Benefits of EU membership for Ireland: An Econometric Analysis

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Ulrich Daun explores the effect of EU transfer and access to the European market on Irish economic growth. Using the tools of econometrics he examines the relationship between these variables and Irish GNP. His findings suggest that both these factors have been important for Irish GNP growth, but that exports have taken on a greater role since the 1990's.

Introduction

Ireland is a small open economy on the periphery of Europe. Due to its links with Great Britain and the mobility of its citizens, it has always been regarded as a regional rather than a national economy and has always depended on access to foreign markets. In 1973 Ireland, along with Denmark and the UK, joined the European Economic Community (EEC), which later became the European Union (EU). This had mainly two impacts. Firstly, the membership led to a reduction of trade barriers. Ireland was now committed to free trade with all other member states and in 1977, all tariffs within the Union had been removed. Secondly, membership of the EU led to an inflow of transfer payments under the Common Agricultural Policy (CAP), and Structural Funds. The CAP subsidises farm prices to support the farmers and ensure farm incomes. As a net-exporter of agricultural goods, Ireland is said to have benefited from these payments. The Structural Funds are aimed at regional development and at social and economic cohesion within the EU. These resources have helped to equip the Irish economy with a more modern infrastructure and thus have contributed to rising productivity.[1] Furthermore membership of the EU makes Ireland more attractive for foreign direct investment. It is a base from which a non-European company can try and access the European market. It is amongst American firms that Ireland has proved to be particularly popular[2].

With the forthcoming eastern enlargement of the European Union, the CAP and the Structural Funds are likely to be reformed. This will involve a reduction of payments in general, but, furthermore, Ireland will no longer be entitled to structural funds as

[1] See Haughton (2000), 'The Historical Background', in O'Hagan, J., (2000) (ed.): *The Economy of Ireland. Policy & Performance of a European Region*, p. 37/38.

[2] See Barry *et al.* (1999): 'The European Dimension: The Single Market and the Structural Funds' in Frank Barry (1999) (Ed.): *Understanding Irish Economic Growth*, p. 115.

these are only for those members whose per capita income is well below the EU average. With an eastern enlargement the Irish per capita income will not rise immediately, but the EU average will decrease significantly. The aim of this paper is therefore to examine the extent to which the impact of EU membership can explain Irish economic performance over the last two decades.

Data and Variables

To model the effects of the EU on Ireland, the Irish Gross National Product[3] (GNP), is used as the dependent variable Y_t, where. 't' denotes the year and runs from 1977 to 1999[4]. There are two explanatory variables: exports to the EU/EEC member states[5] (X_{1t}) and net receipts from the EU budget[6] (X_{2t}). It is obvious, that the benefits from investments in infrastructure reach into the future. Thus an unweighted 5-year moving average is used to model the influence of the net-receipts on GNP:

$$X_{2t} = \frac{1}{5} \cdot \sum_{i=t-5}^{t} X_{2i}$$

In absence of any theoretical backing, the five year period was chosen arbitrarily. It should be good enough to pay regard to the intertemporal nature of these payments, but it is imaginable, that the benefits do not stop accumulating after five years, e.g. if we think of a road financed by the EU. As mentioned above, membership of the EU led to FDI-inflows into Ireland. Assuming that they were aimed at gaining access to the huge European market, rather than the Irish market, their influence will be captured by exports.

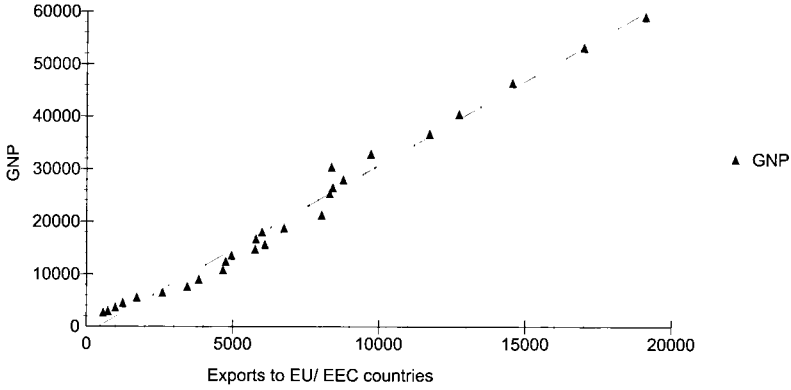
[3] GNP data is taken from various issues of the "Statistical Abstracts" published by the Central Statistics Office.

