

# Economics in Action: Topics and Resources



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ISBN 13: 9781447026419



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McGraw-Hill Custom Publishing

<http://create.mheducation.com/uk/>

Published by McGraw-Hill Education, 2 Penn Plaza, New York, NY 10121.

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ISBN: 9781447026419

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# Foreword

When I was starting out in economics, it never really occurred to me to wonder where the ideas I was being taught came from. Because they were taught to me with such conviction, I guess I assumed that the models and empirical results I was presented with had been carved on to stone tablets and sent down from some holy mountain. It wasn't until in my final year as an undergraduate, where I had to do a research project in a class on business cycles (taught by Prof. Tom Hall, someone who had a mighty impact on my life), that I began to get an inkling of where the things I was taught in class came from. It turns out that the concepts I was being taught – things like the Invisible Hand, the Hecksher-Ohlin model of trade, and Ordinary Least Squares – weren't revealed to humanity by way of a burning bush. Instead, they were ideas that were dreamed up by people, people like my professors.

Every single idea you're taught in your classes has its roots in somebody's bright (or not so bright) idea. Over the course of decades, these ideas get knocked around and, if they stand the test of continued scrutiny, they get written down as "fact" meaning that the idea is a pretty good description of the real world most of the time. Even then those facts get constantly battered by a storm of empirical testing and theoretical refinement. This continued evolution of the ideas is part of what makes economics a growing, living way of understanding the world. It's also the annoying bit that makes the answer to every question "it depends" since the ideas and situations to which they're applied are always changing.

Every one of your professors is part of this continual churning of concepts and applications. Some of us come up with the models and spend our research time trying to use economic theory to make sense of the chaos that is the real world. Others rigorously take those ideas to data to see where the theories make sense and where they don't. Still others try to replicate the theory closely in an experimental lab. Regardless of the researcher's approach, the goal remains the same: to describe the real world and the way people, business, and governments interact.

But at the end of that research, the real work begins. This is because we all believe that research simply for the sake of research is pointless. The goal is to have people use what we learn. That desire to teach is what led us to the role you see on a regular basis: the lecturer. As professors, we want people to understand what we've learned and work to explain our research to government officials, other researchers, and – most importantly – to our students.

That's where this handbook comes in. Across the different chapters, your professors have taken a small slice of what they've learned – often from doing their own research – and have written it up to try to help get that across to you. The chapters in here present ideas and techniques that are used across our programme. Some of the theories will apply from the very first classes we offer, others are geared more to the advanced students. Either way, the goal is to bring the research process full circle, to bring it back to where we all started, back to when we were students working with our professors to learn. When done right, this makes the two halves of what UCD's School of Economics does – teaching and research – a reinforcing whole. And, on occasion, we hope that it might inspire some of you into becoming researchers too.

Professor Ronald B. Davies  
Head, School of Economics  
University College Dublin

# Section One: Topics

# 1

## International trade does not defy gravity

Igor Bagayev  
Zuzanna Studnicka

### Why do countries trade?

International trade refers to exchanges of goods and services across national borders. Its theory is one of the oldest subfields of economics that explains the determinants and consequences of trade flows between countries. It implies one obvious question: why do countries trade? To this fundamental issue economics provided for more than a century a singular answer: countries trade because they are different. Their differences will be the source of a global economic gain when engaging in international exchanges. This is the main idea behind the comparative advantage principle, first mentioned by Robert Torrens in 1815, but usually attributed to David Ricardo who, two years later, has formally and explicitly described it in *On the Principles of Political Economy and Taxation* (1817). All trade models based on comparative advantage mechanism imply that countries can take advantage of some initial differences by specializing and exporting in industries where they have relatively better “abilities” and thus relatively lower costs of producing. In the Ricardian case, these “abilities” are driven by inherent technology differences (e.g., labour productivity differences) across goods and countries. [see Box 1].

During the 20th century, the comparative advantage principle has been widely appropriated in leading international trade theories. Trade models à la Heckscher-Ohlin-Samuelson (HOS) posit that discrepancies in relative costs which underpin a country’s comparative advantage arise from international differences in factor endowments such as land, labour or capital. Both endowment-driven trade à la HOS and trade arising from cross-country differences in technology of production à la Ricardo define what we now call “traditional” or “old trade theories”. These models indicate that comparative advantage (independently of its source) determines the pattern of specialization in terms of inter-industry trade (consisting of countries exchanging different types of goods). Free trade should then imply massive industrial specialization shifts, generating a nonzero sum game, but also adjustment costs and an increase in inequalities in favour of holders of

**Box 1: International trade by David Ricardo**

Imagine a theoretical world without transport or adjustment costs composed of only two countries, Ireland and the United Kingdom, consuming and producing only goods from two industries: stout beer and gin. Moreover, imagine that both countries are identical in everything except that: (i) Ireland is relatively cheaper in brewing stout rather than gin as compared to the UK (Ireland has a comparative advantage in producing stout) and (ii) Ireland is genuinely less expensive than the UK in producing either of these two goods (Ireland has an absolute advantage in both industries). At first sight, in this scenario, it might seem that the UK should not open its borders to trade with Ireland: under free-trade both stout and gin industries in the UK would not be competitive enough, all goods would be imported and produced in Ireland, plants in the UK would shut off and lay off their employees. However, Ricardo says that even in the case when Ireland has an absolute advantage over the UK in both industries, both Ireland and the UK would gain from trade as compared to an autarky situation.

To illustrate Ricardo's argument, imagine for example that Ireland needs 1 worker to produce 1 bottle of stout beer, and 2 workers for 1 bottle of gin. The UK needs 3 workers to produce 1 stout and 4 workers for 1 gin. Ireland has an absolute cost advantage over the UK: it is cheaper (in terms of workers) to produce either good. The population in both countries is equal to 100 workers (remember that, except for differences in the production technology for the same range of goods, both countries are identical (in population size, consumer tastes, etc.). In autarky, Ireland could produce, for example, 15 bottles of gin and 70 bottles of stout ( $15 \cdot 2 + 70 \cdot 1 = 100$ ), whereas the UK could produce 7 bottles of gin and 24 bottles of stout ( $7 \cdot 4 + 24 \cdot 3 = 100$ ). Under free trade both countries would still be constrained by their populations and technologies, but now they could import from each other. For both countries the rational and optimal choice would be to fully specialise in the industry where they are relatively better and import goods from the other one. Thus, Ireland would fully specialise in stout beer, producing 100 bottles, and the UK in gin with a production of 25 bottles. The world production of both goods would increase: 25 bottles of gin and 100 bottles of stout in free trade, against 22 bottles of gin and 94 bottles of stout in autarky. Both countries could, through international trade, cover their autarky needs and gain a surplus of goods. The UK could, for example, export to Ireland 15 bottles of gin for the price of 24 bottles of stout and keep 10 bottles of gin, having 3 more bottles as compared to its autarky situation. Ireland, by accepting this deal would gain 6 more bottles of stout.

This is just one possible situation, but all the scenarios, if consistent with the Ricardian model assumptions, bring the same conclusion: if countries have discrepancies in their relative cost of production, there is a net gain from trade for both of them by fully specialising in the production of the industry where they have a comparative advantage. In the previous example, the Irish comparative cost advantage in producing beer implies as a corollary that the UK has a comparative advantage in producing gin, despite its absolute cost disadvantage in both. And if no country had an absolute advantage over the other, the gain from trade would be even higher (for both the UK and Ireland!).



# 2

## Field and lab experiments training at UCD School of Economics

Liam Delaney

Orla Doyle

Pete Lunn

Till Weber

This chapter examines the increasing use of experimental methods in economics. We discuss briefly the history and rationale behind experimental methods and outline how and why they have become so prevalent in many areas of economics. We then overview the applications of field and lab experiments in real-world policy and business settings. The next section takes students through our modules on experimental methods at undergraduate and postgraduate level at UCD. We conclude with suggestions for further reading for those interested in pursuing this area.

Economics has been taught in universities for approximately 300 years. At the beginning, the main form of economics, known as political economy, was mostly comprised of philosophical methods of argumentation. As the 18th and 19th centuries progressed, economic thinkers increasingly began to use the developing statistical knowledge to quantify their hypotheses. The term economics first began to be used in the late 1800s to capture the development of a scientific form of analysis as a distinct discipline from philosophy. From the beginning, leading figures in economics discussed the problem of causality - how do we know whether changes in one economic variable caused changes in another.

