Quantitative Economic History at the University of Essex

T. J. Hatton
University of Essex

The fourth meeting of the Quantitative Economic History Group was held at the University of Essex on 3rd and 4th September, 1981. As with previous meetings it was supported with funds from the S.S.R.C. and about forty invited participants, ranging from senior economic historians to postgraduate students gathered to hear and discuss nine papers which had been circulated before the meeting.

The first two papers focussed on the international economy but in different centuries. J.S. Lyons and S.E. Satchell (University of Essex) presented the first paper (co-authored with T. J. Hatton) entitled "Eighteenth Century-British Trade: Home-spun or Empire-made?" They set out to examine competing hypotheses about the role of foreign trade during Britain's industrial revolution and, in particular, the view propounded by Deane and Cole.[1] These authors had argued that, after 1745, the expansion of exports was not a result of external forces because of the relatively closed nature of the colonial trading network; this meant that a large part of demand for British exports depended on what the colonists could earn from the mother country and hence, on British import demand. This was criticised in the light of evidence that the near identity of colonial imports and exports did not hold even before American independence. The inference that the net barter terms of trade deteriorated at times of trade expansion could be drawn from examining the gross barter terms in the manner of Deane and Cole only in the unlikely event that the balance of trade did not vary.

The alternative test suggested was to examine the intertemporal move-

[1] Deane P. and Cole W.A. (1962), *British Economic Growth, 1688-1959*, Cambridge University Press.

ments of imports and exports by using the test for " Granger causality " proposed by Sims.[2] The data for the " official values " of net imports and exports were split into two periods, 1697-1745 and 1746-1800 and filtered to obtain stationary serially uncorrelated residuals upon which the tests were performed. For the first half of the century no causal relationship was found but, contrary to Deane and Cole, the tests showed that exports caused imports in the second half. Re-estimating, using dummy variables in the filters to allow for periods of war, weakened this result but did not produce a causal role for imports.

Lyons and Satchell pointed out certain problems of interpretation: finding a causal role for exports did not distinguish between supply and demand forces but short-run fluctuations were more likely to have arisen on the demand side. Tests using the re-export series yielded the result that re-exports caused imports during the first half of the century and it was suggested that the former may have been important in providing foreign exchange for imports from Europe early in the century. One questioner wondered whether evidence from the North American economy could be used to clarify some of these issues but though recent work pointed to a degree of economic independence for the colonies even before 1776, it was too fragmentary to allow formal tests.

Some members of the audience doubted the validity of the tests as applied to trade flows and called into question the interpretation of the results. Could there have been a third variable such as harvest fluctuations or technical change which caused variation in both imports and exports with different lags to yield spurious causality between them? Lyons responded that, in the absence of enough data for a structural model and in the presence of long lags in information, the tests were appropriate. The harvest hypothesis did not seem to fit with the result obtained and, in any case, the object had been to see if the results were consistent with the view of Deane and Cole which they were not.

The international theme was continued with an examination of the world wheat market in a paper by N. Blake (University of York) entitled " An Explanation of the Long Swing in Wheat Prices, 1870-1913 ". The objective was to examine the factors underlying the " Kondratieff " swing in prices for a single commodity. The Gazette price of wheat was deflated by the Sauerbeck-Statist general price index to abstract from world wide monetary effects to yield a profile of decelerating decline, rather than the decline and rise of the undeflated series. This price index was set in a two equation model of supply and demand:

$$Q = S.P_w^e$$
$$Q = D.P_w^\eta$$

where Q is quantity transacted, P_w the deflated wheat price and S and D are vectors of autonomous shift variables affecting supply and demand respectively

[2] Sims C.A. (1972), " Money Income and Causality ", *American Economic Review*, 62.

The latter consisted of population and income of the industrial " core " countries and the former of average yields, the price of substitutes in production and " autonomous acreage ". The contribution of this non-systematic element in the expansion of acreage under wheat (primarily in North America) could not be observed directly but if the contribution to changes in output of the other shift variables were known, it could be calculated by solving the two equations and converting to rates of change to give:

$$\dot{S} = (1 + \dot{D})\,(1 + \dot{P}_w)^{(-\eta-\varepsilon)} - 1$$

where a dot over the term denotes the proportional rate of change.

