

Research Bulletin 19/6 | Expanding the Analytical Toolkit with Computable General Equilibrium Modelling

Samuel Connolly, Economic Modelling, Northern Ireland Statistics & Research Agency (NISRA)

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Summary

Assessing the full economic impact of policy decisions has always been a challenge given the limitations of data and how it can be interpreted. In order to improve this process and make better use of data being provided by the Northern Ireland Statistics & Research Agency (NISRA), the Department for the Economy (DfE) commissioned the development of a Computable General Equilibrium (CGE) model from the Fraser of Allander Institute (FAI) at the University of Strathclyde.

The NI – CGE model provides a detailed representation of the Northern Ireland economy and captures the interlinkages between the private sector, government and households. With this development, the Northern Ireland Civil Service (NICS) now has the ability to examine the macroeconomic implications of policy changes in areas such as international trade, migration, productivity and taxes.

Introduction

As the old saying goes *"if all the economists were laid end to end, they'd never reach a conclusion"*. However, whilst many opinions do exist on important issues, it is important that debate takes place in an informed environment, using the best available research, evidence and data.

This was the prevailing thought behind the development of a Computable General Equilibrium (CGE) model by the Department for the Economy (DfE), assisted by experts from the Fraser of Allander Institute (FAI) at the University of Strathclyde. The policy challenges of EU Exit highlighted the analytical gap within the Department's toolkit to gauge the macroeconomic impact of important policy changes that EU Exit would usher in, not least in the area of international trade.ⁱ

The development of this CGE model gives DfE, for the first time, the analytical capability to analyse the economic implications of a policy decision in all its components, including a detailed sectoral breakdown of key industry impacts. This will provide the ability to analyse impact on key economic variables such as GDP, wages, employment rates and net exports.

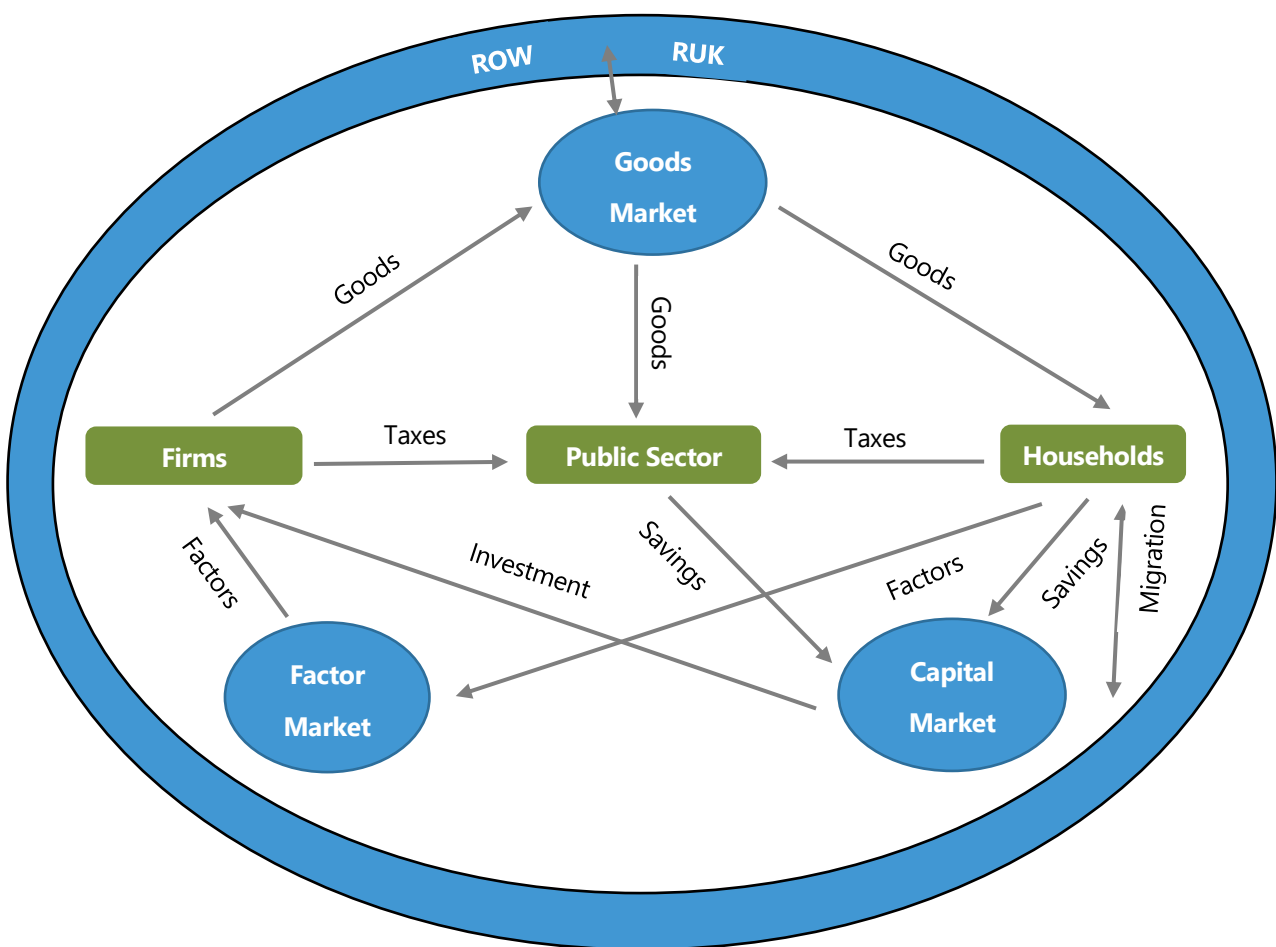
CGE Models have been used by Government bodies (such as HMRCⁱⁱ and the Scottish Governmentⁱⁱⁱ) for a number of years. Northern Ireland can also now benefit from this modelling approach, analysis and methodology.

