Testing and Constraining Inter-Regional Trade Flows using Supply and Use Framework

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Abstract:

Any analysis of regional economies must take into account regional trade flows (i.e. imports to and exports from neighbouring regions) in addition to international trade flows. However estimating and validating inter-regional trade flows is not straight forward and there are relatively few examples internationally. As a result the paucity of such data has retarded the capacity to construct sound regional economic models and provide a robust evidence base with which to formulate and assess regional policy.

This paper uses the Supply and Use (SUT) framework to test the plausibility of trade flow estimates at product and industry level. The SUT provide maxima and minima for each product-industry transaction, which can be used to test and constrain flow estimates. Using Irish data from 2005, inter-regional trade flows are estimated, tested and refined for the NUTS 2 regions.

Keywords: Inter-Regional Trade, Supply and Use Tables, Plausibility, Ireland.

Introduction

Any analysis of regional economies must take into account regional trade flows (i.e. imports to and exports from neighbouring regions) in addition to international trade flows. This presents two challenges: Firstly, these data are not usually available and must be compiled, typically from a wide variety of sources; and secondly, how can these estimates be tested for plausibility.

Part 1 of this paper presents how inter-regional flows for the two NUTS 2 regions in Ireland (the Southern & Eastern Region and the Border, Midland & Western Region) were estimated and Part 2 then outlines how these estimates can be plausibility tested (and constrained) using a Supply and Use framework. Part 3 gives a brief summary of the results.

Reference year 2005 is used as the basis for this exercise, as this is the latest year for which a national Input-Output table exists. It is important to have a national constraint, so that the derived Supply and Use Tables are consistent with both the national tables and the regional accounts.

Part 1 - Estimating Inter-Regional Trade Flows

Inter-regional trade flows were estimated using a variety of data sources. The movement of goods were estimated using transport freight statistics and then converted to values using average import prices. The

regional imports and exports of services and construction were estimated using supplementary data collected as part of the 2006 Annual Services Inquiry (CSO, 2008a) and Census of Building & Construction (CSO, 2008b) on regional purchases and sales. Non-market service sectors were imputed using the traded element of their respective sectors. Regional imports of electricity were estimated using average electricity transmissions sourced from the Eirgrid. A very brief summary of these methodologies are described in sections 1.1 – 1.5.

1.1 - Inter-Regional movement of Goods in Ireland

The CSO Road Freight Transport Survey (RFTS) provided the main platform for estimating the value of inter-regional movement of goods. The 2005 RFTS (CSO, 2006a) gives details on the origin-destination of goods at NUTS 3 level, type of goods and commodities that are carried and the broad industry type or purpose to which these commodities are delivered to/used for. For each region of destination a matrix consisting of 59 commodity groups, classified to NST/R (the EU standard classification for transport statistics) and 10 broad industry type/purpose classifications was compiled. These matrices were then mapped to NACE Rev.1.1 using the international trade CN classification as an intermediary concordance.

While every effort was made to avoid double counting the domestic transportation of goods en route from/to international import/export, it is possible that some of the goods included in the estimates for inter-regional trade have already been included in regional international imports/exports. NACE 29, the transportation of equipment also raised particular challenges, as the movement of goods in this case may not have necessarily involved a purchase transaction but may have only been leased or rented, in which case turnover would also be captured in NACE 71.

Further complications existed as the RFTS only captures the activity of lorries with an un-laden weight (ULW) over 2 tonnes. Furthermore only Irish registered vehicles fall within the scope of the survey. Consequently a number of adjustments were made for small vans, cabotage and additional sea, air and rail freight. The net effect of these adjustments was to increase the volumes of inter-regional goods freight reported by the 2005 RFTS by approximately 8%, from 25.9 million to 27.9 million tonnes.

A number of commodities or services were excluded from the freight data as they are also captured in the services data. For example, laundry, mail and refuse are treated as services (NACE 64, 90 and 93) and hence these services were deducted from the freight volumes, removing a total of 133,000 tonnes of inter-regional laundry/mail/refuse. The services data are seen as superior data, in that they overcome many of the shortcomings noted below. Furthermore, freight supplying the Motor Trades, Retail and Wholesale industries (NACE 50, 51 and 52) were also deducted from the freight totals for the same reason. This removed a further 18.9 million tonnes of freight.