[4] This is due to the availability of data.

[5] Data on the exports is taken from various issues of the "Statistical Abstracts" published by the Central Statistics Office.

[6] Data on the receipts and payments from the EU-budget was kindly left to the author by the European Parliament's Office in Ireland.

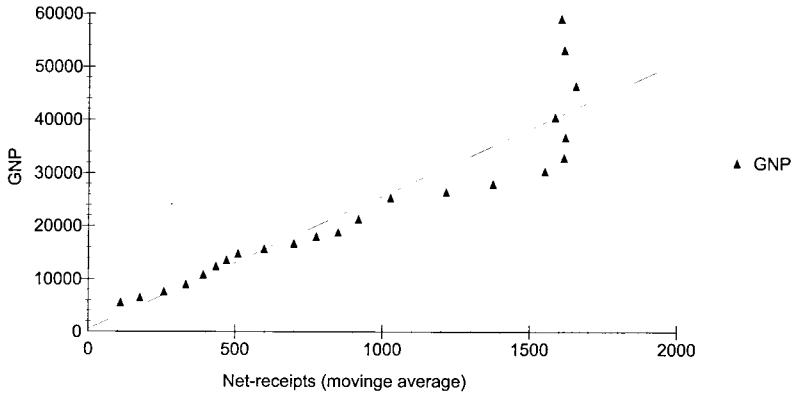
Fig.1: GNP vs. exports



From the scatter-diagram in Fig. 1 we see that there is a good relationship between GNP and the exports to the EU/ EEC member countries. What is conspicuous is that the scatters do not seem to vary randomly around the best fitting line.

The scatter plot from Fig. 2 shows the relationship between GNP and the moving average of net-receipts from the EU budget. This relationship is not as unequivocal as the former one. There is a clear break for high values of GNP as the

Fig. 2: GNP vs. Net-receipts



increase in GNP does not seem to be matched by an equivalent increase in the net-transfer payments from Brussels. This could be an indicator for a structural change and we should keep that in mind for later analysis.

The model

OLS-estimation

According to the ideas described above, we are interested in estimating the population regression function:

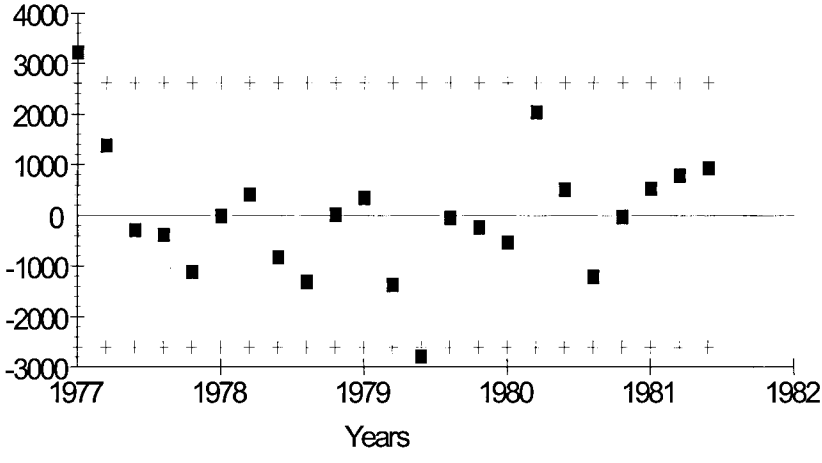
$$Y_t = \beta_o + \beta_1 X_{1t} + \beta_2 X_{2t} + u_t$$

The first approach is to use the ordinary least squares method (OLS) in order to obtain best, linear and unbiased estimators (BLUE) for the three coefficients. From this procedure the sample regression function was as follows:

$$Y = -2961.9 + 2.7497 X_{1t} + 5.3528 X_{2t}$$

All coefficients are significant at a 1% level. The goodness of fit measures R^2 = 0.99318 and Adjusted R^2 = 0.99250 take on huge values. There may be several reasons for this. On the one hand, the model may be very good (Anova-F-test seems to back this).

