Graphical Representation of Transportation Cost in Thunen's Model

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Abstract: This paper is a new look to an ''old theory'' called ''Thunen's model,'' which is considered to be most relevant to agricultural economy and economic geography. Accordingly, reviewing the model using graphical representation is worthwhile. This unique approach to look at Thunen's model leads to a better understanding of the model in a simplistic way, as well as to highlight the relevance of the transportation system regarding cost. In fact, this paper is an innovative approach of looking at Thunen's model in such a way as to prove that Thunen's model is also rather a ''transportation model.'' Towards the end of this paper, an example from Saudi Arabia in context is presented to testify how Thunen's model is closely to related to transportation.

Key words: Thunen's model, Transportation, Transportation cost, Transportation rate, Agriculture land use.

Introduction

Although Thunen Agriculture Land Use Theory, or in short ''Thunen's model,'' was formulated in the early part of the nineteenth century, it is still one of the vital issues among geographers and location theorists. A great deal of attention has been devoted to analyze land use patterns in the light of Thunen's model. Yet, transportation related matters (costs, modes, and facilities) in these analyses were almost completely neglected. Accordingly, this paper is devoted toward the transportation cost in Thunen's model; specifically two components are of the essence: (1) the effect of altering transportation rate (***t***) upon the

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land use, and (2) the effect of introducing more than one mode of transportation on land use.

Significance of the research

Knowledge and sciences evolve over time through paradigms. Geography is no exception. Geographers use both theoretical and empirical approaches to investigate geographical phenomena. Yet, most geographers nowadays engage in empirical and quantitative analyses more than theoretical ones. While there is nothing wrong with applied research, it is clear that the negligence of theoretical studies is indefensible. The value of this paper stems from the fact that overlooking "old theories" is unjustifiable. In other words, looking back to our heritage is worthwhile. Thunen's model is considered as equally important for the agricultural economy and economic geography as Newton's Law of Gravitation is for astronomy (Daggett, 1955). Evaluating Thunen's model from a transportation perspective will add some value to the model by extending the use of Thunen's model.

By doing so, it is hoped to get a better understanding of transportation impacts upon location choice (i.e., crop growing - farms - location choice). In fact, Thunen's model is one of the oldest models that investigates relationships between transportation, urban areas and regional land use (Rodrigue, 2005). This implies that transportation has a major role in any spatial activity.

Thunen's Model

Thunen, in his novel "The Isolated State", brought a model of land use which illustrates the trade off between land values and the distance from a central point of attraction (*i.e.* the market). Von Thunen (1826) was the first to develop a basic analytical model of the relationships between market, production, and distance. Thunen developed two basic models: (1) The intensity of production, and (2) the type of land use. The aim of Thunen's analysis was to explain how and why agricultural land use varies with distance from market. There are two main points that can be drawn from the models: (1) the value of lands (rent) decrease as distance from the market increases, and (2) different land use activities that are clustered in ranges of equal distance from the market are due to the weight of the activity. In other words, land use activities (e.g. agriculture) are the function of distance, which can be translated into transportation costs. Both of Thunen's models are the function of distance from the market.

In the first model, the intensity of production of a particular crop *(measured as the amount of outpus per unit area of land)* will decline as the distance from the market increases. Accordingly, the land use varies with distance from the market. The model compares such a relationship and is expressed as follows:

$$\boldsymbol{R = y(p - c) - ytd} \tag{1}$$

Where:

$\boldsymbol{R}$ = Rent per unit of land.

$\boldsymbol{y}$ = Yield per unit of land.

$\boldsymbol{p}$ = Market price per unit of yield.

$\boldsymbol{c}$ = Production costs per unit of yield.

$\boldsymbol{t}$ = transportation rate per unit of yield.

$\boldsymbol{d}$ = Distance from market.

