Re-Estimation Of The Trade Block In The Bank's Quarterly Macro-Econometric Model

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ABSTRACT

The aim of this paper is to describe the re-estimation of the trade block in the Bank's quarterly macro-econometric model. The trade block is re-estimated as part of a general re-estimation of the entire model. This is necessary as the database for the first version extended only as far as the mid 1990s. Furthermore, a number of problems remained with the first version which it is hoped can be resolved by re-estimation.

It is of particular interest to re-examine the export equations, given the recent exceptionally strong performance of exports and the change in composition towards increasing dominance by high-tech sectors, which are predominantly foreign owned.

The paper outlines the recent performance of the export sector and describes the data on which re-estimation is based. The structure of the equations, in terms of long-run and short-run components, is then outlined. The re-estimation of each equation is then described.

1. Introduction

This paper describes the re-estimation of the trade block of the Bank's quarterly macro-econometric model.

The equations under consideration are the export volume and price equations and the import volume and price equations. For each equation, both a long-run and short-run formulation are estimated. Thus, eight equations in total are estimated. Given the recent exceptionally strong performance of exports, it is of particular interest to re-examine the export equations.

The paper is laid out as follows. Section 2 describes the ESCB context in which the model was initially built, Section 3 why it is being re-estimated and Section 4 the data used. Section 5 describes the recent evolution of exports, and Section 6 the general structure of the equations. Sections 7 to 9 then describe in turn the re-estimation of the export volumes, import volumes, export deflator and import deflator equations. Section 10 concludes.

2. The ESCB Context

The Bank's model forms the basis for the Irish component of the ESCB's Multi-Country Model (MCM) project. This project began in 1997 as interest increased across the ESCB in model-building

1 The author is an Economist in the Economic Analysis, Research and Publications Department. With thanks for helpful comments to Mark Cassidy, Maurice McGuire, Tom O'Connell, Mary Ryan and Karl Whelan. Any remaining errors are the sole responsibility of the author.

as a tool to assist decision making by the future ECB Governing Council. The aim of this project is to develop a quarterly model for each Eurosystem country to facilitate cross-country comparability and the analysis of shocks or simulations pertaining to the euro area. This necessitates a common theoretical framework across countries. Given the euro-area focus, the models may differ from other national models designed without such a focus.

The resulting models should be capable of being linked together. Models from 12 ESCB countries can currently be operated in a linked format through their trade blocks, thus providing a mechanism for assessing policy responses and projections of the group of countries as a whole. The Irish model was linked in 2001. In non-linked or 'stand-alone' mode, the model is used as an input into the Irish contribution to the ESCB Macroeconomic Projection Exercises, for policy analysis within various ESCB fora and for domestic policy analysis within the Bank.

3. Why Re-estimation is Needed

The first version of the Bank's model was estimated in 1999 (see McGuire and Ryan, 2000). The dataset for that first version ended in 1996 for most variables or 1995 for some variables. It is now necessary to re-estimate with an extended dataset to allow the model to be based more on the economy of the 1990s than was the case with the previous version. Other reasons are also relevant. The CSO has made significant revisions to its National Accounts Data which could be incorporated in an extended database. An improved version of the Chow-Lin procedure used for interpolation is also available (Frain, 2004). Furthermore, problems remained with the first version of the model which it is hoped can be ironed out second time round. These include problems with some of the long-run relationships and non-convergence to a long-run steady state. This means that forward-looking expectations could not be incorporated.

The priority with the first version of the model was, however, to produce a model that fitted the data well and could be used for short-term forecasting and policy analysis.

4. Data

The data used come from a specially constructed quarterly dataset covering the period 1980q1 to 1999q4, which was interpolated from annual National Accounts data[2]. This was necessary as official quarterly National Accounts are only available from the mid 1990s onward. Due to the need for a long consistent time series, the data are based on the 1979 version of the European System of Accounts (ESA 1979), as data on an

2 For details see, McGuire, M., O'Donnell, N., and Ryan, M. (2002).

ESA 1995 basis are only available from the CSO from 1990 onwards.

The data were interpolated from an annual to a quarterly basis, with quarterly indicators, using a procedure based on that of Chow and Lin (1971). For details, see Frain (2004). The indicator data was first examined for seasonality using the TRAMO/SEATS seasonal adjustment programme (Gómez and Maravall, 1996). In most cases, the seasonally adjusted indicator series supplied by the seasonal adjustment package was used in the interpolation procedure. However, in the cases of the real exports and imports volumes series, the level of noise in the series was considered to be high, especially when the two series were considered together. This led to sharp quarterly movements in GDP from net trade effects. Therefore, a decision was made to use the underlying trend in these quarterly series as the indicators for the interpolation procedure, i.e., the original series minus both the seasonal and short-term noise components, as estimated by TRAMO/SEATS.

