

Expectations Formation in Disaggregated Models

End-of-Award Report

Kevin Lee and M. Hashem Pesaran
(University of Leicester and University of Cambridge)

Abstract

The project "Expectations Formation in Disaggregated Models" was an ESRC-funded project (reference number R000231813) carried out in the Department of Applied Economics at the University of Cambridge over the period 1/10/89 - 30/9/91. In what follows, we describe the aims of the project and provide a non-technical summary, a full report and a list of papers produced on the project.

Aims of the Project

1. To estimate disaggregate models of employment, prices and wages for the major industrial sectors of the UK, emphasising the role of expectations and the interactions that exist between these sectors in the determination of aggregate employment level and the overall rate of inflation.
2. To consider different expectations formation hypotheses in the context of these disaggregated models, noting the significance of the process of expectations formation in the transmission of output and inflation effects from one sector of the economy to another.
3. To investigate empirically competing hypotheses on the workings of the labour market using direct observations on expectations. Specifically, we will consider the role of expected output levels in employment equations, the role of inflation expectations and other variables, both internal and external to the industry, in wage equations, and the role of demand and cost expectations in the determination of the markup over the cycle in price equations, all estimated at the disaggregated level.
4. To investigate the potential in the UK for influencing the expectations formation process by changing the informational environment of the agents (employers and unions). In this we hope to achieve a better understanding of the policies adopted in "corporatist" economies aimed at maintaining low levels of unemployment and inflation through improved information flows between different groups in the economy.

Non-Technical Summary

The research undertaken in this project aimed to consider the issues involved in the econometric analysis of disaggregated models, especially those involving expectations, and with particular reference to supply side relationships. Specifically, the work has considered the following areas: the development of the theoretical framework suitable for an econometric analysis of disaggregated models containing expectational variables; the empirical investigation of different expectations formation hypotheses through the use of direct observations on expectations; the analysis of wage, price, and employment determination through the estimation of sectoral wage, price and employment equations; and the investigation of the role of informational flows between sectors in policies designed to achieve acceptable levels of inflation and unemployment.

The work undertaken to develop the theoretical framework suitable for the econometric analysis of disaggregated models has concentrated on three issues. First, we have considered the econometric techniques which are necessary for the implementation of disaggregated models containing expectational variables, and extended previous work on testing for the importance of disaggregation to accommodate these techniques. Second, we have considered some of the issues that arise in the time series analysis of disaggregated models. And third, we have concentrated on the specific issue of wage determination in the context of a multisectoral model in which interdependencies between sectors' wage-setting behaviour and expectations are shown to be important. In each of these areas, the analysis has highlighted the technical difficulties generated through the interrelatedness of sectoral decision making, but provided methods for the solution and estimation of these models which accommodate these technical difficulties.

During the course of the project, a data set was collated from the CBI's quarterly publication Survey of Industrial Trends, providing direct observations on expectations formed on a variety of economic indicators for nine industrial groups in the manufacturing sector (plus total manufacturing) over the period 1972(1)-1989(4). Analysis of this data for price and cost inflation expectations provided some interesting insights into the process of expectations formation, as the characteristics of the derived expectation series could be interpreted in terms of the informational requirements made on agents in forming expectations. In particular, the analysis provides further evidence on the Rational Expectations Hypothesis, and uses the contrasting results obtained for the cost and price inflation series to provide useful insights on the potential source of the departures from the REH.

Empirical work was carried out on disaggregated data for the supply side of the UK economy in order to investigate sectoral wage, price, and employment determination in a variety of contexts. This demonstrates that expectations formation plays a central role in the process of supply side adjustments, and contributes to the complexity of this process. Evidence is provided to suggest that, given the complexity of the process, agents rely on particular types of information, and that the associated imperfections in information may play an important role in determining the speed and direction of supply side adjustment. Further, it is argued that an analysis of the supply side cannot be adequately undertaken without explicit consideration of the sectoral structure of the economy. Evidence is presented of considerable heterogeneity in supply side relationships across sectors, and the inadequacy of aggregate analysis in these circumstances is illustrated in a variety of contexts.

The work suggests that the government may be able to implement policies to improve the process of supply side adjustment through a coordinating role aimed at favourably influencing the process of expectations formation. The provision of a widely available forecasting service would be a relatively simple means of influencing agents' information sets, but more sophisticated policies, aimed at influencing wage setting institutions could also be useful, improving information flows between

sectors, minimising the disruption caused by sectoral misperceptions of the responses of agents to shocks, and providing a means by which the wider implications of wage setting decisions could be 'internalised' by individual decision makers. The empirical results also demonstrated that policy measures will have a different impact in different sectors, and as such provides an argument for policies which explicitly take into account structural considerations, directing policy measures at areas in which they will be most beneficial and taking into account the adjustments that take place throughout the economy which are initiated by policies directed at specific sectors.

Full Report of Research Results

0. Introduction

It is now widely recognised that an understanding of the process of supply side adjustment is at least as important in explaining the macroeconomic performance of an economy as an understanding of the effects of demand management policies. In the UK, where the oil price shocks of the seventies were associated with inflation rates that were among the highest in the developed nations, and where in the eighties tight monetary policies designed to defeat inflation resulted in unemployment rates which were equally disappointing by international standards, supply side issues have stood at the heart of much of the macroeconomic debate over the last two decades. Wage bargaining institutions in particular have been subject to considerable analysis, and it is widely believed that the UK suffers relative to other economies in having wage bargaining institutions which are neither highly decentralised (which may provide a high degree of labour market flexibility in the face of shocks), nor highly centralised (which may allow a more coordinated response to shocks). Much of the policy debate focuses on the direction which institutional reform should take along this continuum.¹

Important advances have been made in theoretical and empirical research in the area of supply side adjustment, but in view of the discussion above, it is surprising to find that generally this has been carried out at the aggregate level, with relatively little emphasis placed on the sectoral interactions that exist in the labour market. One explanation for this lies in the technical difficulties involved in the empirical analysis of disaggregated models in which intersectoral interactions are important. For example, the nature of the interactions may involve modelling complicated paths of influence as the effects of sector-specific or aggregate innovations are transmitted from one sector to another. Equally, these interactions may substantially prolong the process of adjustment to an innovation. In these circumstances, the ultimate effects of the innovation may be more difficult to identify, and may be determined by the structure of the interactions as well as by the nature of the shock itself. These issues are particularly relevant when there is less than perfect information, so that agents are required to form expectations both on the values of driving variables and on the reactions of others to changes in these variables.

With these points in mind, the research undertaken in this project aimed to consider the issues

¹ For examples of international comparisons of this sort, see Bruno and Sachs (1985), Flanagan, Soskice and Ullman (1983), Bean, Layard and Nickell (1986), Calmfors and Driffel (1988), and Freeman (1989).

involved in the econometric analysis of disaggregated models, especially those containing expectations, and with particular reference to supply side relationships. Specifically, the work focussed on the following four areas:

- (1) The development of a theoretical framework suitable for an econometric analysis of disaggregated models containing expectational variables;
- (2) The empirical investigation of different expectations formation hypotheses through the use of direct observations on expectations as provided in the CBI's Survey of Industrial Trends;
- (3) Applications to the analysis of wage, price, and employment determination through the estimation of sectoral wage, price and employment equations; and
- (4) The investigation of the role of informational flows between sectors in policies designed to achieve acceptable levels of inflation and unemployment.

