

from Von Thünen's
Isolated State
English Translation by
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Edited with an Introduction
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INTRODUCTION

I HAVE long ago forgotten Cournot; and I may be wrong. But my impression is that I did not derive so much of the substance of my opinions from him as from von Thünen. Cournot was a gymnastic master who directed the form of my thought. Von Thünen was a *bona fide* mathematician, but of less power: his blunder as to the natural wage is not of the same order as Cournot's little slips. But, to make up, he was a careful experimenter and student of facts and with a mind at least as fully developed on the inductive as on the deductive side. . . . And I loved von Thünen above all my other masters. Professor Fisher has cared for Cournot. I wish that someone would care for von Thünen. He should not, I think, be translated: but an abstract of his work should be given, with translations of a good deal of his second volume.¹

Thus wrote Alfred Marshall, of the economist whom he described as "the great unrecognized".² Marshall was writing about 1900 (the quotation is undated): Thünen's work first appeared in 1826, and by 1863 it was completed. Yet, since Marshall, unrecognised he has remained in the English-speaking world, though his influence on English economics, chiefly through Marshall, has been incalculable. In Marshall's own statement, he borrowed the concept of the margin from Thünen (and not from Jevons, whose book appeared after Marshall had read Thünen).³ Marshall's treatment of marginal productivity, his analysis of rent, his careful distinction between partial and total equilibrium, his separation of the short and the long term: all these derive from Thünen, and have passed into the central tradition of English economic thought. Yet Marshall's conclusion, in retrospect, is understandable. His main interest did not lie in location theory; and English economic tradition followed him, to separate sharply from the German. Only in recent decades has Thünen begun to receive his recognition in the English-speaking world, and then in large measure through the work of economic geographers, who have always been centrally concerned with location theory; there now exists one book on agricultural location, that of

¹ A. C. PIGOU (ed.) *Memorials of Alfred Marshall* (1925), 359-60.

² *Ibid.*, 412.

³ A. MARSHALL, *Principles of Economics* (1st edition, 1890), x (note); PIGOU, *op. cit.*, 412.

Chisholm,¹ which is firmly based on a close analysis of Thünen theory. Yet with this awakening, the danger will inevitably be the same as that long experienced in Germany, where the original text of Thünen has been readily available for decades. In the words of Thünen's most important interpreter and critic, Asmus Petersen:

It is an open secret, that though many feel qualified to judge the doctrine of the (Thünen) rings, only a few have read the book in which they are developed.²

For this reason no apology is offered for breaking Marshall's injunction. This edition of Thünen's *The Isolated State* has been prepared especially for economists and economic geographers interested in location theory. It concerns itself only in a summary way with the other main concern of Thünen's work, the wage theory, which has been translated and criticised elsewhere.³

This introduction to the translation is in four parts. Part I is a brief biography of Thünen, with special reference to the writing of *The Isolated State*. Part II is a guide to the successive German editions of the book and of earlier translations of it, plus an explanation of the basis of this translation. Part III is an attempt to provide a guide to the main lines of the location theory in *The Isolated State* with special reference to some of the commoner misapprehensions about Thünen's thesis. Part IV attempts to set Thünen in the context of his age and of the age which followed him—the era of world trade in agricultural products.

I. THÜNEN: LIFE⁴

Johann Heinrich von Thünen⁵ was born on 24th June 1783⁶ in the family home of Canarienhäusen, parish Waddewarden in the Jeverland district near the North Sea coast in East Friesland, north-west Germany. His father stemmed from a long line of landowners;

¹ M. CHISHOLM, *Rural Settlement and Land Use* (1962). For a bibliography of references in English to Thünen, see pp. xlv–xlvii.

² A. PETERSEN, *Thünens Isolierter Staat: Die Landwirtschaft als Glied der Volkswirtschaft* (Berlin 1944), VI.

³ B. W. DEMPSEY, *The Frontier Wage: The Economic Organization of Free Agents* (Loyola University Press, Chicago 1960). The translation stands at pp. 187–367.

⁴ This biographical account is based mainly on H. SCHUMACHER, *Johann Heinrich von Thünen: Ein Forscherleben* (Rostock 1868); O. VON BISMARCK, "Studien zur Geschichte der Familie v. Thünen", in W. SEEDORF and H.-J. SERAPHIM (eds.), *Johann Heinrich von Thünen zum 150. Geburtstag* (Rostock 1933), 9–29; and A. PETERSEN, *op. cit.*, 1–19. Useful short biographies, with appreciations of Thünen's work, published since 1950 include: A. PETERSEN, "Landwirtschaftliche Betriebslehre", in O. KEUNE (ed.), *Männer die Nahrung schufen* (Hannover 1954), 27–51; H. NIEHAUS, "Johann Heinrich von Thünen 1783–1850", in H. HEIMPEL, etc. (ed.), *Die grossen*

his mother was the daughter of a bookseller in the town of Jever. Thünen's father died in 1786 from a fever, and in 1789 his mother remarried a timber merchant, von Buttell, in Hooksiel, a small port on the Bay of Jade. Here Thünen attended the local school, and, with his experience in his stepfather's business, he soon outpaced his teacher in arithmetic. So at the end of his thirteenth year he went to live with his maternal grandfather in Jever, where he attended the celebrated local secondary school and received supplementary instruction in differential and integral calculus. He left the school in 1799, an interest in agriculture already awakened, and went to gain practical experience on a farm at Gerriethausen, in the Jeverland. The proprietor, H. G. von Tungeln, was a typical farmer of the Germany of his day, hardworking but suspicious of scientific method; and here Thünen gained valuable insight into the average agricultural conditions of the time.

Thünen's career was now decided. In 1802 he went to the Agricultural College run by Lukas Andreas Staudinger at Gross-Flottbeck in Holstein, just north-west of Hamburg, and today a suburb of the city. Here his analytical grasp rapidly developed. He soon noticed the profound influence which the cities of Hamburg and Altona exerted on the agriculture of the surrounding area. In a paper written early in 1803—*Description of Agriculture in the Village of Gross-Flottbeck*—he is already pointing out that only farms relatively near the town could make use of town dung to increase their yields, and is indeed already putting forward the idea which is the germ of *The Isolated State*:

If one assumed that in a province of 40 miles diameter, a big town lay in the centre, and that this province could only send its products to this town, and that the agriculture in this district had attained the highest level of cultivation, then one could assume that four types of farming systems would exist around this town.¹

Deutschen, Band V (Berlin 1957), 229–35; S. V. FRAUENDORFER, *Ideengeschichte der Agrarwirtschaft und Agrarpolitik* (München 1957), 285–300; and H. HAUSHOFER, *Die deutsche Landwirtschaft im technischen Zeitalter* (Stuttgart 1963), 138–48.

⁵ Although von was an integral part of Thünen's name, and not a signification of knighthood, modern German literature invariably omits it; and we shall do so for the sake of brevity.

⁶ As given by Thünen himself, and quoted in all biographical sources. But the church register gives 25th June. *Johann Heinrich von Thünen: Ein Wegweiser durch die Ausstellung über das Leben und Wirken...* (Landesmuseums Oldenburg, Oldenburg 1958), 2.

¹ Quoted in SCHUMACHER, *op. cit.*, 15. The full text of this paper appears in Thünen-Archiv, *Organ für exakte Wirtschaftsforschung*, I (1906), 122 ff.

Here also Thünen first became aware of another of the great influences on his life and work. For here he read the *Introduction to a Knowledge of English Agriculture*,¹ by Albrecht Thaer (1752–1828), the leading German agricultural writer of the time; inspired by what he read, he went to see Thaer at his home in Celle, some 45 miles (70 km) south of Hamburg, in 1803, and spent the summer attending Thaer's seminar at Celle. Thaer had set himself the task of introducing to the Germans the knowledge of the great English eighteenth-century agricultural improvements; he emphasised that the farmer should aim constantly to intensify his system of cultivation, above all through improved crop ratios. Higher levels of investment would as a rule bring higher returns. So Thaer was an enthusiastic proselytiser of the most intensive system of cultivation of all: the so-called "crop alternation" system, in which a grain crop and a non-grain crop regularly alternated. The non-grain crop did not exhaust the soil and might enrich it; in any case it supported extra stock, which put manure back on the land. Thünen came to question Thaer's thesis: he believed that no one system was universally right for all times and places; that indeed the attempt to introduce an intensive system on to a wrong soil would result in diminished returns.² This belief proved to be one of the most important influences in the birth of *The Isolated State*. But Thaer's influence was more than merely negative. From lectures given in Celle, Thünen came to realise the importance of mathematics to the theoretical study of agriculture. Under Thaer's influence he interested himself in the new science of agricultural statics (the science of establishing a state of equilibrium between yields and exhaustion in the soil). This, he thought, would provide a technique for testing Thaer's hypothesis about crop systems; and from then till 1810, his theoretical research was almost exclusively concerned with this essential foundation to his life work.

