



THE UNIVERSITY  
OF ASTON  
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## **ECONOMICS ALL-STARS**

**v.**

## **REST OF THE WORLD**

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INAUGURAL LECTURE

*By*

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25th October 1973

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## ECONOMICS ALL-STARS v REST OF THE WORLD

Writing an Inaugural Lecture is a difficult business. Professor John Wood of the University of Birmingham once defined the requirement of an inaugural lecture as “to entertain one’s colleagues’ wives while not appearing a fool to one’s colleagues.” This summarises the dilemma rather well, but I am not sure that it is quite correctly stated. If one’s colleagues’ wives are keen enough to attend then they want something more serious than entertainment – they want to know what the subject is all about. One’s colleagues, on the other hand, know only too well what it’s all about – they’re only here for the digestive biscuits.

Either way, it seems that my duty is to entertain. If, in the process, my colleagues’ wives perceive some indications of the way in which economists think, or of the contributions which economists have made, are making and can make in the future in solving a few of the problems facing us, then perhaps their visit will not have been entirely in vain.

I suppose that at one time or another we have all selected our “all time greats” team to meet an unspecified team of opponents. For footballers, Pele at inside left, Brian Clough at centre-forward, Alf Ramsey right-back, and so on: the sort of team that could only be found in the pages of the *Hotspur*, or in the colours of the Wisbech Methodists Football Club.

It struck me that it would be rather interesting to compose a team of all time great economists and to examine some of the characteristics of their play which may be expected to contribute to the team’s success. My own team is a British team; I leave it to others to pick a team for the Rest of the World. You may want to choose eleven different players called Samuelson: in a Washington bookstore I recently came across a whole shelf of Samuelson’s *Economics*, 8th Edition. Inserted in the midst of them was a small volume entitled “The Living Bible (paraphrased)”.

As for ground rules, the game consists in solving economic problems. This is a game which is played remarkably like association football. The problems are assumed to involve, broadly speaking, applied industrial economics – that is, including market structure, conduct and performance, cost benefit analysis and public economics, but excluding areas such as monetary policy, international and development economics. This explains the omissions from the team of John Maynard Keynes and Edward Heath.

I shall attempt, then, to select a team of all star players to illustrate the applied economist at work. It seems appropriate (especially to those who are concerned about the frivolity of this undertaking) to provide a frame of reference for this selection. I shall begin with a piece of work which may be interpreted, if one wished to be sensational, as arguing that the market economy as we know it in England might well not last out this century. I then consider three questions: first, how does the market

economy work? Second, are there forces within the market economy, known as "externalities", which render the market economy inadequate? Third, what rules of operation would we envisage if we attempted to supplant the market economy? This will conveniently lead us to a prediction of some future developments in economics, and to some comments on the adequacy of present economics curricula, both of which I believe are mandatory at an occasion such as this.

As a final warning before we get underway, let me emphasise that I do not have the time, nor in fact the breadth or depth of knowledge required, to give a thorough analysis of the market economy and the contributions of each economist. All I can hope to do here is use this concept to give some rough coherence to my selection.

I begin with possibly the soundest midfield player in Britain today, a man who consistently provides reliable support for the forwards. However, his latest work holds such promise for goals that I shall play him in the attack. I refer to Professor Sig Prais, whose numerous studies are models of painstaking collection and classification of data, careful reasoning and judicious statistical analysis. His latest work shows essentially that concentration in British industry has increased, is increasing and is likely to continue to increase. In 1909 the one hundred largest companies accounted for only 15% of net manufacturing output; by 1970 this share had risen to 50%. If current trends continue it will be nearly three quarters by 1984 and around 90% by the turn of the century\*. Professor Samuels in his Inaugural Lecture last year might well ask "where will it all end?".

Prais has provided a most elegant statistical model to describe these data. Two forces are operating simultaneously. First, the very fact that firms grow at different rates will cause concentration of output in the top 100 companies to increase. This first element explains about two-thirds of the historical pattern. Second, the trend may be accentuated or countered according as large firms tend to grow at a faster or slower rate than smaller ones. From 1885 to 1939 large firms grew slightly less fast than smaller ones, but not by enough to stop concentration increasing; from 1939-50 they did grow sufficiently slowly to reduce concentration; but since 1950 large firms have in fact been growing faster than small ones, causing an unprecedented increase in concentration.

