THE DEMAND FOR ENERGY IN SCOTLAND

The broad aim of this article is to examine the pattern and determinants of energy consumption in Scotland. More specifically, two aspects of the fuel sector are considered: first, the general trends in the sector since the early sixties and the impact of the change in the price of oil; second, the question of which factors determine the demand for energy in the Scottish economy. Statistical analysis of the second issue is attempted.

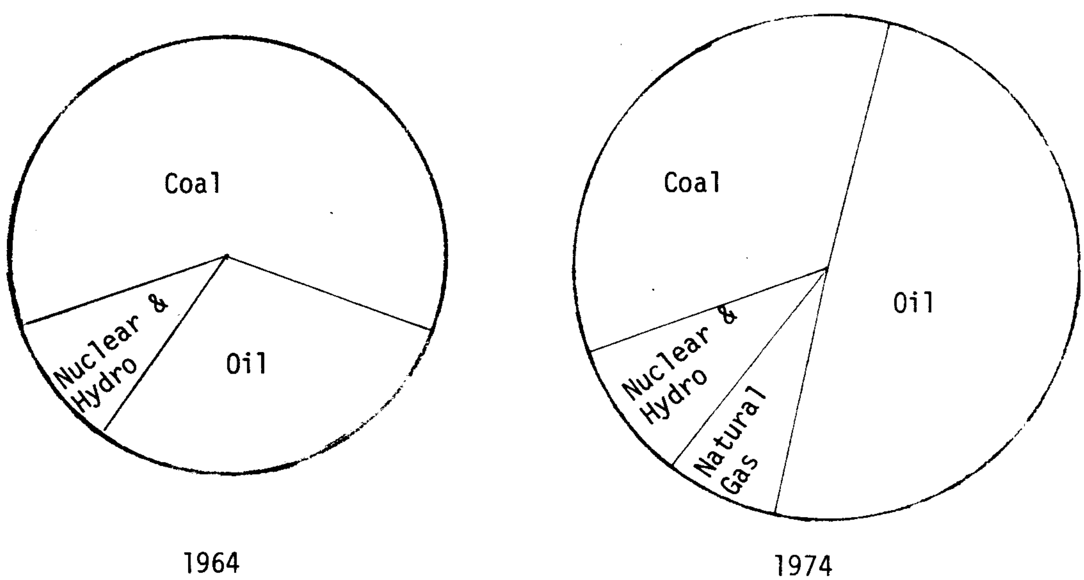
1 Recent Trends in Fuel Consumption in Scotland

As is revealed by Figure (1), total inland fuel consumption in Scotland has fluctuated around a definite upward trend over the last ten years. First impressions suggest that the troughs in the cycle correspond to periods of industrial stagnation. In fact total energy consumption correlates particularly well with Scottish GDP: our estimate suggests that a 10% rise in real GDP produces, on average, a 7% increase in consumption. Whilst the overall cycle is similar to that in Scotland, the UK economy generates a smaller proportional demand for energy - 5½% for a 10% GDP increase. This difference may be attributable to one or both of the following: (1) dissimilarities in industrial structure, (2) less efficient energy usage in Scotland.

Another interesting comparison between Scotland and the whole of the UK suggests (a) that Scotland uses less energy per head of the population and (b) that this differential has narrowed markedly over the last few years. Figure (2) records Scottish and UK energy consumption per capita figures, revealing that in 1964 the level of Scottish consumption was 1304 therms per person - 8% lower than the UK figure of 1422 therms per person. However, by 1974 the margin had fallen dramatically, the figures being 1558 and 1585 therms per capita for Scotland and the UK respectively. The graph shows that most of this differential has been removed since 1972, hence reinforcing the evidence from unemployment and income data of the recent economic improvement in Scotland relative to the rest of the United Kingdom.

It is important to study the demand for energy at a disaggregated level. Until 1972/73, certain overall trends were well-established: the coal industry had declined for two decades, with Scottish consumption in that year standing at only 60% of the 1960 level; both gas and electricity sales had more than doubled from the early sixties; and the total consumption of oil in Scotland had trebled over the same period. Figure (3) reveals the change from '64 to '74 and avoids the problem of 'double counting' the coal and oil used in electricity generation.

Figure (3) Scottish Inland Fuel Consumption



Whilst changes in both institutional constraints and consumers' tastes may have played a part, the principal determinant of this shift in the pattern of energy consumption was almost certainly the structure of relative prices in the fuel sector. Put loosely, coal was over-priced with respect to competing sources of energy and consumption declined as a result. Petroleum emerged as the leading energy substitute; natural gas became important from 1971; and nuclear and hydro electricity sales changed little over the period. It is also interesting to note that the historical substitution trend away from coal was considerably dampened by the huge expansion in purchases of coal by power stations - presumably a result of government policy designed to prevent even greater contraction in the industry.

These fairly stable trends were disrupted in 1973/74 by the decision of the Organisation of Petroleum Exporting Countries to quadruple the price of crude oil in December 1973. One effect of this change in relative prices was particularly notable: oil consumption in 1974 fell - by 3% - for the first time in decades.[1] In addition, total inland fuel consumption dropped by 5% over the year, which was a remarkable decrease even for the year that marked the beginning of our present economic slump. These effects were relatively immediate and obvious results of the OPEC move; but another more controversial question must be considered, namely how the gas, electricity and-perhaps most critically - the coal industries were affected by the dramatic change in relative prices.

Although the extent to which substitution took place is difficult to assess exactly, the evidence can be summarised as follows. First, it is clear from Figure (4) that 1973 marked a boom year for coal by historical standards; yet because the rise in petroleum prices came in December 1973 this must be attributed to the 1973 economic expansion, when Scotland experienced 6-7% growth in real GDP. Secondly, Figure (4) reveals that since the oil price increase the generally expected rise in coal consumption has not occurred: in fact coal sales fell by 15% from 1973 to 1974, thus maintaining the long run trend.[2] Thirdly, gas and electricity consumption have both continued to rise at a steady rate.

In conclusion, fuel substitution stemming from the rise in the price of oil has been relatively unimportant in Scotland. Contrary to popular belief, the oil price change, while precipitating a small fall in oil consumption, did not herald a 'new dawn' for the Scottish coal industry, nor provoke vast increases in the demand for gas and electricity. The reasons for this are probably twofold. First, consumers in the fuel market can only adapt their consumption patterns slowly. Second, the prices of coal, gas and electricity rose substantially after the OPEC decision,[3] partially nullifying the fall in their relative prices and thereby ensuring that most of the long term substitution that might have been produced would never occur.

1 Recent 1975 figures from the Petroleum Institute reveal a continued fall.

2 1975 data are available for the UK, revealing a continuing decline in coal consumption once stock-building is taken into account.

3 See Figure (5) on page 44

It seems possible that the substitution effect was slightly more important in the domestic energy market. As Table I shows, until the change in the price of oil, the growth in domestic purchases of gas, oil and electricity had been surprisingly uniform. Coal had defied this trend,for consumption by 1973 had fallen to a level slightly above one third of the 1961/62 total of 3.8 million tons. However, as the table indicates, 1973/74 probably saw a fall in oil consumption, while the domestic purchase of house coal actually rose by 23% in the year 1973, only to fall by 12% to 1.1 million tons in 1974. Even though the substitution process did not therefore reverse the historical coal trend - 1973's figure was presumably a result of the boom - the 1974 figure was higher than that for 1972 (1.0 million tons), which suggests that the decline in domestic coal sales has been slowed by the change in relative fuel prices. The second section of this article attempts a more rigorous analysis of the domestic demand for fuel in Scotland.

Another aspect of the recent history of domestic energy consumption is worth highlighting, namely the difference in consumption patterns between Scotland and the United Kingdom. Using data from the Family Expenditure Survey it is possible to show that Scottish consumers spent more in percentage terms on electricity and electricity appliances, and less on gas, oil and coke, than UK consumers in 1973/74:

Table II Expenditure Patterns on Fuel, Light and Power

	1961-63		1973-74	
	Scotland	UK	Scotland	UK
Gas and hire of gas appliances	19.4%	18.9%	19.8%	27.9%
Electricity and hire of appliances	37.1%	35.9%	56.0%	44.0%
Coal .	39.0%	36.0%	15.8%	15.8%
Coke	0.3%	3.8%	2.2%	4.8%
Fuel Oil	4.2	5.4%	6.2%	7.5%
Total on Fuel & Light	100	100	100	100

Source: Family Expenditure Survey

Once again the historically established trends towards higher electricity and oil consumption are illustrated, as is the radical decline in the use of coal for domestic heating. Future data should allow a full analysis of the effect of the oil price rise, which from 1972/73 has increased the % spent on fuel oil from 4.6% to 7.5% in 1973/74, even though real oil consumption almost certainly fell.

Finally, it is also useful to consider prices of fuels, both over time and between regions. Some indication of the former is provided by Figure (5). Unfortunately, although prices in Scotland in general differ from those in England and Wales there is no simple and accurate method of comparing prices in the two areas since no summary index of fuel prices in Scotland exists. However, one can compare prices using the data on retail prices of fuels in selected cities in the UK published by the Department of Energy. A small section of the 1974 table is presented below.

