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THE NATURE OF AGGREGATE SUPPLY

OF

NEW ZEALAND AGRICULTURE

BY

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I N T R O D U C T I O N

It is a commonplace of the early stages of economics that agriculture is the typical example of an industry with an inelastic supply curve. There is a tendency to accept the concept of elasticity without really translating the meaning of the inelastic supply of aggregate output (the supply curve of the industry) into a practical realisation of the facts. Fact and theory tend to remain in separate compartments of the mind. The advanced student, however, is in a position to appreciate the elegance of economic theory when the theory of the firm is fully related to the shape of the supply curve of the industry. This thesis is principally a study in the conditions which determine the shape of the supply curve for agriculture. This involves a detailed analysis of the supply and demand conditions of the factors of production as they affect total output.

Particular attention has been focussed in the past on the output conditions of agriculture in depression. The actual increase which took place in 1930-33 following a sharp fall in product prices, has prompted several writers to challenge the application of the classical theory of the firm to agriculture. This thesis, on the contrary, is an effort to show that such changes are compatible with the theory of the firm.

In Part I four hypotheses are derived from theoretical considerations to explain the nature of aggregate agricultural output. In Part II these hypotheses are subject to statistical verification by the use of least squares regression. Part III presents a general review of output conditions over the last thirty years.

For agriculture as a whole the supply of land is virtually fixed. Farmers apply varying quantities of other factors to a fixed area of land in order to perform certain basic tasks. The supply of capital to farming is extremely variable. In difficult times the only available supply may be in the form of cash receipts not spent on immediate costs or used as income. In more prosperous periods there tends to be a flow of capital into farming as farm returns rise and capital rationing is relaxed by lending institutions. We have no accurate measurements, however, of the volume of this flow of capital or of its changing rates of flow between periods of low and high prices. Labour, on the other hand, has been measured sufficiently well to determine both the volume and the rate of flow during different price periods. Thus when changes in demand and technology indicate a re-allocation of resources between agriculture and the rest of the economy, the movement of labour is the only apparent indicator of the changes taking place. For this reason, the initial chapter on the allocation of resources is presented in terms of the movement of labour. Greater information on the movement of capital would be highly desirable.

This analysis of the movement of labour is followed by a review of the explanations of the failure of aggregate output to decline in the depression, such as the presence of high fixed costs in agriculture, the length of the production process and the competitive structure of agriculture. While these explanations deal with aspects of the structure of farming which help to explain its behaviour in response to price changes, they have seemed to lack both clarity and completeness. A necessary

preliminary to a statistical investigation would therefore seem to be some reconsideration of the theoretical relations lying behind the facts so that hypotheses may be set up for statistical treatment.

Chapter III, therefore, sets out the pure theory of the firm. From the theory we can make the necessary assumptions to derive a theory of the agricultural firm. The slope of the marginal cost curve of the firm gives us, in turn, the slope of the supply curve of the industry. If the analysis is to be satisfactory, it should be capable of explaining output at all stages of the trade cycle and not only that of depression conditions. If the depression condition is a special case, the necessary assumptions which need to be made can be clearly set forth and their implications understood.

The statistical verification of the theory of output opened two courses of action. One was to make a detailed study of several known farms (a sample) either historically or at any one point of time, the other was to analyse directly the available statistics of production. This latter course was followed. The application of regression analysis to economic time series presents an initial problem. Chapter IV deals with the precautions that are required when dealing with economic populations of this nature. The rest of Part II is taken up with the presentation of the results of regression analysis.

A modest determination of the total year-to-year variations in farm production might be expected when no one variable in the regression has a constant effect for the whole of the period under analysis. In this case, breaking the whole period down into clearly defined sub-periods, while

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preventing the further use of regression through lack of items, may show up the different influences which have been operating. The breaking down of the production aggregates into their components also simplifies the exposition. This is the work of Part III.

In summary form the aim of this thesis is to show:

1. That the maintenance of agricultural output in depression is explained by the inelastic supply of land and capital together with the lack of opportunity for labour elsewhere in the economy;
 2. that the increase in output which occurred in two known depressions is explained by the actual increase in the supply of labour combined with an acceleration of the long-term movement towards increased efficiency;
 3. that the stability of output in periods of rising prices is explained by the inelastic supply of land together with an inelastic demand for labour and a demand for capital, which, though it may be fairly elastic, cannot be met except with some lapse of time;
 4. and that there is a continuous shift towards greater efficiency, and that it is accelerated when capital is more freely available under rising farm prices.
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S U M M A R Y & C O N C L U S I O N S .

