BRIEFING PAPER

SHORT TERM FLUCTUATIONS IN SCOTTISH OUTPUT, EMPLOYMENT AND UNEMPLOYMENT

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1. INTRODUCTION

This is an interim working paper on the development of a an econometric model of the short-term fluctuations in output, employment and unemployment in the Scottish economy. As is argued by many previous regional modellers and analysts, it is of both theoretical and practical importance to have an in-depth understanding of the regional economic problems and adjustment mechanisms. This is particularly needed at a time when the European nations are moving towards an economic and monetary union, as the importance of 'regional' issues will increase with 'regional' adjustment mechanisms replacing nominal exchange rate mechanism.

However, a major impediment to a proper understanding of the regional economic problems is the lack of regional data, especially sufficient and consistent time series on regional trade and prices. Partly due to this data constraint, and partly due to the great dependence of the regional economy on the national economy, a large number of the extant regional models are simply 'satellite' models in the sense that the regional variables are driven by exogenous national variables without or with little regional simultaneity.

As far as the Scottish economy is concerned, previous attempts have been made to model and forecast its performance along the same line (e.g. see D.Bell, 1978; C. Lythe, et al, 1981). In the present modelling exercise, our basic conceptual approach is more or less the same. Scottish output is determined by a national-regional multiplier relationship. Once the Scottish output is determined, the desired demand for labour services can be derived (either from an inverted production function or from the first order condition of a profit maximization problem). This desired level can be regarded as the long-run equilibrium level of labour requirements. Short term deviations from this equilibrium level can be captured in a partial adjustment mechanism whereby excess demand in the labour market can be established. Finally a regional Phillips-curve type relationship links the excess labour demand and the unemployment level which completes the chain of causation.

In the present modelling exercise, however, differences do exist between this model and the previous ones on the Scottish economy. A major advantage of this model is that it is the first quarterly model of the Scottish economy. A quarterly version of the model adds more power and flexibility than an annual model. With a quarterly model we can not only explore richer lag structures and dynamic processes, but also carry out more routine statistical tests against a variety of null hypotheses. A quarterly model can also provide timely forecasts. Another difference is that in the present model the employment equation is derived from a maximization problem rather than an *ad hoc* specification. In the following section we give a detailed account of the structure and specification of the model.

2. MODEL STRUCTURE AND SPECIFICATION.

2.1. The output block

In most regional models, regional output is specified as driven by the exogenous national output. Unsatisfactory as it obviously is, data problems often prevent any alternative specification, such as one derived from a national accounting identity. Following Bell (1978), we postulate the Scottish-UK output relationship to have an autoregressive-distributed-lag form, ARDL(p,q):

$$\alpha(L)\, SQ_t = \alpha o + \beta(L) UQ_t + \gamma T \qquad (1)$$

where $\alpha(L) = 1 - \alpha_1 L - \ldots - \alpha_p L^p$,

$$\beta(L) = \beta_o + \beta_q L + \ldots + \beta_q L^q,$$

L: Lag operator, SQt: Scottish output, UQt: UK output, T: a time trend.

2.2 The labour market

2.2.1 Labour demand

Given the limitation of data, different forms of desired labour demand functions are specified. It should be made clear that demand for labour here means demand for employment. No distinction is made in our approach between demand for employment and demand for labour services, as is desired. This approach is perforce due, again, to lack of data on working hours. The desired

[1]The research reported in this paper was supported by a fellowship funded by TSB Bank Scotland.

demand for labour functions are derived either from a CES production function, a hyperbolic output demand function and a profit maximization problem, or from an inverted Cobb-Douglas production function. In the former case, the long-run equilibrium level of labour requirement is expressed as:

$$L^* = A\ SQ^{\alpha 1}\ (W/P)^{\alpha 2} \tag{2a}$$

where L^*: desired demand for labour, W: nominal wages, P: current prices.