Table III Retail Prices in Selected UK Cities in 1974

	Aberdeen	Edinburgh	London	Manchester	Newcastle	Liverpool
House coal (winter prices) p per cwt	138	117	133	109	101	107
Standard Grade Burning Oil p per gallon	23.42	23.00	23.00	23.00	23.00	23.00
Electricity (annual level of consumption = 5000 khw) av.p per unit	1.367	1.506	1.540	1.419	1.432	1.446
Gas (annual level of consumption = 400 therms) p per therm	14.95	14.95	13.93	11.61	12.00	11.05

First considering household coal, one finds that retail prices in cities located near major coalfields were substantially below prices paid in other cities. This is hardly surprising since coal is a very costly good to transport. Thus an Aberdonian household could expect to pay 37p per cwt more for coal than a household in Newcastle. London prices were somewhat below those in Aberdeen but 16p higher than those in Edinburgh. On the other hand, oil prices do not reflect transport costs in the same way as coal prices and a uniform price for oil was charged in all the cities considered above, except Aberdeen. Ironically, burning oil in Aberdeen was 0.42p per gallon more expensive than elsewhere. In contrast to oil, electricity has tended to be cheaper in Aberdeen than in the rest of the country. To some extent this will have resulted from the lower than average dependence of the North of Scotland Hydro-Electric Board on coal and oil fired generating stations. Electricity prices in Edinburgh, i.e. those of the South of Scotland Electricity Board,have tended to be broadly similar to those in the English cities considered, except London which has always been more expensive. Lastly, Scottish gas prices in 1974 were considerably higher than those in England, perhaps reflecting the influence of economies of scale in the gas industry.

2 Determinants of the Demand for Fuel

This section of the article summarises some econometric analysis of the demand for energy in the Scottish economy. Two types of function are estimated: simple regressions of total energy consumption on real GDP and a set of domestic demand equations for gas, electricity and coal. The latter equations rest upon the dynamic model of fuel demand that is developed in Appendix (1).

The first and most elementary equations estimate the relationship between the levels of energy consumption in Scotland and the UK and the corresponding levels of real GDP for the two. Both linear and log-linear formulations were estimated and the results are set out below. Appendix (2) attempts to provide an elementary introduction to the interpretation of econometric results.

Scotland 1961-74

$$\underset{}{STEC = \underset{(6.93)}{2226.8} + \underset{(16.02)}{2.11}\ RSGDP} \qquad R^2 = 0.96,\ d = 1.94 \qquad (1)$$

$$Log\ STEC = \underset{(10.50)}{3.44} + \underset{(16.66)}{0.70}\ Log\ RSGDP \qquad R^2 = 0.96,\ d = 2.01 \qquad (2)$$

United Kingdom 1961-74

$TEC = 37726 + 1.47\ RUGDP$ $(5.06)\quad(5.69)$	$R^2 = 0.91$ $d = 1.75$ $Rho = 0.40$	(3)
$Log\ TEC = 5.7 + 0.54\ Log\ RUGDP$ $(6.65)\quad(6.52)$	$R^2 = 0.92$ $d = 1.77$ $Rho = 0.34$	(4)

Real GDP is denoted by RSGDP for Scotland and by RUGDP for the United Kingdom; STEC and TEC represent Scottish and UK total energy consumption (in therms) respectively. The Scottish equations were estimated using Ordinary Least Squares; but using this method in the UK case, substantial autocorrelation was indicated by the very low Durbin-Watson statistics. The Cochrane-Orcutt iterative technique was employed in (3) and (4) to eliminate this autocorrelation.

The 't' statistics - which are given in brackets - all indicate more than 95% significance, and the Durbin-Watson (d) statistics are within the acceptance region. The high R^2 levels reflect the fairly steady trends in the time series data and little significance can be attached to them. There seems little to choose statistically between the linear and log-linear forms.

Three conclusions are warranted. First, the results indicate that over the last 14 years there has been a close relationship between GDP and total energy consumption in both Scotland and the UK. Secondly, as already noted, Scotland generates a greater proportional demand for energy. Thirdly, ex post the models perform well as forecasting devices. Over the period under study the Scottish models' predictions were never more than 3% in error, normally within 1%; furthermore the models roughly explain the fluctuations in consumption in the early seventies. The important general conclusion that emerges from this piece of empirical work is that at the aggregate level the major determinant of national energy consumption is the level of real Gross Domestic Product. This result could be harnessed in forecasting total future demand for energy in Scotland.

Domestic Demand Analysis

The estimation of household energy demand in Scotland was carried out using Ordinary Least Squares, and in some cases the Cochrane-Orcutt iterative technique, for the coal, gas and electricity sectors (with oil being neglected due to the inadequacy of published data). Some of the equations were estimated using 2 stage Least Squares with and without Cochrane-Orcutt; but since the sample size was rather small, it was considered that Ordinary Least Squares and Cochrane-Orcutt would be more robust methods of estimation.

The basic difficulty separating energy demand from normal demand functions is the important complementarity of energy consumption with the stock of appliances in existence, implying that demand is to a large extent governed by these stocks. Clearly then, consumers' choice is not determined in the usual static manner, for once a major appliance is installed in a household (or a factory) there is little scope for substitution among different types of fuel.[1] Thus the approach to the estimation problem necessarily involves a dynamic analysis embracing some form of stock adjustment,[2] the methodology of which is set out in Appendix (1).

A recurrent problem in empirical demand analysis is that of separating the demand side of the market from the supply side. In order to successfully identify demand one requires supply to vary as much as possible with factors independent of demand.

Consider Figures (6) and (7)

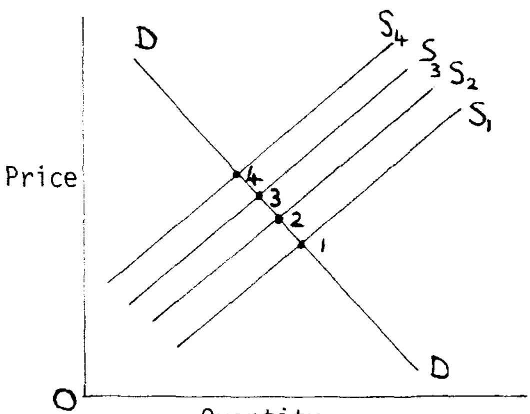


Fig.6

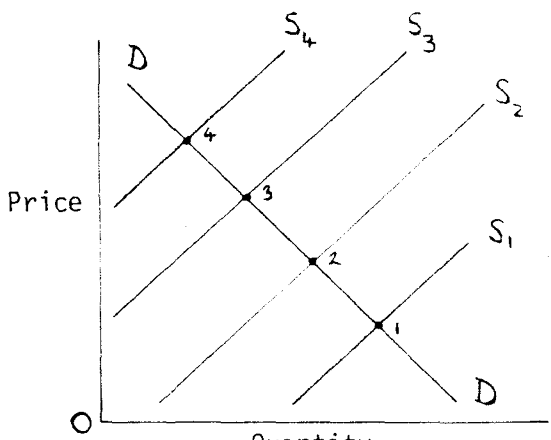


Fig.7

1 Our unpublished estimates of cross elasticities confirmed this.
2 In a similar vein to Nerlove and Balestra's |2| work on estimating demand functions for gas in the USA.

The diagrams portray two markets. In Figure (6) supply varies only marginally with some factor independent of demand, say the cost of a raw material, while in Figure (7) the variation is much greater. Suppose that the cost of the raw material has risen steadily during the period of observation. This will result in a steady shift of the supply curve up and to the left, as the supplier raises the price at which he is prepared to supply a given quantity. The observed combinations of price and quantity are the points 1,2,3, and 4 on both diagrams. To estimate the demand equation one has to fit some function to these points. Given that there is some random error associated with each point one will be able to obtain a much more accurate estimate of the slope of DD in Figure (7) than in Figure (6), since this error obviously has lower relative importance when the supply function varies widely with the price of the raw material. In Figure (6), where the supply curve moves only marginally, estimates of the demand function may be unstable.

Further difficulties, this time at the theoretical level, are posed by the pricing system in fuel markets. For instance, in the electricity market 'block tariff pricing' is used, which means that different prices are charged depending on the level and actual time of consumption. In this situation consumer equilibrium cannot be derived using traditional demand analysis. Therefore reference to tariff block pricing is a fair criticism of econometric efforts to estimate the demand for electricity or gas. However, according to Taylor |3|: "Its importance is more theoretical than practical. If it were to be taken totally seriously, we would be stymied from undertaking any empirical estimation at all regarding the consumer".

To estimate the determinants of domestic fuel demand, a statistical analysis of annual data was undertaken for gas, electricity and coal over the fourteen year period 1961/62 - 1974/75. The main data sources were the separate Boards' annual reports and accounts, the Scottish Abstract of Statistics and the Scottish Economic Bulletin. The model used, which relates consumption to a set of explanatory variables, is stated below:

$$C_t = \beta_0 + \beta_1 Y_t + \beta_2 p_t + \beta_3 T_t + \beta_4 C_{t-1} + u_t \qquad (A)$$

where C is a domestic consumption variable, Y is consumer income, p is a price variable, T is temperature, subscript t relates to a time period where $t = 1,2,3 \ldots\ldots 14$, $\beta_0 \ldots \beta_4$ are constants and u is the error term. This model assumes that the relationships governing economic behaviour have not altered and that the fundamental shifts that have occurred have been the result of changes in the explanatory variables. The difference in equation (A) from more standard demand formulations lies in the inclusion of a lagged dependent variable (C_{t-1}) amongst the regressors. This stems from the essential complementarity between energy and the stock of energy-using appliances.[1] Although it is common to evaluate log-linear forms in demand analysis, this type of transformation is not meaningful in this case.