In Part I of this thesis the theoretical background of changes in aggregate farm output is set out in some detail. Changes in output are shown to depend on certain relationships between the supply and demand conditions of factors of production. Any long-term increase in output is shown to depend on the adoption of technological improvements as they become available.

In Part II an attempt is made to measure year-to-year changes in factors influencing aggregate output by means of multiple regression. To avoid the distortion caused by serial correlation in the time series variables used, it was necessary to use year-to-year differences (coded) of the logs. of the variables. This threw into relief the year-to-year changes where climatic variations would have an influence which has no relation to farmers' production intentions but might be regarded rather as "disturbances" to production. At the same time it would minimise the influence of the changes in technique which, though we know them to be of great long-term influence, show themselves in statistical data in the form of fairly steady trends.

'Summer rainfall at Ruakura' and 'area of hay and silage cut' the previous summer proved to be the only variables reaching the 5% level of significance. The resulting linear model only explains 46.62% of the total variance of the dependent variable ($R = 0.6828$). The modesty of this determination is explained by the lack of suitable climatic

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data on a national basis, by the lack of a constant effect of variables over the time period taken and certain imperfections in the variables themselves.

This low determination is not markedly increased when dairy output is substituted for total output in the regression. ($R = 0.7210$)

The above linear model did not show the presence of serial correlation in the residuals when tested by means of Durbin and Watson's "d" statistic. When the same equation was derived in terms of the logarithmic values of the original variables, the presence of serial correlation was detected at the 5% level of significance. The use of a variable representing "time" in linear form in the logs. showed that for this particular period of years the elimination of trend also eliminates significant serial correlation in the residuals of the estimating equation.

The high standard errors of the regression coefficients between price and production prevent any positive conclusions to be drawn from the results with respect to the price elasticity of supply of aggregate output. The data is only consistent with the theoretical expectations in the negative sense that the regression shows no significant relationship between year-to-year changes in price and agricultural production.

The review in Part III shows that particular stress may be laid on the following factors in explaining increases in farm output.

1. That there is a steady flow of new techniques to farming, but that the rate of adoption of those techniques tends to be sporadic.
2. In past low price periods an adequate labour supply has enabled an increase in output.
3. That temporary increases in output are possible from an increase in effort on the part of existing farmers.
4. Increases in high price periods depend upon improvements in technology, when the rate of adoption of certain capital techniques is accelerated.

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P A R T I

THEORETICAL CONSIDERATIONS.

I. FACTORS INFLUENCING THE ALLOCATION OF LABOUR BETWEEN AGRICULTURE AND OTHER USES.

In any economy, the allocation of resources between different sectors is important, and the objective of economic policy should be the achievement of an optimum distribution. We may define this optimum as that allocation which will produce the greatest satisfaction per head (1). A more recent definition is that given by Reder; "The welfare of the community is said to be a maximum if its productive resources are utilised in such a way that it is impossible to make any one person more satisfied (put on a higher indifference surface) without making at least one other person less satisfied (put on a lower indifference surface)"(2). The nearest measure there is in economics to satisfaction is real income; that is, money income deflated by an appropriate price index. Thus for a working definition we have; that allocation of resources which provides the greatest real income or product per head, or greatest total income or product.

In a closed economy, changes in the relative importance of the agricultural sector to the rest of the economy will necessitate changes in the allocation of resources. The direction of the re-allocation will depend on the relative income elasticity of demand for farm products and non-farm products and

(1) Following J.E. Meade, "Economic Analysis and Policy" 1937, p.263.

(2) M.W. Reder, "Studies in the Theory of Welfare Economics" 1947. p.15.

relative speed of changes in technology in agriculture compared with the rest of the economy. If changes in demand took place at the same rate and in the same direction as the changes in technology the employment of resources in different uses would remain unchanged. But, in fact, the variations in demand for farm products are very different from that in other sectors. Relative changes in technology are hard to assess, so there is very little we can say on this aspect. We can point out, however, that the absolute decline of rural population in the more advanced western countries indicates that the absolute change in farm efficiency, as far as it is labour-saving, takes place at a greater rate than the absolute change in demand for farm products (3).