Progress has been achieved with varying degrees on each of these fronts, following relatively closely the timetable set out in the research application. Papers in each of the areas have been written; many have been published, or are forthcoming, either in learned journals or as chapters in books, and the rest are in preparation or under consideration for publication (see the list of publications at q.10). The rest of this report outlines the major research results of the project under the four headings outlined above.

1. Development of a theoretical framework.

The work undertaken to develop the theoretical framework suitable for the econometric analysis of disaggregated models has concentrated on three issues. First, we have considered the development of appropriate econometric techniques for the empirical analysis of disaggregated models containing expectational variables, and have extended previous work on testing for the importance of disaggregation to this class of models. Second, we have considered some of the issues that arise in the time series analysis of disaggregated models through the development of a suitable framework for the measurement of the persistence of shocks to aggregate output in the context of a multisectoral model of output growths. And third, we have concentrated on the specific issue of wage determination in the context of a multisectoral model in which interdependencies between sectors' wage-setting behaviour and expectations are shown to be important. Further details on our work in these areas is described below:

(i) Rational expectations in disaggregated models

An important aspect of the work undertaken in this project has been to consider the technical issues involved in analysing disaggregated model containing expectations. As discussed in the introduction, particular difficulties are experienced in models in which decision making by agents in each sector is influenced by the agents' expectations of the outcomes of decisions made elsewhere. This interdependence of sectoral decision making gives rise to the problem of 'infinite regress' discussed in detail in Pesaran (1987), and which is a pervasive characteristic of models subject to behavioural uncertainty where information across sectors is heterogenous. In general, the solution to such a problem will not be determinate, although solution and estimation techniques can be derived under particular restrictive assumptions, either on the processes generating the driving variables of the model,² or on the information held by individuals. Some of these issues are considered further in Pesaran (1990a, 1991b) and Lee and Pesaran (1991a).

The solution of a disaggregated model involving expectations, and the form of the appropriate econometric analysis, depends fundamentally on the nature and the structure of the sectoral information sets. For example, if we impose the strong assumption of information homogeneity, so that agents in all sectors are faced with the same information set, then the disaggregated Rational Expectations (RE) model reduces to a standard simultaneous RE model, and the appropriate techniques for the solution and estimation of the model are well established in the literature.³ However, when information disparities prevail across sectors, consistent and efficient estimation of disaggregated rational expectations models require explicit consideration of the form of these disparities. In Pesaran (1990a, 1991b), solution and estimation techniques are proposed for disaggregated RE models when information disparities are asymmetric (i.e. when agents can be classified into two groups, with one group being more informed than the other), and where information is heterogenous (where information differs across agents with no one agent being necessarily more informed than another). In the context of sectoral wage determination, information disparities are likely to be heterogenous, and, as elaborated in Lee and Pesaran (1991a), in this case a reasonable assumption on the structure of the sectoral information sets is that, in forming expectations of sector-specific developments taking place outside their own sector, agents condition their expectations only on the public information set. Given this "common knowledge" assumption, and under the regularity assumptions (B and C) elaborated in

² See Appendix B of Pesaran (1987) for some examples.

³ The existing literature on the estimation of models involving the REH is reviewed in Pesaran (1987), and also discussed in Pesaran (1991c).

Pesaran (1990a), it is shown that the parameters of the disaggregated RE model can be consistently estimated by the IV method using variables in the publicly available information set as instruments.

Once parameter estimates for the disaggregated equations have been obtained, it may be of interest to consider the extent to which the estimated disaggregated model differs from the corresponding aggregate model. Specifically, two issues may be of interest: first, the models may be compared in terms of their ability to predict aggregate outcomes; and secondly, the aggregate and disaggregate models may provide different estimates of key parameters, raising the possibility of aggregation bias in the estimated parameters of the aggregate equation. These issues were considered in a series of papers (Pesaran, Pierse and Kumar (1989), Lee, Pesaran and Pierse (1990a,b) for the least squares case, but it was important to extend the methods developed in these papers to the class of models including rational expectations equations, where the standard least squares assumptions do not hold. This was done in Pesaran and Pierse (1991), where a choice criterion is proposed for discriminating between disaggregated and aggregate models in terms of predictive ability, and where general tests of aggregation bias are developed when both disaggregate and aggregate specifications are estimated by the Instrumental Variables method. These issues are of particular interest where sectoral interdependencies are important, since the interaction of decision making in different sectors simply can not be accommodated into an aggregate model, and may render the aggregate wage equation grossly misspecified.

(ii) Cointegration, aggregation, and the sources and persistence of shocks

An important aspect of the theoretical framework suitable for the econometric analysis of disaggregated models is their ability to adequately reflect the long run properties of the sectoral and aggregate series, which (as discussed in the introduction) may be obscured by the interactions of the sectors. In Pesaran, Pierse and Lee (1991) [PPL], in Lee, Pesaran, and Pierse (1991) [LPP], and in Pesaran (1991c), we have examined this issue in the context of the study of output fluctuations, where sectoral outputs are subject to random shocks, the effects of which may persist well into the future.

The extent to which the effects of shocks to the economy persist over time has been the subject of extensive investigation over the past few years⁴, with discussion centered on the time series properties of important macroeconomic aggregates. It has now become a widely held view that

⁴ See, for example, Campbell and Mankiw (1987, 1989), Harvey (1985), Clark (1987a), Watson (1986), Cochrane (1988), Christiano and Eichenbaum (1989), Shapiro and Watson (1988), Evans (1989), Blanchard and Quah (1989), Demery and Duck (1990), and Mills (1991).

aggregate output is best represented by a first-difference stationary process, rather than by a stationary process around a deterministic trend. This has the important implication that macroeconomic shocks can have effects on output levels which continue into the indefinite future; an isolated recessionary shock may cause output growth to be only temporarily lower than usual, but this would be reflected by a time path for the level of output which is permanently lower than what it would have been in the absence of the shock.

The size of the long run response of output to a unit shock, known as the persistence of shocks to output, is an empirical issue, and several studies have now been conducted to estimate the persistence measure for the real gross national product in the US and elsewhere. The evidence presented in these papers is mixed and inconclusive however, largely reflecting the difficulties involved in determining the long run properties of the output series from the relatively short time series available over the post war period. In our papers, we advocate the use of sectoral output data in order to bring extra information to bear on the analysis of persistence at the aggregate level. Here, we note that the information contained in the relationships between sectoral growth rates can be fruitfully utilised to obtain a more reliable estimate of the persistence measure for aggregate output using a multisectoral model of output growths than can be obtained through a univariate model.

The proposed disaggregated framework also allows us to decompose the persistence of shocks to aggregate or sectoral outputs into those generated by particular "macro" shocks and those generated by "other", possibly sector-specific, shocks. This means that the relative importance of these different types of shocks to the overall persistence measure can be assessed. For example, in LPP, we applied the framework to the UK economy and estimated measures of persistence for eight industrial sectors and for the economy as a whole. We found the persistence measures to be significantly greater than zero. Moreover, the contribution of unexpected growth in the money supply or unexpected changes in excess returns on stocks (money supply shocks and stock market shocks) to this persistence was found to be negligible. The effects of oil shocks and exchange rate shocks were found to be more pronounced, but these too were small relative to other, unidentified (but possibly sector-specific technological) shocks.