The problem is therefore clearly posed. What is it that explains the relative growth rates of different sizes of firms? Is the difference, as Prais asks, "attributable to identifiable real factors in the economy, such as production economics of scale, or to changes in the supply of capital to industry (resulting, for example, from higher estate-duty rates in the post-war period, or the growth of insurance and pension funds and their impact on the capital market)"?\*

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\* Financial Times, 21 March 1973

\*\* S J Prais "The growth in industrial concentration: A theoretical excursus" privately circulated 21 Mar. 1972, p.18.

This is just part of the more general question of what determines the organisation of industry – that is, the way in which the activities undertaken within the economic system are divided up between firms, including government organisations. This is a central and yet neglected problem in our discipline; it is currently being tackled by a number of American economists, notably Alchian, Demsetz and Stigler.\*

To my knowledge, no-one in Britain is interested in it. Luckily for our team, the fourth major figure in this research is a man who lives in Chicago, but in fact was born in Liverpool.\*\* I shall introduce him later.

First, let us go back to examine the nature of the market economy. Why is it that we have an economy at all? Why doesn't everyone produce what they need themselves? The answer is well known: it was given long ago by the 250 year old veteran of our team. If above all the goalkeeper of our team must be completely reliable and inspire confidence, then Adam Smith is our man. It is remarkable that his book "The Wealth of Nations" provides a comprehensive *theoretical* framework for economics, and yet there is scarcely a paragraph which is not illustrated by reference to, say, the conditions of work in Scotland or the practices of employers in Italy, and so on.

His story of the pin factory is surely world famous, but well worth repeating. According to Smith, a workman not educated to the trade of pinmaking could scarcely make one pin a day, certainly not twenty.

"But in the way in which this business is now carried on, not only the whole work is a peculiar trade, but it is divided into a number of branches of which the greater part are peculiar trades. One man draws out the wire; another straightens it; a third cuts it, a fourth points it; a fifth grinds it at the top for receiving the head; to make the head requires two or three distinct operations; to put it on is a peculiar business; to whiten the pins is another; it is even a trade by itself to put them into the paper; and the important business of making a pin is, in this manner, divided into about 18 distinct operations."†

Smith calculates that ten men could thereby manufacture 48,000 pins per day.

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\* eg. A A Alchian and H Demsetz, "Production, Information Costs and Economic Organisation", *American Economic Review*, Vol.LXII, No. 5 Dec. 1972 pp. 777-795. G J Stigler "The Division of Labour is Limited by the Extent of the Market", *Journal of Political Economy*, Vol.LIX, No. 3, June 1951.

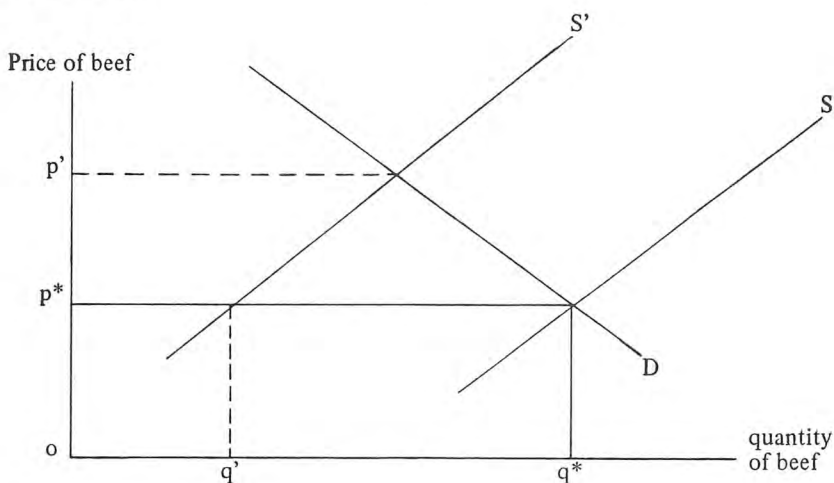
\*\* R H Coase "The Nature of the Firm", *Economica* Vol. 4, Nov. 1939 pp. 386-405 and "Industrial Organisation: A Proposal for Research" reprinted in V R Fuchs (ed) *Policy Issues and Research Opportunities in Industrial Organisation* pp. 59-73, NBER, New York 1972 (paper originally presented 5 Nov. 1970 in Chicago, Ill.)

† A Smith, "The Wealth of Nations" Book 1, Ch. 1.