5. Export Performance

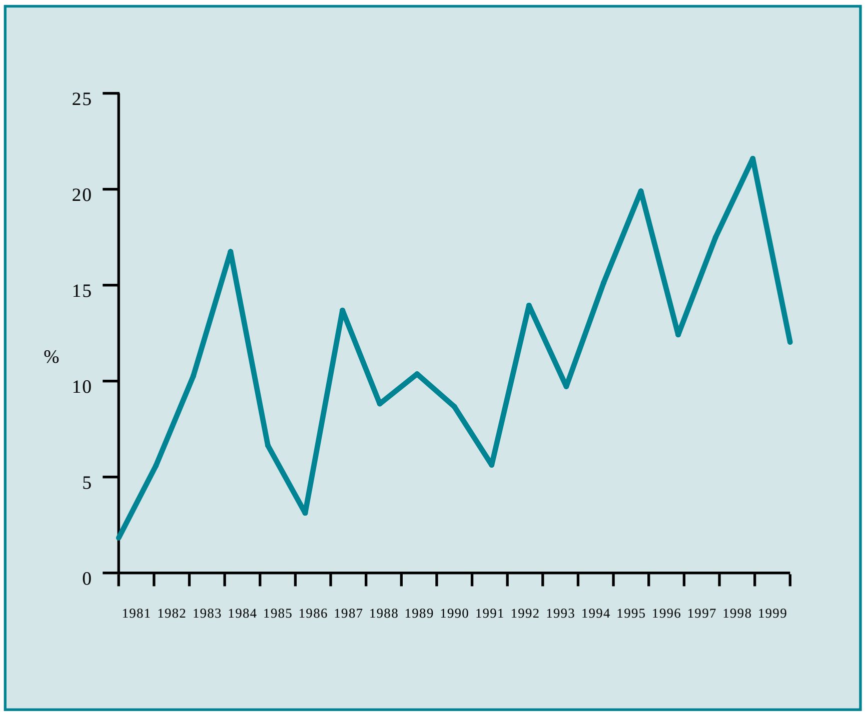
Given the recent exceptionally strong export performance of the Irish economy, it is a particularly interesting exercise to re-examine estimated export equations. Irish export growth has been strong since the 1970s when foreign multi-nationals first began to invest in Ireland as an export base, attracted by industrial policy measures and location within the EU[3]. In the 1990s, export performance was boosted by relatively low labour costs by international standards and a favourable exchange rate. The strength of the US economy at this time also played an important role, as a market for exports and a source of foreign direct investment.

Figure 1 on the following page shows the growth rate in annual export volumes, over the period under consideration, using the annual data provided to the Bank by the CSO. The upsurge in export volumes in the 1990s is clear. Indeed, the average annual growth rate over the period 1990 to 1999 was 14%, compared with 8.5% over the period 1981 to 1989. Over the period 1995 to 1999, exports grew by a huge 80%. Capturing this enormous growth in an econometric equation may well prove problematic.

Compared to its trading partners, the Irish performance has been extremely favourable, reaching around twice the rate of export volume growth of the euro area and the UK between 1987 and 1996, with an average of 11.7%, on a par with the Asian Tiger economies (Cassidy and O'Brien, 2005).

3 For a more detailed study of the evolution of Irish exports, see the article by Cassidy and O'Brien, this issue.

Figure 1: Growth in Export Volumes



Specialisation

Irish exports have become increasingly specialised in the period under consideration. The composition of exports has changed significantly, becoming increasingly dominated by high-tech sectors, which are predominantly foreign owned.

Table 1 below shows the proportion of *nominal*[4] exports accounted for by each of ten SITC[5] classifications for selected years of the time period under consideration. These are taken from the trade statistics published by the Central Statistics Office and do not correspond to the model data.

Table 1: Percentages of Total Exports of SITC Export Categories, Selected Years

SITC		1980	1990	1995	1999
0	Food & Live Animals	33.5	19.9	17.8	8.3
1	Beverages & Tobacco	2.1	2.3	1.8	1.2
2	Crude Materials, inedible, except fuels	4.4	3.6	2.1	1.2
3	Mineral fuels, lubricants & related materials	0.7	0.6	0.4	0.3
4	Animals & Vegetable Oils, Fats & Waxes	0.2	0.1	0.1	0.0
5	Chemicals and Related products, n.e.s.[6]	12.7	15.9	19.3	32.0
6	Manufactured goods classified chiefly by material	12.8	8.0	4.9	2.7
7	Machinery & transport equipment	18.7	31.3	35.1	39.6
8	Miscellaneous manufactured articles	10.9	14.2	15.8	11.5
9	Commodities and transactions not classified elsewhere	4.0	4.1	2.7	3.2
Total		100	100	100	100

4 A breakdown of *real* export data is unavailable.
5 United Nations' Standard International Trade Classification.
6 N.e.s. refers to not elsewhere specified.

The category of 'chemicals and related products' increased its share from around 13 per cent in 1980 to 19 per cent in 1995 with a further large increase to 32 per cent in 1999. Similarly, the 'machinery and transport equipment' category, which includes ICT products, doubled its share from 1980 to 1999 (see figures 2 and 3 below). Both of these categories are predominantly foreign owned.