Changes in the conditions of demand for food depend on changes in population, taste, and income. The growth of population exerts a steady but nevertheless important force on agricultural production. Apart from the effects of changes in taste and income, and given that the larger part of farm production is food production, farm output needs to expand in step with population growth. Changes in taste are responsible for a re-organisation of farm production which can have a considerable effect on total output. This is mainly the case where the price system indicates to the producer that a lower yielding product has a higher value to consumers. Especially with rising standards of living, consumers show a preference for products of animal origin, which, owing to the demands of biological growth and maintenance, can only give a lower yield per acre as compared

(3) J.M. Brewster, "Farm Technological Advances and Population Growth" J.F. Ec. XXVII: 509. 1945.

with products of vegetable origin. Changes in demand between livestock products or between crop products do not have such a marked effect on total output.

The most important factor affecting the total demand for farm products is undoubtedly changes in income. As incomes increase the distribution of consumer expenditure among different items changes; the proportion of income spent on necessities (of which food is one of the most important) decreases, although absolute expenditure will rise, while that spent on other goods and services increases(4). If we define income elasticity of demand as the ratio of the percentage change in the amount of a commodity purchased to the percentage change in income, we find that the income elasticity of demand for food as a whole is usually less than one. Thus, as real income of the community rises, a greater proportion of consumer demand is for goods and services other than those basically produced on the farm.

This concept necessarily views agricultural products as a whole, as there exists a very broad possibility of effective substitution in the case of agricultural resources in producing alternative farm products. As already noted, this substitution can, in one sense, markedly affect total output. The income elasticity of demand, in the case of an individual product and especially livestock products, may well exceed one. Also, we are speaking of the demand for farm products as they leave the farm gate; one of the effects of higher real income being that consumers prefer more services attached to the original farm products. Thus the elasticity of demand at the farm gate is considerably lower than at retail. It is clear, then, that the demand for products

(4) Colin Clark, "Conditions of Economic Progress" 1951.
A.G.B. Fisher, "Progress and Security" 1930.
T.W. Schultz, "Agriculture in an Unstable Economy" 1947.

of agriculture as a whole, given that the major part of production is for food consumption, declines proportionately to that for other sectors of the economy.

Changes in technology have far-reaching effects on the allocation of resources. Changes in productivity are directly responsible for the increase in real income of the whole community, while increased productive efficiency enables a greater demand to be satisfied with a given quantity of resources. Since the increase in farm efficiency takes place at a greater rate than is required by an increasing population or expanding market, there is a tendency for the demand for resources used in agriculture to decline. The demand for certain of these resources will be greater in the non-farm sector, where they are required to produce the new goods and services demanded by a community with a rising level of real income. But since land cannot shift to any significant degree, and capital usually has to move into farming rather than out (except in high income periods) the only visible movement which takes place owing to these changes is that of labour. Combined with a tendency towards a higher birth rate in rural areas, we have the main ingredients of what is commonly known as the "urban drift."

How is an optimum allocation of resources to be achieved? Clearly, resources must be allocated to that use where the value of their marginal products are highest. These will, in turn, be higher in those uses where demand is greater. Now, as we have already seen, the direction of changes in demand depends upon income elasticity of demand. Therefore, "given that the existing distribution of resources is at an optimum, (which implies that there is no involuntary unemployment) and that there is a secular growth of the national product due to the

accumulation of capital and technical progress, it may be concluded that, in order to maintain an optimum distribution of resources, industries should expand at rates determined by the income elasticity of demand for their product. That is, expansion should be such that the composition of the increment of output will be that which consumers will wish to buy with the increment of income"(5). Unless resources are transferred according to this principle, there will be a loss of national product or welfare. It follows that any delays or immobilities in the process of adjustment will interfere with the optimum allocation, and hence reduce the national product.

