



| | |
|-------------------------------------|--------------------------------------------------------------------------------------------|
| Title | On the causes of Ireland's unemployment |
| Authors(s) | Barry, Frank, Bradley, John |
| Publication date | 1991-01 |
| Publication information | Barry, Frank, and John Bradley. "On the Causes of Ireland's Unemployment" (January, 1991). |
| Series | UCD Centre for Economic Research Working Paper Series, WP91/1 |
| Publisher | University College Dublin. School of Economics |
| Item record/more information | http://hdl.handle.net/10197/1478 |
| Notes | A hard copy is available in UCD Library at GEN 330.08 IR/UNI |

Downloaded 2023-03-15T17:09:45Z

The UCD community has made this article openly available. Please share how this access benefits you. Your story matters! (@ucd_oa)



© Some rights reserved. For more information

12129364



608

CENTRE FOR ECONOMIC RESEARCH

ON THE CAUSES OF IRELAND'S UNEMPLOYMENT

by

FRANK BARRY
UNIVERSITY COLLEGE DUBLIN

and

JOHN BRADLEY
ECONOMIC AND SOCIAL RESEARCH INSTITUTE

JANUARY 1991

WORKING PAPER NUMBER WP91/1



UNIVERSITY COLLEGE DUBLIN

Department of Economics

BELFIELD, DUBLIN 4, IRELAND

330.08 IR
UNI

On the Causes of Ireland's Unemployment*

Frank Barry
University College Dublin

and

John Bradley
Economic and Social Research Institute

January 1991

ABSTRACT: This paper attempts to account for the rise in Irish unemployment between 1970 and 1987. To this end a fully articulated medium-term model of the economy is employed, in contrast to the four equation model of the labour market adopted by Newell and Symons (1990) in their recent study on the topic. The proximate causes identified in both cases include the swings in domestic fiscal policy, demographic factors, and the shocks which buffeted the world economy. Our conclusions differ quite sharply from theirs, however, and the reasons for these differences are explored.

* The authors wish to acknowledge John Fitz Gerald's joint work with John Bradley in developing the macro model employed here. Brendan Walsh and Gerry Sexton's written comments on an earlier draft of the paper are gratefully acknowledged, as are our discussions with Mick Devereux, Rory O'Donnell, Alan Matthews, Dermot McAleese and participants in a seminar presented at the ESRI. Full responsibility for opinions expressed and any errors that may remain rests solely with the authors.

1. Introduction

For decades, Ireland's high unemployment and emigration rates have been regarded as the main indicators of the economy's structural deficiencies. The country's experience in these respects over the last decade has led to a spate of recent research which has attempted to isolate the exact causes of the disappointing performance. Even the buoyancy of world demand and improvements in Irish cost competitiveness of the last three to four years have proved slow-acting in their impact on employment and unemployment, so that the analysis of the functioning of the Irish labour market remains one of the most crucial research areas in Irish economics.

Recent research in the area can be divided into two broad categories; studies such as Walsh (1987) and Barry (1987, 1991) which, through the use of reduced-form or simple macro-theoretical models attempt to give some general structure to the way we think about and discuss the problem, or the more econometrically-rigorous approach of Newell and Symons (1990) which uses a structural model of the labour market to explore the extent to which the perspective embodied in that model can empirically "explain" the Irish data. We believe both approaches to be of value, and capable of yielding complementary insights into the functioning of the economy.

The methodology of the present paper is of the second type. Rather than building a small model, however, as Newell and Symons do, we use the large-scale ESRI macroeconomic model to explore the determinants of Irish unemployment in the 1970-87 period¹. For reasons to be spelt out below, we believe a large-scale multi-sectoral model to be necessary if one is to explore some of the complex interactions that determine the aggregate outcome.

The paper begins, accordingly, with a summary of our criticisms of the Newell and Symons (1990) paper (henceforth N-S) with which we share a common methodological approach². Section 3 outlines the structure of our model; Section 4 discusses the main channels through which shocks affect employment and unemployment, and Section 5 presents our simulation results and contrasts them with those of N-S. The key equations of the macromodel are presented in an appendix to the paper.

¹ A complete description of a slightly earlier version of the model is available in Bradley et al. (1989); alterations made since that time are as presented in the Appendix to the present paper.

² Both papers are susceptible to the Lucas critique, which argues that parameter estimates are not invariant to changes in economic policy, because of the impact of such changes on the expectations of economic agents. This means that the results of model simulations which seek to identify the outcomes which would have occurred had economic policies been very different must be treated with caution. Discursive treatments of these issues for the Irish case are contained in Dornbusch (1989), Giavazzi and Pagano (1990), and McAleese (1990).

2. Criticisms of the Newell and Symons Model

We can group our criticisms into three categories: the weaknesses of small models, problems with the data used, and flaws in the modelling procedures adopted.

2(i). Some weaknesses of small models

N-S present a single-sector model of the economy. One problem with this approach is that it implies that employment in the public sector, changes in which have been of significant magnitude in the period under discussion, is driven by the same forces that determine employment in the private sector. At the very least, we believe, a distinction needs to be made between the market and non-market sectors.

Of perhaps greater importance, though, is the need to model industrial and marketed-services employment separately, as their experiences, illustrated in Figures 1 and 2, have been so diverse. The sectors differ in a number of important respects, including export-orientation, the relative importance of multinational companies in production, and how output prices are determined. Our model in fact treats the following four sectors separately: Industry, Agriculture, Market and Non-Market Services³.

Another issue related to the use of small models is the difficulty in finding a summary measure of fiscal stance capable of adequately identifying the demand effects of fiscal policies, although Walsh (1987) found the structural budget deficit to yield statistically significant effects in the Irish case. Buitter (1985), however, argues that the only way to accurately isolate fiscal effects is to use large-scale structural models.

We feel sceptical therefore about Newell and Symons' rejection of the wide swings in Irish fiscal policy as an important contributory factor in the explanation, and particularly so in view of the timing of Irish unemployment fluctuations. N-S are concerned only with the 1979-1986 period, but prima facie evidence of the importance of fiscal policy is provided if we take a longer horizon. As Barry (1990) argues, "the gap between Irish and EC unemployment narrowed between 1976 and 1980, remained constant until 1982, and then exploded.... The reasonably good Irish performance relative to Europe in the 1976-82 period must have been due either to a gain in cost competitiveness, relatively slower growth of the Irish labour force, or an expansion in labour demand in Ireland relative to elsewhere.... Which of these factors was actually responsible for the events of the period? Not the first, because relative hourly earnings measured in a common currency reveal losses in Irish cost competitiveness at the time; not the second, because Irish labour force growth was greater than the European average over the period; therefore the third. The only factor working in the

³ Non-market services consists of public administration, defence, health and education.

direction required to provide an explanation was labour demand". The results of the present model support the implied hypothesis of the importance of fiscal policy.

Interconnected with the issue of fiscal policy, of course, is that of the national debt, leading us to recognise a further advantage in using large models. When the effects of changes in fiscal policies are simulated in a small model such as N-S, it is possible, at best, to analyse its impact (or lack thereof) on a small number of endogenous variables - employment, unemployment and wages. In a large model such as ours, the effects on other crucial variables, and the national debt in particular, can also be identified, so that the trade-offs faced when such policy instruments are used are kept clearly in view. Interactions between variables, such as between employment and tax revenues for example, are also taken into account in our approach.

While accepting that small models are required if inter-country comparisons are to be made, we have, for these reasons, more faith in the answers yielded, and, perhaps paradoxically, in the value of the questions raised by the present approach.

Total Industrial Employment

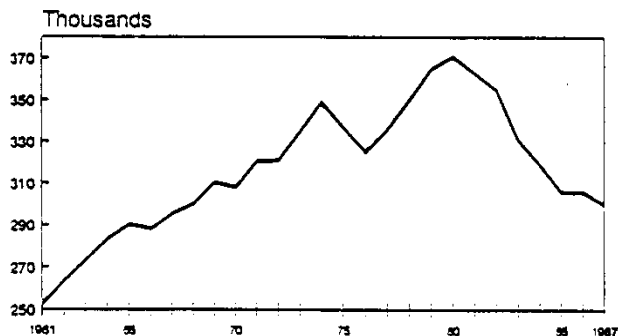


Figure 1

Employment in Marketed Services

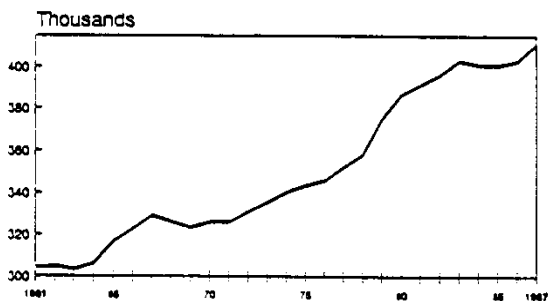


Figure 2

2(ii). The data set

In their paper, N-S use data for Ireland drawn mainly from OECD publications. The OECD employment data of the 1960's and 1970's is particularly suspect and does not appear to have been adjusted in the light of the introduction of the Labour Force Survey in the middle 1970's⁴. Adjusting the labour force data in this way, and using other more reliable national data sources, we attempted to reestimate their model using the period 1960-87, but failed to reproduce the original results. Our inability to reestimate their model successfully with a different data sample casts doubt on the robustness of their approach and also perhaps on the reliability of the data that they used⁵.

2(iii). Modelling procedures

We have two major criticisms of the way in which N-S model the Irish labour market; the first concerns the market environment in which the typical Irish firm is assumed to operate, which feeds into the labour demand function, and the second concerns their failure to recognise the crucial role of migration in the Irish labour market.

To take the less important of these first, N-S assume that the entire economy can be represented by a typical firm selling into an imperfectly competitive market. Such a firm sets its price as a mark-up on wage costs, and this price relation is then rewritten as an equation determining employment. The problem with this is that the extensive empirical literature on price determination points quite unambiguously to Irish internationally-tradable goods prices being externally determined⁶. Aggregation of the tradable and non-tradable sectors will give rise to difficulties in modelling producer prices, particularly in view of the shifts in the importance of industry and services in aggregate employment noted earlier. In this light, the N-S assumption that the aggregate GDP deflator is determined as a mark-up on wages appears inappropriate. We adopt instead the price-taking assumption for industry and a mark-up model for services.

