VON THÜNEN'S ISOLATED STATE

By COLIN CLARK

DURING the later years of the Napoleonic Wars (but apparently not disturbed by them), a practical, serious-minded, but remarkably imaginative German landowner, actively engaged in managing his estate, was reading Smith and Ricardo, disagreeing with them on a number of important points, and slowly preparing his own book on the theory of rents, transport costs, and land use. The writer was Von Thünen. He did not publish his book until 1827, by which time the simple Ricardian theory had obtained a firm hold in the intellectual world. In the later years of his life, which was long, he turned his attention to wage theory, developing some ideas which Sir John Hicks found of great interest. This part of his work is outside the scope of this article.

While Von Thünen's work has been unduly neglected by economists, it has on the other hand suffered from rather excessive attention by geographers, who are not content to treat it for what it is, a most profound and interesting study of a rural economy in the days of horse transport, but seek evidence to prove that the location patterns described by him are still applicable in the present-day world. Such evidence, it is true, can sometimes be found in the case of prolonged persistence of old locational patterns, as often in this country; or by attempting to extend the application of his theory over very much greater distances.

It is more satisfactory, however, to go back to his work and reconsider it from the beginning. It is a geographer who has supplied us with a careful translation and annotation of a work which most English-speaking readers have hitherto only known indirectly.[1] The only fault of the book (apart from its outrageous price) is that the Editor could have greatly increased its usefulness by engaging a competent assistant for a few hours with a desk calculator to translate all the results into modern weights and measures (he gives the necessary conversion factors); and made some of the relevant comparisons with other agriculture, past and present. Von Thünen was far ahead of his time in the thoroughness and accuracy with which he kept records of farm and forest costs and proceeds, rents, and transport costs. Not only did he keep the records; he understood how to generalize the experience of his own and neighbouring estates, and to submit the results to economic analysis.

The essence of Von Thünen's complaint against Ricardo, in modern language, is that Ricardo developed his theory of rent in terms of an

[1] Von Thünen's *The Isolated State*, edited by Peter Hall. Pergamon Press. £5. 0*s*. 0*d*.

undifferentiated agricultural product. Von Thünen's great achievement was to point out that transport costs were the cause, and rents the consequence, of important differentiations of agricultural, dairy, and forest production, according to distance from the market. Northern Germany in the early nineteenth century was an excellent testing-ground for such theories; it was a society which had advanced well beyond the subsistence agriculture stage, and was fully commercialized; while at the same time the high costs of transport in the pre-railway age called for sharp differentiations of production. Von Thünen was additionally fortunate in being able to prepare his studies in a region entirely dependent on land transport; he points out that his theorem would be upset in an area whose transport costs were reduced by the existence of a navigable river. The principal market town of his area, Rostock, was close to the sea. At that time some grain export from the region took place. But probably also there was some import of timber from Scandinavia, which would have affected his calculations.

Long-forgotten considerations are brought back to our minds. In those days, a large proportion of the total agricultural area had to be set aside to produce grain and fodder for the horses; the release of this land has been an important factor in raising the productivity of European and American agriculture during recent decades. At the same time, every town produced vast quantities of horse manure (not to mention the cow manure from town and suburban dairies, which survived until quite recent times) and all of this manure had to be disposed of without incurring excessive transport costs, which necessarily meant a small belt of market garden and milk-producing land in the immediate neighbourhood of the town of exceptionally high fertility, and also exceptionally high rent. Von Thünen quoted a contemporary British writer[1] as showing that horticultural land (including improvements) was being rented at £12 per acre per year on the outskirts of Edinburgh, and near London at a gross rent of £18 (of which rates and tithes took £8). The order of magnitude of average agricultural rents at that time was only about £1 per acre per year. Prices and rents in Germany were much lower, as we shall see; nevertheless high-quality grazing for dairy cows was being leased on the outskirts of Hamburg for £10 per acre per year.

