

# MODELING IRISH UNIFICATION

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## **Research Team**

Given the nature of the undertaking, this report involved quite a number of researchers who contributed to various aspects of the project. Kurt Hübner from KLC provided the overall lead. Renger van Nieuwkoop from Model Works in Switzerland was in charge of the modeling exercise. Yuri Tricys was the project researcher and also in charge of data compilation. Kurt Hübner is overall responsible for the final report. All the kudos goes to the research team and the many commentators who engaged during the life cycle of the research. Any citation of the report refers to KLC.

Over the course of the project we had multiple discussions and interviews with a large number of experts from Northern Ireland and the Republic of Ireland in regards to data, scenarios and feasibility. None of them is in any way responsible for the outcomes of our modeling exercise.

KLC, August 2015  
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## **Kurt Hübner**

Dr. Kurt Hübner received his PhD in Economics and Political Science from the Free University Berlin, Germany. He is a professor at the Political Science Department at the University of British Columbia and holds the Jean Monnet Chair for European Integration and Global Political Economy. Currently he acts as the director of the Institute for European Studies at UBC. He has published 12 books and numerous articles in journals. His most recent books are 'Europe, Canada, and the Comprehensive Economic and Trade Agreement' (Routledge 2011) and 'Global Currency Competition and Cooperation' (publication date: Routledge 2015).

Hübner's expertise is in the area of European integration in the context of the global political economy as well as in the Political Economy of Germany. His main focus is on the Euro, and the role of the Euro in global currency relations as well as the economic mode of governance. A further area of expertise is the relation between international competitiveness, innovation and sustainability where he headed several projects in the past. His most recent project in this area deals with 'National Pathways to Low Carbon Emission Economies'. Over the last years he also contributed to the analysis and assessment of CETA and TTIP. In the past few years he also directed projects for Vancouver-based KLC – a consulting company that focuses on European and North American economic and political relations.



## Dr. Renger Van Nieuwkoop

### Experience

- Since 2011 Lecturer and researcher (part-time), ETH Zurich, Switzerland.  
Since 2009 Director and Founder Modelworks, Thun.  
Since 2003 Lecturer, Ecomod, Workshops advanced applied computational equilibrium modeling, Brussels, Washington, Bangkok, Prague.  
2010-2015 PhD Student, Center for Energy Policy and Economics, ETH Zurich, Switzerland.  
1992-2012 Senior consultant, member of the board (until 2010), Ecoplan, Bern, Switzerland. Mainly working for the government.  
1988-1992 Assistant, Institute for Applied Microeconomics, Prof. G. Stephan, University Bern, Switzerland.  
1984-1988 Physiotherapist, Hospital Permanence (part-time), Bern, Switzerland.  
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### Education

- 2010-2015 Dr. of Sciences, ETH Zurich, Switzerland, supervisors; Prof. T. Rutherford, Prof. S. Rausch and Prof. K. Axhausen.  
2006-2009 Diploma in Advanced Studies in Applied Statistics, ETH Zurich, Switzerland.  
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1980-1984 Diploma Physiotherapy, Stichting Utrechtse Paramedische Akademie, Netherlands.  
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### Languages

- Dutch native  
German fluent  
English fluent  
French intermediate (reading), basic (speaking, writing)  
Italian intermediate (reading), basic (speaking, writing)  
Swiss-German intermediate (understanding), basic (speaking)  
German  
Latin reading

### Computer Skills

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Programming Visual Basic, Powershell  
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## Executive Summary

The current political and economic separation of Northern Ireland from the Republic of Ireland (ROI) has opened up an economic gap between the two regions of the Island. Political and economic unification of the North and South would likely result in a sizable boost in economic output and incomes in the North and a smaller boost in the ROI. The key factors driving this conclusion are the following.

- In the short run, unification would result in the North's adoption of the euro. At current exchange rates, this would effectively devalue the currency for the North, causing a shift in international terms of trade that would favor Northern Ireland relative to the U.K. and relative to other countries in the Eurozone. The consequent increase in exports is projected to initially increase per-capita gross domestic product in the North by 5 percent, and then fade back to the long-run growth path within seven years.
- In the long run, unification would involve the adoption of the Irish tax system, greater openness in the North to Foreign Direct Investment, and diminished trade barriers between Northern Ireland, the ROI, and other countries in the Eurozone. A period of economic catch-up is likely to ensue whereby the Northern Irish economy would shift structurally from low value-added industries to high value-added industries. Additional benefits would derive from lower trade costs across the north-south border. These changes are projected to increase GDP per capita in the long run by 4 to 7.5 percent in Northern Ireland and by 0.7 to 1.2 percent in the Republic of Ireland.

These conclusions follow from an economic analysis of Irish Unification undertaken by KLC – Consulting for Tomorrow. The KLC report relies on simulations generated from a “computable general equilibrium” (CGE) model of the economies of Northern Ireland and the ROI. CGE models employ economic theory and statistical analysis to model the economic relationships driving production, consumption, wages, price, exports and imports, and ultimately, the output of an economy. The model is built to best fit actual economic relationships in an economy in a given year (the model calibration phase) and then used to simulate economic outcomes under alternative institutional and policy scenarios. CGE models have been used to study the economic consequences of German Unification as well as to simulate the potential economic gains from the unification of North and South Korea. Aside from studies applied to political and economic unification, CGE models are commonly used to explore the economic consequences of alternative policy scenarios.

Irish Unification is modeled as impacting the economics of Northern Ireland and the ROI through the following channels.

1. **Harmonization of the tax systems across the Island, with the North adopting the tax rates and regulations of the south.** This harmonization of taxes would involve both changes in adoption of activity taxes as well as taxes on imports, commodities, and institutional taxes. These changes would likely foster greater FDI in the north and contribute to economic growth.
2. **Diminished trade barriers and greater access of Northern Irish firms to the common market.** The modeling in the KLC report assumes that unification would lower trade costs associated with transport and currency transaction between Northern Ireland, the ROI, and other Eurozone countries. This reduction in transactions costs is projected to increase per-capita income.
3. **Adoption of the Euro in the North.** Given the current strength of the pound against the euro, adoption of the Euro in the North would provide a short run boost to economic output associated with an improvement in Northern Ireland's terms of trade.
4. **Productivity Improvements.** Currently there is a sizable productivity differential between Northern Ireland and the ROI. This differential is driven in part by differences in the industrial structure of the two economies, which in turn, is partly caused by the different political and economic institutions. Convergence of productivity levels in the North to those of the ROI would directly the impact of the output in the North and indirectly impact output and incomes in the ROI through higher trade volume.
5. **Fiscal Transfers.** Northern Ireland currently and historically runs a fiscal deficit that is financed by inter-governmental transfers from the UK. Unification would require that this deficit be financed and assumed by the ROI. However, unification would also eliminate the need for two parallel governmental structures in many domains and likely result in public spending in the north that diminishes over time. In the short run, reductions in public spending may reduce output and per-capita output to the extent that labor and capital once employed in the public sector are not reallocated towards other uses. In the longer running, public sector savings may be reinvested in the private economy or in public projects that enhance the long-term productivity of the country.

The KLC report explores the individual effects of each of these factors and performs a series of composite simulations. The range of estimated effects on per-capita GNP and GDP can be thought of as lower and upper-bound estimates from the alternative scenarios.

**Executive Summary prepared by  
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## Comments on “Modeling Irish Unification”

Marcus Noland  
Executive Vice President and Director of Studies  
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August 2015

### Why the Question Matters

Northern Ireland (NI) is falling ever further behind the Republic of Ireland (ROI) in terms of economic development. This growing divergence is particularly relevant insofar as issues of national identity are becoming ever more fluid in the context of the supranational European Union (EU) in which both parts of Ireland belong. Yet in the medium-term future the relationship between these two parts of Ireland potentially could become more problematic due to the possibility of the United Kingdom’s withdrawal from the EU (the so-called “Brexit”). Hence it is an opportune moment to examine the possibility of the two parts of Ireland not envisioning separate development trajectories, but rather in the words of Bradley (2006) planning “a coming together in order to build on natural island economic strengths and remove barriers and weaknesses so that genuine synergies can be realized for the mutual benefit of both economies.”

“Modeling Irish Unification” is a path-breaking analysis of the economics of Irish unification, demonstrating the benefits to both Irelands of closer economic and political relations.

### Basic Modeling Challenge

Analysts attempting to address the issue of Irish unification immediately confront the problem that as a subnational jurisdiction, much economic data necessary to conduct the analysis may not be collected for Northern Ireland as an independent reporting entity. The study’s authors have used a variety of techniques to generate estimates for Northern Ireland when the relevant data are not reported. In some cases the needed data can be backed out of the United Kingdom (UK) accounts fairly easily. In other cases, the authors use informed adjustments to the UK data to construct admittedly more speculative estimates of the Northern Ireland figures. All of this work appears to fall well within the realm of reason.

### Modeling Approach

The authors use a multi-sector, multi-region dynamically recursive computable general equilibrium model (CGE) to model Irish unification. The model is calibrated for 2009 and run over the period 2018-2025. The approach and the authors’ implementation are fundamentally sound. The advantage of the CGE approach is that it enforces intellectual and analytical consistency. It is particularly useful for scenario modeling and tracing out all the implications of a change in policy or some kind of change in economic behavior. One drawback of the CGE

approach and it is not a drawback of the approach but rather how we interpret the results, is a possible tendency toward spurious precision. The models are an abstraction of reality, embodying many assumptions. In the case at hand, some of the underlying data has been estimated or constructed and may not be precisely accurate. So when interpreting the results of the models, it is best to think of them as pointing to or reminding us of the relevant channels through which policy may shape outcomes, and giving us some guidance or insight into the impact of those policies, rather than fixating on the final decimal point of some simulation outcome.

The authors' treatment of the Irish case is quite sensible: Northern Ireland is modeled as a "small country" relative to the ROI; both parts of the island are treated as "small countries" relative to the rest of the world. The implementation is done using a Bayesian approach used in previous CGE work where the researchers need to construct social accounting matrices where underlying data may be missing or subject to significant measurement error, a common experience in many countries. Other details of the modeling approach and model parameterization are quite conventional and do not raise any red flags that unusual assumptions or approaches are being employed to generate particular results or outcomes.

#### Drivers of outcomes

The study examines a series of potential drivers of outcomes in the Irish unification case. These include:

- The tax system (the system is unified island-wide as NI adopts the ROI tax system),
- Barriers to trade (modeled as a 5 percent reduction in cross-border trading costs),
- Political union (modeled as a 2 percent reduction in NI government expenditures through the elimination of duplicative government functions in the two parts of the island),
- Exchange rate (NI adopts the euro which amounts to an effective devaluation), and
- Fiscal transfer (the NI budget deficit is financed by transfers from the ROI rather than the UK).

Each component driver is analyzed separately and then combined into three unification scenarios.

As has been found in past analyses of mergers of partners where one partner is significantly smaller, poorer, and more distorted initially than the larger partner (e.g. Germany, the prospective case of Korea), the results are uniformly more profound for the smaller partner. This is less likely to be important in the Irish case because cross-border flows of labor and capital are already significantly open, so the impact from increased cross-border factor flows which was quite important in the German case, and would also be significant in a prospective Korean case, is less salient in the case at hand.

Tax harmonization provides a modest boost to NI growth by essentially adopting a more uniform less distortive tax system, particularly with respect to commercial taxes. The impact on the ROI is negligible.

The adoption of a more rational tax system and devaluation encourages foreign capital inflows into NI. This is one mechanism through which NI begins to converge on ROI's level of efficiency. NI's productivity increase in the context of closer economic relations with ROI has a positive impact on output in both parts of the island.

Political union has a negative impact on growth in this model, effectively acting as a Keynesian contraction of public expenditure. But this outcome is a function of the fact that output in the public sector is measured by expenditure, and a specific modeling assumption, which is that as public expenditures are reduced, labor and capital employed in the public sector remains fixed. This treatment implies a reduction in public sector efficiency, and hence the Keynesian contraction. However, if as public expenditure is decreased, resources are freed and redeployed, the model would generate something akin to a "peace dividend," and output would likely increase. In short, the specific assumptions of the model may paint an unduly negative portrayal of the implications of an island-wide rationalization of government functions, and an alternative—and arguably more plausible—modeling assumption would likely generate even larger gains to unification.

Trade integration increases output modestly in both parts of the island. However, there is reason to believe that the model does not fully capture the boost to trade that would occur with closer economic integration. Numerous studies done in a variety of settings (the US and Canada, among Canadian provinces) demonstrate that "borders matter" to a much greater degree than most observers would expect. As a consequence increased integration created by the adoption of a common tax code, a common currency, and a centralization of government functions is likely to deliver a much bigger boost to intra-island exchange than occurs in these model simulations.

NI's adoption of the euro has a positive impact on output in NI, a slightly negative impact on output in ROI, and a positive impact on growth for the island overall. The main driver is the move of NI from a relatively small common currency area (the UK) into the much larger one (the EU), one in which its immediate neighbor, the ROI participates.

However, it should be noted that the effective devaluation that the adoption of the euro might represent today may not be a permanent state of affairs. For example if the Bank of England mismanaged UK monetary policy, it could lead to a large depreciation of the pound, and the adoption of the euro would amount to an effective revaluation of the currency for NI. In this case, there might be offsetting benefits to the adoption of a better managed currency, however. Trade creation exceeds trade diversion confirming that the net impact is a boost to the efficiency of the two partners. This latter effect is driven by fundamental complementarities and should not be contingent on the level of the exchange rate.

## Unification scenarios

These building blocks are then combined to into three unification scenarios.

The first scenario is the most conservative, indeed almost implausibly so. The unified Ireland finances the entire NI budget deficit; the harmonization of government functions reduces NI public expenditure by 2 percent; and NI's adoption of the ROI tax system has no impact on attracting FDI or boosting productivity.

In the second scenario, ROI finances the NI fiscal deficit; NI reduces public expenditure by 2 percent. However in this scenario, the adoption the ROI tax system and approach to FDI catalyzes FDI inflows that drive a convergence of NI productivity to the level of ROI over a 15 year period.

The third scenario embodies the assumptions of the second scenario with the added twist that government savings are reinvested in the form of public investment.

As shown in figure 18 of the report, under scenario 1, there is an immediate boost to NI growth that peters out over the course of the simulation. Even though it converges back to its long-run path, NI is clearly better off due to the boost to growth in the intermediate years.

In scenario 2, the intermediate scenario, enhanced FDI inflows means that rather than petering out, unification amounts to a permanent upward shift in NI's growth path as illustrated in figure 20.

Finally, in scenario 3 which envisions additional public investment, NI's growth path is not only permanently higher, but diverges in an ever widening course from the no unification base case trajectory (figure 22).

In all three scenarios, ROI benefits to a varying degree, though as expected the impact of unification is not nearly as profound.

## Conclusion

"Modeling Irish Unification" is an important, timely examination of the economics of Irish unification, applying state-of-the-art modeling techniques to the issue at hand. The modeling work illustrates a variety of channels which are likely to be at play in the Irish case, and concludes that Irish unification would be economically beneficial to both parts of the island, and especially for smaller, poorer, Northern Ireland.



## **Marcus Noland**

Marcus Noland, executive vice president and director of studies, has been associated with the Peterson Institute for International Economics since 1985. From 2009 through 2012, he served as the Institute's deputy director. His research addresses a wide range of topics at the interstice of economics, political science, and international relations. His areas of geographical knowledge and interest include Asia and Africa where he has lived and worked, and the Middle East. In the past he has written extensively on the economies of Japan, Korea, and China, and is unique among American economists in having devoted serious scholarly effort to the problems of North Korea and the prospects for Korean unification. He won the 2000–01 Ohira Memorial Award for his book *Avoiding the Apocalypse: The Future of the Two Koreas*.

Noland was educated at Swarthmore College (BA) and the Johns Hopkins University (PhD). He is currently a senior fellow at the Peterson Institute for International Economics and at the East-West Center. He was previously a senior economist at the Council of Economic Advisers in the Executive Office of the President of the United States. He has held research or teaching positions at Yale University, the Johns Hopkins University, the University of Southern California, Tokyo University, Saitama University (now the National Graduate Institute for Policy Studies), the University of Ghana, the Korea Development Institute, and the East-West Center. He has received fellowships sponsored by the Japan Society for the Promotion of Science, the Council on Foreign Relations, the Council for the International Exchange of Scholars, and the Pohang Iron and Steel Corporation (POSCO).

## Abstract

The economies of Ireland, North and South are interlinked and interdependent, but they are not aligned. Both economies differ enormously in terms of structure, output and growth. Though there is a great deal of research detailing these differences, there is a dearth of research on the subject of economic and political integration. Using available data, and a variety of estimation, extraction and proxy procedures, we build social accounting matrices for both island regions. We then customize a one-country computational general equilibrium model to accommodate the two regions in a global setting and simulate the impact of their economic integration and political unification, using our data set. Under a set of specific assumptions, unification positively impacts output per capita across the two island regions by 1,497 Euro in the year the policy is implemented. This impact, largely centered in the Northern economy, accumulates to 17,168 Euro within 8 years. This outcome is based on the most comprehensive scenario III and builds on scenario component modeling as well as on more modest unification scenarios (I and II). In a short-term perspective, currency effects due to the changeover to the Euro in Northern Ireland heavily drive unification benefits. The effects of a common regime for foreign direct investments and the implied productivity effects drive long-term unification benefits.

Scenario Outcomes: GDP Effects Per Capita

Table 1. Unification Scenario I

REGION	CHANGE IN GDP/CAPITA (EURO)								
	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NI	1,199	1,037	873	707	539	369	196	21	4,942
ROI	3	44	87	131	176	223	272	322	1,259
All-Island	1,202	1,081	960	838	716	592	468	343	6,201

Table 2. Unification Scenario II

REGION	CHANGE IN GDP/CAPITA (EURO)								
	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NI	1,273	1,192	1,113	1,036	960	884	808	732	7,997
ROI	74	188	302	416	531	647	764	882	3,804
All-Island	1,347	1,380	1,415	1,452	1,491	1,531	1,572	1,614	11,801

Table 3. Unification Scenario III

REGION	CHANGE IN GDP/CAPITA (EURO)								
	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NI	1,466	1,577	1,693	1,812	1,935	2,060	2,189	2,322	15,054
ROI	31	101	169	235	300	364	427	488	2,114
All-Island	1,497	1,678	1,861	2,047	2,235	2,424	2,616	2,810	17,168

**The modeling of Irish unification hints to overall positive and strong net benefits that may even be larger if the process of economic and political unification is accompanied by economic policy decisions that make employment- and growth-supporting use of efficiency potentials.**

## I Introduction

Northern Ireland has relatively low living standards, inward oriented industrial policies, high levels of output in low value-added sectors, a small private sector, and an over-reliance on the public sector. These weaknesses contribute to a productivity differential with the South of Ireland, where 2011 Gross Value Added (GVA) per capita was 159% higher than in the North. Both economies differ fundamentally in their regimes of accumulation and their modes of regulation. The Republic of Ireland (“South”) is a strongly outward-looking and export-intensive economy that not only is part of the European Common Market but also of the common currency zone; it’s long-term excellent economic growth record very much is based on a globally competitive regime of foreign direct investment (Crafts 2014). Northern Ireland, on the other side, is a relatively more inward-looking economy that shares features of an economic periphery inside the UK (Healey 2015; Bradley & Wright 1993). Both economies experienced severe economic problems in the course of the global financial crisis from 2008, and it is revealing that the South shows since stronger recovery effects than NI that also reports below the UK-average recovery rates (Office for National Statistics).

Though the South and North<sup>1</sup> have different underlying economic conditions, there are strong arguments which indicate that the economic potential of the northern economy could be unleashed in the context of greater economic integration with the south of the island. Achieving economic integration would entail: 1) a shift in industrial orientation from a closed industrial policy to a more open one; 2) a shift in the tax structure of the North to one compatible with that in the South; 3) a shift along the production possibilities frontier from low to high value-added industries; 4) changes in policies necessary to attract FDI; and 5) greater fiscal autonomy. Some policy makers in the North, however, argue these policy changes cannot be implemented without a complete transfer of political autonomy from the national level to the regional level. The latter claim acts as a linkage between the economic future of the region and its political autonomy, and means such changes can be encompassed in an all-encompassing policy of political and economic unification.<sup>2</sup> The problem is that little information is available on the potential economic effects of a unification policy, and there are therefore little means to numerically gauge its effectiveness. This is further complicated by the data deficit in the North. An econometric model built to examine the impact of reunification would need to accommodate both island regions in a setting with global flows, simulate the effects of changes in the tax regime, and be equipped to deal with changes in the valuation of the currency. It would also require a detailed exposition of industrial and domestic sectors.

To address the above challenges we applied estimation and extraction procedures to generate where necessary the synthetic data needed to build such a model. We then customized an existing model framework to meet the needs of the modeling challenge and built what is to our

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<sup>1</sup> Throughout this report we use sometimes out of convenience ‘South’ as an acronym for the Republic of Ireland (ROI); ‘North’ then stands for Northern Ireland (NI).

<sup>2</sup> Bradley (2006), “An Island Economy or Island Economies” suggests to achieve the four *Porter* competitiveness factors “...policy-makers in the two regional economies should not plan for separate development as two competing regions, but should facilitate a coming together in order to build on natural island economic strengths and remove barriers and weaknesses so that genuine synergies can be realized for the mutual benefit of both economies.”

knowledge the world's first model simulating the political unification and economic integration of Northern and Southern Ireland. In this report, we review some of the literature supporting our data compilation and model selection, describe our model and data methodologies, detail the policy components of our all-encompassing policies, and demonstrate in general our results.

## II Modeling and Data Selection

For the purpose of our study, we looked for existing model frameworks to build on. From those we examined, the HERMES model was the most specific to Ireland. HERMES is an economy-wide structural computational general equilibrium model (CGE) that uses 180 core behavioral equations and a total of 824 functional equations to arrive at indicator responses to simulated shocks to the Irish economy.<sup>3</sup> Our concern was not that HERMES could not be modified to simulate a unification of Ireland scenario, but that modifying it would be extremely resource intensive, and would come in particular with extensive and possibly infeasible data requirements. For example, in HERMES wages are determined through a bargaining model, risks premiums on government bonds are modeled, and the tradable sector modeling includes international cost-competitiveness. Each of these mechanisms presents unique data challenges that could be problematic with a model built on a regional level economy where time-series data are limited. Noland and Robinson's 1998 Korean Integration Model (KIM), however, had been applied to regions where data sources are limited and a policy of unification was being examined. Moreover, in KIM, the level of cross-border trade that should exist is determined with a gravity model and trade is allowed to correct itself exogenously across a policy implementation timeline while other components of the current account adjust endogenously. This was especially fitting because gravity model research commissioned by *InterTradeIreland*<sup>4</sup> revealed measured levels of all-island<sup>5</sup> cross-border under-trading.

In 2002, the IFPRI published a paper detailing their static CGE model template that can be applied to a single region.<sup>6</sup> This model has many of the features available in HERMES, for example supply-side equation blocks, institutional equation blocks, consumption and production modeling, and a neoclassical framework linking the region with the world, without the more data intensive additions. It is also readily customizable. To generate the results presented in this paper, we applied the CGE framework to the two key regions independently, then joined them through linkages in the policy implementation years by customizing Lofgren et al (2002) to fit the multi-regional case with 54 industrial sectors, 4 ROW regions, and representative public and private institutional sectors.<sup>7</sup>

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<sup>3</sup> For a detailed review of the HERMES model see Bergin et al. (2013), "The HERMES-13 Macroeconomic Model of the Irish Economy."

<sup>4</sup> "A Gravity Model Approach to Estimating The Volume of North/South Trade" *InterTradeIreland* (2009).

<sup>5</sup> Concerning only the North and South of Ireland.

<sup>6</sup> For a detailed review of the IFPRI model see Lofgren, Harris and Robinson (2002), "A Standard Computational General Equilibrium (CGE) Model in GAMS."

<sup>7</sup> For a list of industrial sectors see the appendix. The two key regions are ROI and NI. The ROW sector is disaggregated into Great Britain (GB), the rest of the Eurozone, other than the ROI (REUZ), the rest of the EU, other than the Eurozone, GB, and ROI (REU), and the rest of the world (ROW).