Figure 3 below illustrates the extreme openness of the Irish labour market, with large outward and inward migration flows occurring in different sub-periods, mainly to and from Great Britain. Migration can affect the labour force in two ways. The first, and most important, channel is the direct leakage from, or additions to, the working age population. This is ignored in

⁴ See Sexton and Walsh (1982) for a treatment of the revisions to the earlier data.

⁵ Details of our attempted reestimation of the N-S model are available upon request.

⁶ Callan and FitzGerald (1989) gives an up-to-date review of the literature and reasserts the price-taking result in the aftermath of Ireland's entry into the EMS.

the NS model. A secondary effect occurs if there is any atypical pattern of labour force participation by migrants. This was investigated by NS and some significant effects were found; these were ignored in the final operational model, however, which consequently has a closed labour market. The absolutely critical role played by the migration mechanism in our model of the Irish labour market will become apparent later.

Net Migration Abroad

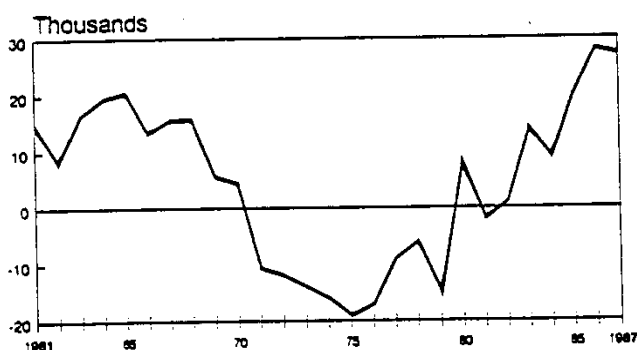


Figure 3

3. Structure of the Present Model

As do N-S, we examine the labour market in terms of factors influencing the size of the labour force, the demand for labour, and the wage bargain. Although the system is simultaneous, it is easiest to think of the wage bargain as determining a point on the labour-demand function, and the difference between this level of employment and the total labour force yields the unemployment level, as in Figure 4 below.

Total labour demand is an aggregate of each sector's demand, the wage equation is modelled as the outcome of bargaining between unions and firms, and demographic factors operating alongside the migration mechanism determine labour supply. We now describe each of these building blocks in turn.

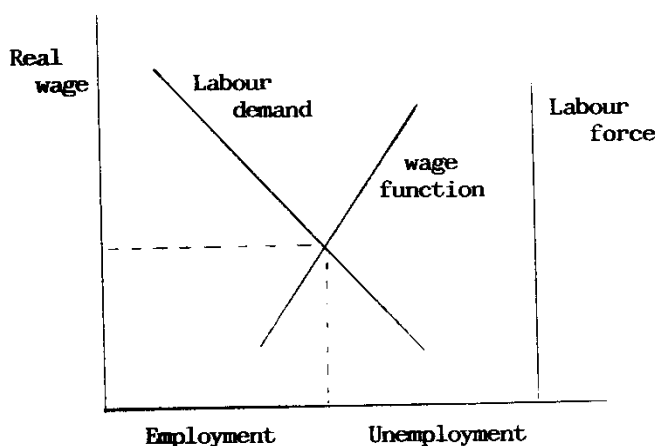


Figure 4

3(i). Labour demand

We describe the demand for labour by presenting firstly the structure of sectoral labour demands, and then spelling out the income-expenditure mechanisms that are embedded in the aggregate demand for labour.

3(i)i. The structure of sectoral labour demands

Consider Industry first: we think of this as an internationally-tradable goods sector, and adopt the Bradley-FitzGerald (1988,1990) multinational-location model to describe its operation. For any given product line, multinationals face essentially three choices: how much to produce; where, amongst a wide range of countries, to locate; and what technology to use in production.

We can abstract from analysis of the first choice by invoking the concept of an exogenous world demand over which "the SOE" has no influence. The second stage relates Ireland's share of this capacity to its industrial profitability relative to a group of countries representing "the rest of the world". Having planned the optimum share of world capacity it intends to locate in Ireland, the firm then makes its decision on factor input ratios on the basis of Irish factor prices.

The overall implication of this is that Irish industrial output and employment are driven by world aggregate demand, Ireland's relative profitability, relative factor prices within the country, and technical change.

The Services sector is of such heterogeneity that it is difficult to justify a comprehensive decision-based factor demand system. The presence of large non-commercial and self-employment components, for example, is likely to affect the response of employment and investment to changes in relative factor prices.

We are therefore forced to model the sector in a pragmatic way. The sector's output, in our model, is determined in Keynesian fashion by a weighted measure of final demand, while investment is driven by trend output in an error correction mechanism. Employment is determined by a "manning" decision, where the labour-capital ratio is sensitive to the relative cost of labour to capital, and to labour-saving technical progress. This imposes a certain consistency of behaviour on the market services sector, and while some of these assumptions may appear questionable they seem preferable to a single-sector approach that bundles services and industry together.

We need mention Agriculture and Non-Market Services only briefly at this stage. The latter is a discretionary policy instrument, while employment in agriculture, forestry and fishing is modelled as a labour-release process, in that agents who do not leave are employed; the secular decline in this sector seems to be adequately captured by a simple time trend.

3(i)ii. Income-expenditure mechanisms in aggregate labour demand

The main explanatory variable in our consumption function is real personal disposable income⁷. Government consumption is a policy instrument, the main components of which are employment in public administration and other purchases from the non-market services sector. Government housing investment is also treated as a discretionary policy instrument, while our approach to modelling private housing investment uses an expenditure-type relation driven by real personal disposable income, but influenced by government housing transfers, interest rates and inflation.

The remaining investment categories have already been discussed, namely the derived factor demands for fixed investment by industry, agriculture and services.

Concerning exports, the component of gross agricultural output which is exported is determined as the residual when domestic absorption, a fairly stable function of output, is subtracted from total output, while the level of non-agricultural exports is determined on the supply-side in accordance with the

⁷ More recent work by Bradley, FitzGerald and Kearney (1990), on disaggregated services-sector data suggests that the substitution effect of wage changes on investment, which our model ignores, is in fact significant. This means that our model overstates somewhat the magnitude of the crowding-out effects operating through the labour market.

⁸ This, of course, is an oversimplification, and possibly a serious one if Ricardian Equivalence effects are important. That issue is currently under dispute; see e.g. Moore (1987), Walsh (1988) and Whelan (1990).

multinational location model discussed earlier.

The service account of the balance of payments assumes great importance in the Irish case, driving a huge wedge between GDP and GNP, and must also be taken into account in quantifying domestic demand. Service-payments on the foreign debt are determined of course by interest rates and the size of the debt, and profit repatriations from the industrial sector are modelled as a fraction of industrial profits.

3(ii). Labour Supply

Labour supply is determined by population growth, education participation, labour force participation and international migration. We have opted for a simple approximation of population growth based on a three-way age disaggregation: the dependent population aged less than 15 (NLE14), the working-age group aged 15-64 (N1564), and those aged over 64 (NGE65). The typical population equation in the model takes the form:

$$\text{Del}(N1564^t) = a_1 N1564^{t-1} + a_2 NMA^t$$

where the parameters a_1 (the "natural" growth rate) and a_2 (the propensity of the age group to migrate) are estimated from the data, and the natural growth rate is permitted to vary by using intercensal dummy variables.

Our model of aggregate labour force participation is the same as that used by Newell and Symons (1990)¹⁰. Three effects influence the participation decision: present income relative to some measure of a possible alternative income (with the property that a rise in the replacement ratio, *ceteris paribus*, reduces the impact of unemployment on participation); a dummy variable to capture the introduction of state-financed secondary education; and a time trend to pick up slowly evolving socio-demographic factors. A "discouraged worker" effect was found to be statistically significant, i.e. when the unemployment rate rises, participation falls and workers become discouraged and leave the labour force. However, for any given level of unemployment, an increase in the replacement ratio will increase labour supply.

Net migration flows depend, in Harris-Todaro fashion, on relative Irish-UK employment prospects and after-tax earnings, reacting slowly to shocks in these variables.

⁹ Although it is a poor substitute for a fully-articulated model based on single-year population age cohorts as provided by Roper et al. (1990) for example, our approach does at least include the migration mechanism directly in the determination of population.

¹⁰ It would be desirable to construct a disaggregated model of labour force participation that separately identified males and single and married females in the different age cohorts, but the paucity of currently-available data makes this extremely difficult.

3(iii). Wage Determination

We model industrial wages as the outcome of bargaining between unions and employers. As an examination of intersectoral wage growth tends to support the assumption of equality across sectors, the wage increases originating in the tradable-goods sector are posited to spread across to the non-tradable (market services) sector in a fashion familiar from the Scandinavian model; cf. Lindbeck (1979).

~~The formal theory of bargaining, e.g. Andrews and Nickell (1983), identifies the explanatory variables to appear in the wage function: output prices; the wedge between the wage denominated in output prices and the take-home consumption wage of workers; the rate of unemployment, and labour productivity¹¹. The rationale for their inclusion is as follows: the output price received by the producer clearly influences the price at which factor inputs can profitably be purchased. The wedge effect arises because workers try to bargain in terms of a take-home wage denominated in consumer prices and not in terms of gross pre-tax wages denominated in terms of the producer's price¹². The productivity effect comes from workers' efforts to maintain their share of value-added, and the unemployment, or "Phillips-curve", effect basically states that the more people who are unemployed in an economy, the lower will be the power of those workers with jobs to achieve high wage settlements through their union's bargaining activities. In fact, in our model wage inflation is influenced by the change in unemployment, an approach consistent with Walsh's (1987) finding that the short-term unemployed exert a stronger influence on wage inflation than do the long-term unemployed¹³.~~

Statistical estimation using the period 1961-87 shows that in the short-run (i.e. within one year) the following is the effect on wages of a specified change in each of the above explanatory variables¹⁴:

| | |
|------------------------------|----------------------------|
| 1% rise in producer prices | -> 1% rise in wage rate |
| 1% rise in wedge | -> 0.44% rise in wage rate |
| 1% pt. rise in unempl. rate | -> 1.8% fall in wage rate |
| 1% rise in lab. productivity | -> 0.61% rise in wage rate |

¹¹ Theoretically, the replacement ratio should also enter this equation. Empirically, however, its inclusion reduces the equation's explanatory power and it was therefore excluded.