The presence of a large export trade in primary products complicates the application of these principles to New Zealand as agricultural production is undertaken in response to an overseas demand of variable magnitude. This trade enables the United Kingdom to maintain a higher industrial population than would otherwise be the case; whereas New Zealand, (among other countries) is given the opportunity to supply farm products to a total of over three times her own consumption and is thereby able to keep a larger percentage of population in farming. Complete specialization, however, is inhibited by the need for service industries to be located round their markets and by increasing costs of production and transport charges. Thus the optimum allocation of resources in a dependent economy such as New Zealand, will be where factors are distributed between agriculture and the rest of the economy in accordance with the practical and economic possibilities of providing secondary and

(5) B.D. Giles, "Agriculture and the Price Mechanism". Oxford Studies in the Price Mechanism, 1951. p. 198.

tertiary goods and services with the existing supply of resources. In general, industries protected from competitive imports will reduce the national product, although economic criteria may not be considered as the sole determinant of public policy.

We can now see why the so-called drift to the towns takes place. Clearly it would be more correct to call it " a re-arrangement of labour and capital resources in response to modern techniques of production" (6). Besides the basic factor of changing technology the urban drift is complicated by other factors. The most familiar of these is the differential birth-rate between town and country. Table I shows the average number of dependent children under sixteen per married man and per married man with children for various selected occupations. Between the two years available it appears that the proportion of families with children has declined, although there is some evidence that these families have been having more children. However the data clearly indicates the higher birthrate in agricultural and pastoral occupations. The rate also does not appear to have declined over the period. Although the differential birthrate is usually attributed to differences between town and country, it would probably be more accurate to emphasize the differences between white-collar and manual occupations. Be that as it may, a higher birth-rate in rural occupations, cut off as they are from other occupations, is a constant factor exerting a downward pressure on rural wages.

(6) H.M. Wadham & F.L. Wood, "Land Utilization in Australia." 1947. p.350.

TABLE I : AVERAGE NUMBER OF DEPENDENT CHILDREN UNDER SIXTEEN
PER MARRIED MAN IN VARIOUS OCCUPATIONS.

SOURCE: Census reports, 1936 and 1945.

	1936		1945	
	Per Married Man	Per Married man with children	Per Married Man	Per Married man with children
Agricultural and pastoral.	1.48	2.37	1.47	2.38
Non-precious metals and electrical fittings.	1.29	2.05	1.275	2.07
Building Construc- tion and Road Maintenance.	1.45	2.28	1.41	2.38
Transport and Communication.	1.42	2.15	1.36	2.18
Financial and Commercial	1.175	1.96	1.05	1.99
Clerical and Professional.	1.15	1.89	1.13	1.96

Arguing from economic theory we would expect wages to be proportional to the marginal product in both town and farm firms, and finding that wages tend to be significantly lower in rural areas, we must conclude that the value of the marginal product of labour on farms is lower than in town firms. Clearly, we can argue further that a transfer of labour from the farms to other sectors of the economy would raise the national product. But the theory of perfect competition tells us that wage rates will always tend to equality in different occupations. Why is it then that rural wage rates have been consistently lower? (See Table IV). I think the disparity can be explained by the non-monetary considerations at work.

Besides the higher rural birthrate, lack of alternative training, payment in kind, preference for "the land" and an element of inertia are all factors which have exerted a downward effect on rural wages in the past. A force in the opposite direction is provided by the greater availability of the so-called "amenities" in the towns. But this factor is only fully operative in periods of full employment, when the movement of labour away from the farms tends to be excessive and hence more apparent. At such times the normal transfer of labour, which economic progress requires, is more likely to be visualised in terms of its "net advantages" rather than in an actual wage difference. It is now possible, therefore, to substitute the equality of "net advantage" of labour (7) for that of wage equality in order to satisfy the theoretical requirements. The resulting margin between town and country wage levels will vary as the relevant circumstances alter. When the employment situation in the towns is not so favourable, the attraction of the amenities is not so great, and the margin between the wage levels increases. In times of widespread unemployment, the rural wage level may be expected to decline in far greater proportion than that of the city, as the net advantage will consist of a large factor representing the security of rural employment. The opposite may be expected as the economy enters full employment; farm wages would increase at a greater rate as the fear of unemployment in the towns disappeared and the normal movement was resumed.

(7) A. Marshall, "Principles". 8th Edition. p.73.