## Data Models

National and international statistics are not typically abundant at the regional level. In the Northern Ireland (NI) case, Michael Burke (2014),<sup>8</sup> lists key data gaps. They include but are not limited to:

- Input-Output
- Retail Sales
- GVA output, income and expenditure
- Inflation
- Capital Stock
- Gross Fixed Capital Formation
- Proportion of value-added in exports
- Trade disaggregated by component or destination
- Compensation of Employee
- Tax receipts
- Public expenditures
- Composition of household consumption

To address the absence of Input-Output (I/O) tables for NI,<sup>9</sup> we looked to Stephen J. MacFeely's publication on regional 2005 Input-Output tables for the ROI.<sup>10</sup> He outlines the three model types used in constructing I/O and SUT tables: 1) survey based models, time intensive, but more robust; 2) non-survey models, fitting for regions with shortages of primary data; and 3) hybrid models, that blend 1 and 2. MacFeely's paper, detailing his survey based methods, was a rich resource and important guide, but to extract an SUT for NI from the UK tables we needed a hybrid model that could incorporate "both survey and synthetically-produced estimates into the construction process."<sup>11</sup> Our hybrid approach was based on Kronenberg and Tobben (2011).<sup>12</sup> It included the application of regional employment shares to a national level transactions matrix and the estimation of by-sector regional cross-hauling constants, using the *Cross-Hauling Adjusted Regionalization Method*, to arrive at estimates for regional trade levels. While these methods assume that "cross-hauling is a function of a commodity and not a region,"<sup>13</sup> they are, in our view, "preferable to no adjustments at all for cross-hauling."<sup>14</sup> Finally, work done by the Scottish government to compile I/O tables for Scotland was methodologically important.<sup>15</sup>

Supply and use tables do not contain all the data needed to build an economy wide model. In CGE-modeling, economy-wide transaction data, like those found in ESA95<sup>16</sup> distribution of

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<sup>8</sup> "A Commentary on Economic Data in Northern Ireland" NICVA's Center for Economic Empowerment ([http://www.nicva.org/sites/default/files/d7content/attachments-resources/economic\\_data\\_march2014.pdf](http://www.nicva.org/sites/default/files/d7content/attachments-resources/economic_data_march2014.pdf)).

<sup>9</sup> Or more precisely the Supply and Use tables that precede them.

<sup>10</sup> "Compilation and analysis of integrated regional input-output tables for NUTS 2 regions in Ireland," University College Cork.

<sup>11</sup> "Compilation and analysis of integrated regional input-output tables for NUTS 2 regions in Ireland," University College Cork.

<sup>12</sup> "Regional input-output modeling in Germany: The case of the North Rhine-Westphalia," Kronenberg, Tobben (2011).

<sup>13</sup> "Cross-Hauling in Input-Output Tables: Comments on Charm," Jackson (2014).

<sup>14</sup> "Cross-Hauling in Input-Output Tables: Comments on Charm," Jackson (2014).

<sup>15</sup> See: "Input-Output Methodology Guide", Scottish Government, 2011.

<sup>16</sup> European System of National Accounts 1995, itself based on the System of National Accounts 1993 (SNA93).

income accounts, are generally recorded in a social accounting matrix (SAM) structure. We therefore relied on a number of SAM projects to guide our SAM construction. Perhaps the most important of these was Miller, Matthews, Donnellan, and O'Donaghue (2005).<sup>17</sup> They compile a 55 industrial sector ROI SAM with 2 factors of production, 3 tax related accounts, private and public sectors, trade and transport margin accounts, and three external sectors. It was instrumental in the construction of our SAM.<sup>18</sup>

## Data

It should be noted that a CGE model depends critically on its data structures to give the most accurate picture possible of economic flows between activities and commodities, taxes, transfer flows between representative agents, and goods and transfer flows between domestic and external regions. The calibration of the model to the base period data set determines the magnitudes of its responses to simulated policy changes. This makes CGE highly sensitive to the quality of data that is entered into it. Data quality therefore impacts on the results. For this reason, we have taken every precaution to ensure the highest level of detail was applied to the data side of the project so that all known information was included. However, despite the fact that compilers must use what means are available for compiling this level of data, and that many of these techniques are compatible with contemporary balance of payment compilation procedures, it should be noted that compilation of both SUTs and SAMS can rely on the crossing of different survey results, and of various estimation procedures, each with their own error measurements. This means data, and therefore model results should be interpreted carefully<sup>19</sup>. In the following section, to aid the reader in interpreting these methodologies, we outline the components of a typical SUT and SAM, and detail our methods for their compilation and extraction with references to SAM cells.

## Compilation of SUTS

Supply and Use tables present the supply and demand of products and services in an economy in a series of tables. In the UK case, these tables include a supply table, an intermediate consumption table, a combined use matrix, and household consumption tables.

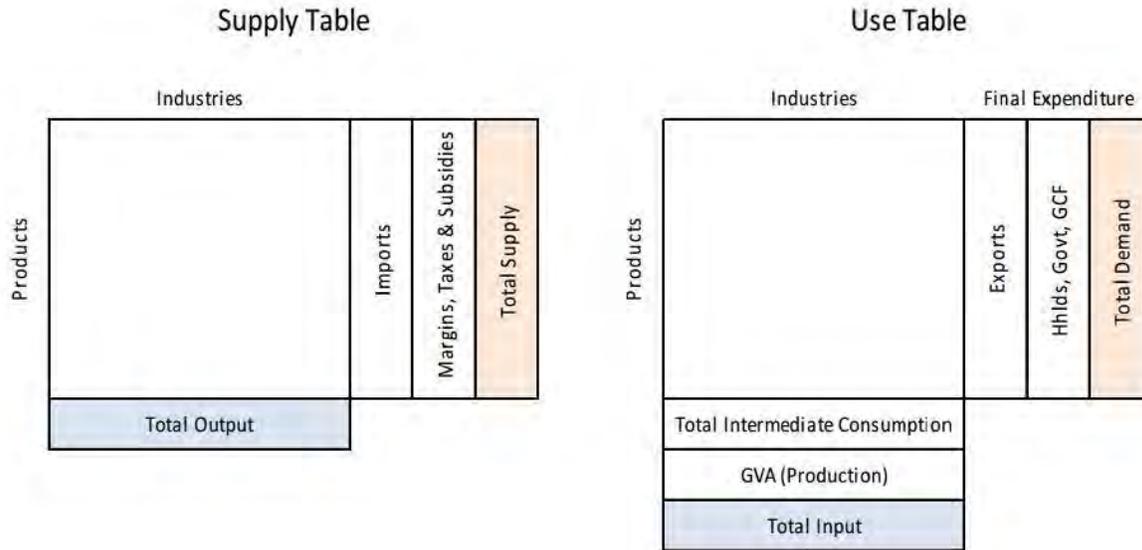
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<sup>17</sup> "A 2005 Social Accounting Matrix (SAM) for Ireland," Miller, Matthews, Donnellan, O'Donaghue (2005).

<sup>18</sup> Many thanks to Corina Miller for providing their 2005 SAM data, and commenting on the methodologies used in its construction.

<sup>19</sup> Our data compilation follows rather strict rules and accordingly we felt positive about the quality of our data, given the particular circumstances.

Figure 1. *Supply and Use Tables*



\*Source: MacFeely (2011)

2009 SUTs were available for Ireland and the UK, but not the NI region of the UK. The first challenge then was to extract the NI SUT from the UK SUT.

### Extraction and Compilation of the NI SUT

#### Supply and Use for Industries

We began by estimating NI employment shares of UK employment to 105 sectors (the UK SUT level of disaggregation) using a combination of the *Business Register Employment Survey's* (BRES) quarterly data and *Interdepartmental Business Registry Data* (IDBR).<sup>20</sup> The final NI employment shares were crossed with UK intermediate consumption to arrive at NI intermediate consumption by sector. These values were used in sectors where they were not distorted by anomalies found in NI employment to output ratios.<sup>21</sup> In other sectors, after published employment compensation costs were disaggregated, ratios of intermediate consumption to employment compensation, from the *Annual Business Inquiry* (ABI), were used to arrive at intermediate consumption.<sup>22</sup> Primary marketed output for each industry (at basic

<sup>20</sup> In the case where NI employment shares were suppressed in the data, homogenous external economies of scale were assumed and the ratio of GB registered business numbers to GB employment was applied to NI registered business numbers to arrive at NI employment levels.

<sup>21</sup> It is quite plausible the homogenous external economies of scale assumption does not hold where household enterprise and self-employment numbers are high, as evidenced by infeasible intermediate consumption estimates.

<sup>22</sup> Employment share sectors: 03, 10.2-3,10.5,10.6,10.7,10.8,10.9,11.01-6,11.07,12,19,20.4,20.5,20A,20B,20C,21,23OTHER,24.1-3,24.4-5,25OTHER,33.16,33OTHER,35.1,35.2-3,36,39,49.3-5,50,53,59 & 60,61,64,68.3,69.1,69.2,84,85,92; other sectors use ABI.

prices) less GVA yields intermediate consumption. It follows that given intermediate consumption and GVA, primary marketed output is also given.

To arrive at primary marketed output, it was necessary to disaggregate NI GVA values, published annually by the UK Office for National Statistics (ONS), from 29 sectors to 105 sectors. To do this UK business registry data were regressed onto GVA shares of sector totals. The correlation between business saturation and sector shares of GVA was applied to business registry data for NI, yielding disaggregated GVA and primary marketed output at basic prices.<sup>23</sup> A similar procedure was used to disaggregate the employment compensation costs published in the same report.

Because GVA is the sum of employee compensation costs, gross operating surplus plus mixed income and taxes less subsidies on production, only estimates of taxes less subsidies on production were required to complete the industrial side of the use table. The ratios of these taxes less subsidies at the UK level were applied to NI GVA to complete the table. Because output at basic prices is the sum of intermediate consumption and GVA, only secondary output was necessary to complete the industrial side of the supply table. The quantity of secondary output was estimated using the sum of by-product output relative total primary production by activity, at the UK level. To disaggregate secondary 'off-diagonal' output we applied a homogenous product assumption and homogenous process assumption across the two island regions.

## **Trade, transport and tax**

To complete the supply side of the NI SUT, trade and transport margins plus commodity taxes less subsidies were added to total imports and total domestic supply at basic prices. Both the UK's SUT and the ROI's SUT restrict distribution to the import side--exports are exported directly from their own sector. As a consequence, trade and transport margins in both our SUTs and SAMs are on the import side. In the NI case, distribution margins were extracted from total imports and domestic output with ratios from the national level SUT for each sector. These totals were adjusted across sectors in a consistent fashion during import estimation, constraint and harmonization. Tax margins were given the same treatment as distribution margins, only the tax totals were constrained to NI tax receipts.

## **Total Trade**

Total trade values for the NI SUT were calculated with pure non-survey formulae. This was done with a cross-hauling constant for each sector, derived from a non-linear function using the

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<sup>23</sup> In a few highly capitalized sectors, data points were far from the mean, indicating either a very small or very large number of businesses relative to GVA share. In these cases regression errors were added back, so the GVA share of the sector total relative to the number of businesses was more consistent with the national level.

*Cross-Hauling Adjusted Regionalization Method.*<sup>24</sup> A series of procedures were implemented to disaggregate total trade into regions. These procedures, also applied to the ROI's SUT, are briefly described here.

## Regional Trade

Disaggregation of trade into regions of origin and destination was done using commodity trade data bases and service trade balance of payment publications. The first step was to partition total SUT trade into services and commodity trade. In the NI case, this partition was taken directly from the UK SUT. In the ROI case, commodities trade data base sector totals were differenced with the SUT sector totals to get the cross-sector distribution of services and commodities trade. This distribution was kept but both commodity and service trade totals were constrained to values published by Ireland's Central Statistics Office (CSO).<sup>25</sup>

In the second step, commodities trade data bases were compiled for both the UK and the ROI. The UK data base, built with *HMS Treasury 2009* data,<sup>26</sup> given in standard industrial trade classification (SITC), was sorted and queried into regions and sectors and harmonized with the Classification of Products by Activity (CPA) classifications through a multistep process. The resulting distribution was applied to NI's share of the UK external commodities trade. To disaggregate the ROI's commodities trade into regional destinations and origins, a similar process was executed on the Irish trade data we received from the CSO.<sup>27</sup>

Services trade distributions were found for both NI and the ROI in balance of payments (BOP) publications. A concordance method was used to harmonize BOP data into CPA classifications. These data were then sorted and queried by region. The resulting distributions were applied to each sector's trade in services.

The third and final step was to balance the trade data. We were able to avoid iterative proportional fitting methods, like the RAS method, by using a manual adjustment process that incorporates known information so "balancing adjustments are made as much as possible to data items with the least robust data source."<sup>28</sup> For NI trade data, this meant transforming cross-hauling constants into a lower limit to either imports or exports. For NI-ROI trade, it was a matter of matching sector suppression in the ROI SUT and incorporating all-island trade data given in the *InterTradeIreland*<sup>29</sup> data base. This completed the expansion of the ROI's SUT to include a regional disaggregation of trade, and the supply side and industrial and trade portions of NI's SUT, leaving only NI domestic demand.

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<sup>24</sup> For more on this see: "Regional input-output modeling in Germany: The case of the North Rhine-Westphalia," Kronenberg, Tobben (2011). The cross-hauling constant is an estimate of trade in the same product across regions in both directions.

<sup>25</sup> Commodities data base values and published CSO values differed slightly.

<sup>26</sup> 30,000,000 data points.

<sup>27</sup> Thanks to Devraj Chaitanya for his work on the ROI SAM.

<sup>28</sup> "Input-Output Methodology Guide", Scottish Government, 2011.

<sup>29</sup> <http://www.intertradeireland.com/>

## NI Domestic Demand

NI domestic demand, or final domestic use in the SUT tables, is the sum of expenditures from households, non-profits and institutions serving households (NPISH), central and local governments, and gross capital formation. The latter is composed of gross fixed capital formation (GFCF), changes in valuables, and inventories.

NI household expenditure was extracted from the UK SUT at the COICOP level of detail. First, detailed household expenditure<sup>30</sup> was averaged across the years 2007-2011 and divided by the same expenditure at the UK level to yield a regional expenditure factor. Second, a concordance was derived to match the factor for expenditure categories in the survey with COICOP expenditure categories in the UK SUT. Finally, the average number of households in NI across the same period was used to extract NI expenditure from the UK SUT and the resulting numbers were adjusted by the regional expenditure factor.

NPISH and government expenditures were extracted from the national level using regional shares derived in the *Net Fiscal Balance Reports* (NFBR).<sup>31</sup> The expenditure calculation was a ratio of NI to UK *total managed expenditure* that included accounting adjustments but excluded North Sea oil revenues.

NI Inventories were extracted from the national level SUT using ABI information on beginning and year end differences of total stocks and works in progress, relative to GVA. The same survey was used to assess net capital expenditure relative to GVA. This total was applied to the by-sector distribution of GFCF at the national level to arrive at NI's GFCF. Finally, changes in net valuables relative to household expenditure at the national level determined changes in net valuables at the regional level. This completed both the extraction of the NI SUT and the regionalization of the ROI SUT. It is important to note that both of these SUT tables are highly dependent on, and congruent with, statistics published by both the ONS in the UK and the CSO in Ireland.

## SAMs

Social accounting matrices track base-year data expenditures and incomes by account. Expenditures are paid from columns to row. Neoclassical assumptions force market clearance so that row totals balance with column totals. Though all net flows between the economy and external economies for the period are accounted for, not all gross flows necessarily are. This is the case with central bank open market operations and government debt issuances. Furthermore, flows need not be disaggregated, as with the macro SAM presented below; however, higher levels of disaggregation, into a micro-SAM, can reveal important economic information.

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<sup>30</sup> "Detailed Household Expenditure by UK Countries and Regions" ONS Family Spending Survey, 2011.

<sup>31</sup> <http://www.dfpni.gov.uk/northern-ireland-net-fiscal-balance-report>

Figure 2. *Basic Structure of a SAM*

Basic structure of a SAM									
Expenditure columns									
	Activities C1	Commodities C2	Factors C3	Households C4	Government C5	Savings and investment C6	Rest of world C7	Total	
Income rows	Activities R1		Domestic supply					Activity income	
	Commodities R2	Intermediate demand			Consumption spending (C)	Recurrent spending (G)	Investment demand (I)	Export earnings (E)	Total demand
	Factors R3	Value-added						Total factor income	
	Households R4			Factor payments to households		Social transfers		Foreign remittances	Total household income
	Government R5		Sales taxes and import tariffs		Direct taxes			Foreign grants and loans	Government income
	Savings and investment R6				Private savings	Fiscal surplus		Current account balance	Total savings
	Rest of world R7		Import payments (M)						Foreign exchange outflow
	Total	Gross output	Total supply	Total factor spending	Total household spending	Government expenditure	Total investment spending	Foreign exchange inflow	

\*Source: "Social Accounting Matrices and Multiplier Analysis. An Introduction with Exercises."<sup>32</sup>

Our SAMs were structured at the macro-level much like the SAM presented above, only with the addition of enterprise and tax accounts, and higher levels of disaggregation. Below the rows and columns in our SAMs, with matching accounts.

<sup>32</sup> Breisinger, Thomas, Thurlow (2010), IFPRI.

Table 4. *Row and Column Accounts for Irish SAMs*

ROW NO.	COLUMN NO.	ACCOUNT
R1-R58	C1-C58	Activities
R59-R116	C59-C116	Commodities
R117	C117	Employee compensation costs and payroll remittances
R118	C118	Gross profits, including depreciation
R119	C119	Aggregate households and NPISH
R120	C120	Municipal and Central Government
R121	C121	Domestic based enterprises
R122-R124	C122-C124	Direct Tax, Indirect Tax and Customs Revenue
R125-R126	C125-C126	Trade, transport and distribution on domestic and
R127-R128	C127-C128	Savings/Investment and Inventories
R129-R133	C129-C133	External Regions

Cross-sections from these row and column numbers can be matched directly with values from the SUTs. For example, cells (R1-R58, C59-C116) represent marketed output at basic prices, or payments from the commodities accounts to activities accounts, which correspond with the transposition of the industrial supply side of the SUT. Similarly, cells (R59-R116, C1-C58) represent intermediate consumption, sourced directly from the industrial demand side of the SUT.

Data not given in the SUTs were compiled with hybrid methods and entered into the SAMs before they were balanced. These constitute internal transfers between institutions, investment and factor accounts, and non-trade components of the current account balance. Described here then, with reference to the rows and columns, are the procedures used to compile the non-SUT portions of the SAMs.

## **NI Non-SUT SAM Values**

### **NI Taxes**

While indirect taxes less subsidies, paid to the tax accounts by activities, commodities, and tariffs, were taken directly from the SUTs, direct taxes paid by enterprises and households were sourced from an ONS publication, *Regional Gross Disposable Household Income by Component at Current Prices* (GDHI). (R122, C119), taxes paid by households, were set equal to the sum of household tax and total remittance contributions paid, both source from the GDHI, less those paid to government by enterprises, derived as a share of the published UK total with a relative GVA factor. (R122, C121), enterprise direct taxes paid, were set to the sum of corporate taxes, capital gains and business rates. Corporate taxes paid by enterprises were a scaled down version of those from the UK level, capital gains were apportioned between enterprises and

households using turnover ratios from a small and medium size enterprise survey,<sup>33</sup> and business rates were taken as a component of the NFBR. Three cells in the NI SAM cover taxes paid from the tax account to government revenues. (R120, C122), income tax receipts from households and enterprises, (R120, C123), indirect tax receipts, and (R120, C124) tariff tax receipts. The complete NI tax data compilation is consistent with the ONS GDHI publication and the NFBR.<sup>34</sup>

### **NI Households and NPISH (HHO)**

NI HHO employee compensation income, cell (R119, C117), was taken directly from the GDHI, as was (R119, C118), NI HHO capital income, the sum of property incomes and operating surplus and mixed incomes received.

HHO income from government, (R119, C120), was set to total contributions received in the GDHI, less those received from enterprises. HHO income from enterprises, (R119, C121), was set to contributions paid by enterprises, calculated as a GVA share of UK enterprise contributions. The final HHO cell (R119, C119), transfers between households, was positive in the GDHI matrix, but set to zero in the SAM, as SAM payments to and from the same account are illegal in the model.

HHO payments not paid to tax accounts (covered above) were taken as GDHI total transfers paid, comprising those paid to enterprises, taken as a share of UK level net-non life insurance premiums paid, and the remainder, submitted to government.

### **NI Government**

Non-tax government income or capital, (R120, C118), and household non-tax remittances, (R120, C119),<sup>35</sup> were also taken from GDHI publications. NI Government transfers paid are covered above and below.

### **NI Enterprises**

(R121, C118) and (R121, C120), enterprise capital income (corporate profits) and insurance premiums and transfers in kind from government to enterprises, respectively, were scaled down from the national level with regional shares of financial and non-financial GVA.<sup>36</sup> These, plus transfers received from HHO, described above, comprise total domestic enterprise income.

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<sup>33</sup> "SME Statistics for the UK and Regions 2009", UK GOV national archives.

<sup>34</sup> Where there were discrepancies between the NFBR and the GDHI, the GDHI data was used; for example, direct taxes paid from households of 3027 or 3275 million GBP, respectively.

<sup>35</sup> Social contributions, social benefits and other social transfers.

<sup>36</sup> But not subsidies, which were netted from tax receipts.

## NI Public and Private Savings

The remaining cells of the domestic transfers matrix, (R127, C119-C121), comprising private and public savings, are derived in the private case as column remainders and in the public case (government savings) as the capital portion of NI government total services expenditure, less the local and central government capital consumption component of the accounting adjustment, as presented in the NFBRs.

## NI Current and Capital Account

Imports and exports in both SAMs, prior to final balancing, cells (R129-R133, C59-C116) and (R59-R116, C129-C133), respectively, correspond with values from the SUTs. The other components of the current and capital account (the external balance) are detailed here.

## NI External Labour Flows

NI wages remitted from abroad, cells (R117, C129-C133), were modelled as a share of Eurostat published UK compensation credits, using employment share calculations. To disaggregate these values into regions, two information sources were combined, *ONS Travel Trends 2009* and *NI Transport Statistics Chapter 7*.<sup>37</sup> The process assumes correlation between travel to and from destinations and wages paid to and remitted from those destinations. This level of assumption is comparable with balance of payments compilation procedures.<sup>38</sup> A similar process was followed to arrive at wages paid abroad, cells (R129-R133, C117). NI's share of UK level compensation payments were disaggregated into regions using the *ONS Travel Trends 2009* study,<sup>39</sup> the NI-ROI values were adjusted for the *ONS Travel to Work* study,<sup>40</sup> and the final distribution was scaled to account for market clearance.

## NI External Capital

Gross profits received from abroad and paid to abroad, cells (R118, C129-C133) and (R129-R133, C118), respectively, were derived through a proxy data model. Property income use/resource data,<sup>41</sup> tracking magnitude of capital flows between the UK and ROW, were scaled down, using NI financial sector output relative the national level, to arrive at total NI external capital flows in both directions less NI-UK flows. The distribution of flows between the UK and ROW was taken from the IMF Coordinated Profile Investment Survey (CPIS) and applied to the NI share of UK flows. Because the CPIS included flows between the UK and the British Isles

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<sup>37</sup> [http://www.drdni.gov.uk/index/statistics/stats-categories/ni\\_transport\\_statistics.htm](http://www.drdni.gov.uk/index/statistics/stats-categories/ni_transport_statistics.htm)

<sup>38</sup> <http://www.imf.org/external/pubs/ft/bop/2014/pdf/guide.pdf>

<sup>39</sup> <http://www.ons.gov.uk/ons/rel/ott/travel-trends/2009/travel-trends---2009.pdf>

<sup>40</sup> <http://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/other/travel-to-work-areas/index.html>

<sup>41</sup> Interest, distributed income of corporations, reinvested earnings on direct foreign investment, and property incomes attributed to insurance policy holders.