These are the benefits of the division of labour. In order to attain these benefits, it is necessary to have a market where products can be exchanged. Now we may find different products, or different stages of manufacture, whether it be of pins or motor cars, linked via the market, or instead directly controlled by a single firm. Which we find will depend upon a number of factors, not least the costs of operating a market compared to the costs of operating a firm. Of such costs, we know very little as yet. Strangely, economists have not been much concerned with the question of where the market ends and where the firm begins. They have seemingly been content to explain how it is that an unsupervised market is apparently able to organise itself to do the work of a firm or of a government control body.

The key to this organisation is surely to be found in the man-in-the-street's definition of economics as "supply and demand". Who better to explain this than Alfred Marshall – or, as they say on the terraces, Al-fred-Mar-shall. He is an old favourite of the crowd; for comprehensiveness he is probably not excelled; "It's all in Marshall", they say. He shall be our sweeper.

Let us illustrate Marshall's partial equilibrium analysis\* by asking: Why are they eating horsemeat in Detroit? Let us construct supply and demand curves  $S$  and  $D$  in the US beef market. From the geometric representation popularised by Marshall, we are immediately led to the notion of the equilibrium price ( $p^*$ ) at which supply equals demand, equal to  $q^*$ .



(Incidentally, the popularisation of geometric constructions is surely one of Marshall's important contributions to economics. It is difficult to over-estimate the insight which they give. At the same time, it is arguable that

\* A Marshall, *Principles of Economics*, Macmillan, 1st ed. 1890 8th ed. 1920, Macmillan.

economics has been severely distorted towards the analysis of problems in one or two variables which can be represented geometrically on a two-dimensional graph. I shall comment briefly upon this later.) Back to the beef market. Suppose that increasing costs cause the supply curve to shift upwards to  $S'$ , consequently the equilibrium price rises to  $p'$ . But suppose also, as in the United States recently, that the government imposes a price ceiling equal to the previous equilibrium price  $p^*$ . What do we expect to find? The supply of beef  $q'$  at that ceiling price will fall short of demand  $q^*$ ; shortages occur and shops run out; restaurants specialising in beef steaks close down; cuts of beef appear that were previously unheard of (and consequently have no price ceiling); cattle rustling is reported again; the "Canadian connection" is forged whereby beef is exported, processed and reimported at unrestricted price; the price of pork and chicken doubles as demand switches to substitute meats; and finally, a gentleman in Detroit sells 10,000 lbs of horsemeat on the first day of sale.\*

The market economy is based upon exchange. Horsemeat will be produced and sold if and only if the butcher correctly anticipates that there will exist a buyer who will offer something in return which the buyer values less than the horsemeat, but which the manufacturer values more. Can we therefore argue that a market economy is an efficient means by which society compares benefits with costs, compares alternative uses of its resources and thereby decides upon its preferred pattern of production and consumption? In this question we take as given three things: First, the legal system which in this case prohibits the exchange of beef at certain prices; second, the initial distribution of income within society which one may believe should be changed; third, the freedom of individual choice allows some people to choose horsemeat whether other people think this desirable or not. Leaving these three issues aside, is the market efficient?

At least two reasons have been put forward to believe it might not be. First, as Prais' evidence emphasises, economics of scale might dictate firms so large that they would dominate their respective markets, thereby acquiring the power of monopolists to restrict output in order to increase profit. It is an interesting question whether in fact monopolists actually *do* restrict output rather than devise discriminatory pricing schemes to increase their income from a level of output approximately equal to the competitive level. Nationalisation is one remedy often applied for this disease; whether the patient is better off under this treatment is not really known: another area calling for research. We shall examine later the policies suggested for such nationalised undertakings.

The second possible deficiency of the market mechanism was argued most enthusiastically by Marshall's disciple and successor, Arthur Pigou. I shall include him in my team for his wide-ranging analysis of industrial problems, with their particular emphasis on the social spheres of welfare,

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\* *Newsweek*, 6 August 1973.

distribution and wages\* which have been largely neglected by economists until the last few years, when Atkinson and others have revived interest in them. Nonetheless, it would seem that his play is now suspect; as a full-back, he has had the ball pushed past him rather too often recently, as we show in a moment, and he will need to be seriously reconsidered for next season.

Suppose the production of horsemeat involves emitting nasty smells, a form of air pollution. This is a so-called external diseconomy. Then the private cost to the butcher, which will be compared with the benefit to the purchaser, constitutes only part of the cost to society, for it ignores the discomfort of pollution imposed on householders living near the slaughterhouse.