Toward his goal, Thunen set a few basic assumptions about agricultural conditions surrounding a city (Bradford & Kent, 1977, Sampson, et al., 1985; and Rodrigue, 1999-2004). **First,** there is only one isolated market in an isolated state with no trade (interactions) with the outside world. **Second,** lands surrounding the city are uniform plains over which fertility, climate, and terrain are equal. **Third,** farmers have an economic sense to maximize their profits and they are perfectly free to grow any type of crop they want. However, market price is not subject to farmers control (i.e., *No Monopoly*). **Fourth,** there is only one mode of transportation (horses and carts) available to all farmers and can be utilized anywhere by farmers to ship their production to the market. Transportation cost (***TC***) is a simple, linear function of distance. Costs are the same per mile regardless of the number of miles traveled. Transportation rate (***t***) is fixed for all farmers.

Transportation Effects

Thunen employed these assumptions in order to control the variations among places, farmers, and environments. Virtually, Thunen made all factors effecting land use as constants for farmers; however, he explicitly allowed the transportation cost, **the key variable**, to vary among farmers who are not - of course - located in an equal distance from the market, suggesting that distance from the market would be a main determinant of agricultural land use (Johnston, 1998). Another way to look at Thunen's model is to conceive the assumption that was made by Thunen regarding the economic sense of farmers: that they are profit maximizers. Farmers' profit maximization depends upon how far farms are from the market. Since everything else is equal for all farmers in terms of production costs, maximizing profit can be only achieved by saving in transportation expenses. Reduction in transportation costs means to be located as close to the market as possible. The goal of farmers is to maximize profit, which is simply the market price minus the transportation cost. As such, Thunen's model may be regarded as an assessment of transportation impact upon the land use.

Thunen's model provides a form of land use interaction with transportation facilities and infrastructures, in what is called the agriculture land rent theory, which argues that marginal land generates less rent because of the higher transport costs required to transport goods to the market. As a consequence of this basic transportation cost reality, higher rent is paid to land located nearer the market. The land rent decreases with increasing distance from the market, to recompense the cost of traveling. In another words, places near to the market pay higher rent, because transportation cost is minimal, and the accessibility factor is high. In fact, not only agriculture activities enjoy the convenience and easiness of movement, but also all kinds of economic activities depend upon accessibility provided by the transportation system.

The relationship between transportation and land use is not always as illustrated in Figure 1. The interaction between transportation and land use is always described as a chicken-and-egg dilemma, each one has its own effect upon the other. That is, we can start with transportation, or we can begin with land use; in either case, the fundamental feedback leads certainly to a hierarchy of central places and different levels of transportation links connecting these activities, according to importance (Rodrigue, 2005). As a result, transportation and land use interaction is considered to be a dynamic and open system.

Modification of the Model

The potential impact of modifying transportation costs is great. To conceive the idea, go back to model (1):

$$\boldsymbol{R = y(p - c) - ytd}$$

Let us consider the following simple profit model for only one unit of land:

$$\boldsymbol{R = p - c - td} \tag{2}$$

Where:

$\boldsymbol{R}$ = Rent.

$\boldsymbol{p}$ = Market price.

$\boldsymbol{c}$ = Production costs.

$\boldsymbol{t}$ = Transportation rate.

$\boldsymbol{d}$ = Distance from market.

Because production cost is equal to all farmers, we can omit component (***c***) from model (2), to become the following:

$$\boldsymbol{R = p - td} \tag{3}$$

Since the market price (***p***) is equal for all farmers, then ***R*** is a function of ***td***. Graphically, this situation is illustrated in Figure 1 below.