(Guernsey, Jersey, Isle of Man), it was possible to weight NI's financial sector relative those in the British Isles and proxy UK-NI flows. There was, however, the problem of flow direction, which we solved with a reversal of uses and resources after scaling. The intuition is that London's financial sector borrows from ROW, paying more interest than it receives from ROW, and then buys ROW, receiving more dividends from ROW than it pays. We propose this function works in the reverse in NI. A similar model was applied to apportion capital flows between NI and the ROI completing the external capital approximation and distribution.

### **NI External Consumption Expenditure**

NI Foreign domestic consumption, cells (R119, C129-C133), were derived firstly by apportioning UK inward expenditure by region using the average of 2008 – 2011 regional expenditure data from the ONS *Demand Side of Tourism* report. This external expenditure in NI was disaggregated into non-UK regions using inbound visitor statistics from *Visit Britain*.<sup>42</sup> GB's expenditure in NI was sourced from the same publication. NI domestic expenditures abroad, cells (R129-R133, C119), were modelled as a share of UK outward expenditure using ONS *Travel Trends 2009* data. Again spending from NI in GB was estimated using *Visit Britain's UK Tourist Statistics 2009*.<sup>43</sup> It should be noted these expenditures don't account for military or diplomatic non-procurement consumption (personnel).

### **NI External Government Transfers**

NI pays no government transfers abroad in the data or the model. Government transfers received from abroad, cells (R120, C129-C133), were determined endogenously in the SAM. Income and expenditures were fixed at determined levels (see above), while savings were originally fixed at zero, leaving the transfer to balance the account. The intuition was that NI budget shortfalls are funded by transfers by the British Public Finance System, and that there was therefore no deficit. The challenge was that the shortfall was much lower in the model than in the NFBRs. While this lower deficit supports arguments that NI revenues are under-represented in the NFBRs, and that at least for some departments 'identifiable' expenditures are not always 'identified,' in that they are not necessarily expended in NI,<sup>44</sup> it doesn't account for an NI government funding model where market driven deficit funding doesn't crowd out investment. To account for this, we included the capital portion of total services expenditure, from the pro-rated NFBRs, less the central and local government depreciation on capital component of the accounting adjustment in the government savings and investment column and the fiscal transfer. The result is an endogenously determined 2009 fiscal transfer from GB of 4.9 billion GBP, cell (R120, C129). This is less than the 6.52 billion GBP determined through prorating the identifiable net fiscal balance from the NFBRs, but more than the 3.17 billion GBP originally determined in the SAM through market clearance.

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<sup>42</sup> <http://www.visitbritain.org/insightsandstatistics/inboundvisitorstatistics/latestdata/>

<sup>43</sup> [http://www.visitbritain.org/Images/UK%20Tourist%202009\\_tcm139-191452.pdf](http://www.visitbritain.org/Images/UK%20Tourist%202009_tcm139-191452.pdf)

<sup>44</sup> "A Commentary on Economic Data in Northern Ireland"

## **NI External Enterprise Transfers**

Enterprise transfers received from and paid to abroad, cells (R121, C129-C133) and (R120, C129-C133), respectively, were scaled down from the UK level resource and use publications using relative financial and non-financial sector gross operating surplus and mixed income. These transfers primarily comprise net non-life insurance premiums, total other current transfers, and social contributions and benefits not included in external employee compensation transfers.

## **NI Net Borrowing from Abroad**

Cells (R127, C129-C133), in both the SAMs, constitute net borrowing from abroad, or net residual capital flows. These are the residuals of the foreign region columns that ensure the columns balance with the rows. A negative value indicates capital inflows exceed outflows resulting in regional current account surplus, or lending abroad. Such a surplus could materialize financially as claims against foreign regions in the form of accumulated holdings of foreign currencies or foreign debt. A positive value indicates a regional current account deficit.

## **ROI Non-SUT SAM Values**

### **ROI Taxes**

As with the NI SUT, indirect taxes in the ROI SAM were reconciled with exchequer statements. Indirect activity taxes, given by sector in the ROI SUT, were subtracted from exchequer statement totals, as were exchequer tariff totals, the remaining commodity taxes were allocated among commodity sectors according to the SUT distribution. Tariff revenues were allocated by sector in accordance with the 2005 SAM.<sup>45</sup>

(R122, C119), direct taxes paid by HHO, were sourced from the secondary distribution of income accounts, in the CSO StatBank,<sup>46</sup> and were taken as a combination of current taxes on income and wealth and a share of social contributions paid by households. The other share of social contributions paid by HHO was allocated to enterprises, based on enterprise social contributions received in the same sector accounts.<sup>47</sup> (R122, C120), direct taxes paid by enterprises (corporate tax), was taken as total direct taxes received in exchequer statements, less those paid from HHO.<sup>48</sup>

## **ROI Households and NPISH (HHO)**

ROI HHO employee compensation income, cell (R119, C117), was sourced from CSO allocation of primary income account data, as was gross operating surplus and mixed income, (R119,

<sup>45</sup> "A 2005 Social Accounting Matrix (SAM) for Ireland," Miller, Matthews, Donnellan, O'Donoghue (2005).

<sup>46</sup> CSO StatBank: Quarterly Accounts by Current Account, Institutional Sector, Uses and Resources.

<sup>47</sup> Enterprise data are the sum of quarterly financial and non-financial accounts for the year 2009 before balancing.

<sup>48</sup> Quarterly institutional sector enterprises taxes paid would have also worked as it is almost exactly the same.

C118), which includes net property income. Social contributions received by HHO from government, (R119, C120), were taken before balancing from allocation of secondary income data. The three sources for this cell, government expenditure data from the exchequer and from the StatBank sector accounts, as well as HHO income from the StatBank sector accounts, were each different, but within a narrow range. The same sources were applied to HHO income from enterprises, (R119, C121), other current transfers (with an adjustment for net equity). Domestic transfers paid by HHO, (R119, C119) and (R121, C119), or those paid to other HHO and to enterprises, respectively, sum to HHO allocation of secondary income, other current transfers, as reported in the CSO StatBank data. The HHO to HHO portion (not used in the model) was scaled up from the 2005 SAM, and the remainder of domestic transfer paid to HHO were allocated to enterprises.

### **ROI Government**

(R120, C118), government operating surplus, was sourced directly from government quarterly CSO institutional sector data. Enterprise transfers to government, (R120, C121), were taken as the remainder of the enterprise domestic transfers matrix. (R120, C123), indirect tax revenue,<sup>49</sup> and (R120, C124), import tariff revenue, sum to allocation of primary income account indirect tax revenue. Government expenditure that is not covered above, namely (R121, C120), or transfers from government to enterprises, is again derived in the enterprise domestic transfers matrix.

### **ROI Enterprises**

(R121, C118), enterprise gross operating surplus, was set to sum of financial and non-financial surpluses, as reported in allocation of income institutional sector data, less the HHO operating surplus, representing non-corporate business (including entrepreneurial and small business profit). Other domestic enterprise income and expenses have been covered.

### **ROI Private and Public Savings**

The remaining cells of the domestic transfers matrix, (R127, C119-C121), comprising private and public savings, were each derived as column remainders. Though these three numbers are not exactly the same as any published numbers, the sum of all three is approximately the gross total domestic physical capital formation reported in National Income and Expenditure (NIE) tables (2012).<sup>50</sup> Moreover, the sum of enterprise financial and non-financial savings, from the StatBank data, is quite close to the SAM value for enterprise savings, and the StatBank reported government deficit is also close to the SAM value. While private savings is larger by almost half the nearest published number, it is important to remember the NIE numbers don't disaggregate

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<sup>49</sup> This cell is net of indirect subsidies.

<sup>50</sup> As it should be.

the net national savings provision for depreciation, an important component of gross total available for investment in domestic physical capital formation.

### **ROI Current and Capital Account**

Imports and exports in both SAMs, prior to final balancing, cells (R129-R133, C59-C116) and (R59-R116, C129-C133), respectively, correspond with values from the SUTs. The other components of the current and capital account (the external balance) are detailed here.

### **ROI External Labour Flows**

ROI wages remitted from and paid to abroad, cells (R117, C129-C133) and (R129-R133, C117), respectively, were modelled by disaggregating CSO data into regions. Firstly, ROI-UK costs were apportioned using Eurostat data. These data were adjusted for NI-ROI totals derived above. Next, the ratios of ROW external compensation costs relative total external compensation costs were taken from the 2005 SAM and applied to the total. Finally, the remaining regional values, sourced from Eurostat, were sorted and queried to arrive at the complete regional disaggregation.

### **ROI External Capital Flows**

Gross profits received from abroad and paid to abroad, cells (R118, C129-C133) and (R129-R133, C118), respectively, were sourced from CSO StatBank data. They were apportioned by region using the sorted and queried CPIS distribution. The balance of domestic owned foreign assets by each region for the preceding year was compared and the earnings on those assets applied to each region proportionately. The same procedure was followed to disaggregate credits (liabilities) by region.

### **ROI External Consumption Expenditure**

ROI Foreign domestic consumption and domestic consumption abroad, cells (R119, C129-C133) and (C129-C133, R119), respectively, were again given in CSO National Income Expenditure accounts.<sup>51</sup> Their disaggregation was similar to the NI case. Travel survey data were used to arrive at the share of travel to and from main regions, while ratios of expenditures in and from non-published regions were derived through the compilation of flight statistic data bases.<sup>52</sup> Again, this method is similar to methods used in balance of payment statistics compilation at both the national and international levels.

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<sup>51</sup> Tables 13 & 13.1, NIE1995-2012

<sup>52</sup> CSO Household Travel Survey, outbound flight data from:

<http://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=ctm01> , and inbound flight data from:

[http://www.dublinport.ie/fileadmin/user\\_upload/documents/Tourism\\_prospects\\_report.pdf](http://www.dublinport.ie/fileadmin/user_upload/documents/Tourism_prospects_report.pdf), as well as the UK International Passenger Survey.

## **ROI External Government Transfers**

Government transfers received from and paid to abroad, cells (R120, C129-C133) and (C120, R129-R133), were comprised of current taxes on income and wealth paid and received, as given in CSO StatBank ROW sector account, and a portion of the other current transfers found in the same. This latter portion was partitioned from the external enterprise transfers, described below, to incorporate other current government transfer values from another CSO StatBank publication.<sup>53</sup> Information in the latter statistical series, except for other current transfers and social insurance payments to the rest of the world, both given as net values, were incorporated in the residual net capital flow, or foreign domestic borrowing. This means, in particular, the bulk of central bank market operations, like interest on government debt paid and received, are not allocated to the government account but integrated in the net capital flows.

## **ROI External Enterprise Transfers**

Enterprise transfers received from and paid to abroad, cells (R121, C129-C133) and (R120, C129-C133), respectively, were sourced, before the above partitioning, from CSO StatBank ROW sector accounts, other current transfers.

## **ROI Net Borrowing from Abroad**

Cells (R127, C129-C133), net borrowing from abroad or net capital flows, were derived as the residuals of the foreign region columns that ensure the columns balance with the rows. A negative value indicates capital inflows exceeded outflows resulting in a regional current account surplus, or lending abroad. Such a surplus could materialize financially as claims against foreign regions in the form of accumulated holdings of foreign currencies or foreign debt. A positive value indicates a regional current account deficit.

## **Balancing the SAMs**

A series of procedures were applied to balance the SAMs. As with the balancing of the SUTs, we were able to avoid iterative proportional fitting methods, like the RAS method,<sup>54</sup> by using a manual adjustment process that incorporates known information so “balancing adjustments are made as much as possible to data items with the least robust data source.”<sup>55</sup> These procedures included some treatments to accommodate model rules. For example, in CGE models negative entries frequently pose problems; in some cases it was necessary to move those entries from rows to columns and reverse their signs. Adjustments were also made in cases where exports were higher than domestic production, as the model does not directly

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<sup>53</sup> Central and Local Government - Transfer Payments, National Debt. T24

<sup>54</sup> For a detailed look at the RAS procedure, or the cross-entropy estimation procedure used in the IFPRI model see TMD discussion paper NO. 33, Robinson et. al (1998) IFPRI.

<sup>55</sup> “Input-Output Methodology Guide”, Scottish Government, 2011.

account for the simultaneous import and export of products. Finally, there was a final balancing procedure to ensure the SAMs were balanced to the precise number of significant digits. This completed, in general, the data side of the project.

We next describe, though without detailed mathematical exposition, some theoretical limitations to the CGE framework that can aid interpretation of model results, followed by a brief non-technical description of our model.

### **III CGE and NIROI**

Though we have selected CGE as the optimal econometric economy-wide modeling framework for this project, as with all econometric models, CGE has limitations. First, it uses optimization mathematics to model the aggregate effects of agent level decisions subject to macroeconomic constraints; but, in its static form, the dynamic scope of those decisions are limited because agent decision making is restricted to myopic expectations and excludes rational and adaptive expectations. This means though producers seek to minimize costs or maximize profits and consumers to minimize expenses or maximize utility, they do so without inter-temporal selections between consumption and production in current or future periods.

Second, the strict accounting rules that apply to data sets used in CGEs apply also to the equations simulating economic flows, such that constant economy of scale assumptions are forced on the supply side, all markets clear and all agents operate in a perfectly competitive environment.<sup>56</sup> Thus productivity in the model occurs when returns to scale are constant, which does not account exactly for rapidly developing infant industries or those in decline.

Third, while CGE is apt at simulating changes in prices and quantities of products, it does so in real terms so that there are no mechanisms for modeling changes in nominal variables that prompt real effects, like changes in money supply that can lead to real economic changes. This means there is no modeling of quantitative easing, or its absence. Moreover, though there is room in the theoretical framework for changes in consumer preferences, they are not frequently applied because preference changes are not easily substantiated empirically. This means representative consumers with increasing income will not change the share of that income spent on a particular good. It also means changes in by-sector output, as a result of price changes, are not met with commensurate changes in by-sector investment.

Finally, CGE does not account in any way for non-economic political or social forces. As a consequence, CGE results should be interpreted strictly in the economic sense.

And yet, CGE modeling has become a workhorse for empirical studies. In light of this large body of limitations, the question naturally arises, why use CGE at all? The short answer: CGE works. More specifically, CGE works best suited to quantifying the effects of a variety of policy changes on output, trade flows, changes in current accounts balances, changes in various aspects of government budgeting, and changes in factor supply and demand, subject to the quality of data inputted, scenario design and the selection of assumptions. Over the last twenty

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<sup>56</sup> Homogeneity is enforced on the model.

years, both economic theory and modeling techniques have gone through repeated cycles of rigorous testing, refinement and rigorous testing again, and thus it is no surprise CGE models have become a standard part of the economists toolbox, used to inform practitioners of all kinds about potential implications of particular policy actions. Our Irish unification model shares all the general advantages and restrictions found in contemporary state-of-the-art modeling procedures.

In addition to this virtue, CGE offers surprising flexibility. For example, the static solution process can be appended into a recursive dynamic process that strengthens its dynamic scope. This latter development, in conjunction with calibration procedures that capture relationships in the data, lends itself quite readily to situations where time-series data are unavailable. Further to the point, because the model is used to contrast a number of distinct scenario results with benchmark results, model short-comings are present on both sides of the analysis excellently isolating effects on indicators from policy changes, *ceteris paribus*. And then there are external economies of scale for developers. The rapid and continued rise in CGE use has left behind a large body of accumulated publically available modeling resources that drastically lower the cost of developing models for specific regions or policies.

This leads us in accord with the literature to the conclusion that CGE is a highly valuable and reliable tool for interpreting the economic effects of a variety of policy changes.

## **The NIROI Model**

The NIROI computable general equilibrium model used in this study is based on the famous IFPRI model.<sup>57</sup> A key feature of the standard model is its flexibility, which permits the analyst to capture country-specific aspects of economic structure and functioning. The basic model contains different rules for treatment of relations between exchange rates and the current account, the treatment of the government deficit, the savings of the households, and the labor market. Depending on the scenario and the actual policy in a country, these rules can be adjusted accordingly. For example, the government deficit can be balanced by adjusting taxes, transfers, or government savings.

To build the NIROI model, the IFPRI model was extended to a multi-regional case, comprising NI and the ROI. Exports, imports and other current account components were differentiated according to their origin and destination from and to both countries, as well as from and to: Great Britain (GB), the rest of the Eurozone, other than the ROI (REUZ), the rest of the EU, other than the Eurozone, GB and ROI (REU), and the rest of the world (ROW). Until now only one study has extended the IFPRI model in this direction.<sup>58</sup>

The second important improvement over the basic IFPRI model is the temporal resolution in the NIROI model. Instead of a static framework, we use a recursive dynamic framework, in which the model is solved forward for consecutive years from 2015 to 2025. This means that

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<sup>57</sup> For a detailed description of the IFPRI model see: "A Standard Computational General Equilibrium (CGE) Model in GAMS," Lofgren, Harris and Robinson (2002).

<sup>58</sup> See Noland et al. (2000), "Modeling Korean Unification."

some of the exogenous variables are changed over time using transition equations. Capital stock, for example, is updated endogenously given previous investment and depreciation. The updated values are used for solving the next year equilibrium. Other updated variables are the population, factor productivity, export and import prices and transfers. Once again, this extension can only be found in working papers.<sup>59</sup> A further important feature of the model is the transfers between the governments and the households. These transfers are not fixed but depend on the deficits and the population. This allows a more realistic modeling of actual policies in both countries.

To our knowledge, the NIROI model is the first state-of-the-art, data intensive, recursive dynamic model that has been applied to a unification of Northern and Southern Ireland scenario. No other model has been customized specifically to simulate the unique situation in NI where the local government deficit is not funded with debt issuances, by the usual market mechanism, but by transfers within the British public finance system. Additionally, NIROI includes the linkage of such transfers in a way that makes it to an endogenous variable (rather than to an exogenous as in IFPRI). This feature thus allows for growth-induced adjustments without making it necessary to introduce ad hoc-assumptions. Also, in the NIROI model, the small-country assumption is applied between both-island regions and off-island regions while the large country assumption is applied between island regions.<sup>60</sup> In other words, both regions are treated as small countries in regards to other entities; ROI is then treated as a large country in regards to NI. This customization accommodates more accurately for geographical proximity between island regions and resulting price sensitivities.

NIROI follows the production and consumptions layouts given in the IFPRI model albeit with a few changes. At the top of the chain, producers maximize profits with a constant elasticity of substitution technology to arrive at activity output, disaggregated into 54 sectors.<sup>61</sup> The elasticity substituting value for intermediate consumption is constant and near to 1, reflecting the relatively constant proportions of value added and intermediate consumption typically found in empirical production analysis. The mix of value-added also follows a CES structure, enabling the substitution of labor for capital, though this substitution also is relatively inelastic.<sup>62</sup> Just as in the IFPR model, and in the SAMs developed for model use, off-diagonal or secondary output follows constant distributions over time according to fixed yields. Marketed activity output, in prices and quantities (PXAC and QXAC, in the diagram below), are combined and distributed into exports and domestic sales (QE/PE and QD/PDS-PDD). Unlike in the supply of imports, exports are supplied without distributions costs, which are born by importers and third party transportation providers. Domestic sales are imperfectly substituted with imports into a composite commodity (QQ/PQ) that is distributed to the domestic market

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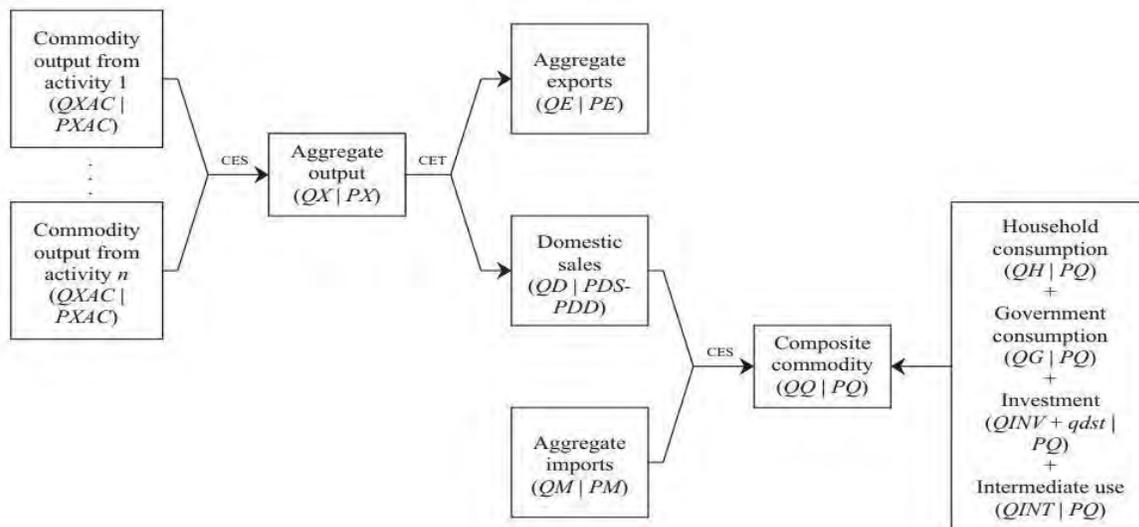
<sup>59</sup> Morley et al. (2011), "A Dynamic Computable General Equilibrium Model with Working Capital for Honduras."

<sup>60</sup> ROI and NI.

<sup>61</sup> For a description of industrial sector disaggregation see appendix.

<sup>62</sup> Limited data availability in NI prompt the restriction to one type of labour and one type of capital. As such there was no need to customize IFPRI for substitution among various levels of labour and various levels of capital (as in the PEP model).

Figure 3. *Commodity Flows in NIROI*



\*Source: Lofgren, Harris and Robinson (2002).

On the demand side, while the share of composite good consumption is constant across the set of absorbing entities, it varies across industrial sectors according to price-levels.<sup>63</sup> The supply of imported commodities is selected based on regional distributions subject to regional elasticities and regional distribution costs. While consumers optimize utility according to a Cobb-Douglas function, the government consumption path is exogenously determined. The government consumption product mix is not price dependent but fixed coefficient dependent. Exogenous final values of investment are linked neo-classically in a one to one proportion with endogenous savings levels, while by-sector investment follows again a fixed-coefficient distribution.

Transfers in both data and code (not shown in the diagram) are modeled slightly differently than in the IFPRI model. There are relatively large transfers from households to governments, especially in NI, consisting of remittances from home-based small business units, which are relatively large in the data. Government transfers to households and enterprises are standard, but there are no transfers between households and the ROW sectors. In the code, these transfers represent foreign domestic expenditures and domestic expenditures abroad, consequently bypassing institutional income but not private consumption.

NIROI's factor transfers paid abroad from island regions are endogenously tied to domestic factor demand and wages in a linear formulation. Similarly, factor transfers received from abroad are tied to factor supply, which in the case of labour's growth with population, while in

<sup>63</sup> Absorption is fixed, intermediate consumption is substituted with value added by CES.

the case of capital accumulates recursively according to an internal rate of return.<sup>64</sup> Domestic consumption abroad and foreign domestic consumption follow an exogenously determined growth path, along with external enterprise transfers and, in the ROI case, external government transfers.

NI transfers from within the British Public Finance System are set equal to the short fall between government revenue and government expenditure, where government expenditure includes a portion of capital expenditure that in the model code is included in the savings/investment balance.<sup>65</sup> This is a departure from the usual CGE practice of allowing the government deficit to crowd out private investment by negatively impacting the savings/investment balance. We apply it only to the NI case, because the NI deficit is completely funded with fiscal transfers from the UK, and our unification scenarios do not include the possibility of NI funding their own deficit. As a consequence, in spite of the NI government deficit, NI government capital formulation continues at a modest but consistent rate, in-line with the historical results reported in the NFBR literature.<sup>66</sup>

There are several tax categories in the NIROI model that are solved for in the base year and remain exogenous throughout model simulations. Income taxes are deducted from institutional incomes prior to expenditure calculations and directed to the government revenue function. Consumption taxes and other levies constitute commodity taxes, which are inclusive in composite commodity prices but combine with other tax revenues and transfers to arrive at government income. Net activity taxes, which are added to employee compensation costs and gross profits to arrive at gross value added, and import taxes (tariffs), which combine with import distributions costs to form part of import prices, are also components of government revenue.