¹² In contrast to N-S we find that the tax wedge has a permanent effect on the product wage. Such permanent pass-through effects are also found in the international literature; see Calmfors and Nymoen (1990).

¹³ Newell and Symons also identify such hysteresis effects in the Irish Phillips curve.

¹⁴ See the Appendix for fuller details of the model estimated.

4. Primary Channels of Influence on Employment and Unemployment in the Model

Before attempting to quantify the impact on the labour market of the various shocks which hit the economy over the last two decades, we highlight in this section the main channels through which such shocks operate in our model. We focus on external and internal factors in turn.

4(i). External factors

We concentrate on the following three external factors : world demand, world interest rates, and the state of the UK labour market.

Any shock to the rate of growth in the rest of the world is transmitted to Ireland through its effects on industrial activity. In the short run, a rise in world output results in a temporary rise in exports and a rise in capacity utilisation in the industrial sector above its long-run norm. If the rise in world growth is sustained, the capacity of the Irish industrial sector rises over a period of years to increase the long-run output potential of the economy. This rise in capacity restores the level of capacity utilisation to its normal level while permitting a sustained increase in domestic output.

There is a positive demand side effect on service-sector employment, and a supply-side effect operating in the opposite direction since the tightening of the labour market puts upward pressure on wages.

Higher world interest rates affect investment through feeding into Irish interest rates (the impact on investment, of course, has both supply-side and demand-side effects), and exert a further contractionary effect through taking an increased proportion of the government budget in the form of debt-service payments.

Conditions in the UK labour market, through their impact on migration, loosen or tighten the Irish labour market and affect employment in the various sectors by influencing wage demands.

4(ii). Domestic factors

The main domestic factors we need to discuss are the demand-side and supply-side effects of fiscal policy, and the operation of demographic factors. As wage demands are determined endogenously, we do not discuss this component of cost competitiveness separately, but focus instead on how the tax wedge operates on employment through this channel.

The direct effect of increased public sector hiring or purchases is to raise domestic demand. This impacts on the services sector, and has a transitory effect on capacity utilisation and output in industry. This is not sustained in our model however, as the

investment and long-run production decisions of firms in this sector are driven by competitiveness and world demand (on which SOE demand has a negligible effect). An expansion in the size of the public sector also tightens the labour market, however, and crowds out private sector employment through increased wage demands. Further consequences will depend on how the increase in public-sector spending is financed.

If financed by borrowing, then debt-service payments rise endogenously, reducing considerably the long-run multipliers of the model. Alternatively, if financed by taxation, the wedge is increased and we get further crowding-out of private sector employment.

Demographic shocks affect the labour market as follows: any increase in the labour force, through its initial effect on unemployment, stimulates migration and also reduces wage pressures, thereby leading to an expansion in employment.

5. Simulation Results

In this section we simulate the model we have been describing to quantify the impact on certain key variables of changes in the external economic environment, domestic policy, and the demographic situation. We treat each in turn, and then change all three simultaneously to try to determine the fraction of the rise in unemployment of 11.9 percentage points between 1970 and 1987 for which each factor is responsible.

5(i). Changes in the external economic environment¹⁵

To investigate how the low and fluctuating growth of world output over the period affected Irish growth, and as a consequence Irish unemployment, we create a synthetic measure of world growth that equals actual growth up to 1970 and then proceeds at a constant rate of 3.6% per annum (the average rate for the 1960's) out to 1987. The fact that the hypothetical world growth was systematically higher than actual growth would lead us to expect a simulated Irish outturn better than the actual outturn.

As with world growth, we have generated synthetic measures of the UK unemployment rate and growth rate of real wages which equal the historical rates up to 1970 and remain constant thereafter. This hypothetical unemployment rate is 2%, while real wage growth is set at 3% (representing average outcomes for the 1960's) out

¹⁵ We are grateful to Brendan Walsh for drawing our attention to some weaknesses in the way we initially carried out this simulation.

to 1987¹⁶. The fact that the hypothetical UK unemployment rate was systematically lower than the actual rate, and the hypothetical real wage growth generally higher (particularly from the late 1970's), would imply that the simulated Irish outturn would display higher out-migration and a consequently tighter labour market.

In order to investigate the effects of the negative real interest rates that prevailed during the 1970's and the rapid rise in real interest rates in the 1980's, we have created a synthetic real interest rate in the model with a value of 1.2%, i.e. the average of the real rates that prevailed during the 1960's. The procedure is to take the model's inflation rate, add the imposed real interest rate and obtain a derived nominal interest rate. The fact that the hypothetical real interest rate was systematically higher than the actual real rate for the period 1970-82 would normally result in a simulated Irish outturn worse than the actual outturn. The reverse would hold true for the later period 1983-87.

Before examining the decomposition of the influences on unemployment, we show in Figure 5 a standard series of variables from the model. In this set of graphs we present the historical outturn for the variables we subsequently wish to examine.

The main results from the examination of world influences are presented in the graphs of Figure 6. These graphs, and all others in the remainder of the paper, show the difference between the simulated and historical outturns. Hence, graph (a) shows the difference between the rate of unemployment that would have prevailed had the world economy been more buoyant, and the historical rate of unemployment; the negative difference that appears indicates that the hypothetical (buoyant) world scenario would have given rise to a rate of unemployment less than the historical level.

An alternative way of describing this graph (a) is to say that the negative shocks to the world economy (relative to the benign benchmark) increased unemployment. In what follows we use this latter terminology.

A full analysis of the results depicted in Figure 6 is given in Barry and Bradley (1991), so we confine ourselves to several remarks here. Unemployment was indeed substantially affected by the world downturn, with almost all the increase stemming from this factor coming in the years 1980-87 when the actual world

¹⁶ We leave the "world" (including the UK) profit rate at its actual value while simulating the model with the hypothetical higher UK real wage growth rate, rather than using a (higher) hypothetical 1960's value for the profit rate also. The procedure we adopt clearly overestimates the UK profit rate (since higher real wage growth would reduce profits), so the alternative would represent an even greater overestimate. The fact that we overestimate world profits means that we underestimate the level of multinational investment that would have occurred in Ireland under the buoyant world scenario, so the negative world shocks probably contributed more to Irish unemployment than our final table of results shows.