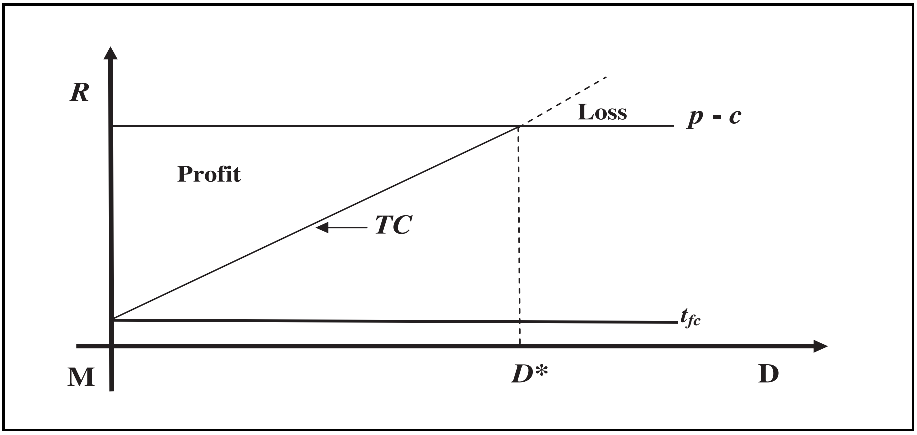

Figure 1: Model (1) illustrated

In general, transportation cost (***TC***) is a function of transportation rate (***t***), distance (***d***), the amount needed to be transported [yield] (***y***), and terminal cost, "Transportation Fixed Cost" (t_{fc}), as shown in the fallowing equation:

$$TC = (y * t * d) + t_{fc} \tag{4}$$

Assuming, for the moment that t_{fc} is constant for every farmer (as shown in figure 1), it should be clear, at the beginning, that when ***TC > P-C***, then there is no profit from farming any land, as in the case beyond ***D**** in Figure 1.

Transportation Cost Manipulations

Free Transportation:

If we assume the transportation is provided for free, then what would happen to land use under Thunen's model? Of course, this assumption is a hypothetical one and far from reality, but if it existed, another factor would substitute transportation effect. Time dimension is the most likely one to be the factors that would affect land use. In other words, since "time is money," the closest places to the market will be more highly utilized than the farthest ones, and high rent will be given to nearest places to the market. Assuming a linear relationship between time and land use, changing the ***TC*** curve in figure 1 to be a time curve, then land would be profitably used until we reach point ***D**** where the value of time that is spent on travel to the market is equal to the profit. It is interesting to note that there is no assumption regarding time in the Thunen model.

Reduction in Transportation Cost:

When transportation rate (***t***) is altered, land use configuration changes as a result. Reducing (increasing) ***t*** will allow more (less) land to be cultivated. To see this effect, ***t*** in figure 1 is reduced by an amount to generate a new ***t*** (see figure 2).

The difference between the two curves (Old *TC* and New *TC*) is the amount that is gained by reducing transportation cost (***TC***). Not all the farmers have the same amount of gain, because ***TC***, as mentioned earlier, is not only a function of ***t***, but also, t_{fc}, ***d***, and ***Y***. Due to such a reduction in transportation rate, more land profitability will be utilized up to point ***D****.

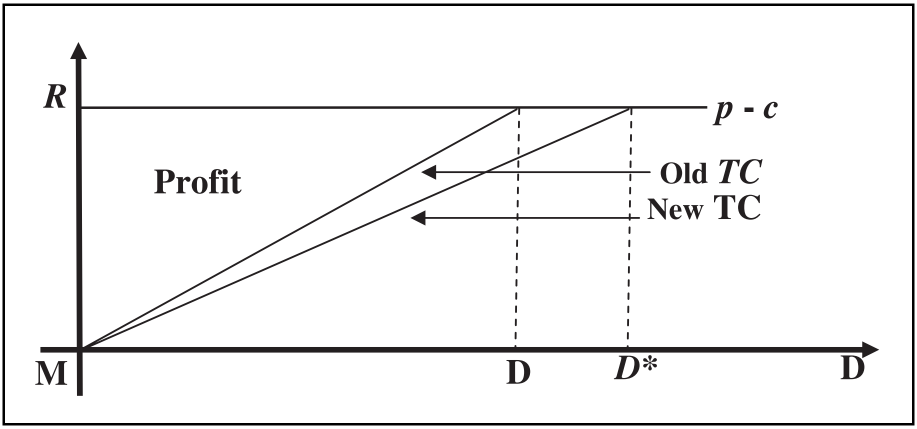

Figure 2: Effects of reducing *TC* upon Land use.

When the transportation cost (***TC***) is decreased by a constant amount for all farmers, say decreased to t_{fc}, the gain from this reduction will be the same (equal) for every farmer, regardless of location, since t_{fc} is a fixed cost that needs to be paid by farmers anyway. Figure 3 shows this situation.