The NIROI savings and investment balance formulation is consistent with the IFPRI model, in that it works in conjunction with the functions for the government balance and the current account balance to ensure the slack variable is equal to zero.<sup>67</sup> However, a separate equation for enterprise savings has been introduced, and the endogeneity of the government savings variable is partitioned into exogeneity for the NI region (as discussed above) and endogeneity for the ROI region. The entire expenditure on net investment is funded from the savings/investment balance.<sup>68</sup>

Model closure ensures proper identification of model variables. In NIROI's external balance the endogenous variable is foreign savings while the exchange rate is exogenously fixed at base year valuations, until changes in the scenario are introduced. In the government balance, another component of model closure, government expenditure is exogenously determined, tax rates are fixed, and government savings, as mentioned above, are partitioned by region. In the savings/investment closure, both government and investment expenditure are fixed, while government and investment shares of absorption are left to adjust to ensure the model solves.

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<sup>64</sup> The rate of return here is not derived from forward profits discounted to net present values, but rather from the ratio of new capital to prior period capital less depreciation.

<sup>65</sup> In the base year the portion of expenditure that is capital expenditure is taken from "NI Net Fiscal Balance Reports."

<sup>66</sup> Northern Ireland Net Fiscal Balance Report 08/09, 09/10, 10/11. DFPNI Government of United Kingdom.

<sup>67</sup> All markets in the model clear.

<sup>68</sup> Gross fixed capital formation plus net changes in valuables less inventories.

In NIROI's factor market closure, an economy wide wage adjusts to ensure factor market demand and factor market supply are equated, while a sector specific wage-distortion term remains constant. As mentioned above, the quantity of factors supplied is exogenously determined.

NIROI's labour supply follows a growth path commensurate with population growth rates taken from historically reported population data points. Its capital supply accumulates periodically in accordance with an interest rate derived at the end of each period.<sup>69</sup> This means the capital supply allocated in each period is the product of a constant depreciation rate and the accumulation of capital in the prior period. The quantities of capital demanded are endogenously derived. We next briefly comment on base year selection, then introduce some theoretical and technical aspects of our model scenario components.

### **Base Year**

CGE models are characterized by a calibration process that enables comparative scenario simulation without extensive time-series data. The model is parameterized to a base-year data set and this parameter structure is maintained and altered subject to scenario design. If there are options in terms of data availability, often the case at the national level where SUT data are published more frequently, a base year coinciding with a neutral phase of the business cycle should be selected. In our case, data compilation began in the third quarter of 2013, while the 2010 SUT for the ROI was not published until the first quarter of 2014. Our base year selections were then limited to 2009 and 2005, from which we selected the more recent year 2009.

### **IV Scenarios: Component Analysis and Relative Benchmarks for ROI and NI**

Broadly speaking, in our scenarios, the all-encompassing policy of economic unification between NI and the ROI, means simply that NI leaves the economic, monetary and legal space of the UK and joins the ROI. NI would consequently have to give up the British Pound as legal tender and, as a part of a unified Ireland, adopt the EU's common currency and its regulations. Monetary policy, in all its forms, would be decided by the European Central Bank (ECB), rather than in London. This can be described as a move from a small currency space to a relatively large one. Size of course is no guarantee for exchange rate stability, but a larger currency space offers small members better safeguards than a smaller currency space.

It is also evident that size plays a critical economic role in regards to NI and ROI. Even though in an international comparative perspective both regions should be labeled as small economies, in the relative case, by the data on labour productivity and capital stock, NI is a small economy and ROI a large one. The merger of units that differ in economic development offers the weaker unit potential for catch-up, mainly due to modernization effects. The process of catch up is most readily conceptualized in the context of shifts along the production possibilities frontier from lower value-added industry output to higher value-added industry output. It seems fair to

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<sup>69</sup> Population data are from CSO and ONS publications.

assume that that unification facilitates harmonization and integration across the island. For example, even though NI in its current state is part of the European Common Market (ECM), the ECM from the perspective of a united Ireland potentially offers NI more attractive opportunities, as it now would operate in a competitive growth supportive tax environment under a common legal and currency framework.

The challenge, in terms of modeling, however, is how to represent these benefits (and costs) within the model's math and data structures. In the CGE format, this is done through a variety of potential model closures that work in conjunction with other economic tools and projections to yield valuable insights into the effects of changes in economic interdependencies.

Technically speaking, then, unification, expressed in model mechanisms, means 1) tax harmonization across the island of Ireland 2) benefits of a unified access to the common market, modeled through reductions in import transaction costs, 3) the costs or benefits of political unification, 4) the fixing or sharing of a currency, and 5) the impact from all of the above on returns to production inputs and increases in factor and goods market integration that lead to GDP enhancing efficiency gains. NIROI processes these policy changes into measurable outputs by linking recursive dynamic solutions along a benchmark path and comparing them to solutions from so-called counterfactual paths. The benchmark path is described next.

## The Benchmark

The benchmark or baseline scenario is a constant growth rate recursive dynamic forecast of the economies of NI and the ROI. It runs for 12 years from 2014 to 2025. Annual growth rates for exogenous transfers, government consumption, and investment in NI and the ROI are set to a long-run trend of 1.5% and 3%, respectively. It should be re-emphasized that neither the benchmark scenario nor the individual scenarios are economic forecasts. Rather, they are trending scenarios used comparatively to measure unification effects. This means the same growth rates used in the benchmark are used in the unification scenarios.

Benchmark and model-specific labour supply grow at compound annual growth rates derived from population data for the two regions from 1966 to 2011. The ROI annual population growth rate is 1.05%, while in NI it is 0.45%. Capital in both regions accumulates at a rate derived from an internal-rate of return, a depreciation rate and initial capital stock and investment levels.<sup>70</sup>

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$i_{rt} = ((\delta_r + \eta_{rt}) \cdot K_{rt} - \delta_r \cdot IO_{rt}) / IO_{rt}$ , where  $i_{rt}$  is the annually determined internal rate of return,  $\delta_r$  the regional depreciation rate,  $\eta_{rt}$  the constant annual growth rates  $K_{rt}$  the current capital stock,  $r$  and  $t$  the subscripts for region and year respectively and  $IO_{rt}$  the initial level of capital stock. An annual capital growth rate is set equal to:  
 $(1 - \delta_r) + (i_{rt} \cdot \omega_{krt} \cdot \sum_c QI_{crt}) / QS_{krt}$ , where  $\omega_{krt}$  is the annual economy wide wage rate,  $QI_{crt}$  annual investment level,  $QS_{krt}$  the annual addition of capital stock, and  $k$  the subscript for the capital factor.

## Component Scenarios

The modeled unification policy is compiled of individual scenario components and implemented in a policy year of 2018. Individual scenarios, that combine the components in their entirety and demonstrate the aggregate effects of changes relative the benchmark scenarios, are run from 2018 to 2025. Simulations are also run at the individual counterfactual component level to isolate the effects of each component on economic indicators. The following section details the benchmark process and describes each policy component and how it is linked to model architecture. Relevant model results are then examined.

## Taxes

The abolishment of the Control and Manufactures Act, in the late 50s, and its replacement with an inward investment oriented policy framework, built on a low corporate tax regime, marks the turning point in the economic development of the ROI.<sup>71</sup> Membership in the EU, and then joining the common currency zone, also increased outside investment, because companies saw ROI as an entrance to the European common market.<sup>72</sup> The southern economy has experienced periods of higher inward FDI, diversification among trading partners, and gradual shifts in the incidence of output toward modern higher value added sectors.

Though any actual post-unification tax regime could take a wide-variety of forms, we model the all-island tax regime in such a manner that the north becomes integrated within the current southern system. In the model, production taxes less subsidy rates for each activity sector are determined in the calibration year and remain constant throughout benchmark years. In the unification scenarios, tax rates on the NI side of the model are harmonized with the ROI side of the model. These changes amount to four counterfactual components: the harmonization of 1) activity tax rates, 2) commodity taxes, 3) import taxes and 4) institutional taxes. It is important to note that tax treatment in the model is ad valorem, or proportionate to value, rather than the more complex scaled tax schemes that incorporate fixed rates, base values and exemptions, as one might encounter in typical tax code. Though this treatment does not accommodate tax quotas or legal differences between tax regimes, it is still quite accommodating relative general contemporary modeling methodology.<sup>73</sup>

## Barriers to Trade

As with most aspects of a unification policy, the costs and benefits of reductions in barriers to trade, as a result of a physical removal of a border and the more abstract merger of a political and institutional business environment, are largely intangible and difficult to measure. This is evident from contrasts between early surveys, suggesting there is 'little difficulty with

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<sup>71</sup> See Bradley (2006)

<sup>72</sup> Barry (2014); Campa and Cull (2013).

<sup>73</sup> For a display of NI tax rates compared to ROI tax rates by tax classification and sector see appendix.

distribution' between NI and ROI as a result of the physical border,<sup>74</sup> and later research, highlighting cross-border under-trading:

“For all sectors except Non-Metallic Minerals the parameters for the deviations are found to be negative, indicating that the trade between the two jurisdictions is below that expected, even after controlling for the wide range of variables included in the analysis.”<sup>75</sup>

The contradiction, between physical border barriers, that despite depreciation probably have not slowed distribution any further since the survey was conducted in 2000, and the significant levels of under-trading in 2009, hint at the wide variety of issues affecting cross-border trade. John Bradley and Michael Best express these issues rather succinctly in their division of border related barriers into spatial, sectoral and institutional categories.<sup>76</sup> The first two categories relate to their concepts of ‘peripherality’ and ‘policy fault-lines,’ both of which they claim result in lower border-region populations and their absence of sector specific industrial development. The institutional category is quite vast and highlights not only a lack of incentive and coordination at the institutional level to develop border infrastructure, but also those more frequently discussed barriers to cross-border trade, like disharmonies in documentation procedures, tax rates, legal regimes, and currency related transaction cost impediments.

The challenge again was how to model the effects of a unification policy on these intangible factors. The fact is econometric models are data driven and there are usually little data on intangible factors. Our strategy was to segment cross-border unification effects into transportation costs, productivity improvements and currency related transaction costs, because the SAMs track data on distribution, productivity and international trade. But even such methods are unlikely to capture the network synergies, industrial clusters, and border-region development that should be expected when unification improves spatiality and border-region industrial development, and merges institutions. It should be noted then that our model is likely to underestimate the gains from unification, especially so under the category of barriers to trade. In any case, in the data, imports are distributed through a transportation sector and these costs applied to the margin for each product. To model reductions to barriers in trade arising from border removal we introduce reductions to these costs at the rate of 5% per year after the policy implementation.

## Political Unification

There is no established order between economic and political unification. In the German Unification case, economic unification happened *before* political unification. But, it was clear that this was only a brief delay and latter would follow swiftly. This foresight reduced uncertainty for investors and citizens alike. On the other hand, we know from the European Integration experience that economic unification is not automatically accompanied by political

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<sup>74</sup> *Intertradelreland's* discussion paper, “Cross-Border Trade”, November 2000.

<sup>75</sup> Intertradelreland, “A Gravity Model Approach to Estimating The Expected Volume of North/South Trade,” May 2009.

<sup>76</sup> “Rethinking Regional Renewal: Towards a Cross-Border Economic Development Zone in Ireland.” *Journal of Cross-Border Studies in Ireland*, No. 7, 2012.

unification. As a matter of fact, the creation of the Common Market and then later the provision of a – smaller – currency union happened under conditions with still existing nation-states. Member states in both modes of integration kept their national sovereignty but were willing simultaneously to pool lesser parts of their sovereignty.

Our exercise focuses on economic integration, and thus NIROI assumes no political frictions or political transition costs. This is less the heroic assumption as political transitions costs are not necessarily negative, particularly in the case where economic unification is a democratically legitimized event. Political unification outside of transition, however, is generally understood to be a more efficient form of government. This is evident in theory that supports harmonization of functions of government, like tax collection, legal order, and tax-funded operations of political machinery. The removal of duplicate government services on the island would lead to greater efficiencies, synergies, and economy of scale savings. In NIROI, these are modeled by imposing a 2% annual reduction in NI government expenditures against exogenous government expenditure growth rates.

### **Exchange Rate**

At this point in time, NI and ROI belong to different currency zones and are thus subject to different monetary policy regimes. In our combined scenarios, NI, as a part of an economically unified Ireland, automatically becomes a member of the Eurozone. From a political-legal perspective this situation would be nearly identical to the German unification, when former Eastern Germany first moved to the Deutschmark regime and then – even before political unification was eventually ratified – to the newly established Eurozone. Obviously, such a policy change would not add monetary sovereignty to an economically unified Ireland, as membership in the European Monetary Union (EMU) is by definition a yielding of sovereignty in money affairs to the ECB. However, the long-standing differential between the GBP and the Euro, and the current international monetary trends that see the Euro devaluing relative the Pound, despite the period of low interest rates in the UK that will eventually come to an end, promises NI, under a unified Ireland, a rapid devaluation in currency. Of any region in the UK, NI demonstrates the economic fall-out from an over-valued currency. In economic theory, when a currency cannot be devalued, either the labour market must adjust or fiscal transfer must be adequately supplied and adequately used. It can be argued that NI's labour market is no longer flexible enough to adjust, perhaps because of long-periods of under-employment that creates hysteresis effects. It can also be argued that the quantity of fiscal transfer is not optimal, and more importantly, that it is inadequately spent. From this view, unification promises a monetary policy fix, even if there is no change in sovereignty over local monetary policy.

In addition to currency devaluation, there are other benefits to membership in a large currency union rather than a small one. For example, as the experience of the ROI during the financial crisis from 2008 demonstrates, the EMU has a history of providing liquidity in times of crisis. Also, a change in currency both increases and decreases transaction costs. Cultural ties and evolved integration in supply chain management suggest increases in these costs would be less likely to cause trade diversion between NI and GB. This limits downside risk and means to the

extent the new economic unit integrates with other members of the Eurozone, and those economies whose currencies are tied in some form to the Euro, the advantages of having the Euro as a common currency would be larger.

Technically, exchange rates in the model are fixed and remain at 2009 rates.<sup>77</sup> We assume no changeover costs incurred by Irish banking facilities, as these costs though relevant in the changeover period would be small one-time costs in the long run. Table 5 below shows the 2009 exchange rates used in the model for ROI and NI.

Table 5. *Exchange Rates Used In Model*<sup>78</sup>

	NI (1 GBP)	GB (1 GBP)	ROI (1)	REUZ (1)	REU (1)	ROW (1)
<b>NI (GBP)</b>	1	1	0.8902	0.8902	0.9813	0.6384
<b>ROI (Euro)</b>	1.1233	1.1233	1	1	1.0977	0.7176

### Productivity Improvements

Our model hypothesizes a unified policy framework would be focused industrially on changing the incidence of by-sector output in the North from lower value-added industries to higher value-added industries. This could be done by upgrading the skill-level of the workforce, improving public infrastructure, lowering corporate tax rates, to attract multinational FDI and encourage diversification among trading partners, and the like. Foreign owned firms are more likely to operate in higher value-added sectors, at least when they first arrive, and are far more likely to engage in international trade.<sup>79</sup> Thus policies that attract inward investment are likely to catalyze the necessary shifts along the production possibilities frontier. Policy in the ROI is known to focus on equipping both importers and exporters with skills necessary to engage and prosper in cross-border trading, and it is not only the friendly tax regime that attracts a high-presence of multinationals, but also a supportive overall policy drive. It is this kind of framework that has earned the ROI the highest level of trade-openness among G20 nations,<sup>80</sup> and this kind of policy framework that can be anticipated in NI if it unifies with the ROI and becomes integrated into the island economy.

Technically, modeling the effects on productivity from a merger in political regimes can be done by hypothesizing that the quality of capital improves significantly. While FDI is attached to more volatile capital flows, which can accentuate boom and bust cycles, it is also generally attached to larger businesses with higher market shares, innovation capacity and capital. In the data, this is evident in the higher rate of return the ROI earns on production as measured by outputs over

<sup>77</sup> As insightful as it might be to apply a variety of forward looking forecasts to the region-pair exchange rates, the exercise is left for future research.

<sup>78</sup> USD/GBP is from the Bank of England, USD/Euro is from FRED, Euro/GBP is from the Bank of England. SDR data is from IMF. Exchange rates are annual averages from daily, weekly or monthly data.

<sup>79</sup> Bradley (2006) points out that, "US owned plants are over 17 times larger than indigenous owned plants, over five times as productive, and almost eight times as profitable."

<sup>80</sup> Total trade relative to GDP. OECD trade openness indicators.

inputs. In CGE, this relationship is captured by the production shift co-efficient that represents production technology. Because we assume production technologies across the island are homogenous,<sup>81</sup> the difference in shift parameter values can be seen as a result of a higher quality FDI or a higher incidence of multinationals in business demography.

We run additional component and combined counterfactual scenarios to demonstrate the impact on production that could occur in NI if a lower tax regime and new FDI policy cause a gradual harmonization between NI and ROI productivity functions. In these scenarios, the difference between by sector shift parameters in NI and ROI is distributed to NI production functions across the policy implementation years, 2018-2025, at a rate that would equalize the two shift parameters over a 15 year period.<sup>82</sup>

### **Fiscal Transfer**

Fiscal transfer into NI, which covers the short-fall between government revenue and expenditure, is modeled as a revenue source and doesn't impact government gross-fixed capital expenditure. The quantity of fiscal transfer, however, is affected by changes in both government expenditure and revenue imposed by other counterfactual components. In other words, changes in NI's income tax revenue will change the amount of the fiscal transfer, as will changes in government consumption.

We found that changing the origin of the fiscal transfer had no effect on output or trade valuations, but did affect the quantity of net foreign capital, and thus at least the regional distribution of the current account balance. For this reason, all scenarios and components in the model are run under the assumption that the ROI funds entirely the fiscal transfer to NI, paid by GB prior to 2018. Again, given model architecture, this changes the ROI's deficit but not the ROI's investment level, the extra funding required to fund investment is sourced from the net foreign borrowings. For future exercises that can allow detailed analysis of the current account balance, NIROI is coded with alternative incidences in fiscal transfer. These include: 1) a scenario that assumes a 50% split between GB and Brussels (REUZ) in the incidence of fiscal transfer, followed by a 5% annual increase in the funds paid from Brussels and a commensurate decrease in funds paid by GB; 2) a 50% split of the transfer, in the policy year, between ROI and Brussels, with annual increase of 5% in funds by the ROI and a commensurate decrease in funds paid by Brussels.

### **IV Component Scenario Results**

In this section we look at various components of our scenarios. In regards to modeling language we follow a long-standing practice and use the term 'benchmark' as a short-hand for a development that uses historical data as input for a future trend. The term 'counterfactual' is

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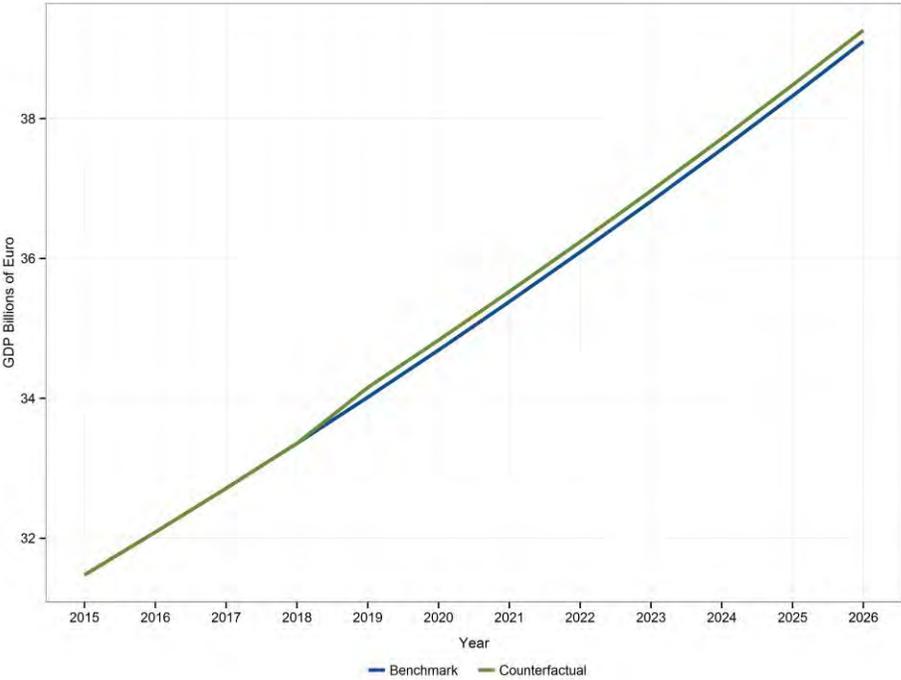
<sup>81</sup> Levels of capital stock are not the same, but plants in NI are given to have at least access to the same technologies as plants in ROI.

<sup>82</sup> The convergence in productivity doesn't mean a change in specialization, from say agriculture to technologies, but rather an equilibration of the leveraging of human capital and foreign direct investment in each sector.

a short-hand for our policy assumptions for various scenario components. The difference between benchmark and counterfactual indicates gains or losses for particular modeling assumptions. The label benchmark illustrates outcomes in the context of maintaining the status quo. The label counterfactual illustrates the outcomes in the context of unification. The term "counterfactual" is commonly used in econometric modeling to refer to the path that a particular outcome or outcomes would have taken under an alternative scenario. Such alternative scenarios may involve different policy choices other than those that were actually pursued, the state of the world in the absence of a natural calamity or civil conflict, or more generally, a projection of what would have been under an alternative set of circumstances. This term is frequently employed in econometric and theoretical modeling in this narrow and precise manner. For the purposes of the current application, one should consider the phrases "counterfactual" and "condition consistent with the unification scenario" as functionally equivalent.