Figure 2: Contribution to Total Exports of Chemicals and Related Products, %

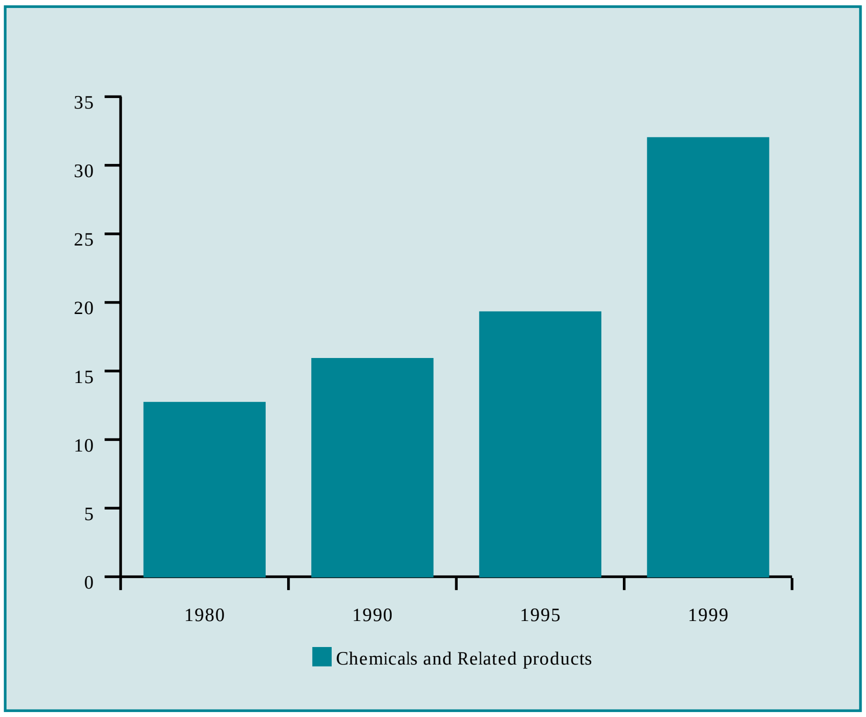
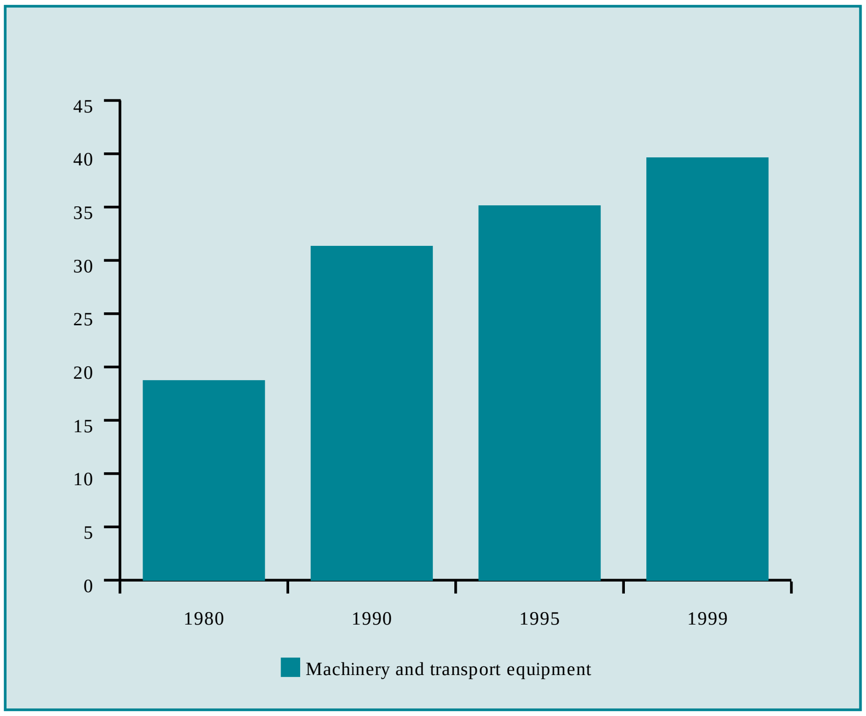


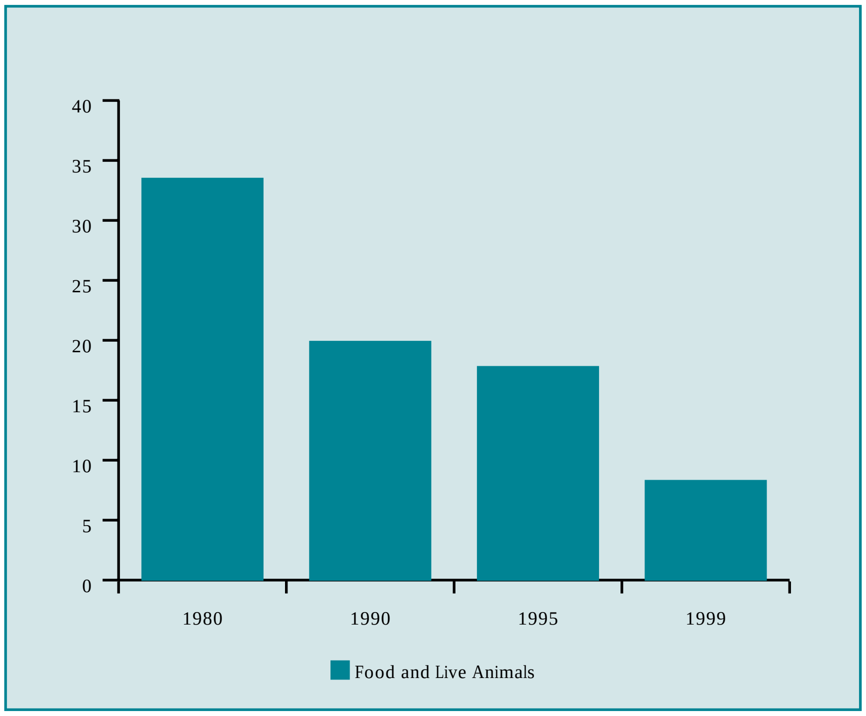
Figure 3: Contribution to Total Exports of Machinery and Transport Equipment, %



Taken together, these two categories accounted for just over 31 per cent of total exports in 1980, jumping to 71.6 per cent in 1999.

Categories showing a large decline in their share were ‘food and live animals’ (see figure 4 below), and ‘manufactured goods classified chiefly by material’.

Figure 4: Contribution to Total Exports of Food and Live Animals, %



Within each category, detailed breakdowns are possible and they too have an interesting picture to tell. For example, the sub-category ‘office machines and automatic data processing machines’ which covers ICT products, increased its share of the ‘machinery and transport equipment’ category from 34 per cent in 1980 to 58 per cent by 1999. Again, this sub-category is dominated by foreign owned firms.