Average import price per tonne of commodities for 2005 sourced from the international trade data (CSO, 2006b) were used to convert the estimated inter-regional tonnage into monetary values. Import prices rather than export prices were used as it was reasoned that these would correlate better or be more consistent with the values used in the international imports table. This approach while necessary had a number of limitations or short-comings that are worth noting:

1. The average international import prices used may not have been the appropriate prices to apply to goods being traded domestically. Most likely this was most problematic for commodities such as chemicals where internationally-traded prices typically contain a large element of value added or complications associated with transfer pricing;
2. The same average prices were used to value commodities going in either direction i.e. the average tonne of commodity *x* had the same price whether commodity *x* was being imported by the SE region or the BMW region;

3. The volume of trade reported in the RFTS was classified to an aggregate NST/R commodity code. Consequently the exact specifications of the commodity were unknown. Hence an average aggregate price per tonne was applied. This allowed a wide margin for error i.e. to significantly undervalue or overvalue the loads being transported between the regions. For example, broad headings such as "*Toxic Chemicals"* or "*Vehicles, Machinery, Appliances and Parts thereof*" left plenty of room for interpretation. This problem was even more pronounced for headings such as "*Mixed Loads*" or "*Miscellaneous Articles*". For example, the freight data contained 1.66 million tonnes of "mixed loads" (or approximately 6% of total inter-regional freight tonnage), of which 692,000 tonnes were moving from the BMW to the SE and 972,000 tonnes from the SE to the BMW.

1.2 – Inter-Regional flows of Market Services

The inter-regional flows of market services were estimated using the results of a one-off supplementary survey incorporated into the 2006 ASI. This survey asked a sub-sample of the sampled enterprises to apportion their turnover and purchases between the SE region, the BMW region or international trade. Enterprises were asked to apportion the value of their turnover between exports and the two NUTS 2 regions. For both purchases for direct resale and purchases of other goods and services, enterprises were also asked to apportion between imports and purchases from either of the two NUTS 2 regions.

The quality of the turnover data was far superior to that of the purchases data i.e. responding enterprises appeared to have a much clearer knowledge of the value and location of their customers than they did regarding their suppliers. Certainly the partial non-response for the purchases questions was markedly higher than for the turnover questions. In many instances the purchases for the inter-regional trade part of the questionnaire didn't correspond with (or make sense *vis-a-vis*) the data provided in the main body of the questionnaire.

Rather than calibrate the sales and purchases data, the turnover data were used exclusively. Regional exports (sales) were transposed so that services products were converted to regional imports (purchases) by the industry sector. In other words industry outputs were converted to commodity inputs. Thus turnover generated by the Business Services sector (NACE 74) located in the SE region from exporting to the BMW region, equalled the value of Business Services commodities (services) imported by the BMW region from the SE. As there were insufficient services deflators, the 2006 data were weighted to 2005 regional Use Tables.

1.3 – Inter-Regional flows of Construction services

Flows of Construction services between the two regions were estimated from a special supplementary survey to the CSO Census of Building & Construction (CBC). As this census is limited to enterprises employing 20 persons or more an estimate for small enterprises had to be added. This was done using data from the DKM Economic Consultants review of the construction industry (DKM, 2007). Additional adjustments were made to take account of payments made to sub-contractors and VAT. As a consequence, the official measure of Construction output of €14.6bn published in the CBC was increased to €38.8bn.

It was assumed that the smaller building enterprises (i.e. those with less than 20 persons engaged) were only involved in local work and consequently are not involved in cross-regional activity. Furthermore some additional adjustments were made to remove possible double counting between the survey results and purchases of building materials (such as timber, stone etc.). In the absence of any data it was assumed that sub-contractors, like smaller building contractors were not involved in cross-regional activity. This last assumption may well be unrealistic but is important as sub-contractors possibly

account for as much as 55% of output. Consequently the estimates for inter-regional construction services may be underestimated.

1.4 – Inter-Regional flows of Non-Market Services

In recent years the scope of market services has extended into some sectors traditionally considered non-market, such as health, waste collection etc. The 2006 ASI study on inter-regional trade covered enterprises in NACE 85 (Health & Social Work Services) and 90 (Sewage and Refuse Disposal Services). The traded element of these services did not report any inter-regional trade in 2006. This was the basis for imputing zero inter-regional trade for the sectors as a whole (traded and non-traded). The same pattern was applied to NACE 75 (Public Administration and Defence) and 80 (Education) also.