Throughout the first half of the 20th century, many scholars began to integrate economics, mathematics, and statistics to form the discipline of Econometrics. The Econometric Society was formed in the 1930s to integrate these fields. These scholars sought to use econometric techniques to estimate causal relationships between economic variables. Beginning with classical statistical models, this period saw the development of the toolkit still used today by applied economists in many fields. Econometricians developed techniques such as instrumental variables analysis and generalised methods of moments to use natural variation in economic data to estimate causal relationships, for example, using changes to the minimum school leaving age to examine the returns to education. The methods developed during this period were refined substantially in the second half of the 20th century. Students of economics in UCD and many other universities still study these techniques and they form the main toolkit of applied economists

throughout the world. With increasing availability of data and the development of computing power, the ability to estimate models with large amounts of data has increased dramatically.

However, these methods are based on a number of assumptions that economics students study in detail yet often may not hold in the data. For example, instrumental variables analysis is based on the assumption that the ‘instrument’ can explain changes in the explanatory variable but has no independent effect on the dependent variable. Throughout the 1950s and 1960s, several economic scholars argued that economics should, like natural sciences, use direct experiments to study causal relationships. Field and lab experiments involve researchers randomly assigning entities (e.g. individuals, schools, villages) to experience different treatments and then comparing the entities across conditions to determine which is most effective. The most common form of an experiment involves assigning entities to a treatment condition or a control condition, similar to a medical trial. The early experiments focused on core questions in economics such as the effects of health insurance on health and healthcare utilisation and the effect of income tax on labour supply. The famous negative income tax experiments conducted by the US and Canadian governments between the late 1960s and 1980s were among the first large-scale applications of field experiments in economics and public policy. While the use of field experiments in economics throughout the 1980s and 1990s was relatively uncommon, this has changed dramatically in the last two decades with field trials becoming an increasingly standard form of practice in economic evaluations, particularly within development economics, a trend we will discuss below.

Another strain of thinking that evolved in the 20th century was the idea that economic phenomena could be studied in laboratory settings. The laboratory setting allows researchers to simulate the structures of market conditions while systematically varying aspects of these conditions. While Psychology has traditionally had a strong emphasis on the use of the laboratory to understand human behaviour, this was not prevalent in economics, with many scholars believing that economic behaviour could not be studied in laboratory settings. The emergence of experimental economics laboratories in the US and Europe throughout the 1950s and 1960s was a major breakthrough in economics, with the work of one of the original labs earning the Nobel prize in economics for Vernon Smith in 2002.

The rest of this chapter is structured as follows. The first section examines the use of field experiments in economics, in particular the increasing use of field experiments in public policy analysis. The second section likewise examines lab experiments and their increasing use in public policy. The third section provides an overview of the experimental training on offer in UCD, situating our experimental modules within the overall context of economics training in UCD and in relation to other disciplines. The fourth section provides advice to students on how to approach the study of experimental methods. The fifth section provides some key resources, including references to websites and key background reading, in these areas.

# 3

## The economic effects of migration

Benjamin Elsner

Immigration is at the centre of the political debate in many countries. While some embrace the cultural diversity immigrants bring to a country, others fear that immigration leads to job losses, increases crime rates or affect public spending. But concerns about migration are not confined to the receiving countries. For a long time, policymakers in sending countries have been expressing concerns about the emigration of the most skilled workers. Emigration may drain a country of its most productive workers, with repercussions for firms and for people staying behind. At the same time, remittances and knowledge flows are just two out of many channels through which a sending country may benefit from emigration.

While economists have studied globalization for a long time, the main focus of the literature was on trade and capital flows. International migration is an aspect of globalization that has entered economics fairly recently. Some earlier contributions aside, the first major articles appeared in journals in the 1970s.<sup>1</sup> Since then, the economics of migration has established itself firmly as an active field of research. Economists nowadays study a broad spectrum of questions related to migration. These range from the causes of migration — Who migrates and who stays? And why? Why do some people move to the UK and others to Ireland? — to the consequences of migration on wages, employment, voting outcomes, crime, public spending, attitudes, economic growth, trade flows and many more.

This chapter will provide an overview of some of the most important themes of research in the economics of migration. The focus will be on the consequences of migration. It will be taken as given that some people migrate from one country to another for reasons outside the scope of this chapter. After defining what constitutes a “migrant” and presenting some stylized facts about migration, we will introduce a simple theoretical framework that allows us to study the effects of migration on wages through several important channels. We will learn how migration affects the incomes of different types of workers and how the movement of people from poor to rich countries can lead to global efficiency gains. The insights from the theory will be confronted with the most recent empirical findings from around the world. We will place particular emphasis on Ireland, whose migration history over the last 200 years is unique and fascinating at the same time.

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<sup>1</sup> Examples are Bhagwati & Hamada (1974), the very first article published in the *Journal of Development Economics*, and Chiswick (1978).

## What makes a migrant a migrant?

Before we analyse the effects of migration, it is important to define the term “migrant.” Throughout this chapter we will only consider international migrants. These are people who were born in one country — referred to as “sending country” or “country of origin” — but are currently living in another country — referred to as “receiving country”. This definition of migrant is consistent with the one used by the United Nations or the OECD and is easy to apply. Readers should be aware, however, that some have their own definitions of who counts as a migrant based on citizenship or ancestry rather than country of birth. In order to describe non-migrants — people who live in their country of birth — we will use the term “native” for non-migrants living in the receiving country and “stayers” for non-migrants living in the country of origin.

## There is less migration than we think

When asked how many migrants live in their country, most people vastly overestimate this number. In a recent study by Alesina, Miano and Stantcheva (2018), the average person in the USA estimated the share of immigrants to be 36% — the true share is 10%. Similarly, in the UK the estimate was 32% and in Germany 30% — the respective true shares are 17% and 15%.

But how many migrants are there currently in the world? The United Nations estimate that the global number of migrants — defined as people residing in a country different from their country of birth — to be 258 million (UN, 2017). This may sound like a large number, but it represents less than 3% of the world population. These numbers beg two questions at the same time, namely why there are so many migrants, and why there are so few. Given the differences in incomes across the globe, people in developing countries face a substantial incentive to migrate. For example, a worker in a fast-food restaurant in India only earns about 14% of a worker doing the same job in the same restaurant in the US, even after adjusting for differences in cost of living (Ashenfelter, 2012). Differences in living standards, along with push factors such as conflicts and natural disasters, are among the main reasons why so many people migrate or plan to do so in the future. At the same time, most countries severely restrict immigration. The right to reside in another country enjoyed by most people in the EU is an exception by global standards. These restrictions can come in the form of overall caps on the number of immigrants, or an immigration policy that favours some immigrants over others. Some countries, for example Australia, New Zealand and Canada, have sophisticated points systems that award points based on the migrants education, age, and occupation and only admit those with a high score. Migration restrictions lead to a large discrepancy between the number of people who are actual migrants and the number who would like to be migrants. Based on data from the Gallup World Poll, Docquier, Machado and Sekkat (2015) estimate that if people could freely migrate and afford the trip, 19% of the global population would move to another country.

# Private health insurance in Ireland

Kanika Kapur<sup>1</sup>

Forty-five percent of the population in Ireland held private health insurance coverage in 2018.<sup>2</sup> This may appear to be a relatively high rate of private health insurance coverage given that the public health care system in Ireland provides universal entitlement to acute hospital care in public hospitals.<sup>3</sup> So, why do so many individuals choose to purchase private health insurance? There are several advantages of private health insurance. One advantage is that it can be used to pay for care in private hospitals. Private hospitals have been growing in importance in health care delivery. They comprise almost one-third of acute hospitals, and they provide a high proportion of “high-tech” procedures. For instance, 50% of all heart surgeries and 65% of all spinal surgeries are conducted in private hospitals (Private Hospitals Association, 2017). Private health insurance can also be used to pay for care in public hospitals in private or semi-private beds. Public wards can often be crowded, and the media is rife with reports of patients being left on trolleys in corridors as a result of bed shortages in public hospitals (Burke, 2018, Ryan, 2018). Another issue with relying on public hospitals is that there are long waiting lists for access to non-emergent inpatient and outpatient procedures in these hospitals. Having private insurance can reduce waiting times and increase access to specialists. Many private health insurance policies also provide some coverage for GP visits and other outpatient health visits. (Harmon and Nolan, 2001, Finn and Hardiman, 2011).<sup>4</sup> Private health insurance can be purchased from multiple insurers (Vhi, Irish Life Health, Laya) and plan benefits, coverage, and premiums vary between providers.

