and
Steven Brakman

CAMBRIDGE

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How do borders affect trade? Are cultural and institutional differences important for trade? Is environmental policy relevant to trade? How does one's income or wage relate to the fact that trade partners are nearby or far away?

These are just some of the important questions that can be answered using the gravity model of international trade. This model predicts and explains bilateral trade flows in terms of the economic size and distance between trading partners (e.g. states, regions, countries, trading blocs). In recent years, there has been a surge of interest in this model and it is now one of the most widely applied tools in applied international economics. This book traces the history of the gravity model and takes stock of recent methodological and theoretical advances, including new approximations for multilateral trade resistance, insightful analyses of the measurement of economic distance, and analyses of foreign direct investment.

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1 Introduction

The comeback of the gravity model

P. A. G. van Bergeijk and S. Brakman

1.1 Introduction

The gravity model describes one of the most stable relationships in economics: interaction between large economic clusters is stronger than between smaller ones, and nearby clusters attract each other more than far-off ones. This formulation of the model admittedly is vague. What is meant by large economic clusters, or “far-off”? In fact, this ambiguity reflects the success of the gravity model in economics. Although the model is probably best known in the context of international trade and capital flows between countries, it has also been successfully applied to describe how consumers flow between different shopping malls, patients between hospitals and much more. Also “distance” is a very broad concept. It might reflect actual distances in miles, as an approximation of transportation costs, but over the years more subtle elements of distance-related factors have been considered. Economic factors such as tariffs and non-tariff barriers have been included in applications of the gravity model, but also “non-economic” factors have been included, such as cultural differences, differences in religion, language (dis)similarities, the presence or absence of former colonial ties, institutional differences, differences in technological development, and so on.

The list of applications is long and, most remarkably, empirical tests show that this simple idea is very successful from an empirical point of view and is able to show that many economic phenomena between different locations can empirically be described by a gravity equation.

The papers in this volume were presented in October 2007 at a conference at the Faculty of Economics, University of Groningen, the Netherlands and coorganized with the Ministry of Economic Affairs, Directorate-General for International Economic Relations (DG-BEB). We would like to thank Harry Garretsen, conference participants, and the referees – selected by Cambridge University Press – for their comments and suggestions on earlier versions of the papers and this chapter in particular. We would also like to thank Chris Harrison and his team for editorial support and the Ministry of Economic Affairs, Directorate-General for International Economic Relations (DG-BEB) and the Faculty of Economics of the University of Groningen for financial support for the conference.

Remarkably and in contrast to popular belief, recent estimates of the gravity equation show that distance-related variables have become *more* instead of *less* important. A recent special issue of the *Cambridge Journal of Regions, Economy and Society* (2008), for example, was titled “The World is not Flat,” in order to indicate that distance is still one of the most salient characteristics to describe economic interaction in the world economy.¹

Table 1.1 summarizes (most of) the contributions in this book. The table shows the versatility of the model and provides a good impression of the many questions that can be studied with a gravity model. Why do borders matter (and by how much)? Are cultural and institutional differences important for trade? What is the contribution of an ambassador to bilateral trade? Is environmental policy relevant for trade? How does one’s income or wage relate to the fact that trade partners are nearby or far away? These are just a small sample of all the questions that can be answered by the gravity equation. The collection of papers in this book also provides a rich sample of different empirical approaches with regard to the gravity model. Indeed, many chapters contain comparisons and tests of the different modeling strategies including – extended versions – of Tinbergen’s straightforward OLS, the method proposed by Anderson and van Wincoop, and more practical variants thereof. One finding stands out – as Table 1.1 testifies: although the magnitude of the distance effect on trade may differ, its sign and significance endure the hardship of scientific scrutiny.

Since the gravity equation was introduced by Tinbergen in 1962 in his *Shaping the World Economy* (where it actually was developed in one of the appendices), the gravity model has always been around in policy circles, because of its robustness and as a versatile tool to analyze all kinds of (trade) policy issues. The academic popularity of the gravity analysis, however, waned in the 1970s and 1980s, especially since the gravity equation could be derived from almost any international trade model, thus offering no scope to test between theories. The lack of a convincing and unambiguous micro-economic foundation gave the gravity model a somewhat ambivalent reputation: perhaps useful as an empirical tool, but unsatisfactory from a theoretical point of view. In the last twenty years the model has again become fashionable due to seminal contributions by Anderson and Bergstrand. The chapters in this book vividly reflect this renewed interest.