Figure 5 : Historical Values for Standardised Data Set

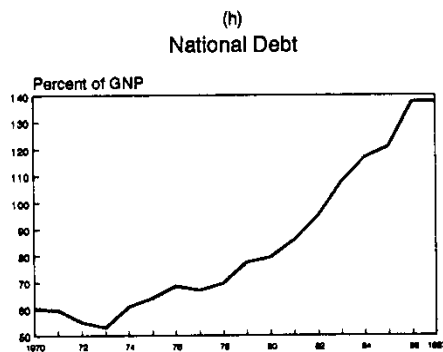
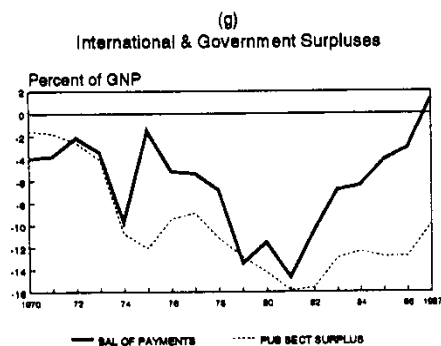
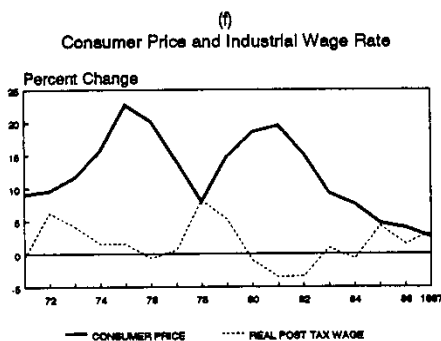
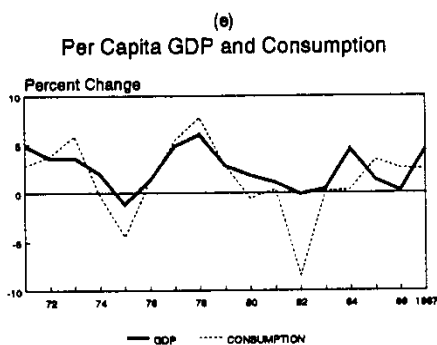
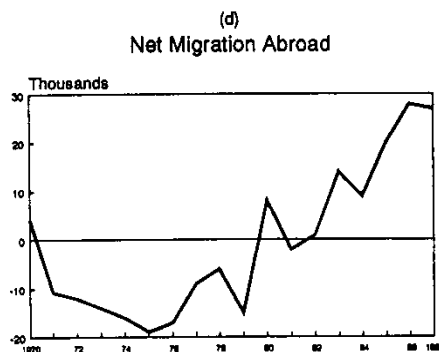
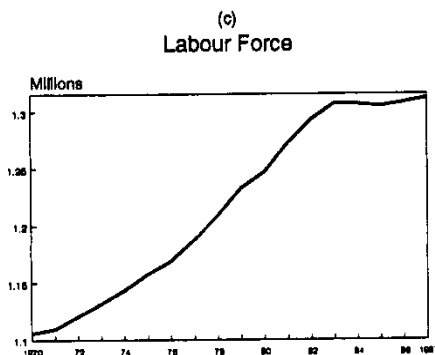
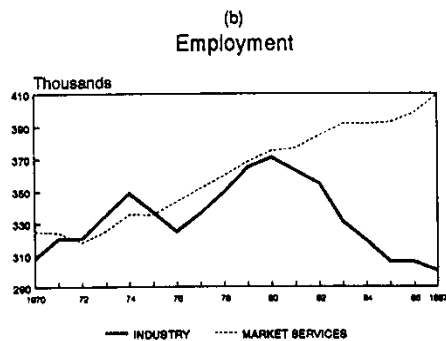
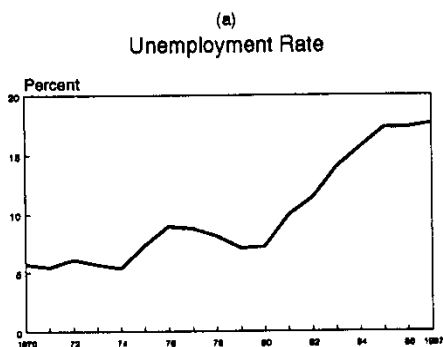
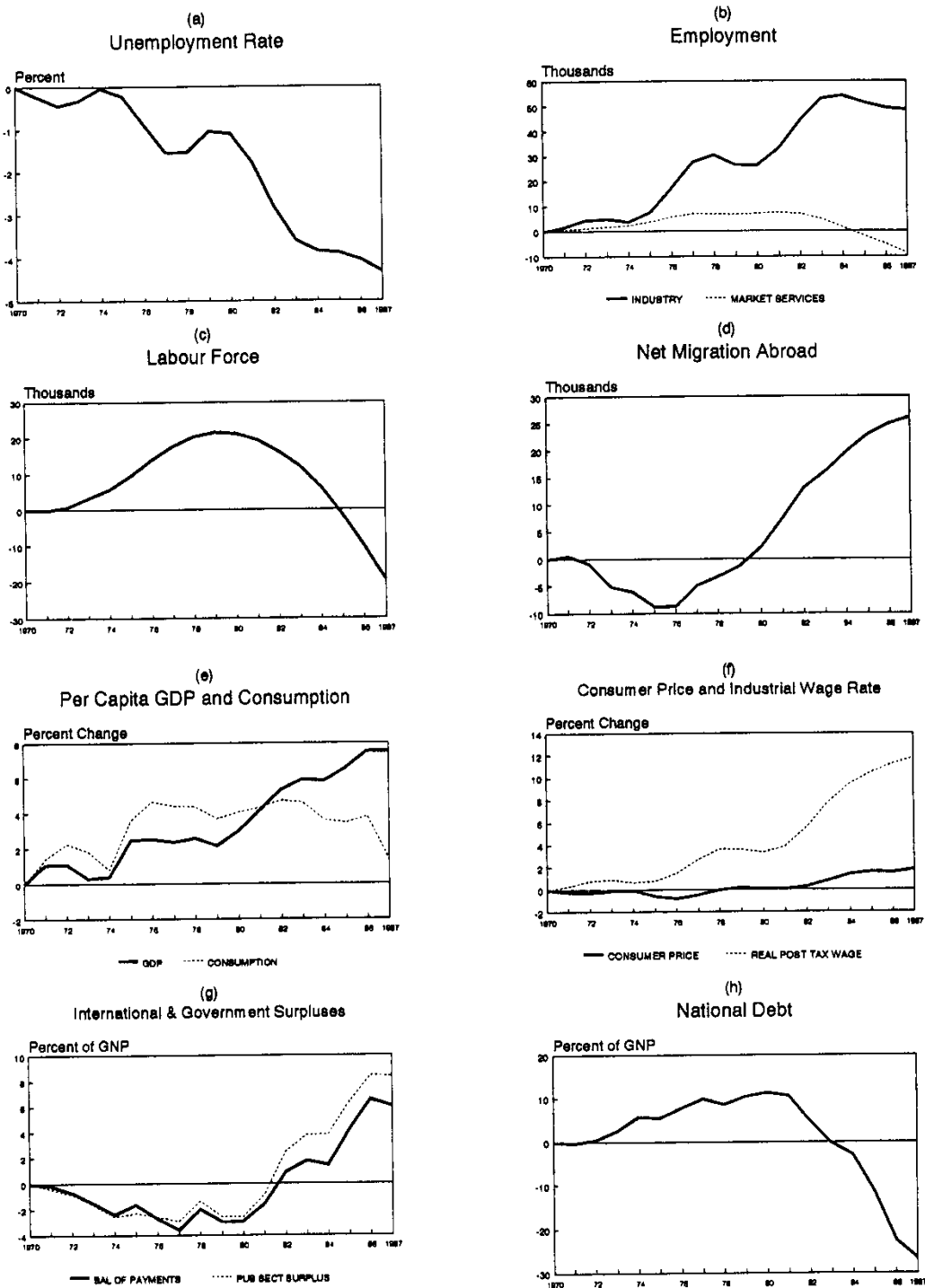


Figure 6 : World Shocks and Irish Unemployment



environment, and in particular the UK unemployment rate, was considerably worse than the stylised one.

The latter factor has a strong effect on migration; it raised the labour force, which loosened the labour market and raised the level of employment in services. Industrial employment was driven mainly by the world economic downturn however, and per capita GDP and consumption were both adversely affected by the world shocks.

5(ii). Changes in domestic policy

During the period 1970-87 the public authorities in Ireland pursued active taxation and expenditure policies that could be characterised as mainly expansionary during the 1970s and contractionary during the 1980s. Furthermore the conduct of expenditure and taxation policies were noticeably different; while expenditure policies were strongly expansionary in the 1970s and broadly neutral in the 1980s (up to 1987), taxation policies were, on balance, relatively neutral in the 1970s but strongly contractionary in the 1980s.

To investigate the impact on the economy of this pro-cyclical public policy and the separate effects of its expenditure and taxation components we need to define a stylized public policy stance that captures the notion of the policy authorities "sitting on their hands", or behaving in a neutral way. The indexation of policy instruments comes nearest to this concept.

For the taxation indexation, percentage rate taxes are indexed by holding them at their 1970 levels, while excise taxes, which are a nominal quantity per real unit, are inflated by an appropriate price index. Public expenditures on goods and services are also inflated using appropriate price indices with public sector employment numbers being held constant at their base value.

Given the radically different behaviour of taxation and public expenditure over our simulation period, 1970-87, we have run three separate counterfactual experiments for fiscal policy. In all three we set external factors at their historical levels. In our first simulation we index both taxation and expenditure policies (Figure 7). In the next we index taxation but set expenditure instruments back to their historical levels (Figure 8). In the final simulation we index expenditure policies but set taxation policies back to their historical settings (Figure 9).

The effects of the three counter-factual simulations on the unemployment rate differ between the 1970s and the 1980s (graph (a) in Figs.7-9). During the 1970s, while the neutral tax policy made little difference (Fig.8a), the expansionary effects of fiscal expenditure policies adopted raised employment in market and non-market services, and reduced unemployment by a peak of 2.4 percentage points by 1981 (Fig.9a). During the 1980s the effects stemming from the expenditure side gradually declined

Figure 7 : Total Taxation & Expenditure Indexation and Unemployment

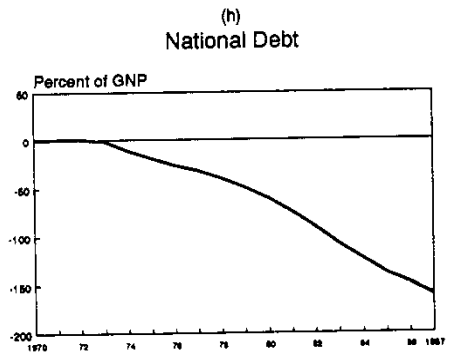
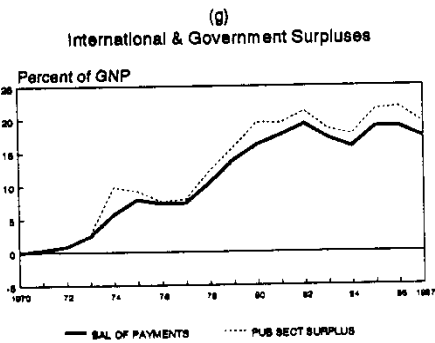
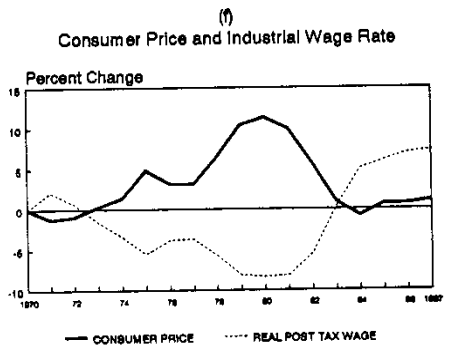
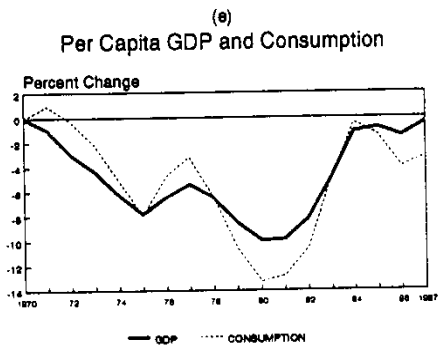
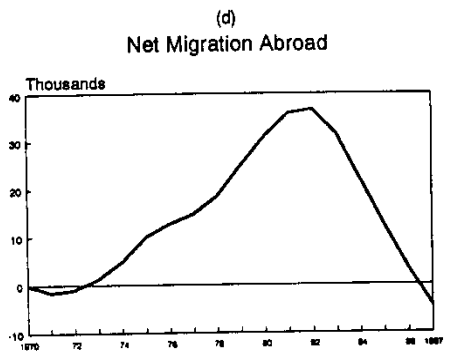
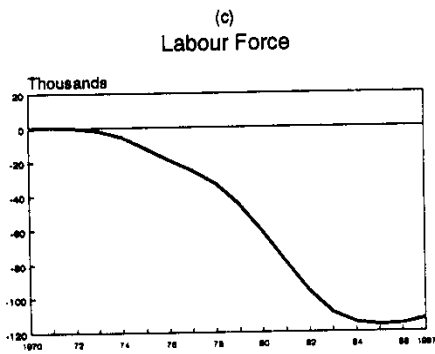
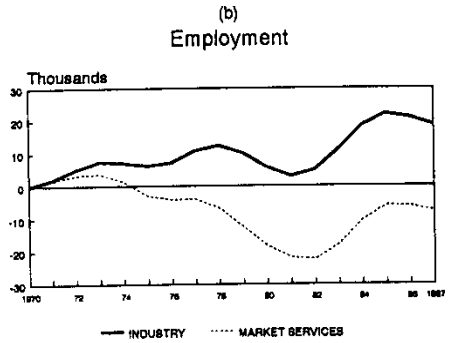
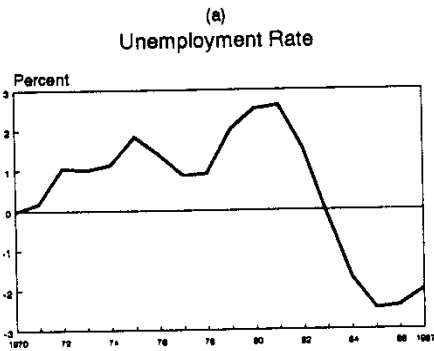