Ireland has a unique blend of public and privately funded health care. In 2017, health expenditure per capita was €4,800, with 73% coming from publicly funded sources and the remaining 27% coming from private sources that included private health insurance and out-of-pocket payments by individuals (OECD, 2017). Unlike the situation in many other countries, individuals with private health insurance are often treated in public hospitals. In fact, about half of all “private” care is delivered in public hospitals. In most cases, medical consultants can treat both

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1 I would like to thank Brendan Lynch and Don Gallagher of the Health Insurance Authority for providing access to the data and for helpful comments on the private health insurance market. I would like to acknowledge research funding from the Health Insurance Authority.

2 Author’s calculation based on data from the Health Insurance Authority.

3 Acute hospital care includes inpatient scheduled care, unscheduled/emergency care, maternity services, outpatient and diagnostic services.

4 Individuals with incomes below a certain threshold are entitled to a Medical Card and do not have to pay charges for public hospitals, visits to the GP or medical specialists in public hospitals. Furthermore, they do not pay for dental, aural and ophthalmic care, and pay a nominal charge for prescribed medication.

public and private patients.<sup>5</sup> They earn a salary for treating public patients and can top-up their salary income by treating private patients in public or private hospitals (Nolan, 2006). Private health insurance enables individuals to access medical specialists quicker in private hospitals, and even in public hospitals. This creates a “two-tier” system in health access, with public patients potentially waiting in long queues for access to care, and patients with private health insurance gaining quicker access. This feature of the Irish health care system has led to concerns about equity in access to care, and a debate on the funding model of private patients in public hospitals (Hunter, 2010, Mullahy, 2016, Irish Medical Organisation, 2018).

## Private health insurance in Ireland: A brief history

It is useful to understand the history of private health insurance in Ireland to gain insight into the structure of the current system. Private health insurance in Ireland began in 1957 when the Vhi (Voluntary Health Insurance) Board was established to provide health insurance for the top 15% of earners. Vhi was established as a state-backed monopoly that was operated on a not-for-profit basis. The rest of the population had public entitlement to free care in public hospitals. The exclusion of the top 15% of the population from public entitlement to free care was a result of pressure from medical providers who wanted to maintain their fee income from high income individuals. In 1979, the exclusion of the top 15% of earners from the public entitlement to free care in public hospitals ended. As a result, universal eligibility for free public hospital care was implemented. Over several decades, the proportion of the population purchasing private health insurance steadily increased. In 1960, only about 4% of the population had insurance. This rose to 13% in 1970, and up to about 20% by the late 1970s. This proportion further increased to 35% by 1987, and up to 48% in 2002. (Colombo and Tapay, 2004, Nolan, 2006, Finn and Hardiman, 2011).

In 1994, the Health Insurance Act was implemented that opened the private health insurance market to competition. Vhi's state-sanctioned monopoly ended. Health insurance regulations in the Health Insurance Act of 1994 (and subsequent iterations up to 2005) mandated some of the key features of the current Irish health insurance market – minimum benefits, open enrolment, lifetime cover, and community rating. As the name suggests, the minimum benefit regulation specifies the minimum level of cover that an in-patient health insurance contract must include. Under open enrolment regulations, private health insurers must accept all applicants for insurance cover, regardless of their risk status, age or sex, subject to prescribed waiting periods. The lifetime cover regulation protects consumers by guaranteeing all consumers the right to renew their policies, irrespective of factors such as age, risk status or claims history. Lastly, community rating ensures that all consumers are charged the same premium for the same health insur-

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<sup>5</sup> Medical consultants can be on three different types of contracts. Consultants on Type B contracts can treat both public and private patients with an 80:20 ratio. Consultants on Type A contracts only treat public patients. Consultants on Type C contracts are required to do 37 hours of public hospital work, but there are no restrictions on the number of hours that the consultant devotes to private patients. Type C contracts are very rarely awarded to new consultants.

# 5

## Understanding and fighting collusion: Theory and practice

Patrick Kenny  
Sarah Parlane

In this chapter we look at the topic of collusion. In a first part we explain the relationship between market structure and surplus. We show that the overall surplus generated in an economy decreases when firms gain greater market power. In a second part we illustrate the theory underlying the organization of cartels and collusive behaviour. We point to the fragility of cartel agreements and to the factors that support them. Finally, in a third and last section we give several examples of collusive behaviour that have been successfully fought by the Competition and Consumer Protection Commission in Ireland.

### On the creation of value and the importance of market structure

An important concept you will come to understand when studying economics relates to the creation of value and the generation of surplus for the producer and the consumer.

The amount of surplus generated in an economy depends on the market structure, which ranges from perfect competition to monopolistic. To understand why this is so, we must first explain what we mean by surplus.

#### Production and the creation of value

Suppose that Adam starts a new business producing coloured pencils.

These are very nice but, given the technology that Adam relies on and the cost of the raw materials, it costs €5 to create one pencil. It is very unlikely that anyone would be willing to pay that much for a pencil. In such a case, production would not generate any value.

If, however, the production cost falls to €0.10 per pencil, Adam would probably be able to find customers willing to pay more than ten cents for a pencil. In such a case, some value or surplus could be created.

Suppose now that Aoife would like to pay at most €7 for 10 pencils. If Adam sold her a box for €5, he would get €4 surplus (since it costs him €1 to produce the 10 pencils) and Aoife would get €2 surplus since she paid €5 for a bundle of pencils she valued €7.

If Adam wants to sell more pencils, he may have to lower the price to attract more customers. So long as he finds someone willing to pay more than €1 for 10 pencils, some surplus is created. How it is divided between Adam and his customers depends on the price.

So broadly speaking, producer surplus is created provided the price paid for a good exceeds the cost of producing it. Similarly, consumer surplus is created when consumers pay a price for a good that is less than that which they were willing and able to pay for it.

**The firms’ objective and the demand function**

Economists assume that firms want to maximize their profits. These are the firm’s total revenue minus the total production cost. As we will see, the maximization of profits can lead to a situation where the surplus created reaches a maximum.

The cost of production depends on the technology that the firm relies on and the cost of all the inputs (resources) used to manufacture the good it is producing. Inputs include the workers that must be contracted, machineries, raw materials, building and so on and so forth.

Total revenue is simply the price times the quantity sold by the firm. These two factors are not completely unrelated.

The maximum price that the firm can charge for any given quantity depends on the demand function. You can think of a demand function as representing the willingness to pay of the consumers for a given output.

Suppose that Alex produces fancy wallets and faces a market with 12 consumers. When she shows them the wallets she can produce to her friends, each of them calculates how much he or she is willing to pay for this good, and Alex ranks them from the one willing to pay the most to the one willing to pay the least. The data are shown in Table 1. The person willing to pay the most is Ciara who is willing to pay €23 for a wallet. Then comes Eoin who is willing to pay €22, and last is Martin who is willing to pay €12 for a wallet. Alex now knows what her demand function looks like.