It was first necessary to obtain estimates of the elasticities of demand and supply: the elasticities were evaluated using time series regression at 0.3 and 0.5 respectively. Accounting for the sources of price change over three sub period averages, Blake found that over 90% of the changes in growth rates was due to supply factors, dominated by " autonomous acreage ". In the form of frontier development, this caused the rapid decline in prices to the mid 1880's and its retardation as the frontiers were reached, accounted for most of the slowdown to the 1890's. But further increases in capacity due to the diffusion of " dry-farming " had their effects on prices masked as Russian net exports dried up before the Great War. It was therefore concluded that the determinants of wheat prices might be seen more usefully in the context of twenty-year swings in the development of new lands than in any long run logic of a Kondratieff swing.

A number of members of the audience were concerned that the object of the study was somewhat misplaced. Deflating the wheat price index abstracted from the general swing in prices (which, in any case, Kondratieff had not assumed) was the result of the expansion of gold production. It was suggested that the analysis could be applied more readily to arguments over the relative importance of demand and supply shifts during the Great Depression such as those of Phelps-Brown and Ozga who had examined wheat prices in that context.[3]

Questions were also raised about the estimation of the supply equation used to obtain the price elasticity of acreage under wheat which took the form of a distributed lag of current and past wheat and maize prices and formed a component of the total supply elasticity. It was noted that this provided a high degree of explanatory power without serial correlation over the whole period of observation but the elasticity used in the later calculations was based on a truncation of the distributed lag. Hence the estimate of " autonomous acreage " was based on ignoring the effects of prices of more than nine to thirteen years earlier which effectively ruled out a Kondratieff swing explanation. As an

[3] Phelps-Brown E.H. and Ozga S.A. (1955), " Economic Growth and the Price Level," *Economic Journal*, 65.

alternative it was suggested that supply and demand elasticities from studies of more recent periods might be used.

The next two papers turned the attention to industrial performance in different contexts and the first of these was presented by P. Wardley (University of Aberdeen) on "Corporate Strategy and Entrepreneurial Performance within a Cartel: The Lincolnshire Ironmasters' Association, 1895-1913". Wardley argued that an important but neglected aspect of entrepreneurial performance is the art of selling products as well as producing them, a feature largely overlooked in the debate over the failures of the late ninteenth century British economy. This was illustrated in the case of the Lincolnshire Ironmasters Association, a close cartel consisting of five producers dominant in the regional iron market which provided detailed flows of information to its members. Firms accepted forward contracts in the form of orders to be fulfilled at an unspecified future date at a price fixed by the cartel at the time of contract. If they expected prices to rise in the future, they could speculatively postpone contracts by running down their order books and, if a price fall was expected they could attempt to expand them. These positions could be at least partly hedged by altering the rate at which advance purchases of coke were made.

Wardley examined the records of the cartel in the form of key ratios for each firm and the Association as a whole. The ratio of average outstanding orders to monthly production was found to conform to a pattern of seven cycles over the sixteen years to 1911, though the pattern for individual firms differed from the aggregate. A chi-squared test on the rank ordering at turning points rejected the hypothesis that one firm acted as "sales leader" though more positive results were found for the ratio of outstanding orders to deliveries which was interpreted as reflecting differences in the degree of risk that member firms were willing to take. The determinants of the flow of new orders were evaluated in a framework of supply and demand. An estimated regional demand equation gave the expected negative coefficients on the own price variable and positive coefficient or the difference between the prices of Cleveland and Lincolnshire pig iron. Supply equations at the firm level gave positive signs on the iron price and negative signs on coke prices which were similar between firms and gave broad support to the qualitative findings.

A number of participants questioned the interpretation of the ratios and the econometric results. Could the cyclical movement of the ratio of outstanding orders to output be interpreted as evidence of speculative behaviour? This could have been consistent with a variety of underlying behavioural patterns. Could the difference between outstanding orders and deliveries for transport by ship compared to that for rail transport be used as an index of firms discriminating between markets as Wardley had suggested? Some members of the audience wondered if this simply reflected the differences in transport modes and patterns of ordering.