1.5 – Inter-Regional flows of Electricity

The Eirgrid Transmission Forecast Statement 2005 - 2011 (Eirgrid, 2005) was used to estimate flows of electricity between the regions. The appendices to these reports (J and K) provided average electricity flows (and direction) in terms of megawatts (MW) between each node on the grid. The nodes were mapped to each region then flows of electricity transmitted between the regions were isolated. Calculations were based on the "inbound" megawatts figure (i.e. electricity lost during transmission was not counted). Annual flows of electricity between the regions was estimated by taking the simple arithmetic average of the transmissions for Summer and Winter 2005-06 and the Summer Night Valley and Winter Peak demand for 2005 (Eirgrid, 2006).

Converting MW to monetary values was problematic, as insufficient information was available on the relative consumption between residential and enterprises (by size class, sector and region). Consequently ratios of flows of electricity between the regions over total electricity consumed were applied to the electricity element of NACE 40 (approximately 45%) from the Total Use Tables 2005 net of imports. Only total intermediate consumption plus final household demand was included. The result was electricity worth approximately €413 million was imported by the BMW region from the SE while €132 million worth of electricity flowed from the BMW region to the SE.

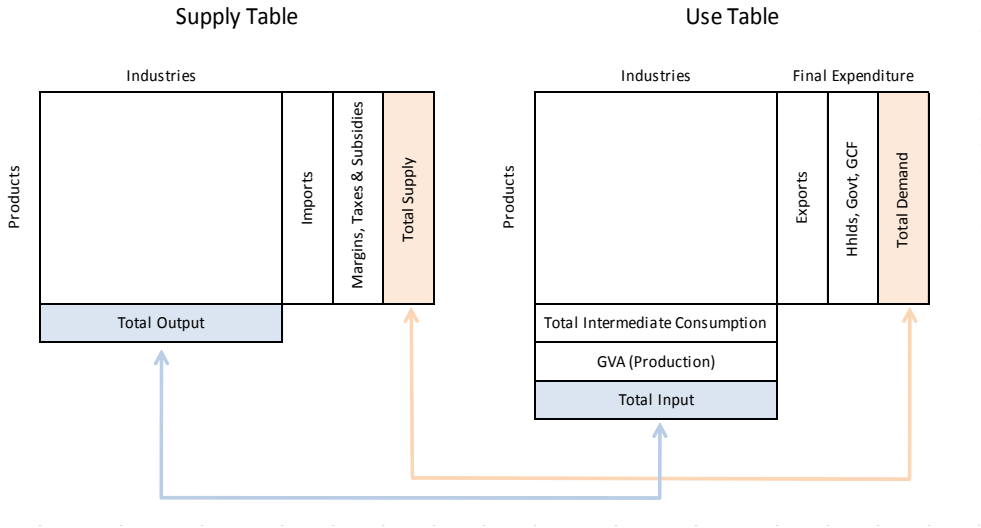
Part 2 – Testing and Constraining Estimates

The national Supply and Use framework provides a detailed, balanced version of the income, expenditure and output approaches to national accounts. Consequently there are a number of identities that must be observed. In particular, for any national (or regional) tables two critical identities must hold:

(1) Total output for each industry must equal total input for each industry;
(2) Total supply of each product must equal total use of each product.

This requires the purchaser's prices in the Use Table matrix to be transformed or revalued to basic prices by accounting for taxes, subsidies and margins.

Figure 2.1 – Balanced Supply - Use Framework



For balanced regional Supply and Use Tables (R-SUT), where regional SUT sum to national SUT, have an additional set of identities that must hold:

(1) The sum of the inter-regional trade flows (domestic imports and exports) must cancel out to zero.