In 1803, though, Thünen's formal education was not quite complete. From Celle he went to the University of Göttingen, where for two semesters he studied philosophy, biology, economics and languages. Thence, in the summer of 1804, armed with a letter

¹ A. THAER, *Einleitung zur Kenntnis der englischen Landwirtschaft* (Hannover 1798).

² Cf. R. KRZYMOWSKI, *Geschichte der deutschen Landwirtschaft* (Stuttgart 1939), 165 (Third edition, 1961); E. SCHNEIDER, "Johann Heinrich von Thünen und die Wirtschaftstheorie der Gegenwart", *Schriften des Vereins für Sozialpolitik*, N.F. 14 (Berlin 1959), 24; and E. WOERMANN, "Johann Heinrich von Thünen und die landwirtschaftliche Betriebslehre der Gegenwart", *ibid.*, 32–3.

of introduction from Thaer, he embarked on an agricultural tour. He travelled via Saxony to Mecklenburg, where he visited Herr von Berlin, the father of a student friend in Göttingen, and proprietor of the Liepen estate. The youngest of von Berlin's nine children, his daughter Helene, immediately won Thünen's heart. They were married two years later, on 14th October 1806.

On marriage Thünen had to consider where he would pursue his life's vocation as a farmer. The family farm of Canarienhäusen would pass to his younger brother Friedrich; so Thünen decided to look for an estate in his father-in-law's country, far to the east of Friesland, in the province of Mecklenburg. But he postponed final decision in the then troubled political state of Germany and of Europe. As the Napoleonic and Prussian armies fought their way across central Europe, there were a thousand impositions and uncertainties for the farmer: quartering of troops, the requisitioning of horses and men, forage and cattle, heavy taxes, recurrent animal and human epidemics. In the meantime Thünen took a lease on the Rubkow estate near Anklam in western Pomerania, belonging to his brother-in-law. The farm was in poor condition, and caused Thünen to brood long on problems of agricultural improvement. Finally, after inspecting thirteen farms in Mecklenburg, he bought the 1146-acre Tellow estate from his brother-in-law Heinrich Schröder, on 28th June 1810, four days after his twenty-seventh birthday.

Tellow lies 5 miles (8 km) north-north-west of the small market town of Teterow, and 23 miles (37 km) south-east of Rostock, in the administrative district (*Regierungsbezirk*) of Neubrandenburg in the former *Land* of Mecklenburg. The main road from Neubrandenburg to Rostock passes just east of the estate. It lies at just over 40 m (130 ft) above sea-level, in a country of glacial ground moraine, many small lakes, and alluvial marsh. *The Agricultural Atlas of the German Democratic Republic* officially classed the land, in 1956, as "loamy sand—strongly loamy sand". Out of the 21 grades of soil recognised in the Atlas, the soils of the Tellow region rank in the eighth grade; they are ranked 5.5. The best soils, those on the loess of the Halle-Magdeburg *Börde* country, are graded 2 and 2.5.¹

Mecklenburg is a remote land, and in the early nineteenth century it was yet more remote. The pace of economic development in

¹ *Agrar Atlas über das Gebiet der Deutschen Demokratischen Republik* (Deutsche Akademie der Landwirtschaftswissenschaften zu Berlin/Institut für Agrarökonomik, Gotha 1956).

Germany had begun to quicken a little in the far west, along the Rhine and in the towns of Westphalia, but here change came slowly. Mecklenburg, when Thünen first made it his adopted home, was a land with no major navigable rivers and without improved high-ways. Only after his death, in the mid-1860s, did the railway penetrate to Teterow, the town near Tellow; only in the 'eighties did a branch come close to Tellow. The possibilities of commercial agriculture then were poor. And the technical development of Mecklenburg agriculture had been much retarded, first by the Thirty Years' War (1618-48), which had reduced the population of Mecklenburg from 300,000 to 50,000, then by the Northern War (1700-21), then by the Seven Years' War (1756-63). But fundamental change did come, in the late eighteenth century. The age-old medieval three-field system (spring grain, winter grain, fallow) was replaced by the system developed in the province of Holstein to the west, which the Germans call the *Koppelwirtschaft* and which we have translated, throughout this edition, as the improved system. The essential features of the improved system, as with some English improved systems of the eighteenth century, were that it was based on enclosed fields; and that it combined cereal crops and a short grass ley. And a little later, root crops were introduced. One other essential feature of the English improved system was, however, late to develop in Mecklenburg. The grass ley provided pasture; but the lack of transport facilities for dairy products held back the full exploitation of that pasture.¹ These facts are important for our understanding of *The Isolated State*. For though the thesis of the work itself has a general validity unlimited by time or place, the actual working-through of the examples is closely conditioned by the facts of agricultural life as Thünen knew them. It is, as the Germans say, *zeitgebunden*.

We have seen that, in the years up to the purchase of Tellow, Thünen had laid the first foundations of *The Isolated State*, in the study of statics. In this time, too, he had allowed his mind full speculative play, and he had developed many of the basic ideas of *The Isolated State*. But they remained speculations. Thünen realised—and here lay the unique nature of his contribution to economics—

¹ This is based on F. HONCAMP, "Die mecklenburgische Landwirtschaft unter besonderer Berücksichtigung der Zeit von Johann Heinrich von Thünen", in W. SEEDORF and H.-J. SERAPHIM, *op. cit.*, 63-78. This account would indicate that Mecklenburg was strictly speaking outside the area of Thünen's Isolated State, where even the most remote ring could produce milk for conversion into butter or cheese.

that they must be reinforced by detailed calculations taken from reality. This research took the form of laborious investigations into costs and returns on his own estate at Tellow, which took him ten years; the basic bookkeeping was undertaken from 1810 to 1815, and the results were checked from then to the end of 1819; and, as Thünen said in his New Year letter to his brother at the beginning of 1821, the work had proved so colossal that it had precluded almost all other study. But, as the results emerged, they could be fitted directly into Thünen's speculative framework. Thünen had now got what he wanted: an abstract model of an economy, based upon actual facts. In his middle thirties, he had already produced what was to make him, in Schumpeter's words, "one of the patron saints of econometrics".¹ The work itself could now be written fairly quickly. The first draft of *The Isolated State* was produced in 1818-19, but was thoroughly revised in 1824. It was published in 1826.

With the appearance of this, which was to become Part I of his work, Thünen had really completed his major contribution to location theory. Part I reappeared in 1842, revised but not substantially so; and Thünen did continue to develop and revise his location theory between 1826 and 1842, as the fragments published posthumously in 1863 show. But even before 1826 Thünen had turned his attention to the other major inquiry of his life: the study of wages. He had indeed discovered the famous formula for the "natural wage", $A = \sqrt{ap}$, as early as 1830.² But it was not until 1850, the year of his death, that part of the wage theory was published, as Part II, Section 1 of *The Isolated State*.³

All through the years from 1810, Thünen was engaged simultaneously in ceaseless agricultural improvement on Tellow. He was marling, deepening the level of arable soil, improving moor soils, afforesting parts of the estate, increasing the capital stock, creating a big park. In 1840-1 he replaced the six-course rotation, which he had found on the estate when he took it over, by a ten-course rotation on the inner part of the farm and a five-course rotation on the outer part—a system described in the 1842 revision of Part I of *The Isolated State*.⁴ He was an enthusiastic advocate of sheep-rearing,

¹ J. A. SCHUMPETER, *History of Economic Analysis* (1954), 466.

² For the meaning of this expression cf. the text at p. 251 below.

³ Other material appeared in the posthumous fragments published as Part II, Section 2 in 1863; much remains unpublished in the Thünen archives in Rostock.

⁴ O. MIELCK, "Die Wirtschaftsgeschichte von Tellow seit dem Ausgang des Mittelalters", in W. SEEDORF and H.-J. SERAPHIM, *op. cit.*, 48-50.

and doubled the number of sheep on Tellow between 1820 and 1839. And on the basis of his experience he was producing a steady flow of papers on practical agricultural matters, which were published in the local Mecklenburg agricultural journal, the *Neue Annalen der Mecklenburgischen Landwirtschaftsgesellschaft*. The University of Rostock recognised the distinction of his work by granting him an honorary doctorate in 1830.

The last years of Thünen's life were years of intense political activity and revolutionary change in Germany. In the year of revolution, on 15th April 1848, he felt able to carry into operation his long-conceived scheme for profit-sharing on the Tellow estate. In 1848 also he was elected a representative to the German National Assembly, the ill-fated "Professors' Parliament", at Frankfurt-am-Main, but could not take his seat.