The estimates for the three sectors are presented below:-

Table 1V Estimates of the Coefficients of the Scottish Domestic Fuel Consumption Equations +

Equations based on	Constant Term	Average Weekly Real Earnings	Price	Annual Mean Temp-erature	Fuel Consumed Previous Period	R^2	d	Rho*
1) COAL	1.36 (0.91)	0.11 (2.18)	-0.23 (-1.45)	-0.36 (-2.41)	1.25 (6.87)	0.99	2.23	-
2) SSEB	5285.6 (4.5)	-60.04 (-1.39)	2819.4 (1.35)	-703.2 (-3.96)	1.12 (13.1)	0.99	2.06	-0.5
3) NSHEB	1389.1 (4.14)	33.48 (3.41)	-305.9 (-0.78)	-169.7 (-5.31)	0.91 (19.1)	0.99	1.74	-0.64
4) GAS	-20.6 (-0.15)	7.67 (1.99)	-2.45 (-0.52)	-0.71 (-0.085	0.59 (3.65)	0.99	2.07	-
5) COAL	1.3 (2.78)	- -	-0.28 (-2.57)	- -	0.87 (11.42)	0.98	2.10	0.43
6) SSEB	2777.4 (1.68)	- -	-2529.4 (-1.11)	- -	0.91 (27.7)	0.99	2.35	0.44
7) NSHEB	682.0 (1.22)	- -	-833.2 (-0.98)	- -	0.96 (18.6)	0.99	2.14	-0.26
8) GAS	127.6 (2.17)	- -	-8.06 (-2.17)	- -	0.78 (5.54)	0.99	2.01	-

\+ Average revenues and earnings have been deflated by the retail price index.
* In equation (2),(3),(5),(6) and (7) the Cochrane-Orcutt iterative technique has been used to remove autocorrelation.
SSEB - South of Scotland Electricity Board
NSHEB - North of Scotland Hydro-Electric Board

1 See Appendix (1) for the rationale.

The t statistic has been corrected for asymptotic bias resulting from the use of Cochrane-Orcutt with a lagged dependent variable |see Cooper 1|.

All the fuel variables are expressed in quantities - million tons of coal, million Khw of electricity and million therms of gas. Price variables are in pence per particular unit: for example, pence per therm. Equations (1) to (4) are estimates of the complete formulation (A) above, whereas equations (5) to (8) illustrate the effects of removing income and temperature from the model.

In general the coefficients in the eight equations have the expected signs - for example, income has a positive effect, price a negative effect - although the t statistics (given in brackets) are below 2 in many cases. While the d statistics are satisfactory they should be interpreted with caution because of the inclusion of a lagged dependent variable. Again the R^2 levels are exceptionally high, for the reasons mentioned earlier. For the first two equations the parameter on the lagged dependent variable is greater than one, a result which is inconsistent with theoretical expectations; but this problem is not present in the other equations.

Equation (2), for the SSEB, is an exception to the fairly reasonable findings cited above and may be a result of the fact that the 'real' price has not varied much over the period, implying only a marginally shifting supply curve. Thus we appear to have a situation analogous to that of Figure (6), namely an extreme identification problem possibly coupled with multicollinearity amongst the regressors; whereas equation (3), for the North of Scotland Board, does not reflect these difficulties to the same extent due to the much greater variation in its real price.

To examine the responsiveness of demand to price changes we calculated average estimates of the 'price elasticity of demand' for the three fuels. This measures the percentage change in demand that results from a one per cent fall in price. Both short-run and long-run estimates are provided in the table below:

Table V Average Price Elasticities

	Equations (1) to (4)		Equations (5) to (8)	
	Short-run	Long-run	Short-run	Long-run
Coal	0.13	3.1	0.16	3.8
SSEB[1]	-	-	0.21	2.5
NSHEB	0.09	2.3	0.25	6.2
GAS	0.14	0.64	0.46	2.1

The short-run average price elasticity is given here by

$$\ell = \frac{\partial c}{\partial p} \cdot \frac{\bar{p}}{\bar{c}}$$

and the long-run elasticity by

$$E = \frac{1}{r} \cdot \frac{\partial c}{\partial p} \cdot \frac{\bar{p}}{\bar{c}}$$

where c is consumption, p is price, $\bar{p}$ is mean price, $\bar{c}$ is mean consumption and r is the stock depreciation rate. As would be expected, the long-run responsiveness of demand to price changes is far greater - i.e. demand is more elastic - than in the short-run.

Again there is some evidence that the average price elasticities are affected by the identification and collinearity problems, with the gas and NSHEB price coefficients showing considerable variation between the two formulations. One must also remember that the depreciation rate is used to calculate the long-run elasticities. It is necessary to be very cautious of the 6.2 long-run elasticity figure for the NSHEB due to the above; however, the 2.1 long-run estimate for gas under the same formulation is probably nearer the true value than that suggested by equation (4). One way of explaining this instability is through Taylor's |3| argument that in cases of tariff pricing the exclusion of a marginal price will lead to biased price coefficients in equations such as ours.

1 No estimate because of poor results.

Finally, it is worth noting that temperature changes have a significant effect on the consumption of coal and electricity(from both Boards). In addition, because of the influence of the stock of appliances, the level of energy consumption in the previous year is clearly an important determinant of demand in each sector.

The preceding paragraphs have illustrated a first attempt at estimating domestic demand functions for energy on the basis of the theoretical model discussed in the Appendix.

Conclusions

The first section of the article attempted to analyse the recent trends in Scottish energy consumption, focusing in particular on the impact of the change in the price of oil. Perhaps the principal conclusion stemming from the study is that the substitution effects resulting from the oil price increase appear to have been surprisingly weak. While oil consumption in Scotland has fallen over the last two years, there has been no substantial change in the historically established consumption trends in the coal, gas and electricity industries. Most important of all, the latest figures suggest that the coal industry will probably continue to decline, despite the forecasts that were made in some quarters after the OPEC decision in 1973.

Although there are many problems involved in implementing econometric techniques in this area of research, the second section of the article summarised the results of our formal analysis of the domestic demand for fuel in Scotland. A model was developed and tested with the data and theoretical constraints in mind.

References

|1| J P Cooper "Asymptotic Covariance matrix of procedure for Linear Regression in the Presence of First Order Serially Correlated Disturbances". Econometrica, March 1972, Vol.40, No.2

|2| P Balestra & M Nerlove "Pooling Cross Section and Time Series Data in the Estimation of a Dynamic Model: The Demand for Natural Gas" Econometrica, July 1966, Vol.34, No.3

|3| L D Taylor "The Demand for Electricity: A Survey" The Bell Journal of Economics, Spring 1975, Vol.6,No.1

Appendix (1) The Theoretical Model of Fuel Demand

Section 1

Much of our econometric work has centred upon a method of implicitly incorporating the crucial complementarity of energy and energy-using appliances. This method will now be set out formally.

A widely used identity in this area of demand theory is given by:

$$C_t = \lambda_t S_t \qquad (1)$$

where C is the consumption of fuel, λ is defined as the average rate of capacity utilisation and S is the total stock of appliances. As the stock of appliances will change only slowly, and because it can be argued that λ will be roughly constant over time, fuel consumption is far more insensitive to price changes than is the case for other goods. However, 'new' or 'incremental' demand will be affected by relative prices and other variables. Hence define

$$C_t^* = \lambda_t S_t^* = f(p,Y,T) \qquad (2)$$

where C^* is 'new' consumption, S^* defines the new purchases of appliances, p is price, Y is income and T is average temperature.

Now it is obvious that, by definition,

$$S_t = S_t^* + (1 - r)S_{t-1} \qquad (3)$$

where S_t is the level of stocks in period t, and r is the rate of depreciation of the stock of fuel-using appliances. Equation (3) merely states that the level of stocks in period t is given by the sum of new purchases and the stock remaining after depreciation from period t-1.

By combining (1), (2) and (3) it is possible to derive a dynamic theory of the demand for fuel. First, assuming $\lambda_t = \lambda_{t+1} = \ldots. = \lambda$, allows equation (3) to be rewritten as

$$C_t = C_t^* + (1-r)\, C_{t-1} \qquad (4)$$

where r is assumed to be constant. Assuming that

$$C_t^* = ap_t + bY_t + cT_t + d \qquad (5)$$

produces the final form:

$$C_t = ap_t + bY_t + cT_t + (1-r)\, C_{t-1} + d \qquad (6)$$

Equation (6) is of course the model that was estimated in the paper. Repeated substitution of C_{t-1}, C_{t-2} ... into (6) produces the distributed lag form:

$$C_t = \sum_{n=o}^{\infty} (1-r)^n \,(ap_{t-n} + bY_{t-n} + cT_{t-n} + d) \qquad (7)$$

where, assuming $0<r<2$, $\lim_{n \to \infty} (1-r)^n C_{t-n-1} = 0$

In conclusion, the dynamic formulation of the demand for fuel assumes that, because of the necessary complementarity between appliances and fuel, the level of demand is in fact determined by all past prices, income and temperature levels. The simplest estimation form is given by equation (6), where a lagged dependent variable is employed.

The dynamic model of fuel demand in fact implicitly assumes that stocks adjust according to the widely used - although normally ad-hoc - partial adjustment mechanism:

$$S_t - S_{t-1} = f(S_t^d - S_{t-1}), \qquad (8)$$

where S_t and S_t^d are actual and desired stocks respectively.

In long run equilibrium - i.e., the steady state - the stock of energy consuming equipment will equal the desired stock, S^d:

$$S_t^d = S_t = S_{t-1} = \ldots S_\infty \qquad (9)$$

Substituting this into equation (3) gives

$$S_t^* = rS_t^d \text{ in the steady state} \qquad (10)$$

We can now substitute equation (10) into equation (3), giving

$$S_t - S_{t-1} = r(S_t^d - S_{t-1}) \qquad (11)$$

Therefore it seems that if we work with equation (9), as we have done in this article, we <u>imply</u> that stocks adjust as in the traditional equation (8). The rate of depreciation is the partial adjustment parameter.

Appendix (2) An Elementary Introduction to the Interpretation of Econometric Results

This note attempts to provide a very simple introduction for the non-specialist to the interpretation of the results of multiple regression analysis. The latter, which is a statistical method for analysing the relationships between economic variables, is used extensively in the second half of the paper.