Figure 8 : Taxation Policy Indexation and Unemployment

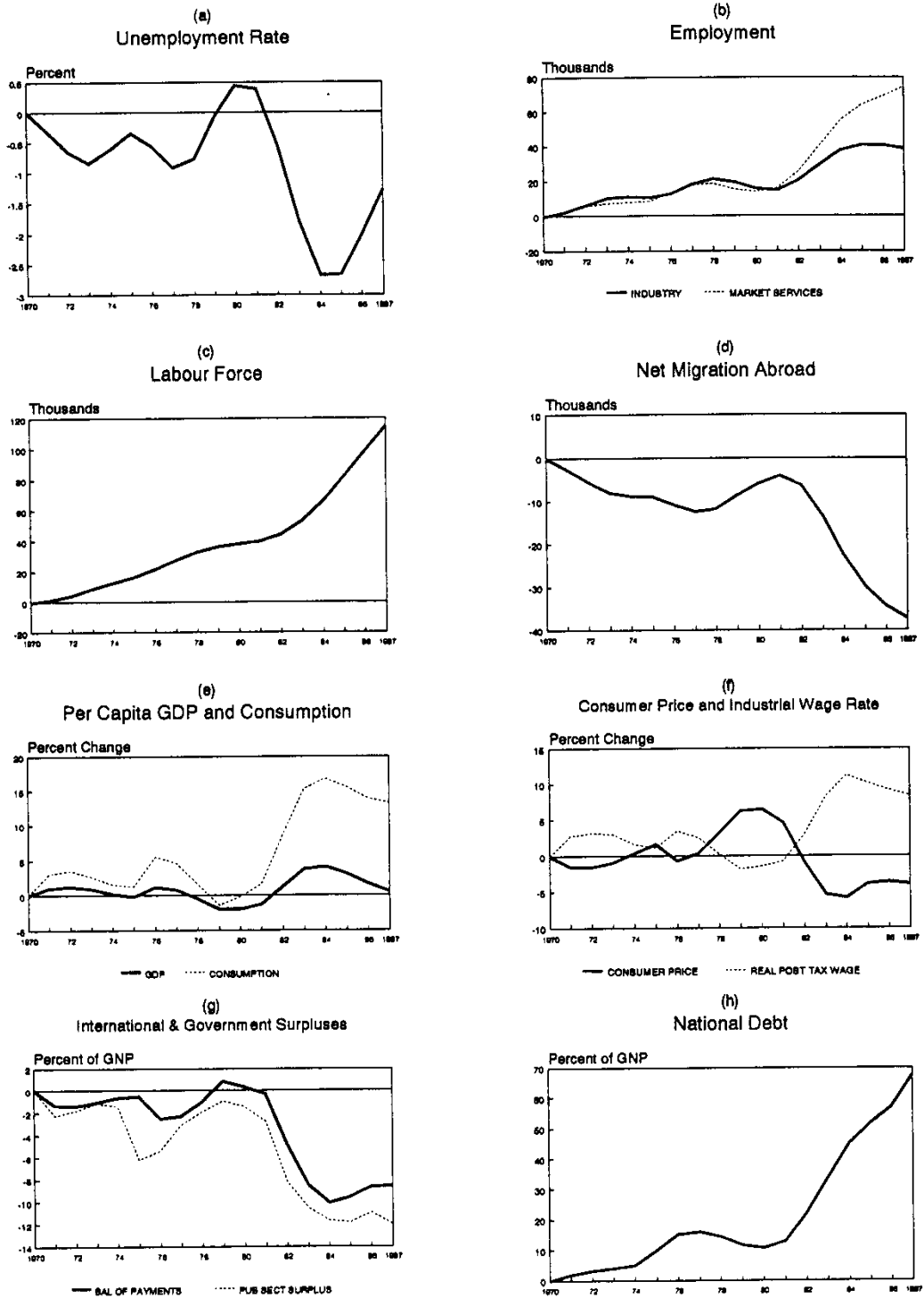
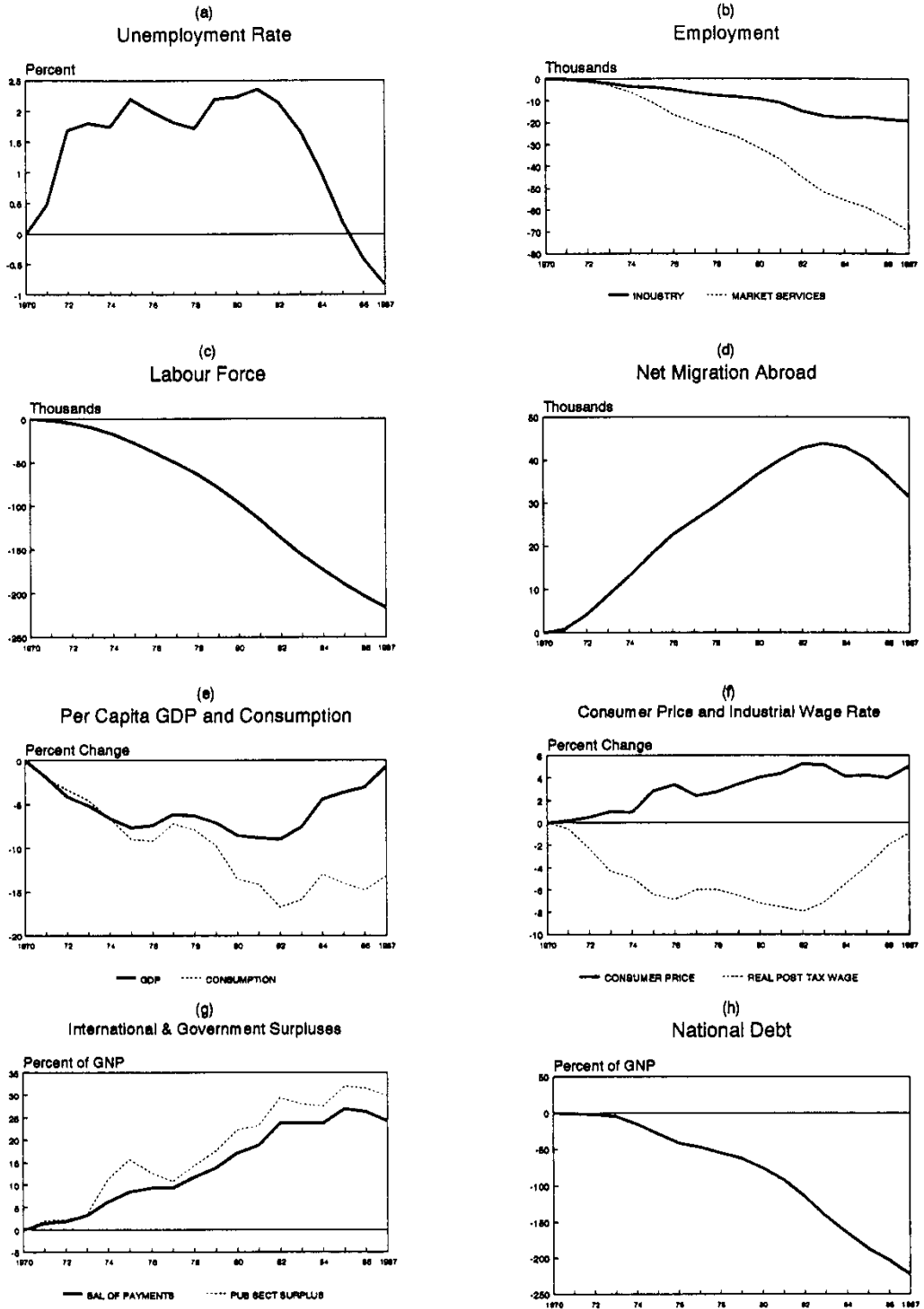


Figure 9 : Expenditure Policy Indexation and Unemployment



until, by the end of the period, they had little effect on the unemployment rate. The dominant effect in the 1980s was the contractionary impact of the tax policies implemented. These raised the unemployment rate significantly throughout the 1980s (Fig.8a). Overall, unemployment would have been only about 2 percentage points lower in 1987 had a completely neutral fiscal policy been followed throughout the period since 1970 (Fig.7a), but the national debt, a positive level of which represents problems stored up for the future, would actually have been negative! (Fig.7h; See below for a fuller discussion).

The expansion in public sector employment in the 1970s and '80s relative to the neutral fiscal policy peaked in 1982 at about 86,000 jobs. Fiscal spending has almost no effect on industrial employment (Fig 9B), but the taxation policies followed had a negative stimulus, particularly in the 1980s, through the effects on the tax wedge and thus on industrial wages (Fig.8b). The overall fiscal policy therefore served to "crowd out" the industrial sector, with the associated employment losses peaking at just above 20,000 in 1985, and numbering 18,500 in 1987 (Fig.7b). The sheltered market services sector fared better. Being more dependent on domestic demand, employment in market services was increased by the expansionary expenditure policies of the '70s. However, particularly after 1981, the effects of the contractionary tax policy on both domestic demand and the tax wedge significantly offset this, with the expansion in market services employment due to fiscal policy limited to about 7,500 by 1987 (Fig.7b). The total number of market economy jobs lost by 1987 through fiscal policy was therefore about 11,000. Total employment, including non-market services, was thus some 70,000 above the level it would have attained had fiscal policy remained neutral throughout the period. As this gain was associated with a very substantial national debt, however, (Fig.7h), prospects for future employment are a good deal poorer than in the hypothetical scenario.