In the second case, following Ball and St Cyr (1977) and Bell (1978), we use a time trend as a proxy for the combined effects of capital stock and technology in the Cobb-Douglas production function. By inverting it we have another form of the desired labour demand:

$$L^* = A_1\ SQ\phi_1\ \exp(\phi_2 T) \tag{2b}$$

2.2.2 Labour market adjustment

The short-term adjustment of employment to its desired level is assumed as being not instantaneous, and is assumed to follow a partial adjustment process:

$$L^i_t / L^i_{t-1} = (L^{*i}_t / L^i_{t-1})^{\lambda i},\ 0 < \lambda_i < 1,\ i = 1,2; \tag{3}$$

From equations (3) we obtain the excess labour demand at time t which is given by $L_t - L^*_t$. By taking natural logarithms of equations 2a, 2b and 3, and rearranging the terms, we have the following employment functions:

$$l_t = b_o + b_1\ sq_t + b_2\ (w/p)_t + b_3\ l_{t-1} \tag{4a}$$

$$l_t = a_o + a_1\ sq_t + a_2\ l_{t-1} + a_3\ T \tag{4b}$$

where $l_t = \ln(L_t)$, $b_o = \lambda_1 \ln(A)$, $b_1 = \lambda_1\ \alpha_1$, $sq_t = \ln(SQ_t)$, $b_2 = \lambda_1\ \alpha_2$, $b_3 = 1 - \lambda_1$, $a_o = \lambda_2 \ln(A_1)$, $a_1 = \lambda_2\ \phi_1$, $a_2 = 1 - \lambda_2$, $a_3 = \lambda_2\ \phi_2$.

It is clear from these equations that all the structural parameters can be exactly determined.

2.2.3 Excess demand for labour

From (3) we can obtain the excess demand equations (in logarithm form):

$$l_t - l^*_t = \frac{\lambda_{i-1}}{\lambda_1}\ \Delta l_t,\ i = 1,2 \tag{5}$$

where $\Delta l_t = l_t - l_{t-1}$.

2.2.4 Unemployment and the regional PC representation

The excess demand for labour equations are linked to unemployment via a regional Phillips-curve type relationship, as shown below:

$$u_t = \tau_o + \tau_1\ (l^*_t - l_t) + \sum_{j=5}^{7} \tau_j \dot{p}_{t-j+5} + \tau_8 u_{t-1} + \tau_9 u_{t-2} \tag{6}$$

where u is the natural logarithm of Scottish unemployment, U, and p is expected rate of change in price (in log-form).

3. DATA SOURCES AND PROPERTIES

Since there are no quarterly data on actual outputs, the output equation is based on output indices for production industries. Both the Scottish series and the UK series cover the period from quarter 1, 1978 to quarter 1, 1991 and are seasonally adjusted with 1985 = 100. The source of the Scottish series is various issues of the Scottish Economic Bulletin (SEB), and that of the UK series is Economic Trends (ET).

The employment measure is employees in employment. The series runs from quarter 1, 1978 to quarter 4, 1990, as does the unemployment series. They are both obtained from the SEB. The series of wage rates is proxied by current weekly earnings for all employees. The Scottish annual series is calculated on the basis of information in the Scottish Abstract of Statistics (SAS) combined with the New Earnings Survey (NES). This annual series is then interpolated using the UK quarterly data to produce the Scottish quarterly series. Since there are no regional price data, the price series used in our estimation is proxied by UK retail price index obtained from the ET with 1975 = 100.

In recent econometric literature, the orders of integration of time series and a related topic of testing for co-integration of variables have received much attention. As Engle and Granger (1987) pointed out, co-integration between variables means that deviations from the postulated equilibrium relationship between these variables should not tend to drift away in an unbounded fashion from zero. The stationary linear combination or the co-integrating vector of parameters derived from a static regression on these variables can be viewed as the long-run equilibrium solution to the model. However, before testing for co-integration, the orders of integration of time series should be established, which act as a guide as to which variables may enter the co-integrating or static regression, and then enter the stationary linear combination(s) in the dynamic specification. Therefore, this research on stationarity and co-integration of variables establishes a rigorous approach to checking the long-run properties of econometric models and to modelling short-term dynamic adjustment process. However, Engle and Granger only considered bivariate case. Later Clements in a series of papers (1989a, 1989b, 1990) considers co-integration in a more general setting. However, there is yet no sound theoretical foundation for the multivariate case and the empirical implementation is still highly controversial. In what follows, we examine the property of our data series using Dickay-Fuller (DF) regression and the augmented version (ADF). Given the limitations and still controversial nature of the test procedures, this exercise only offers a rough guide. The procedure and results are described below.

Testing for unit root in a stochastic process, Yt, is carried out using ADF regressions:

$$\Delta Y_t = \delta_o + \delta_1 T + \varrho Y_{t-1} + \sum_{i=1}^{n} \alpha_i \Delta Y_{t-i} + \epsilon_t$$

$$\Delta^2 Y_t = \psi_o \Delta Y_{t-1} + \sum_{i=1}^{n} \psi_i \Delta^2 Y_{t-i} + \nu_t$$

The null hypotheses are: $\rho = 0$, $\delta_o = \delta_1 = \rho = 0$, $\delta_1 = \rho = 0$, $\psi_o = 0$.