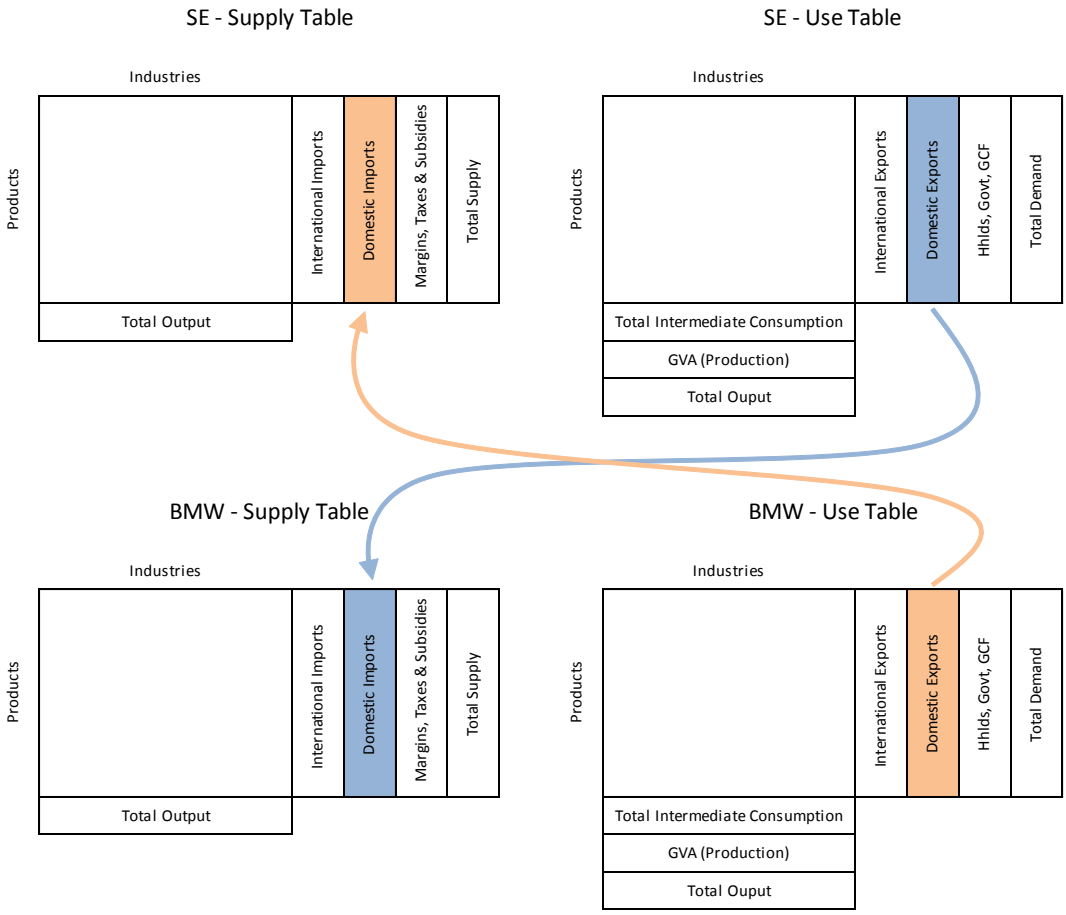
Thus, for the 2 region model presented in this paper, the domestic imports in one region must equate to the domestic exports from the other. The inter-regional flows can thus be dropped out to reconcile with the national SUT. Consequently for R-SUT, and extra set of columns, representing the inter-regional trade flows, for each additional region, must be added to the SUT. So for the 2 region model, an additional import column must be added to each Supply Table and an additional export column must be added to each of the Use Tables (see Figure 2.2).

Regional SUT provide a very robust framework with which to test the plausibility of inter-regional flows. Furthermore, they provide a set of constraints (maxima and minima) both at the overall regional economy level and at the individual product/industry level. Figures 2.1 and 2.2 show that for each regional economy:

- *Total Output* = *Total Input*;
- *Total Supply* = *Total Demand*; and
- $\sum$ *Domestic Imports* = $\sum$ *Domestic Exports*.

Furthermore the sum of the R-SUTs must equal the national SUT, once inter-regional trade drops out. These constraints allow estimates to be tested at the aggregate level. A further constraint exists however, that allows inter-regional flows to be tested at the product/industry level.

Figure 2.2 – Inter-Regional Trade flows in Regional Supply - Use Framework



The Use Tables for Domestic Output are simply the Final Use Tables adjusted to exclude imports (both domestic and international) i.e. total flows are converted to domestic flows and where purchaser's prices have been transformed to basic prices by excluding margins, taxes, subsidies. This transformation is described by the following statement:

$$U^D_{Rn} = U^T_{Rn} - M_{Rn} - T_{Rn} + S_{Rn} - I^I_{Rn} - I^D_{Rn}$$

Where:

U^D_{Rn} and U^T_{Rn} are Use Tables for Domestic Output and Total Use Tables for region *Rn* respectively.

M_{Rn} are Trade Margins for region *Rn*.

T_{Rn} and S_{Rn} are Product Taxes and Subsidies for region *Rn*.

I^I_{Rn} and I^D_{Rn} are International and Domestic Imports for region *Rn*.