Pigou suggested a way of bringing these external costs into the reckoning; in this case it would imply setting a tax on production of horsemeat equal to the cost of the pollution discomfort. Then the slaughterhouse would continue to operate if and only if the butcher were able to pay a tax set at the level required to compensate the householders for the smell. Rather than banning the production of horsemeat at this location altogether, the government is helping the market to decide whether the benefits of production in that particular location do or do not outweigh the "external" costs of pollution.

Let us digress for a moment to consider an application of this theory to the problem of traffic congestion. A certain amount of congestion is inevitable, a price which commuters are prepared to pay in order to travel by car. But in making this decision a person considers only his own time, expense and discomfort; he does not consider the fact that, by adding to traffic congestion, he actually *increases* the discomfort of others, by only a small amount for each person to be sure, but by a sizeable amount in aggregate. This is precisely an example of an externality, of a divergence between the private cost to the individual and the cost to society. In effect, roads are underpriced at peak hours, and this underpricing leads to excessive usage. Following Pigou, a congestion tax could be imposed to remedy the situation.

The contribution of Professor Alan Walters was to actually compute what levels of taxes would be required.\*\* By combining econometric estimates of the relationship between traffic speed and volume of traffic together with estimates of motorists' cost functions, Walters was able to calculate that, for the majority of urban roads in the USA, a fuel tax of the order of 33 cents per gallon would be appropriate, compared with the existing level of 10 cents per gallon. For two specific facilities better data were available. The charge for the Lincoln tunnel in New York was then

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\* A C Pigou, *The Economics of Welfare*, Macmillan, 1st ed. 920, 4th ed. 1952.

\*\* A A Walters, "The Theory and Measurement of Private and Social Cost of Highway Congestion", *Econometrica*, Vol. 29, No. 4, Oct. 1961.

50 cents regardless of time of day; this amount was calculated to be too high for low traffic volumes but for the majority of traffic it was too low. The charge for using the Merritt Parkway worked out at only one cent per mile then, whereas something of the order of 14 cents per mile was called for during peak hours.

Walters' paper stimulated considerable interest. In Britain, a government committee was set up in 1964\*. It estimated that a system of congestion taxes could yield benefits of between £110–150 m per year. The appropriate level of tax would depend upon the traffic speed attained; for Central London, where 20 mph were feasible the appropriate tax would be 5 old pence per mile; at 10 mph about 40 old pence per mile; at 5 mph over £2 per mile.

Nowadays, every ministerial speech on transport contains a reference to traffic congestion taxes\*\*; I believe they are looking for a suitable town to experiment with.

Walters' paper clearly constitutes a splendid goal, so I choose him as my first striker, probably playing on the right wing.

Now let us consider the problem of beekeeping. The textbooks consider that apple growing and beekeeping provide a perfect example of external economies†. Increasing the production of apples provides more food for bees, so presumably more honey. Likewise, more bees provide better fertilization for the apple-blossom, hence a bigger crop of apples. But if the fruit grower cannot charge the beekeeper for the food which the bees obtain, then the grower will have no incentive to consider the bees in deciding on his level of apple production. Similarly for the beekeeper. The production of both apples and honey will therefore be less than would yield maximum joint profit. In order to remedy the situation subsidies for both beekeeping and apple growing would appear to be in order, in amounts which could presumably be decided if the relevant technologies were investigated in detail.

Professor Cheung†† of Chicago has recently destroyed this argument. Contractual arrangements between fruitgrowers and beekeepers have long been common in the United States and indeed in England. The beekeeper locates his hives wherever a fruitgrower is willing to pay him enough to cover the cost of the hives net of the value of the honey. The fruitgrower, in turn, knowing that the bees forage only within about twenty-five yards of

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\* Ministry of Transport (R J Smeed, Chairman) *Road Pricing: The Economic and Technical Possibilities*, London HMSO, 1964.

\*\* eg. A speech at Conservative Party Conference, October, 1973.

† J E Meade, "External Economies and Diseconomies in a Competitive Situation", *Econ. Journal*, Vol. 52, p. 54, 1952.

†† S N S Cheung "The Fable of the Bees: An Economic Investigation" *J. Law & Econ.* Vol. XVI, No. 1, April 1973, pp, 11–34.



their hive, is willing to pay up to the value of the extra pollination which the hive engenders. In Wisbech (England) the current rate is about £3.50 per hive per year.

The fact that there exist property rights in the services of the bees, which can be transferred from the beekeeper to the fruitgrower, means that the market is *not* in fact inadequate because of the existence of externalities. We can be assured, therefore, that growth of British GNP is not being held back because of a failure to subsidise beekeepers.