The results suggest that SQ, UQ, Ln(L) and Ln(U) follow a random walk without drift, whilst Ln(P) follows a random walk with a drift, and Ln(W/P) is an explosive series. This renders Engle and Granger's two step co-integration estimation procedure inapplicable in estimating the employment and unemployment equations. However, it should be noted that test statistics for serial correlation, normality and heteroscedasticity (in particular) for the ADF regressions are quite large, indicating that the power of the ADF test is very low. Therefore, the results should be interpreted with caution, and alternative testing procedures are desirable.

4. ESTIMATION, HYPOTHESIS TESTING AND DISCUSSION

4.1 The output equation

In actual estimation, we roughly followed a specific to general modelling approach. We first tried to run the co-integrating regression of SQ on UQ. The null hypothesis on non-cointegration cannot be rejected even at 10% significance level. This evidence, in conjunction with the evidence from diagnostic test statics, suggests that some relevant explanatory variables might be missing from the equation. Since there is no hint to what these variables might be, we finally tried an ARDL form of order (2,2). Since the data is seasonally adjusted, the seasonal dummies are excluded and a period dummy variable for quarter 1, 1986 to quarter 1, 1987 is included in the estimation. The period dummy allows for the adverse effect on the economy of the 1985 oil price shock. Considering the possible serial correlation in quarterly time series, we tried both the OLS and Cochrane-Orcutt iterative estimation method, and the results revealed that there is a fourth order autocorrelation in the error term. The final estimated equation using Cochrane-Orcutt correction for autocorrelation AR(4) is listed below (figures in the brackets are t-ratios):

$$\underset{}{SQ_t} = \underset{(-1.57)}{-3.2396} + \underset{(6.10)}{.7587UQ_t} \underset{(-3.93)}{-.583UQ_{t-1}} + \underset{(14.68)}{.8608SQ_{t-1}} \underset{(-3.77)}{-2.3302D}$$

4.2 The employment equation

In actual estimation of the employment equation, indices of output and prices are used instead of actual levels. This is due to the fact that we do not have quarterly series on levels. This does not cause serious problem though, since the levels are obtained by multiplying the indices by the base year levels which are unobservable. After taking logarithms of the variables, the logarithm of the unobserved base year levels are picked up by the constant term. So only the constant term is affected, and the parameters of the other variables are still correct.

We estimated extended forms of both (4a) and (4b). It turns out that equation (4a) performs better in almost every aspect than (4b), suggesting that (4b) is a poor specification. The final OLS estimated equation of (4a) is listed below:

$$l_t = \underset{(2.42)}{.4421} + \underset{(3.76)}{.0719sq_t} + \underset{(2.90)}{.1sq_{t-2}} \underset{(-2.70)}{-.0862sq_{t-3}}$$
$$+ \underset{(1.94)}{.0652(w/p)_{t-3}} \underset{(-3.34)}{-.1189(w/p)_{t-4}} + \underset{(26.37)}{.8855l_{t-1}}$$

R = .99, R = .99, SE = .00409, SD = .0399, DW = 1.71, Serial correlation (SC): χ^2 (4) = 1.43, Functional form (FF): χ^2 (1) = 1.84, Normality (NOR): χ^2 (2) = 0.13, Heteroscedasticity (HET): χ^2 (1) = .0002.

4.3 The unemployment equation

In estimating the unemployment equation, the actual UK inflation rate is used to proxy the expected inflation rate. The unemployment equation is estimated using OLS. It turns out that the coefficients on the excess demand term and the price change and lagged price changes are all insignificant. The equation failed all the diagnostic tests for serial correlation, functional form, normality and heteroscedasticity. This result casts serious doubt on the applicability of the regional Phillips Curve.

5. SUMMARY

The present model is in the simplest form, and the unemployment equation performs badly. Nevertheless, the output and employment equations track the past reasonably well (The actual and fitted values are plotted in Annex A). In the course of model development, it will be far more interesting if the Scottish industrial and trade structures can be taken into account, and both the demand side and supply side of the labour market can be considered. Work is continuing along these lines.

REFERENCES

Ball, R J and St Cyr, E B A (1977) "Short term employment functions in British Manufacturing industry", Review of Economic Studies, 33, pp.179-207.

Bell, David (1978) "Regional output, employment and unemployment fluctuations", Discussion Paper 10, Fraser of Allander Institute, University of Strathclyde.