What is a CGE Model?

A Brief Guide

A CGE model is a large scale numerical model that uses a system of equations to mimic the economic interactions between agents within the economy. It seeks to capture all the economic activities within the economy in order to facilitate an understanding of how a change in one sector e.g. manufacturing exports, will impact on another sector e.g. retail. Figure 1 below provides a high level overview of how the economy is represented within this modelling framework:

Figure 1: Circular flow diagram of the Northern Ireland Economy



Note: ROW = Rest of World; RUK = Rest of UK

Within this circular flow diagram, Northern Ireland is represented as a small open economy that cannot influence prices internationally. The grey arrows represent the relationships between firms, households, government and markets and these relationships are modelled through equations established from decades of economic study.

Using this framework it is assumed that at any one time the economy is in equilibrium. At this point, producers have chosen output levels that maximise efficiency and consumers have chosen goods that maximise their utility. Consequently any shock or policy simulation that is introduced will disturb this equilibrium, and the shock will reverberate through all the markets simultaneously. The Computer software - General Algebraic Modelling System (GAMS)^{iv} can calculate the impact of this by solving over 100,000 equations simultaneously and the results can then be analysed to determine what impact the policy change has had to key economic variables.

It is important to note that although a CGE model can simulate the future effect of policy changes, it is not a forecasting tool. Economic impacts derived from a CGE model will only ever demonstrate the difference between a pre-policy baseline year and differences due to the policy change. The results it produces cannot be interpreted as being the likely future position given that the economy will be affected by a range of factors that will not necessarily be included within the policy framework e.g. demographic changes, currency fluctuations, geopolitical shocks etc.

Data Requirements

The development of the NI - CGE model has only been made possible due to the pioneering work undertaken by NISRA since 2015 in developing a set of National Accounts.^v This work includes producing Supply Use Tables (SUTs), which captures data relating to four basic economic activities: Production, Consumption, Investment and Trade. The SUTs also provide detailed data on the supply and use of commodities, inter-industry flows and the structure of the economy. These SUTs are used to derive Input-Output tables that provide a framework for modelling the impacts of changes to the domestic economy and specifically economic multipliers that are used for economic planning, analysis and forecasting.

These two parts of the National Accounts produced by NISRA represent the key components of the data requirement for a CGE model. This is further augmented by the inclusion of data on households as well as more government expenditure data to produce a Social Accounting Matrix (SAM) that contains details of all the economic transactions that take place within Northern Ireland and is a matrix representation of the circular flow diagram noted above. Table 1 below provides a summary of how this data is arranged.

Table 1: Overview of the Northern Ireland Social Accounting Matrix

	Expenditures							
		Industries	Factors	Household	Government	Saving	ROW	Total
Incomes	Industries	Intermediates		Private consumption	Public consumption	Investment	Exports	Total demand
	Factors	Value added					Factor income from the ROW	Factor income
	Households		Factor income to HH	Inter-HH transfers	Transfers to HH from G		Transfers to HH from the ROW	HH income
	Government	Indirect taxes and tariffs	Factor income to G, factor taxes	Income taxes		Taxes on capital formation	Transfers to G from the ROW	Government income
	Saving			Private savings	Public savings		Foreign saving	Saving
	ROW	Intermediate Imports	Factor income to the ROW	Household imports	Transfers from G to the ROW	Investment imports		Foreign exchange flow
	Total	Total supply	Factor expenditures	HH expenditures	Government expenditures	Gross Investment	Foreign exchange flow	

Note: ROW = Rest of World; RUK = Rest of UK; HH = Households; G = Government.