Thünen died at Tellow on 22nd September 1850, "quickly and in autumn, when the leaves fall", as he had wished. He was buried in the village churchyard of Belitz, the village next to Tellow. Under his name on the gravestone, following his wish, is engraved his formula for the natural wage: $A = \sqrt{ap}$.

II. THE ISOLATED STATE: GUIDE TO EDITIONS AND TRANSLATIONS: PLAN OF THIS TRANSLATION

Part I of *The Isolated State* contains Thünen's theory of agricultural intensity and of the location of agricultural systems and of crop zones. It was first published in 1826 by Perthes, in Hamburg. A second edition, improved and extended, was published in 1842 by Leopold, in Rostock.

Part II, Section 1 (generally known as II. 1) contains Thünen's wage theory, but starts with a long introduction in which the inquiry of Part I is summarised, and subjects for further inquiry are outlined. It was published in 1850 by Leopold, in Rostock. Thünen himself undertook this edition before his death.

Part II, Section 2 (II. 2) consists of selections of Thünen's posthumous papers dealing mainly with the problems of Part I: taxation, customs duties, settlement policies, the consequences of improved roads and railways. Some of the papers are important because they show the ways in which Thünen wished to develop his inquiry so as to take into account all factors which affect the location of

agricultural production. The selection was made by Hermann Schumacher of Rostock, and was published in 1863 by Hinstorff, in Rostock.

Part III consists of a separate selection of posthumous papers on forestry, also made by Schumacher of Rostock, and published by Hinstorff, in Rostock, in 1863.

The first collected edition of *The Isolated State*, and the only complete one, was edited by Schumacher and published by Wiegandt, Hempel and Parey, in Berlin, in 1876.

A collected edition containing only Part I and Part II, Section 1 was edited by Heinrich Waentig, and published by Fischer, in Jena, in 1910. Further, similar editions came from the same editor and publisher in 1921 and 1930.

A selection of passages from Part I and from Part II Section I, was made by Walter Braeuer, and published as *Johann Heinrich von Thünen: Ausgewählte Texte*, by Anton Hain, in Meisenheim, in 1951.

The most important critical guide to *The Isolated State* is *Thünens Isolierte Staat*, by Asmus Petersen, published by Parey, in Berlin, in 1944. It is nothing less than a detailed companion to the work, and it is indispensable to the serious student of Thünen. It forms the basis of the analysis in Part III of this introduction below.

A French translation of Part I of *The Isolated State* was made by Jules Laverrière and published in Paris in 1851.¹ A translation of Part II, Section 1 was made into French by Mathieu Wolkoff and published in Paris in 1857.² Wolkoff also translated *The Isolated State* into Russian; this translation was published in Darmstadt in 1857.³ An Italian translation appeared in Turin in 1860 and was published in a journal in 1875.⁴ A Czech translation appeared in Prague in 1926.⁵

Part II, Section 1 was translated into English by Bernard Dempsey and was published as part of his book *The Frontier Wage*, in Chicago in 1960.⁶

¹ J. LAVERRIÈRE, *Recherches sur l'influence que le prix des grains, la richesse du sol et les impôts exercent sur les systèmes de culture*. Paris, 1851.

² M. WOLKOFF, *Le Salaire naturel et son rapport au taux de l'intérêt*. Paris, 1857.

³ M. WOLKOFF, *Uedinennoe Gosudarstvo v otnosenii k obscestvennoj ekonomii*, Karlsruhe, 1857.

⁴ *Ricerche sull'influenza che il prezzo del grano, la ricchezza de suolo e le imposte esercitano sui sistemi di coltura*, Turin, 1860. Appeared in *Biblioteca dell' Economista*, 2a serie, Torino, 1875, 819-1046.

⁵ *Tschechische Uebersetzung anlässlich eines Kongresses zum 100. Jahrestag des "Isolierten Staates"*. Prag, 1926.

⁶ *Op. cit.*

The present translation has been prepared specifically for students of location theory. It presents in full most of Part I, summarising only some of the detailed calculations of yields and costs, and omitting a long discursion into agricultural statics which has little organic connexion with the rest of the work. It presents a new translation of the introduction to Part II, Section 1 (which also appears in Dempsey's translation) but then presents only a bare summary of the rest of II. 1, which is accessible in full in Dempsey's version. But it gives in full most of the important Chapter 19, where Thünen develops his concept of marginal productivity, because this concept is of interest to the student of Part I. Lastly it presents extracts from II. 2, which are important for students of location theory. These extracts are in a sense exhumed for the English edition, because they have not appeared in the German editions since that of 1876.

III. GUIDE TO THE STRUCTURE OF THE ISOLATED STATE

Krzymowski, one of the major figures of German agricultural studies, published his history of German agriculture in 1939, near the end of his career. It is a model of lucid exposition. Yet of Thünen and his book he had to write:

About this book an enormous amount has been written, and there is still no end to the literature on Thünen. The doctoral dissertations which have appeared in Germany on Thünen's theories alone run into several hundreds. And Thünen's work is in fact an inexhaustible mine. But it is a book that is difficult to read; I myself have found no book on agriculture such heavy going as von Thünen's. The beginner, who wants to study Thünen, would do well first to prepare himself, by reading relevant text and handbooks, for the closer study of von Thünen's work.¹

Fortunately, five years after Krzymowski published this, there appeared Petersen's commentary. The analysis which follows of the main lines of Thünen's thesis is largely based on this work. But it is necessarily a bald summary. The serious student of Thünen would be well advised to turn first to Petersen.

Petersen first disposes of two common misconceptions in Germany about Thünen. There the book is thought difficult because of the old-fashioned measurements and weights and currencies which Thünen used (the decimal system was introduced in Germany only in the

¹ R. KRZYMOWSKI, *op. cit.*, 172.

second half of the nineteenth century, and there was a proliferation of local measures when Thünen wrote), and because of the mathematical formulae in which the book abounds. Both ideas are unfounded. One soon becomes familiar with the measures used (and, it should be said, modern British readers may at least have less difficulty than modern Germans); and the formulae soon prove to depend on relatively simple mathematics. (A guide to measurements and currencies appears in the alphabetical glossary of terms before the present translation at pp. xlix-liv.) We can then turn to the book itself with less apprehension.

Part I starts with a brilliant, and celebrated, summary picture of *The Isolated State*. It can only be quoted in full.

Imagine a very large town, at the centre of a fertile plain which is crossed by no navigable river or canal. Throughout the plain the soil is capable of cultivation and of the same fertility. Far from the town, the plain turns into an uncultivated wilderness which cuts off all communication between this State and the outside world.

There are no other towns on the plain. The central town must therefore supply the rural areas with all manufactured products, and in return it will obtain all its provisions from the surrounding countryside.

The mines that provide the State with salt and metals are near the central town which, as it is the only one, we shall in future call simply "the Town".

The problem we want to solve is this: what pattern of cultivation will take shape in these conditions?; and how will the farming system of the various districts be affected by their distance from the Town? We assume throughout that farming is conducted absolutely rationally.

It is on the whole obvious that near the Town will be grown those products which are heavy or bulky in relation to their value and which are consequently so expensive to transport that the remoter districts are unable to supply them. Here also we find the highly perishable products, which must be used very quickly. With increasing distance from the Town, the land will progressively be given up to products cheap to transport in relation to their value.

For this reason alone, fairly sharply differentiated concentric rings or belts will form around the Town, each with its own particular staple product.

From ring to ring the staple product, and with it the entire farming system, will change; and in the various rings we shall find completely different farming systems.

Two things need to be noticed about this opening statement. The first is that Thünen makes immediately clear the nature of his method. It is the method of *idealisation*. In the first draft, it is significant that the title was *The Ideal State*: that is, the *idea* of a State. We are dealing here with the world's first economic model, and one which proves to be extraordinarily completely developed. Thünen

himself found it necessary to defend, in the preface to the 1842 edition, this novel method of analysis:

I hope that the reader who is willing to spend some time and attention on my work will not take exception to the imaginary assumptions I make at the beginning because they do not correspond to conditions in reality, and that he will not reject these assumptions as arbitrary and pointless. They are a necessary part of my argument, allowing me to establish the operation of a certain factor, a factor whose operation we see but dimly in reality, where it is in incessant conflict with others of its kind.

This method of analysis has illuminated—and solved—so many problems in my life, and appears to me to be capable of such widespread application, that I regard it as the most important matter contained in all my work.