The easiest way to convey the essential ideas is by way of an example from the text. Consider the first equation given,

$$\underset{}{STEC} = \underset{(6.93)}{2226.8} + \underset{(16.02)}{2.11}\ RSGDP \qquad R^2 = 0.96, \quad d = 1.94$$

Total energy consumption (STEC) is measured in million therms and real Scottish gross domestic product (RSGDP) in million pounds. The equation implies that there exists a relationship between energy consumption and domestic product such that the level of energy consumption is equal to 2.11 times the level of domestic product plus 2226.8 ie. if domestic product equals £2000m then total energy consumption equals

$$(2.11 \times 2000) + 2226.8 = 6446.8 \text{ million therms.}$$

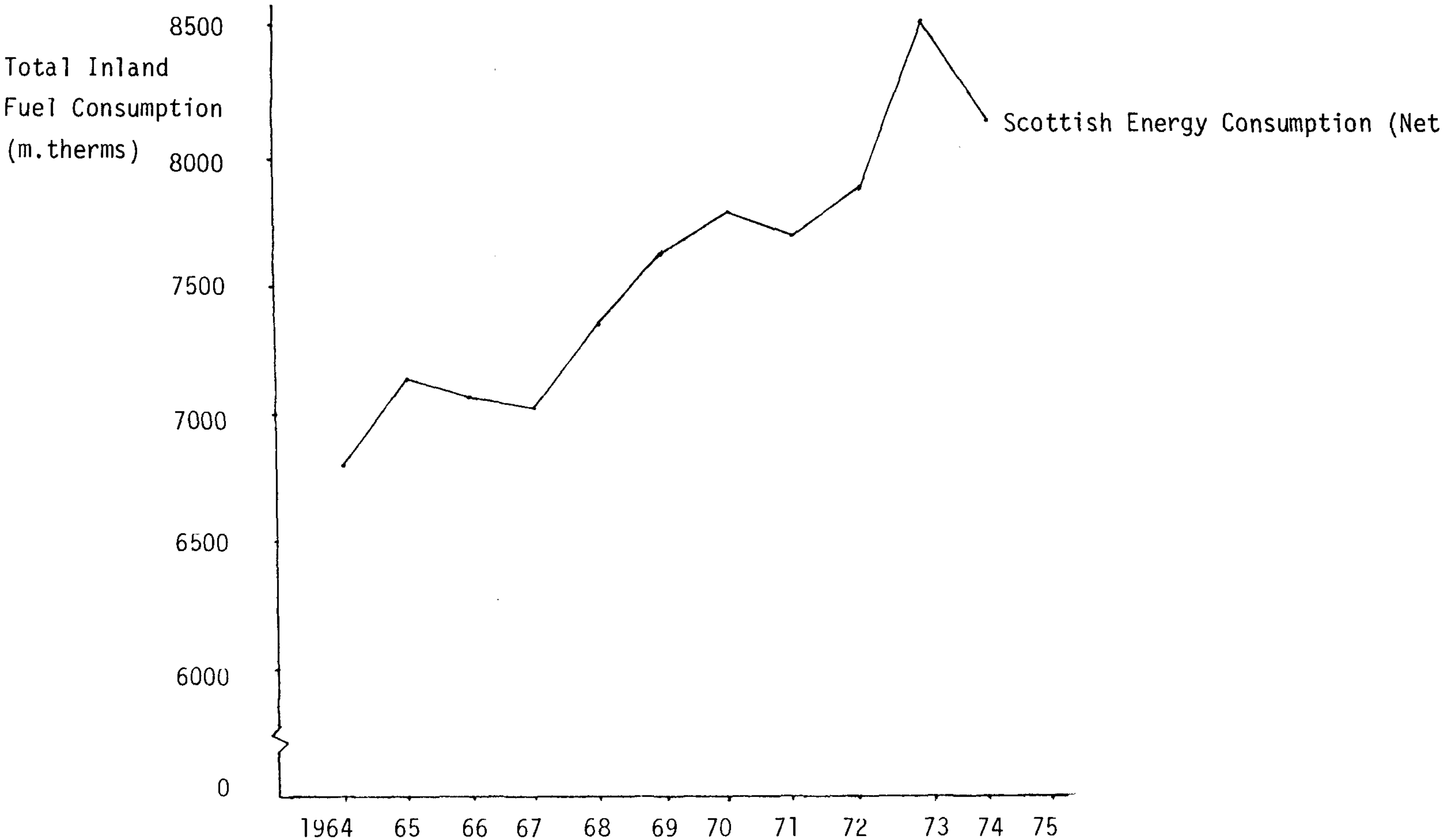
This is a linear statistical estimate based on the data and its reliability can be checked by reference to three fundamental indicators: the t statistics (the figures in brackets), the R^2 level and the figure for 'd'.

If there were no relationship between total energy consumption and real Scottish gross domestic product, the coefficient on RSGDP would be zero indicating that the level of energy consumption was unaffected by the value of domestic product. The size of the 't' statistic indicates how certain one can be that a particular coefficient differs from zero. If a 't' statistic is either less than -2 or greater than 2, one can be fairly confident that the corresponding coefficient differs from zero.

The coefficient of determination, R^2, measures the 'goodness of fit' of the statistical relationship: for example, 0.96 implies that 96% of the variation in energy consumption is 'explained' by the behaviour of Scottish GDP. The d (or Durbin-Watson) statistic provides further information on the quality of the results; if d is between 1.75 and 2.25 this is generally considered satisfactory.

These three indicators provide the basic test of any econometric results, but the extremely simplified rules of thumb suggested here can only give the most informal insight into this field. This caveat cannot be stressed too vigorously.

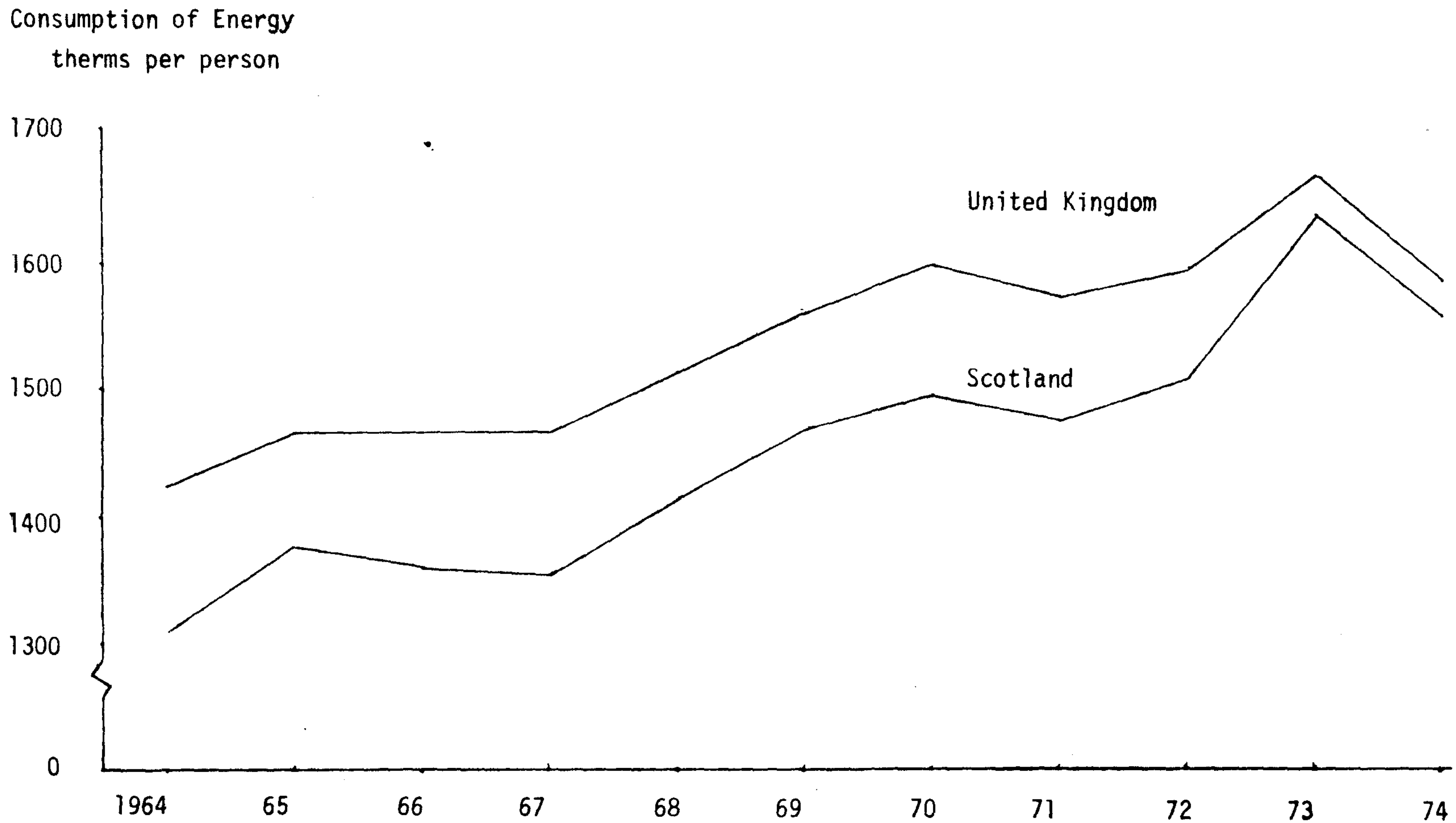
Figure (1)



TOTAL INLAND ENERGY CONSUMPTION (PRIMARY FUEL INPUT BASIS)