Rank	Name	Willingness to pay
1	Ciara	€23
2	Eoin	€22
3	Jamie	€21
4	Aoife	€20
5	Maria	€19
6	Alice	€18
7	Laura	€17
8	John	€16
9	Alex	€15
10	Oliver	€14
11	Lucy	€13
12	Martin	€12

**Table 1:** Willingness to pay for fancy wallet



# 6

## Hunger, food insecurity, and poverty traps: Theory and empirical evidence from developing countries

Dominik Naeher

This chapter introduces the reader to two important topics in development economics: the ongoing problem of hunger and food insecurity, and the potential existence of poverty traps. Despite many decades of research on the causes of poverty, considerable amounts of foreign aid spent on assisting low-income countries, and significant progress in reducing extreme poverty in some regions of the world, poverty remains the day-to-day reality of billions of people. According to World Bank (2018) estimates, nearly half of the world's population lives on less than \$5.50 a day (a typical poverty line among upper-middle-income countries), and one in ten people live on less than \$1.90 a day. What does it mean to live on just a few dollars per day? In an attempt to illustrate the multidimensionality of poverty, Azariadis and Stachurski (2005, p. 303) write:

*“Poverty translates into hunger, lack of shelter, illness without medical attention. Calorie intake in the poorest countries is far lower than in the rich. The malnourished are less productive and more susceptible to disease than those who are well fed. (...) The poor are more vulnerable to events they cannot control. They are less able to diversify their income sources. They are more likely to suffer from famine, violence and natural disasters. They have lower access to credit markets and insurance, with which to smooth out their consumption. Their children risk exploitation, and are less likely to become educated.”*

An influential hypothesis in development economics is that all the factors mentioned above contribute to the existence of a vicious circle of underdevelopment, causing poverty to persist. Nations or individuals that start off poor tend to remain poor, because the scarcity they face hinders them from taking advantage of opportunities to improve their situation.

One of the most obvious indicators of persistent poverty is malnutrition. While the share of the undernourished in the population has decreased by half since 1990, today still one in every nine people in the world suffer from chronic hunger.<sup>1</sup> The vast majority of these people, 98%, live in developing countries (FAO, 2018). The prevalence of hunger and malnutrition is particularly disturbing in light of the fact that global food production is much higher than what is needed to feed everyone on the planet.<sup>2</sup> Given the apparent inability of the global economic system to allocate food sufficiently well, a common argument is that food should be provided through international aid. This view is often justified by the claim that low-income countries are caught in a poverty trap, requiring a sufficiently large external transfer to escape poverty, commonly known as a “big push” (Sachs, 2005; UNCTAD, 2006). However, an opposing view is that foreign aid such as food relief creates dependence, is not sustainable, and impedes the development of local solutions (Easterly and Pfutze, 2008). Which side is right? The extent to which poor nations and individuals require assistance to transit out of poverty depends to a large degree on whether poverty traps exist, and how severe they are. If there is a poverty trap, this provides a strong case for external interventions such as government programmes or foreign aid. If, on the other hand, there is no poverty trap, then aid is mainly just a redistribution from the rich to the poor and would not necessarily bring any efficiency gains.

In the following, we first discuss the theoretical foundation of poverty traps and then review empirical evidence. The analysis focuses on two potential sources of poverty traps commonly studied in development economics: Nutrition and low adoption of modern farming technology, such as hybrid seeds and fertilizer, which are often argued to play a crucial role in fighting hunger, food insecurity, and persistent poverty.

## Theory of poverty traps

Poverty traps can be thought of as a set of self-reinforcing mechanisms which cause poverty to be persistent. In the presence of such mechanisms, low income today is itself a direct cause of low income in the future. In the developing world, many factors can contribute to the existence of a poverty trap, including imperfect markets, corruption, and limited access to health care and education, since all these factors tend to reduce the ability of the poor to benefit from profitable technologies and investments in physical and human capital (recall the quote from Azariadis and Stachurski, 2005).

One of the oldest and most debated hypotheses in this context is that of a nutrition-based poverty trap. Consider the following, arguably stylized, idea. A day labourer working on a farm in rural Kenya is paid according to the amount of work performed each day (e.g., the quantity of harvested cotton or area of ploughed land). With his salary, the labourer buys food, which gives him the strength to work the next day. This creates a relationship between income today and income

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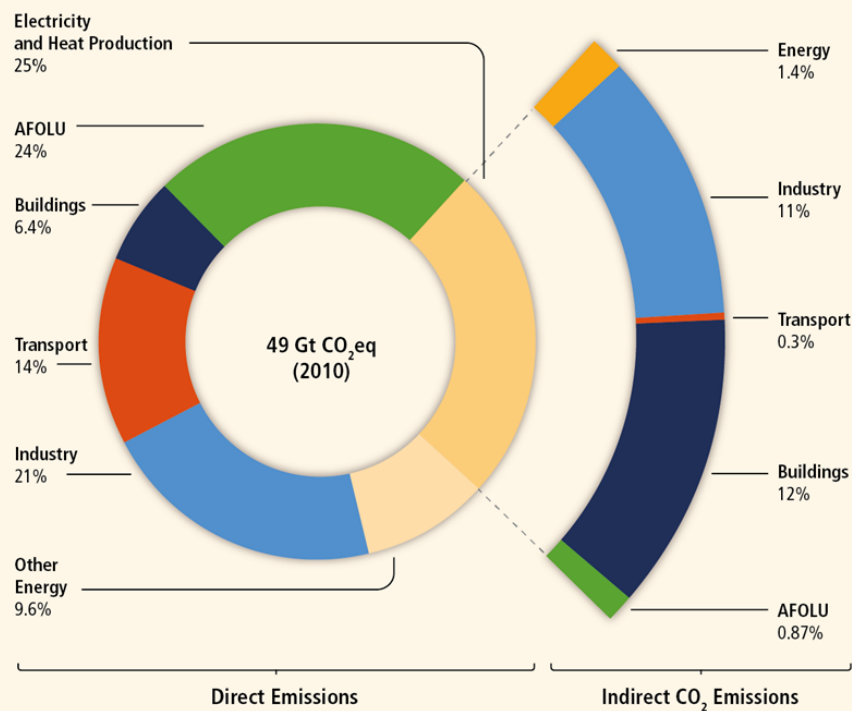
<sup>1</sup> The FAO defines chronic hunger as a state, lasting longer than one year, of having a caloric intake which is insufficient to meet the minimum energy requirements for a given population (e.g., 1,800 kilocalories per person per day).

<sup>2</sup> According to FAO (2009) estimates, the world produces 1.5 times enough food to feed everyone, and global food production has been growing faster than global population over recent decades.

# Policies to reduce CO<sub>2</sub> emissions from passenger cars

Lisa Ryan

Transport contributes 25% of global CO<sub>2</sub> gas emissions and is forecast to remain a significant source of concern in this regard in the future (IEA 2018). Figure 1 illustrates the emissions of CO<sub>2</sub> from transport compared with other economic sectors. Global demand for transport services is predicted to continue to increase over the coming decade, with Asia accounting for approximately 80% of the growth (BP, 2018). Reducing greenhouse gas emissions from transport is an important objective of climate action strategies and international agreements, such as the EU Climate Framework in Box 1.



**Figure 1:** Global greenhouse gas emissions by economic sector (IPCC, 2014)

Greenhouse gas emissions from transport are mainly made up of CO<sub>2</sub> emissions from the combustion of petroleum fuels - petrol and diesel – in internal combustion engines. The transportation sector includes mobility services provided by cars, trucks, trains, ships, airplanes, and other vehicles. Among these, passenger cars and light-duty trucks (LDVs) are the largest sources of transportation greenhouse gas emissions, accounting for 72% of transport emissions in the EU (EEA, 2018). Methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) emissions are also emitted in small amounts during fuel combustion. In addition, a small amount of hydrofluorocar-

bon (HFC) emissions also result from the use of mobile air conditioners and refrigerated transport. In this chapter we will use an environmental economics framework to examine policy measures to mitigate CO<sub>2</sub> emissions from passenger cars.

Passenger cars are becoming more fuel-efficient, yet demand for road passenger and freight transport has increased in the EU by 22% since 1990 and thus emissions have risen (EEA 2018). Government initiatives, such as regulations, agreements and economic instruments, can play an important role in arresting this trend (Box

### **Box 1: International climate agreements and EU policy**

The agreement of the Kyoto Protocol in 1997 and its subsequent ratification in 2004 provided the policy backdrop to initiatives in Europe to reduce greenhouse gas emissions. Under the agreement (which entered into force on 16th February 2005), Europe committed to reduce greenhouse gas emissions by 8% compared with 1990 levels by the period 2008-2012. In 2015, the EU further committed to reduce greenhouse gas emissions by at least 40% by 2030 compared to 1990 under its 2030 climate and energy framework. In order to fulfil this goal, the European Union has most recently agreed to slash carbon dioxide emissions from new cars by 37.5% by 2030 (compared with 2020) (Euractiv, 2018). This will be achieved through EU-wide policies applied to manufacturers and energy or CO<sub>2</sub> emissions performance of vehicles and member state policies designed to encourage the uptake of better performing vehicles and switches to electric vehicles.