It is this firm foundation, in terms of statistical data and comprehensive coverage, to which the system of equations taken from economic literature is applied. These equations are taken primarily from general equilibrium theory and result in the simultaneous determination of prices and quantities in multiple sectors of the economy.

This provides the ability to quantify values associated with various “what if” scenarios that allow an economist to make a powerful contribution to the debate about economic policy.

Introducing a shock

When seeking to introduce a shock to the model, it is important to fully understand the question or policy change being considered. This will ensure that the full ramifications of a potential policy have been thought through and not just part of it. For example, the imposition of tariffs on trade may increase the price of imports and so disadvantage consumers, but they are also likely to generate tariff revenue that may benefit the level of available expenditure available for public services.

There is also a requirement to quantify the shock for input into the model. This can often take weeks of research in order to turn a high level change in policy (e.g. imposing tariffs, changing tax levels, improving productivity) into something that can readily be translated into a change to one of the key variables or parameters within the model. For example, if the economic impact of changes to migration policy were being considered, the full impact of this policy in terms of the overall supply of labour would need to be known taking account of baseline trends as well as changes to the working age population, prior to operating any specific simulation within the model. This part of the modelling process relies on the assistance of policy experts as well as those with a detailed understanding of data sources, surveys and how the scenario can be coded using GAMS to fit within the model.

Interpreting results

Once a model simulation has run and a new equilibrium produced, the results can be interpreted to understand how the policy change has impacted throughout the economy and changed key economic variables. These include, but are not limited to GDP and components, wages, labour supply, imports, prices, unemployment and investment. Given the range of results that the model produces, it represents quite a powerful tool when it comes to policy analysis. Furthermore, some of the metrics produced e.g. changes to unemployment and Gross Value Added (GVA) can be applied to official statistics to provide an indication of the absolute levels of GVA changes or changes to the number of individuals in employment resulting from a particular policy change. The model has the further benefit of providing this information at a detailed industry sector level so that very specific impacts (on the retail or agriculture sector for example) can be known. Indeed, the model can produce certain impacts at a sectoral level for the following main industrial classifications shown in Table 2 below:

Table 2: Sectoral Classifications used within the CGE Model

Sectoral Classifications	
Agriculture, Forestry and Fishing	Food & Accommodation Services
Other Primary	Water, sewerage and Waste
Food and Drink	Construction – Buildings
Textile, Leather, Wood, Paper, Printing	Wholesale and Retail
Chemicals and Pharmaceutical	Information & Communication
Rubber, Cement, Glass, Metals	Financial Services, insurance and services
Electrical Manufacturing	Real Estate, professional, R&D
Mechanical & Other Manufacturing	Public Administration, Education and Health
Energy	Other Services

These classifications are based on Standard Industrial codes and can be re-aggregated to take account of any industrial classification as specified within the Supply Use framework.

Conclusion

The NI – CGE model provides a detailed representation of the Northern Ireland economy and captures the interlinkages between the private sector, government and households. Having a CGE modelling capability will provide DfE and the wider NICS with an additional resource with which to analyse important policy decisions. As the policy ramifications of EU Exit become known, this tool will help inform the debate around issues such as post Brexit trading arrangements and their impact on the Northern Ireland economy.

However, it is not the intention that the model will be used solely in relation to EU Exit. The model has many other applications to other policy areas e.g. health and education/skills and it is hoped that the analytical capability can make a contribution in these areas going forward.

Samuel Connolly

For further information or queries please contact: samuel.connolly@nisra.gov.uk

ⁱ The Department for the Economy's webpage relating to EU Exit research is available at the following link:

<https://www.economy-ni.gov.uk/articles/eu-exit-analysis>

ⁱⁱ <https://www.gov.uk/government/publications/computable-general-equilibrium-cge-modelling>

ⁱⁱⁱ <https://www.gov.scot/publications/cge-modelling-introduction/>

^{iv} <https://www.gams.com/products/introduction/>

^v <https://www.nisra.gov.uk/statistics/economic-accounts-project/ni-economic-accounts-overview>