The framework developed in PPL, LPP and Pesaran (1991c) provides important insights into the econometric analysis of the properties of sectoral time series data and the corresponding aggregate series. In particular, given the framework's ability to identify the sources of unexpected innovations, and to discriminate between their effects, it is hoped that this analysis can be extended in future work to help identify which shocks are important in influencing the long run evolution of the macroeconomy,

and to provide further insights on the mechanism by which the effects of shocks are propagated across sectors.

(iii) Wage determination in a disaggregated union model involving expectations

In view of the significance attached to the functioning of wage bargaining institutions in the macroeconomic debate, we have devoted some effort in the project to developing a framework suitable for the analysis of wage determination which explicitly acknowledges the interrelatedness of wage setting across sectors and the importance of expectations formation in this process. Two issues in particular were believed to be potentially important. The first issue concerned the nature of the intersectoral interactions involved in wage determination, concentrating on the wage/employment opportunities available to a worker should she/he lose her/his current job. In particular, the structure of existing wage relativities, and the vulnerability of workers in certain sectors to unemployment, contrasted with the relative security of employment opportunities in other sectors, are features of the labour market whose influence needs to be elaborated and investigated empirically. The second potentially important issue concerned the intertemporal aspects of wage bargaining decisions, noting that when wage settlements are made, negotiators recognise that decisions arrived at today have implications for future levels of employment and wages.

In Lee and Pesaran (1991a,1991c), we address these issues, and develop a disaggregated union model of the labour market⁵ which pays particular attention to the interactions that take place between sectors in wage negotiations. The model considers wage settlements in each sector, and focuses on the influence exerted on a sector's wage setting decisions by the current distribution of wages across sectors and by the sector's position in that distribution. It also elaborates on the association between the distribution of wages across sectors and the distribution of productivity levels across sectors, considers the extent to which average productivity levels provide an 'anchor' for average wage settlements, and notes the role played by sectoral decisions for wage and employment determination in disseminating the effects of aggregate and sector-specific innovations across all sectors. The union model is also extended to accommodate adjustment costs⁶, and thereby introduces the need for intertemporal decision making. The solution to a union model of this form is derived, stating

5 The union model developed is in the tradition of models of the labour market beginning with Dunlop (1944) and Nash (1950), and extended and investigated more recently by, among others, McDonald and Solow (1981), Svejnar (1986), Ashenfelter and Brown (1987) and Carruth and Oswald (1989).

6 Building on the work of Lee et al (1990b) and Pesaran (1991a) which consider the dynamic nature of employment demand in the presence of adjustment costs.

explicitly the assumptions made on the bargaining framework and on the information sets used in forming expectations in order to achieve the model solution. The analysis provides important insights into the complexities of wage bargaining in a disaggregated context, and suggests that sophisticated estimation procedures, involving non-linear regression techniques, careful measurement of 'alternative' wage options and the imposition of a well-defined dynamic structure (as suggested by the economic theory), will be required to adequately investigate sectoral wage movements empirically.

2. Direct observations of expectations ; measurement and tests of rationality

An important aspect of the project was to consider different hypotheses on the formation of expectations, and in this, direct measures of expectations play an important role.⁷ In the absence of direct measures, analysis of the expectations formation process can only be carried out indirectly, and conclusions derived are conditional on the validity of the underlying theory employed to model expectations. Direct measures are not without their limitations however: data is usually obtained in the form of surveys of opinions and these may be susceptible to sampling errors; respondents may be influenced by the process by which they are surveyed, and may express opinions which differ from those which they truly hold; the responses provided are frequently of a qualitative nature, and there may be difficulties in quantifying the data; and the need for anonymity may require the data to be presented in an aggregated form, introducing problems in matching agents' responses with their information sets. Nevertheless, direct observations on expectations provide an important source of information which can be used to study explicitly the process by which expectations are formed. In particular, the availability of a time series of direct observations on an agent's expectations of a particular variable, used in conjunction with a time series of the realisations of the variable, can be used to provide insights into the agent's use of information and the 'rationality' of the expectations formation process.

For this reason, during the course of the project, we have constructed a data set providing direct observations on expectations formed on a variety of economic indicators for nine industrial groups in the manufacturing sector (plus total manufacturing) over the period 1972(1)-1989(4). Although the data was readily available from the CBI's quarterly publication Survey of Industrial

⁷ For examples of the use of direct observations in the analysis of expectations formation in various economic aggregates, see Turnovsky and Wachter (1972), Jacobs and Jones (1980), Friedman (1980), Brown and Maital (1981), Leonard (1982), Batchelor (1982), Pesaran (1984, 1985, 1987), or Wren-Lewis (1986), among others.

Trends, it was not publicly available in computer readable form, and the collation of the disaggregated data into such a form was more time consuming than had been anticipated.⁸ However, the data bank has now been constructed, providing qualitative data on movements in variables observed over the preceding four months, and expected to occur over the coming four months, in the sample of firms covered by the CBI's Survey. This should provide a valuable resource for future work in the analysis of expectations formation and in many areas of applied econometric analysis where expectations are important.⁹ In particular, we intend to use this data set in a future ESRC-funded project aimed at investigating the mechanism by which sectoral shocks are propagated across time and across sectors (see section 6 below).

(ii) Price and cost inflation expectations

The analysis described in Lee (1991b) provides some interesting insights into the expectations formation process at a sectoral level. The analysis highlights the difficulties involved in distinguishing the properties of the expectations data from the properties of the conversion methods used to obtain quantitative data from the qualitative responses. Having said this, some important observations can be made on the basis of the results that have been so far obtained. For example, one observation to arise from the results is the asymmetry in the responsiveness of inflation expectations to increases and decreases in the inflation rate, with expectations generally being revised upwards more quickly in periods of rising inflation than they are revised downwards in periods of falling inflation. While we do not offer any explanation for this asymmetry in this work, it is clear that such asymmetries will both reflect and influence the process by which wages and prices are adjusted, and could have important implications for wage and price dynamics.

The results presented in Lee (1991b) also provide insights into the 'rationality' of expectations formed on price and cost inflation in the nine industrial groups covered by the CBI data set. These emphasise the fact that the interpretation of the results is greatly influenced by the assumptions made on the nature of the errors introduced by the quantification procedure. Specifically, the results

8 Given the disaggregated nature of the data, the main task was to keyboard a substantial volume of information to the computer. Moreover, the task was complicated by the need to work at a lower level of aggregation than the nine industrial sectors for which the consistent time series data was ultimately obtained because of changes in the definitions of some of the industrial classifications employed over the sample period. Further details are provided in Lee (1991b).

9 An area of particular interest, given the results reported for the manufacturing sector by Wren-Lewis (1986), is in the use of expectations on output changes in sectoral employment equations. This is an area of analysis which we aimed to consider in this project, and although we have not yet done so, we hope that such an analysis can be undertaken now that the data is available.

demonstrate that *under the assumption that the conversion errors are not systematically related to known data*, the REH can generally be rejected with some confidence using the proposed orthogonality test. However, the recognition that the conversion procedure may introduce errors into measured unanticipated inflation which could be systematically related to known data means that the REH can only be tested under particular assumptions on the nature of this relationship. When the REH is tested on price and cost inflation expectations under assumptions which attempt to accommodate the potential effect of conversion errors, the degree of confidence with which the REH can be rejected is substantially reduced in many sectors, and the REH cannot be rejected on the basis of these tests in many cases.