A more general criticism was that the analysis was not explicitly set in

the framework of the theory of the firm and one member suggested that the cartel might be analysed in a model of joint profit maximization. Wardley took the view that the usual theoretical models did not fit the complexity of the objects or behaviour of the firms in the cartel who were satisfiers rather than maximisers. Could this be placed in the context of the debate over entrepreneurial failure? Wardley rejected the usefulness of this debate. British entrepreneurial performance was as good as any but had to be seen in the context of the prevailing institutions in which they operated. The rationality of the cartel was called into question but was difficult to evaluate when the objectives of member firms were complex and diverse.

The evening session was devoted to a paper by J. Ginarlis (Quilter Hinton Goodison and Company) who spoke on "Investment, Profits and Industrialization". His experience as an investment analyst had led him to recognise that economists and economic historians had too often abstracted from the practical aspects of the relation between finance and industry. He did not set out to provide new results from research but to raise the whole question of this relationship across different eras of economic history. The long term decline of Britain's share of world trade and productivity performance relative to her competitors had intensified in the 1970s. Accelerating inflation had made it more difficult to compute real rates of return but by 1980, they had fallen to $2\frac{1}{2}\%$ and as a result the share of profits had fallen to 5% from over 15% in the mid 1960's.

Ginarlis argued that the evidence was conclusive that realised and expected real rates of return determined investment and productivity growth. This had been the reason that nineteenth century investors had accumulated such large foreign portfolios and with the relaxation of exchange controls, present day institutional investors were following suit. Evidence from early canal companies and turnpike trusts suggested that excessive rates of return induced waves of optimism and over-investment which depressed average rates. But the institutional framework of taxes and incentives held back such bursts of investment in the twentieth century even in such important areas as genetic engineering. This was the result of a subtle blend of strangulating controls, intransigent unions and incompetent management.

It was felt among the audience that the paper was provocative but lacked substance. Could the claims be justified with more detailed evidence? Could industry, labour and government be blamed and financiers exonerated? Some critics suggested that more attention should be paid to supply and demand in determining interest rates on loanable funds and for policy purposes to the composition of investment. Ginarlis took the view that funds were available but government deficits had raised interest rates in recent times and that tax incentives had channelled investible funds into housing. One member of the audience, drawing on his own research, suggested that, in the nineteenth century, many profitable opportunities might have been missed because of the lack

of willingness of the U.K. financial sector to spend enough effort in ascertaining the true potential profitability of an enterprise and cited the example of the German banks at this time. Another suggested that when banks had intervened directly in the interwar period, they had failed to take a progressive role. Ginarlis admitted that there had been weaknesses but that banks had recently begun developing a new system with regional managers taking over some of the functions of branch managers and specialising in industrial finance.

The next two papers on the following day focussed on the implications of economic policy in different historical settings. M. Thomas (Nuffield College, Oxford) presented a paper entitled " The Liberal Reforms and the Distribution of Income, 1906-10 ". The redistributive effects of the Liberal budgets introduced by Lloyd George were evaluated using first a partial equilibrium and then a general equilibrium approach. The first step was to estimate the underlying household income distribution for the period using the 1906 Wage Census, information from the Select Committee on Income Tax (1906), a report of the British association for 1909 and the 1911 Census of Population. This yielded a Gini coefficient of 0.519, somewhat larger than Bowley's estimate. The change in the direct tax schedule between 1907 and 1910 gave an estimated increase of 6% in the degree of progressiveness (as measured by the income elasticity of the tax function) but to analyse the effects of indirect taxes, demand functions for different categories of goods were needed. Engel curves were derived from data or household budgets for 1890-1 and, using these functions, the degree of regressiveness of indirect taxes was reduced by an estimated 3% between 1906 and 1911. Taking benefits as well as taxes into account, the total (partial equilibrium) effect was to reduce inequality, significantly raising the Gini coefficient by about 8%.