The importance of recognising transferable property rights as a solution to the externality problem was first argued by Professor Ronald Coase of Chicago, whom I have referred to earlier\*. Let us apply this idea to the horsemeat case.

The reason why the market is inefficient, and why corrective taxes appear to be necessary, is that the butcher has no incentive to take account of the smell which his slaughterhouse generates. But suppose that every householder had a legal right to clean air (somehow defined) – a right, moreover, which was transferable. Then in order to operate his slaughterhouse the butcher would have to buy the “clean air right” from all the neighbouring households. He would have to compare these “clean air costs” with the increased transportation costs of locating out of town, and choose whichever location had the least *social* cost. The market is thereby made efficient by defining property rights rather than by applying corrective taxes.

But this by no means the end of the story. To Coase is due a much more penetrating observation, the so-called Coase Theorem. This states that, in the absence of transactions costs, an efficient allocation of resources will be obtained *regardless of the initial distribution of property rights*. In other words, if householders initially had no clean air rights whatsoever, so that the butcher had the right to pollute the atmosphere, then exactly the same decision would be arrived at concerning where to locate the slaughterhouse, as if householders *did* have the right to clean air. In the one case the householders would have to decide whether or not it was worth their while to pay the butcher *not* to pollute, whereas in the other case the butcher would have to buy the right from the householders. In either case the highest bidder would win the property right.

We should emphasise that the *ultimate distribution of benefits* is obviously not independent of the initial distribution of property rights. The householders would much prefer to be compensated themselves than to have to compensate the butcher. The theorem, however, refers to the *ultimate allocation of resources*, to the question of where the slaughterhouse will be allocated.

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\* R H Coase “The Problem of Social Cost”, *Journal of Law and Economics*, Vol. III, Oct. 1960, pp. 1–44.

The significance of this work is as follows. For a whole variety of pressing environmental problems, involving air and water pollution, automobile and aircraft noise, destruction of scenic beauty and historical monuments, for all these problems we now have in principle a third option open to us. The first option is to pass a law to ban or legalise the action in question; the second is to tax or subsidise it; the third is now to establish property rights in order to make the action subject to negotiation and bargaining. Instead of bypassing the market, or distorting the market in the hope of counter-balancing an existing distortion, we can now attempt to remove the distortions by helping the market to operate more effectively.

This raises a whole new set of questions which one hopes will be of concern to lawyers as well as to economists. When is it feasible to set up a system of property rights? Or, to take a more economic approach, when do the benefits of an admittedly imperfect set of property rights exceed the costs of establishing and enforcing them, and exceed the net benefits of some other form of solution? How are property rights presently established? What legal framework is likely to minimise the costs of enforcement and exchange between interested parties?

For example, would it be sensible to give each household the right to a noise-free environment, and to require the British Airports Authority to locate its third London airport and its low-flying corridors wherever it could most cheaply purchase permission? How high would the price have to be before "noise speculators" would start buying up tracts of air space in order to resell it for airports? Would this not be an effective way of compensating airport communities, as well as an efficient way of locating the airport? Surely the market mechanism can be utilised in some way to generate more efficient and equitable solutions to environmental problems than those presently achieved.

Every team needs what is euphemistically called a "ball-winner": someone who can not only intercept loose balls but also dispossess opponents. My own team has two such men, the first of whom is Professor Coase. To him must go the credit for first pinning down this weakness in Pigou's theory of externalities, and for setting up the counter-attack based upon the theory of property rights.

So much for externalities. We turn now to the final question originally posed. If economies of scale justify larger and larger firms, then it is not unlikely that in some areas they will justify a single firm for the whole economy, especially when that economy is relatively small, as it is in Britain. For many people, government ownership or control becomes necessary. We do not have time to discuss here whether performance of nationalised industries warrants this policy. We shall concentrate instead on methods which have been suggested by economists for use by governments in making their pricing and investment decisions.

In 1955 a team from the Road Research Laboratory and the University of Birmingham began to investigate the costs and benefits of building a

proposed motorway for about 60 miles between London and Birmingham.\* The aim was to estimate a consumers' surplus rate of return for this project, to see if the investment was worthwhile. In 1960 it was concluded that the rate of return would lie between 10% and 15%, so that the investment would be justified – rather fortunately, for the M1 had been opened a few months earlier.