1). To realise a sustainable transport system, changing transport purchasing decisions and behaviour is required to drive technological improvement and reduce travel demand.

This chapter will lay out the market failures associated with transport greenhouse gas emissions, the policies to address them, and use a case study of the reform of Irish vehicle taxes to illustrate the impact of environmental taxes on greenhouse gas emissions.

# 8

## The economics of minimum wages

Frank Walsh

*“It is a serious national evil that any class of His Majesty’s subjects should receive less than a living wage in return for their utmost exertions...”<sup>1</sup>*

### What are minimum wages and who do they affect?

Minimum wages are an example of a “Price floor” where there is a barrier preventing a price falling below a minimum threshold (the wage is the price for labour). For example in Ireland it is illegal to pay an experienced adult employee less than 9.80 per hour in 2019. Minimum wages are very common, indeed the International Labour Organization [ILO (2019) notes that “minimum wages exist in more than 90 per cent of the International Labour Organisation’s (ILO) member States”. Minimum wage workers are typically more likely to be young, female, part-time, work in low skill service sectors and in some countries migrants are more likely to be on the minimum wage. For example, in Ireland in 2017, 53% of minimum wage workers were female, over a third of employees under 25 were on the minimum wage, and over half of minimum wage workers were part-time (Low pay Commission (2018).

### What kinds of economics courses discuss minimum wages?

Minimum wages are enforced in many countries across both the developed and developing world. They tend to be widely referred to in several different types of economics courses. In introductory economics classes, minimum wages are often analysed in a fairly simple way as an example of a price control in Microeconomics classes or in terms of their relationship with unemployment in Macroeconomic classes. The implications of imposing minimum wage policies tend to be examined in more detail in courses on labour economics or on Public policy.

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<sup>1</sup> This is a quote from Winston Churchill from 1909 in the British house of Commons. Churchill was the president of the Board of Trade and was proposing legislation “The Trade Boards Act” which led to the first minimum wages in the UK and Ireland. Some might be surprised that Churchill, who was then a liberal but went on to join the Conservative party, was the proponent of minimum wages.

## Why do countries enforce minimum wages?

Often the arguments used by proponents of a minimum wage are based on the idea that for some categories of workers the free market wage will lead to a wage that is too low for the worker to be able to afford a reasonable standard of living. It is often argued that particular groups such as young, low-skilled or migrant workers might not be in a strong position to bargain for higher wages and may end up being exploited in the absence of a minimum wage. A minimum wage is also sometimes advocated as a policy tool to tackle poverty and inequality. The argument for a minimum wage is often contentious since the employers who pay worker's wages may strongly oppose minimum wages. This is unsurprising since a binding minimum wage would be expected to lower profits for employers. Critics of minimum wages argue that a minimum wage will price low skilled labour out of the market leading to a loss in employment and output and a decline in rates of economic growth. There has been a huge amount of research conducted on the impact of minimum wages on a variety of outcomes. Below, we will discuss some theoretical models that help us understand how a minimum wage might be expected to affect the labour market and then summarise some of the main research findings from empirical studies.

## How are minimum wages set and how do we measure “toughness” of the minimum wage

Ireland has had a National Minimum Wage since April 2000. At the time of writing (May 2019), the hourly minimum is €9.80 per hour for an adult worker (over 20) with the rate at 70% of this for workers under 18, and corresponding rates of 80% and 90% of this for workers aged 18 or 19. The Irish Low Pay Commission is a statutory body that is tasked with conducting research on issues around the minimum wage and low pay in Ireland. This Commission then makes annual recommendations to the government on the appropriate minimum wage given a variety of factors such as changes in the cost of living, employment conditions and competitiveness.

The UK has a national minimum wage and a similar system to Ireland, with different age based rates up until the age of 25, at which age workers receive the highest rate (£8.21 per hour in 2019). The UK Low Pay Commission also conducts extensive research and makes recommendations to the government.

Many European countries have National minimum wages, but many also have sectoral minimum wages which are negotiated between Trade unions and employer groups. There can be a complex set of minimum wages for different types of workers in different jobs and these sectoral minimum wages are often not legally binding.

The impact of a minimum wage will depend on how high it is. We call this the “toughness” of the minimum wage. While we could look at the money value of the minimum wage, this is not very informative unless we have something to compare it to. Economists usually measure the “toughness” of the minimum wage using the “Kaitz index”. This looks at how high the minimum wage is relative to other wages in the economy, such as the average wage or the median wage. Of course, if the minimum wage raises the wage of the lowest wage workers it will automatically impact on the average wage, and so they are interdependent. Mea-

# 9

## Competition policy: Theory, legislation, and importance for the Irish economy

Ciara Whelan

This chapter examines the topic of competition policy and the importance of effective competition policies for the Irish economy. Firstly, we consider the economic rationale for competition policy as we highlight the link between theory and policy. In particular, we examine what economic theory prescribes in terms of a possible pathway to achieving the objectives of competition policy through legislation.

We then consider the existing EU and Irish competition legislative frameworks which govern firm behaviour in Ireland. Within these frameworks, we examine the importance of effective competition policy (both at the EU and the national levels) for Ireland. Rather than basing our discussion on a dichotomy between non-traded and traded sectors as traditionally done in the literature, we focus on a distinction between the sales of goods and services in Ireland, and the sales of goods and services abroad (exports). Both EU and Irish competition legislations ensure benefits of lower prices, greater innovation and efficiency in the sale of goods and services in the domestic market. They also result in both direct and indirect benefits from ensuring effective competition in exporting and competitiveness (through lower costs) of exports.

### From economic theory to legislation

In this section we examine the economic theory behind competition policy and legislation. We first consider the concept of market power, and how this depends upon both market concentration and the behaviour of firms in the market. This allows us then to hypothesise about the possible drivers of market power, and the implications that this has for anti-trust authorities and the design of effective competition legislation.

#### Market power and concentration

An economic argument centred on efficiency and welfare improvement motivates the drive for competition in an industry. This is obvious if one considers a spectrum of market structures between perfect competition and monopoly. Un-

der perfect competition (where a large number of firms sell identical products), firms set price equal to marginal cost and allocative efficiency, whereby output is produced up to the point where marginal cost of producing equals marginal benefit for the consumers, is achieved. As a result total welfare (consumer plus producer surplus) is maximised. Under monopoly, a single firm exercises market power, as prices are set above marginal cost. The price-cost mark-up for a profit maximising monopolist is given by the expression  $\frac{P-MC}{P} = \frac{1}{\eta}$ , which shows that the degree to which the monopolist can set prices above marginal cost (MC) is inversely related to the (absolute) market price-elasticity of demand  $\eta$ . The more inelastic demand for the good is, the greater the market power.

Prices are higher and output is lower with monopoly compared with perfectly competitive outcomes. While producer surplus is higher under monopoly, consumer welfare will be lower. Moreover, allocative *inefficiency* (as measured by the deadweight loss) means that total welfare is lower where there is market power [see chapter 5]. Additional costs associated with monopoly include possible rent seeking (socially wasteful activities undertaken in pursuit of monopoly profits, e.g. lobbying for preferential treatment of acquisition of a monopoly position), productive inefficiency (due to not producing at the minimum of Average Cost curve), and x-inefficiency (as the absence of competitive pressure to reduce costs results in the Average Cost curve being higher than it otherwise would be).

It follows that overall efficiency and consumer welfare in an industry depend on the extent to which firms can exercise market power, which intuitively seems to depend (inversely) upon the number of firms in the industry. Indeed there are theoretical models which predict this. Under Cournot oligopoly we have a small number of firms competing for market share, where quantity is the strategic variable.<sup>1</sup> In such a market, identical firms selling homogenous products will set price above marginal cost, but price will decline toward marginal cost as the number of firms  $N$  in the market goes up [see Box 1]. Hence, market power declines with the number of firms in the market.

One could on this basis conclude that measuring  $1/N$ , where  $N$  is the number of firms in the market, can provide a good assessment of the degree of market power in that industry. The reality that firms in an industry are not necessarily equal in size, however, requires a more refined measure of market concentration that captures the degree of firm dominance in the market.