Such specialisation has implications for Ireland’s export growth. Cassidy and O’Brien (2005) show that Ireland’s degree of specialisation in the ICT and chemicals sectors was higher than the world average at the beginning of the 1990s, and was also growing. World demand for exports grew most rapidly in these sectors, particularly ICT, during the 1990s. These factors combined would lead to an increase in Ireland’s export market share.

Implications for Estimation

The extremely strong growth in exports, fuelled by foreign direct investment, will have implications for estimation of an exports equation. World demand and relative price competitiveness variables are typically included as explanatory variables in export equations. These alone are, however, unlikely to be sufficient to account for recent export performance. Unfortunately, as suitable data on foreign direct investment covering the estimation sample are not readily available, it is difficult to isolate

the effect of the foreign direct investment boom on overall export performance. Efforts will be made to proxy for this effect in estimation, as will be described below.

6. The Structure of the Equations

The MCM models have a dual structure in that relationships between variables differ over different time horizons. There is assumed to be an equilibrium structure to the economy that determines the relationships between variables in the long run. The long-run co-integrating relationships were estimated by a variety of methods; the Johansen procedure (Johansen, (1998), Johansen and Juselius (1990)), the Phillips-Hansen approach (Fully Modified Ordinary Least Squares, FM-OLS, (Phillips, 1991), (Phillips, 1994), (Phillips and Hansen, 1990)) or by the Auto Regressive Distributed Lag (ARDL) approach to cointegration. The most satisfactory (or least unsatisfactory) relationship was then selected.

The short-run relationships are generally freely estimated by OLS with the long-run co-integrating relationships entered into the short-run equations as error correction terms. A general to specific approach was adopted for the short-run relationships with a very general starting specification that includes a number of lags of variables that might be considered relevant along with the lagged error correction term. Where choices exist in relation to the selection of long or short-run equations, relative diagnostics are assessed and also the likely behaviour of the equations in the model context. In some instances, it may be preferable to retain insignificant variables in the interests of the functioning of the overall model. Unless otherwise stated, the sample period was from 1980q1 to 1999q4.

7. Estimation of Exports Relationships

7.1. Recent Research on Exports

Considering recent studies of Irish exports, Bredin *et al* (2003) analyse the long and short run relationships between exports to the EU, foreign income, relative prices and exchange rate variability over the period 1979 to 1995, using quarterly data. Total exports and sectoral exports SITC 0-4 and SITC 5-8 are considered, corresponding broadly to the exports of indigenous Irish firms and multinationals, respectively. While their main focus is on exchange rate variability, the long-run relationship between Irish exports to the EU and EU economic activity[7] is found to be positive, large and statistically significant, especially in the multinational sector where the estimate is 4.87 compared with 2.59 for indigenous exports. According to the authors, this reflects the fact that exports of multi-national firms are generally high-tech products which tend to be highly income elastic.

7 The weighted average of the GDP series of Ireland's five most important trading partners , i.e., the UK, Germany, France, the Netherlands and Italy.

A high income elasticity of demand for Irish exports was also found by earlier studies, e.g., O'Connell (1978) and Browne (1979) find long-run elasticities in excess of 3. It should be noted that these earlier studies were carried out before the advent of non-stationary time series econometric techniques.

Other recent studies which employ modern time-series techniques include Caporale and Chui (1999) which in a multi-country study finds an income elasticity for Ireland of 2.97[8] and McGettigan and Nugent (1995) which finds, depending on the measure of exports chosen, a long-run elasticity with respect to world demand of 1.782 to 2.042[9].

However, within the country blocks of the ESCB multi-country model, it is necessary that the coefficient on foreign demand is unity in order to operate the models in linked mode. A value greater than unity implies that a country's exports and therefore output would grow at a faster rate than world demand in the long-run and this would not be feasible.

Thus, similar structures are evident across different country blocks with the explanatory variables in the export equations being foreign demand and relative prices, with a unitary elasticity on foreign demand. Time trends and dummies also feature. For example, the export equations in the Greek and Belgian models contain time trends to capture deteriorating export performance, in contrast to the Irish case (Sideris and Zonzilos, (1995), Jeanfils (2000)).

7.2. Estimation of Long-Run Relationship

Long-run exports in the MCM system are generally modelled as a function of world demand (WDR) and a price competitiveness indicator and this was the case in the first version of the Irish MCM block.

$$X^* = f(\log(WDR),(\log(XTD)-\log(CXD)) \qquad [1]$$

where X^* refers to the long-run level of exports, WDR to world demand and XTD to domestic export prices. The variable CXD refers to competitors' prices for their export goods.

Data on world demand and competitors' prices were supplied by the ECB. For a description of the indicators used in the interpolation procedure, see Annexe 1. Tests for stationarity (Augmented Dickey Fuller (ADF) tests) showed that all variables were stationary in first differences.

The estimated coefficients in the previous version were in line with what one would expect from a small open economy with

8 Using annual data for the period 1960-1992.
9 Using quaterly data for the period 1975-1994.

exports having a unitary elasticity with respect to world demand, with this restriction accepted by the data. Exports were also highly price elastic with respect to relative prices.

This was the starting point for re-estimation. However, attempts to simply re-estimate this equation with the new dataset proved unsatisfactory. The estimated coefficient on world demand was generally estimated at a value greater than unity and a unit value could not be imposed. A value greater than unity implies that Irish exports and therefore output would grow at a faster rate than world demand in the long run. This would cause the model to be explosive and lead to convergence problems.