The general equilibrium approach was implemented in the framework of a social accounting matrix which interlinked factor rewards and their distribution with expenditure and production in order to allow each to vary and interact endogenously. The data base on household income and expenditure distribution was supplemented with information on the industrial distribution of factor shares, an input-output table derived from the 1907 census of production and a matrix to convert industrial outputs to commodities. This was implemented for two factors, ten income groups, seven commodities and eleven industries which, including exogenous accounts, gave a 32 x 32 matrix. The impact of the tax changes was made operational through the matrix of transfers between income groups. The system exhibited some tendency towards compensatory changes, the effect of the 1906 reforms reducing the (10 income class) Gini coefficient by 6% and a reversal in 1910 increasing the Gini coefficient by 4%.

Thomas noted certain qualifications to his results: that the fixed price model ruled out shifting the tax burden via price changes and, given that there was no supply side to the model, unemployment of factors had to be assumed.

One member of the audience suggested that this might be an important disadvantage especially in export industries such as mining and textiles. Asked about the macroeconomic effects of redistribution, Thomas replied that, in his model, a transfer of £1 from the rich to the poor would lead to a £0.08 increase in imports. The compensatory changes referred to earlier, appeared to arise from the fact that low income groups demanded commodities such as foodstuffs whose production generated a high share of non-labour income. Another member suggested that, if primary commodities were traded on world markets, a rise in demand might spill over into imports without stimulating domestic production.

On a more general level, some participants thought that evaluating the Liberal reforms as purely redistributive measures obscured the fact that one motive for introducing them was to increase the aggregate tax yield to cover expenditure commitments. On the other hand it was felt that the model could be extended to evaluate the distributive effects of a range of counterfactual policies such as a wealth tax which Thomas had suggested would have been a more effective redistributive measure.

The next paper was delivered by L. Hannah (Business History Unit, London School of Economics) on " Capitalism v. Socialism: An Empirical Investigation of the Electrical Utility Industry in Britain ". The object of the paper was to compare the efficiency of public and private enterprise when operating under similar market conditions. Available data on electric utilities compiled by the electricity commissioners for 1937/8, prior to nationalisation, provided a sample of detailed information for 600 stations which comprised a mixture of private companies and municipally owned enterprises. With the establishment of the National Grid, the Central Electricity Generating Board acted as a wholesale purchaser and, with prices based on variable cost, it gave preference to least cost stations. Under these conditions evidence of relative efficiency from the " survivor technique " favoured the private companies since their share of output during the 1930's rose from 35% to between 42% and 44%. Electricity was subsequently sold back to the companies whose retail prices were free to reflect differences in demand patterns and costs of distribution.

Hannah specified a cross-section regression equation with average distribution costs depending on the proportion of output sold for domestic cooking, heating and lighting, the percentage sold as industrial power, average sales per consumer, population density, scale and capacity utilisation variables and a dummy variable for company ownership. Though some of these took perverse signs or were insignificant, the overall explanatory power was high and the coefficient on the dummy variable suggested that average company costs were higher by some 28% due to ownership alone. A similar equation explaining capital stock per unit sold indicated that company costs were higher by a similar proportion. The relative inefficiency of the companies in distribution as compared to that in production was thought to reflect the response of companies to demand

conditions which were competitive for output and monopolistic for distribution. Equations for price indicated that the mark up on costs for companies was 12% of their average price higher than municipalities but in household supply alone the differential was three times as great. This was interpreted as reflecting the desire of local councils to cultivate householders' votes by holding electricity prices down.

A large part of the discussion centred around the adequacy of the data, the interpretation of the results and the appropriate specification of the equations. There was concern that written down values of the capital stock used would reflect different accounting practices between the two sectors which might bias the capital per unit equation. Neglect of the different ages of capital might have affected the cost equations but this would not apply to the distribution cost equation since these costs consisted mainly of wages. One participant suggested that this raised another difficulty — that of separating the costs of maintaining the distributive network from those of extending it which would be capital costs not operating costs. It was suggested that this might be overcome by defining the variables to represent specific components of costs.