The model, then, works by assuming that most of the factors which normally co-determine the location of agricultural production are either uniform or unique, so putting them temporarily at rest: the climate, the quality of the soil, the existence of alternative supplies or alternative markets, the quality of management, the character of the transport network. Thus one can isolate the operation of one factor: transport costs, as an expression of distance. This Thünen does deliberately, with the full intention of later relaxing his assumptions, one by one. The method essentially assumes that one factor can be independently varied without affecting the fixed assumptions; and on that ground it has been criticised for logical inconsistency.¹ But the criticism should not detract from the fact that here is the first use of the method of "fiction", of "As if"; a method which received philosophical recognition only two generations later, in the work of Vaihinger.² From the basic concept of fiction Thünen comes

¹ Carell has argued as follows (my paraphrase): Thünen assumed constant gross product for any given cultivation system at every distance from the market (expressed in grain); and constant costs, including constant labour costs expressed as money or grain. But a constant gross product is possible only if real (grain) wages are constant, money wages falling with the fall in grain prices. Thünen however assumes constant money wages, which imply a rise in real (grain) wages with increasing distance from market. This is inconsistent with his assumption of a stationary or static state; for it implies that workers are blind to differences in real wages. Carell's solution is to abandon the assumption of a static state, and then to allow the other Thünen assumptions. "Situation rent" then becomes a form of "intensity rent" produced by extra applications of (cheaper) labour near the market. E. CARELL, "Die Lagerente", *Zeitschrift für die gesamte Staatswissenschaft*, 106 (1950), 473-91. Thünen realised this inconsistency (Carell says elsewhere), but thought that partial analysis could be justified on the *ceteris paribus* argument. Cf. E. CARELL, "Johann Heinrich von Thünen und die moderne Wirtschaftstheorie", *Zeitschrift für die gesamte Staatswissenschaft*, 106 (1950), 600-10.

² A. JACOBS, "Johann Heinrich von Thünen als Lehrmeister der Statistik", in W. SEEDORF and H.-J. SERAPHIM, *op. cit.*, 161-9; E. GUTENBERG, *Thünen's Isolierter Staat als Fiktion* (Bausteine zu einer Philosophie des "Als-Ob"). 4. Bd., Munich 1922).

directly to this technique of isolation. But Thünen's originality does not end there. He is not content to isolate the force of one factor in a situation, and to find a mathematical expression for it; he must then fit to his formulae detailed empirical data, taken from his experience at Tellow. The result is an astonishing pioneer triumph of econometric model construction. In 1958 Schneider, the German economist, said of Thünen's achievement:

... here the importance of model construction for the understanding of reality is made evident with unsurpassable lucidity and forcefulness... And within the area of his model, the Isolated State, he now shows with great care the importance and fruitfulness of partial analysis, which he handles with masterly virtuosity... Thünen shows us that neither experience alone, nor theoretical speculation, can illuminate the unfathomable sea of reality... His work is econometrics in the best sense of the word.¹

The second point concerns the objects of Thünen's inquiries in Part I. Here he is concerned to analyse the pattern of agricultural production around the central Town, as affected by distance. But in the paragraphs of his opening chapter which follow the quotation above, he writes of the *direction* of agricultural production, the nature of the main crop produced. Only in the last paragraph of his opening section does he imply, rather obscurely, that as the main product changes, so does the whole *system* of agriculture, the way crops are produced. This introductory obscurity has been the source of the most fundamental confusion about the whole of Thünen's analysis; indeed one may say that the majority of critics and commentators have been guilty of it, and that Petersen's work was concerned to remedy it.

For the most important fact about *The Isolated State*, as Petersen emphasised, is that it has *two* aspects, *two* main objects of inquiry; that these are to a large extent separable; that they are indeed separated in the book, though its formal organisation, in three sections, obscures the point. The *first* inquiry can be summarised thus: A given crop, say a grain crop, may be cultivated under different systems, some more intensive than others; that is, some systems involve higher costs than others, but (in the right circumstances) they bring higher returns. We may find that though the crop is the same, it is produced by an intensive system in one place, an extensive system in another. How, Thünen asks, is this variation related to distance from the sole consuming market?

¹ E. SCHNEIDER, *op. cit.*, 17, 19. Cf. M. CHISHOLM, *op. cit.*, *passim*.

The second subject of inquiry is the one Thünen stresses in this opening quotation. As well as the same crop being grown in different places under different systems of intensity, the crop itself may vary. How is this phenomenon related to distance from the market?

These two subjects must not be confused. There is an intensity theory and a crop theory. But the crop theory is not a theory of intensity. It has indeed something to do with intensity; but the main factor is something other.

Thünen's first major analysis is concerned with the intensity theory. He develops this in Chapters 4 to 18, and then in Chapters 21 to 23 he describes the pattern of "intensity rings" which develop for a given grain crop. In all these chapters he is concerned directly only with one crop, the most important of crops, grain; but the analysis could be applied to any other one crop.

Thünen's intensity theory says that the intensity of production will, other things being equal, depend on the price the farmer gets for his grain, and that this will depend directly on transport costs and thus on distance from the sole market. In Chapter 4 he therefore starts by finding a formula for the farm price of grain. Up to now he has worked in purely hypothetical terms. Now he must introduce reality. He gives transport costs per mile and these are based on actual conditions around Rostock at the time he wrote. But notice that these are empirical facts fitted into a model; the model remains; this is not itself a description of reality.

The formula for the net farm price is based on a market price of 1.5 thalers per bushel. That price is determined conjointly by the size of the town demand and by the costs of the marginal producer (the farmer who just finds it profitable to get his grain on the market). This hypothesis is maintained almost throughout, being relaxed only in a chapter on intensive systems of grain production (Chapter 16) and one on taxation (Chapter 35), as well as in the famous diagrams at the end of the book, which, Thünen was concerned to point out, were not important to the understanding of his thesis. From this fixed market price, transport costs are subtracted. The actual formula produces a complicated sliding scale, in which farm price falls progressively more slowly with increasing distance from the market.

Now Thünen has the farm price he can study the output of the farm and the costs which must be balanced against price. First, in Chapter 5, he studies output and costs under a system of middle

intensity: the Improved (Koppel) System. The data are based on the Tellow accounts of 1810-19 but are applied to a poorer soil which Thünen used as standard throughout the Isolated State. (This is theoretically inadmissible and leads to errors, but these are small.) They are also applied throughout to a standard area slightly smaller than Tellow: 100,000 square rods or 217 ha. Thünen's fundamental assumption about costs is that they fall into two groups. One group of costs originates on the farm and can be expressed in grain. Agricultural wages are a good example; they then chiefly represented means of subsistence, and a quantity of grain was the direct measure of that. Seeds, manure and draught animals are other "farm-based" costs. But a smaller proportion represented things that had to be bought for money from the town; for instance, agricultural implements made in town workshops. Thünen determined that at all times and under all systems (not just the improved system, which we are considering at the moment) $\frac{3}{4}$ of costs should be rendered in grain (as "farm-based" costs) and $\frac{1}{4}$ in money (as "town-based" costs). This distinction is important because finally both sets of costs have to be rendered in money, and when this is done the "farm-based" costs will vary directly with grain prices (that is, they will decrease as grain price decreases, away from the town); but "town-based" prices, which are rendered already in money, remain fixed. (Actually, they should rise away from the town, because these products will incur rising transport costs; curiously, though fortunately for the sake of simplicity, Thünen's formula takes no account of this.) The result is that since only a part of costs falls with falling grain price, while the other part remains fixed, *costs fall more slowly than grain prices away from the market*, and thus there must come a point where the surplus of grain, expressed in money, can no longer meet the fixed money costs. A numerical statement for the improved system will make this clear. On a standard unit of 100,000 square rods, in the Isolated State, this system gives a gross product of 3144 bushels of grain. The total costs, expressed $\frac{3}{4}$ in grain and $\frac{1}{4}$ in money, are 1976 bushels and 641 thalers. Subtracting, this means that the farmer has left a surplus for sale of 1168 bushels, but still has to find 641 thalers to cover his "town-based costs". All now depends on the farm price at which the farmer can sell his grain surplus. Let us look at this at the critical margin, between 25 and 30 miles from the market.¹

¹ Cf. PETERSEN, *op. cit.*, 65.

Miles from market	Price of grain on the farm per bushel th	Gross product in money th	"Farm-based costs" in money th	Market surplus for sale in money th	Fixed "town-based costs" in money th	Net product or land rent under improved system in money th
25	0.656	2062	1296	766	641	125
28.6	0.549	1726	1085	641	641	0
30	0.512	1610	1012	598	641	-43

As the price of grain falls away from the market, so do gross product and "farm-based costs", both converted from grain into money. The difference between them, or the "surplus for sale", falls too. But the "town-based costs" remain constant, and there must come a point where the "surplus for sale" can no longer meet this burden. The point at which this will occur is implicit in the nature of the formula: it is the point at which 1168 bushels of grain (the surplus expressed in grain) will fetch exactly 641 thalers in money. The calculation shows that this happens 28.6 miles from the market, and here is the marginal farm under the improved system. At all sites nearer than this, when the fixed costs are subtracted from the residual surplus, there remains a net product, or land rent. This is pure situation rent, arising from the more favourable situation of the site as compared with the marginal site.¹ It is purely a function of the more favourable farm price near the market, costs (in grain and money) remaining constant. In the table above, the situation rent 25 miles from the market, or 3.6 miles nearer the market than the marginal farm, is 125 thalers per 100,000 square rods.