SCOTLAND 1964-74 Source: Scottish Economic Bulletin

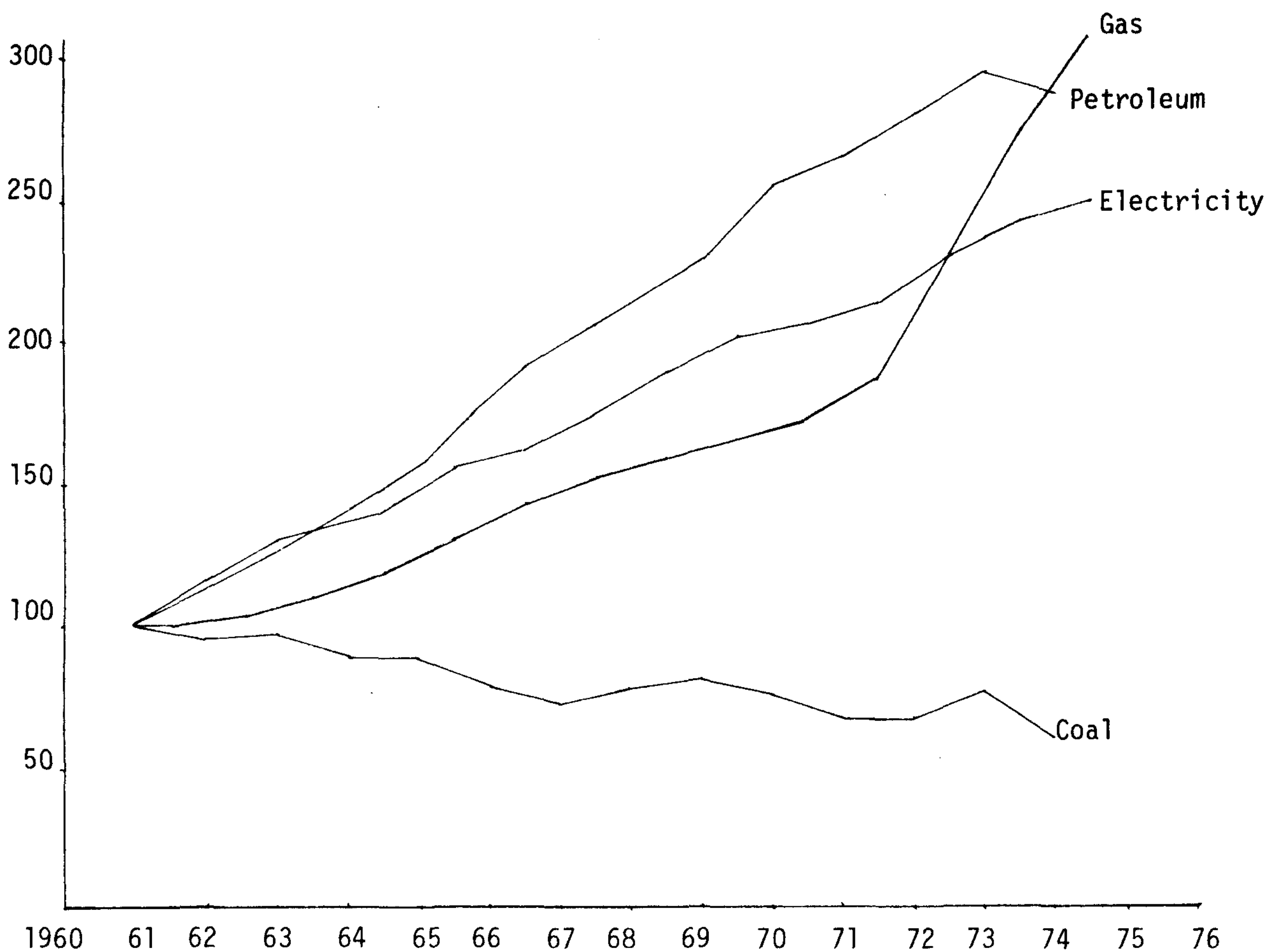
Figure (2)



Total Inland Energy Consumption Per Capita
UK and Scotland: 1964-74

Source: Scottish Abstract of Statistics

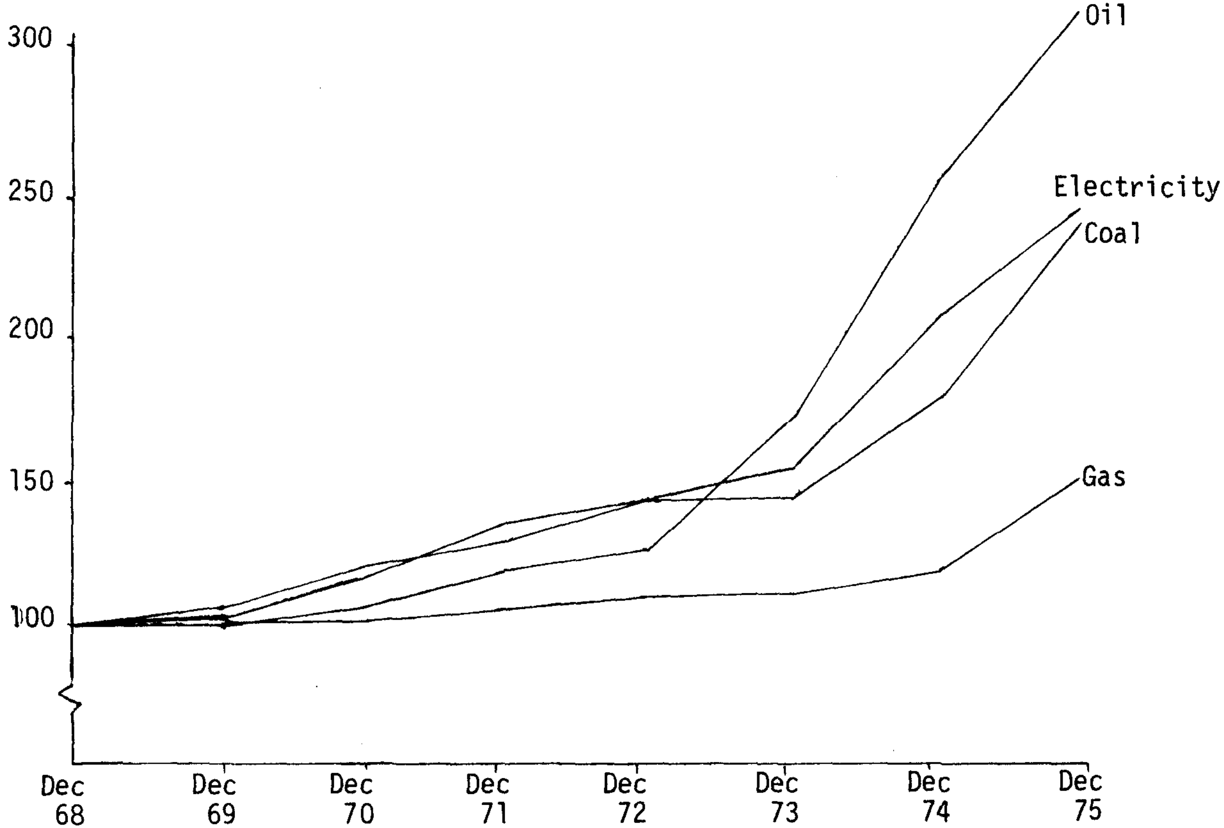
FIGURE (4)



Gross Fuel Consumption in Scotland (Index number form) : 1961-74/75

Source: Scottish Abstract of Statistics

FIGURE (5)