Fig. 3: OLS-residuals



On the other hand this could be a sign of autocorrelation[7]. This would be backed by the Durbin-Watson statistic that takes a value far away from 2 (DW = 1.1187). Therefore we test:

$H_0 : \rho = 0 \qquad vs. \qquad H_1 : \rho > 0$

The one sided test is chosen, because the value of DW and the plot of the residuals in Fig. 3 suggest positive serial correlation. For a 5% level, with $k' = 2$ as the number of true regressors and sample size $n = 23$, the upper bound of DW is 1.544, the lower bound is 1.168. The test criterion is to reject the Null, if DW lies below the lower bound. As $DW = 1.1187 < 1.168$, we have to reject H_0 and assume the presence of positive autocorrelation in the data set. This means, that the calculated standard errors of the OLS estimators may not be correct and OLS is no longer efficient. We risk the calculation of wrong confidence intervals and wrong test statistics and therefore risk wrong test decisions. Hence, we have to try and take remedial action.

[7] See below for multicollinearity.

Autocorrelation: Remedial action[8] Autocorrelation might be caused by AR(1), an autoregressive process of order 1. This means that the residuals in period t are a function of those in the previous period and a random term:

$$u_t = \rho.u_{t-1} + \varepsilon_t$$

where $|\rho| < 1$ is a constant and ε_t denotes the "true" error term in period t. In this case the transformation $Y^*_t = Y_t - \rho Y_{t-1}$ leads to the population regression function[9]:

$$Y^*_t = \beta^*_0 + \beta_1 X_{1t}^* + \beta_2 X_{2t}^* + \varepsilon_t$$

This regression function does not violate the classical normal linear regression model assumptions of no autocorrelation, as it does not contain the former error term u_t that caused the original problem. The coefficients are nevertheless the same, except there is a linear transformation of β_1. This procedure is called Generalised Least Squares (GLS) estimation, but unfortunately requires knowing ρ to obtain BLU estimates. Nevertheless, if we could get an estimate for ρ, we could compute a "feasible" GLS.

We can solve the problem of estimating ρ using the DW-statistic:
$DW = 2(1 - \rho)$
Thus, we can solve this expression in order to obtain ρ and get an estimate by substituting the calculated DW-statistic:

$$DW \approx 2(1 - \rho)$$
$$\Leftrightarrow$$
$$\rho = 1 - DW/2 = 1 - 1.1187/2 = .44065$$

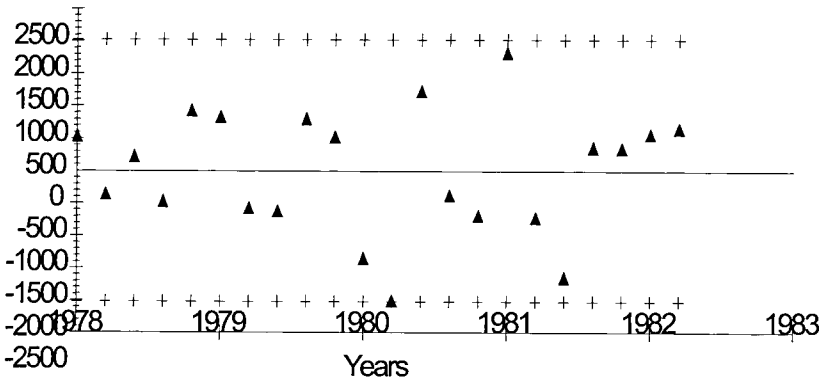
Feasible GLS-estimation:
As result of the remedial action we obtain feasible GLS estimates that are BLUE. They take the values $\beta_0 = -2308.2$, $\beta_1 = 2.6876$ and $\beta_2 = 6.8088$. The problem of autocorrelation seems to be solved, as DW=2.1875 indicates that we cannot reject the Null of no autocorrelation at a 5% level. The plot of the GLS residuals supports

[8] This procedure- is based on Pindyck and Rubinfeld (1998), *Econometric Models and Economic Forecasts*, p.160-165.

[9] with $\beta_0^* = (1 - \rho).\beta_0$ and $X_{it}^* = X_{it} - \rho. X_{it-1}$ for i = 1,2..

this.