¹ This statement is true for all sites as long as we consider the improved system in isolation, as the only possible system. In comparison with a less intensive system (e.g. the three-field system), we shall shortly see that rent under the improved system may include an element which arises from a factor other than situation. This second type of rent does not however arise on a site 25 miles from the market, so the statement above remains true.

"Situation rent" is similar to the "fertility rent" enjoyed by producers in physically-superior locations (better soil, kinder climate or superior aspect). Strictly speaking this latter type of rent does not exist in the Isolated State, where the soil is of uniform fertility; but Thünen does discuss it in order to understand reality better. For a discussion see I. BRINKMANN, "Die von Thünensche Rentenlehre und die Entwicklung der neuzeitlichen Landwirtschaft", *Zeitschrift für die gesamte Staatswissenschaft*, 107 (1951), 311.

In Chapters 12 and 13 (supplemented by calculations in Chapters 7 to 11) Thünen calculates in a similar way the rent formula for the less intensive three-field system. It is in the nature of this system that it gives a lower gross product but that it involves lower costs. The precise comparison between the two systems is set out below.

Per 100,000 square rods:	Improved system	Three-field system
Gross Product	3144 bushels grain	1720 bushels grain
Costs	1976 bushels and 641 th	1024 bushels and 327 th
Land Rent	1168 bushels minus 641 th	696 bushels minus 327 th

It is important to keep in mind the exact nature of the land rent formulae shown above. Each formula contains a fixed surplus of grain, available for sale; but from the proceeds of that sale must be subtracted a fixed burden of money costs. The improved system enjoys a bigger grain surplus than the three-field system; but it bears a bigger burden of money costs. (In fact the *percentage* increase in costs is greater than that in product: but *absolutely* there is an increase in the surplus for sale.¹) It can afford these only if the price of grain is high; that is, near the market in the Isolated State. As we move away from the market, the farm price of grain falls, and this causes the land rent of the improved system to fall faster than that of the three-field system, because with lower prices the bigger grain surplus of the improved system is progressively less capable of meeting the relatively higher money burden associated with the system. At a distance of 24.7 miles from the market, the formulae give equal rents for the two systems, expressed wholly in money; from then on the three-field system yields a higher rent and will therefore take over from the improved system according to the rules of a free economy. At 28.6 miles the improved system ceases to yield any rent and would necessarily disappear anyway; at 31.4 miles the three-field system ceases to yield rent and will disappear, so that cultivation stops here.

¹ Cf. I. BRINKMANN, *op. cit.*, 315.

Miles from market	Price of grain on the farm	Land rent under improved system	Land rent under three-field system	
20	0.809	304	236	(Improved wins)
24.7	0.665	136	136	(Equal advantage)
25	0.656	125	130	(Three-field wins)
28.6	0.549	0	55	(Improved yields no rent)
30	0.512	-43	29	(Improved yields negative rent)
31.4	0.470	-92	0	(Three-field yields no rent; cultivation ends)

To put the matter in exact numbers: the less intensive three-field system works on a basis of a surplus of 696 bushels minus 327 thalers; it becomes viable where 696 bushels fetch 327 thalers, that is at 0.47 thalers the bushel, which price obtains at 31.4 miles from the market. The more intensive improved system works on a basis of 1168 bushels minus 641 thalers; compared with the three-field system it bears twice the money costs, but it enjoys less than twice the market surplus of grain, reflecting the operation of the law of diminishing returns following intensification. In *absolute* terms however the increase in grain surplus is large. The system produces 472 extra bushels but they have to bear 314 extra thalers; that is each extra bushel costs 0.665 thalers to win. This is only economic when the price of grain reaches the level of 0.665 thalers per bushel, that is at 24.7 miles from the market. From this point inwards towards the market, the extra bushels which the improved system produces continue to cost 0.665 thalers to win, but they are sold at a price which progressively rises higher than this. As compared with the three-field system, the more intensive improved system is here producing an *extra* surplus, which should properly be called *Intensity Rent*. This is additional to the basic *Situation Rent*, which more favourably sited farms cultivated on the three-field system would also enjoy. At the market itself the "intensity rent" of the improved system rises to a maximum of 394 thalers: 1111 thalers minus the 717 thalers of "situation rent" which the three-field system would have produced there anyway.

This then is the Thünen system of intensity. It says essentially that (given a certain level of soil fertility) at higher net farm prices, that is at sites nearer the market, it will pay to choose a more intensive system of cultivation, in which a higher level of cost is associated with a later point of diminishing return. This point is however brought out fully only in Part II, Section 1 of the *Isolated State*, where in Chapter 19 Thünen develops the concept of the marginal productivity of units of labour applied to land.

The concept of marginal productivity does however implicitly underly the first Part of *The Isolated State*; and it may be approached through a simple illustration. Imagine that land, everywhere of equal fertility, may be cultivated for wheat at varying levels of intensity. On each acre of land the farmer may apply one unit of capital, or two, or more; each application will bring forth an additional return, but, because of the law of diminishing returns, each additional return will be smaller than the last. Imagine further that the wheat is worth \$1 at market, and that everywhere there are uniform transport costs of 2½c per bushel per mile; so that at a farm 10 miles from market wheat will be worth only 75c a bushel, at 20 miles only 50c, and so on. The following table may now be produced (all figures apply to 1 acre of farm land):

Applications of capital	Cost of each application	Total crop bushels	Extra crop bushels	Value of the extra crop resulting from the extra \$1 application of capital at transport costs of 2½c, per bushel per mile				
				at market	10 miles	20 miles	30 miles	35 miles
				where farm price will be:				
				\$1	75c	50c	25c	12½c
1	\$1	4	4	\$4	\$3	\$2	\$1	50c
2	\$1	6	2	\$2	\$1.50	\$1	50c	25c
3	\$1	7½	1½	\$1.50	\$1.12	75c	37½c	18½c
4	\$1	8½	1	\$1	75c	50c	25c	12½c
5	\$1	9	½	50c	37½c	25c	12½c	6½c

The values shown here in heavy type are the marginal values: that is, they are the values where production ceases to be profitable. Below

them, the italicised values indicate losses. At the marginal points, the total costs and returns are:

	At market	10 miles	20 miles	30 miles	35 miles
Total costs per acre	\$4.00	\$3.00	\$2.00	\$1.00	—
Total crop per acre (bushels)	8½	7½	6	4	—
Total value of crop	\$8.50	\$5.60	\$3.00	\$1.00	—
Surplus rent per acre	\$4.50	\$2.60	\$1.00	nil	—

Thus intensification brings a higher rent; but as compared with the less intensive methods, it stops being profitable at smaller distances from the market.

Here the farmer is allowed a very free choice. He may apply successive dollars of cost and consider the profitability of each. In reality it is not usually so easy for the farmer. He has in effect a choice between two or three fully developed agricultural systems, with certain levels of costs and returns. This is the choice Thünen gives the farmers in Part I of the *Isolated State*, although he stresses the importance of transitional forms. It is mainly because of this that the concept of marginal productivity does not appear with any clarity in Part I.

But there is another main subject of study in *The Isolated State*, and it is if anything the central study. That is the general location theory for a number of different agricultural products, which is developed in Chapters 19 to 32.¹ It is important at the outset to emphasise that the pattern of location which Thünen describes in these chapters in no way follows any simple rule of intensity. Thus in the second ring, between 4 and 7.3 miles from the market, there is forestry, a very extensive activity; within this zone, the firewood producing part, which is more extensive, is inside the more intensive structural timber part. And in the sixth or outermost ring we find a whole series of intensive cash crops such as oilseeds, hops, tobacco and flax. Intensity provides no explanation; and that explanation must be sought elsewhere.