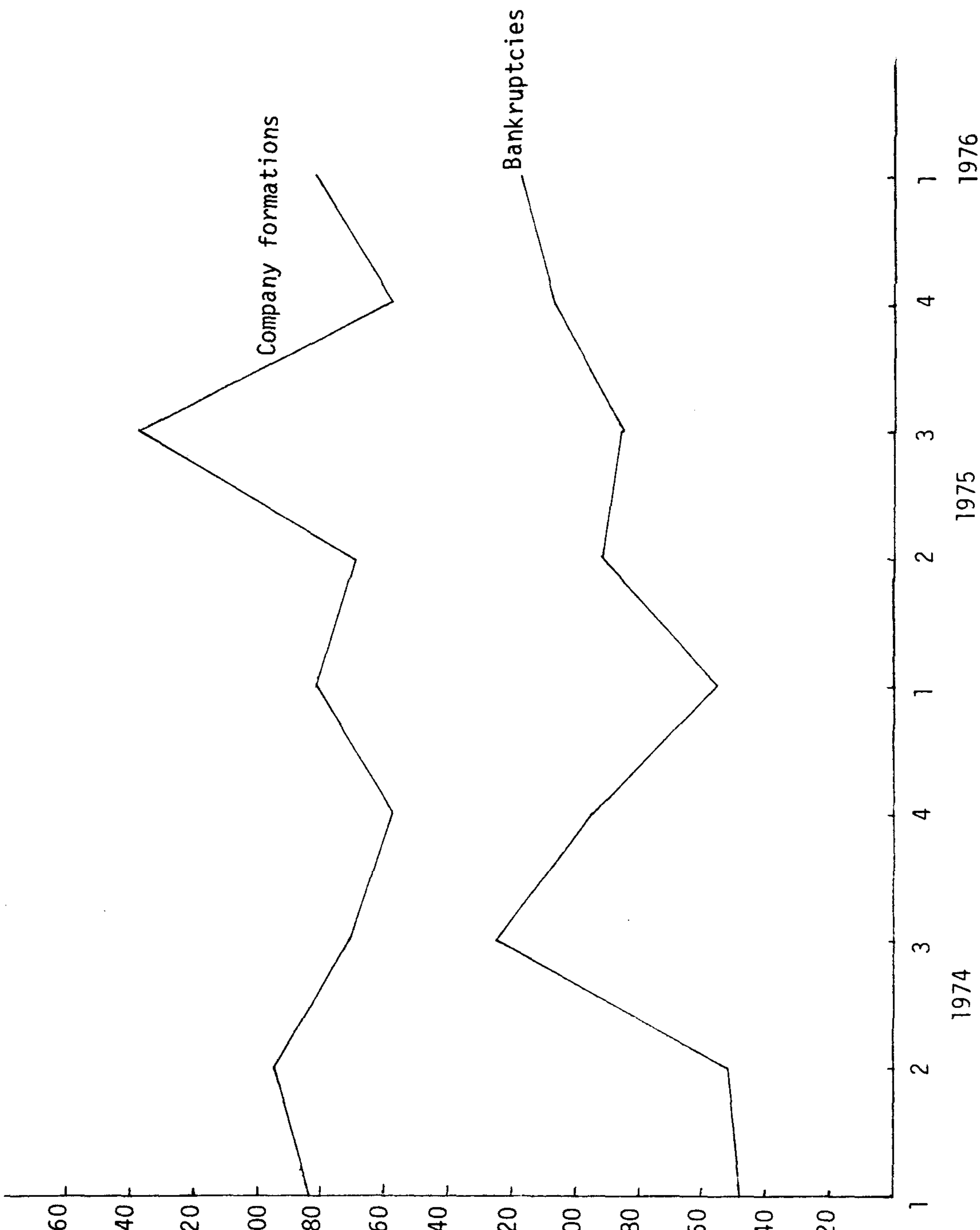


Fuel Retail Price Indices (Edinburgh) 1968-75

N B : 1975 Figures are Department of Energy estimates

Source: Digest of Energy Statistics

<u>Figure (8)</u> Company Formations and Bankruptcies in Scotland



Source: Registrar of Companies

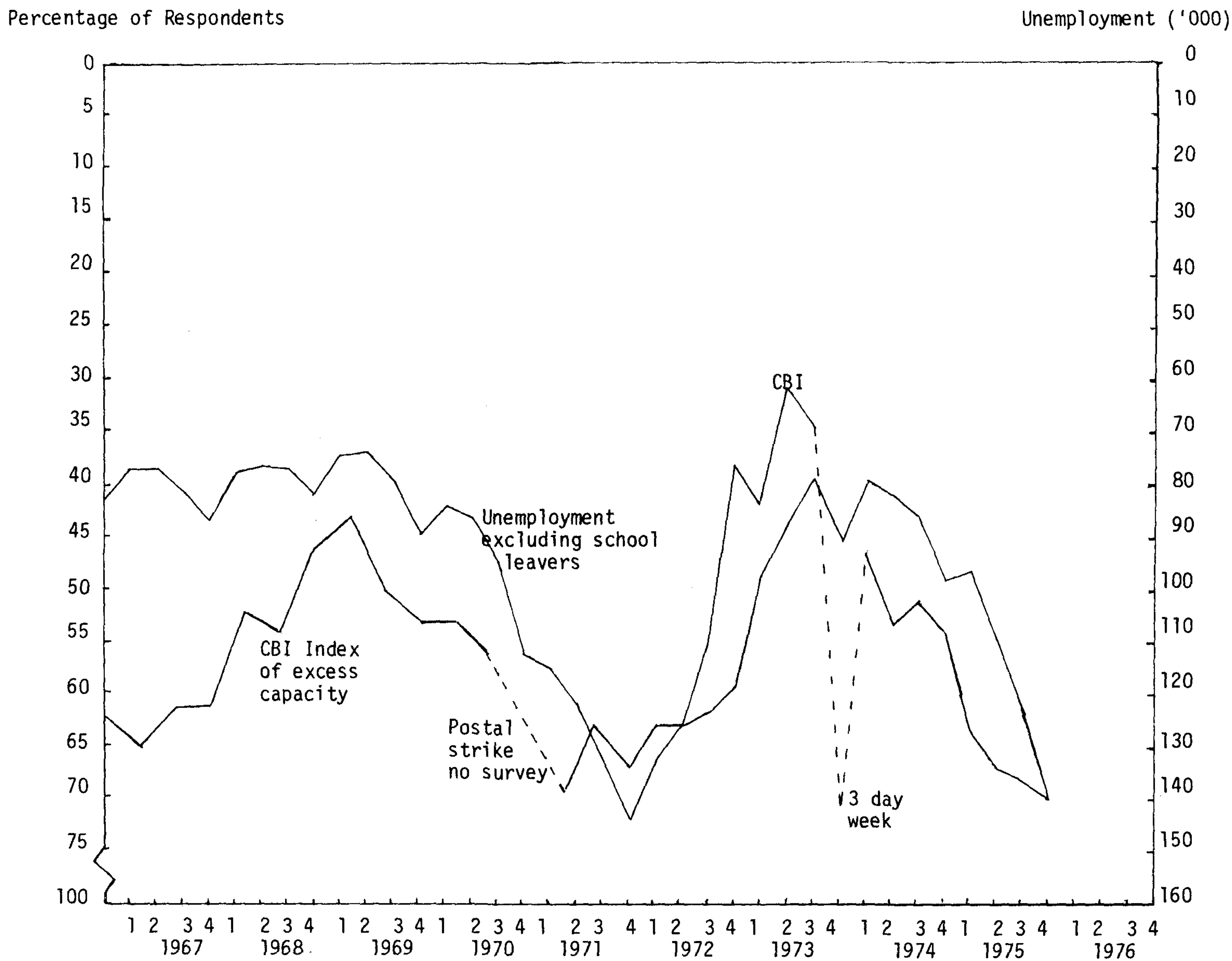


Figure (9) CBI Capacity Utilisation Index for Scotland

Source: CBI Industrial Trends Survey
Department of Employment Gazette

TABLE (I)

Domestic Consumption of Fuels in Scotland

(Index number form)

	GAS	HOUSE COAL	ELECTRICITY	OIL*
1961/62	100	100	100	100
1962/63	106	97	123	136
1963/64	114	91	138	130
1964/65	126	80	149	140
1965/66	144	76	170	152
1966/67	163	68	179	162
1967/68	176	62	198	180
1968/69	183	60	216	200
1969/70	194	56	233	227
1970/71	206	49	244	230
1971/72	211	41	250	261
1972/73	236	36	270	292
1973/74	252	39	279	287
1974/75	284		285	

* Estimates for Scotland, assuming proportionality with UK.

HOUSE COAL SALES (by Calendar Year)

	(000 tons)
1970	1680
1971	1381
1972	1041
1973	1279
1974	1127

Source: (1) Scottish Abstract of Statistics

(2) NCB, GAS & ELECTRICITY BOARD REPORTS.

Table (VI) Unemployment in the Regions

	UNEMPLOYMENT (THOUSANDS)				
	DEC '75	MAR '76	CHANGE DEC-MAR	% CHANGE	UNEMP. RATE MAR '76
Highland	4.5	4.6	0.1	+3	7.0
Shetland	0.2	0.3	0.1	+29	5.0
Orkney	0.1	0.2	0.1	+38	3.8
Western Isles	1.5	1.3	-0.2	-11	16.6
Grampian	5.3	6.1	0.8	+15	3.7
Tayside	9.8	10.8	1.0	+10	6.5
Fife	7.3	8.0	0.7	+10	6.3
Strathclyde	74.6	83.4	8.6	+12	7.7
Lothians	16.2	18.2	2.0	+12	5.6
Central	6.2	6.9	0.7	+12	6.4
Dumfries & Galloway	4.0	3.9	0.1	-3	7.9
Borders	1.4	1.5	0.1	+7	3.9
Scotland	131.0	145.1	14.1	+11	6.7

Table (VII) Unemployment and Vacancies in the Regions of the UK March 1976.

	Unemployment (Thousands)	Unemployment Rate (%)	Vacancies (Thousands)	Unemployment/Vacancies
South East	298.9	4.0	49.0	6.1
East Anglia	33.2	4.9	4.2	7.9
South West	101.4	6.5	8.9	11.4
West Midlands	127.9	5.6	7.6	16.9
East Midlands	69.4	4.6	8.3	8.4
Yorks & Humberside	108.1	5.3	9.7	11.1
North West	185.6	6.7	11.7	15.9
North	90.8	7.0	10.1	9.0
Wales	74.3	7.2	5.1	14.6
Strathclyde	83.4	7.7	8.0	10.4
Rest of Scotland	51.7	5.0	7.7	6.7
Scotland	145.1	6.7	15.7	9.2

Table (VIII) Employment in Scotland

	Total Employees in all Industries (Thousands)	Total as % of GB	Employees in Manufacturing (Thousands)	Manufacturing as % of GB
June 1972	1989	9.19	643	8.45
June 1973	2050	9.24	657	8.57
June 1974	2084	9.35	676	8.77
Sep. 1974	2087	9.31	681	8.78
Dec. 1974	2067	9.23	671	8.70
Mar. 1975	2040	9.25	657	8.72
June 1975	2053	9.27	646	8.75
Sep. 1975	2061	9.31	640	8.73

Figure 10 (a) *Numbers of wholly unemployed in Western Isles, Highland & Grampian Regions*
January 1968 - March 1976