The expenditure simulation shows that, had expenditure been indexed, massive exchequer surpluses would have resulted, and the debt/GNP ratio would have been over 220 percent below its actual level by 1987 (Fig.9h); had taxes been indexed, on the other hand, and expenditure policies not, the ratio would have been nearly 70 percentage points higher than its actual 1987 level (Fig.8h). Combining these in the full fiscal policy indexation experiment shows that the fiscal policies actually pursued gave a debt/GNP ratio 160 percent above the outturn that would have resulted under full indexation (Fig.7h); i.e. the negative national debt referred to earlier. It need hardly be said that such an outturn would have been politically implausible and the ability of a macromodel to analyse such a severe departure from the historical outturn is, in any case, questionable.

5(iii). Changes in the demographic situation

The population equation in our model makes a clear distinction between natural population growth and alterations due to net emigration effects. In our counterfactual experiment we set the natural growth rate to zero but still permit migration to influence population.

The equation explaining the aggregate labour force participation rate is identical to the one used by Newell and Symons (1990). Like them, we also conduct a counterfactual experiment where we eliminate the trend growth in participation, but leave the other explanatory variables in place.

The main results from the counterfactual demographic simulation are shown in Figure 10. Again we will comment only briefly on them here. Demographics, we see, added some 3.5 percentage points to the unemployment rate by 1987, and increased the labour force by about 115,000, partly through the trend growth in participation, but also because the natural growth in population raised the population of working age. Alongside the increase in unemployment, we see, in panel (d), the impact of demographic factors on net migration abroad.

5(iv). Accounting for Ireland's Unemployment

The effects of the three separate shocks (world, policy and demographic) have been examined above. If the model was fully linear, these effects could simply be added together to obtain the total effect. Since the model is non-linear, we have simulated the effects of all three shocks together and the main results are shown in Figure 11. The ability of the model, combined with the stylised shocks, to accurately reproduce the historical outcome is revealed by comparing these results with the historical values graphed in Figure 5.

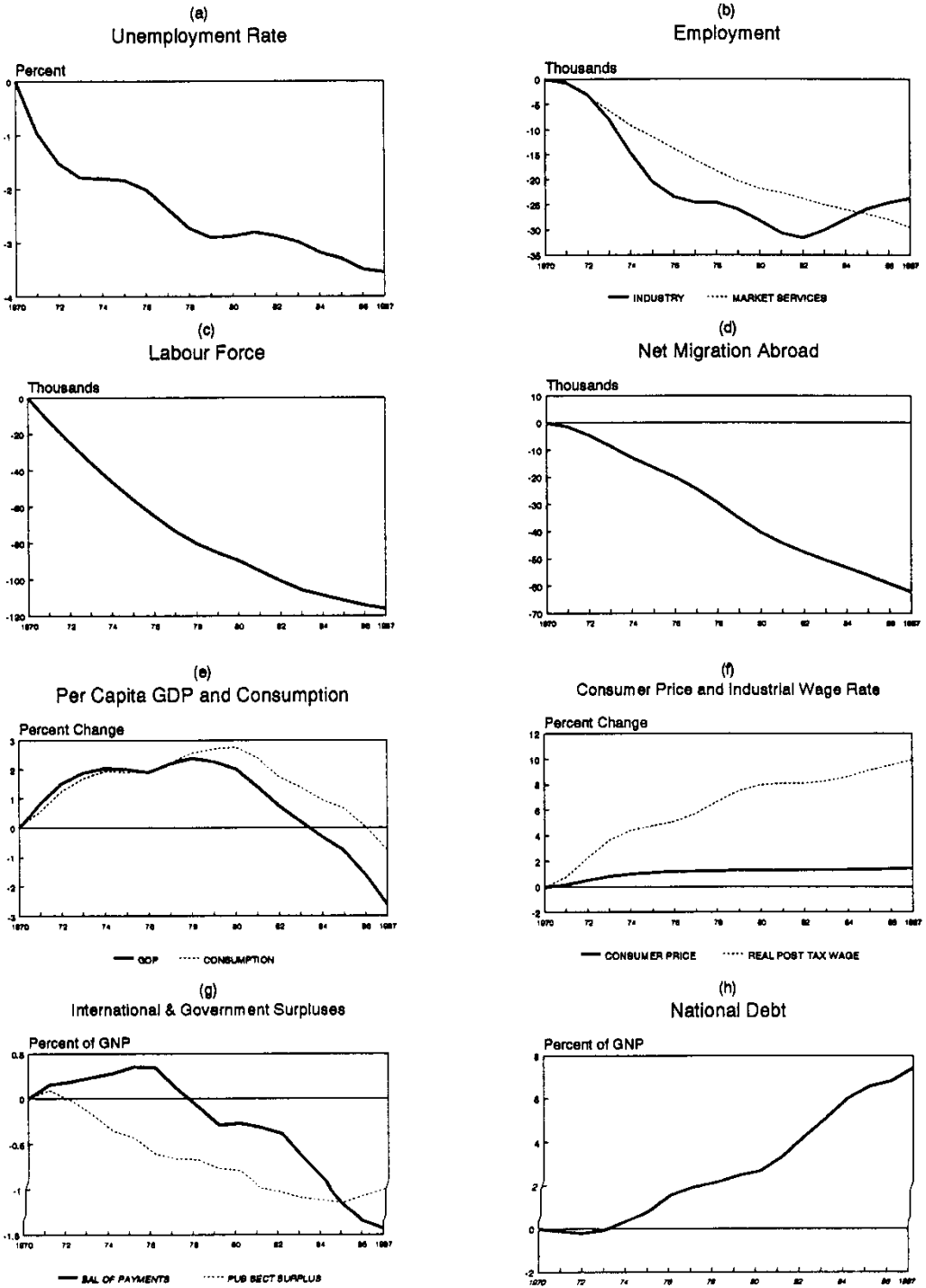
(a) The various shocks which buffeted the economy raised the unemployment rate in each year (graph (a)). Between 1970 and 1987, the simulated increase is of the order of 9.7 percentage points, compared to a historical rise of 11.9. Between 1979 and 1986 (the Newell and Symons period of analysis), the simulated increase is 8.4 points, compared to a historical rise of 10.2.

(b) The shocks reduced employment in industry for almost all years, while raising service sector employment. By 1987 the induced employment changes in the two sectors largely cancelled each other.

(c) The shocks raised the labour force by 230,000 by 1987 (graph(c)).

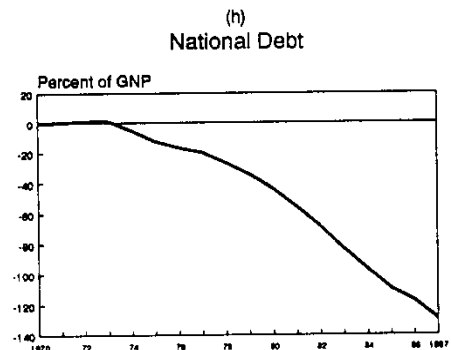
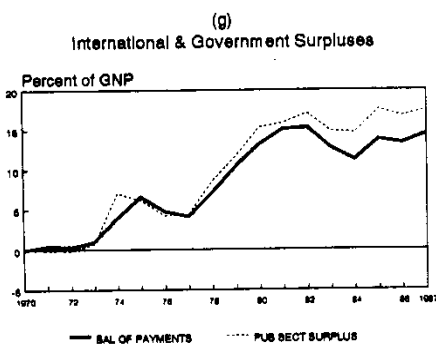
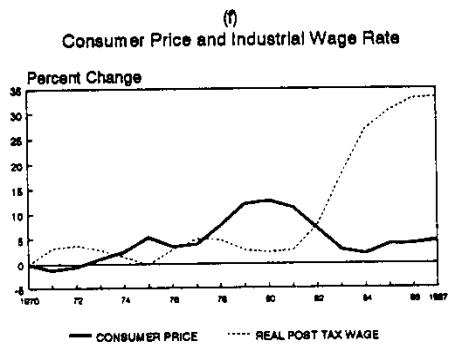
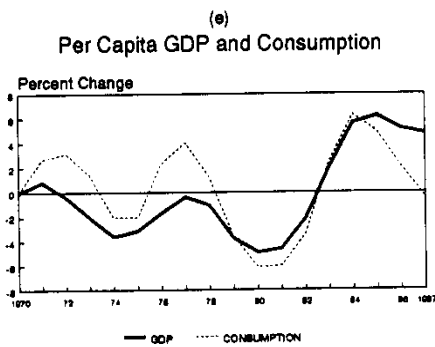
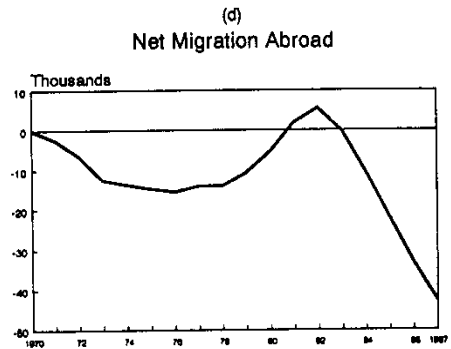
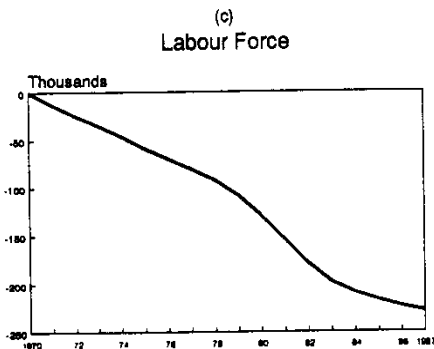
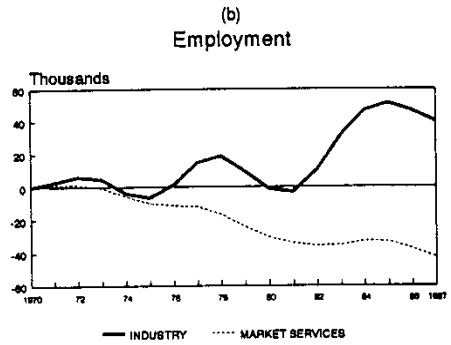
(d) They reduced net migration abroad in the 1970's and strongly increased it in the 1980's (graph (d)).