Another questioner wondered whether the perverse sign on the population density variable might reflect locational advantages outweighing the extra trasmission cost in rural areas — a point which the author had explored but he had not found a separate rural/urban variable to be important. A related question was whether the extent of geographical monopoly within the area could have affected generating and distribution costs differentially through the choice of location. Hannah replied that he had found that the costs and benefits of moving out of urban centres were roughly offsetting in the interwar period.

Changing both the theme and the format of presentation, Jim Oeppen (Cambridge Population Group) spoke on " The Derivation of the Population estimates in Wrigley and Schofield's ' *The Population History of England 1541-1871: A Reconstruction* ' ". This was both a preview of the book shortly prior to publication and a more detailed explanation of the method of estimating population by back projection. Using estimates of aggregate births and deaths, a benchmark of population in five year age groups from the 1871 census and age specific mortality and migration schedules, the English population was simulated backwards in quinquennial steps by adding back deaths and migration and subtracting births. The fertility and mortality rates so obtained were then used in subsequent iterations to reach final estimates of these rates, migration, population and its age distribution as far back as 1541. Comparing the resulting rates of growth of population with the growth of Phelps Brown and Hopkins' index of real wages suggested that population could grow at an annual rate of 0.5% before real wages would fall.

Oeppen examined some of the problems inherent in the method. Adding back deaths of those aged 90-94 was a critical factor in the overall results and became more hazardous beyond 95 years from the original census. The pro-

gramme generated a migration series from the computed birth and death rates but the age distribution which conformed to a fixed schedule would feed back on to age specific and hence aggregate birth and death rates. The English lifetable used to generate transition proportions conformed to the "North" type while before the late seventeenth century, the "West" type would be more appropriate.

The system was subjected to a variety of different tests including estimation on different populations and simulating the effect of large shocks. Estimates of Norwegian and French populations using "North" and "West" models respectively and of Finnish population using both, were all close to census or official estimates of population totals but the migration flows compared less favourably with available data. The model tended to smooth the migration series though the cumulative totals were similar — a finding illustrated with the populations of single cities such as Stockholm. The introduction of a large shock caused a damped response in the simulated system, probably due to lack of adjustment in the age specific vital rates but convergence to the long run path would eventually occur.

A number of questions were raised about the assumptions for migration which, it was felt, might be supplemented with other available information. Several members of the audience thought that the lack of distinction between males and females was a serious shortcoming since the impact of any imbalance on fertility would not be taken into account. This would be particularly serious at times when emigration, which was known not to reflect the sex composition of the population, was an important component. Oeppen expressed the intention of extending the model to include marriage and to examine the transition from the stage when it dominated fertility to the stage when fertility became controlled within marriage.

Turning to the popular topic of economic policy between the wars, M.E.F. Jones (St. Antony's, Oxford) spoke on "Regional Unemployment and Policy in the 1930s: A Preliminary Study". He noted the intimate links between the decline of the old staple industries and the rise of new industries and the dispersion of regional unemployment rates and addressed the question of whether new industries could have been effective tools for regional policy and which type of industry had the greatest potential for such policy. The regional employment multiplier was defined as $\sum_{i=1}^{m} e_{ij}^{R}$ where e_{ij}^{R} is, for region R, the amount of employment generated in industry i by a unit increase in employment in industry j. This was defined as:

$$e_{ij} = r_i k_{ij} l_{ij} (E_i/E_j)^N b_{ij}$$

where r_i represents 'for industry i' the regional purchase coefficient and k_{ij} the proportion of output used in j nationally. l^{ij} and b_{ij} represent respectively

the regional, relative to national, labour/output ratio and material/labour ratio in j for inputs from i, and $(\acute{E}_i/E_i)$ employment in i relative to j nationally.