¹ In Chapter 2 Bergstrand and Egger attack another myth related to the assumed flatness of the world, namely the idea that increased exports and direct investments from developing countries dominate international trade and investment flows.

Table 1.1. *Overview of gravity analyses in this book*

Chapter	Subject	Period	Sample	Range of the distance parameters	Significant positive regional trade agreements
2 Bergstrand, Egger	GE theory bilateral FDI, final goods and intermediate goods	1990–2000	160 countries	–0.58 ^a –0.83 ^b	n.a. 0.31 ^b
4 Baier, Bergstrand	Replication Anderson and van Wincoop (2003) and application of GE approximation	1993	10 Canadian and 20 US states	–0.79	n.a.
5 Bikker	Trade creation <i>versus</i> trade diversion	2005	178 countries	–1.30	–1.70
6 Head, Mayer	Interpretation of border effects in relation to measurement of distance	1997 1993–95	US states European countries	–0.47 –0.74	–0.73 –1.20
7 Bosker, Garretsen 8 Möhlmann, Ederveen, de Groot, Linders	Market access Cultural and institutional distance by product group	1996 2000	97 countries 55 countries (27 OECD)	–0.72 –0.53	–0.0 –1.42
9 Rose, Spiegel	Trade impact of international environmental arrangements	2001–03	68 source and 221 host countries	–0.49	–1.07
10 Afman, Maurel	Diplomacy and trade in the context of East–West Trade	1995, 2000, 2005	56 countries (26 OECD)	–1.13	–1.44
11 Brakman, Garita, Garretsen, van Marrewijk	Cross-border mergers and acquisitions	1986–2005	211 countries	–0.26 ^b	n.a.

^a Final goods and intermediate goods.

^b FDI.

This introductory chapter is organized as follows. First we give a brief historical account of developments surrounding the gravity model. Next we turn to the empirical applications and highlight some of the problems that arise when estimating the model. The main aim of this introduction is to place the contributions of this volume into perspective, rather than providing a full-fledged survey.² The final section formulates some of the challenges that lie ahead.

1.2 The gravity model

1.2.1 *The history of gravity*

The gravity model has a long history as many authors have noted the relationship between, on the one hand, flows between different locations and on the other hand, the “weight” of these locations and the inverse of distance. An early cogent formulation of the gravity narrative is Ravenstein (1885, pp. 198–99) who explains how “currents” of migration are driven by the “absorption of centers of commerce and industry” but “grow less with the distance proportionately.” Noteworthy is also the discontent with the classic trade model’s neglect that was voiced in the first half of the twentieth century by Ohlin and in the German trade and location school that comprises Weber, Furlan, Engländer, Predöhl, and Lösch. Building on these theories and motivated by a desire to bring multilateral trade and distance into the trade economist’s common toolkit, Isard and Peck (1954) empirically demonstrate the negative impact of distance for different modes of both domestic and international transport.³ Isard (1954), in fact, comes close to formulating a gravity equation, but he uses a somewhat different metaphor from physics than Newton’s gravity (electric potential rather than gravity). Still, Isard had already envisioned many of the issues that engage researchers of the gravity model today as he stresses the importance of measurement issues, the composition of trade, cultural factors, and politics for empirical research into the determinants of bilateral trade flows that takes distance seriously. Although the gravity narrative thus has many fathers, the first mathematical formulation and empirical application of the gravity model is due to a group of Dutch economists headed by Tinbergen who were the first to actually publish a gravity model and an empirical application (Tinbergen 1962,

² The reader may wish to consult Anderson and van Wincoop (2004), or Combes *et al.* (2008).

³ Interestingly the same desire to integrate gravity into the much wider class of general equilibrium trade models is still a strong motivation. See, for example, Chapter 3 by Anderson.