**1. Activity Tax Harmonization**

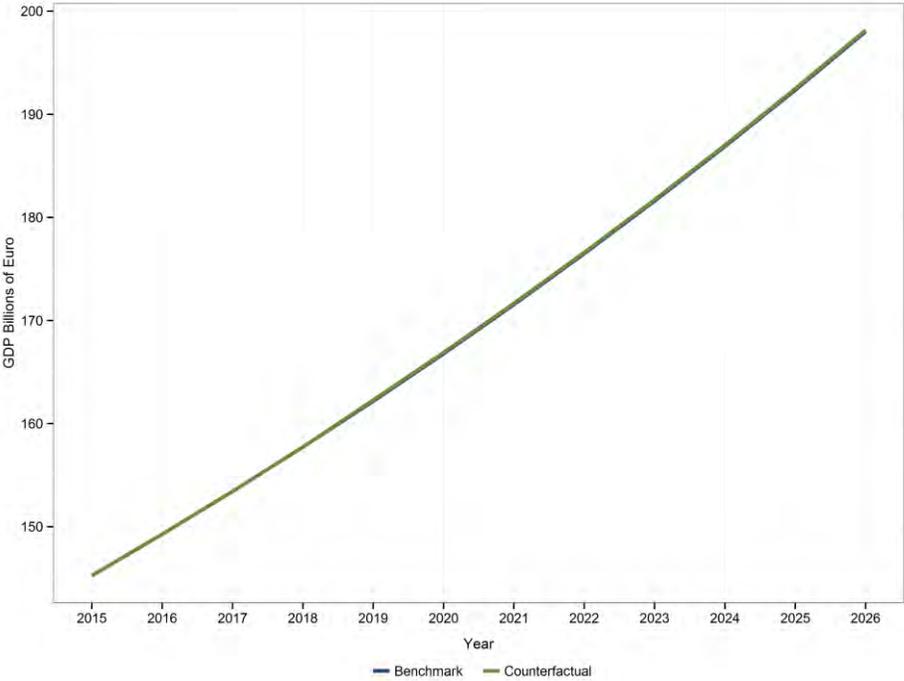
Figure 4. Northern Ireland Activity Tax Harmonization: Simulation Relative Benchmark



In NI harmonization of activity taxes less subsidies results in a 0.41% increase in output in the first year. The trend is relatively constant across the scenario timeline so that the GDP gain of 138.8 million Euro, in 2018, increases to 158.3 million Euro in 2025. The accumulated GDP gain from activity tax harmonization in NI reaches 1.2 billion Euro by 2025. The by-sector growth incidence is predictable in that sectors where the ROI’s tax regime awards a higher level of subsidy see higher changes in growth, across the policy, while those sectors confronted with

previously lower NI taxes are negatively impacted. For example, GVA in NI’s agriculture, forestry and fishing sector improves under the new activity tax regime by 2.7%; sewerage, refuse and remediation services improve by 2%; repair of consumer goods improves by 6.4%; and GVA in the other services sector improves by 8.6%. On the other hand, GVA in the scientific research and development services sectors declines by 4.6% and air transport services output falls off by 1.9%.<sup>83</sup>

Figure 5. Republic of Ireland Activity Tax Harmonization: Simulation Relative Benchmark

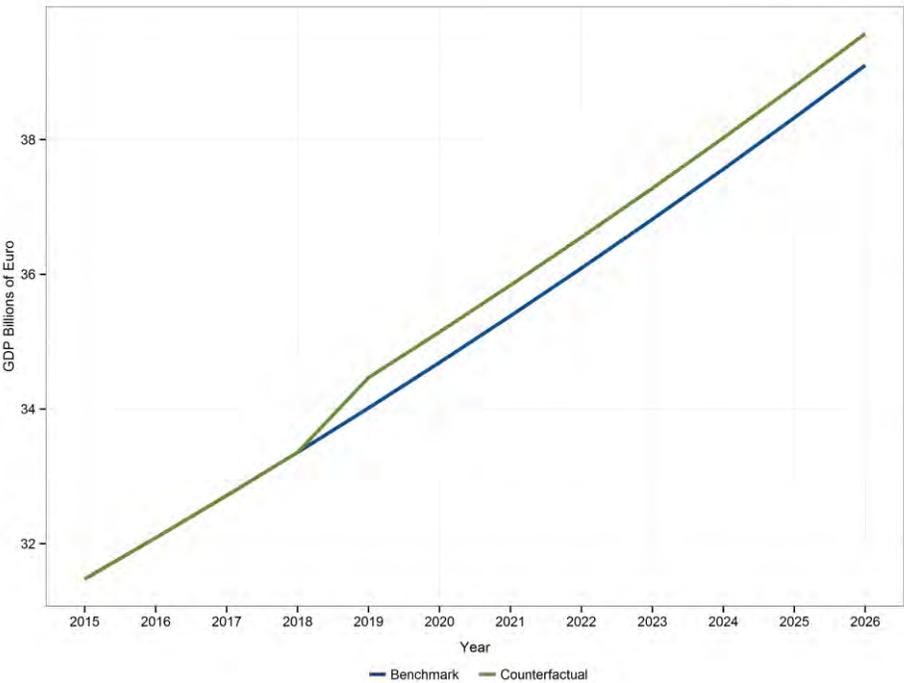


The customized model linkage between NI and the ROI effectively causes each island region to have repercussions for each other. This means changes to output in one region, and associated changes to the price-level, ensure changes to output in the other region. As a consequence, though only NI is subject to changes in the activity tax regime, output in ROI is also affected, though in a negligible manner. GDP improves by only 0.064% in 2018, but that improvement still amounts to 104.4 million Euro. By 2025 the gain is closer to 131.3 million Euro, and the accumulated gain 938.6 million Euro. The all-island gain from NI’s activity tax harmonization is 243.2 million Euro in the first year and accumulates to 2.1 billion Euro by 2025.

<sup>83</sup> See the appendix charts for by-sector changes in output as a result of the combined scenario.

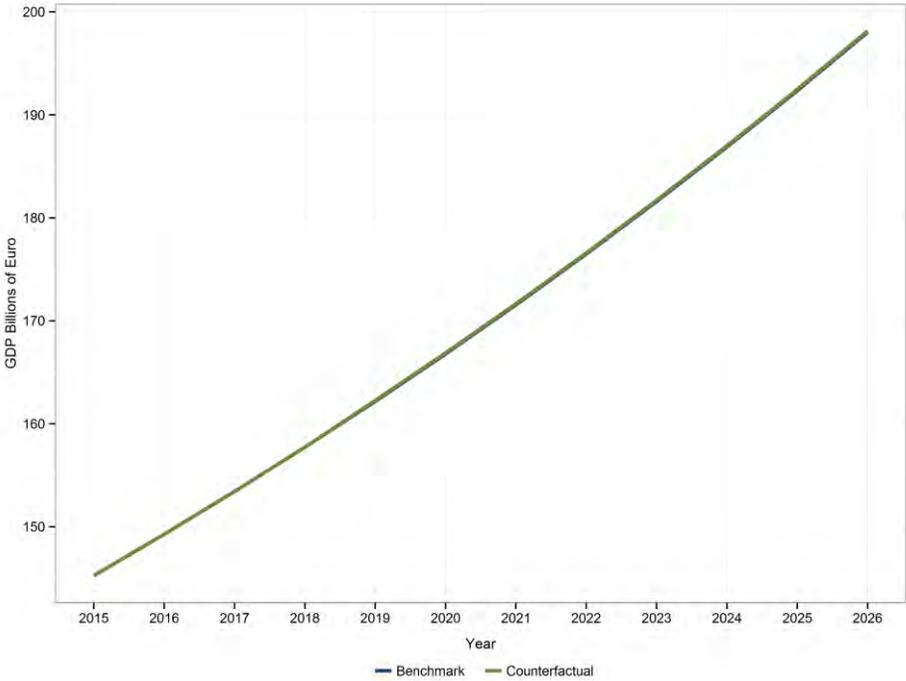
## 2. Commercial Tax Harmonization

Figure 6. Northern Ireland Commercial Tax Harmonization: Simulation Relative Benchmark



The simulated change from the NI commercial tax regime to the ROI’s commercial tax regime causes a 12.3% drop in aggregated commercial tax rates. The lower rates bring prices down in NI, which in turn increases slightly domestic consumption, but also lowers the composite price of intermediate inputs prompting higher output. Additionally, there is a small substitution effect that lowers import demand and positively impacts the trade balance. The over-all improvement to GDP in NI is 1.06% in the first year of unification, but the rate of annual gain declines slightly to 0.97% by 2025. Though the numbers appear small, the effect of around 449.3 million Euro per year, accumulates to 3.7 billion Euro by the end of 2025.

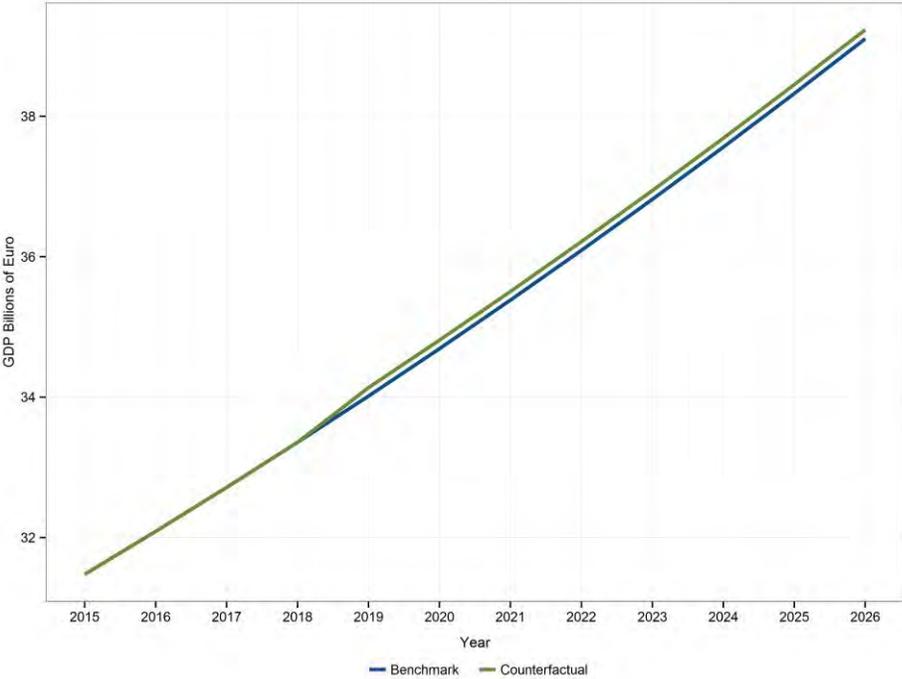
Figure 7. Republic of Ireland Commercial Tax Harmonization: Simulation Relative Benchmark



Again, changes in output and intermediate demand in NI affect output in ROI. In the commercial tax case, the 2018 change in output for the ROI is only 0.05% relative the bench, or 87.5 million Euro. This gain in GDP increases very slightly each and reaches 126.2 million Euro in 2025. By 2025 the accumulated change in the ROI’s GDP is 848.6 million Euro.

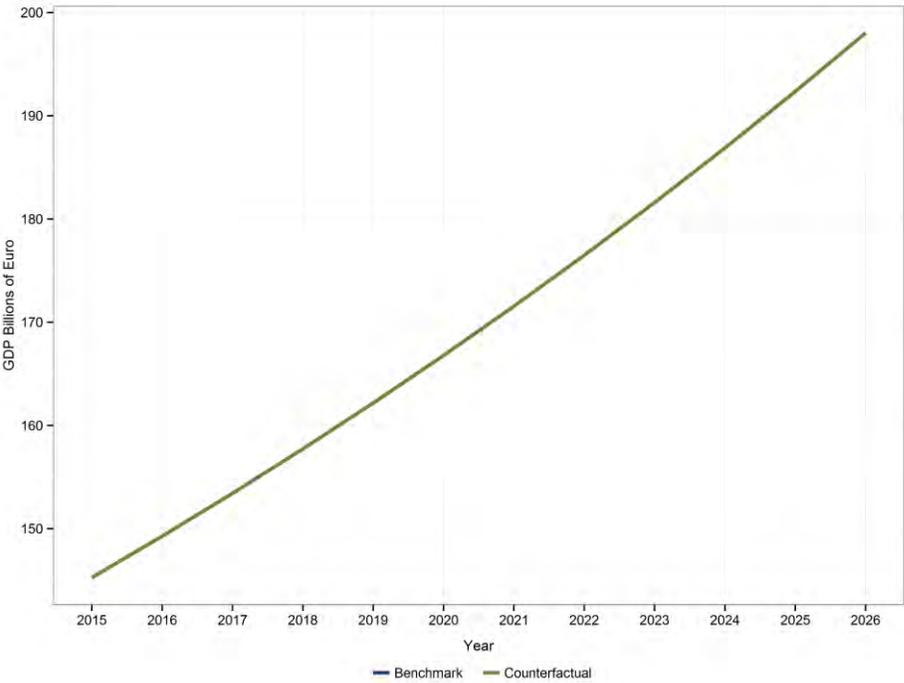
### 3. Import Tax Harmonization

Figure 8. Northern Ireland Import Tax Harmonization: Simulation Relative Benchmark



Harmonization of NI import tax rates with ROI rates boosts NI exports by approximately 184.9 thousand Euro per year after unification, with a slight rise in the improvement every year. NI imports improve relative the bench by 77.8 million Euro in 2018 and 85.5 million Euro in 2025. This more efficient trade allocation boosts productivity both by demanding more output and reducing the burden of intermediate input and consumption. GDP in NI improves by 0.35%, or 119.6 million Euro, in 2018 and 128.8 million Euro in 2025. The accumulated increase in NI’s GDP reaches 993.2 million Euro in 2025.

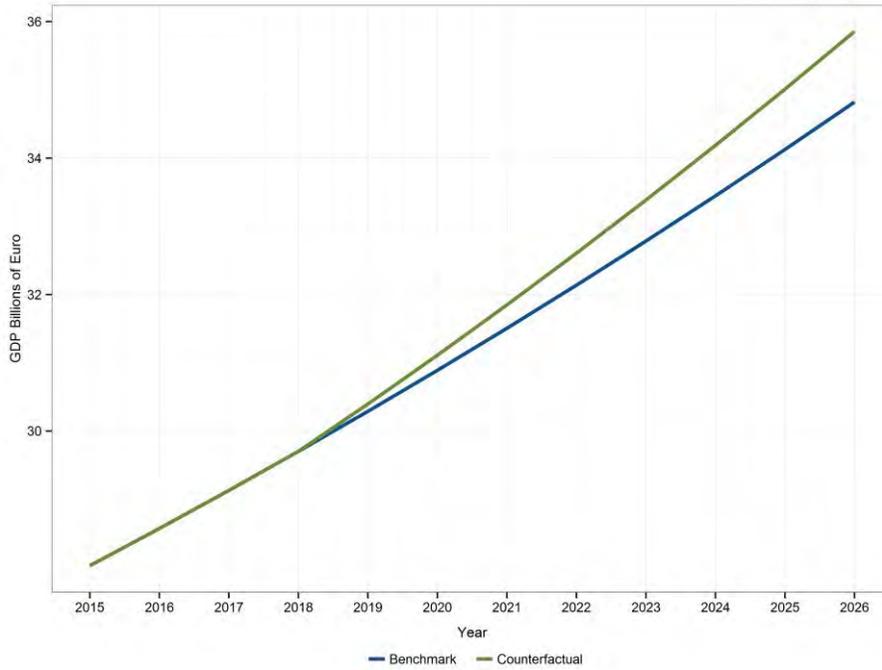
Figure 9. Republic of Ireland Import Tax Harmonization: Simulation Relative Benchmark



The more favorable NI tax regime has a negligible effect on the ROI’s output. The GDP improvements of 649.7 thousand Euro in 2018 and 6.1 million Euro in 2025 don’t show on the scale of the chart. The accumulated effect, however, on the ROI’s GDP, from the harmonization of NI’s tax regime with that of the ROI, reaches 26.2 million Euro by 2025. In total, the import tax harmonization component of the policy has a net positive effect on all-island trade of 77.6 million Euro in 2018, accumulating to 654.4 million Euro by 2025.

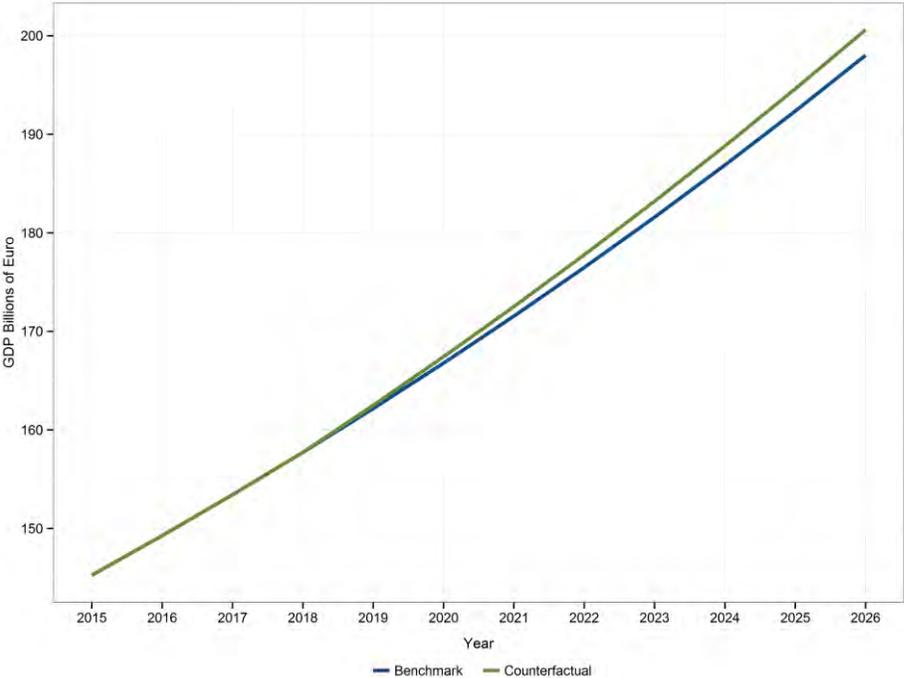
#### 4. Productivity Improvements

Figure 10. *Northern Ireland Gradual Harmonization of Returns to Productivity: Simulation Relative Benchmark*



Gradual improvement in productivity as a result of convergence in returns to productivity inputs lift GDP in NI by 120.5 million Euro in 2018, relative the benchmark. The new post-unification policies, attract FDI and prompt movements along the production possibilities frontier improving NI's GDP every year. In 2025 the improvements have grown to 1.2 billion Euro over the benchmark. GDP gains in NI accumulate to 4.9 billion Euro by 2025.

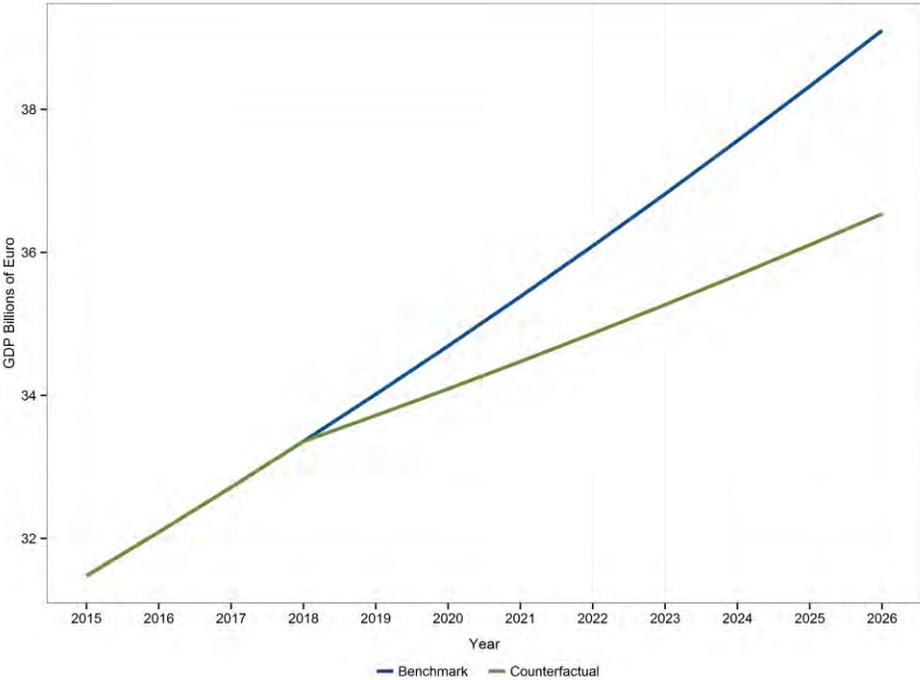
Figure 11. Republic of Ireland Gradual Harmonization of Returns to Productivity: Simulation Relative Benchmark



The new productivity engine in NI also generates movements toward the *Pareto efficient* point in ROI. These lift the ROI’s GDP by 323.5 million Euro in 2018 and 2.6 million Euro in 2025. The accumulated effect on GDP in the ROI, from the productivity scenario component, reaches 11.6 billion Euro by 2025. In total, the all-island accumulated effect sums to 16.6 billion Euro, across the first 8 years of unification.

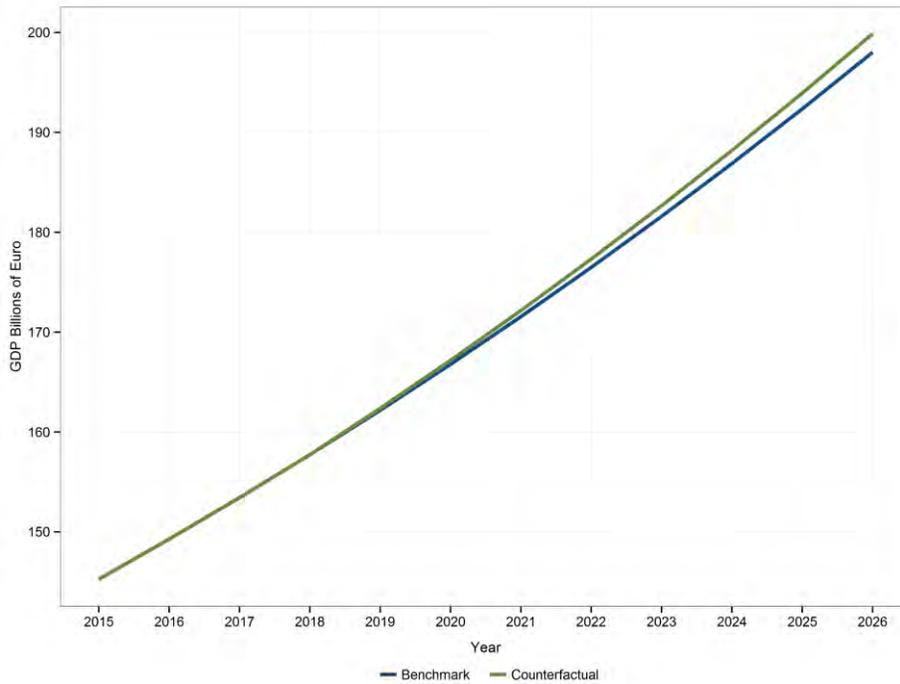
5. Political Unification

Figure 12. Northern Ireland Harmonization of Functions of Government: Simulation Relative Benchmark



The harmonization of government functions lowers NI government expenditure. The multiplier effect, that leverages fiscal expenditure into output, works in reverse and NI GDP is reduced by 296.4 million Euro in 2018 and 2.6 billion Euro in 2025. Across the first eight years of the policy, NI GDP is reduced by 11.2 billion Euro.

Figure 13. *Republic of Ireland Harmonization of Functions of Government: Simulation Relative Benchmark*



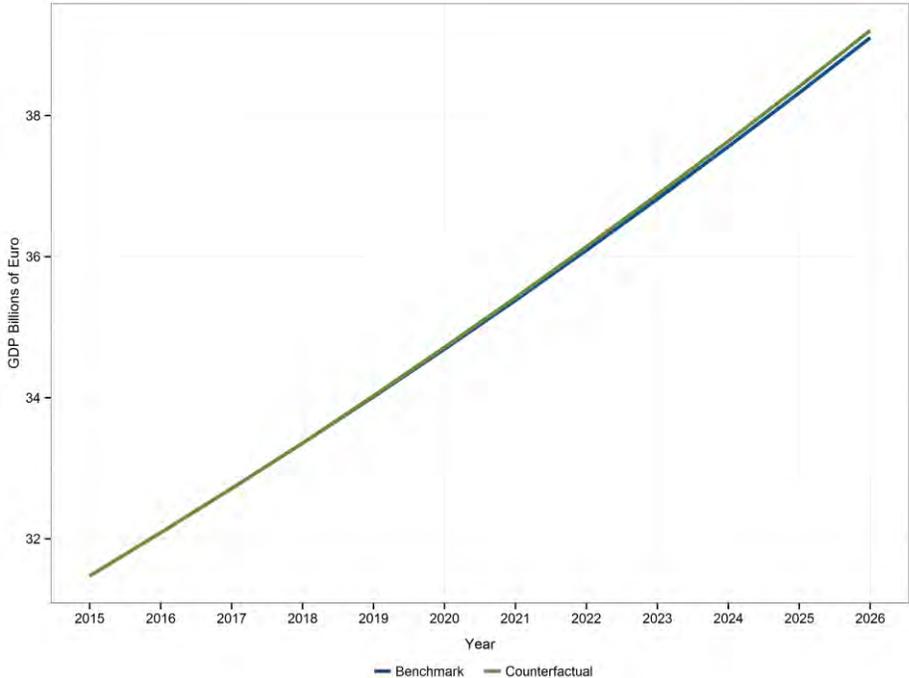
However, lower expenditure lowers the NI deficit that is entirely born by ROI. Moreover, the drop in productivity creates trade in ROI relative the bench, improving output in ROI. 44.7 million Euros of trade are created in ROI in 2018, as result of lower NI output. Further, the NI government deficit drops by 263.9 million Euro and reduces the transfer burden on ROI, which improves expenditure in ROI.<sup>84</sup> The result is an increase of 193.4 million Euros in ROI GDP in 2018, which improves to 1.9 billion Euros in 2025. The net effect of the 2% reduction in NI expenditure is reduction to all-island GDP of 103 million Euros in 2018 and 711 million Euros in 2025, accumulating to negative 3.4 billion Euros by 2025.<sup>85</sup>

<sup>84</sup> The reduced deficit lowers the 'crowding out' effect, which allows higher private consumption.