Finally in Lee (1991b), we note the significance of the use of disaggregated data in this analysis. Although there was relatively little difference between the results obtained under different assumptions on the content of the information sets held across the sectors, there was a clear distinction between the results obtained at the sectoral level and those obtained at the Total Manufacturing level. We found that the REH is rejected more comprehensively when the tests were applied to the aggregated data than when they were applied to the data from most of the constituent sectors. This provides some evidence for the presence of an aggregation bias (which is potentially present whenever there is heterogeneity across sectoral relationships)¹⁰, and suggests that further work, at an even lower level of aggregation, might be of interest in testing the rationality of expectations formation.

Finally here, we note that an important issue to resolve in the analysis of pricing behaviour is the extent to which the markup of prices over costs is responsive to demand fluctuations. While there has been extensive investigation of this issue in the literature, the empirical work has relied exclusively on 'realisations' data on prices and costs in the analysis. It is our contention that in practice, the decision on the size of the markup is based on expected cost movements and not actual or historical costs, so that a more appropriate approach might be to examine the markup pricing hypothesis using expected price and cost series rather than their realisations. The empirical work currently being written up in Lee and Pesaran (1991b) builds on the characterisation of the price and cost inflation series described above, and considers precisely these issues, investigating whether the use of ex ante data provides the means to achieve a more adequate empirical analysis of pricing behaviour than can be obtained by using realisation data only.

10 The evidence for the presence for aggregation bias is strengthened if it is recognised that the REH should be rejected at the aggregate level even if the REH is rejected for only one sector.

3. Econometric analysis of wage, price and employment determination

The development of the theoretical framework appropriate for the analysis of disaggregated models, and the analysis of Survey data on expectations are areas of interest in their own right, but these studies also provide important insights into the econometric analysis of supply side adjustments which is one of the areas of particular interest in this project. Empirical work has been carried out on disaggregated data on the supply side of the UK economy, investigating sectoral wage, price and employment determination, and the results of this work is presented in the papers described below:

(i) Wage determination in disaggregate models involving expectations

Wage equations for 16 industrial sectors covering the whole of the UK economy have been estimated on the basis of data over the period 1954-1990 in Lee and Pesaran (1991a, 1991c). The estimated relations provided in these papers draws on the theoretical work, and implements the techniques, discussed in Part A above. Lee and Pesaran (1991a) [LP(a)] focuses primarily on the need for a disaggregated analysis of wage determination, and aims to demonstrate the advantages of a sectoral analysis of wage determination as compared to an analysis carried out at the aggregate level. For this purpose, the model that is employed explicitly incorporates the influences of intersectoral interactions in wage determination, but simplifying assumptions are made in order to obtain a specification for the disaggregated and aggregate model which are comparable.¹¹ Lee and Pesaran (1991c) [LP(c)] provides the results of the estimation of a more sophisticated econometric analysis of the sectoral wage data which is able to capture more precisely the intersectoral interactions and which also takes account of intertemporal considerations.

The empirical results obtained provide some interesting insights into the process of wage determination. First, and most importantly, the results confirm that wage levels outside the sector are the primary determinant of wages set in the sector. The coefficients obtained across the sectors in the estimated wage equations of LP(a) demonstrate that the average long run elasticity of wages in a given sector with respect to wage change in the rest of the economy is 0.86, while the corresponding figure for a sector-specific, internal pressure variable is 0.14.¹² Moreover, in eight of the sixteen

11 The chosen specification follows relatively closely that estimated on firm level data in Nickell and Wadhvani (1990).

12 The long run insider estimate obtained here is in line with those reported elsewhere: an estimated value of 0.13 is given in Nickell and Kong (1988), while the range 0.08-0.18 is reported for this parameter in Nickell and Wadhvani (1990).

sectors (primarily concentrated outside the Manufacturing sector) the coefficient on the internal pressures is not statistically different from zero. This provides important empirical support for the hypothesis of wage-wage comparisons and for the significance of the transmission of expectations in sectoral wage formation. Second, it is clear that there are complicated dynamic adjustments influencing wage formation. In LP(a), complicated lag structures need to be incorporated in the estimated wage equations in order to obtain relations which fit the data adequately¹³. The relatively sophisticated dynamic structure imposed, on the basis of the proposed presence of adjustment costs, on the estimated relations in LP(c) provided a useful means of interpreting these dynamics. And third, the results of LP(a) show that the remaining 'external' influences on wages that were considered, namely the aggregate unemployment rate, the replacement ratio, and incomes policy effects, have a relatively weak influence in some sectors, and no statistical influence in others. This again demonstrates the importance of intersectoral interactions in the process of wage determination, as the unemployment rate, benefits and incomes policy exert only an indirect influence, through wage-wage comparabilities, on wage setting in a substantial section of the economy. In the case of the influence of unemployment on sectoral wages, for example, one interpretation of these results is that the fear of unemployment will exert direct downward pressure in sectors which employ relatively unskilled workers only. The subsequent reduction in wages at the bottom end of the distribution of wages across sectors will reduce the attractiveness of opportunities available to those workers who are currently located higher in the distribution of wages should they lose their current job. However, it is clear that this represents only an indirect path of influence from unemployment to wage setting in many sectors, and that wage setting decisions of the highly paid/ highly skilled may be extremely unresponsive to changes in aggregate unemployment levels. This is precisely the type of argument which is captured by the intersectoral interactions implicit in the model developed and estimated in LP(c). Here it is confirmed that attempts to model explicitly the path by which unemployment influences sectoral wages will improve the empirical adequacy of the model.¹⁴

LP(a) also considers the problem of choice between the aggregate and the disaggregated

13 Given the complexity of the dynamic adjustments of sectoral wages, the economy-wide effect of changes in either the sector-specific or aggregate determinants of wages will take place only slowly over time, and will be the outcome of an accumulation of the reactions taking place in each sector. Such effects will be extremely difficult to capture through an aggregate wage equation.

14 Specifically, in LP(c), higher unemployment rates exert a downward influence on wage setting through their (depressing) effect on the probability of a worker becoming reemployed if she/he loses her/his current job. Modelling this effect adequately involves non-linear regression techniques, and these are employed in LP(c).

wage equations, and provides a comparison of the estimates of the parameters of the disaggregated model with the corresponding estimates of the aggregate wage equation. Of particular interest in the context of wage determination is the elasticity of the real wage rate with respect to changes in the rate of unemployment, reflecting the responsiveness of real wages to cyclic fluctuations. The conclusion derived on the basis of the relevant choice criterion (based on the use of results obtained by the IV method) was that the disaggregated model outperforms the aggregate equation, suggesting that a disaggregated model is preferred to an aggregate one even if interest primarily lies in understanding the evolution of the aggregate wage variable. Moreover, also considered in LP(a) is an application of the tests of aggregation bias discussed in Pesaran and Pierse (1991) to the particular case of the aggregate elasticity of wages with respect to the unemployment rate obtained from the disaggregate and aggregate specifications. The expression for this long-run elasticity, in the case of the disaggregated model, is a complicated (non-linear) function of the parameters of the model, calculated to represent the responsiveness of aggregate real wages to a change in the unemployment rate as it accumulates across sectors. The estimated aggregate elasticity obtained from the disaggregated results is, at -0.2531, rather larger than is generally obtained in the analysis of aggregate wage data. Further, the estimated test statistic provided strong evidence in support of rejecting the null hypothesis of no aggregation bias, suggesting that the aggregate equation significantly underestimates the degree of responsiveness of wages to changes in the unemployment rate. This finding raises the general issue that policy prescriptions based on estimated parameters obtained from the analysis of aggregated may be misleading.