One such measure is the Herfindal-Hirschmann Index (HHI), which takes into account the relative sizes of firms in the market. Taking each individual firm  $i$  market share (where this can be calculated as firm sales as a share of total market sales, either in terms of revenue or unit sales), squaring it, and then summing over all firms in the market gives . This measure exceeds zero and, where market shares are computed in percentage terms, has an upper bound of 10,000 (in the case of monopoly). The larger the market share of a firm, the greater the impact that it will have on the HHI for the market. Thus, if the market is dominated by a small number of large firms, then the HHI will be high.

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<sup>1</sup> In contrast with perfect competition and monopoly, the central feature of oligopoly is the strategic interdependence between firms in their decision making. Each firm understands the need to take into account the strategic reaction of other competing firms when they are deciding on their optimal output.



# Section Two: Resources

# 10

## Strategies for effective learning in economics

Gavin Cassells

This opening chapter in the Resources section of this book is aimed at providing you, a student in Economics, with information on how best to approach learning in this subject here in UCD. First off, let me introduce myself. My name is Gavin and I run UCD's Economics Support Centre, also known as the Economics Drop-in Centre. I recently graduated from the UCD School of Economics bachelor's and master's programs and so have been a student in the same courses that you are about to take. I am here to give you some basic pointers on how to approach your academic challenges, and where to go if you need some help. Some of this is common sense and some of this many of you will already have experienced, but if you take the time to read this in its entirety then hopefully you will find something useful here.

### **Essential requirements for the study of economics**

Economics is a broad subject that requires an equally broad skillset to master. You will need a good level of maths, an ability to write well, and an ability to think critically about the world. You should already have a basis in these skills, but you will have the opportunity to improve these further as part of your continued university experience.

#### **Economics and maths**

It is important that you take the mathematics courses in your degree programme very seriously. If you struggle with maths in general, I would strongly suggest that you approach the Maths Support Centre in the Library as early as possible. This facility is only available to first years and second years, so if you are still eligible and you need the extra help, act quickly! With their help and plenty of practice you should be able to overcome most maths deficits.

A good understanding of the basic mathematical skills taught in first year is essential (and assumed) for many economic modules taken after stage 1. As you progress into stages 2 and 3 of your economics degree, economic analysis often involves moving from ‘normal’ language to a mathematical formulation, using mathematical techniques to aid analysis, and interpreting mathematical results back into ‘normal’ language. Being comfortable with maths will help you enormously over the course of your degree and beyond.

If you have progressed beyond Stage 1 without feeling confidence in your required math skills, download and save all your lecture notes and materials from your level 1 Quants module and keep them at hand for reference – when you hit a hurdle in your understanding, work on this with the help of the Math Support Centre.

You should also check out “All you need is (a bit of) maths!” included later in this section of this book [see chapter 13] which covers all of the important things you need to know.

## Economics and writing

An important difference between third level and second level education is that in university, knowing relevant facts is only a part of the answer. The questions you will be asked in college will require you to assemble evidence and organise it in support of an argument. This will be the core of a good approach to essay writing. You must now see facts as potential evidence for an argument. You must take a position and then present the facts in a way that either helps support your argument or refute counterarguments. The evidence you present must be of a high quality of course (you can’t just make things up!), but the whole argument now matters a lot more.

You will also need to reference correctly. You can’t just pluck facts from deep within your memory. You need to provide a trail so that someone can check any claims you make within an essay. The quality of your sources will matter too. You should always reference the highest quality source possible.

Academic journals are often (but not always) the highest quality source. You should become comfortable using [scholar.google.com](https://scholar.google.com), a search engine specifically tied to academic content. Use this to search for papers and read brief paper summaries, known as abstracts. If you want to read more of the paper then search for that paper using the UCD Library OneSearch, which should give you access to almost everything you will need. When you read an article make sure you understand the research question the article is addressing, the literature strand the article fits in, and the innovation in the article. Textbooks and other academic books are also high quality sources.

You can manage the technical side of referencing with a specialised referencing program such as EndNote or Zotero. Alternatively Word which you can acquire for free from the college also comes with basic referencing functionality that will suffice. You can find more information on this topic in ‘A guide to student research projects’ [chapter 11] later in this section.

# A guide to student research projects

Aisling Reynolds-Feighan

One of the key skill sets that students of economics develop in their undergraduate training is the ability to plan and undertake economic research and communicate findings. Economic research is the systematic and creative investigation into understanding and explaining how the economy works. It has an important role in providing strong conceptual and empirical bases for decision making and policy formation. There are several distinct paths which may involve some of the following aims

- The assessment of the effects of public policies on economies
- The projection of the effects of alternative policy prescriptions
- The estimation of models of economic behaviour
- The development of new statistical measurements of economic activities
- The development of new theories about the nature of economic relationships

Many students find the task of doing a research project quite daunting. This chapter explains how economic research projects are undertaken and points to important resources that help plan and develop research ideas. The next section will examine the initial steps in developing research ideas by identifying topics of interest, focusing on research questions and composing a title and abstract. The second section outlines different data types and sources and understanding the scope of data resources to support different kinds of research. This section also reviews the use of charts to display data. The third section sets out the typical format followed when presenting an executed research agenda, while the fourth section describes the approaches towards communicating research findings. The chapter concludes with a short summary of the main points. 0

# Identifying topics of interest and focusing on research questions

## How do I begin a research project?

The first step in developing your research project will be to decide on the broad area of focus and begin to identify specific topics or research questions. Inspiration can come from lectures, discussions with your lecturers and professors, newspaper articles, blogs or even discussions over coffee with your friends. You will need to do some reading to get an understanding of the types of issues explored in recent research in the area, the types of approaches being used to undertake research, the nature of the data utilised and, if relevant, the empirical methods used to analyse the research questions.

The library is a critically important resource for economic research. UCD Library provides several resources to help you to explore topics, find good quality information and resources on your topic as well as offering supports as you undertake and write up your research project<sup>1</sup>. So, let's look at a number of library resources that you might use as you begin to develop your research topic.

Palgrave Dictionary of Economics: the online version contains thousands of entries by leading economists on topical issues. In short contributions, topics are introduced, and suggested follow-up references are provided. This is an excellent first stop when reading into a new topic.

1. Subject Databases<sup>2</sup>: these are searchable databases providing descriptions and links to thousands of academic papers, business reports, government research and documents, industry journals etc. For economists, the most often used databases are
  - EconLit: This is an academic abstracting database published by the American Economic Association and covering articles and other published materials dating from 1969. It uses the JEL classification Codes<sup>3</sup> (JEL is the Journal of Economic Literature which originally set out a classification scheme for categories of economic research)
  - JSTOR: This is a digital store of digitised issues of over 2,000 academic journals, with some books included recently. The economics collection contains full text issues of the leading academic economics journals as well as other interdisciplinary journals.
  - ScienceDirect: This is an Elsevier-owned website with subscription-based access to thousands of academic journals and e-books in a large number of fields including economics.

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<sup>1</sup> UCD Library has a set of resources specifically for economics that can be accessed at <https://libguides.ucd.ie/economics>. The website includes a number of short videos that will show you how to use the various databases, find journal articles and books and access databases.

<sup>2</sup> The key databases for Economics may be accessed through UCD Library at: <https://libguides.ucd.ie/economics/journals>

<sup>3</sup> See <https://www.aeaweb.org/econlit/jelCodes.php>

# 12

## Data graphing and visualization with Stata

Kevin Denny

It has often been said that a picture paints a thousand words. This is certainly true when it comes to data analysis. There are two good reasons to acquire some skills in graphing your data: (1) graphical methods are a powerful way for a researcher to explore data and (2) graphs can be a very useful way of illustrating your data and results whether it is in a presentation, a project or a thesis.

To motivate the first reason above, consider the set of graph in Figure 1. These four graphs are collectively known as Anscombe's Quartet. You may be surprised to learn that the  $x$  variables in these four graphs have the same mean and the same variance. This is also true of  $y$  and, moreover, the covariance between  $x$  and  $y$  is the same and hence the regression line is the same. Clearly, they are very different relationships. Without graphing the data, you would probably never know.