It is necessary to stress this point because even in the German literature, which is based on a long tradition of Thünen study, there has been the most fundamental confusion about it. Again and again

¹ Cf. the commentary by PETERSEN, *op. cit.*, Ch. 8.

the statement recurs that "the central feature of the Thünen system is that intensity of cultivation rises towards the market". Weigmann asserts this, in his account of Thünen's location theory published for the 150th anniversary of Thünen's birth;¹ Theodor Brinkmann, perhaps the leading worker on agricultural location theory in twentieth-century Germany, says it at one point of his analysis:

Districts near the market—that is, districts with favorable economic locations—are therefore districts of intensive methods of farming. Districts far from the market—that is, districts with unfavorable economic locations,—are the areas of extensive methods of farming. In the "isolated state" the optimum degree of farming intensity reaches its maximum in the immediate vicinity of the market, its minimum where communication with the market disappears entirely and agriculture becomes a purely self-sufficing economy. . . . Zones near to the market are locations of specifically intensive types of land use. Zones at a distance from the market are locations of specifically extensive types of land use. Increasing intensity of land cultivation therefore means not only increasing expenditure in cultivating the given crops but at the same time a change to specifically intensive crops.²

Brinkmann is led to this conclusion from the observation that the spread between the prices of agricultural products, and those of the production goods necessary (agricultural costs) is greatest near the market; the greater the spread, the greater the number of units of cost that can be applied before, under the operation of the law of diminishing returns, the marginal point is reached. (Cf. the simple arithmetical explanation on p. xxix.) This is perfectly true for any one crop. But in comparing two different crops, we are dealing with two different patterns of costs and returns. In this analysis it is necessary to use the words "intensive" and "extensive" very carefully, in their strict sense: to refer to the number of cost inputs that are applied up to the economic margin. This concept has no necessary connexion with physical yield. One of the two crops may have very low production costs, per unit of weight of product, but nevertheless (because of the relationship to price) experience diminishing returns quickly, so that the margin is soon reached, and the pattern of production remains extensive. Nevertheless, if the yield is relatively high compared with other crops (and it may be, even though cultivation is extensive; recall that there is no necessary connexion) then the

¹ H. WEIGMANN, "Standortstheorie und Raumwirtschaft", in W. SEEDORF and H.-J. SERAPHIM, *op. cit.*, 139.

² Theodor Brinkmann's *Economics of the Farm Business* (English translation of *Die Oekonomie des Landwirtschaftlichen Betriebes* (Tübingen 1922, being part of Vol. VII of *Grundriss der Sozialökonomik*)) (Berkeley 1935), 14, 20. But cf. his analysis later on pp. 86–7, where he correctly interprets the relevant passage in Thünen.

product will be produced near the market. Forestry is the example of this in the Thünen system. Or the opposite may occur. In the *Isolated State*, industrial crops, like grain for distilleries and flax, have high production costs, per unit weight of product, but they can bear a considerable number of cost *increments* without showing diminishing returns, i.e. they are intensively cultivated. Yet if such crops also show relatively low weight yields per acre (through being compressed or processed for the market as the commercial crops invariably are) they become highly transportable, and can and will be cultivated far from the market.

It will perhaps be evident from this that the analysis which must be made is a fairly complex one; several factors enter into it. In considering the production of a single crop under a single system, we have seen that only one factor—the farm price—varied. When we came to consider the production of a single crop under alternative systems, the farm price still varied (though for any crop at one place it was the same, whatever the system); but in addition the gross output, and the costs per unit of area, varied under the one system as against the other. When we come now to consider the production of alternative crops, we have to reckon with the fact that all these variations will be repeated for each crop; for every crop cultivated under a given system there will be a certain level of gross output per acre, costs per acre, and a range of farm prices depending on the transportability of the crop. The precise advantage which one crop derives from cultivation near the market may be very different from the advantage derived by another crop. To discover which crop will produce the highest returns at any particular distance from the market, it is then necessary to analyse *all* costs that go into its production.¹ When this is done, the general rule will be that the site nearest the market will be appropriated by that product which experiences the greatest cost reduction nearest the market, or in other words, the greatest cost increase away from the market.² When this happens (and only then) will private advantage and social gain both reach their maximum. For the interests of consumers will best be

¹ As I. Brinkmann points out, Thünen observed that the choice is invariably more complex even than this; for crops are not usually grown by themselves, but combined with other crops in agricultural systems. Cf. I. BRINKMANN, *op. cit.*, 323-4.

² This concept is the same as Th. Brinkmann's "Ground Rent Index": the product with the highest "ground rent index", will preempt the site nearest the market. Cf. TH. BRINKMANN, *op. cit.*, 78-99. Petersen also drew attention to this fact. PETERSEN, *op. cit.*, 97.

served when production is so arranged that for a particular location near the market, that product preempts the area which saves the greatest sum of total costs by location near the market; but in doing so, it will produce the highest ground rent.¹ The rules of advantage from the supply and demand side, for the individual proprietor and the many consumers, for what the Germans call *Privatwirtschaft* and *Volkswirtschaft*, prove to be the same.

This pattern of "cost reduction" is to be found from the patterns of costs per load transported to the market, multiplied by the number of loads lifted from the unit area of land. The product gives us the total costs involved in raising a crop from a given area of land, and then getting that crop to market. But Thünen finds it is simplest to present the sums in terms of costs per load, and to make the variation in other costs accordingly, in terms of the load; we will follow him.

Let us produce a simple case. Imagine that grain is being produced everywhere in the *Isolated State*, but that farmers are considering whether to grow other crops instead. These are the cost data for grain at varying distances from the market:

Grain	Thalers per load			Total
	production costs	transport costs	land rent	
0 miles	30	0	10	40
5 miles	25	10	5	40
10 miles	20	20	0	40

The total of all three costs is the same for the one crop at every site. That follows from the nature of rent as a residual: it merely expresses the saving in the other two sets of costs, as compared with the least advantageous site (the marginal site) where no land rent is produced; here, the site 10 miles from the market.

Now consider four possible alternative crops. We are going to assume that the transport costs, *per load*, are in all four cases the same as for grain. That would be the case, unless they had some special peculiarity (such as extreme perishability, which required

¹ Cf. E. WOERMANN, *op. cit.*, 41. Notice that here the successful product is producing a *third* type of rent, over and above "situation rent" and "intensity rent"; it might be called "displacement rent". Cf. I. BRINKMANN, *op. cit.*, 328 n.

specially rapid transport, or (in a day later than Thünen's) refrigeration plant. But production costs and land rent may vary.

Now the point about the comparison is that the farmer must consider for each crop not merely the production costs, and the transport costs, but also *the land rent which grain would produce on any given site*. The reason is that only in this way can we see the relative advantage of producing the crop in question, as against grain. If the new crop is to displace grain, it does not merely have to produce a land rent, but a land rent bigger than the rent grain would produce; because grain is there, and has to be displaced. (Of course it is all the same if grain is not there, but only potentially there.)

Consider a first alternative crop. It has the same yield per unit of area as grain. That means that we can directly substitute the grain land rent figures above. The production costs of this crop, per load (and per unit of area, since we assume equal yields) are however only half those of grain.

Crop 1	Thalers per load			Total
	production costs	transport costs	equivalent grain land rent	
0 miles	15	0	10	25
5 miles	12½	10	5	27½
10 miles	10	20	0	30

Here, production is more profitable near the market than that of grain, and the crop will displace grain.

Consider a second, opposite case. Again the yield, per unit of area, is the same as with grain. But this time the production costs, per load, are double those of grain.

Crop 2	Thalers per load			Total
	production costs	transport costs	equivalent grain land rent	
0 miles	60	0	10	70
5 miles	50	10	5	65
10 miles	40	20	0	60

Here production is unprofitable, compared with grain, anywhere within 10 miles of the market. This crop will be produced very far from the market, and grain will not be displaced from its position near the market.

From these two cases, we can conclude that with equal yields per acre, the product with the lower production costs (per load) will be cultivated nearer the market, and vice versa. According to this general rule, production of crops will be distributed round the market according to rising production costs. This is because, in the Thünen system, production costs fall away from the market. A product in which production costs loom especially large will therefore be produced in the area far from the market, where production costs generally are lower.

Consider a third, slightly different case. This crop has double the yield, per unit of area, that grain has. Or, to put it in a slightly more convenient way for our purpose, it has only *half the land requirement of grain*.¹ The same amount of land, which would produce two loads of the new crop, would produce only one of grain. The land rent for grain, considered in terms of a load, will only be half that of the new crop. But in this case production costs, per quantity of product, are equal.

Crop 3	Thalers per load			Total
	production costs	transport costs	equivalent grain land rent	
0 miles	30	0	5	35
5 miles	25	10	2½	37½
10 miles	20	20	0	40

Here total costs near the market are lower than for grain. The crop will displace grain.

Consider a fourth case, opposite to the third. This crop has only half the yield, per unit of area, of grain. A given load of the crop therefore only bears half the grain land rent; or in other words, per load, the land rent of grain itself is double that of the product. Again production costs, per quantity of product, are equal.