Clements, M P (1989a) "The estimation and testing of co-integrating vectors: a survey of recent approach with an application to the UK non-durable consumption function", Discussion Paper 79, Institute of Economics and Statistics, University of Oxford.

[----] (1989b) "Cointegration and model evaluation, an application to the long-run consumption function", Institute of Economics and Statistics, University of Oxford.

[----] (1990) "The mathematical structure of models that exhibit cointegration: a survey of recent approaches", Institute of Economics and Statistics, University of Oxford.

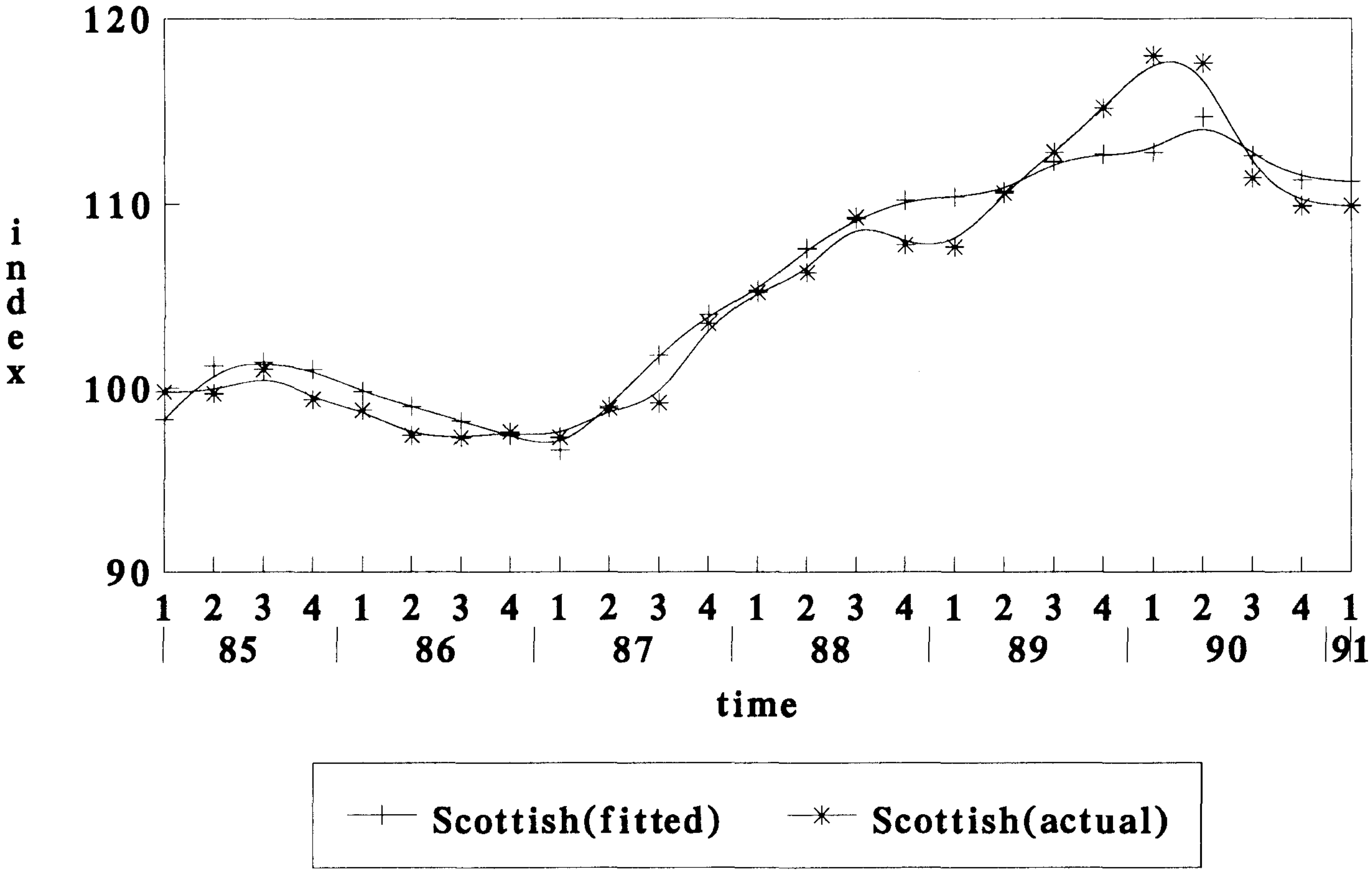
Engle, G F and Granger, C W J (1987) "Co-integration and error correction: representation, estimation, and testing", in Econometrica, Vol.55, No.2, pp.251-276.