(ii) Wages, unemployment, and equilibrium in sectoral labour markets

Given that there is less than perfect labour mobility across sectors and that there are sector specific shocks to labour markets, one expects sectoral labour markets to differ in terms of wage levels and unemployment experiences. However, one also expects to find equilibrating forces which ensure that sectoral labour markets do not diverge too far from each other. In order to investigate this idea, time series analysis has been applied to different sectoral data sets, investigating the cointegrating relationships that may exist between sectoral data series and between sectoral and aggregate series. Important insights on the nature of the 'productivity anchor', and the relationship between relative wage movements and relative productivity movements, are provided in LP(c) as an introduction to the analysis of sectoral wage determination described above. A similar analysis has also been carried out on labour market data for the 11 standard regions of the UK covering the period 1964-1988. In Lee

(1990a), tests are carried out in each region to establish the number of cointegrating vectors to be found among the regional real wage rate, regional unemployment rate, the economy-wide real wage rate and aggregate demand in order to identify the nature of equilibrating pressures in the regional labour markets. When used in conjunction with regression analysis of sectoral real wages, the results of the cointegration analysis showed up some interesting contrasts between labour market relations of the low-pay/high unemployment regions of the 'North' and those of the high-pay/low unemployment regions of the 'South'. In particular, in contrast to the regions of the 'South', there appears to be an insufficiency of equilibrating pressures in the 'North'. This analysis is used to provide an understanding of the continuing disparities that are observed in unemployment rates across regions in the UK, while there is a clear tendency for wage rates to converge across regions.

(iii) Supply side adjustment and changing industrial structure

A central theme in the project's work is that econometric work based on aggregate data may be inadequate when important structural influences are at work. In Lee (1991a), a model of the UK supply side is considered, including employment, price, wage and output demand relationship estimated for 38 industrial sectors covering the whole of UK production over the period 1954-1981. Considerable variability is found in the responsiveness of employment, wages, prices and output across different sectors to changes in their determinants, and it is noted that it is precisely in the presence of such heterogeneity that aggregation biases are likely to appear. Moreover, it is also noted that this heterogeneity will cause particular problems in aggregate modelling when there are changes in industrial structure taking place over time. As an illustration of this point, a simple analysis of the parameters of the disaggregated model show that the responsiveness of the aggregate wage to the imposition of incomes policy will have changed considerably over the period simply because of the growth in importance of particular sectors and the decline in others. Changes in industrial structure taking place during the first half of the sample period will have served to increase the direct responsiveness of aggregate wages to incomes policy changes, while the opposite effect took place over the second half of the period. Moreover, this effect will have been further complicated by changes in the extent to which wage setting in different sectors is more or less responsive to changes in expected aggregate wage movements, as structural change will have caused a persistent reduction in the overall responsiveness of aggregate wages to periods of incomes policy via this path of influence.

The significance of the interactions between sectors is demonstrated in this paper through

model simulations. In these, the consequences of a hypothesised shock to the system of equations (imposed through a hypothetical incomes policy) is identified by first using a dynamic simulation of the estimated model to track the time paths of actual industrial employment, prices, wages, and output over the period 1954-1981. Next, the hypothetical shock is imposed and the model is re-run, allowing a comparison to be made between the base (actual) simulation and the new one incorporating the effects of the shock. Further, by running a sequence of artificial simulations in which some of the feedbacks between sectors are suppressed, the simulation method provides a means of illustrating the relative importance of the various paths of influence by which shocks in any sector are transmitted across sectors and over time.

A number of conclusions are drawn from the simulation experiments. First, it is clear that the imposition of a once-and-for-all policy shock has implications for nominal wages and prices which continue for many years; the feedbacks incorporated in the model are sufficiently widespread for repercussions to be felt five and six years after the imposition of the hypothesised incomes policy shock, for example. This raises doubt on the precision of much of the work carried out, using aggregate wage equations, to investigate the impact of incomes policies in the past. This aggregative work typically considered the impact (and possibly some catch-up) effects of policy, but rarely allowed for the long-term effects found here, and was simply unable to capture the important inter-industry feedbacks in its framework of analysis. A second conclusion drawn from the simulations is that indirect, expectation-based feedbacks are in many cases at least as important as actual demand and cost changes. In the simulations, expectations on future aggregate wage change, on aggregate price inflation, and on cost changes are all shown to be influential in the wage and price setting decisions made at the industrial level. And third, the simulations illustrated the difficulties faced in capturing empirically the dynamics of supply side adjustment without employing some degree of disaggregation. Important inter-industry feedbacks were confirmed to exist in wage setting (through wage-wage comparisons and the desire to maintain real purchasing power) and in price setting (through the aggregation of industrial prices into the cost of material inputs). Feedbacks from (un)employment levels, on the other hand, did not show strongly in the estimated model of this paper, although it was confirmed that such feedbacks from the unemployment rate to wage setting that were identified relied on an accumulation of effects over time, as the influence operated primarily through expectations on the aggregate wage level.

4. Overview of the Research and Implications for Policy

In the seventies and eighties, the economic programmes of many developed nations underwent a shift in emphasis away from direct intervention in the economy and towards liberalisation of market mechanisms. In the UK, this shift in emphasis meant that the defeat of inflation was given priority over other policy objectives, and the government advocated, and remain strongly committed to, policies designed to facilitate the free adjustment of the labour market in order to reduce the problem of stagflation. An important element in the justification of this line of argument is the emphasis placed by many neoclassical economists on the informational content of market prices, which underlies the view that government intervention is unnecessary and may even obscure the efficient functioning of markets. One of the primary aims of the project has been to consider, in the context of the analysis of supply side adjustments, whether this argument, and the related policy prescriptions, are valid in an economy with many sectors and in the presence of informational imperfections. Below, we briefly summarise the broad findings of the research project, and then consider the implications of these findings for policy.

The single most important conclusion to be drawn from the work of this project is that expectations formation plays a central role in the process of supply side adjustment. In all of the empirical work examining sectoral wage, price and employment determination, the influence of expected developments taking place outside the sector was shown to be substantial. In the determination of sectoral wages, evidence was obtained for an important role for expectations formation through the wage that is expected to be achievable 'elsewhere'. In sectoral price determination, expectations were shown to be important both through the influence of expected cost of inputs, based on the pricing decisions of other sectors, and through the expected share of aggregate demand, based in turn on expected aggregate price movements, and so on. Further, the analysis of the persistence of shocks to sectoral output also highlights the potential significance of expectations. This work provides evidence that sector-specific shocks are one of the major sources of business cycle fluctuations. While sector-specific shocks are not necessarily related to expectations, one possible candidate for explaining sector-specific shocks are those generated by sectoral misperceptions, as agents in one sector fail to correctly interpret sectoral signals emanating from other sectors due to the presence of information imperfections. In our future research, we are hoping to examine and identify the sources of such sector-specific shocks in more detail.