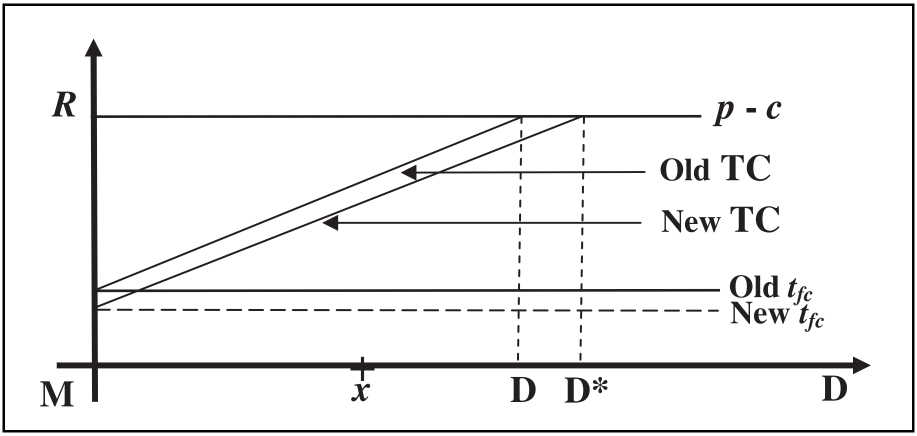

Figure 3: Reduction in t_{fc}

At the market, the profit is (***p*** - ***c***) minus t_{fc}. After a reduction of ***TC***, the profit at the market is equal to (***p*** - ***c***) minus the new t_{fc} . At any other location, the same amount of reduction (savings) will happen. At ***x***, for example, ***R*** is (***p*** - ***c***) minus old t_{fc}, and after the reduction ***R*** became equal to (***p* - *c***) minus the new t_{fc}. In short, new ***TC*** equals old ***TC*** minus the difference between the old and new t_{fc}. Due to such a reduction in ***TC***, more land will be used profitably equal to the area between ***D*** and ***D****.

Production Increment

When the yield per unit of land (***y***) increases uniformly over the land, and transportation rate (***t***) does not change, two things in regard to land use will happen: (1) the market price (***p***) per unit of land will increase, but the production cost (***c***) will increase too in the same proportion, and (2) ***TC*** will increase unequally over the land, since there is an extra yield needed to be transported to the market, which means that the new ***TC*** curve will be steeper than the old one. However, this increment in yield has no effect on the expansion of land use (Jones, 1982) (see figure 4), since nothing changed on ***t*** or on t_{fc}.

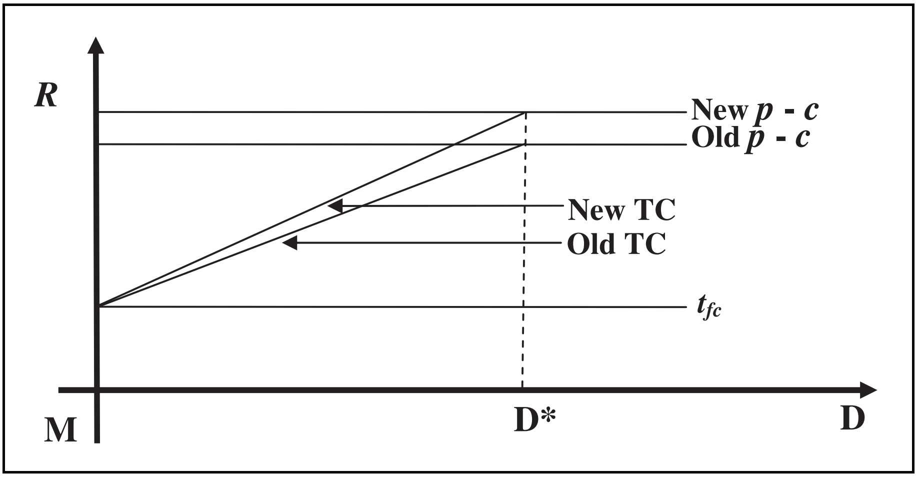

Figure 4: Production Increment

Transporting Different Crops

So far, our discussion has concerned only one crop. Now let us consider the effect of transportation cost on the growth of more than one crop (for simplicity, we examine two crops).