¹ Cf. I. BRINKMANN, *op. cit.*, 325-6.

Crop 4	Thalers per load			Total
	production costs	transport costs	equivalent grain land rent	
0 miles	30	0	20	50
5 miles	25	10	10	45
10 miles	20	20	0	40

This crop can be grown as profitably as grain 10 miles from the market. Outside that range it will begin to displace grain; but nearer the market grain will not be displaced.

From these third and fourth examples we may draw another general conclusion. With equal production costs per load, the product with the higher yields must be produced nearer the market; and vice versa. According to this second general rule, production will be ordered around the market according to a pattern of falling yields.

The reason for this lies in transport costs per unit of productive area. A product with high yield per unit of area has to carry high transport costs because it produces more loads to be carried. In the case of Crops 3 and 4 above, this is expressed in terms of the grain land rent, which represents saved transport costs for grain. Crop 3 bears double the transport cost, per unit of area, that grain does; or inverted, in comparison with crop 3 grain bears only half the transport costs, per unit of area; or in other words, it bears only half the land rent per load.

The comparison of four crops made here is a very simple one. I have done this deliberately, for the sake of clear exposition. Thünen's own is more complex; it is made on pp. 114-118 of this edition of *The Isolated State*.¹

Petersen considers Thünen's calculations, and the resulting laws of location for agricultural products, in great detail. He concludes that the laws suffer from two limitations. One is that the first law is *zeitgebunden*. Thünen makes his production costs decline away from the market, because three-quarters of them consist of grain, which is cheaper away from the market. This answered to reality in Thünen's day. But since then an increasing proportion of agricultural production costs have become costs of industrial, town-based products, which if anything will become more costly away from the market.

¹ Cf. Petersen's analysis of it; PETERSEN, *op. cit.*, Ch. 8.

The other limitation is perhaps of greater theoretical importance. Both laws work only for those products for which they are in agreement. That is, they apply for products which show higher yields accompanied by lower production costs and for products which combine lower yields and higher production costs. But for products which show contradictory tendencies—for instance, in the case of one product compared with another which has higher yields *and* higher production costs—the laws will not resolve the location question; they will not tell us which product will be cultivated nearer the market. In that case it is necessary to work from separate formulae for production costs, transport costs, and land rent of the alternative product, for each product. This rather laborious technique is of general application, and its results have a general validity.

But for most products the laws do work, and on their basis it is now possible to understand more clearly why certain products are grown where they are in the Isolated State. Forestry¹ is carried on near the market, because as compared with grain it has both high yield per unit of area (partly because the whole area is in production), and low production costs per load. Given the very poor and expensive transport which Thünen assumed as the basis of the Isolated State, this is correct. But even then, as Thünen himself points out, it was often not correct in reality, because many if not most towns lie on navigable water, which does not exist in the Isolated State. Besides, fertility and topography play a large part in the real world.

Butter² is a very interesting extreme case of a product produced far from the market. It has a very low yield per unit of area (or a high "land requirement"). It also has high production costs but they fall very rapidly away from the market, because they consist mainly of grain. Essentially therefore, it is not excluded from the locations near the market by inability to pay the rent; as Petersen says, it seeks distant locations of its own accord.

Wool³ is an even more extreme case; it has higher production costs and an even lower yield (high land requirement). Therefore it should occupy the outermost place of all within the cultivated area of the Isolated State. Much of Thünen's description of sheep farming, in Chapter 30, is devoted to explaining why this was not the case at the time he wrote, due solely to short-term inelasticities

¹ Cf. PETERSEN, *op. cit.*, Ch. 9.

² Cf. PETERSEN, *op. cit.*, Ch. 10.

³ *Ibid.*

in the supply of certain types of wool. The position righted itself shortly after Thünen's death, and wool-production occupied the place he had assigned it.

Perhaps the most interesting locational case of all is presented by the industrial crops,¹ which Thünen discusses in Chapter 31. These provide the most direct contradiction of the common misapprehension that intensive crops are grown near the market, because they are intensively cultivated in the outermost ring of all. They tend to have low yields compared with grain, and very high production costs per load. Chicory² is the sole exception: it had higher yields and lower production costs. In the same class as the majority of commercial crops are crops grown specially for industrial production; for instance, grain grown for distilleries, which is found in locations where grain for flour would not bear the land rent. Because such crops are reduced in weight, the effective yield, per unit of area, is very low. Because the reduction in weight involves manufacturing costs on top of purely farm costs, the costs of production are very high. Such products will positively seek the farthest locations.

Is there, then, any relation at all between intensity and the crop pattern in the Isolated State? Petersen attempts an analysis of this difficult question.³ His answer is that there is, but not a simple one. The common idea that intensive crops are grown near the market depends on a vague assumption that there is some necessary connexion between *yield* and *intensity*; that crops with a high yield per acre involve high basic costs per acre, and vice versa. But this is only partly true. Admitted, there are few products with a high yield per acre and low basic costs. (Forestry is the obvious example in the Isolated State.) But there are many cases of the opposite: products with low yield per acre and high basic costs. The commercial and industrial crops of the sixth ring mainly fall into this class. Nevertheless, when one has said all this, the predominant impression is one of rising intensity towards the town. Wool, meat and butter production all have a low intensity and are produced far from the town: vegetables, milk and potato production have a high intensity and are produced near; grain has intermediate characteristics and occupies the intermediate positions. The two conspicuous exceptions are forestry in the second ring and industrial crops in the sixth.

¹ *Ibid.*, Ch. 11.

² For processing, not for use as a vegetable.

³ *Ibid.*, Ch. 12.

Petersen drew repeated attention¹ to the misleading quality of the famous graphical illustrations in *The Isolated State*, if considered apart from the analysis. These easily give the impression that the rings are intensity rings, because in ring 2 the distinction between firewood and constructional timber, and in ring 6 all mention of the commercial crops, are omitted. In addition the diagrams include a crop system for grain cultivation—the so-called crop alternation system—which has no actual place in the Isolated State, and which Thünen considered only as a theoretical possibility in the event of higher soil fertility.

This brings us to the end of Part I of *The Isolated State*; and with it, we abandon the particular assumptions which have governed the partial equilibrium analysis made there. In the introduction to Part II, Thünen is already posing the questions that arise when the assumptions are relaxed. Suppose we allow differences in soil quality and in climate, the effect of navigable rivers and of railways? Suppose we no longer regard the presence of the town and its industries as given, but seek to ask why they are there? These questions he poses; but he admits straightaway that a complete solution to the problem is not to be found within the covers of a single work, but in that of a generation. In fact many generations have gone by since Thünen wrote this; but we are still little nearer the final resolution that he sought.

The analysis Thünen actually proceeds to make in the rest of Part II, Section 1 of *The Isolated State* is actually rather surprising after the sweeping nature of the introduction. Having there posed seventeen questions for further inquiry, he concentrates on the first of them: "What is the wage which Nature has determined for the labourer; and what governs the interest rate?" This inquiry, Thünen stresses when he first poses it, is only very indirectly concerned with the Isolated State itself. The connexion is a wholly methodological one, for Thünen finds that his method of isolation allows him to produce an answer to the question; he discovers a formula for the "natural wage" by asking "What is the wage on the frontier of the Isolated State, where no land rent occurs, and where any agricultural labourer can have land, free for the asking?" Thünen's method, and his resulting formula for the natural wage, have proved to be the

¹ First in *Die fundamentale Standortstheorie Joh. Heinrich von Thünens, wie sie bisher als Intensitätslehre missverstanden wurde und was sie wirklich besagt* (Jena 1936) and then in PETERSEN (1944), *op. cit.*, 142–5.

most fiercely debated, and the most fiercely criticised, of all his writings. This is not the place to summarise the controversy or enter into it; it is most fully discussed by Dempsey.¹ But it must be said that even if the formula for the natural wage proves based on a misapprehension, this must not divert attention from the fact that before arriving at it Thünen has already made a discovery of the most fundamental significance. He turns to apply the principle of diminishing returns, no longer to land, but to labour and capital. In the Introduction he develops the idea that the increased yield, due to the additional cost of capital and labour, will eventually decline, so that a point is reached where the value of the increased yield is equal to the value of the increased cost. Later, in Chapter 19 of Part II, Section 1, he says more specifically that extra labour will be employed to that point where the extra product of the worker last employed is just absorbed by the wage he is paid. Here Thünen introduces the notion of the margin (*Grenze*) which Marshall took from him. He has discovered, in fact, the concept of marginal revenue productivity.² And he has already suggested the parallel notion of the marginal efficiency of capital: that continued investment in any particular direction will pay until the marginal rate of interest in the marginal investment equals the market rate of interest.