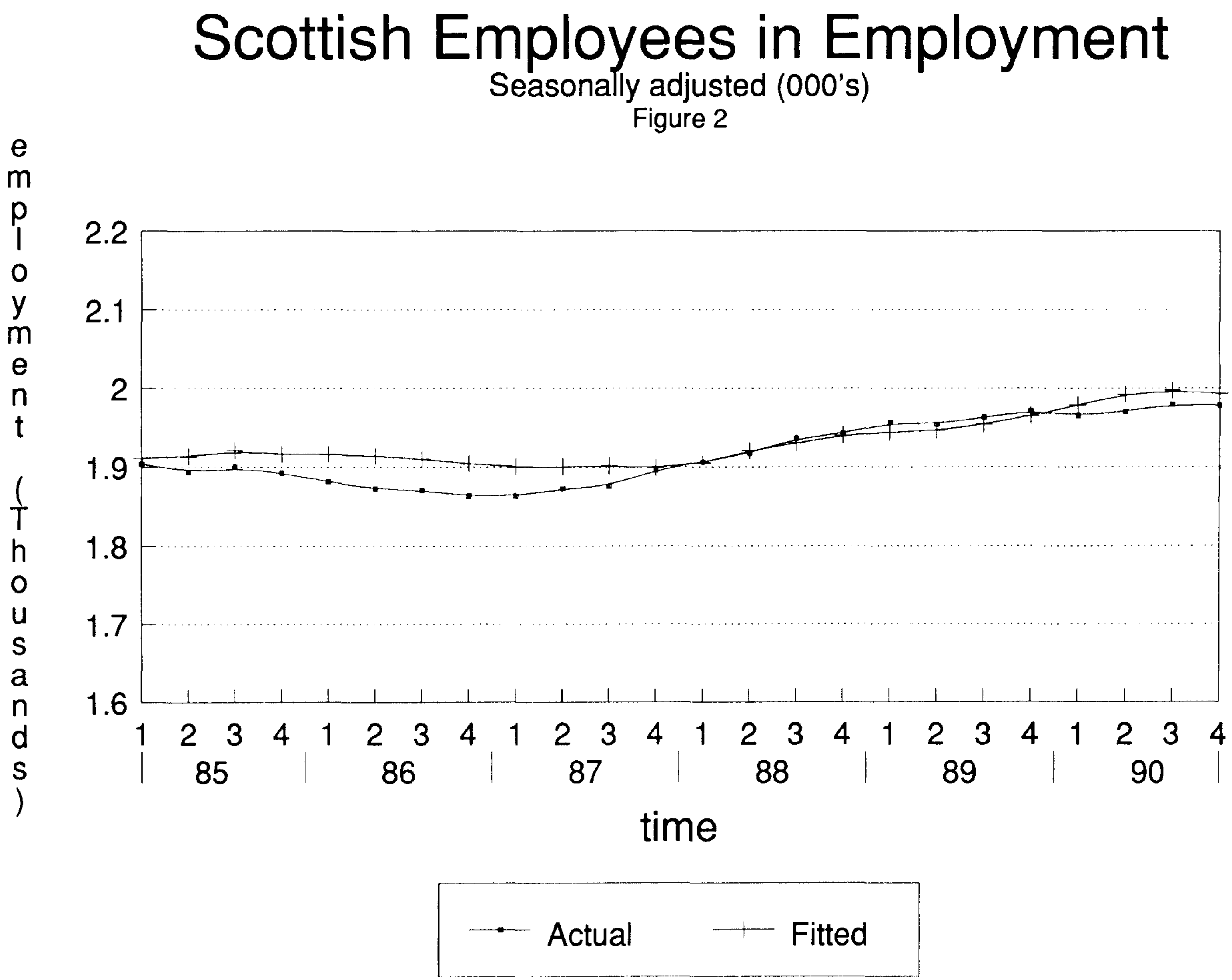
Lythe, C, Dewhurst, J, Parrillo, S, Cox, M and Devlen, J (1979) "TEMPTRESS: An Econometric Model of Scotland", Occasional Paper, No. 15, Department of Economics, University of Dundee.

Annex A: Output Indices for Prod. Ind.

Seasonally adjusted (1985 = 100)

Figure 1





Scottish Employees in Employment
Seasonally adjusted (000's)
Figure 2
employment (Thousands)
2.2
2.1
2
1.9
1.8
1.7
1.6
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
85
86
87
88
89
90
time
Actual
Fitted