A second important insight to be obtained from the work of the project is a recognition of the complexity of the process of supply side adjustment. This complexity implies that exacting

informational requirements are made of agents in forming expectations on which to base decisions. For example, the appropriate response of agents to a change in the market fundamentals in their sector depends on knowledge of developments in the market fundamentals taking place elsewhere, and of the nature of behavioural relationships in all other sectors. If there are large costs involved in collecting information relevant to decision-making, agents may rely on particular types of information (such as developments in key sectors of the economy, or simple summary measures of developments taking place across all sectors). Evidence presented in the project on the form of information imperfections suggests that this consideration may be relevant in the UK. For example, estimated equations of the structural form of disaggregated models wage determination that were investigated appeared to outperform the associated reduced form of these models. This may be interpreted as providing evidence that there are influences on agents' expectations beyond those of expectations of changes in the market fundamentals; As a second example, the inclusion of (aggregate) summary measures of sectoral developments generally performed satisfactorily in estimated sectoral relationships (relative to models which include the sectoral developments explicitly)¹⁵; Thirdly, direct measures of expectations indicated that there may be systematic errors made in the formation of expectations of different variables, and that the extent of these systematic errors may be explicable in terms of the informational requirements involved in each case. Further empirical work is required to substantiate these findings, but it is clear from this evidence that information imperfections may play an important role in determining the speed and direction of supply side adjustment, and that policies directed at influencing the form of information imperfections may significantly influence the nature of supply side adjustment.

Associated with the complexities of the interactions between sectors in disaggregated models is the finding that such models will generally involve very complicated dynamic structures. As a consequence, the full impact of shocks will only be felt after a protracted period of adjustment, during which the effects are propagated across sectors, and may be offset or compounded by other shocks. The need for intertemporal decision-making in the presence of adjustment costs further complicates the solution to disaggregated models, increases the informational requirements made on agents, and raises the potential influence of information imperfections in affecting supply side adjustment.

A third important conclusion to be drawn from the project is that an analysis of supply side adjustment cannot be undertaken without explicit consideration of the sectoral structure of the economy. All of the empirical work has provided evidence that there is considerable heterogeneity in

15 Although it was noted also that these summary statistics may have to be relatively sophisticated in order to adequately capture the complexities of sectoral interactions

supply side relationships across sectors, and the inadequacy of aggregate analysis in these circumstances has been illustrated in a variety of contexts. In the particular case of wage setting, some insights were obtained on the source of the heterogeneity, as the responsiveness of wages in the sector to changes in their determinants was shown to depend on the nature of the labour employed in the sector. In this case, it was further illustrated that the evolution of wages in the UK could not be adequately modelled without explicitly acknowledging this heterogeneity and the intersectoral interactions that followed from it.

Each of these general conclusions have implications for the formulation of policy which suggest that some degree of government intervention in the operation of the supply side might be useful in reducing inflation and unemployment rates. The form that such intervention would take may involve introducing new policy instruments which can address the issue of information flows between sectors and bring about the coordination of sectoral responses to shocks. Our work suggests that it might also be worthwhile to re-evaluate the effects of previous periods of supply side intervention on the basis of more disaggregated models; earlier work on these issues has been frequently based on aggregated data, so that estimated models would have been unable to accommodate some of the intersectoral influences shown to be important in our work, and econometric work may have been subject to aggregation biases. Policy conclusions drawn on this evidence may be misleading therefore, and certainly it would be foolish to discount any policy option on the basis of such evidence alone.

The results obtained under in the project suggest that the government may be able to implement policies to improve the process of supply side adjustment through a coordinating role aimed at favourably influencing the process of expectations formation. This may take the form simply of a provider of information, aiming to make the process of expectations formation less subject to the uncertainties that generally surround the flow of information between sectors of the economy.¹⁶ The provision of a credible and widely-available forecasting service by the government would be a relatively simple means of influencing agents' information sets. However, this could easily reduce the detrimental influence of any backward looking element of the process of expectations formation currently important simply because of costs of collecting information. More sophisticated policies aimed at influencing wage setting institutions could also be useful in influencing agents' information sets, reducing the size of the bargaining zone and providing a means by which the wider implications of

16 See also Taylor (1983).

wage setting decisions could be 'internalised' by individual decision makers¹⁷. Moreover, such policies may have useful side effects too, if their effect was not only to improve information flows between sectors, but also to improve the speed of supply side adjustments. There is an argument that the effects of a shock are more likely to persist if the period of disequilibrium associated with the shock is long and protracted. If this is the case, improved dynamic adjustments obtained through more coordination in expectations formation would help improve the resilience of the macroeconomy to recessionary shocks. Certainly, such policies would be useful if they could help to minimise the disruption caused by sectoral misperceptions of the responses of agents to adverse shocks.

The recognition of the heterogeneity in sectoral relationships and of the complexity of intersectoral interactions in supply side adjustment may also form the basis of an argument for an industrial strategy in which policy is designed taking explicit account of structural considerations. The empirical results clearly show that policy measures would have a different impact in different sectors, so that there is a clear case for directing policy measures at areas where they will be most beneficial and where they will be most cost-effective. On the other hand, the complexity of the interactions between sectors means that the impact of a policy implemented in a particular sector is more difficult to assess, and must take into account the adjustments which will take place throughout the economy which are initiated by policy directed at a specific sector. This does not invalidate the argument for structural policies, but it does demonstrate the need for coordination of the policies aimed at promoting employment growth and controlling inflation. While explicit policy prescriptions are beyond the scope of this project, these suggestions, taken with the above discussion on the role of government in influencing information flows between different sectors of the economy, have much in common with the 'indicative planning' exercised briefly in France over the post-war period. This view is also consistent with recent exhortations to unions and employers in the UK to synchronise decision-making, concentrating major settlements in a short period following public discussion between government, employer associations and unions in which the economy's prospects are evaluated.¹⁸

17 Meade's (1981) suggestions for 'almost-compulsory arbitration', for example, could serve this purpose; the provision of guidelines for wage increases, either stated explicitly or inferred from the decisions on disputes taken to the Arbitral body, would provide an important source of information on which to base expectations on current and future developments taking place elsewhere in the economy. Moreover, by identifying the promotion of employment growth as an important criterion by which wage claims would be judged by the Arbitral body, these guidelines would also help internalise the externalities involved in wage setting.

18 See, for example, the agenda for union bargaining suggested in the GMB/UCW's (1991) paper, or the Employment Institute's (1990) Economic Report.

5. Computer Programs and Data Collection

The applied work that was undertaken in the project has been undertaken using the GAUSS matrix programming language or the statistical package **Microfit**. Where possible, the project members are willing to make available for other academic use data sets and programmes employed in the work, including the code used for the calculation of the various test statistics and model selection criteria. The CBI Survey data described in section B above is also available on request from the project members.

6. Continuity

A two year ESRC project on "An Empirical Analysis of Business Cycle Fluctuations in the Context of a Multisectoral Model" has been awarded to the Principle Investigators, M.H. Pesaran and K.C. Lee, to provide an empirical analysis of output fluctuations in a number of industrialised economies, including the UK and US in the context of a simple multisectoral model. This work follows directly from the work of this project, and particularly that described in section A(ii) above, and focusses on the different sources of cyclic fluctuations with particular reference to the role of information disparities across different sectors of the economy.