If we assume that both crops have the same transportation rate (***t***) and the same yield per unit (***y***), but the market price (***p***) is different, then the crop with lowest (***p***) will not be grown, unless the farmers are not wise. Figure 5 below depicts this situation.

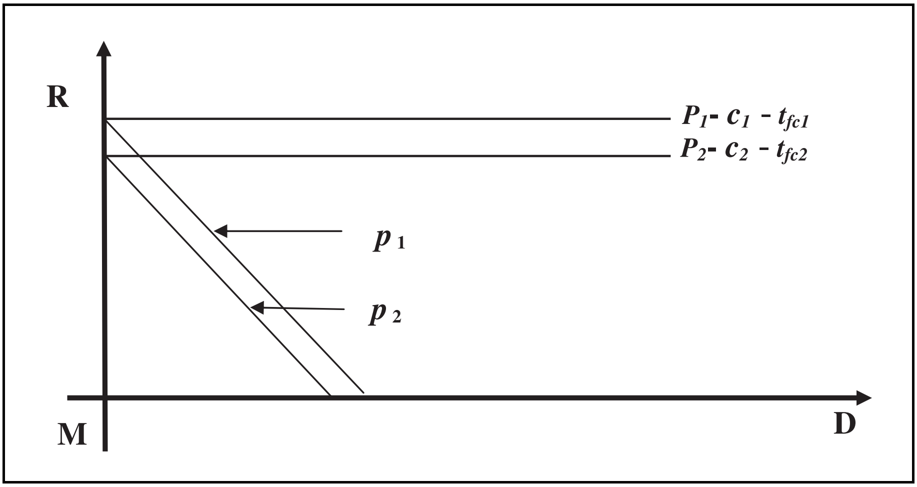

Figure 5: Two crops with same TC, but different P.

However, if we allow the transportation rate (***t***) and market price (***p***) to be different between the two crops as it should be, then the cultivation (land use) will change accordingly, and the crop of less value (***p***) may be cultivated, but not necessarily so. Figure 6 presents these two situations.

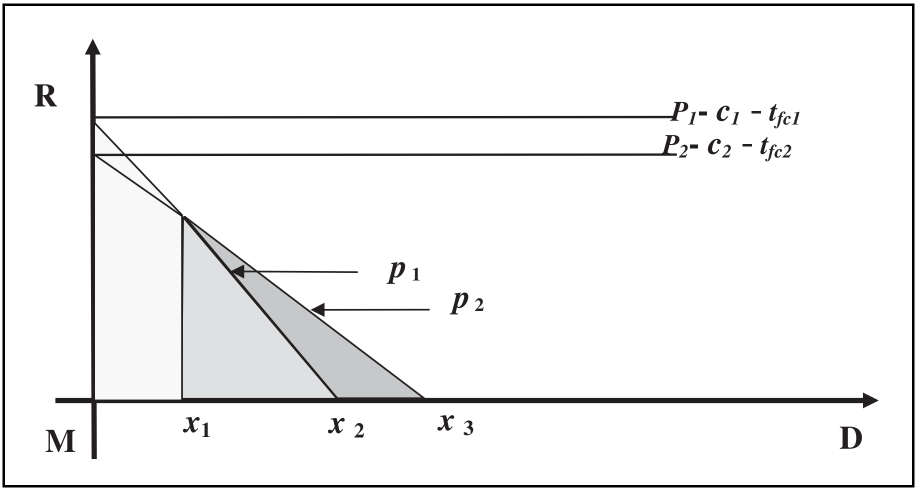

Figure 6: Two Crops with Different TC and Different P.