The movement of labour is further governed by the occupational status of the various categories of farm workers. The farm operator or owner will weigh his ownership of land and advantages of being his own boss etc., against the attraction, if any, of other occupations for which he has little training or preference. It thus happens that during a period of low returns, he will accept a lower reward than that offering elsewhere so as to remain in farming. Farm owners are, in fact, the stable element in the farm labour force. As they form over fifty per cent of the force in New Zealand (fifty-two per cent, excluding managers, according to the 1945 Census), there is no marked movement out of farming as perhaps might be expected in a period of low prices, but instead they are willing to accept whatever labour reward current farm prices provide for them after costs have been met. Their attachment to the land is a historic factor which has tended to keep farm labour rewards at a level lower than the rest of the economy.

But without this attachment to the land, the hired worker is the mobile element. He will more closely balance the farm wage plus the perquisites going with the job (house, meat, milk, wood, etc.,) against the town wage with a higher cost of living, but locality advantage of being near the "city lights" and educational institutions etc.. If the worker has a strong desire to own land one day, there will be added reason to stay on in hard times. But available evidence (8) indicates that a large proportion of hired workers on farms are youths, usually from the cities, who are looking for an outdoor life and are willing to put up with a few minor discomforts. But once

(8) Employment Gazette, No.1, Vol.I, 1951. p.31.

burdened with family responsibilities, however, they are bound to look for town employment unless good farm accommodation is available. But the behaviour of all hired workers of any age is closely related to ruling economic conditions.

In depression, higher wages may exist in the towns, but they carry with them the fear of unemployment. With dole and soup-kitchens in the towns and works schemes, we can visualise a perimeter of marginal workers, who for reasons of pride, family support etc., will accept whatever employment is available rather than go unemployed. In the depth of a depression, security and the prospect of meals and a bed may have been sufficient reward to some down-and-out itinerant workers. Part of Table II shows the marked increase in working rural population which actually did take place in 1930-36 in New Zealand. Probably family labour was held back on the farms as well as more hired workers being available. The increased numbers do indicate that at the time the net advantage lay in farming with at least security of employment, if not a very high reward.

The actual situation in New Zealand altered rapidly with the introduction of the newly elected Labour Government's "insulation" policy, with its associated aim of full employment, and, later, the war, (1939-45). The first markedly decreased the advantage which farm work had had in terms of security from unemployment, while the war not only further reduced the number of hired workers, but cut into the operator's family in many cases. The war thus accelerated the rate of adoption of many labour-saving devices, so that since its conclusion there has been no marked indication of a large-scale return of labour to the land to replace this excessive drain of workers.

These latter events have been taking place when the earlier objective of full employment had already been achieved. The change in prices which took place over the same period and also the exigencies of war both made it apparent to the farmers that greater production was a desirable objective, and that the fixed market conditions of the thirties was past. But such an increase could not take place when the labour required had been drawn off the farms at a rate far in excess of that at which it could be replaced by other factors. Had recovery taken place more steadily, the movement of labour out of farming would have been much slower and wage levels would have remained more or less unequal. As it is, wage rates for equivalent types of work in town and country are about equal, and the possibility exists that an even greater rural wage is required to balance present net advantages of town employment such as availability of overtime and employment in protected industries competing for the existing labour supply.

Nevertheless we must not lose sight of the fact that in the past, periodic bouts of depression have tended to shape the nature of rural wage rewards by tradition. With no easily available alternative employment, and no unionism or wage-fixing authority (up to 1936), rural workers have in past low price periods accepted very low wages rather than be unemployed. Farm employers in their turn become accustomed to these awards and have psychological difficulty in making wage adjustments when alternative opportunities are available for the workers. Under such circumstances, the movement of the more mobile elements out of agriculture can hardly be deplored, as long as the standard of town wage reward being offered in competition

with farm wages is the product of the changing real balance of farming and non-farming industries and not the temporary and "unfair competition" generated jointly by inflation and its related need for import control.

If present full employment policies are successful, the farm community will need to make permanent adjustments to this situation, and realise that the factors making for lower wages and prices in depression make for high wages and prices in full employment conditions. In this case, wages of rural hired workers plus other advantages (housing etc.) must at least be commensurate with town conditions, if not with the conditions that the owner operator now enjoys.