Fig. 4: GLS-residuals

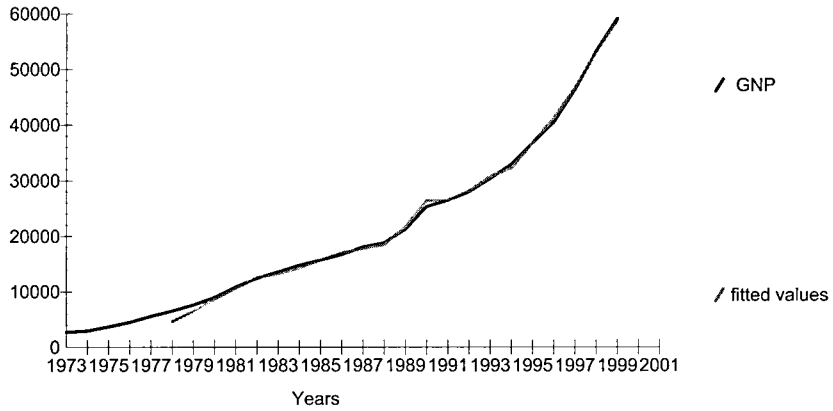


We can now compute the sample regression function:

$Y_t = -4126.6 + 2.6876X_{1t} + 6.8088X_{2t}$

All coefficients are significant at a 1% level.

Fig. 5: Actual and fitted values of the GLS-regression



Goodness of fit measures are still high, but this time we know that this it not caused by autocorrelation: $R^2 = 0.98866$ and adjusted $R^2 = 0.98746$. The ANOVA-F-test of the overall explanatory power of the model is significant on a 1% level. Indeed, Fig. 5 does not show major fluctuations of the fitted around the true values.

To learn about the preciseness of the obtained estimates we can calculate confidence intervals. As there are 22 observations (one is lost due to AR(1)) and 4 estimated parameters (the three coefficient-estimates and ρ), $[\beta_i - \beta_i] / se[\beta_i] \sim t_{18}$ With the 1% percentile $t^{0.01}_{18}$ we obtain the 1% confidence intervals: [-5370.1 ;-2883.1] for the intercept, [2.3299; 3.0452] for the coefficient of exports to the EU/EEC member states and [3.5461; 10.0715] for the net-receipts from the EU budget.

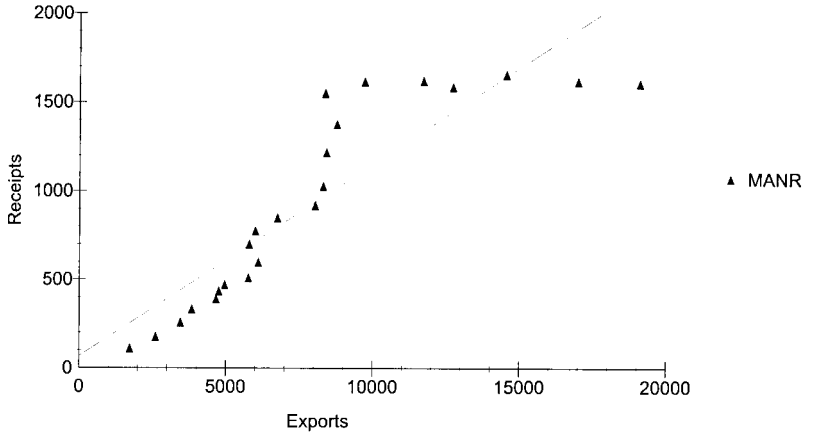
Multicollinearity

In its original meaning, multicollinearity is defined as a perfect linear relationship among all or some explanatory variables. From Fig. 6 we see, that this is not the case. But today, the term multicollinearity is used in the broader meaning that the variables are correlated, but not perfectly.[10] It cannot be rejected that there is

[10] See Gujarati (1995): *Basic Econometrics*, p. 320.

pairwise correlation in the given data (Pearson's is 0.83), but as Gujarati[11] mentions, it

Fig. 6: Exports vs. Net-receipts



may not pose serious complications, as long as the t-values are significantly high. With multicollinearity, it is possible to obtain a high measure of goodness of fit, while the t-statistics for the single coefficients are insignificant. In our model R^2 is very high, but all of the explanatory variables are significant at a 1% level. Thus we do not need remedial action.

Normality of residuals

A further assumption of the classical normal linear regression model is that the residuals are distributed normally. The χ^2 test in the regression output for normality that is based on the skewness and the kurtosis of the residuals indicates that we cannot reject the Null, that the residuals are normally distributed at a 5% level. The p-value is 0.751. The histogram of residuals (Fig. 7) backs this.