Figure 10 : Demographic Factors and Unemployment



13122364

Figure 11 : The Causes of Irish Unemployment



(e) Real GDP per capita was reduced by 4.8 percent by 1987 under the impact of the shocks, while the effect on consumption per head fluctuated; in 1987 this was back at the level that would have prevailed anyway had the shocks not occurred (graph (e)).

(f) On aggregate the shocks were slightly deflationary, with prices lower than they would otherwise have been by 5 percent. The combined shocks reduced real after-tax wages by 34 percent, compared to what they would have been in the neutral environment (graph (f)).

(g) Both the international and exchequer surpluses were massively reduced by the shocks, by around 15 percentage points of GNP in each case by 1987 (graph (g)).

(h) The debt/GNP ratio was raised dramatically by the exchequer deficits, and ended the period up 130 percentage points of GNP compared to the neutral scenario (graph (h)). Had the shocks not occurred, we see from Figure 5 that the debt/GNP ratio would have been close to zero in 1987!

In Table 1 we summarise our findings and compare them with the results of Newell and Symons. The numbers here represent the difference between the actual historical outturn and the hypothetical simulated result. So, for example, the figure +4.3 in the table below means the following: the fact that the actual world outturn was on balance worse than the hypothetical one added 4.3 points to the rate of unemployment.

Over the longer period 1970/87, the world and demographic shocks account for the bulk of variation in the unemployment rate, since the periods of expansionary and contractionary fiscal policy cancel each other out to some extent. When attention is focussed on the shorter period 1979/86, however, the fiscal effect becomes much more important and dominates the combined effect of the other two factors explored. The demographic effect largely drops out of the calculation. This contrasts sharply with the Newell and Symons results also shown in the table for comparative purposes.

Table 1: Decomposition of Unemployment Changes: 1970-87 ^{17, 18}

Change in Unemployment Rate (% Points)

| | 1970/87 | 1979/86 | 1979/86 (N-S) | 1970/80 |
|-------------------------|---------|---------|------------------|---------|
| External factors | 4.31 | 3.00 | 4.3 | 1.09 |
| Domestic Policy Factors | 2.00 | 4.41 | 1.9 | -2.53 |
| Demographic Factors | 3.54 | 0.60 | 3.0 | 2.86 |
| All Factors Combined | 9.74 | 8.44 | 9.2 | 1.19 |
| Historical Data | 11.9 | 10.2 | 10.2 | 1.5 |

6. Summary

Newell and Symons (1990) summarised their findings in the following terms: "Irish unemployment problems in the 1980s (were) caused by demand shocks, supply side factors and demographics in the approximate ratio 4:2:3, respectively. The demand shocks were external in origin; the demographic factors were obviously beyond conventional government control. On the supply side, the increase in taxes was caused in part by world interest rates; and the Irish replacement rate is not exceptionally generous. It seems to us (that) Ireland's problems had more to do with bad luck than bad management".

Our own analysis forces us to draw a rather different moral from the history of Irish policy making, particularly in the light of the right-most column in the table above. During the period 1970/80 the world environment was on balance fairly neutral, contributing about 1 percentage point to what the unemployment rate would otherwise have been in the hypothetical "golden age" scenario. Demographics, however, were moving in such a way as to put severe upward pressure on the labour supply, due both to the trend growth in participation and the high natural population growth rate. The public policy stance was strongly expansionary, and pro-cyclically so towards the end of this period, reducing the end-period (1980) rate of unemployment by almost 3 percentage points relative to a hypothetical policy of fiscal neutrality. It was financed to a large extent by foreign borrowing, and a huge national debt was accumulated.

This placed the authorities in an unfortunate position when the

¹⁷ The fact that the sum of the individual shocks does not add up exactly to the number representing "all factors combined" is due to the non-linear nature of the model.

¹⁸ The historical data shown for the 1979/86 period differs from that given by Newell and Symons, presumably because of data revisions.

"bad luck" struck after 1980 in that a pro-cyclical (meaning, by this time, contractionary) policy stance had to be adopted if the debt/GNP ratio was not to explode. The "wages of sin" now had to be paid and the public policy stance increased the unemployment rate by 4.4 percentage points over the period 1979/86 (the Newell and Symons period) at a time when the deteriorating world environment was causing a rise of a further 3 percentage points. The net effect of demographics was negligible during the 1979/86 period, hiding large plus and minus cancelling processes.

This was not simply the "bad luck" of an unexpected world recession; the unemployment of the 1980's has been to a significant extent a consequence of the fiscal mis-management of the 1970s, when inappropriate policies were pursued, the tax base eroded, and the national debt built up. Our analysis highlights the perils of using fiscal policy as a macroeconomic instrument in a small open economy.

7. Concluding Comments

In this paper we have used a very specific model of how the Irish economy functions in order to quantify the proximate causes of the rise in unemployment over the last two decades. It is important therefore that we recognise both the limitations of the model employed and the narrow focus of the questions we have been attempting to answer.

One limitation of the model is its inability to handle the issue of expectations and policy credibility which play a central role in current theoretical discussions; these emphasise the differential effects of temporary versus permanent and anticipated versus unanticipated disturbances, as well as of sustainable versus unsustainable government policies; see e.g. Persson (1988). The extent to which these factors have been important in the recent functioning of the Irish economy is controversial¹⁹, although the argument that they have been, made by Giavazzi and Pagano (1991) and McAleese (1990), has applied mainly to the post-1987 period, with which we are not concerned in this paper²⁰. The difficulties involved in incorporating these processes in an econometric model have not yet been surmounted.

A broader issue concerns the nature of the questions asked in the paper. Taking as given the structure of the Irish economy as captured in the ESRI macromodel, we have attempted to account for

¹⁹ The view presented in this paper has more in common with that of Honohan (1989) than with Dornbusch (1989).

²⁰ Note, though, that a domestic demand-driven expansion caused by an "expansionary fiscal contraction", the mechanism these authors hypothesise, should be associated with a worsening of the balance of payments, in contrast to the improvement which actually took place. The latter, on the other hand, is consistent with an expansion driven by buoyant world demand and improving cost-competitiveness, mechanisms central to the approach embodied in the present paper.

the rise in unemployment. What we have not done is to identify the reasons why the Irish labour market should adjust in precisely this fashion to the shocks with which it is buffeted; we have had nothing to say, for example, on what processes generate the precise magnitude of the parameters in the Phillips curve relation, in the migration equation, etc. A crucial area for future research is to inquire into how manpower and training policies, more corporatist labour-market structures, or a different orientation to industrial policy, for example, would affect these parameters, and thus affect the ability of the economy to handle exogenous shocks without such high unemployment being generated.

References

- Andrews, M. and S.J. Nickell (1983) "Unions, Real Wages and Employment in Britain 1951-79", Oxford Economic Papers, Vol. 35 (Supplement), pp. 183-206.
- Barry, F. (1987) "Macroeconomic Perspectives on Irish Unemployment", in Perspectives on Economic Policy, Centre for Economic Research, University College Dublin.
- Barry, F. (1991) "Aggregate-Supply, Aggregate-Demand, and Structural Factors in Recent Irish Unemployment", ESRI Quarterly Economic Commentary, (forthcoming).
- Barry, F. and J. Bradley (1991) "Irish Employment and Unemployment: A Macroeconomic Analysis", Report for the National Economic and Social Council. ESRI Policy Research Series, (forthcoming).
- Buiter, W. (1985) "A Guide to Public Sector Debt and Deficits", Economic Policy, 1, Pp. 13-79.
- Bradley, J. and J. Fitz Gerald (1988) "Industrial Output and Factor Input Determination in an Econometric Model of a Small Open Economy", European Economic Review, Vol. 32, pp. 1227-1241
- Bradley, J. et al. (1989) HERMES-IRELAND: A Model of the Irish Economy: Structure and Performance, Dublin: The Economic and Social Research Institute.
- Bradley J. and J. Fitz Gerald (1990) "Production Structures in a Small Open Economy with Mobile and Indigenous Investment", European Economic Review, Vol. 34, pp. 364-374.
- Bradley, J., J. Fitz Gerald and I. Kearney (1990) "A Model of the Irish Marketed Services Sector", mimeo, ESRI
- Callan, T. and J. Fitz Gerald (1989) "Price Determination in Ireland: Effects of Changes in Exchange Rates and Exchange Rate Regimes", The Economic and Social Review, Vol. 20, pp. 165-188
- Calmfors, L., and R. Nymoer (1990) "Nordic Unemployment", Economic Policy, October, pp. 397-448.
- Dornbusch, R. (1989) "Credibility, Debt and Unemployment: Ireland's Failed Stabilisation", Economic Policy, April, pp. 173-208.
- Giavazzi, F. and M. Pagano (1990) "Can Severe Fiscal Contractions be Expansionary? A Tale of Two Small European Countries", National Bureau for Economic Research Macroeconomics Annual, Cambridge, Mass.: NBER

- Honohan, P. (1989): "Comment on Dornbusch", Economic Policy, April, pp. 209-212.
- Lindbeck, A., (1979): "Imported and Structural Inflation and Aggregate Demand: The Scandanavian Model Reconstructed", in Inflation and Employment in Open Economies, ed. A. Lindbeck, Amsterdam: North-Holland
- McAleese, D. (1990) "Ireland's Economic Recovery", Irish Banking Review, pp. 18-32.
- Moore, M. (1987) "The Irish Consumption Function and Ricardian Equivalence", Economic and Social Review, Vol. 19, 1, pp. 43-60.
- Newell, A. and J. Symons (1990) "The Causes of Ireland's Unemployment", Economic and Social Review, vol. 21, no. 4, pp. 409-429.
- Persson, T. (1988) "Credibility of Macroeconomic Policy: An Introduction and a Broad Survey", European Economic Review, vol. 32, pp. 519-532.
- Roper, S., A. Schofield, G. Gudgin and M. Tavakoli (1990): A Guide to the NIERC Model of the Northern Ireland Economy, Belfast: NIERC
- Sexton, G. and B. Walsh, (1982): "A Study of Labour Force Flows", Quarterly Economic Commentary, ESRI, May.
- Walsh, B. M., (1987): "Why is Unemployment so High in Ireland Today?", Perspectives on Economic Policy, Centre for Economic Research, University College Dublin.
- Walsh, B.M., (1988) "Ricardian Equivalence and the Irish Consumption Function: A Comment", Economic and Social Review, vol. 20, 1, pp. 49-52.
- Whelan, K. (1990): "Ricardian Equivalence and the Irish Consumption Function: The Evidence Re-Examined", mimeo, ESRI

APPENDIX 1

TECHNICAL DETAILS ON THE MACROSECTORAL MODEL

The ESRI medium-term macroeconomic model, HERMES-Ireland, was developed under contract for the EC, Directorate General for Science, Research and Development (DG XII) over the period 1982 to the present date. It has been used extensively in economic analysis (Bradley, *et al*, 1985) and in preparing the *Medium-Term Review* in the ESRI (Bradley, Fitz Gerald and Storey, 1987; Bradley and Fitz Gerald, 1989). A complete description of the model is available in Bradley *et al*, 1989, where a comprehensive account of the structure of the model is given, together with a listing of all equations and statistical estimation results.