In order to account for the recent exceptionally strong export performance of the economy, an attempt was made to include a variable which would capture the effect which inflows of foreign direct investment have had on exports. However, suitable data on foreign direct investment are not available. Instead, a variable measuring the share of industry in total output[10], *INDSH*, was constructed and included in an attempt to capture the strong export performance of the foreign-owned sector. However, inclusion of this variable on its own did not markedly change the results.

The next approach taken was to include a time trend in the original specification, again in an attempt to proxy for the performance of the foreign-owned sector. This again proved futile as once more the coefficient on world demand could not be restricted to unity.

The approach which was eventually settled upon was to include both a time trend and the variable measuring the share of industry in output in the original specification. This yielded two potential long-run relationships. Table 2 below shows the results before the coefficient on world demand was constrained to unity, Table 3 shows the results after the restriction is imposed.

Table 2: Results from re-estimation of long-run exports equation, including industry share variable and time trend

	Johansen[11]	Phillips-Hansen[12]
intercept	None	3.6649 (0.62953)
lwdr	0.9147(*) (0.33923)	0.64649(**) (0.21658)
lxtd-lcxd	−1.6371 (0.38784)	−1.5137 (0.19569)
lindsh	1.7526 (0.16901)	1.3991 (0.14054)
time	0.011445 (0.0050184)	0.015898 (0.0030892)

Standard errors in brackets
(*)Restriction to unity accepted, CHSQ(1) = 0.062537 [0.803].
(**)For imposition of restriction that the coefficient on lwdr=1, CHSQ(1)=2.6642[0.103]

10 See Annexe 1 for details.
11 Order of VAR = 3, chosen r = 1.
12 Parzen weights, truncation lag = 2, Trended Case, sample is from 1981q1 to 1999q4.

Table 3: Results from re-estimation of long-run exports equation, including industry share variable and time trend, restricting coefficient on world demand to unity

	Johansen[13]	Phillips-Hansen[14]
intercept	None	4.4780 (0.48045)
lwdr	1.00	1.00
lxtd-lcxd	–1.7107 (0.25636)	–1.8177 (0.17586)
lindsh	1.7311 (0.14650)	1.3026 (0.13618)
time	0.010186 (0.0003)	0.010810 (0.00032)

Standard errors in brackets

7.3. Short-run Relationship

The next step was to estimate a short run equation, with a long-run relationship entered into the short-run equation as an error correction term. The short-run equation in the previous version of the model was a function of lagged changes in world demand and relative prices, the lagged dependent variable and the error correction term.

However, re-estimating a short run equation which satisfactorily incorporated an Error Correction Mechanism from either of the long-run equations above proved difficult. The ECM term either appeared wrongly signed or insignificant in the short run equation.

The approach taken was to constrain the coefficient on the ECM term in the short run equation and then proceed with a general to specific approach. Constraining the coefficient on the ECM to be less than or equal to zero, using either of the above long-run equations yielded an ECM coefficient of zero which is not appropriate.

A short-run equation was eventually derived by constraining the coefficient on the ECM term to take its value in the previous version of the model, i.e., –0.077, and then proceeding with the general to specific approach. This was tried with the results from both the Johansen and Phillips-Hansen approaches shown above. The short-run equation which resulted from applying this method to the Phillips-Hansen approach was considered more appropriate in the model context and is shown in Table 4.

13 Order of VAR = 3, chosen r = 1.
14 Parzen weights, truncation lag = 2, Trended Case, sample is from 1981q1 to 1999q4.

Table 4: Short-run export volumes equation

DLXTR	Coefficient	Standard Error	T-ratio[Prob.]
INTERCEPT	0.007304	0.001725	4.2345[0.000]
DLXTR(–1)	1.3178	0.1107	11.900[0.000]
DLXTR(–2)	–0.5716	0.0994	–5.7496[0.000]
DL(XTD/CXD)(–1)	0.09671	0.02385	4.0540[0.000]
DLWDR	0.17704	0.06797	2.6047[0.009]
DLWDR(–1)	–0.1987	0.0664	–2.9915[0.002]
XSTAR(–1)	–0.077	imposed	imposed
R-Squared	0.7847		
R-Bar-Squared	0.7876		

The overall effect of the lagged export variables is correctly signed but the same can not be said for the overall effect of the world demand variables, where the positive coefficient on the contemporaneous change is slightly outweighed by the negative coefficient on the first-period lag. Similarly, the sign of the relative prices variable is also incorrect, as it also was in the previous short-run model equation.

Comparing these long and short-run equations to their predecessors, in the long-run formulation, the coefficient on relative prices is of a more appropriate magnitude but the need to include a time trend may create convergence problems in long-run model simulations, although the trend could be tapered off gradually or 'run-down'. Even with an imposed coefficient on the ECM term, the short-run specification is not wholly satisfactory, which was also true of the previous version[15].

8. Import Volumes

8.1. Long-run Relationship

The long-run import volume relationship was again examined by a variety of methods; the Johansen, Phillips-Hansen and ARDL approaches. Long-run imports in the MCM system and in the previous version of the Irish block are modelled as a function of import-weighted final demand and relative prices.

$$M^* = f(\log(WER), \log(MTD/YED), TIME) \qquad [2]$$

where M^* refers to the long-run level of imports, WER to import-weighted final demand, MTD to the import deflator and YED to the GDP deflator. Imports were fairly inelastic with respect to relative prices and had a unitary elasticity with the weighted demand indicator, the latter being a general feature of the MCM country blocks to ensure long-run simulation properties.