7. Concluding comments

Economists' understanding of the operation of the supply side of the economy has improved considerably in recent years. However, the reliance on empirical work based at the aggregate level may have obscured some of the detail of the processes of supply side adjustment. An explicit analysis of supply side institutions and the interactions of individuals across industries, occupations and regions seems essential in building a more satisfactory understanding of the workings of the supply side. Further work at a lower level of disaggregation may provide the scope for more imaginative policies to reduce the incidence and severity of stagflation. The work of this project should be viewed as an attempt to encourage research in this direction.

References

- Ashenfelter, O. and Brown, J.N. (1987). Testing the Efficiency of Employment Contracts, **Journal of Political Economy**
- Batchelor, R.A. (1982). Expectations, Output and Inflation: the European Experience, **European Economic Review**, 17, 1-25.
- Bean, C. Layard, R. and Nickell, S. (1986). **The Rise in Unemployment**, Basil Blackwell.
- Blanchard, O.J. and D. Quah (1989), "The Dynamics of Aggregate Demand and Supply Disturbances," **American Economic Review**, 79, pp. 655-673.
- Brown, B.W. and Maital, S. (1981). What Do Economists Know ? An Empirical Study of Experts' Expectations, **Econometrica**, 49, 491-504.
- Bruno, M. and Sachs, J. (1985). **The Economics of Worldwide Stagflation**, Basil Blackwell.
- Calmfors, L. and Driffil (1988). Bargaining Structure, Corporatism, and Macroeconomic Performance, **Economic Policy**, 6, 13-47.
- Campbell, J.Y. and N.G. Mankiw (1987), "Are Output Fluctuations Transitory?" **Quarterly Journal of Economics**, 102, pp. 875-80.
- _____ and _____ (1989), "International Evidence on the Persistence of Economic Fluctuations", **Journal of Monetary Economics**, 23, pp. 319-333.
- Carruth, A.A. and Oswald, A.J. (1989). **Pay Determination and Industrial Prosperity**, Oxford University Press.
- Christiano, L.J. and M. Eichenbaum (1989), "Unit Roots in Real GNP: Do We Know, and Do We Care?", **NBER Working Paper Series**, No. 3130.
- Clark, P.K. (1987), "The Cyclical Component of U.S. Economic Activity," **Quarterly Journal of Economics**, 102, 797-814.
- Cochrane, J.H. (1988), "How Big is the Random Walk Component in GNP?" **Journal of Political Economy**, 96, pp. 893-920.
- Demery, D. and N. Duck (1990), "Are Economic Fluctuations Really Persistent?", **mimeo**, University of Bristol, June 1990.
- Dunlop, J.T. (1944). **Wage Determination under Trade Unions**, Macmillan.
- Employment Institute (1990). **Economic Report**, 5,5.
- Evans, G. (1989), "Output and Unemployment Dynamics in the United States 1950-85," **Journal of Applied Econometrics**, 4, pp. 213-237.

Flanagan, R.J, Soskice, D.W. and Ullman, L. (1983). **Unionism, Economic Stabilisation, and Incomes Policy: European Experience**, Brookings Institute.

Freeman, R.B. (1988). Labour Market Institutions and Economic Performance, **Economic Policy**, 6, 63-78.

Friedman, B.M. (1980). Survey Evidence on the 'Rationality' of Interest Rate Expectation, **Journal of Monetary Economics**, 6, 453-65.

GMB/UCW (1991). **A New Agenda; Bargaining for Prosperity in the 1990's**.

- Harvey, A.C. (1985), "Trends and Cycles in Macroeconomics Time Series," **Journal of Business and Economic Statistics**, 3, pp. 216-27.
- Jacobs, R.L. and Jones , R.A. (1980). Price Expectations in the US: 1947-1975, **American Economic Review**, 70, 269-77.
- Lee, K.C. (1988). Inflation and Labour Market Adjustment: The UK Experience, **Economica**, 55, 409-416.
- Lee K.C. (1990a), Wages, Unemployment and Equilibrium in the Regional Labour Markets of the UK, **mimeo**, Cambridge.
- Lee K.C. (1991a), Modelling Supply Side Adjustment and Changing Industrial Structure, forthcoming in C. Driver and J.P. Dunne (eds) **Structural Change and the UK Economy**, CUP.
- Lee, K.C. (1991b), Formation of Price and Cost Inflation Expectations in British Manufacturing Industries; A Multisectoral Analysis, **mimeo**, August 1991.
- Lee, K.C. and M.H. Pesaran (1991a), An Empirical Investigation of the Role of Sectoral Interactions in Wage Determination in the UK Economy", **mimeo**, September 1991.
- Lee, K.C. and M.H. Pesaran (1991b), An Empirical Analysis of Pricing Behaviour of Firms in UK Manufacturing Using Ex Ante Data, **mimeo**, September 1991.
- Lee K.C. and M.H. Pesaran (1991c), Wage Determination in a Disaggregated Union Model involving Expectations, **mimeo**, December 1991
- Lee, K.C., M.H. Pesaran and R.G. Pierse (1990a), "Testing for Aggregation Bias in Linear Models", **Economic Journal**, (Supplement), 100, pp. 137-150.
- Lee, K.C., M.H. Pesaran and R.G. Pierse (1990b), "Aggregation Bias in Labour Demand Equations for the UK Economy", in T.S. Barker and M.H. Pesaran (eds.) **Disaggregation in Econometric Modelling**, pp. 113-149, Routledge.
- Lee, K.C., M.H. Pesaran, and R.G. Pierse (1991), Persistence of Shocks and its Sources in a Multisectoral Model of UK Output Growths, **Economic Journal**, (forthcoming).
- Leonard, J.S. (1982). Wage Expectations in the Labour Market: Survey Evidence on Rationality, **Review of Economics and Statistics**, 64, 157-61.
- McDonald, I.M. and R.M. Solow (1981). Wage Bargaining and Employment. **American Economic Review**, 71, 896-908.
- Meade, J. (1981) **Wage Fixing**, George Allen and Unwin, London.
- Mills, T.C. (1991), "Are Fluctuations in U.K. Output Transitory or Permanent?", **Manchester School**, LIX, 1, pp.1-11.
- Nash, J.F. (1950). The Bargaining Problem, **Econometrica**, 28, 155-162.