In this appendix we restrict ourselves to a brief description of selected behavioural equation of direct relevance to the study of the labour market. Where these equations have been altered or improved since the publication of Bradley *et al*, 1989, we present the new estimation results. A complete up-to-date listing of the model equations and estimation results is available from the ESRI on request, as is the entire model data bank (in SORITEC data-bank (SDB) format).

Industry Sector

Planned industrial capacity in Ireland (QSTARI) is determined in the model schematically as follows:

$$\log(QSTARI/QWSTARI) = f(PRWOR/PRIRL, t)$$

where PRIRL is the Irish rate of profit and PRWOR is the "world" rate. In the full model, a distinction is made between the profit rates in Germany, the United Kingdom and the United States (refer Bradley *et al*, 1989, pp. 65-66 for details)

In the long term a production function links planned output (QSTARI) to planned factor inputs labour (LSTARI), capital (KSTARI) and energy (ESTARI). A bundled CES-CES function is used where the inner CES function combines capital and energy, and the outer CES function combines the capital-energy bundle with labour. The parameters of the production function are recovered using the same method as in the OECD INTERLINK model (Helliwell, *et al*, 1986) and these parameters, together with the related elasticities, are reported in Bradley *et al*, 1989, pp. 12-15. Actual output (QHI) is related to a vintage-based measure of normal output (QVIN), and is also influenced by unexpected shocks to domestic sales and world demand.

Actual employment (LI) and capital stock (KI) adjust to their planned values (LSTARI and KSTARI) in an error correction mechanism (ECM) of the form:

$$\Delta \log(LI) = a_1 + a_2 \Delta \log(LSTARI) + a_3 \log(LSTARI/LI)_{-1} + a_4 \log(CURH)$$

Market Services

Output in market services (OSM) is driven by a weighted measure of final demand (GSOSM), where the weights are taken from the 1975 input-output table and the time trend is used to capture any systematic shifts in market services content over time.

$$\log(OSM) = a_1 + a_2 \log(GSOSM) + a_3 t$$

The estimation results were as follows:

| | coefficient | t-statistic |
|------------------------|-------------|-------------------|
| a ₁ | 2.30 | 5.5 |
| a ₂ | 0.75 | 12.3 |
| a ₃ | 0.0034 | 1.3 |
| R ² = 0.998 | | DW = 2.33 |
| | | RHO = 0.286 (1.8) |

A2

The capital stock in market services (KSM) is driven by a moving average of services output (OSTARSM) in an ECM.

$$\Delta \log(KSM) = a_1 + a_2 \Delta \log(OSTARSM) + a_3 \log(OSTARSM_{-1}/KSM_{-1}) + a_4 t$$

The estimation results were as follows:

| | coefficient | t-statistic |
|------------------------|-------------|-------------|
| a ₁ | -0.0977 | 1.0 |
| a ₂ | 0.530 | 2.4 |
| a ₃ | 0.381 | 2.2 |
| a ₄ | 0.00545 | 1.4 |
| R ² = 0.564 | | DW = 2.17 |
| RHO = 0.673 (4.7) | | |

The ratio of labour (LSM) to capital (KSM) is determined as a function of the price of labour (AAESM) relative to the cost of capital (UCCS), where a lagged adjustment is permitted.

$$\log(LSM/KSM) = a_1 + a_2 \log(AAESM/UCCS) + a_3 \log(LSM_{-1}/KSM_{-1})$$

The estimation results were as follows:

| | coefficient | t-statistic |
|------------------------|-------------|-------------|
| a ₁ | -0.617 | 2.2 |
| a ₂ | -0.285 | 3.1 |
| a ₃ | 0.498 | 4.1 |
| R ² = 0.997 | | DW = 2.01 |
| RHO = 0.879 (23.9) | | |

Labour Supply

The three population equations are similar in structure. In each, the change in population is a function of lagged population and of migration (except in the case of population aged over 65 where the coefficient on migration was found to be very small and insignificant. The coefficient on lagged population can be interpreted as a natural growth rate, and is permitted to vary discretely between each different census of population.

$$\Delta NLE14 = (a_1 + a_2 DUM_{6165} + a_3 DUM_{6670} + a_4 DUM_{7180} + a_5 DUM_{8185}) NLE14_{-1} + a_6 NMA$$

| | coefficient | t-statistic |
|------------------------|-------------|-------------|
| a ₁ | -0.00653 | 3.3 |
| a ₂ | 0.0195 | 10.0 |
| a ₃ | 0.0163 | 9.2 |
| a ₄ | 0.0142 | 5.5 |
| a ₅ | 0.0112 | 6.1 |
| a ₆ | -0.3518 | 6.1 |
| R ² = 0.964 | | DW = 2.23 |

$$\Delta N1564 = (a_1 + a_2 DUM_{6165} + a_3 DUM_{6670} + a_4 DUM_{7180} + a_5 DUM_{8185}) N1564_{-1} + a_6 NMA$$

| | coefficient | t-statistic |
|------------------------|-------------|-------------|
| a ₁ | 0.0147 | 6.7 |
| a ₂ | -0.00238 | 1.0 |
| a ₃ | -0.00523 | 2.6 |
| a ₄ | -0.00242 | 0.8 |
| a ₅ | -0.00061 | 0.3 |
| a ₆ | -0.66496 | 5.1 |
| R ² = 0.969 | | DW = 2.23 |

A3

$$\Delta NGE65 = (a_1 + a_2 DUM_{6165} + a_3 DUM_{6670} + a_4 DUM_{7180} + a_5 DUM_{8185}) NGE65_{-1}$$

| | coefficient | t-statistic |
|------------------------|-------------|-------------|
| a ₁ | 0.0128 | 5.4 |
| a ₂ | -0.00813 | 2.2 |
| a ₃ | -0.00912 | 3.1 |
| a ₄ | -0.00185 | 0.7 |
| a ₅ | -0.00522 | 1.8 |
| R ² = 0.860 | | DW = 2.16 |

The labour force participation equation is identical to the form used by Newell and Symons, to which paper we refer the reader.

$$LFPR = a_1 + a_2 UR * (1 - REPR) + a_3 DUMED + a_4 i^2 + a_5 LFPR_{-1}$$

| | coefficient | t-statistic |
|------------------------|-------------|-------------|
| a ₁ | 14.733 | 2.3 |
| a ₂ | -0.09441 | 2.2 |
| a ₃ | -1.0704 | 4.6 |
| a ₄ | 0.00139 | 3.1 |
| a ₅ | 0.7901 | 8.8 |
| R ² = 0.924 | | DW = 1.75 |

Net migration abroad is a function of the relative probability of obtaining employment in Ireland and the UK (RE) and the relative real rate of compensation (RW). The equation adjusts very slowly to employment shocks, and the year 1980, a totally anomalous one from examination of the data in Figure 5 previously, is eliminated by a dummy variable.

$$NMA = a_1 + a_2 RE * RW + a_3 NMA_{-1} + a_4 DUM_{80}$$

| | coefficient | t-statistic |
|------------------------|-------------|-------------|
| a ₁ | 80.23 | 3.0 |
| a ₂ | -79.91 | 3.0 |
| a ₃ | 0.8686 | 9.1 |
| a ₄ | 26.74 | 4.1 |
| R ² = 0.840 | | DW = 2.34 |

Wage Rates

The formulation used in the model is as follows, where AA EI is the nominal wage rate (actually, average annual earnings in industry), PQTI is the output price, WEDGE is the "wedge" variable UR is the rate of unemployment and LPROD is labour productivity.

$$\log(AAEI/PQTI) = a_1 + a_2 \log(WEDGE) + a_3 \frac{(UR + UR_{-1})}{2} + a_4 \log(LPROD) + (1 - a_4) \log(AAEI/PQTI)_{-1}$$

| | coefficient | t-statistic |
|------------------------|-------------|-------------|
| a ₁ | -0.1999 | 4.7 |
| a ₂ | 0.4390 | 4.8 |
| a ₃ | -0.0178 | 4.6 |
| a ₄ | 0.6144 | 6.8 |
| R ² = 0.699 | | DW = 2.06 |

A second version was tested (but not used in the simulations), incorporating a modification to the UR term, based on the Newell and Symons results. The unemployment rate is multiplied by (1-REPR), where REPR is the replacement rate.

$$\log(AAEI/PQIT) = a_1 + a_2 \log(WEDGE) + a_3 \frac{(UR + UR_{-1})}{2} * (1 - REPR) + a_4 \log(LPROD) + (1 - a_4) \log(AAEI/PQIT)_{-1}$$

| | coefficient | t-statistic |
|------------------------|-------------|-------------|
| a ₁ | -0.2114 | 4.7 |
| a ₂ | 0.4159 | 4.3 |
| a ₃ | -0.0229 | 4.0 |
| a ₄ | 0.6327 | 6.3 |
| R ² = 0.660 | | DW = 1.79 |