15 The share of foreign firms in the gross output of all manufacturing establishments in the Census of Industrial Production was computed and considered as an alternative indicator of the importance of foreign owned firms in Irish exports. However, the results were again often problematic and those using the *INDSH* variable were preferred.

This was the starting point for re-estimation[16]. Attempts to simply re-estimate this equation with the new dataset proved reasonably satisfactory. Inclusion of the time trend was again necessary to constrain the coefficient on the weighted demand indicator to unity or to achieve a plausible coefficient on relative prices. This may reflect that a large proportion of imports are inputs into goods produced for export and have therefore been affected by the tremendous export growth already described. Several candidate long-run equations were found, see Table 5 below.

Table 5: Examples of preliminary results from re-estimation of long-run imports equation

	Johansen[17]	Phillips-Hansen[18]	ARDL[19]
intercept	none	−1.0724	−1.1615
		(0.36804)	(0.35956)
lwer	1.1009(*)	1.0717(**)	1.0873(***)
	(0.045257)	(0.047086)	(0.046306)
lmtd-lyed	−0.28306	−0.14581	−0.23937
	(0.083026)	(0.073253)	(0.079967)
time	0.0012005	0.0033604	0.0020979
	(0.0010519)	(0.0009924)	(0.0010347)

Standard errors in brackets.
(*)For imposition of restriction that the coefficient on lwer=1, CHSQ(1)=4.2773[0.039]
(**)For imposition of restriction that the coefficient on lwer=1, CHSQ(1)=2.3171[0.128]
(***)For imposition of restriction that the coefficient on lwer=1, CHSQ(1)=3.5534[0.059]

Re-estimating with the coefficient on weighted demand restrained to unity yielded the following results.

Table 6: Re-estimation of long-run imports equation; coefficient on weighted final demand constrained to unity

	Johansen	Phillips-Hansen	ARDL
intercept	none	−0.5173	−0.53755
		(0.018712)	(0.033548)
lwer	1.0	1.0	1.0
lmtd-lyed	−0.16853	−0.06308	0.050778
	(0.069776)	(0.060845)	(0.11285)
time	0.0031048	0.0048585	0.0054558
	(0.0005418)	(0.0003596)	(0.0006616)

Standard errors in brackets.

Clearly, the relative prices term has become insignificant under the Phillips-Hansen and ARDL options. Thus, short-run estimation was pursued using the long-run relationship derived under the Johansen method in Table 6 above, with imports again relatively inelastic with respect to relative prices. This is as expected, given the high degree of dependence on imports and lack of substitutability between imports and domestic output.

16 For a description of the indicators used in the interpolation procedure, see Annexe 1. Tests for stationarity (Augmented Dickey Fuller (ADF) tests) showed that all variables were stationary in first differences.

17 Order of VAR = 2, chosen r = 1.

18 Parzen weights, truncation lag= 2, Trended Case. Sample is from 1981q1 to 1999q4.

19 ARDL(2,2,1) selected based on Schwarz Bayesian Criterion. Sample is from 1981q1 to 1999q4.

8.2. Short-run relationship

The short-run relationship in the previous version of the model was a function of lagged changes in the final demand term and the error correction mechanism. Re-estimating a short-run equation which incorporated the above long-run Johansen equation as an error correction mechanism proved reasonably satisfactory. The starting specification included a constant, two lags of the dependent variable, two lags and the contemporaneous change in the weighted final demand variable, two lags of the relative prices term and lastly, the error correction term. The short-run equation then reduced to the following:

Table 7: Short-run import volumes equation

DLMTR	Coefficient	Standard Error	T-ratio[Prob.]
INTERCEPT	−0.12686	0.020744	−6.1154[0.000]
DLMTR(−1)	0.43925	0.083813	5.2409[0.000]
DLWER	0.73504	0.078802	9.3277[0.000]
DLWER(−1)	0.45089	0.080067	5.6314[0.000]
DL(MTD/YED)(−1)	−0.091685	0.030484	−3.0077[0.004]
DL(MTD/YED)(−2)	−0.072868	0.029409	−2.4777[0.016]
MSTAR(−1)	−0.2737	0.044734	−6.1184[0.000]
R-Squared	0.77729		
R−Bar−Squared	0.7582		

The estimation sample is from 1980q4 to 1999q4.

As can be seen, the ECM term, MSTAR(-1) is correctly signed and significant and of a satisfactory magnitude. The lagged import variable is correctly signed as are the import-weighted final demand variables. Similarly, the sign of the relative prices variable is also correct and reflects inelastic demand with respect to relative prices.

Compared to the equations in the previous version of the model, the long-run Johansen formulation is actually very similar to the previous long-run equation. The new short-run formulation is satisfactory.

9. Export Deflator

9.1. Long-Run relationship

The long-run export deflator relationship was again examined by a variety of methods; the Johansen procedure, the Phillips-Hansen approach (Fully Modified Ordinary Least Squares, FM-OLS) or by the Auto Regressive Distributed Lag (ARDL) approach to cointegration.

Long-run export prices in the first version of the Irish MCM block were modelled in a price-maker / taker framework, as a function of competitors' export prices and domestic prices as measured by the GDP deflator, as follows:

$$XD^* = f((\log(XTD)-\log(CXD)), (\log(XTD)-\log(YED)), TIME) \qquad [3]$$

where *XD** refers to the long-run level of export prices, XTD to the export deflator, CXD to competitors' prices for their export goods and YED to the GDP deflator. Unsurprisingly, a high degree of price-taking behaviour was evident, with only a small role for the GDP deflator, as would be expected in a small open economy. It was hoped that the time trend would not have to be included in the re-estimation. Thus, the starting point for re-estimation was a specification with the above variables, excluding the time trend[20]. In this instance, finding a long-run relationship proved relatively straightforward, see Table 8 below.