Not only the cost, but also the delays of horse transport, made it obligatory that perishable products—milk and fresh vegetables—should be produced in the immediate neighbourhood of the town—on this very highly manured and very highly rented land. But Von Thünen also pointed out that wood, both for fuel and building, could not stand high transport costs, and that it was therefore essential that some areas should be

[1] Sinclair, *The Code of Agriculture*, 1817.

preserved for forests in fairly close proximity to each city. (The woodlands which still make the German landscape so attractive in the neighbourhood of cities were apparently not preserved solely for recreational reasons). Owners of forests, however, Von Thünen concluded, must be running them as a public service rather than as a business; financially, they would be better off by clearing their land and investing the proceeds in fixed-interest securities, unless the rate of interest fell below 3 per cent. He appears to be thinking in terms of nearly a hundred-year growth cycle, for beech, also a favourite in neighbouring Denmark, a beautiful tree producing hard and valuable wood which we now use for furniture and similar purposes. It seems a mistake to use such a wood for ordinary building and fuel purposes; and perhaps already it was feeling competition in the market from Scandinavian softwoods. Much of the forest in Europe today is maintained by local authorities, and as a public service (for recreation etc.) rather than as a business investment. At any probable rate of interest, the returns from forestry fall far short of the returns from agriculture on good land, indeed on any land that is not exceptionally steep or cold.

Apart from these limited areas required for the production of fresh vegetables and milk, timber and firewood, the city will be surrounded by an approximately circular zone of grain-growing land, right up to the limits permitted by its cost of transportation. At a time when a substantial part of the cost of transportation consisted of the feeding of the horses *en route*, and some of the men's wages were also paid in grain, Von Thünen measured transport costs in 'natural units', a device which it has been found very useful to revive for analysing the problems of low-income farm economics.[1] The natural unit is measured by the actual quantity of grain fed to horses[2] on the journey and the return journey, together with the grain, or grain-equivalent of the cash expended on wages and other costs, per ton-kilometre of transport performed. Measured in this way, we can see directly how many kilometres a ton of grain can be transported before it has lost half (or any other specified proportion) of its value. In the case of products with a higher selling value per unit of weight than grain (e.g. butter and wool) the distance over which they can be transported rises in the ratio of their price to the price of grain; we expect these products therefore to be produced at a greater distance from the city.

The staple grain in North Germany at this time was rye, wheat being little used. All economic measures therefore are expressed in terms of kilograms of rye. (The nutritive value of rye bread is not significantly

[1] Clark and Haswell, *The Economics of Subsistence Agriculture*, 2nd edition.

[2] A horse can live on grass and hay, but usually requires grain-feeding when he is working hard. In any case hay would be a too bulky and inconvenient fodder to carry on a long journey.

different from that of wheat bread; most people find the latter more palatable; many Germans on the other hand still prefer rye). Rye was carried in large wagons, containing 1·16 tons when they reached their destination (more when they began their journey, to provide fodder on the way). On a representative journey of 37 kilometres length, costs worked out at 2·73 kilograms of rye-equivalent per ton-kilometre of delivered weight. Von Thünen calculated the absolute maximum distance from the town at which grain could be grown at 230 kilometres. At this distance, transport costs would reduce the proceeds to one-third of the town market price, which would leave no rent at all. Von Thünen then goes on to illustrate his principle by an interesting theoretical statement. 'If potatoes were the only edible vegetable, arable farming would cease at 70 kilometres from the town; the Isolated State would be far smaller; and the town itself would have a smaller population.'

Converting prices into British currency (one new thaler = 3·21 shillings) the price of rye at Rostock was 5·55£/ton. Von Thünen's estimates for the estates in his neighbourhood, where the price of rye at farm was 4·78£/ton, showed that the proportion of the gross proceeds (which included barley, oats, and pasture as well as rye) represented by rent (pre-tax) was 29 per cent., and a further 27 per cent. represented a contribution to the farm overheads, including payment of interest on the buildings. This latter entry is unfortunately somewhat ambiguous. We have, however, some grounds for estimating the order of magnitude of the interest, depreciation, and maintenance costs on the buildings and equipment at 10 per cent, of the gross product, thus making rent, defined in the broadest manner, some 45 per cent. of the gross product, i.e. cultivation costs, excluding all rent elements, as 55 per cent. of price at Von Thünen's farm, or 47 per cent. of the price in Rostock market. It appears at first sight that Von Thünen's figure of 230 kilometres as the distance limit set by transport costs for grain cultivation, which reduced the price at farm to one-third of the Rostock price, was too high. But this figure may be explained if we take into account (see below under dairying) the consideration that in the more distant zones labour may have received the same wage in terms of rye, but a lower wage in terms of money.

Evidence has been collected[1] from numerous sources, past and present, of transport costs in low-income agricultural countries, measured in the same natural units. The median cost of wagon transport is 3·4 kilograms grain-equivalent/ton-kilometre transported, making it cheaper than pack-animal transport (median cost 4·1) or human porterage (median cost 9·0), though much less advantageous than boat transport (median cost 1·0). Costs of wagon transport were found as low as 1·6 in the United States in

[1] *The Economics of Subsistence Agriculture*, ch. 9.