The information needed to compute these multipliers for one region (the North East special area) was derived for 1935 from Barna's national input-output tables and regional details from the census of production. Calculated regional employment multipliers were found on average to be larger for the " Old ", " New " and " Building " groups than for the " Diverse " group of industries. The results suggested that, insofar as Special Areas policy was designed to promote employment in diverse industries, it was misplaced. A detailed analysis for new industries corroborated the findings of a national aggregate study presented to an earlier meeting of the group by G. N. von Tunzelmann. The size of the regional multipliers suggested that incentives to firms would have been preferable to job creation through industrial transference of workers.

Jones noted several deficiencies in the calculation of the multipliers notably by the in-built over-estimation of the regional purchase coefficients but pointed out that since the totals only represented the first round impacts, they would exclude the local expenditure effects. Several members of the audience suggested that calculating the employment effect of financial subsidy to different sectors might have been more useful in evaluating the efficacy of alternative policies. This would require taking into account all taxes and benefits on the region and induced interregional flows which would require extending the model to other regions.

Other members suggested that blaming the Commissioners for misconceived policies was aiming at the wrong target since ultimate responsibility for financing such schemes lay with the Treasury. Jones responded that this would underestimate the influence of the Commissioners and further, that it was still valid to examine actual policies relative to a set of alternative potential policies even though the chance of the alternatives being adopted was small. Even this might be undermined, however, if it would not have been practically feasible to implement the alternative policies as one member of the audience suggested.

The final paper was presented by R. Floud (Birkbeck College, London) on " Heights among London's Poor, 1770–1850 " (co-authored with K. Wachter). The starting point of the study was a unique set of data obtained from the records of the Marine Society, a charitable organisation established to take in poor boys, aged 13 to 16 and prepare them for a life as seamen. There were a total of 47,000 recruits whose heights and ages were recorded at the time of entry and the most striking pattern revealed in the data for heights at each year of age was an abrupt rise, between 1815 and 1820. One critical problem was the " selection bias " imposed because of the minimum height standards enforced by the society which led to a short fall at the lower tail of the height distributions, particularly in the younger age groups. This minimum rose from 51 inches to 57 inches over the sample period. A number of methods were used to over-

come this including the " Quantile Band Estimator " where segments of the observed distribution were matched to the area under segments of a normal distribution and the lower tail inferred from the fitted distribution. The results suggested that the increase in average heights of 5 inches was a jump of nearly 5 standard deviations. Other evidence from the sample, such as literacy and father's occupation, indicated that this could not be ascribed to a change in the composition of the population from which the samples were drawn. The average heights measured after 1820 were consistent with evidence from other populations but those before 1815 were unusual and reflected an extremely deprived population.

This raised the issue of the precise connection between heights and living standards. Floud argued that the weight of evidence from other studies suggested a strong link between height and nutrition, especially during adolescence when its effects on growth are particularly sensitive. The effect on adult height would be smaller since a period of retarded growth induced by poor nutrition could be compensated by a later spurt in growth when nutritional standards improved. Given the closeness of this relation, heights might be viewed not merely as corroborative evidence of improvements in living standards but as more direct evidence than inherently imperfect measures of real wages, since they would also reflect changes in the degree of physical exertion and possibly in the incidence of smallpox. Although the movements of Tucker's real wage index (excluding rent) for London artisans did not follow that of average heights exactly, both series exhibited the sharp improvement between 1815 and 1820.

In the discussion a number of questions were raised by one questioner about the usefulness of the Tucker index for comparison since, owing to the component series used, the index could be too volatile, a concern underlined by the decline of the index after 1840. In addition, the budget weights used in the index were for artisans and would not be appropriate to the poorest section of London's population. The authors, however, had preferred a London index to alternative national indices in the face of uncertainty about regional price variations.

Another member of the audience expressed serious doubts about the procedures used to correct the samples for selection bias because the adding back of missing observations would not eliminate the effect of truncation. Without more firm evidence on the mean of the underlying distribution, this was thought to be hazardous procedure, a doubt supported by the close correspondence between the minimum heights observed the means computed.

This was especially important after the Napoleonic wars when minimum observed heights rose by 4 to 5 inches. In response Floud maintained that sufficient information on the slope of height distribution was available to draw the necessary inferences and several different methods had produced similar results.