Table 8: Examples of preliminary results from re-estimation of export deflator equation

	Johansen[21]	Phillips-Hansen[22]	ARDL[23]
Intercept	none	0.33856	0.40027
		(0.050382)	(0.14154)
lcxd	–0.42487	0.65562	0.81067
	(0.3527)	(0.097587)	(0.27838)
lyed	0.14795	0.12326	0.037539
	(0.21859)	(0.052839)	(0.14150)

Standard errors in brackets.

While the results from the Johansen and ARDL approaches were poor, those from the Phillips-Hansen method were satisfactory. Inclusion of a time trend in the ARDL model would have led to a significant and correctly signed coefficient on the GDP deflator but the Phillips-Hansen formulation without the trend was preferred. A high degree of price-taking behaviour is again evident.

9.2. Short-run relationship

The short-run relationship in the previous version of the model was a function of lagged changes in the dependent variable, the error correction term and the contemporaneous change in competitors' export prices.

Incorporating the long-run relationship found under the Phillips-Hansen method into a short-run equation as an error correction term proved relatively straightforward. The starting specification included a constant, 4 lags of the dependent variable, the GDP deflator, competitors' prices and the error correction term. After elimination of insignificant variables, this yielded the following short-run equation.

20 For a description of the indicators used in the interpolation procedure, see Annexe 1. Augmented Dickey Fuller (ADF) tests showed that all variables can be considered as stationary in first differences.

21 Order of VAR = 2, chosen r = 1. Sample is from 1980q3 to 1999q4.

22 Parzen weights, truncation lag = 4, Trended Case. Sample is from 1980q1 to 1999q4.

23 ARDL(2,1,2) selected based on Schwarz Bayesian Criterion. Sample is from 1981q1 to 1999q4.

Table 9: Short-run export deflator equation

DLXTD	Coefficient	Standard Error	T-ratio[Prob.]
INTERCEPT	0.0044882	0.0028551	1.5720[0.120]
DLXTD(–1)	–0.38079	0.11122	–3.4238[0.001]
DLXTD(–2)	0.29766	0.098461	3.0232[0.003]
DLCXD(–1)	0.37440	0.13143	2.8488[0.006]
XDSTAR(–1)	–0.23071	0.099177	–2.3263[0.023]
R-Squared	0.56173		
R-Bar-Squared	0.53669		

The estimation sample is from 1981q2 to 1999q4.

The ECM term is correctly signed and significant and of a good magnitude. A flaw present is that the overall effect of the lagged export deflator is negative but the effect of competitors' export prices comes through strongly. The GDP deflator also does not appear in this short-run formulation, similar to the previous version, confirming price-taking behaviour.

10. Import Deflator

10.1. Long-Run Relationship

The long-run import deflator relationship was again examined by a variety of methods; the Johansen procedure, the Phillips-Hansen approach (Fully Modified Ordinary Least Squares, FM-OLS) and the Auto Regressive Distributed Lag (ARDL) approach to cointegration.

Long-run import prices in the MCM system are generally modelled as a function of domestic and foreign prices. The long-run relationship in the first version of the Irish MCM block was a function solely of competitors prices:

$$MD^* = f(\log(CMD)) \qquad [4]$$

where *MD** refers to the long-run level of import prices and CMD to competitors prices on the import side (the export prices of countries we import from). The extent of price-taking behaviour is evident with the domestic GDP deflator not appearing in the long-run relationship.

It was hoped to be able to include energy prices (*PEI*)[24] in the long-run relationship, along with the domestic GDP deflator (*YED*). Thus, this specification was the starting point for re-estimation. For a description of the indicators used in the

24 The energy price index is calculated as a weighted average of commodity prices and oil prices, with equal weights applied. Analysis of import data suggested that it was reasonable to assume weights of 50 — 50. The starting figure for the index was taken from the first version of the model dataset. It was then brought forward using equally weighted growth rates from series for commodity prices and oil prices supplied by the ECB. The commodity price series was taken from the Hamburg Institute of Economics (HWWA) and is the world market price of raw materials in US Dollars, excluding Energy. The oil price series is the price of UK Brent in US dollars per barrel.

interpolation procedure, see Annexe 1. Augmented Dickey Fuller (ADF) tests showed that all variables can be considered as stationary in first differences.

Estimation by the ARDL and Johansen methods yielded an insignificant coefficient on the price of energy index variable in the Johansen case and on several variables in the ARDL case but the Phillips-Hansen approach yielded satisfactory long-run results as can be seen from Table 10 below. All variables are correctly signed and while the coefficient on the energy index is small, its inclusion represents a significant improvement on the previous version, as does the retention of the domestic GDP deflator.

Table 10: Examples of preliminary results from re-estimation of import deflator equation

	Johansen[25]	Phillips-Hansen[26]	ARDL[27]
Intercept	none	−0.090132	0.39601
		(0.16075)	(0.64475)
lyed	−0.41273	0.33188	−0.0056979
	(0.090027)	(0.046353)	(0.26883)
lcmd	−0.29954	0.44865	0.61742
	(0.15599)	(0.082321)	(0.33653)
lpei	−0.075532	0.073624	−0.021250
	(0.061985)	(0.032931)	(0.12740)

Standard errors in brackets.

10.2. Short-run relationship

The next step was to incorporate the long-run relationship into a short-run equation as an error correction term. The short-run relationship in the previous version of the model was a function of the contemporaneous and lagged changes in the export prices of countries we import from, the error correction mechanism, a constant and oil prices.