Now the whole point of the motorway was to reduce travel time – in fact, time savings accounted for about three-quarters of the gross benefits. But how do you value time? The research team assumed that business travel was valued at average industrial wage, but that non-business time was valued anywhere between 2/- and 10/- per hour. The actual value might not have mattered in the case of the M1, but subsequent borderline proposals were bound to arise in which the value attached to time savings would be crucial. It is probably no exaggeration to say that the recommendation of the Roskill Committee that the Third London airport be built at Cublington stands or falls upon the precise valuation of time savings.

Clearly, some empirical work needed to be done, and indeed it was. I have in mind the imaginative analysis carried out by my second striker in the team, Michael Beesley\*\*. In 1963 some 2,500 civil servants at the Ministry of Transport were asked to fill out a questionnaire specifying their current mode of journey to work and their best alternative. About 60% replied (about par for the Civil Service?). For each respondent it was possible to calculate the monetary expense and the time involved for both alternatives. For two-thirds of the respondents both time and expense were less on the preferred route. But for nearly one-third of the respondents time was less and expense greater, or *vice versa*. In other words, these latter respondents were faced with a trade-off between time and money. On the assumption that each person minimised the sum of financial cost and value of time. Beesley was able to calculate what valuation of time best explained their eventual choices. It turned out to be 2/- per hour for clerical officers and 3/2 per hour for Executive Officers, both figures amounting to about one-third of average wage.

These figures were significantly lower than those previously used, and previous studies needed to be re-evaluated. For example, the new figures halved the estimated net present value of the Victoria Line, as calculated by Foster and Beesley. Other rail investments in London already showed low returns, and the new data indicated that very little further extension of underground lines would be justified.

Beesley's study highlights the importance of empirical measurement for major investment decisions. Let us turn now to pricing policy. A

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\* T M Coburn, M E Beesley, D J Reynolds, *The London-Birmingham Motorway: Traffic and Economics*, HMSO, 1960.

\*\* M E Beesley, "The Value of Time Spent Travelling: Some New Evidence" *Economica* May 1965.

beautifully succinct example of the interaction between pricing and investment policy is provided by my first striker, Alan Walters, in his study of Kennedy airport in New York\*. In 1967 planes arriving during the peak hours were having to wait for over an hour to land. The New York authorities responded by raising the minimum landing fee from \$5 to \$35 during peak periods and by examining the extension of Kennedy airport into Jamaica Bay. Walters observed that the increase in landing fee had the effect of reducing general aviation traffic by nearly half. (General aviation consists of private and company aircraft as opposed to scheduled carriers.) He calculated that an increase in the minimum landing fee to \$100 would practically eliminate general aviation during the peak periods. This would increase available capacity by about 10%, which would be sufficient to reduce delays from an hour to about ten minutes. This time savings would be worth about \$12,000–\$15,000 or about \$1,000 per aircraft movement.

Now ask whether the new extension to Jamaica Bay is justified. The capital plus operating cost would work out at about \$35m. per annum, which would provide capacity for about 100,000 additional landings. To recover cost would therefore require an average landing charge of \$350 per aircraft or, say, \$300 per aircraft if revenues from terminal concessions are deducted. This is not only considerably in excess of present charges, but also three times the \$100 minimum for peak hours only which it was estimated would suffice to eliminate the need for the additional capacity. The case for an airport extension begins to look a little thin, simply because the benefits it provides are not worth the cost.

One of the reasons for picking Alan Walters for my team is that he can get more mileage out of a handful of figures than any other economist I know. Whereas economists are often accused of being theoretical and unwordly, this paper is the epitome of common sense. Despite what politicians would like to believe, and would like to have us believe, the building of excessive airport capacity is indeed a waste of money.

Pricing thus emerges as a language by which society talks to itself, to decide whether its right hand can afford what its left hand wants. In the normal course of events a set of prices is thrown up by the market. We have examined so far whether the set of prices thrown up is a “correct” set. We now wish to ask how the economists can contribute to generating an artificial set of prices when the market is replaced by a government body. (Of course, a large private company has exactly similar problems itself, hence the interest in transfer prices by General Motors and others.)

Let us not suppose that economists are unanimous about pricing policy. One popular rule, to which Walters and many others would broadly-speaking subscribe, goes under the name of marginal cost pricing. The second ball-winner on my team is Professor Jack Wiseman, a man who has dispossessed more economists than most of us have had hot dinners – or

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\* A A Walters “Investment in Airports and the Economists Role” in *Cost Benefit and Cost Effectiveness* (ed. J N Wolfe) Unwin University Books, 1973.

should I say Yorkshire puddings? (For him the slogan “Jack bites yer leg”?). Fifteen years ago Wiseman published a paper entitled “The Theory of Public Utility Price: An Empty Box”\*, which has been often quoted but largely ignored. Possibly the reason is that his arguments are inconvenient. For example, Wiseman argues that the marginal cost pricing rule is quite arbitrary, unless supplemented by rules for dividing expenditures into those which are to be counted as marginal cost, to be re-couped via price, and those which are to be counted as investment and so recouped via subsidy. When an expenditure is incurred in order to produce several outputs simultaneously, yet another rule is required to divide this expense between the outputs concerned.