1800, where horses were exceptionally cheap; and as high as 8·0 for long journeys carrying army supplies in thirteenth-century England, where the driver may have had to take out the medieval equivalent of an insurance policy. Von Thünen's cost of 2·73 was obtained using his estate horses and labour. Beech logs were carried from the forest to the town by a contractor at a cost of 3·1, over a fairly short distance, not precisely specified. However, this was an exceptionally bulky load (7·8 cubic metres/ton) and possibly for grain transport the contractor's quotation might have been lower than the cost with estate horses. Butter, which had to travel a distance of 166 kilometres, incurred a transport charge as high as 7·5 per ton-kilometre. Presumably the carrier had to travel as fast as possible because of the perishability of his load; but in any case these long journeys always seemed to incur higher costs per ton-kilometre, probably because of the difficulty of persuading men to spend some time away from home.

We are given an interesting glimpse of the landscape beyond the 200-kilometre limit from a market town, whose inhabitants will grow a limited amount of grain for their own subsistence, but most of whose land will be given over to grazing, to produce butter and cheese which can be sold, milk for their own consumption, and meat animals who can be walked to market. Still more distant zones were given over to the production of wool, whose value per unit of weight was some five times that of grain, and which would stand much greater transport costs. It was another achievement of Von Thünen's theoretical insight that he foresaw the development of wool production in Australia, as indeed took place, many years before the coming of railways.

Von Thünen gives us a most interesting collection of average prices of rye in German markets over the period 1828–41, showing 'transport bias' whereby grain prices fall with distance from the market—and with them wages and other costs expressed in money, because rural wages tended to be at a uniform real level expressed in grain. Von Thünen himself took this consideration into account in calculating costs in the remote pastoral zone.

Rye Prices 1828–41 £/*ton*

East and West Prussia	4·02
Posen	4·26
Silesia	4·55
Brandenburg and Pomerania	4·65
Saxony	5·07
Westphalia	5·84
Rhineland	6·30

Prices rose towards the western and more populous part of Germany; which was also nearer to the export market. Here, however, Von Thünen

had a justifiable grievance. Britain, which had been a grain-exporting economy up to 1750, had become, with the rise both in population and in real incomes, a grain-importing country, subject to comparatively moderate tariffs, in the later eighteenth century. In 1815, the 'Landlords' Parliament' made the Corn Laws more stringent.[1]

Germany was the principal source of exportable grain at this time. The effect of the Corn Laws was to create a great disparity in prices. During the period 1828–41, when the maximum German price of rye was only a little over £6 per ton, our ancestors were paying £14 per ton for wheat, and many of them were going hungry. Further analysis is required before we can judge the extent to which these adverse consequences fell upon German landowners and German labourers respectively; the relative movement of German wages and of German rents after the sudden repeal of the Corn Laws in 1846 should provide interesting material for study.

The next point to be noted is that on the estates which Von Thünen recorded productivity was exceptionally high by the standards of the time, indeed was at a level which Germany as a whole did not attain until a century later.

Crop yields in tons/hectare

	Wheat	*Rye*	*Barley*	*Oats*	*Potato*	*Other roots*	*Hay*
Mecklenburg 1810–1840							
Von Thünen	2·14	1·98	(2·0)[h]	2·10	20·0	14·4	7·0[a]
France[b] 1781–90	1·15[c]	0·8	1·1	0·5	..	..	..
1815–24	0·82	0·65	0·84	0·73	..	..	..
England[d] about 1700	1·3	1·3	1·4	1·3	..	..	..
Germany Bittermann[e]							
1800	1·03	0·90	0·81	..	8·0	..	..
1846–52	1·19	1·05	1·05	..	..	..	..
1878–82	1·46	1·16	1·58	1·32[g]	8·9	23·7[f]	..
1908–12	2·07	1·78	2·01	1·96[g]	13·3	28·0[f]	..

[a] Clover hay.
[b] Toutain, Cahiers d'Isea No. 115 (1961), p. 74.
[c] Spring wheat 0·9 and 0·8 respectively.
[d] Deane and Cole, *British Economic Growth*, p. 67, Richardson, *Outlook on Agriculture*, winter, 1960, gives 1·4 for 1750, for which date, however, M. K. Bennett (Economic History, vol. iii) gives only 1·0, rising to 1·8 in 1850.
[e] *Die Landwirtschaftliche Produktion in Deutschland* 1800–1950.
[f] Sugar beet.
[g] Agrarwirtschaft, Apr. 1960 (for 1881–5 and 1910–14).
[h] Area not given, but approximately inferred from information on rotation.