<sup>85</sup> Negative effect in NI less positive effect in ROI.

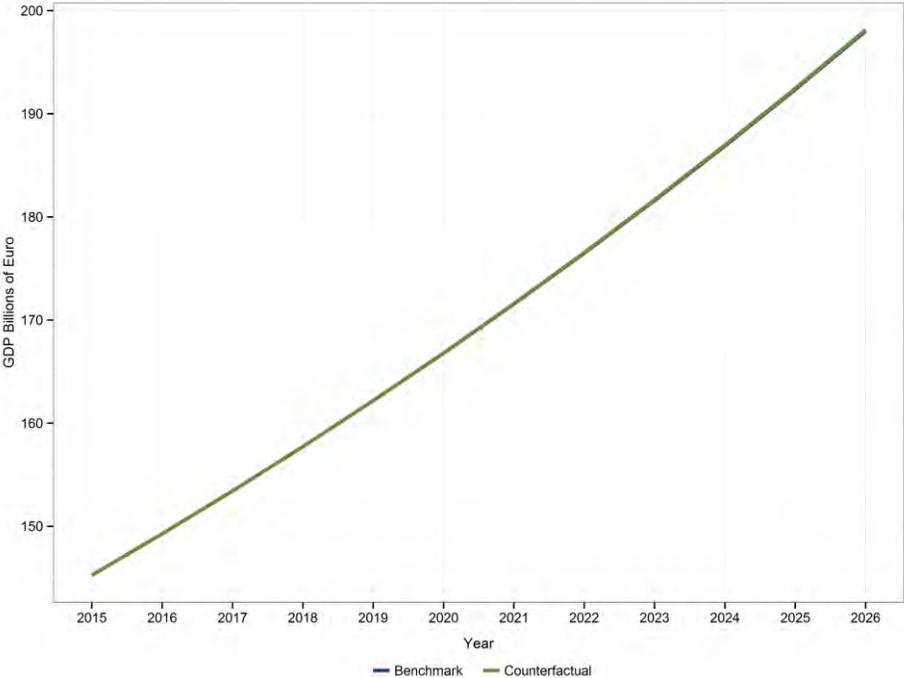
### 6. IMPORT TRANSACTION COSTS

Figure 14. Northern Ireland Reductions to All-Island Trade Barriers: Simulation Relative Benchmark



The reduction to import transaction costs is modeled as a 5% annual reduction in distribution costs. While this reduces prices, it also unfortunately reduces distributor revenue, thus the over-all effects on trade and output are negligible. In NI the net effect on trade is only 352.3 thousand Euro in 2018, this is associated with an improvement to GDP of 12.5 million Euro that grows to 102.8 million Euro of GDP by 2025. The accumulated effect on NI’s GDP reaches 457.3 million Euro by 2025

Figure 15. Republic of Ireland Reductions to All-Island Trade Barriers: Simulation Relative Benchmark

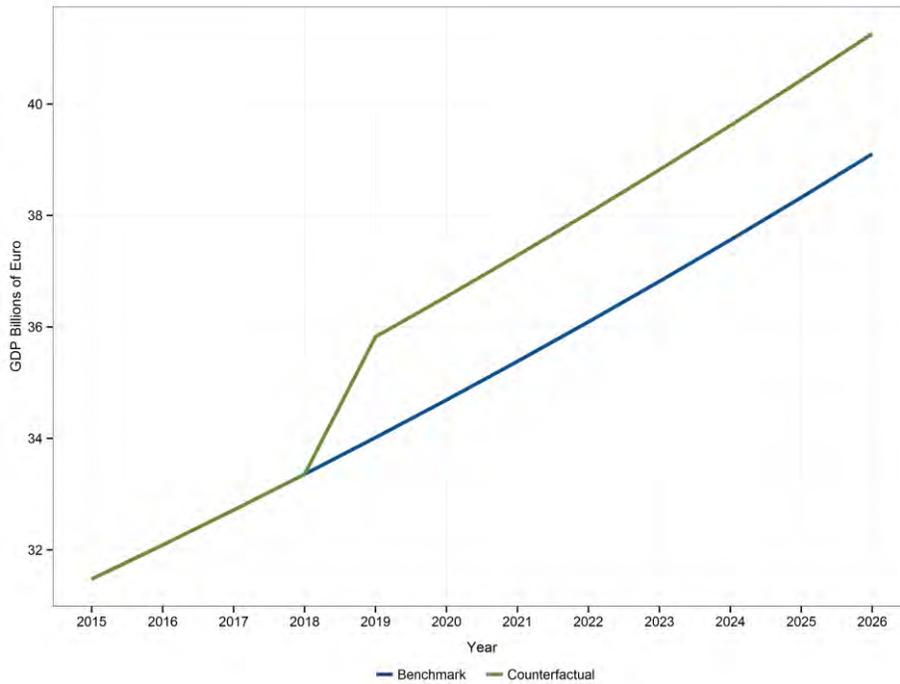


In the ROI in 2018 the effect on trade amounts to 573.4 thousand Euro, this causes an increase in the ROI’s GDP of 13 million Euro. By 2025 the effect on the ROI’s GDP improves to 124.4 million Euro. The accumulated trade driven GDP gains in the ROI sum to 526.4 million Euro by 2025. From 2018 to 2025, the net all-island effect on trade accumulates to 249.6 million Euro. While, across the full span of the policy all-island GDP improves by 983.7 million Euro.<sup>86</sup>

<sup>86</sup> While unification would undoubtedly result in improved cross-border trade, this scenario component models only improvements to border infrastructure, like highways and border crossings. Still, the effect of such improvements on output (less the multiplier effect from their construction) would be likely higher than the model predicts. This could perhaps be avoided by modeling costs reductions as reductions to distributor’s intermediate input costs, though the IFPRI framework is slightly restricted in this regard.

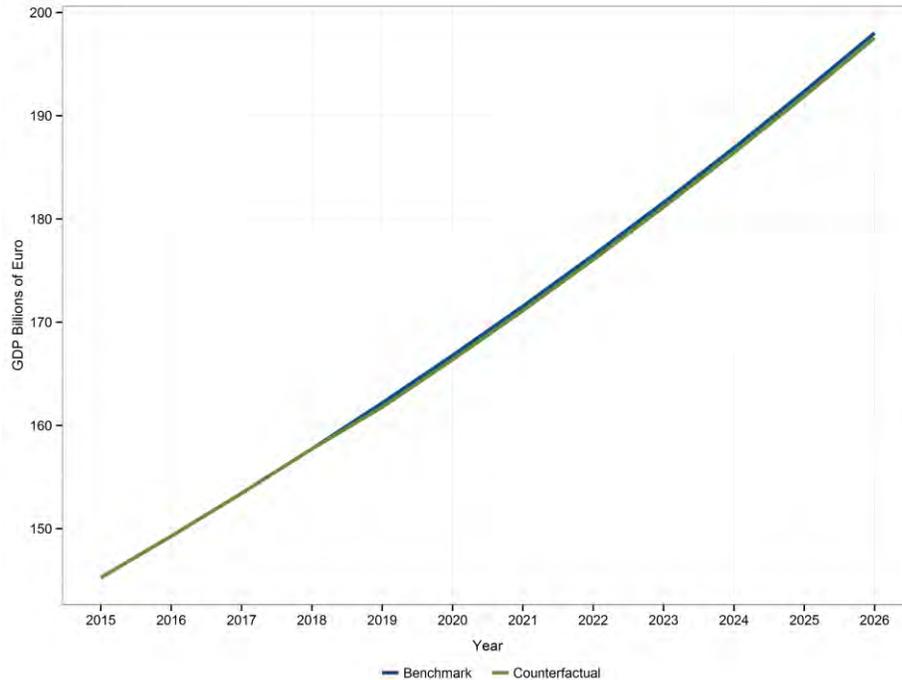
## 7. NI Conversion to Euro

Figure 16. Northern Ireland Adopts the Euro: Simulation Relative Benchmark



The Euro changeover effect on GDP is pushed by the trade creation/trade diversion story. We look at the over-all changes in country-pair trade flows, and by-sector changes to trade for 2018 are shown in the appendix. The isolated effect of only the currency conversion boosts exports in NI by roughly 18.7% annually and imports by roughly 8.4% annually or 9.4 billion Euro of NI trade creation, that accumulates to 79.8 billion Euro by 2025. Currency changeover from the GBP to the Euro increases NI GDP by an average of approximately 2 billion Euro annually, which accumulates to a total of 15.8 billion Euro by 2025.

Figure 17. *Republic of Ireland Adopts the Euro: Simulation Relative Benchmark*



In ROI, 2018 exports to NI fall-off by 14.2% or 210 million Euro, with other exports remaining flat across the policy year. 2018 ROI imports from NI improve by 30 million Euro but imports from other regions fall off so that total imports are reduced by 510 million Euro. The NI currency conversion has an accumulated effect on the ROI's total trade that reaches 4.4 billion Euro by 2025. While increases in exports boost output, increases in imports lower domestic product demand, lowering output. The result is an average reduction in ROI's annual GDP of more than 400 million Euros. The net effect on all-island GDP however, is an improvement of 1.4 million Euros in 2018 that accumulates to 12.3 billion Euros by 2025.

## V Unification Scenarios

After presenting the modeling outcomes of the various policy components we now turn to our unification scenarios that look more in-depth into the combination of several policy components. We distinguish overall three scenarios that differ in the way unification efficiencies are being used as well as in the way effects of a common FDI-regime and thus a common tax regime are modeled. Scenario 3 is the most advanced scenario in that it contains the most comprehensive modeling assumptions.

**Unification Scenario 1**

Unification in combined scenario 1 means that the unified Ireland pays 100% NI government deficit, harmonization of functions of government reduces NI government expenditure by 2% annually from 2018-2025, and adoption of ROI's tax regime and foreign investment policy platform in NI has no effect on returns to productivity in NI.

Figure 18. Northern Ireland Combined: Simulation Relative Benchmark, Scenario I

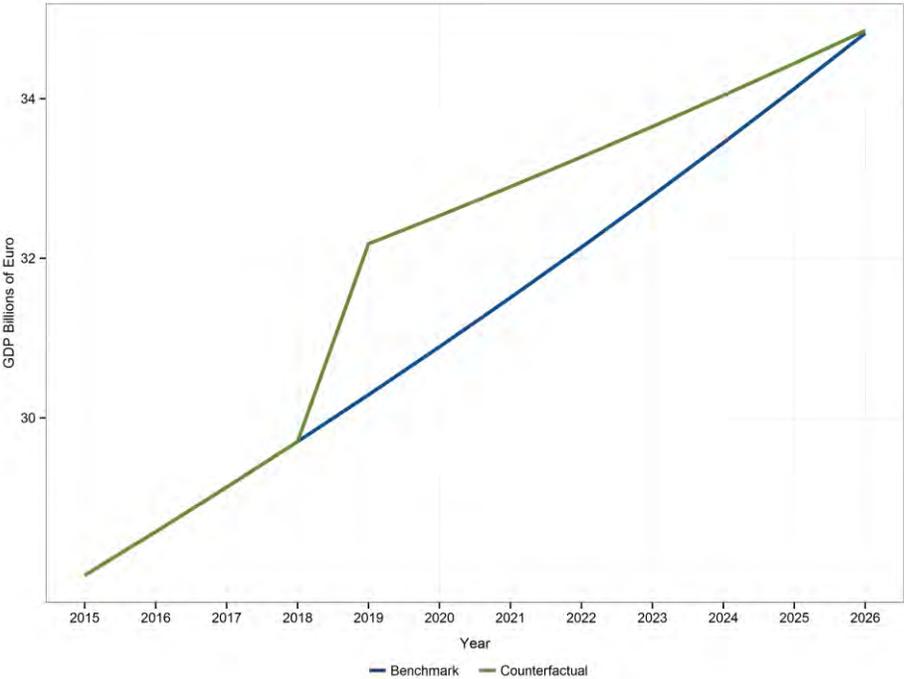
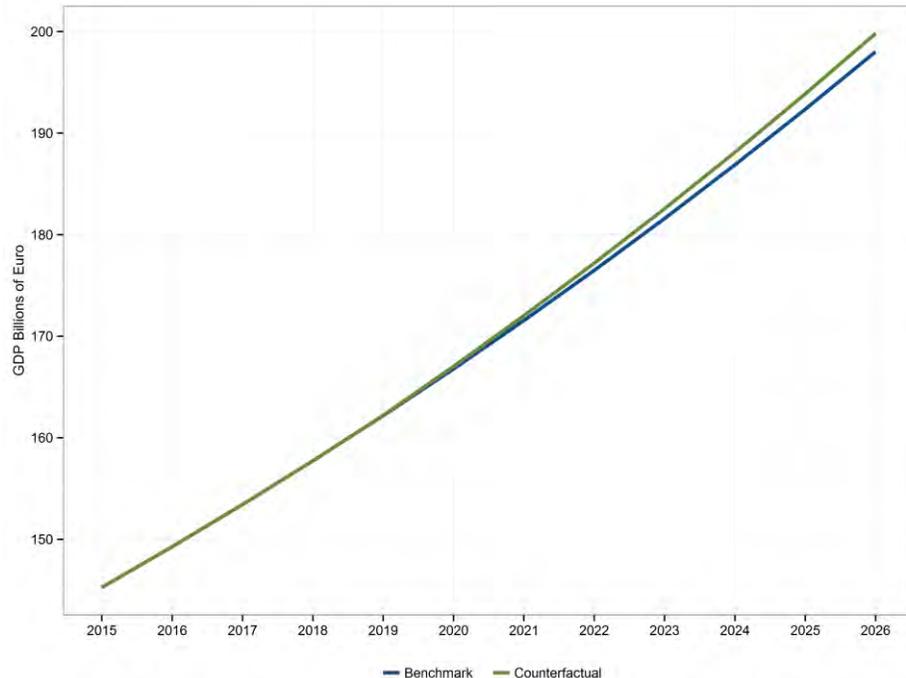


Figure 19. Republic of Ireland Combined: Simulation Relative Benchmark, Scenario I



The combined scenario 1, with a reduction to government expenditure in NI as a result of harmonization of functions of government, boosts NI GDP in the policy implementation year, yet the percentage gain declines until the counterfactual trend returns to the benchmark output path. As discussed earlier, the decline is a result of reductions in government expenditure, which not only demand higher private sector savings,<sup>87</sup> but also have a negative multiplier effect. The gain in 2018 of 2.2 billion Euro in NI GDP accumulates to 8.8 billion Euro by 2025, while the 2018 ROI GDP gain of only 30 million Euro accumulates to 1.8 billion Euro by 2025. Total island change in GDP across the 8 year counterfactual climbs to 15.8 billion Euro.

Table 6. Change in GDP/Capita and GNP/Capita, Scenario I

REGION	CHANGE IN GDP/CAPITA (EURO)								
	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NI	1,199	1,037	873	707	539	369	196	21	4,942
ROI	3	44	87	131	176	223	272	322	1,259
All-Island	1,202	1,081	960	838	716	592	468	343	6,201

REGION	CHANGE IN GNP/CAPITA (EURO)								
	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NI	1,238	1,076	911	744	576	405	231	55	5,235
ROI	3	44	87	131	176	223	272	322	1,259
All-Island	1,241	1,120	998	875	752	628	503	377	6,495

<sup>87</sup> Lowering private expenditure and thereby crowding out investment.

Table 7. *Percent Change in GDP/Capita and GNP/Capita, Scenario 1*

PERCENT CHANGE IN GDP/CAPITA									
REGION	2018	2019	2020	2021	2022	2023	2024	2025	AVERAGE
NI	5.1	4.4	3.6	2.9	2.2	1.5	0.8	0.1	2.6
ROI	0.0	0.1	0.3	0.4	0.5	0.7	0.8	0.9	0.5

PERCENT CHANGE IN GNP/CAPITA									
REGION	2018	2019	2020	2021	2022	2023	2024	2025	AVERAGE
NI	5.1	4.4	3.7	3.0	2.3	1.6	0.9	0.2	2.6
ROI	0.0	0.1	0.3	0.4	0.5	0.7	0.8	0.9	0.5

### Unification Scenario 2

Unification in scenario 2 means ROI pays 100% NI government deficit, harmonization of functions of government reduces NI government expenditure by 2% annually from 2018-2025, and adoption of the ROI's tax regime and foreign investment policy platform in NI attract a higher presence of multinational firms, which catalyzes returns to productivity in NI. Over a 15 year period NI's productivity structure converges with that found in the ROI.

Figure 20. Northern Ireland Combined: Simulation Relative Benchmark, Scenario II

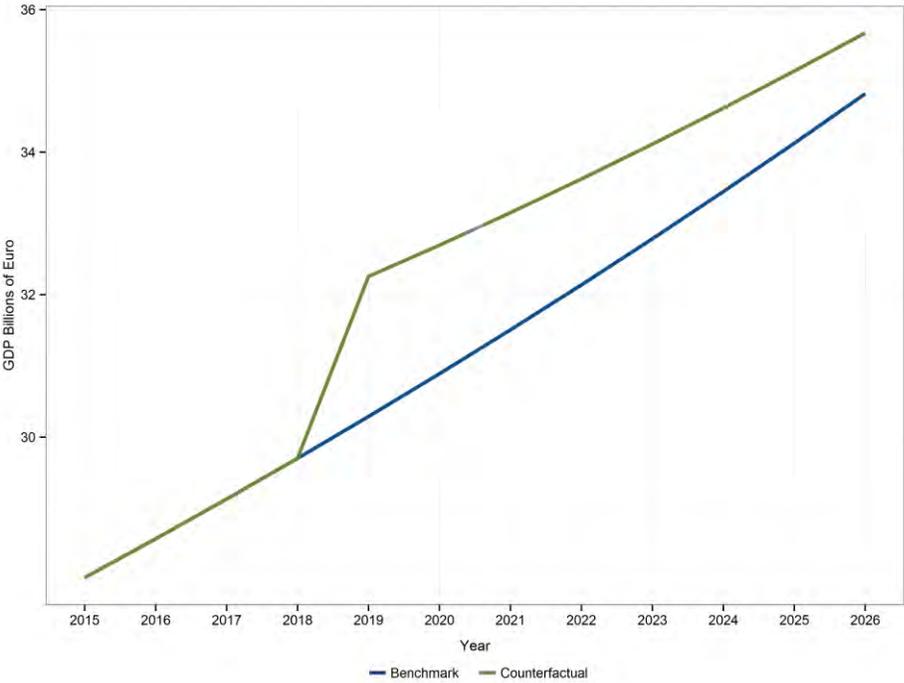
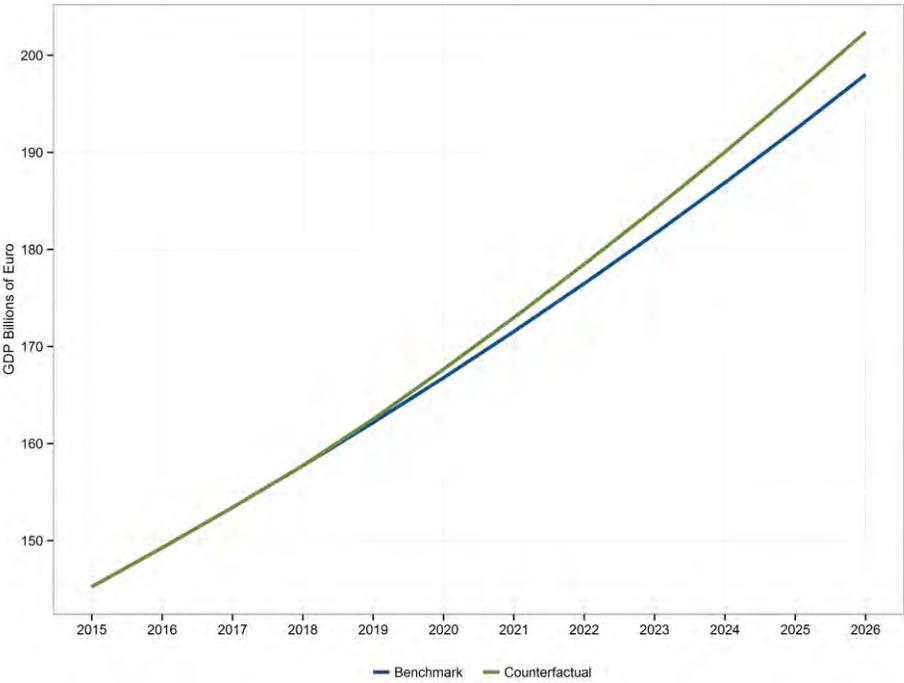


Figure 21. Republic of Ireland Combined: Simulation Relative Benchmark, Scenario II



Improvements to productivity in NI have a strong positive effect on GDP. While the reduction in government expenditure in NI still negatively affects NI's GDP, the productivity gain somewhat offsets the negatively sloped percentage change trend-line for the policy implementation years. As a result, the NI GDP counterfactual rises above the bench by 2.2 billion Euro in 2018 and accumulates to 11.27 billion by 2025. The ROI's GDP gain is only 349 million Euro in 2018 but accumulates to 18.5 billion Euro by 2025. The all-island effect on GDP accumulates to 31.2 billion Euro by 2025.

Table 8. *Change in GDP/Capita and GNP/Capita, Scenario II*

CHANGE IN GDP/CAPITA (EURO)									
REGION	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NI	1,273	1,192	1,113	1,036	960	884	808	732	7,997
ROI	74	188	302	416	531	647	764	882	3,804
All-Island	1,347	1,380	1,415	1,452	1,491	1,531	1,572	1,614	11,801

CHANGE IN GNP/CAPITA (EURO)									
REGION	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NI	1,309	1,224	1,142	1,062	984	907	829	752	8,210
ROI	64	165	266	368	470	574	679	785	3,370
All-Island	1,373	1,389	1,408	1,430	1,454	1,481	1,508	1,537	11,581

Table 9. *Percent Change in GDP/Capita and GNP/Capita, Scenario II*

PERCENT CHANGE IN GDP/CAPITA									
REGION	2018	2019	2020	2021	2022	2023	2024	2025	AVERAGE
NI	5.4	5.0	4.6	4.2	3.9	3.5	3.2	2.8	4.1
ROI	0.2	0.5	0.8	1.1	1.4	1.7	2.0	2.2	1.2

PERCENT CHANGE IN GNP/CAPITA									
REGION	2018	2019	2020	2021	2022	2023	2024	2025	AVERAGE
NI	5.4	5.0	4.6	4.2	3.8	3.5	3.2	2.8	4.1
ROI	0.2	0.5	0.8	1.1	1.4	1.7	2.0	2.3	1.3

### Unification Scenario 3

Unification in combined scenario 3 means the ROI pays 100% of NI's government deficit, harmonization of functions of government reduces NI's government expenditure by 2% annually from 2018-2025, and adoption of the ROI's tax regime and foreign investment policy platform attract a higher presence of multinational firms, which catalyzes returns to productivity in NI. Government savings are not applied to deficit reduction, but are spent to expand and improve functions of government. Over a 15 year period NI's productivity structure converges with that found in the ROI.