Consider a specific example from Wiseman’s paper\*\*. A man wishes to fly to Scotland to visit a sick relative, he cannot quite afford to charter an aeroplane at £30 for the trip but a prospective rail traveller would be willing to pay £20 to share. In such circumstances what pricing policy should a nationalised airline follow? One only has to look at the current airline pricing fiasco to recognise that the problem is by no means simple and certainly not solved by current international pricing rules. These, admittedly, are not marginal cost pricing rules but the point is that it is not clear what marginal cost pricing rules would dictate in this situation.

Let me digress for a moment to introduce another member of my team, Francis Ysidro Edgeworth, of whom Paul Samuelson wrote “utility was as real as his morning jam”. Remarkable though Edgeworth was, I doubt if he ever ate jam in the morning. In his willingness to conjure with mathematical concepts he is the Rodney Marsh of the team. If Martin Peters was ten years before his time, Edgeworth was sixty years in advance. We are only now beginning to realise the full significance of his contributions to the game. Midfield is the appropriate place for him.

Edgeworth is familiar to every student as one half of the famous Edgeworth-Bowley Box team, giving the impression of a circus act in which Edgeworth saws Bowley in half. In fact, Edgeworth’s contribution here was the “contract curve” – the notion that when there are few buyers and sellers in the market, the price is not *determinate*, but rather lies within a *range* determined by the market opportunities of the participants.† Thus in Wiseman’s aeroplane example we might expect to find the first passenger paying up to £25, the second up to £10, but the sum equalling £30.

Now this is precisely the *core* of an appropriately defined two or three person game. The modern mathematical theory of games, in which new results are being obtained almost daily, can be viewed as a formalisation and generalisation of Edgeworth’s theory of contracts, put forward one

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\* *Oxford Economic Papers*, pp. 56–74, 1957.

\*\* *op.cit.* fn.2 pp. 66–7.

† F Y Edgeworth, *Mathematical Psychics*, Kegan Paul London 1881.

hundred years ago. Furthermore, it can be used to analyse the very difficulties in public utility pricing, concerning common costs, which Wiseman identifies.

I will venture to predict that, within the next decade, game theory will form the basis of major advances in the theories of imperfect competition, industrial organisation, organisation of the firm and patterns of residential location within cities. In particular, I suspect that it will be able to provide a framework for integrating behavioural theories of organisation into economics, and thereby to provide an approach to the question of economies of scale and relative growth of firms with which we began.

What is it about game theory which prompts this confidence, particularly since game theory from its very inception has had the reputation of promising more than it can deliver? The most important reason is that game theory concerns the interactions of many decision makers, and is therefore a generalisation of the situation where one player is an all-powerful monopolist, or where all players may be lumped together to form a faceless demand curve. It is precisely because the problem areas I have mentioned involve more than two significant participants that the geometrical representations of Marshall are inadequate: we need an alternative means of expression. The mathematics associated with game theory are consequently of a different kind: they emphasise relationships, either qualitative or quantitative, between members of groups in contrast to the smooth functional representations of the differential calculus. (In technical terms they involve algebra rather than analysis.)

The most recent and promising developments in game theory have involved the so-called "characteristic function", which specifies the minimum payoff attainable by any group of players. In contrast to previous game theoretic approaches, which have focused on the calculations of these payoffs, and the actions necessary to attain them, characteristic function game theory subsumes these details and concentrates on the sharing of the payoffs. The emphasis is rather more on co-operation than on conflict, with the specification of alternative opportunities providing the setting within which negotiations of the terms of co-operation takes place. Perhaps these few comments will suggest why this form of game theory might be relevant to the topics I mentioned, at least to public utility pricing and organisation of the firm.\*

If I am right in these predictions, we might ask how well our team is equipped to deal with these new game-theoretic problems. We observe that the only adequately equipped member is getting on for 130 years old. But today's team is designed to solve today's problems. What of tomorrow's team? Here I am even less optimistic. Is there a single

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\* A good discussion of recent advances in game theory along these lines can be found in A Rapoport *N-person Game Theory: Concepts and Applications*, Ann Arbor, University of Michigan Press, 1970. Many of the latest developments appear in the new *International Journal of Game Theory*.

economist in Britain working in game theory? Is there a single University here which offers a course making more than passing reference to the works of Shapley and Shubik, Aumann and Maschler? Is there a single 'mathematics for economists' course here which instructs its students in any modern algebra other than vectors and matrices? There is no doubt that in this particular competition, Great Britain simply cannot field a team; the trophy will be played for by Belgium, Israel and the United States, the three countries where game theory is being carried forward.