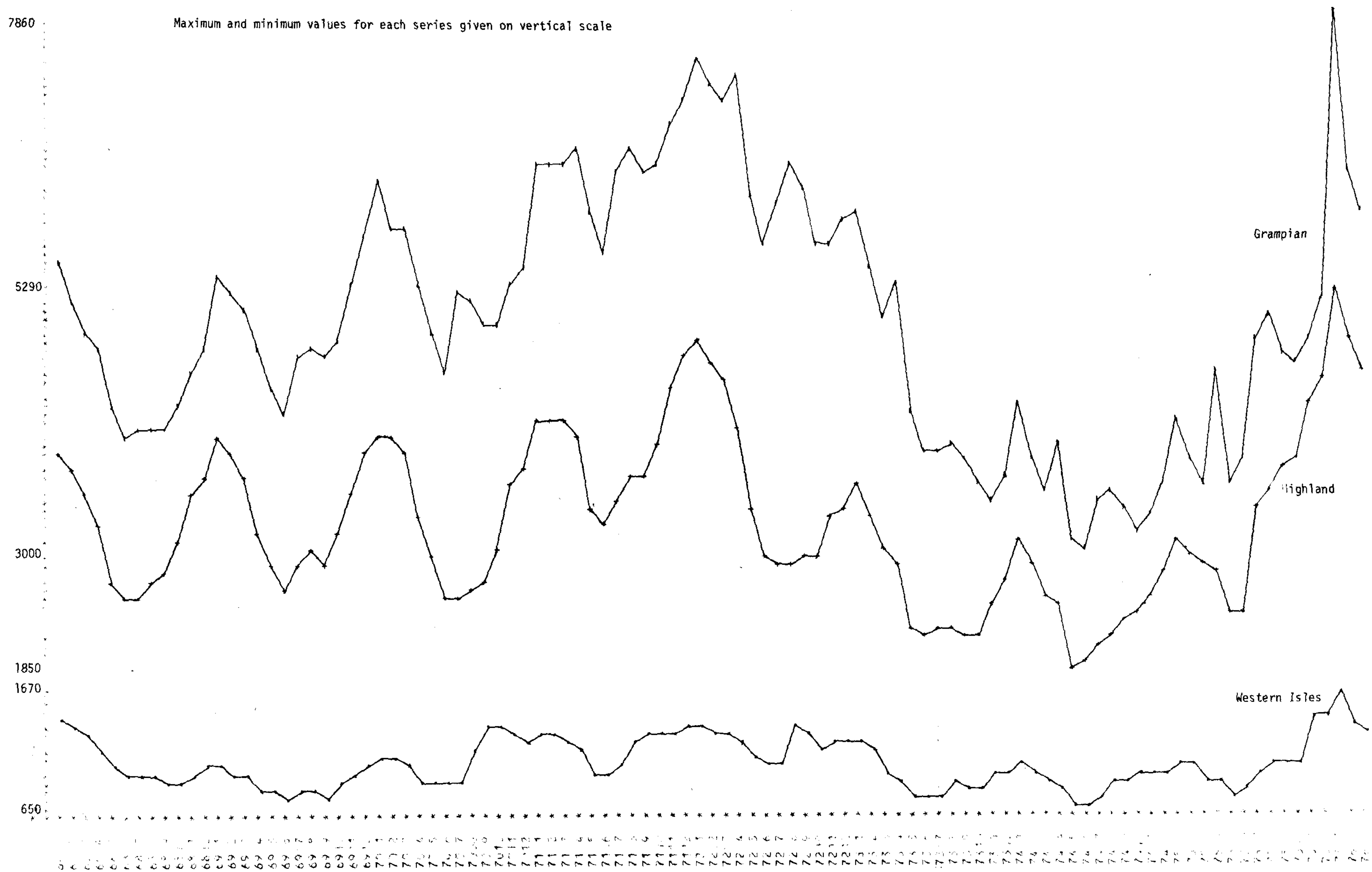


Figure 10 (b) Numbers of wholly unemployed in Shetland and Orkney
January 1968 - March 1976

Maximum and minimum values for each series given on vertical scale

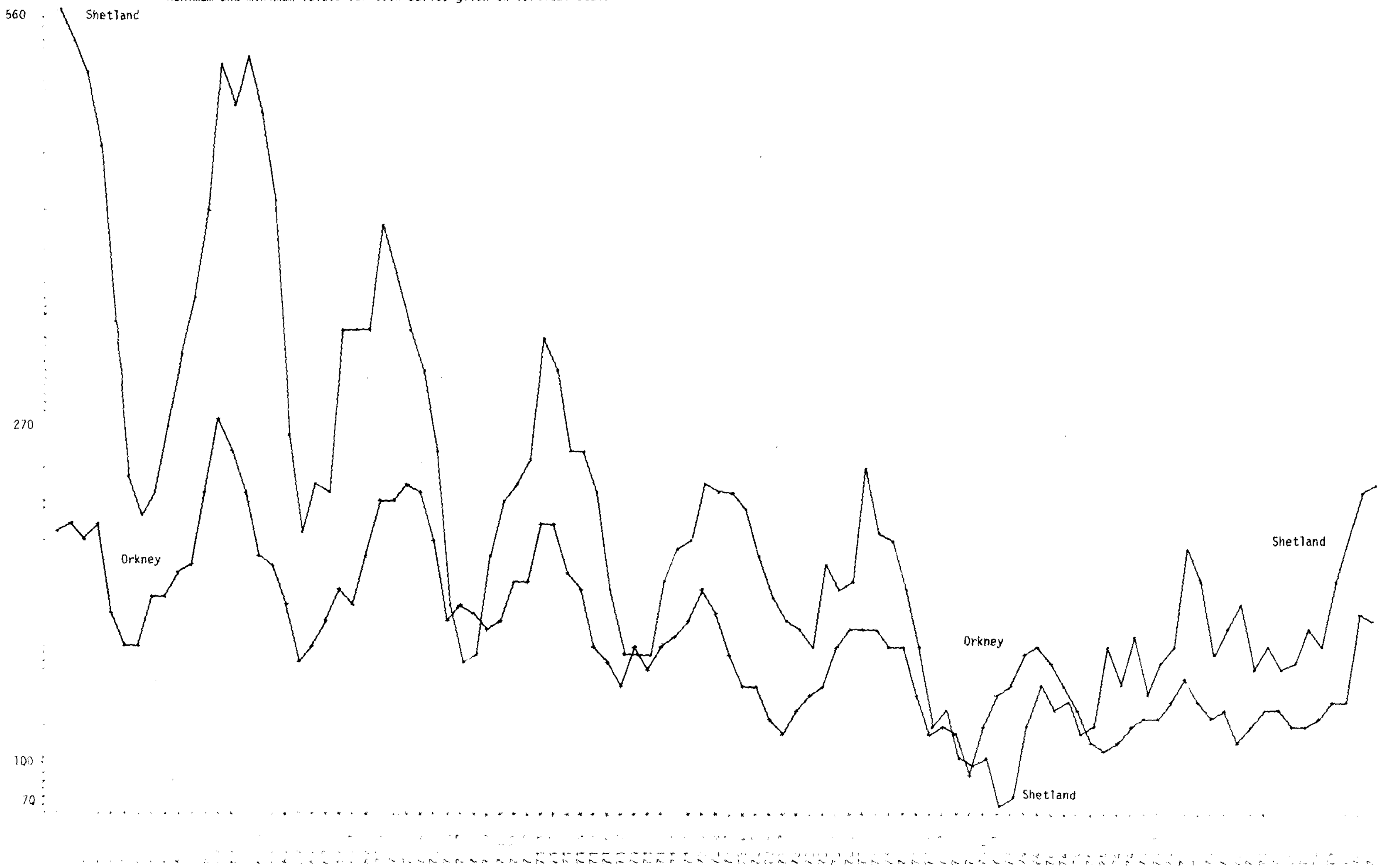


Figure 10 (c) Numbers of wholly unemployed in Fife, Tayside and Central Regions January 1968 - March 1976