Farmers located anywhere from the market up to x_2 could produce crop 1 or crop 2 up to there choice, yet it is more profitable to grow crop 1 in the area between the market and x_1. Then crop 2 becomes more profitable up to point x_3. Although, the area located between x_1 and x_2 can be used to cultivate both crops, it is more profitable to raise crop 2 than crop 1 in that area. This is due to the assumption regarding the economic sense of farmers who are profit maximizers, and then it is expected to see crop 2 covering the area from x_1 to x_3. Beyond x_3, no crops will be grown profitably. This situation produces a different land use pattern existing as rings surrounding the city center (the market) as shown in figure 7.

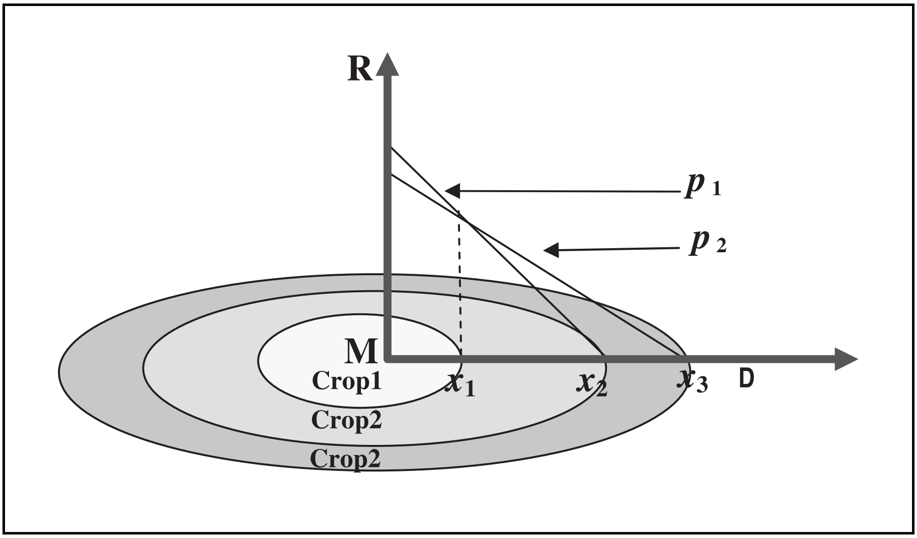

Figure 7: land Use Rings.

If the transportation rate (*t*) is not the same for both crops, then the crop that has a lower rate (*t*) will be grown. That is to say, the crop which has highest market price (*p*) will be raised, as shown in figure 8.

As shown in figure 8, the yield (Y) of any crop is equal to: the market price (MP) minus production (C), minus transportation fixed cost (TF), minus transportation rate (*t*) which is not the same for all kinds of crops. As such, different price curves (}**P**) will be produced for different crops. It is clear from figure 8, that crop 1 is more profitable than crop 2. The price curve (*p*) for crop 1 is higher than the one for crop 2.

Accordingly, crop 1 will be grown all the time up to the point ***D****. Beyond that point, no crop is profitable.

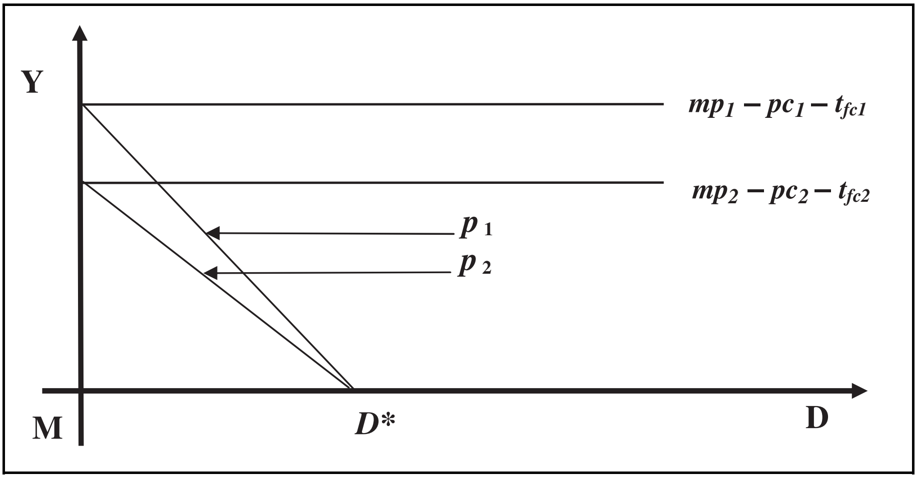

Figure 8: Two Crops with Different TC.