Thünen saw that he could not hope to complete the work he had started. But had he lived longer, we cannot doubt that his mind would have engaged with some of the other topics he had put forward for inquiry. As it is, the posthumous fragments published in Part II, Section 2 offer extraordinary glimpses of the range and quality of his perceptions. Perhaps the most astonishing of all is the section on industrial location, where he clearly anticipates Alfred Weber's concept of agglomeration. Hardly less fascinating is the section on highway construction, where he begins to grapple with the problem of the rate of return on public investments—a subject which has begun to receive serious attention in Britain and North America only in our own day. These fragments, unformed and speculative as they are, offer an amazing picture of the free-ranging quality of Thünen's imagination.

¹ *Op. cit.*

² The American economist John Bates Clark, who is usually credited with the discovery of marginal productivity, acknowledged his debt, though he claimed that Thünen had failed to develop the implications. Cf. J. B. CLARK, *The Distribution of Wealth: A Theory of Wages, Interest and Profits* (New York 1899), 322–4.

IV. THÜNEN AND HIS AGE

It would be wrong to say that Thünen wrote his book in a pre-commercial economy, one with ill-defined or rudimentary markets. The specific feature of the Thünen system as it is described in *The Isolated State* is that it is a highly specialised economy, but one conducted on a small scale; even stock farming ends 50 German miles (or 230 English miles) from the central town. This is characteristic of a rather remarkable transitional economy within which Thünen wrote. The complete self-sufficiency of the medieval economy was broken down, if indeed it had ever existed. The work of Heinrich Backe¹ shows that the ancient world had possessed an advanced and large-scale system of Thünen rings; that though the Middle Ages had seen some regression, there were nevertheless considerable long-distance movements of foodstuffs, especially grain. And to some extent *The Isolated State*, because of its very simplification, is not a true picture of the Mecklenburg of the period; for Thünen does not allow it in the first place to contain any navigable water, the chief means of transport of his day.

Even while Thünen was revising Part I for the second (1842) edition, though, the European economy was changing rapidly. In 1840, Britain had become a great grain importer, but 65·4 per cent of her imports came from western and central Europe, and Germany alone accounted for 46·3 per cent. Only thirty years later, in 1870, Germany's share had dropped to 8·7 per cent; the steppes of east and south-east Europe were then supplying about half Britain's imports. By 1913 *all* Europe's share of Britain's grain imports was down to 13 per cent; Argentina then accounted for 28·5 per cent and Canada for 15·4 per cent.² Sheep production, which was important in Mecklenburg when Thünen wrote, moved out even more rapidly. The total number of sheep in Germany fifteen years after Thünen's death—in 1865—was 30 million; by 1913 it was down to 5·5 million.³ Sheep rearing on a large scale was by then relegated to those countries and areas—Central Asia, Australia and New Zealand, South Africa, southern South America—most remote from the great population centre of north-west Europe; and this had constituted by 1913, as

¹ H. BACKE, *Um die Nahrungsfreiheit Europas: Weltwirtschaft oder Grossraum* (Leipzig 1942).

² *Ibid.*, 45–8.

³ *Ibid.*, 42; KRZYMOWSKI, *op. cit.*, 148.

Backe says, a great "World Thünen Town", whose demands for foodstuffs and industrial raw materials embraced the whole world. By then Mecklenburg, and indeed all Germany, were well within an inner Thünen ring, which finds no precise place in the Thünen scheme but which Thünen himself realised would come to spread across Europe: the system of crop alternation, which combines intensive production of grain with that of certain specialised crops.

In this dramatic geographical change, which was complete in less than a century, three factors were at work. They were changes in agricultural techniques; changes in transport techniques; and, most fundamental of all, the rapid rise of population during the nineteenth century, which increased demand and made improvements profitable. In Germany alone the density of population rose from 17-20 per square kilometre in 1300 to only 26-28 in 1700, but then to 40-45 in 1800, 104 in 1900, and to 133 in 1925.¹ For German agriculture Krzymowski concluded:

It was not Albrecht Thaer who overturned the old three-field system and put intensive crop alternation in its place, as is often claimed; the whole course of history has done it, and Thaer himself was only the tool of this historical process.²

The growth in demand could be met, as already suggested, in two ways. Yields could be increased on the existing agricultural areas, by improvements; or more could be fetched from new land, which could be brought within the margin of cultivation by transport improvements. Both types of change came about in the nineteenth century, and they were to some extent contradictory. For a transport improvement will (assuming for the moment that demand remains constant) cause a reduction of farm prices near the market and an increase away from the market; thus the incentive to intensify near the market will be reduced. This contradiction led Theodor Brinkmann to inquire how much world agriculture had benefited, since 1870, from improved yields on "old" land and from taking in "new" land, respectively. He concluded that grain production had risen between 1870 and about 1930 by about 200 million tons, of which one-third had come from the "old" land and two-thirds from the "new".³ The United States provides a particularly dramatic illustration of the contribution of the "new" land. Its agricultural

¹ *Ibid.*, 142.

² *Ibid.*

³ Quoted in I. BRINKMANN, *op. cit.*, 346.

settled area in 1860 was 148 million acres, in 1880 284 million acres, in 1900 415 million acres; wheat exports in 1851-60 averaged 5.5 million bushels per annum, in 1860-70 22 million bushels, in 1875 55 million bushels, and in 1880 150.5 million bushels, their maximum.¹ At that time no less than 58 per cent of the total grain imports into England came from the United States;² and the agricultural economy of the wheatlands of North America was disproportionately geared to the needs of the "West European Thünen Town". To some extent, the story after that is of the growth of other, independent Thünen towns, in North America itself, in eastern Asia. The pattern has therefore been complicated, though in a way that Thünen allowed for in *The Isolated State*; for even in Part I he does relax the assumption of a single consuming centre.

The size and the form of *The Isolated State*, if not the principles underlying them, are thus powerfully conditioned by the time when and the place where Thünen wrote his original manuscript. And the very subject-matter, of course, is similarly influenced. Thünen's main concern is firmly with the dominant form of economic activity of his age and his region. Agriculture is seen as the central economic activity; the manufacturing industry of the town, which produces the things to exchange with the products of the countryside, is relatively unsophisticated in character, and the very location of the town does not centrally excite Thünen's attention. It took in fact over half a century after Thünen's death before the first satisfactory theory of location for manufacturing industry, that of Alfred Weber, appeared in 1909.³ The gap is understandable: for when we move from agricultural to industrial location, we face a new set of problems. Thünen deals with immobile soil; there is no choice of location other than the source of raw material; the only questions open to the farmer are first, shall he cultivate at all?; secondly, what shall he cultivate? With industrial production, the question is different, as Chisholm⁴ and Engländer⁵ have pointed out: the type of production is postulated, and the place of production is sought; the new choice arises

¹ *Ibid.*, 349.

² BACKE, *op. cit.*, 47.

³ A. WEBER, *Über den Standort der Industrien*, Teil I: *Reine Theorie des Standorts* (Tübingen 1909). English translation, edited by C. J. FRIEDRICH: *Alfred Weber's Theory of the Location of Industry* (Chicago 1929). For the link between Thünen and Weber, cf. C. PONSARD, *Histoire des Théories économiques spatiales* (Paris 1958).

⁴ CHISHOLM, *op. cit.*, 41.

⁵ O. ENGLÄNDER, "Kritisches und Positives zu einer allgemeinen reinen Lehre vom Standort", *Zeitschrift für Volkswirtschaft und Sozialpolitik*, 5 (1927), 475-6. Cf. also H. WEIGMANN, *op. cit.*, 144-5.

because the factors of production tend to be mobile, so mobile indeed that one of the chief problems is to set one or more of them at rest for analytic purposes.

This was a more complex problem for a more complex age. Fifty years after Weber, it is still not satisfactorily resolved. In justice to Thünen, though, it is right to record two things here. The first is that, just before his death, he was already reaching out into general location theory, and groping towards concepts which were properly developed by others decades later. The second is that the most important later development of general location theory was done by Germans, in full knowledge of the foundation which Thünen had laid. Without this magnificent foundation, indeed, it is difficult to believe that location theory would have developed quite as it did. All in all, we can but echo the verdict of the German economist, Schneider, before the conference held to honour Thünen's name on the 175th anniversary of his birth in 1958:

Wherever economic theory is studied today, his ideas, his working methods, the problems he posed, have proved seminal right up to the present day—even there, where his name seems to have been forgotten, Thünen has worked. His work shines brighter than ever today. Much, which seems self-evident to us, goes back to him. And still not all the riches which are buried in his work are brought to light. To find them, you must without doubt read *The Isolated State* carefully and often.¹

London, December 1963.

PETER HALL

¹ SCHNEIDER, *op. cit.*, 27-8.

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