The Use Table for Domestic Output imposes a detailed set of constraints on any estimate of inter-regional flows, as the flows are distributed across all the sectors in the intermediate matrix. Thus U_{Rn}^{D} provides a maximum and minimum constraint for each product/industry in the matrix. The minima are always zero i.e. there are no negative imports or exports. The maximum valued of inter-regional trade for a particular product/industry is where $U_{Rn}^{D} = 0$ i.e. no negative cells are permissible in the Use Tables for Domestic Output, or in other words, no negative use (or production) is allowed. This value will vary for every product/industry cell in each regional matrix.

Part 3 - Results

As noted in part 1, a combination of primary and secondary data was used to estimate inter-regional flows between the two sub-national regions of Ireland. These estimates required some adjustments to reconcile them within the regional Supply-Use framework. In all cases, adjustments were downward, as original estimates were too large (over-estimated) *vis-a-vis* the residual domestic regional production (i.e. acceptable ranges in the regional Use Tables for Domestic Output). Table 3.1 shows the extent of these revisions.

Perhaps not surprisingly, the volume of merchandised goods moving between the regions which was based primarily on road freight statistics and converted to values using average unit prices derived from the international merchandised import statistics required the biggest adjustments (in absolute and relative terms). In addition to the limitations noted above an additional contributing explanation may be a double counting between international and domestic trade. Although every effort was made to exclude international imports and exports from the domestic trade flows, the possibility remains that hauliers who collect/deposit freight at ports may legitimately record journey as a domestic one, when in fact the ultimate origin/destination of goods is outside the State.

The construction, market services and non-market services estimates were derived directly from survey data and required considerably less adjustment. Nevertheless non-trivial adjustments were required. For the construction sector in particular the sample of the supplementary survey was small and any repeat studies should address this. This criticism applies less to the services sector, although more data could be collected on the financial sectors. The artificial nature of the NUTS 2 regions in Ireland no doubt contributed to survey error, as respondents would most likely not be familiar with the boundaries of these regions and may not have given the instructions and maps provided in the questionnaire due care and attention.

Table 3.1 – Adjustments to Inter-Regional Estimates to Reconcile with R-SUT

Industry	Adjustment
Agriculture	-0.37
Mining & Quarrying	-
Manufacturing	-0.32
Electricity, Gas & Water	-
Construction	-0.45
Distribution	-0.33
Transport & Communications	-0.13
Financial Intermediation	-0.20
Public Administration	-
Health & Education	-
Business Services	-0.11
Total	-0.23

Conclusions

There are a variety of methodologies and sources from which estimates of inter-regional trade can be derived. Once these estimates have been compiled, it is important that their plausibility be tested, particularly if those estimates are to be used to support policy decisions.

The R-SUT provides a useful framework where such estimates can be tested at both an aggregate and at a product/industry level. The R-SUT provides a range of constraints against which estimates can be tested and constrained. In particular the regional Use Tables for Domestic Output provide a powerful tool for plausibility testing, especially as any changes to these tables must be fed back and reconciled with the overall SUT.

References:

CSO (2006a), 2005 Road Freight Transport Survey. www.cso.ie

CSO (2006b), 2005 Average Import Prices – Special Tables from International Trade data. www.cso.ie

CSO (2008a), 2006 Annual Services Inquiry. www.cso.ie

CSO (2008b), 2006 Census of Building & Construction. www.cso.ie

CSO (2009), Supply and Use and Input-Output Tables for Ireland. www.cso.ie

CSO (2006), 2005 Road Fright Transport Survey 2005. www.cso.ie

DKM Economic Consultants (2007), Review of the Construction Industry 2006 and Outlook 2007 – 2009. Dublin.

Eirgrid (2005), "Transmission Forecast Statement 2005 – 2011". www.eirgrid.com

Eirgrid (2006), "Transmission System Performance Report 2005 – System Data and Performance Statistics". www.eirgrid.com

Eirgrid (2009), "Generation Adequacy Report 2010 – 2016". www.eirgrid.com

Eurostat (2008), "Eurostat Manual of Supply, Use and Input-Output Tables. Eurostat Methodologies and Working Papers", ISSN 1977-0375, European Commission, Luxembourg.

MacFeely, S., R. Moloney and M. Kenneally (2011), A study of the NUTS 2 Administrative Regions using Input-Output Analysis, *Journal of the Social and Statistical Inquiry Society of Ireland,* Vol. XXXX.