Heteroscedasticity

Heteroscedasticity means that the conditional variances of the residuals differ: $V[\varepsilon_t X_{1t}, X_{2t}] = \sigma_t^2$. We can test

$H_0: \sigma_t^2 = \sigma^2 \ \forall_t$ vs. H_1: *not* H_0

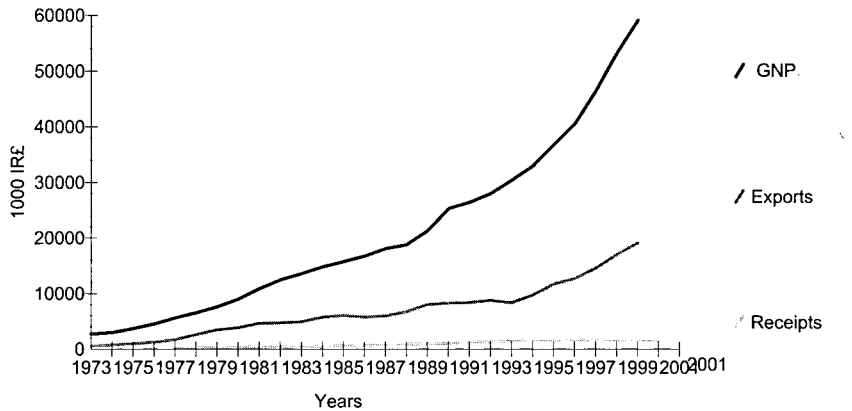
[11] Gujarati (1995) *Basic Econometrics*, p. 336.

The test used by Microfit is based on a χ^2 distribution. The result is that we cannot reject the Null at a significance level of 5%.

Structural change in the 1990s?
If we take a look at the time path of GNP (Fig. 7) we can see, that economic growth has accelerated in the 1990s. This acceleration can also be identified in the export figures, but not in the net-receipts. Has the Celtic Tiger changed the relationship between the variables in favour of the exports? To answer this question, we are going to test for a structural change in 1990.
Pindyck and Rubinfeld [12] suggest a test involving a dummy-variable: D_t :

D = 1 *if t › 1989*
D = 0 *for all other years*

Fig. 7: GNP, Exports and Net-receipts 1973-1999



This variable takes the value 0 for any period before the structural change and from then on the value 1. If we assume that the structural change occurred in 1990 we can run the regression:

[12] Pindyck and Rubinfeld (1998), p.137. It would also be possible to run two separate regressions and then test for equality of coefficients, but as the second regression would only be based on 9 observation we rejected this alternative.

$$Y_t = \alpha_0 + \alpha_1 X_{1t} + + \alpha_2 X_{2t} + \alpha_3 (X_{1t} - X_{1;1990}) D_t + v_t$$

with v_t as the error term. Then we can use a simple t-test to test
$H_0 : \alpha_3 = 0$ vs $H_1 : \alpha > 0$

If we cannot reject the Null, then the data does not support the idea of a structural change in 1990. But if we can reject it, then the data suggests a positive α_3 and the influence of X_1 has increased during the years of the Celtic tiger.

We obtain $\alpha_3 = 1.1029$, significant at a 1% level. Thus we reject the Null and do not deny the possibility of a structural change.

Conclusion

In the model described above we showed, that we can model the relationship between Irish GNP, Irish exports to the EU/EEC member states and the Irish net-receipts from the EU budget. Both explanatory variables have a positive influence on GDP. The high values of the goodness of fit measures nearly indicate a deterministic relationship rather than a stochastic one. But we have to note, that this model is only based on a vague idea of possible dependencies rather than a precise economic model.

A further finding is that there was a structural change in the 1990's, when the Irish economy went into a process of rapid growth. During these years the exports became more important in explaining the Irish performance. This is especially interesting as, with the forthcoming enlargement of the EU towards the east, Ireland's position in Europe will change from a net recipient from the budget to a net-contributor. Nevertheless, Ireland has to ensure that it takes advantage of the new export markets in the east.

Bibliography

Barry, F., Bradley, J., and Hannon, A. (1999) 'The European Dimension: The Single Market and Structural Funds' in Barry, F. (Ed.) (1999) *Understanding Irish Economic Growth*, Macmillan.

Gujarati, D. N. (1995) *Basic Econometrics.* McGraw-Hill.

Haughton, J. (2000) 'The Historical Background' in O'Hagan, J. W. (Ed.) (2000), *The Economy of Ireland. Policy and Performance of a European Region.* Gill and Macmillan.

Pindyck, R. S. and Rubinfeld, D. L. (1998) *Econometric Models and Economic Forecasts*. McGraw-Hill.