Figure 22. Northern Ireland Combined: Simulation Relative Benchmark, Scenario III

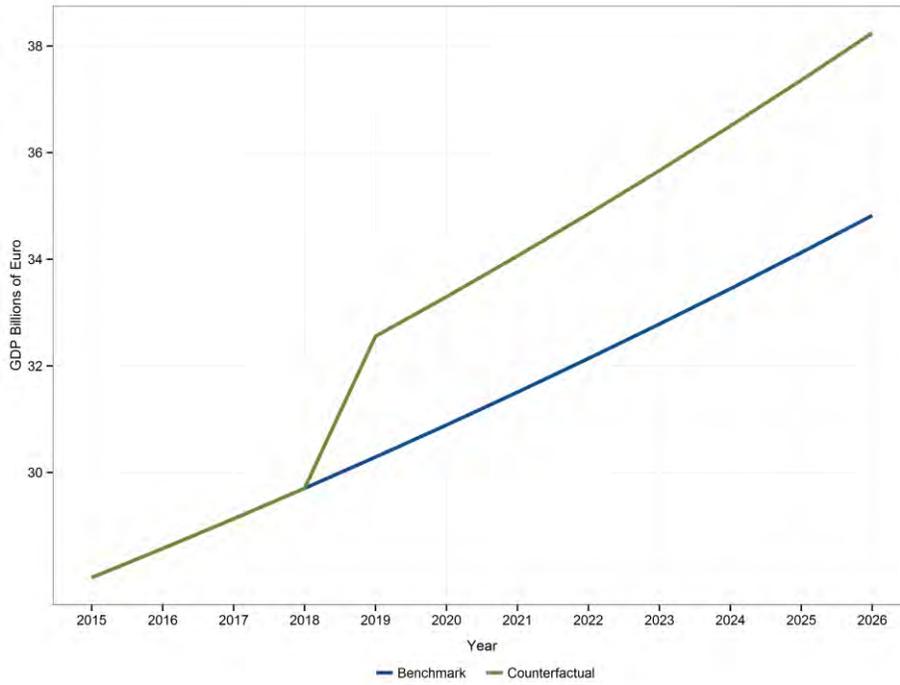
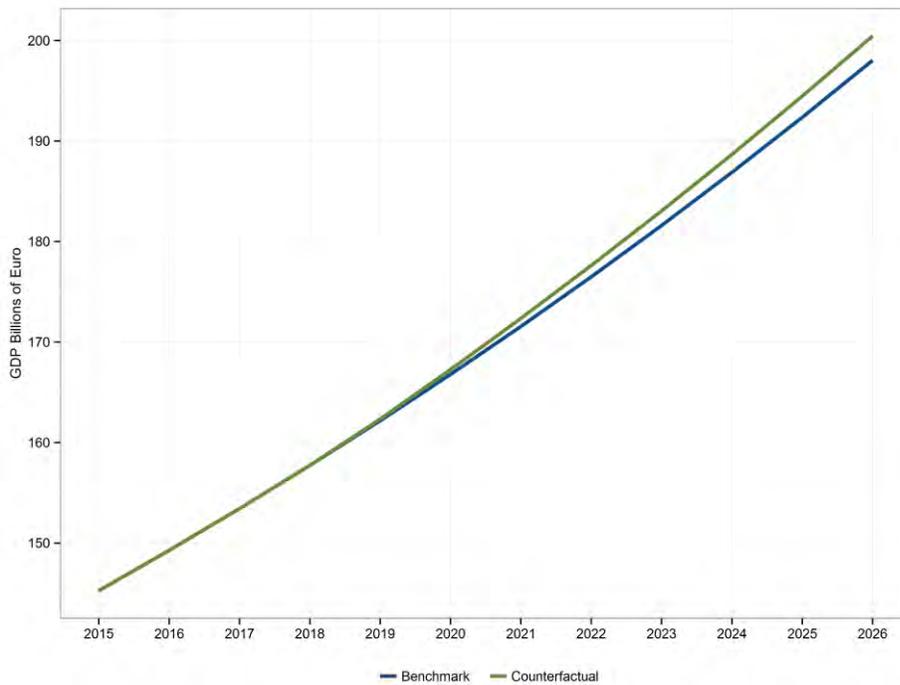


Figure 23. Republic of Ireland Combined: Simulation Relative Benchmark, Scenario III



Redirecting NI government savings into expenditure boosts NI’s GDP but negatively effects the ROI’s GDP, relative the scenario where NI’s government expenditure cuts are applied to deficit

reduction. While GDP gains from unification in NI grow from 2.6 billion Euro in 2018 to 25.3 billion Euro in 2025, the ROI's growth, beginning in 2018 at 152 million Euros, accumulates to only 10.33 billion Euros. The net effect on all-island GDP is a gain of 2.7 billion Euros of GDP in 2018, 6.3 billion Euros of GDP in 2025, and an accumulated gain of 35.6 billion Euros of GDP across the policy timeline of 8 years.

Table 10. *Change in GDP/Capita and GNP/Capita, Scenario III*

CHANGE IN GDP/CAPITA (EURO)									
REGION	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NI	1,466	1,577	1,693	1,812	1,935	2,060	2,189	2,322	15,054
ROI	31	101	169	235	300	364	427	488	2,114
All-Island	1,497	1,678	1,861	2,047	2,235	2,424	2,616	2,810	17,168

CHANGE IN GNP/CAPITA (EURO)									
REGION	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NI	1,503	1,613	1,726	1,844	1,965	2,090	2,218	2,350	15,309
ROI	26	87	148	207	265	322	378	434	1,865
All-Island	1,529	1,700	1,874	2,051	2,230	2,412	2,596	2,783	17,175

Table 11. *Percent Change in GDP/Capita and GNP/Capita, Scenario III*

PERCENT CHANGE IN GDP/CAPITA									
REGION	2018	2019	2020	2021	2022	2023	2024	2025	AVERAGE
NI	6.3	6.7	7.0	7.4	7.8	8.2	8.6	9.0	7.6
ROI	0.1	0.3	0.5	0.6	0.8	1.0	1.1	1.2	0.7

PERCENT CHANGE IN GNP/CAPITA									
REGION	2018	2019	2020	2021	2022	2023	2024	2025	AVERAGE
NI	6.2	6.6	6.9	7.3	7.7	8.1	8.4	8.8	7.5
ROI	0.1	0.3	0.5	0.6	0.8	1.0	1.1	1.3	0.7

## VI Drivers of Unification Effects

### Trade Diversion -Trade Creation

The changes in trade policy, tax policy, and incentives for foreign direct investment, strongly effect gains in unification in the long run, but short-run changes are currency devaluation driven. This is the policy fix typically recommended for regions suffering from restrictive monetary policy. At the root of the trade story are values of country-pair net trade creation or diversion. These are driven by both product level and regional level elasticities.

Thorough research has been conducted on trade elasticities, particularly the 'Armington elasticity' that measures substitution between domestic and foreign goods and services. Unfortunately, the bulk of this research is not applicable to NIROI's country-pairs or levels of product disaggregation and country aggregation. The challenge is that elasticities themselves

represent wide ranges of factors that influence trade. For example, Olekseyuk and Schurenberg-Frosch (2013) comment on Welsch's (2006) observation that elasticities from older studies are not necessarily applicable to modern studies, because trade patterns and motives change with time. Their paper also cites Blonigen and Wilson (1999), who caution against the use of elasticities derived from one country's data for modeling other countries. This is because elasticities are culture and policy driven, and purchasers in different regions operating under different legal regimes react differently when confronted with varieties of distinct products, or even somewhat fungible products, with different origins.

In a perfect world, where economists have access to perfect information, elasticities would be derived for every region and every product. In our case, the problem was an absence of time-series data at the regional level, and perhaps even the national level, from which to empirically estimate elasticities. Moreover, deriving elasticities through regression is both time and resource intensive. As a consequence, we were not able to derive our own elasticities and chose instead default-level constant elasticity parameters across sectors and regions. This largely restricts NIROI's reactions to policy shocks to the price-level, rather than the levels of importer and exporter preference for sector specific products.

Our constant elasticities of substitution and transformation between domestic and traded products and services are low, while regional elasticities are higher. This means suppliers and demanders are more likely to substitute between products with different origins than between domestic and foreign markets. Moreover, in NIROI, all-island regions treat one another as large countries so that specialized trade functions allow prices in one region to influence prices in the other. Off-island regions view both NI and the ROI as small price-taking economies.

There are important observations in the literature and regional characteristics that support the selection of inelastic trade parameters. We discuss some of these here.

Irish supply chains are integrated with each other, and with GB. These long-lasting business relationships are founded in historical cultural and industrial ties. As Bradley and Barry (1999) note, "Since many Northern-produced goods are sold as intermediate inputs to other British firms before being exported as final goods, Northern Ireland's crucial intra-UK trade is unlikely to be protected for long from sterling strength against the euro." This comment works in reverse if NI abandons Sterling and joins the Euro, so that NI's intra-UK trade is likely to be protected for as long as the GBP stays relatively high against the Euro. This supports the selection of a low constant elasticity of transformation.

Olekseyuk and Schurenberg-Frosch (2013) estimate elasticities for several European countries and note that, "Generally speaking, we find smaller elasticities of substitution between imported and domestic goods for sectors with lower value added (processing of raw materials and agricultural products and basic manufacturing) while elasticities are higher in sectors with higher value added (more elaborate manufacturing and technology.)" This supports the selection of low elasticities in NI's external trade functions, as NI has a higher incidence of output in lower value-added industries.

Olekseyuk and Schurenberg-Frosch's results show over-all low elasticities across sectors for European nations. In Italy, for example, the range is 0.93 -- 1.31, while in Denmark it is 0.88 – 1.42.

McDaniel and Balistreri (2001), emphasize that long-run elasticities are higher than short-run elasticities, which is consistent with long-run firm entry and exit dynamics, and intuitively makes sense, as new business relationships take time to build even when price differentials are large. They also suggest higher disaggregation yields higher elasticities. In NIROI, other than ROI-NI trade and all-island trade with GB, all-island regions trade with many nations highly aggregated into regions. Again, the low elasticity case is fitting.

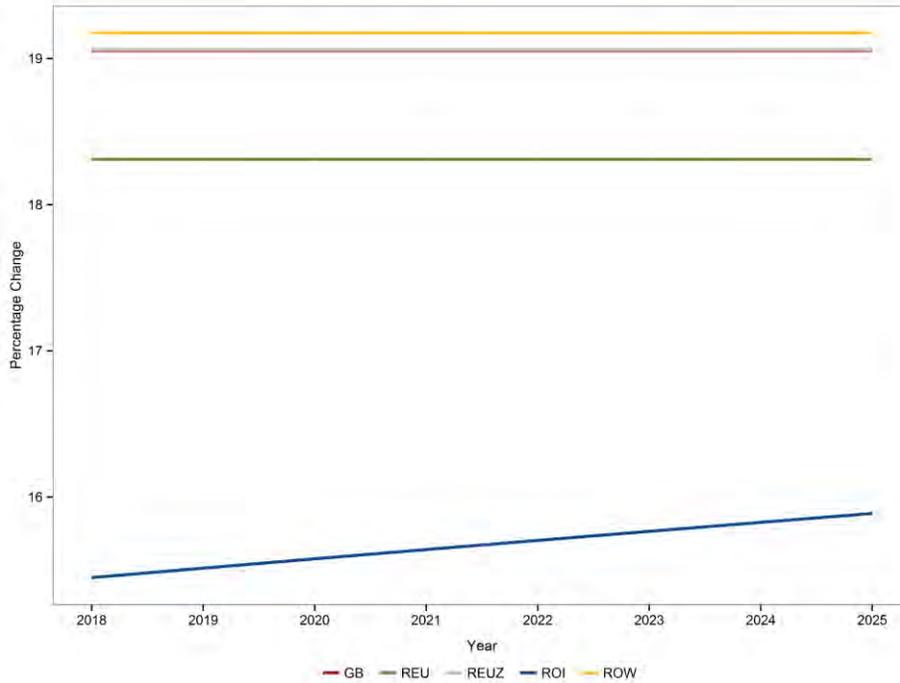
In NIROI, domestic transformation elasticities are fixed at 0.25. This means domestically focused firms are slow to access international markets. It is fitting for NI because NI due to the size and composition of the private sector. NIROI's regional transformation elasticities are fixed at -2 for off-island trade and 2 for all-island trade, resulting in CET parameters of 0.5 and 1.5, respectively. Recall CET elasticities are negative, but not in the specialized trade function that prompts all-island regions to view one another as large countries. The two numbers with opposite signs are not comparable, but ensure that transformations between all-island regions are more sensitive to prices than transformation with off-island regions. This is explained by their close proximity and cultural unity; it is to say that producers don't view markets in the other island region as international.

Domestic substitution elasticities are also fixed at 0.25, meaning consumers and industries sourcing intermediate consumption are slow to substitute domestic products with international products. This home-based bias is not unusual. Regional substitution elasticities are also fixed at 0.25 for off-island trade, and 2 for all-island trade, resulting in CES parameters of 5 and 0.5, respectively. Again, the higher elasticity for all-island trade corresponds with the specialized all-island trade function, and is fitting with regions where cultural ties are close.

### **Trade Diversion -Trade Creation Results**

GDP gains from unification are largely driven by the Euro change-over effects on trade creation and trade diversion. To show percentage changes in trade value relative the bench, we ran an additional counterfactual with no change in NI productivity and no reduction in NI government expenditure. This highlights the effects of the currency change, rather than expenditure and production.

Figure 24. Northern Ireland Percent Change in Exports

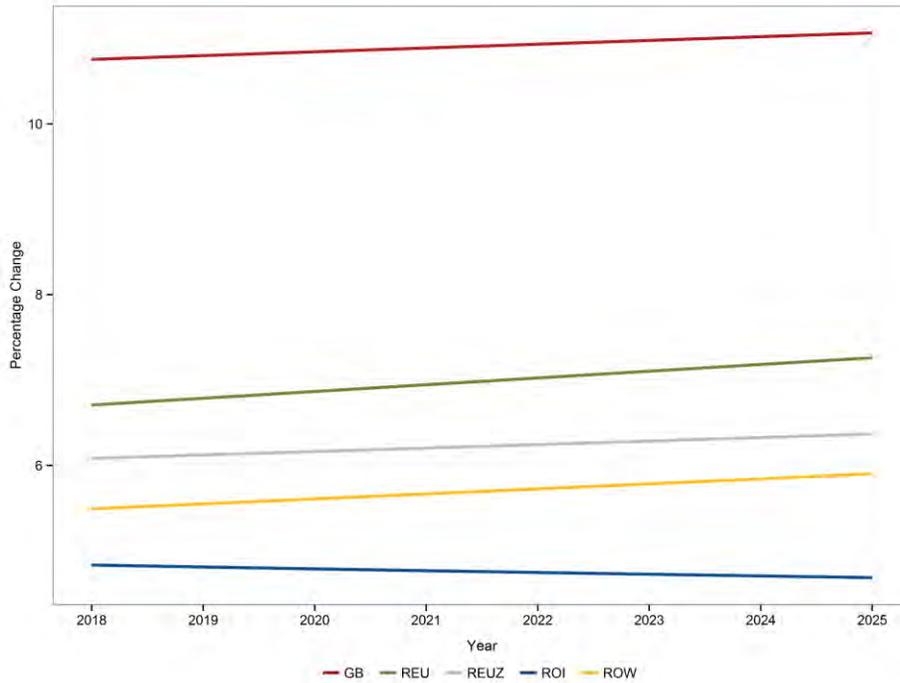


The model predicts a jump in exports between NI and GB of 19.1%. NI exports to GB increase because 1 GBP now buys more NI goods and importers in GB, especially those importing intermediate inputs along the supply chain, increase their demand for the now cheaper NI exports. The increase is a one-time increase to a higher level of trade because the model isolates the effects of policy by fixing currency exchange rates over-time, while export quantities are driven by fixed world prices of exports

Exports from NI to other regions in the Eurozone are now less expensive, as are those to the ROI, the REU, and the ROW. Those to REUZ rise by 19.1%, those from NI to ROW rise by 19.2%, and those to REU rise by 18.3%. The percentage change in exports from NI to ROI across the policy implementation increase at a lower but increasing rate for two reasons: 1) all-island exports are modeled as imports from the other island region and combined counterfactuals include an increasing reduction in import transaction costs between island regions; and 2) while exports are a function of a fixed world price, import volumes are affected by changes in internal demand, which respond to changes in composite goods prices.

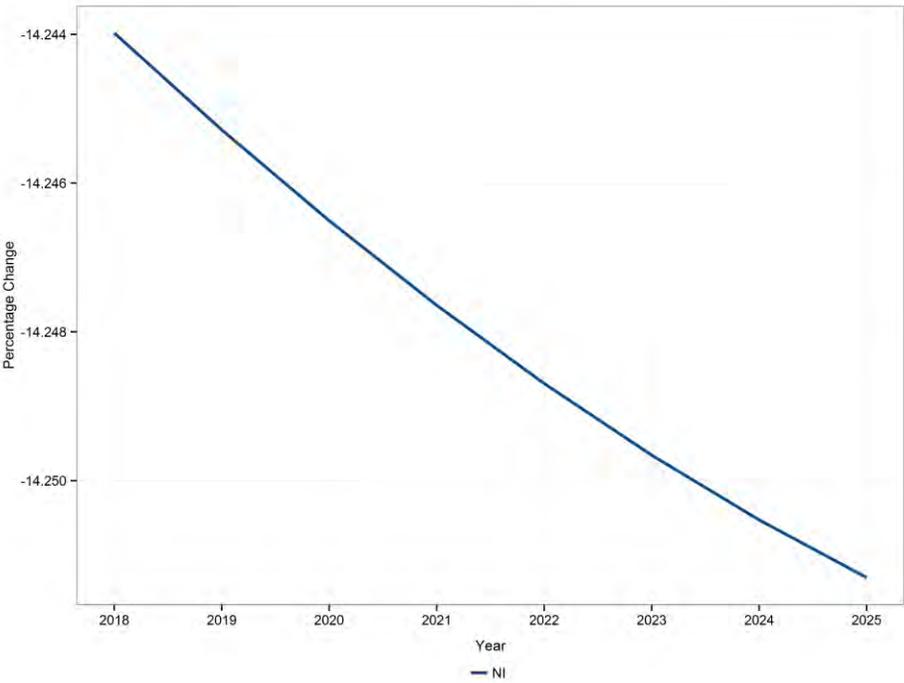
The high level of integration between GB and NI mean exports between the country-pair are responsible for 79% of the total gains in 2018 exports, or 5.2 billion Euro from a total of 6.2 billion Euro. Exports to the ROI are responsible for 450 million Euro of those 6.2 billion, while the remainder are divided among the other regions.

Figure 25. Northern Ireland Percent Change in Imports



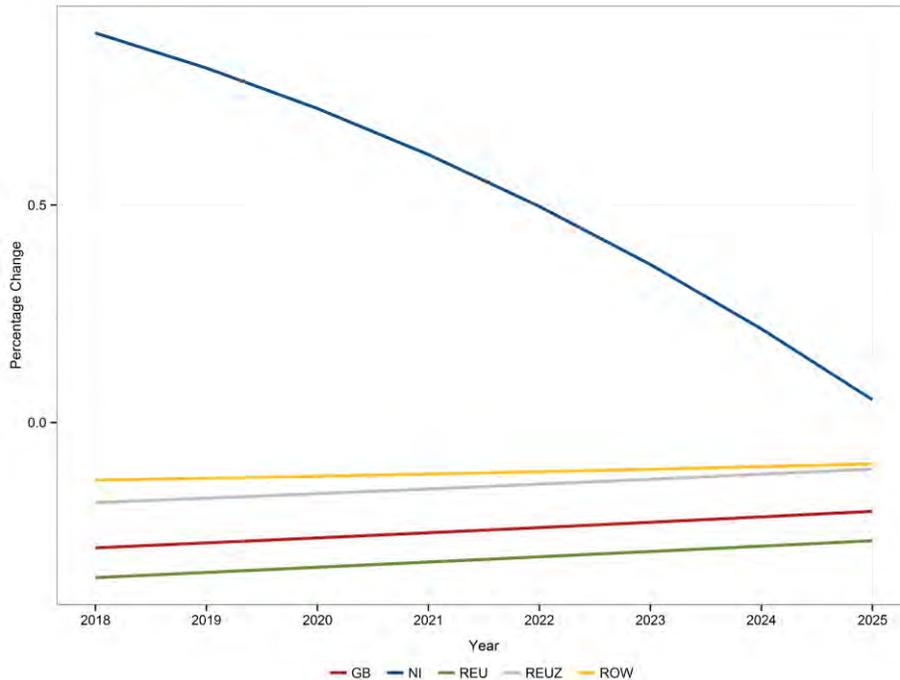
The responsiveness of imports to internal demand, in combination with the increased exports and over-all increases to output from other policy components, drive increases in intermediate consumption, which gradually increase imports. Imports into NI from all regions except ROI increase as a result of particularly the exchange rate component of the policy implementation, but also the new lower tariff regime. The largest percentage increase in imports, of 10.8%, is actually from GB, which is surprising because the currency differential between GB and NI has expanded and imports from GB have increased in price. Though a part of the increase in imports from GB is due to increases in internal demand, they are also a function of those price increases themselves, as the import pricing function includes an exchange rate variable which appreciates, while the rise in internal demand and inelasticity of trade keep the quantity of those imports rather constant or increasing. The end result is that imports between NI and other regions increase in total value. The same causation gradually lowers the price of NI imports from the ROI, though they also jump in the policy implementation year. The change in NI imports from the ROI gradually drops because inelasticities delay heavy substitution away from ROI products while gradually decreasing distribution costs lower the price and thus the valuation of those imports.

Figure 26. Republic of Ireland Percent Change in Exports



From the ROI perspective, exports into NI fall-off by more than 14% because exporters into NI are no longer reaping the benefits of the higher exchange rate. The exchange rate component in the price of those exports, now at parity, reduces both the incentive to export to NI and the valuation of those exports quantities that remain. The exports between the ROI and the other external sectors remain constant as they respond to a constant exchange rate and fixed world prices. This is a case of trade diversion that works against output in ROI, because production in the model is pulled from the demand side. In reality, exporters in the ROI may not adjust production levels quickly; they might instead take reduced revenues or let inventories build up. Eventually, however, they would either reduce output or find alternative buyers willing to pay more.

Figure 27. Republic of Ireland Percent Change in Imports



Imports into the ROI from off-island regions drop in total value because imports from NI increase. This is a quantity substitution, as prices of external imports are fixed at constant prices. The initial increase of imports from NI is consistent with the initial increase in NI exports to the ROI, though the shares are relative different bases. This is price driven substitution, where importers recognize cheaper imports and buy more. The rate of the increase falls-off gradually, however, while the rate of increase in NI exports to the ROI increases. This is due to the model's import function, which assigns lower distribution costs as a result of a unified NI and ROI to the valuation of the imports, lowering their valuation on the import side, while on the NI export side the lower valuation increases quantities exported relative the bench.

Unification creates 6.6 billion Euro of NI exports in 2018, 5.2 billion of these go to markets in GB. 3.4 billion Euro of NI imports are generated with 2.6 billion Euro coming from GB. 210 million Euros of ROI exports are diverted from NI markets in 2018, while 220 million Euros of NI imports are diverted in the same year, with 10 million of those receding from ROW. Keep in mind, while NI imports from ROI increase, ROI exports to NI decrease, while the quantity of the trade is consistent the NI price of imports appreciates relative the domestic currency, lifting the valuation. Similarly, the price of the ROI exports into NI depreciates and the valuation consequently falls. In total, 9.6 billion Euro in net trade is created in 2018, which accumulates to 81.1 billion Euro by 2025.

Table 12. *Accumulate Net Trade Creation: All-Island*

ACCUMULATED NET TRADE CREATION			(BILLIONS EURO)	
All-Island			2018	2025
Trade Created			10.0	84.6
Trade Diverted			-0.4	-3.5
Net Trade Created			9.6	81.1

## VII Conclusions

To generate the results displayed in this paper, we customized an existing CGE model to fit the multi-regional case with 54 industrial sectors, 4 ROW regions, and representative public and private institutional sectors. In the paper, we detailed our methods for extracting a regional level SUT from the national level, and for compiling SAMs for both the ROI and NI, then outlined the circumstance surrounding our scenarios and scenario components and explained how they fit to the model. Finally, we demonstrated and analyzed critical parts of our numerical findings.

NIROI shows positive net effects on output for NI as well as for the ROI. The bulk of positive net effects are centered in NI, and this was to be expected given the gap in economic development between the ROI and NI. Exports from NI to GB increase by as much as 43.8 billion Euro by 2025, while total NI exports increase by as much as 49.4 billion Euro. Imports into NI from GB increase by 22.2 billion Euro, between 2018 and 2025, while imports from the ROI into NI increase by as much as 560 million Euro. Total imports into NI increase by as much as 49.4 billion Euro, by 2025.