Both the climate and the soil of Mecklenburg are favourable to agriculture; and from the book we can gauge the care and thoroughness devoted to manuring, rotation, and other methods then available for preserving soil fertility, in those days before chemical fertilizers. At that

[1] They had included, since the seventeenth century, with a view to stabilizing internal prices, the device now known as the 'variable levy', a deplorable ancient error which the Common Market authorities are determined to revive, under the impression that they have hit upon something ingenious and new.

time, the chemical requirements for soil fertility were not even theoretically understood. Von Thünen made an heroic effort to compute fertilizer units, the requirements of different crops, and the amount of manuring required in consequence.

Until recently, Mecklenburg landowners had operated the old 'three-field system'. A representative estate covered 150 hectares—large even by modern standards—worked as a single unit, only one-eighth of the total area being sown to rye in any one year, which was expected to yield at the rate of 1·9 tons/hectare, or 36 tons of rye. The rest of the farm was in barley, fodder crops, pasture or fallow, yielding, after feeding its own livestock, further saleable products equivalent to another 40 tons of rye. Out of this gross yield equivalent to 76 tons of rye, he reckoned a pure rent (pre-tax) at the equivalent of 25 tons, and contribution to farm overheads, including paying 5 per cent. interest on structures, at another 20 tons, which latter may have included, as stated above, some elements of economic rent. The remaining expenses included 7 tons of rye-equivalent for seed, 13 for cultivation, and 11 for harvesting—the two latter being predominantly payments for labour. At the beginning of the nineteenth century, progressive landowners were going over to the seven-year rotation, dividing their estates into seven equal areas for one year each of rye, barley, and oats cultivation, three years of pasture, and one for fallow. This raised the gross product on the same area to 111 tons rye equivalent. Rent per unit of area rose, but it now represented a smaller proportion of the gross product, at 32 tons; the contribution of overheads was again put at 27 per cent. of the gross product. Von Thünen had received and scrutinized information from Belgium, the most densely populated and most productive part of Europe. If Belgian methods were applied in Mecklenburg, he concluded, they could raise the gross yield 2·2-fold and the rent 1·7-fold.

The figures for dairy production, however, tell a very different story. The average cow weighed only 250 kilograms, or about half the weight of a good modern dairy cow; and produced butter at the rate of only 42 kilograms/year, corresponding to a milk yield of only 900 kilograms (200 British gallons). In the Rostock market butter exchanged for eleven times its weight of rye—very similar to the ratio prevailing in the world market now. Even at the high transport cost already quoted (7·5 kilograms rye equivalent/ton-kilometre) butter could be carried 200 kilometres for less than 15 per cent. of its selling price. A butter producer near the city would have incurred, quite apart from rent, direct production costs equivalent to 9·6 kilograms of rye in producing a kilogram of butter which he could exchange for 11 kilograms of rye. Of these costs, however, only 22 per cent. were actually payable in cash (purchases of equipment etc.) and the

remainder were, in effect, payable in rye, namely payments for labour and contract services.[1] Farm workers further away from the city obtained exactly the same amount in rye for their labour service, but its money equivalent was less. Costs at a distance thus represented a smaller proportion of proceeds, leaving a larger amount for rent (in rye-terms: it would not be higher in money-terms). Or, if we like to put it another way, distant dairy-farming lands could earn rents which represented the fruit of the manœuvre of transporting rye values to Rostock in the form of butter, which was more compact to transport. There was, of course, a limit to this. The possibilities of producing butter and wool extended the effective boundaries of the Isolated State, but nevertheless in due course a limit must be reached at which rent fell to zero.

Von Thünen's tidy mind was offended, as indeed are those of agricultural economists throughout Europe to this day, by the ancient and irrational farm boundaries. He made some striking calculations to show precisely how much they increased farm costs. Rationalization of farm boundaries, then as now, was hindered not only by the conservatism of farm families, and their attachment to their ancestral property, but also by a severe and vexatious system of taxation of land sales. Land should be taxed when people hold it without selling it, rather than the converse.

[1] Von Thünen clearly implies that wages were negotiated in rye-terms, not in butter-terms. Real wages, though above subsistence level, were low, and most of the butter output appears to have been consumed in the town. To contemporary readers, no doubt, these facts would have been too obvious to need stating explicitly.