In order to re-estimate a satisfactory relationship, it was necessary to include the contemporaneous change in competitors import prices and the energy price index in the short-run relationship. As these are exogenous variables, this would not be expected to be problematic. Thus, the starting specification included a constant, 4 lags of the dependent variable, and of the other variables in the long-run relationship along with the contemporaneous changes as mentioned above and the error correction term. After elimination of insignificant variables, this yielded the following short-run equation.

25 Order of VAR = 3, chosen r = 1. Sample is from 1980q4 to 1999q4.
26 Parzen weights, truncation lag = 4, Trended Case. Sample is from 1983q1 to 1999q4.
27 ARDL(2,2,3,0) selected based on Schwarz Bayesian Criterion. Sample is from 1981q1 to 1999q4.

Table 11: Short-run import deflator equation

DLMTD	Coefficient	Standard Error	T-ratio[Prob.]
INTERCEPT	0.0026535	0.0022204	1.195[0.237]
DLMTD(–2)	0.1905	0.071348	2.6700[0.010]
DLCMD	0.36694	0.086980	4.2187[0.000]
DLPEI	0.058227	0.030455	1.9119[0.060]
MTDSTAR(–1)	–0.81316	0.10085	–8.0630[0.000]
R-Squared	0.70261		
R-Bar-Squared	0.68373		

The estimation sample is from 1983q1 to 1999q4.

The ECM term is correctly signed and significant and of a very high magnitude, signifying rapid convergence to the long-run equilibrium value. The lagged term of the dependent variable is correctly signed as is the contemporaneous change in competitor prices. The energy price index is correctly signed and significant, if modest in size. Unlike the long-run, there is no role for domestic prices in the short-run, again indicating a high degree of price — taking behaviour. Overall, the equation is satisfactory.

11. Conclusion

The aim of this paper was to describe the re-estimation of the trade block in the Bank's quarterly macro-econometric model. The rationale for re-estimation was outlined and a brief description of the data on which it is based provided. The structure of the equations was briefly outlined. The re-estimation of each equation, both short and long-run components was then described.

The re-estimation did not always result in an improvement upon the previous version. For example, it was necessary to include a time trend in the long-run export volumes equation where previously this had not been needed. On the other hand, it was possible to re-estimate a satisfactory long-run export deflator equation without a time trend, where previously one had been needed. Similarly, the inclusion of the energy price index in the long-run formulation of the import deflator represents an improvement over the previous version. Overall, therefore, important advances were made.

Annexe 1

Interpolation

XTN – Nominal Value of Exports of Goods and Services

Annual data – Data on ESA 79 basis were provided by the CSO from 1990 onwards. Growth rates of the older model databank series were applied to extend the series backwards.

Quarterly data – The quarterly data was derived as XTR * XTD. Quarterly Balance of Payments data have existed since 1981 but the total of exports of goods and services from this source is not used as an indicator in the present exercise. This is because the CSO has revised the annual totals for this variable but not carried them through to the quarterly data. In addition, the quarterly data suffer from significant discontinuities, so it was considered preferable to use the indicators for volumes and prices described below, which have fewer discontinuities, to provide quarterly volume and price series.

XTR – Real Value of Exports of Goods and Services

Annual data – Real export data on ESA 79 basis were provided by the CSO from 1990 onwards. Growth rates of the older model databank series were applied to extend the series backwards.

Quarterly data – The quarterly indicator used is the Export Volume Index (CSO code TSAM203).

XTD – Deflator of Exports of Goods and Services

Annual data – The export deflator was derived as the ratio of XTN/XTR.

Quarterly data – The quarterly indicator used is the Export Price (unit value) Index (CSO code TSAM205).

WDR – World Demand

This index was provided by the ECB.

INDSH – Share of Industry in Output

Annual data – Annual data on the share of industry in output is taken from Table 3 of the National Accounts. Industry is defined to include construction. (A series excluding construction could not be found to go as far back as 1980).

Quarterly data – The quarterly indicator used is the Volume Index of Industrial Production (CSO code MIAQ062). This series was seasonally adjusted and passed all diagnostic tests in Demetra. The annual series was interpolated to a quarterly series using this indicator. The interpolation diagnostics were not good, however, but the interpolated series was proceeded with.

MTN – Nominal Value of Imports of Goods and Services

Annual data – Data on ESA 79 basis were provided by the CSO from 1990 onwards. Growth rates of the older model databank series were applied to extend the series backwards.

Quarterly data – The quarterly indicator used is the nominal value of Total Imports (CSO code TSAM001) from the monthly trade statistics.

MTR – Real Value of Imports of Goods and Services

Annual data – Data on real imports were provided by the CSO on an ESA 79 basis from 1990 onwards. Growth rates of the older model databank were applied to extend the series backwards, which re-based the series in 1995.

Quarterly data – The quarterly indicator used is the Import Volume Index (CSO code TSAM202).

MTD – Deflator of Imports of Goods and Services

This series was defined as MTN/MTR.

YED – GDP Deflator

This series was defined as YEN/YER, where YEN, nominal Gross Domestic Product is calculated by summing the nominal expenditure components and YER, real Gross Domestic Product, is calculated by summing the real expenditure components.

CMD (CXD) – Competitors' Prices on the Import(Export) Side

This is calculated as CMUD/EXR (CXUD/EXR) where CMUD (CXUD) is competitors' prices on the import (export) side in dollars (supplied by the ECB) and EXR refers to the exchange rate.

PEI – Energy Price Index

This is calculated based on data provided by the ECB.

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