While total exports from the ROI are predicted to decrease by 1.8 billion Euro and total imports into the ROI to decrease by 1.7 billion Euro, total trade creation is still expected to be positive, accumulating to 81.1 billion Euro by 2025. The model also suggests unification will raise GDP in NI by 2.1 to 2.6 billion Euro in the year the policy is implemented, depending on the extent to which NI government expenditure is cut and the amount of FDI attracted by the new tax regime. These gains could accumulate to as much as 25.3 billion Euro in the first eight years following unification.

GDP in the ROI could rise by 30 million to 152 million Euro in the year of policy implementation, again subject to the same assumptions. Across the first 8 years of unification, GDP gains in the ROI could rise from 10.3 billion Euro to 18.5 billion Euro. In total, Irish unification could boost all-island GDP in the first eight years by as much as 35.6 billion Euro.

The positive effects of our economic simulation exercise are strongly driven in the short-run by NI's change-over from the British Pound to the Euro. However, in the long-run they are the result of a common FDI regime that prompts NI's industrial activities to mirror the ROI's industrial structure. In theory, the common FDI regime attracts capital into NI and forces movements along the production possibilities frontier from low value-added industrial output to high value-added industrial output. But what works automatically in the model is in the real

world a combination of economic and political policy that is neither easily defined nor implemented. Krugman (1997) and Bradley (2006), for example, explain the dynamics that turn an inward oriented FDI regime into output. We relay some of those aspects here.

Attracting FDI is not only about implementing globally competitive tax rates but also, and in many ways more importantly, about restructuring an entire policy framework to attract and feed high value-added enterprises. This process catalyzes an initial clustering of similar industries, which generate a skilled and knowledgeable workforce. Skilled and knowledgeable human capital attracts more cluster growth through FDI, leading to information spillovers and, with the help of improvements in physical infrastructure, further investment. This process is fostered and supported with political action. High-value economic activities ask for high-end professional training, and thus for a forward-looking education system, an open labor market that makes efficient use of labor mobility in the EU, and active state based provisions that ensure excellent infrastructure, to name only the most prominent policy actions. In other words, successful economic unification, in terms of output, can't be expected from a solely market-driven process. The process needs to be closely monitored and guided with economic policies. In other words, magnifying already positive unification effects is part of an accommodating state policy.

The German Unification case is the most prominent example of the importance accompanying policy plays in economic and political unification. Across the life cycle of German Unification, currency valuation, wage setting, fiscal transfer, and industrial policy, among a myriad of other significant policies, each strongly influenced the accounting and opportunity costs paid by taxpayers<sup>88</sup>.

In the case of German Unification, given that both entities had their own currencies and the currency of the former German Democratic Republic was not convertible, a decision had to be made about an adequate exchange rate. Rather than following underlying economic fundamentals, the decision was guided by political considerations. The conversion rate of roughly 1:1 implied a 400 % appreciation of the former currency of the Democratic Republic, and this enormous cost-push drove substantial parts of the economic sectors of the East into insolvency. Moreover, in the German case, the also politically motivated initial move to adapt the system of industrial relations of the West, and to put East Germany on a wage path that was close to the one of the West, contributed further to undermining gravely the price competitiveness of the Eastern industrial sector. Unlike the first mistake, however, the second one could be reversed, but this revision was time-intensive. Finally, in a positive way, German unification can be seen as a case where ongoing accommodating policies for the relatively weaker region in the economic union paid off over time. Only substantial fiscal transfers from West to East made it possible for Eastern Germany not to lose out in the unification process.

Our modeling of Irish unification underplays potential positive effects of a political union as our key modeling assumption in regards to the public sector only considered the reduction in expenditures due to synergies but did not further assume that labor and capital employed in

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<sup>88</sup> See the most recent analysis of the Deutsches Institut für Wirtschaftsforschung (DIW 2014) that provides analytical as well as empirical insights in the processes of unification from today's perspective.

the public sector would be channeled to more effective use outside the public sector. Such a 'peace dividend' (Noland) seems plausible but also requires efficient reallocation processes that we excluded in our modeling. Rather, we opted for a conservative modeling that focuses on structural drivers. It seems fair to assume, though, that the positive effects of our modeling may even be a bit stronger than shown.

Two lessons for an Irish unification can be drawn. First, uniting two separated economies requires careful and reflective public policies that deal with fall-outs on the one side and foster adjustments on the other. Second, securing and strongly improving the skill levels of the workforce and providing a complementary industrial policy will not only reduce the fiscal cost of unification but also will also potentially attract genuine FDI and reduce the opportunity cost

Our modeling exercise points to strong positive unification effects driven by successful currency devaluation and a policy dependent industrial turn-around. While these effects occur in a static global economic environment, under ideal political conditions, they underline the potential of political and economic unification when it is supported by smart economic policy.

## Appendix 1

### Regional Trade [Trade Diversion Trade Creation Scenario]

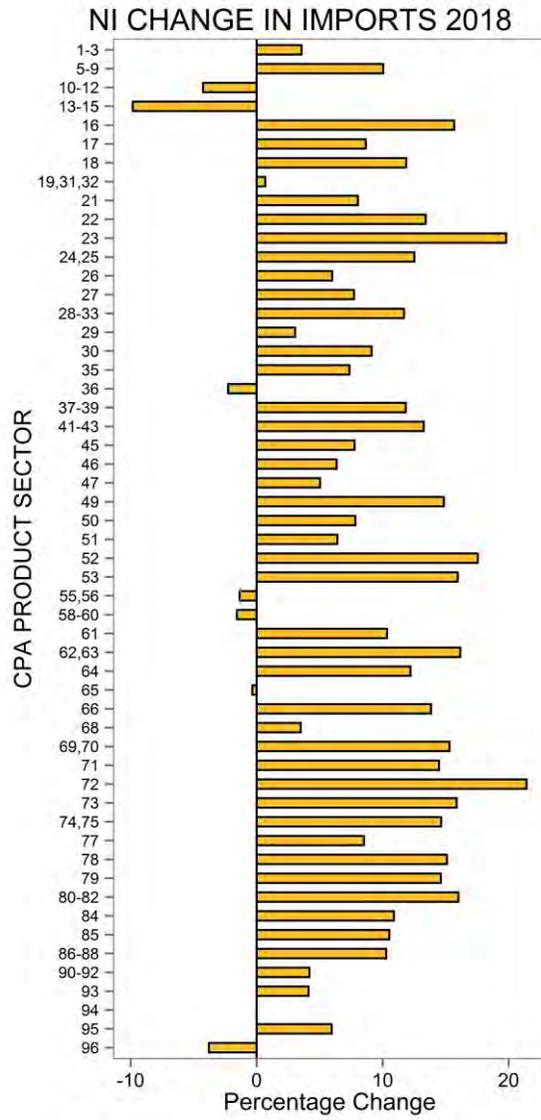
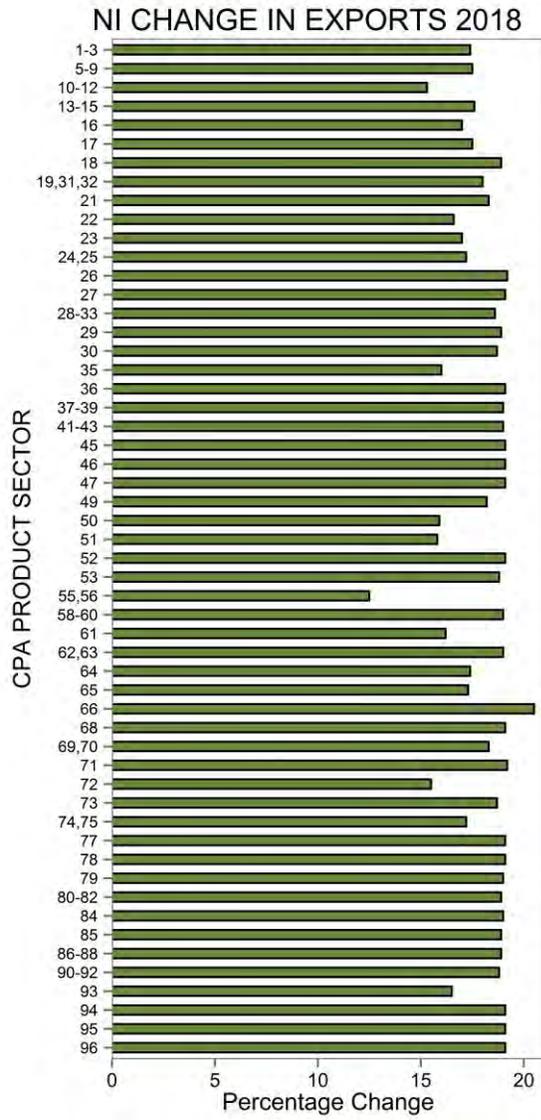
TRADE PARTNER	NI		CHANGE IN EXPORTS					(BILLIONS EURO)	
	2018	2019	2020	2021	2022	2023	2024	2025 TOTAL	
GB	5.19	5.27	5.35	5.43	5.51	5.59	5.68	5.76	43.80
REU	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.56
REUZ	0.36	0.36	0.37	0.37	0.38	0.38	0.39	0.40	3.01
ROI	0.45	0.46	0.46	0.47	0.48	0.48	0.49	0.50	3.79
ROW	0.51	0.52	0.52	0.53	0.54	0.55	0.56	0.57	4.29
TOTAL	6.57	6.67	6.77	6.88	6.98	7.08	7.19	7.30	49.36

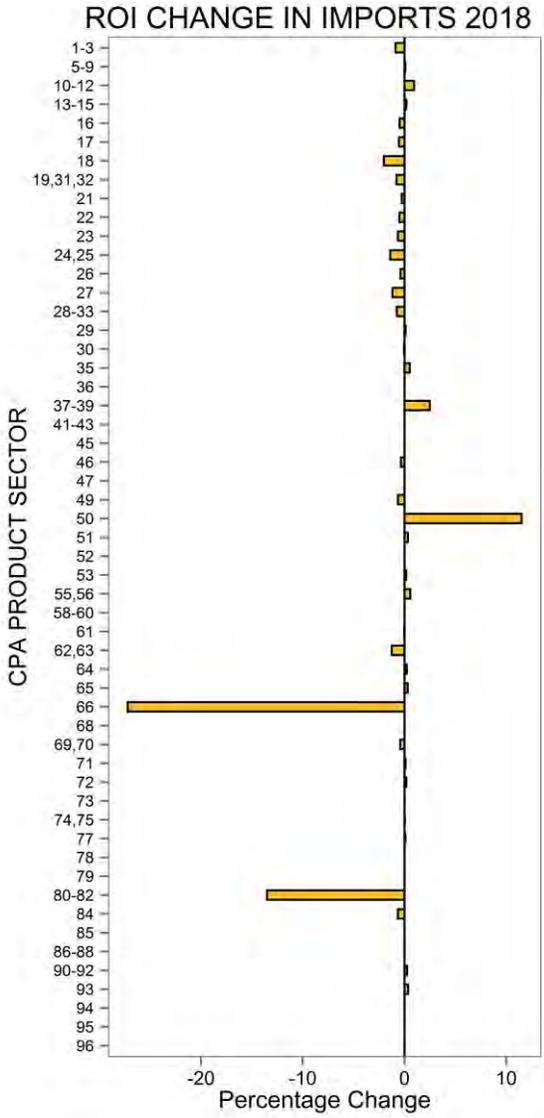
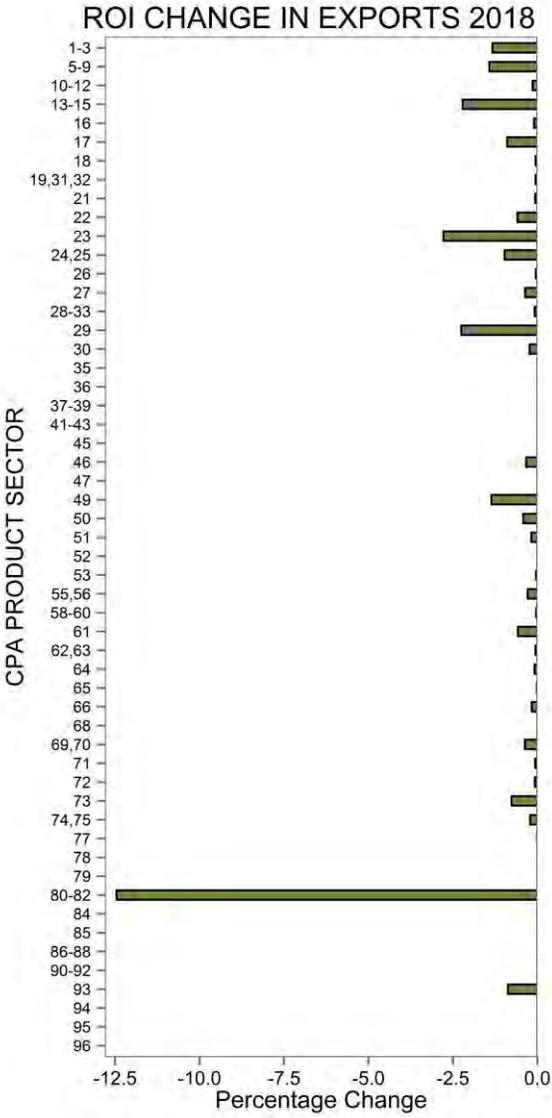
TRADE PARTNER	NI		CHANGE IN IMPORTS					(BILLIONS EURO)	
	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
GB	2.62	2.66	2.71	2.75	2.80	2.84	2.89	2.94	22.20
REU	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.47
REUZ	0.30	0.30	0.31	0.31	0.32	0.32	0.33	0.33	2.51
ROI	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.80
ROW	0.37	0.38	0.38	0.39	0.40	0.41	0.42	0.42	3.16
TOTAL	3.43	3.49	3.55	3.61	3.67	3.73	3.80	3.86	49.36

TRADE PARTNER	ROI		CHANGE IN EXPORTS					(BILLIONS EURO)	
	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
GB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NI	-0.21	-0.22	-0.22	-0.23	-0.23	-0.24	-0.24	-0.25	-1.82
REU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
REUZ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	-0.21	-0.22	-0.22	-0.23	-0.23	-0.24	-0.24	-0.25	-1.82

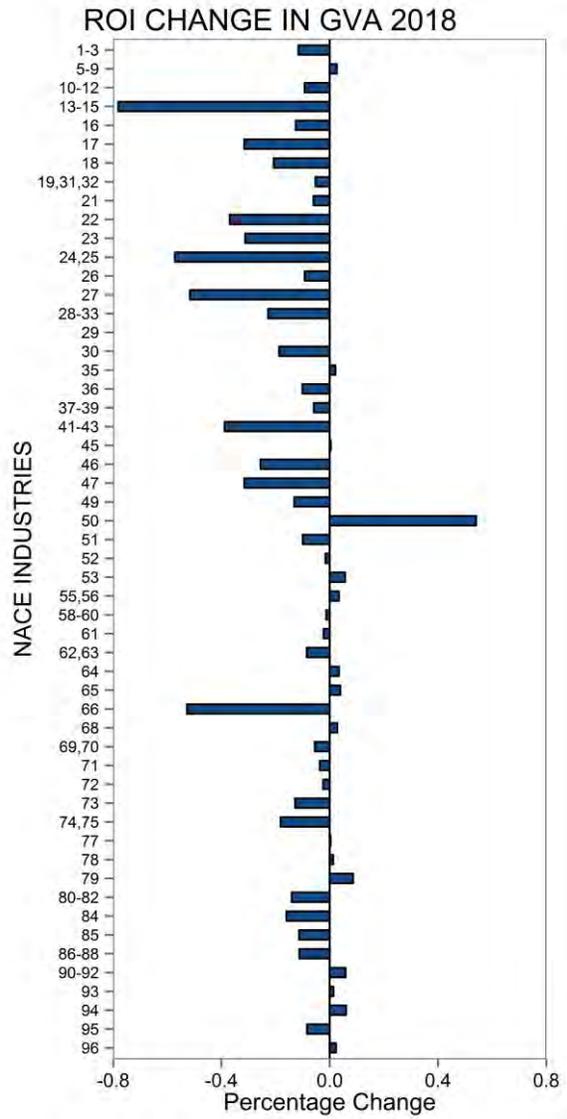
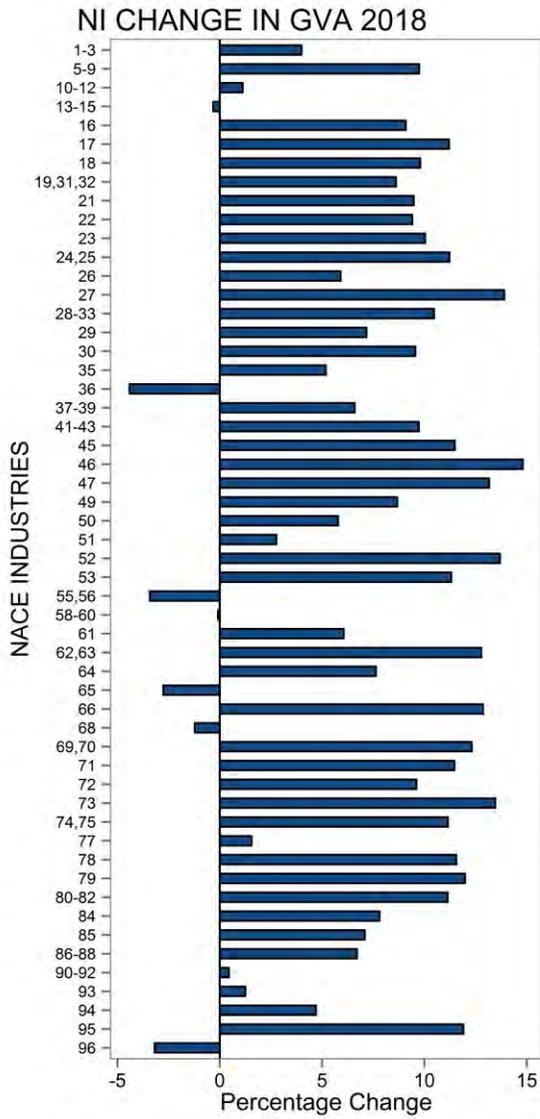
TRADE PARTNER	ROI		CHANGE IN IMPORTS					(BILLIONS EURO)	
	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
GB	-0.08	-0.08	-0.08	-0.07	-0.07	-0.07	-0.07	-0.07	-0.58
REU	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.15
REUZ	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.12
ROI	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.04	-0.03	-0.34
ROW	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.09	-0.09	-0.79
TOTAL	-0.22	-0.22	-0.22	-0.21	-0.21	-0.21	-0.20	-0.20	-1.69

### Sector Trade [Combined Scenario 3]





### Sector GVA [Combined Scenario 3]



## Model Commercial Tax Rates [and Sector Titles]

PRODUCT	NACE CODE	NI		ROI	
		Commodity Tax	Import Tax	Commodity Tax	Import Tax
Agriculture, forestry and fishing	G1_3	0.0001	0.0000	-0.0573	0.0052
Mining, quarrying and extraction	G5_9	0.0067	0.0003	0.0087	0.0021
Food & beverages and tobacco products	G10_12	0.1548	0.0056	0.1686	0.0276
Textiles, wearing apparel and leather products	G13_15	0.1207	0.0412	0.1112	0.0086
Wood and wood products (excl furniture)	G16	0.0123	0.0005	0.0183	0.0005
Pulp, paper and paper products	G17	0.0350	0.0029	0.0873	0.0001
Printed matter and recorded media	G18	0.0731	0.0000	0.0234	0.0000
Petroleum; furniture; other manufacturing	G193132	0.3965	0.1569	0.2776	0.0011
Basic pharmaceutical and chemical products	G21	0.0494	0.0033	0.0458	0.0008
Rubber and plastics	G22	0.0206	0.0011	0.0518	0.0008
Other non-metallic mineral products	G23	0.0291	0.0019	0.0183	0.0007
Basic and fabricated metals	G24	0.0170	0.0007	0.0236	0.0003
Computer, electronic & optical products	G26	0.0786	0.0057	0.0168	0.0011
Electrical equipment	G27	0.0668	0.0030	0.0535	0.0007
Machinery and equipment and repair/installation	G28	0.0187	0.0007	0.0266	0.0000
Motor vehicles, trailers and semi-trailers	G29	0.0449	0.0026	0.1733	0.0014
Other transport equipment	G30	0.0226	0.0007	0.0170	0.0010
Electricity and gas supply	G35	0.0399	0.0000	0.0563	0.0000
Water collection, treatment and supply	G36	0.0000	0.0000	0.1223	0.0000
Sewerage, refuse and remediation services	G37_39	0.0556	0.0024	0.0360	0.0000
Construction and construction works	G41_43	0.0665	0.0031	0.0903	0.0000
Motor fuel and vehicle trade and repair	G45	0.1133	0.0000	0.0140	0.0000
Wholesale trade	G46	-0.0002	0.0000	0.0012	0.0000
Retail trade	G47	0.0006	0.0000	0.0007	0.0000
Land transport services	G49	-0.0508	-0.0003	-0.0225	0.0000
Water transport services	G50	-0.0268	-0.0007	0.0009	0.0000
Air transport services	G51	0.0619	0.0022	-0.0033	0.0000
Supporting and auxiliary transport services	G52	0.0084	0.0000	0.0008	0.0000
Postal and courier services	G53	0.0198	0.0001	0.0330	0.0000
Accommodation and food & beverage services	G55_56	0.0827	0.0029	0.0999	0.0000
Publishing, film and broadcasting services	G58_60	0.0580	0.0030	0.0355	0.0000
Telecommunications services	G61	0.0499	0.0006	0.0479	0.0000
Computer consultancy; data processing	G62_63	0.0362	0.0002	0.0154	0.0000
Financial intermediation services	G64	0.0009	0.0000	0.0078	0.0000
Insurance, reinsurance and pension funding	G65	0.0287	0.0004	0.0139	0.0000
Other financial activities	G66	0.2309	0.0064	0.0655	0.0000
Real estate services	G68	0.0014	0.0000	0.0161	0.0000
Legal and accounting services; mgt consultancy	G69_70	0.0228	0.0001	0.0796	0.0000
Architectural and engineering services	G71	0.0150	0.0001	0.0026	0.0000
Scientific research and development services	G72	0.0509	0.0016	0.0000	0.0000
Advertising and market research services	G73	0.0140	0.0001	0.0064	0.0000
Other professional, scientific services	G74_75	0.0284	0.0013	0.0483	0.0000
Rental and leasing services	G77	0.0454	0.0021	0.0138	0.0000
Employment services	G78	0.0222	0.0002	0.0087	0.0000
Travel and tourism service activities	G79	0.0094	0.0000	0.0206	0.0000
Security, office & business support services	G80_82	0.0495	0.0016	0.0220	0.0000
Public administration	G84	0.0000	0.0000	0.0021	0.0000
Education services	G85	0.0018	0.0000	0.0003	0.0000
Human health and social work services	G86_88	0.0070	0.0000	0.0002	0.0000
Cultural and sporting services	G90_92	0.0957	0.0040	0.0009	0.0000
Recreation services	G93	0.0729	0.0013	0.0310	0.0000
Membership organisation services	G94	0.0038	0.0000	0.0004	0.0000
Repair of consumer goods	G95	0.0149	0.0004	0.0535	0.0000
Other services	G96	0.0361	0.0001	0.1298	0.0000

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**Report commissioned by K.R.B.**

A voluntary California Non Profit Social Welfare organization that is based in the San Francisco Bay area. It promotes friendship and peaceful resolutions to conflict. We would hope that this particular project will come to the attention of those that are involved politically and /or economically in Ireland. Conflict resolution leads to a more stable form of government which, in turn, leads to a more productive workforce and economy which leads to better returns on investments. Our organization believes that in today's world, if people are made aware of an alternative to the current situation, and that that alternative can bring a better quality of life then this may lead to a change in thinking of age old beliefs and prejudices. We believe that through totally independent studies such as this and by educating people and those of influence within governments on how their everyday lives may improve with change, that they may become more prone to cooperate and understand their adversaries point of view.

*Helping to Resolve Conflicts through Education*