Let us review the team and consider its strengths and weaknesses. Adam Smith in goal; Wiseman, Coase, Marshall and Pigou constituting the back four; Edgeworth in midfield and Walters, Beesley and Prais in attack. We need two more players; time prevents me from selecting them so I invite you to do so. Had I drawn the net a little less tightly so as to include public finance, then Tony Atkinson would surely have been chosen.

It is difficult to single out one player as captain but I think I must choose Coase. He has made fundamental contributions to the theory of the firm and the organisation of industry, the theory of externalities and property rights, public utility pricing, the history and theory of government regularity institutions, etc. The term "economic insight" means roughly the same as "ability to read the game", and each of these terms has at least half a dozen interpretations, but whichever one we choose, we find that Coase is endowed with it.

What are the strengths of the team? It is particularly well balanced. Evidence of individual technical skills is most noticeable in the elegance of the work produced. It gives the feeling that the technique used was "just right for the job", and that this is how such problems will be tackled in the future. Such, for example, is Prais' regression model for the size distribution of firms.

Tactical skills are evident in the choice of problems which are just ripe for solution, and where a great volume of further work will be triggered off. Walters on congestion pricing and investment, Beesley on cost benefit analysis and value of time, Coase on externalities and property rights are particularly outstanding here.

Strategic skill is apparent in the ability to take a broad view of the terrain, to synthesise and to order a variety of disparate activities. Adam Smith, Marshall and Pigou clearly demonstrate this ability.

Finally, we must mention the concern for what I can only call the "fundamental nature of things". For example, Edgeworth's dissatisfaction with existing theories of bargaining, or Wiseman's dissatisfaction with public utility pricing rules and current concepts of cost in view of the nature of choice in economics. Fundamental thinking often appears counter-productive at the time, but ultimately determines the nature of the game.

What are the limitations of the team? If it were not for the rather fortuitous inclusion of Coase in our team, I should have to instance the lack of interest in the organisation of industry, which is surely a central problem in applied micro economics. A recently issued Penguin book of 25 readings in the Economics of Industrial Structure contains not one contribution from Britain. This is tantamount to playing without half-back line.

A second criticism that might be levied concerns the limitation of technique. I have already mentioned the absence of game theory. Last week Leontief was awarded the Nobel Prize in economics for his development of input-output economics, but how many people in Britain are working on this topic? Linear programming was almost entirely developed in the USA; Beale and associates have done notable work in developing programming algorithms here but there is no one concerned with economic and managerial applications comparable to Charnes and Cooper and Manne.

It is true that econometric techniques have been extensively used, but even here there are serious gaps: if we view economic history as the testing of economic hypotheses about the past, and consequently as a branch of applied economics, then we shall be dismayed to find that a second recent Penguin book of readings, on the New Economic History, also contains no contribution from Britain.

I don't wish to over-emphasise the place of mathematical techniques in applied economics. For almost all economic policy-making – for example, whether in the coming weeks to ration petrol or alternatively to increase the tax on it, or incredibly, as Mr. Wilson suggests, to *lower* the tax on it – for all these problems it is only necessary to “think like an economist”. In a few cases quantitative estimates of demand elasticities or other magnitudes might be required. Even on the theoretical plane once removed from application, mathematics is by no means necessary. Coase is an outstanding example of a non-mathematical economist.

Yet, when one comes to formulate precisely a theory, to test it for consistency, to remove inessential assumptions, to deduce testable propositions, to find out exactly how it ticks, then one needs a more tractable language of analysis. Mathematics may be difficult, but economics without mathematics is even more difficult. And one cannot argue that economic theory is not the applied economist's responsibility, for it is economic theory which he is applying.

So much for the strengths and weaknesses of my British team of all-star applied economists. It is a team which stands up well against that of any other country. It would even, I think, beat any Rest of the World team excluding players from the USA. But perhaps more important than winning, it is a team which is enjoyable to watch. Which brings us to the end of another Match of the Day.