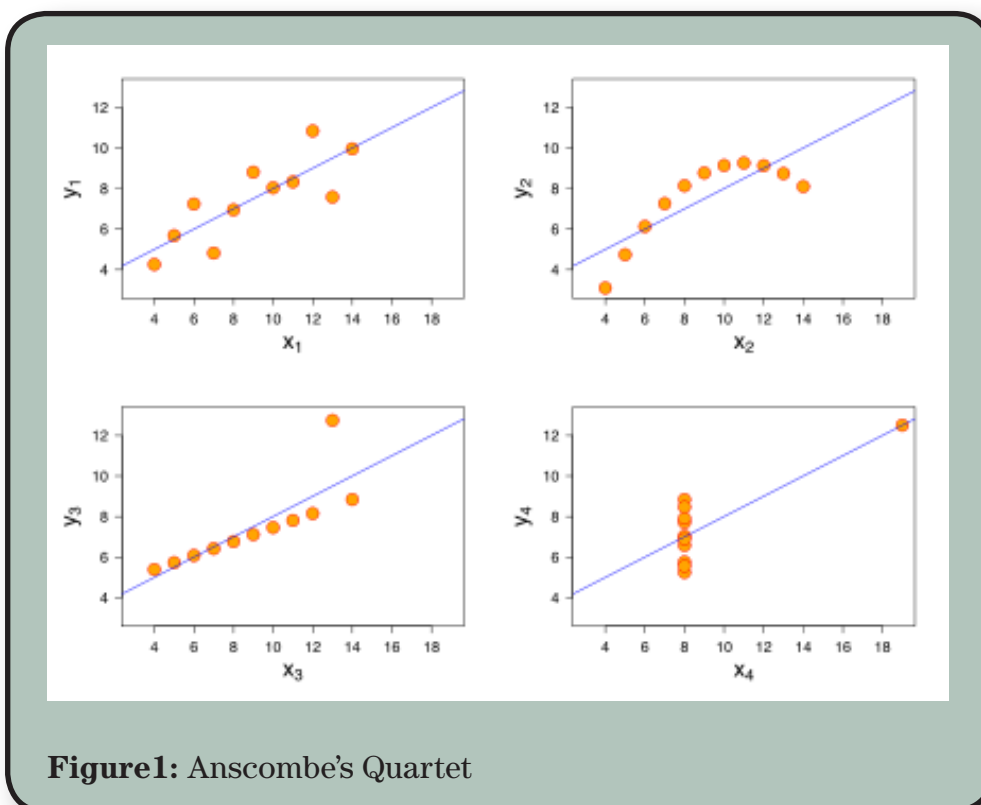


Figure 1: Anscombe's Quartet

In this chapter I show how to use Stata to generate some of the key graphs that economics students should know about and should consider using in their projects, presentations and theses. It covers univariate discrete and continuous variables, bivariate distributions, some simple time plots and methods of visualising the output from estimating models. It shows a small number of the many options available and includes references to further resources.

There are several good online treatments of Stata graphics (listed in the references). Stata's *Youtube* channel has videos on graphics which are excellent. The book by Michael Mitchell is a fantastic resource which you could also draw on. Andrew Jones' guide, though designed for health econometrics, is of general interest if you are using Stata. Here I am going to outline the main methods that I think economics students should know at a minimum. Along the way I show a few of the many options available to whet your appetite. The definitive source of information is the Stata Graphics Manual which is a mere 739 pages long. A classic text on data visualization and graphics is Tufte (2001). For a shorter guide targeted at economists see the paper by Schwabish (2014).

All of the datasets used here are either available online and can be accessed in Stata using the **webuse** command, or they are provided with Stata and can be accessed using **sysuse**. To switch from one dataset to another you need to use **clear** first. Stata commands will be in **bold**. A basic knowledge of Stata is required. There are two ways to create graphs in Stata. You can either (a) use a written command which can be typed either in the command line or in a do-file, or (b) you can use the dialogue boxes/pull-down menus at the top.

A nice feature is that, if you use the dialogue box to create a graph, Stata will show you the equivalent syntax in the output window so you can learn how to generate the graph. You could copy the syntax into a do-file so you can repeat the exercise. I generally use the pull-down menus to experiment until I get the graph looking like I want. Then I copy the command that generates it from the output window into my do-file so I can replicate it later.

When Stata produces a graph for you on the screen, click on "file" at the top left: you can either save it or you can open the editor to make further changes. Stata's native format for graphs is .gph. There are several ways to include your graph in a document. The easiest is to simply cut and paste it. You will probably need to resize it then. Alternatively, you can save it to a format like a portable network graph (.png), or a postscript file (.ps). You may need to experiment saving to different formats to get something that works with your document. If in doubt I recommend saving the graph as .png. Postscript files can end up taking a lot of space if there are a large number of data points in your graph.

A feature I will not discuss here is that you can create two graphs separately and then combine them into one graph. Koffman (2015) has a few slides on this or look up directly on Stata by typing **help graph combine**.

The Stata graphics editor has numerous options and you can customize the graph in many ways. It is beyond the scope of this chapter to describe how. Here I am mostly going to use the graph commands that come with Stata. However there are some good user-written commands for Stata graphics that are freely available online. You can find and download them within Stata using the **findit** command. In the next sections I will draw on four of these: **binscatter**, **coefplot**, **fabplot** and **vioplot**. To download the first of these say, just type **findit binscatter** in the command line or **ssc install binscatter**. Hit return and follow the steps. As these user-created commands are occasionally revised, it is worth using the **adoupdate** command periodically to ensure you have the latest version.

# All you need is (a bit of) maths! A compendium of mathematical rules and procedures used in economics

Tiziana Brancaccio

No doubt the most asked question that we receive at open days from prospective students is “Do I need to be good at maths to do economics?” Our answer is usually that in economics we do not use fancy maths but we use it regularly, so if a student does not enjoy maths, then studying economics may turn out to be a very painful experience!

Economics aims to explain very complex situations using simplified ‘models’ which incorporate what we think are the crucial elements that should be investigated. This is where maths comes in. We use equations to model relationships among variables, like demand and supply functions, or consumption functions for example. We use objective functions coupled with constraints to model decision making problems (consumers’ choices, firms’ production decisions). We use dynamic equations to model the behaviour over time of macro variables (growth theory). Maths is a powerful tool that allows us to handle these models, find the solution, characterize it, and answer questions like ‘what happens if?’

I imagine that some of you are raising an eyebrow at this point, and wondering if economics is all about models, theories and maths. No, indeed there is much more to it! Once we have the model and worked out its solution, the next, and for some the most exciting step, is to test the model to see whether we have succeeded in generating something that is a good reflection of reality and which might be useful for instructing policy. This requires data analysis (statistics and econometrics), but alas, even here you need some maths!

The good news is that when we say that no fancy maths is required, we mean it! Most of the maths you will use in your economics courses will not be new to you, as you will have already studied it for your Leaving Cert (algebra, functions, differentiation); some other topics will be new and will require more effort (partial differentiation, constrained optimization), but these are not overly difficult.



This chapter is a compendium of the maths rules, definitions and procedures that you will regularly use in your economics curriculum. It is intended to be a resource to consult any time your mathematical memory fails you. It is definitely NOT meant to be used when preparing for your *Intro to Quants* exam, when you need instead to study in depth each of the topics mentioned above.

Apart from hopefully being a handy reference for a quick review of various rules and procedures, this chapter would also like to develop in you an appreciation of the relevance of maths in economics. Maths is not a useless complication that you need to put up with in order to pass your exams; it is the tool that allows economists to see through complex situations, simplify them, and represent them. Ultimately it gives us a *forma mentis* – a mindset, a way of thinking about and solving problems.

This revision is structured around four main sections. The first section revises some basic rules of algebra; the second looks at rules of differentiation and how differentiation is used in economics; the third section is dedicated to optimization; and finally the last section looks at how differentiation helps us in interpreting the estimated parameters of econometrics models.

## Good old algebra!

Yes indeed, it is the same old algebra that you have seen throughout your secondary school and yet many students make mistakes when using these rules even in their advanced stages of their academic life. Calculation mistakes in exams are taken into account, perhaps with a small penalty. However the biggest penalty you will face from algebraic errors is ending up with unmanageable expressions you cannot simplify any further (unless you discover new algebraic rules on the spot!), or finding unreasonable results (negative market equilibrium quantities are NOT possible!). Algebraic mistakes may hinder your ability to move on to the next part of an exam question. It is important that you take a good look at these rules and make sure that you know them really well.