- Nickell, S.J. and Kong, P. (1988). An Investigation into the Power of Insiders in Wage Determination, **Oxford Institute of Economics and Statistics DP**, no. 49.
- Nickell, S.J. and Wadhvani, S. (1990). Insider Forces and wage Determination, **Economic Journal**, 100, 496-509.
- Pesaran, M.H. (1984), Expectations Formation in Macroeconometric Modelling, in P. Malgrange and P.-A. Muet (eds.) **Contemporary Macroeconomic Modelling**, Basil Blackwell, Oxford.
- Pesaran, M.H. (1985), Formation of Inflation Expectations in British Manufacturing Industries, **Economic Journal**, 95, 948-975.
- Pesaran, M.H. (1987), **The Limits to Rational Expectations**, Basil Blackwell, Oxford.
- Pesaran M.H. (1990a), Rational Expectations in Disaggregated Models; an Empirical Analysis of OPEC's Behaviour, **UCLA Program in Applied Econometrics DP**, no 13, March 1990 (Jacob Marhsack Lecture of the Econometric Society, Santiago, Chile).
- Pesaran M.H. (1991a), Costly Adjustment under Rational Expectations, **Review of Economics and Statistics**, 73, 2, 353-357.
- Pesaran M.H. (1991b), Expectations in Economics, in D. Greenaway, M. Bleaney and I. Stewart (eds) **Companion to Contemporary Economic Thought**, Routledge.
- Pesaran M.H. (1991c), Estimation of a Simple Class of Multivariate Rational Expectations Models: A Test of the New Classical Model at a Sectoral Level, **Empirical Economics**, pp. 211-232.
- Pesaran M.H. and R.G. Pierse (1991), Choice Between Disaggregate and Aggregate Specifications Estimated by IV Method, **mimeo**, May 1991, under revision.
- Pesaran, B. and M.H. Pesaran (1991), **Microfit 3.0: An Interactive Econometric Software Package**, Oxford University Press.
- Pesaran, M.H., Pierse, R.G. and Kumar, M. (1989). Econometric Analysis of Aggregation in the Context of Linear Prediction Models, **Econometrica**, 57, 861-888.
- Pesaran, M.H., R.G. Pierse, and K.C. Lee (1991), Persistence, Cointegration, and Aggregation: A Disaggregated Study of Output Fluctuations in the U.S. Economy, **Journal of Econometrics**,(forthcoming).
- Shapiro, M.D. and M.W. Watson (1988), "Sources of Business Cycle Fluctuations," **NBER Macroeconomics Annual**.
- Svejnar, J. (1986). Bargaining Power, Fear of Disagreement, and wage Settlements: Theory and Evidence from U.S. Industry, **Econometrica**, 45, 1377-85.

- Taylor, J.B. (1983). Rational Expectations and the Invisible Handshake, in Tobin. J (ed.) **Macroeconomics, Prices and Quantities**, Basil Blackwell, Oxford.
- Turnovsky, S.J. and Wachter, M.W. (1972). A Test of the Expectations Hypothesis Using Directly Observed Wage and Price Expectations, **Review of Economics and Statistics**, 54, 47-54.
- Watson, M.W. (1986), "Univariate Trending Methods with Stochastic Trends," **Journal of Monetary Economics**, 18, pp. 49-75.
- Wren-Lewis, S. (1986). An Econometric Model of UK Manufacturing Employment Using Survey Data on Expected Output, **Journal of Applied Econometrics**, 1, 297-316.

I. Papers arising directly from the research

- [1] Lee K.C. (1990a), Wages, Unemployment and Equilibrium in the Regional Labour Markets of the UK, **mimeo**, Cambridge.
- [2] Lee K.C. (1991a), Modelling Supply Side Adjustment and Changing Industrial Structure, forthcoming in C. Driver and J.P. Dunne (eds) **Structural Change and the UK Economy**, CUP.
- [3] Lee, K.C. (1991b), Formation of Price and Cost Inflation Expectations in British Manufacturing Industries; A Multisectoral Analysis, **mimeo**, August 1991.
- [4] Lee, K.C. and M.H. Pesaran (1991a), An Empirical Investigation of the Role of Sectoral Interactions in Wage Determination in the UK Economy", **mimeo**, September 1991.
- [5] Lee, K.C. and M.H. Pesaran (1991b), An Empirical Analysis of Pricing Behaviour of Firms in UK Manufacturing Using Ex Ante Data, **mimeo**, September 1991.
- [6] Lee K.C. and M.H. Pesaran (1991c), Wage Determination in a Disaggregated Union Model involving Expectations, **mimeo**, December 1991
- [7] Lee, K.C., M.H. Pesaran, and R.G. Pierse (1991), Persistence of Shocks and its Sources in a Multisectoral Model of UK Output Growths, **Economic Journal**, (forthcoming).
- [8] Pesaran M.H. (1990a), Rational Expectations in Disaggregated Models; an Empirical Analysis of OPEC's Behaviour, **UCLA Program in Applied Econometrics DP**, no 13, March 1990 (Jacob Marhshack Lecture of the Econometric Society, Santiago, Chile).

- [9] Pesaran M.H. (1991a), Costly Adjustment under Rational Expectations, **Review of Economics and Statistics**, 73, 2, 353-357.
- [10] Pesaran M.H. (1991b), Expectations in Economics, in D. Greenaway, M. Bleaney and I. Stewart (eds) **Companion to Contemporary Economic Thought**, Routledge.
- [11] Pesaran M.H. (1991c), Estimation of a Simple Class of Multivariate Rational Expectations Models: A Test of the New Classical Model at a Sectoral Level, **Empirical Economics**, pp. 211-232.
- [12] Pesaran M.H. and R.G. Pierse (1991), Choice Between Disaggregate and Aggregate Specifications Estimated by IV Method, **mimeo**, May 1991, under revision.
- [13] Pesaran, M.H., R.G. Pierse, and K.C. Lee (1991), Persistence, Cointegration, and Aggregation: A Disaggregated Study of Output Fluctuations in the U.S. Economy, **Journal of Econometrics**,(forthcoming).

II. Other papers relating to the research programme

- [14] M.H. Pesaran, R.G. Pierse and M. Kumar, (1989),Econometric analysis of aggregation in the content of linear prediction models, **Econometrica**, 1989.
- [15] M.H. Pesaran and R.G. Pierse, 'A proof of the asymptotic validity of a test for perfect aggregation', **Economic Letters**, 1989.
- [16] T. Barker and M.H. Pesaran (1990), Disaggregation in Economic Modelling -an Introduction, T. Barker and M.H. Pesaran (eds), **Disaggregation in Econometric Modelling**, in Routledge, 1990, p. 1-14.
- [17] K. Lee, M.H. Pesaran and R.G. Pierse (1990a), Testing for aggregation bias in linear models, **Economic Journal** (supplement), pp., 137-150.

- [18] K. Lee, M.H. Pesaran and R.G. Pierse (1990b), Aggregation bias in labour demand equations for the UK economy, in T. Barker and M.H. Pesaran (eds.), **Disaggregation in Econometric Modelling**, Routledge, pp. 113-149.
- [19] M. McAleer, M.H. Pesaran and A. Bera (1990), Alternative approaches to testing non-nested models with autocorrelated disturbances: application to models of U.S. unemployment, **Communication in Statistics: Theory and Methods**, Volume 19, pp. 3619-3644.
- [20] M.H. Pesaran and R. Smith (1990), A Unified Approach to Estimation and Orthogonality Tests in Linear Single Equation Econometric Models, **Journal of Economics**, pp. 41-66.
- [21] V.K. Borooah and K.C. Lee (1991), The Regional Dimension of Competitiveness in Manufacturing', **Regional Studies**, 25, pp.219-229.
- [22] M.H. Pesaran, A.K. Bera and M. McAleer (1991), Joint test of non-nested models and general error specifications, **Econometric Reviews**, (forthcoming).
- [23] M.H. Pesaran and H. Samiei (1991a), Persistence, Seasonality, and Trend in the UK Egg Production, **Applied Economics**, 1991, pp. 479-484.
- [24] M.H. Pesaran and H. Samiei (1991b), Estimating limited-dependent rational expectations models: with an application to exchange rate determination in a target zone, **Journal of Econometrics**, (forthcoming).
- [25] M.H. Pesaran and Hossein Samiei (1991c), An Analysis of the Determination of Deutsche mark/French franc Exchange Rate in a discrete-time target-zone model, forthcoming **Economic Journal**.