Maximum and minimum values for each series given on vertical scale

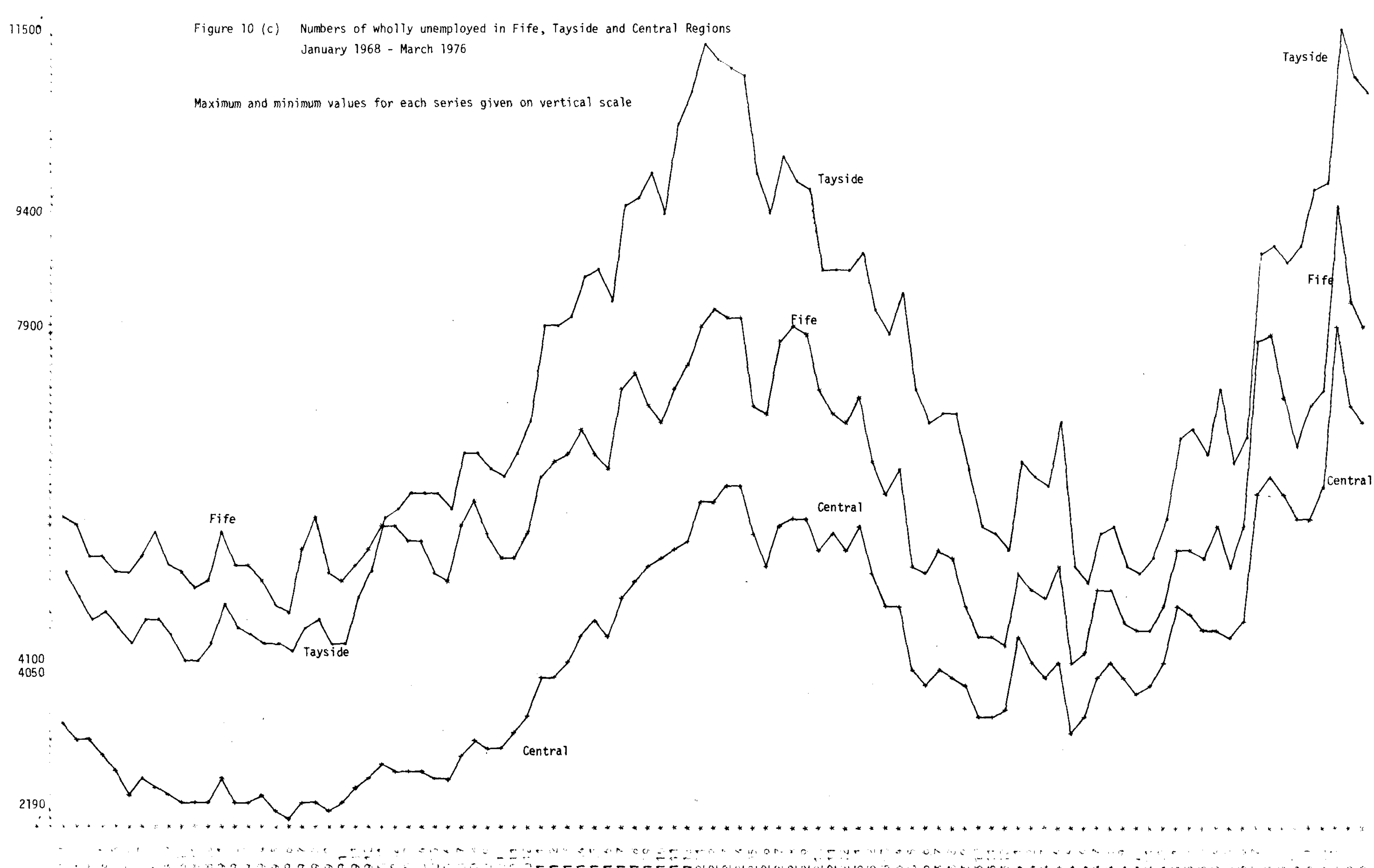


Figure 10 (d) Numbers of wholly unemployed in Strathclyde and Lothian Regions

January 1968 - March 1976

Maximum and minimum values for each series given on vertical scale

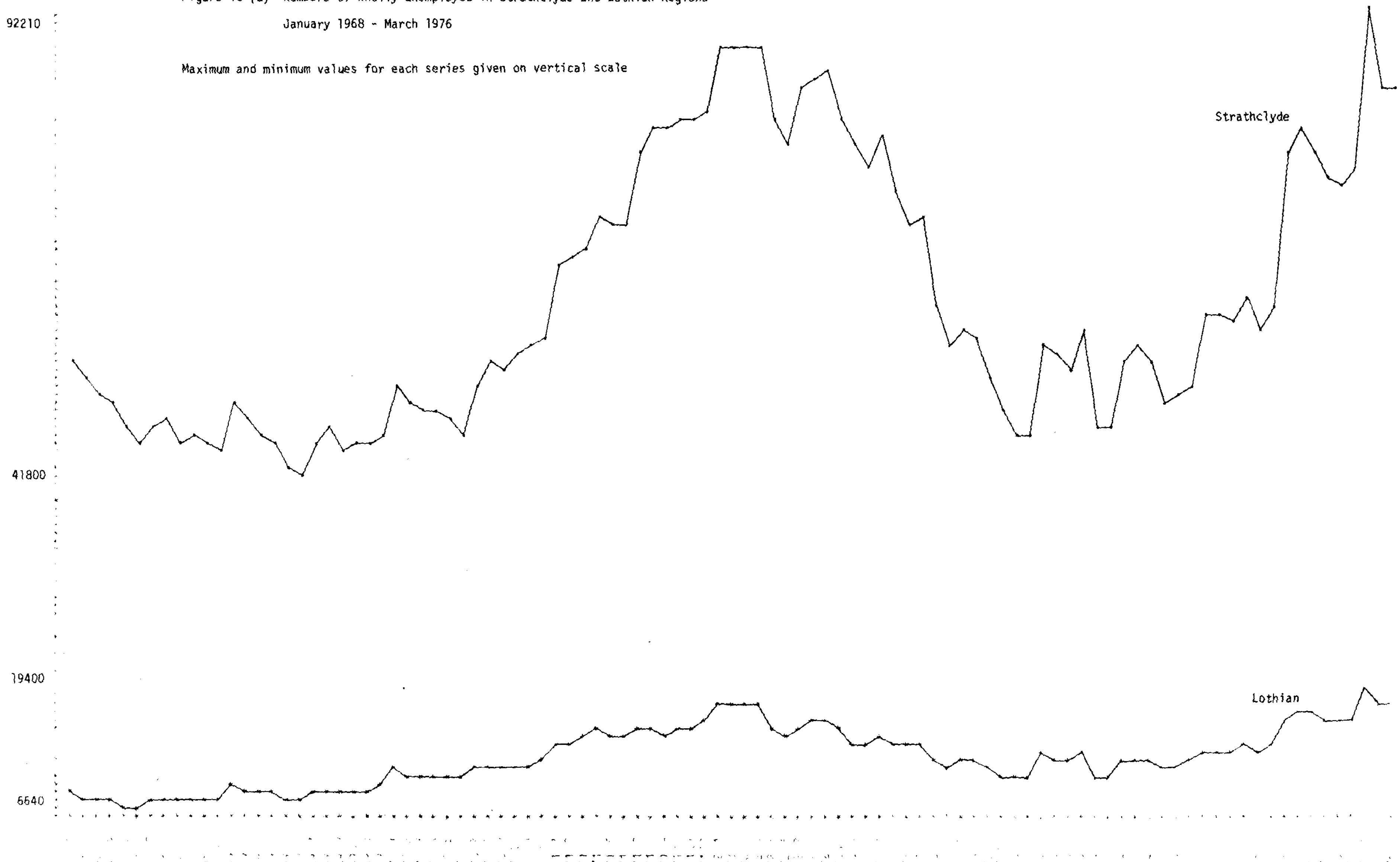
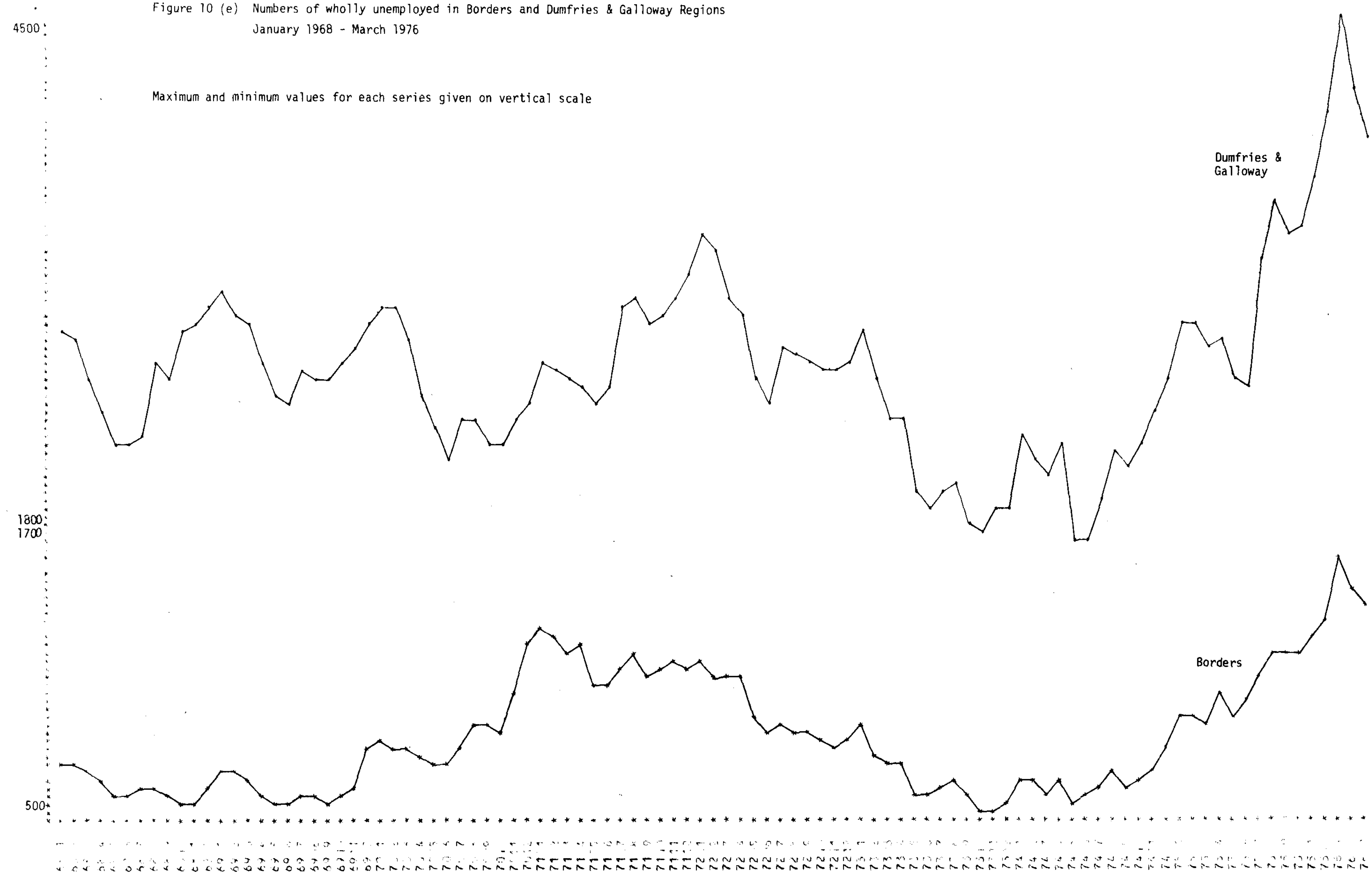


Figure 10 (e) Numbers of wholly unemployed in Borders and Dumfries & Galloway Regions
January 1968 - March 1976

Maximum and minimum values for each series given on vertical scale



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