Section Three:  
Sample Student  
Research Projects

# 14

## Differences in Loan-To-Value (LTV) ratios across race and gender in the United States

James Brennan

### Abstract

The aim of this paper is to investigate the differences in Loan-to-Value (LTV) ratios across race and gender in the United States. The paper uses data made publicly available by the Federal Housing Finance Agency (FHFA). Due to the dependent variable being categorical, logit and probit models are applied to try and determine how race and gender influence the probability of an individual to fall in a given category of the LTV ratio received when taking out a mortgage. Overall, the marginal effects found in the data are too small to conclude that race is an important determinant of the LTV ratio. The marginal effects for the male dummy are even smaller and practically zero.

### Introduction

Differences in economic characteristics between male and females, but also across different races and ethnicities always prove to be an interesting research topic. Generally, the main focus of these research papers are on empowerment, health and income. In terms of empowerment, several papers look at political representation across gender, race and ethnicity (Minta 2012, and Stewart 2000). An interesting paper by Reagan et al. (2014) investigates racial differences in health gains identified using different socioeconomic indicators. However, the most investigated outcome in the literature on race/gender discrimination is by far income. Differences in income across gender, race and ethnicity is amongst the most researched topics in the field of economics. Recent books by Blau et al. (2012) and Evans (2016) explore in detail existing evidence in support of gender inequality; while a recent paper by Bailey et al. (2014) looks at race-based income inequality.

This paper moves away from the traditional outcomes of interest in which gender and racial differences have been analysed so far and focuses on disparities in credit markets. For centuries banks have been a vital part of the economy providing credit and savings facilities for businesses and individuals. The mortgage market has always been a vital business for commercial banks and credit institutions, and buying a house is the single largest investment most individuals will make in their lifetime.

Central to measuring financial leverage in the mortgage market is the loan-to-value (LTV) ratio. The LTV ratio is expressed as the value of the loan to the value of the property purchased. The LTV ratio is “arguably the most widely used indicator for measuring financial leverage and assessing credit risk in the United States and around the world” (Bian, Lin and Liu, 2018). An important idea to understand in terms of LTV ratios is that when the LTV ratio increases, the credit risk associated with the loan increases. This occurs due to a number of reasons. Firstly, a higher LTV ratio increases the likelihood of negative equity, default therefore becomes more likely. Secondly, if the loan defaults, “a higher LTV ratio means the collateralized property is less likely to bring sufficient proceeds at the foreclosure sale to cover the outstanding loan balance, past due payments and other foreclosure costs incurred by the lender” (Bian et al. 2018). The effects of LTV ratios on credit risk provide interesting implications for this paper, looking at how credit institutions assess credit risk across gender and race.

## Literature Review

As it can be seen in the introduction, comparisons of race and gender in terms of empowerment, health and income are plentiful in economic literature. However, despite the importance of credit markets in the global economy, the lack of literature on comparisons of gender, race and ethnicity in loan level data is astonishing. One explanation for the lack of literature may be the reluctance of credit institutions to disclose loan level data publicly or with academics. However, since the subprime mortgage crisis in the United States legislation has been passed requiring certain information to be made publicly available (Housing and Economic Recovery Act, HERA, 2008). These measures were introduced to improve transparency in credit markets and to reduce the risk of such disasters occurring again. With loan-level data being made publicly available, academics can now study an aspect of credit markets that they may not have been able to research before.

One of the main inspirations for this research project came after reading the work by Haughwout, Mayer and Tracey (2009). Their paper focuses on how the subprime lending boom made mortgages more accessible to all Americans, “yet concerns persist that not all borrowers have been treated equally.” The data used in the paper is a specific dataset created by the authors, which combines data disclosed under the Home Mortgage Disclosure Act and the LoanPerformance dataset from 2005. The authors match individual loans from each dataset and merge them to create their own unique dataset. The authors create a model for the initial interest rate received by the borrower controlling for the borrower’s credit score, the LTV ratio, debt-to-income (DTI) ratio and some neighborhood characteristics such as unemployment rate, homeownership rates and house appreciation in

# Gender disparities in mathematical achievements in Junior Certificate results

Annie Walsh

## Abstract

This paper explores the role that gender plays in the level and grade of mathematics (maths) achieved by individuals in the Irish secondary schooling system. While previous literature suggests that males outperform females at the upper end of the distribution in maths, there doesn't seem to be extensive amount of research carried out in regard to the performance of individuals in the middle of the distribution around the mean. In fact, our findings indicate that females score higher than males in Junior Certificate (JC) exams at the mean level. There also would seem to be less females choosing to study higher level maths for the Leaving Certificate (LC), whereas there are more females studying higher level maths for the JC. These gender differences can be attributed to a large number of factors, which are discussed in greater detail in this paper.

## Introduction

Given the recent awareness of achieving gender equality – evident in enforcing laws of equal pay among sexes – the issue of gender equality has never been more relevant. There is no doubt that there have been significant strides in closing the gender gap globally. Even though many countries have achieved important milestones towards gender parity in areas such as education, health, economic and political systems, there still is a lot more work to be done (World Economic Forum, 2018). The specific area of education I will focus on is gender disparities in mathematical achievement. Although education levels of women have increased significantly relative to men in recent times, women are still found to suffer from under-representation in Science, Technology, Engineering and Mathematics (STEM) college degrees and occupations (Devereux and Delaney, 2019). To this day there still exists a large gender gap when applicants list their preferred college courses in Ireland. Around 40% of males list a STEM course as their first preference when applying to university, whereas only approximately 19% of females

do so (Devereux and Delaney, 2019). Many people claim that no such disparities exist in terms of academic achievements and abilities. However, the evidence suggests the contrary – certain university degrees do have a significantly higher proportion of male students than females. There are many divided opinions about why gender disparities may exist in this context. Some argue that there is a biological difference between gender when it comes to academic performance. Others suggest that there is a cultural influence of gender stereotypes that consequently translates into the way students behave when picking subjects for exams, or future college prospects. Furthermore, gender stereotypes may have an effect on students' self-evaluation and confidence regarding their ability and performance in maths.

The aim of this paper is to undertake an in-depth and critical examination of the relationship between maths test scores and gender, with a particular focus on Junior Certificate (JC) results in Ireland. Moreover, this paper sets out to understand whether *any* gender difference exists in terms of different levels of maths available to students in Ireland. The data used here constitute a significant novelty in the existing literature available on this topic. The data come from the latest Growing Up in Ireland (GUI) dataset, which was only released in 2016 and include relevant variables which have never been used in other empirical analysis on the topic, such as an individual's perception of his/her mathematical ability. The questions which we will attempt to answer throughout this paper are: do males outperform females in maths and why might this be the case? What other factors may affect one's maths scores? Are there more boys than girls choosing higher Junior Cert and/or Leaving Cert level maths?

The paper is divided into several sections. Section 2 contains a descriptive empirical literature review on the topic, while Section 3 provides a detailed outline of the empirical methodology and data utilized to examine various relationships. The fourth section outlines the empirical results and discusses the various findings. Finally, the paper concludes with some remarks on the findings and their significance in the realm of economic analysis. Mathematical appendices are included at the end, providing details on the empirical analysis.

## Literature review

Much of the debate surrounding the under-representation of women in STEM was incited by Benbow and Stanley, who conducted a study of 40,000 students. They demonstrated that the male-female ratio in the early 1980s on the Scholastic Aptitude Test (SAT)-Mathematics was 2.1 to 1 for scores higher or equal to 500, which was equivalent to the top 0.5% of the distribution. They also found that the male-female ratio was 4.1 to 1 for scores higher or equal to 600, and a shocking 13 to 1 for those scoring higher or equal to 700, which was equivalent to the top 0.01% of the distribution. Since the publication of the above-mentioned findings, there has been a substantial rise in the amount of discussion and research concerning this topic. The male-female ratio in the top 0.01% of mathematical ability on the SAT-M has substantially declined from 13 to 1 in the early 1980s to approximately 4 to 1 in the early 1990s (Wai *et al.*, 2010). Wai *et al.* (2010) have also conducted a study in which they attempt to provide a broad historical analysis of sex differences in the upper end of the distribution curve of maths test scores. They attempted to

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ISBN-13: 978-1-4470-2641-9  
ISBN-10: 1-4470-2641-1