Adding more Modes of Transportation

Now if we relax Thunen's assumption regarding the availability of only one mode of transportation, what will happen to the land use? That is to say, what is the effect of introducing more than one mode of transportation upon land use? For simplicity, our discussion concerns only two modes. If the two modes (say train and trucks) had the same transportation rate (***t***) and transportation fixed cost (t_{fc}), of the less comfortable one would inevitably diminish to the point of dying. In the situation where one of them is cheaper than the other, the more expensive one would be utilized the least possible amount (since farmers are profit maximizers by minimizing transportation cost (***TC***)).

The Thunen classical example included an isolated state and modified conditions by introducing these asumptions: (1) a navigable river which is cheaper and faster than horse mode, and (2) a smaller city (acting as a competing market center) (Bradford & Kent, 1977). With all of Thunen's assumptions, the land use is uniformly circled around the market according to use, as shown on the left side of figure 9. However, after relaxing these assumptions, the situation changes to a different style of land use as shown on the right side of figure 9.

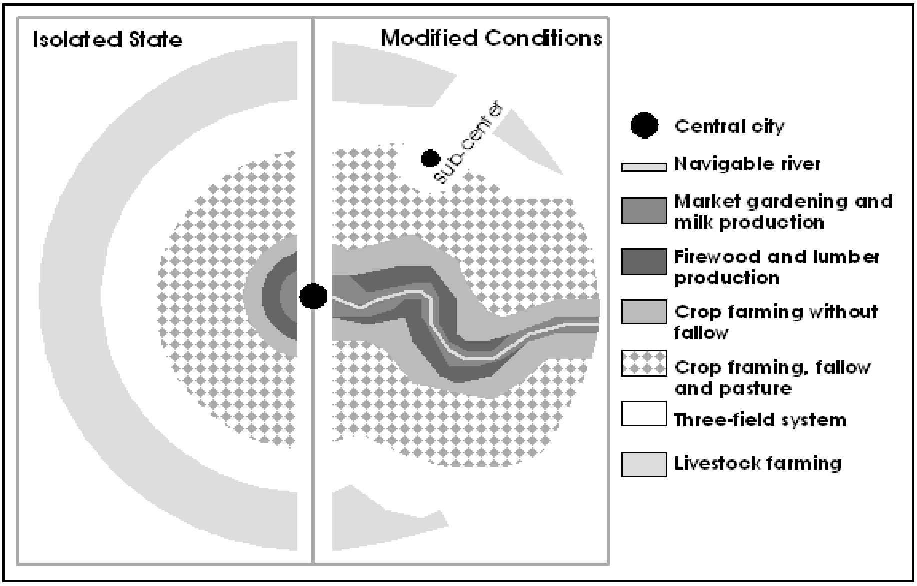

Figure 9: Effect of Introducing New Transportation Mode upon Land Use
Source: after Rodrigue (1999-2004).

Concentrating in the transportation effect, let us begin with the situation of introducing one more mode to Thunen's Model (say train). Farmers can thus utilize both modes (truck and train). However, unlike the truck; the train is not available everywhere. Yet, it is cheaper. Therefore, utilizing profitably, the train mode is limited to the surrounding area of its track railroad. Roughly, Figure 10 shows this surrounding area.

Obviously, farmers in the south part of the circle can utilize the train to transport their products to the market. However, minimizing ***TC*** by utilizing the train mode depends upon how far the farm is from the railroad tracks. In figure 11, this situation is revealed.

Assuming the transportation rate by truck (t_t) is twice higher than it is by rail (t_r), thus though A and B in figure 11 are located at an equal distance from market, ***TC*** of A is half as much as ***TC*** of B. Freight from B to the market (M) can either flow directly to M or via C in order to benefit from low-priced transportation rate (t_r) provided by train. However, this route (B-C-M) may not be the cheapest path.

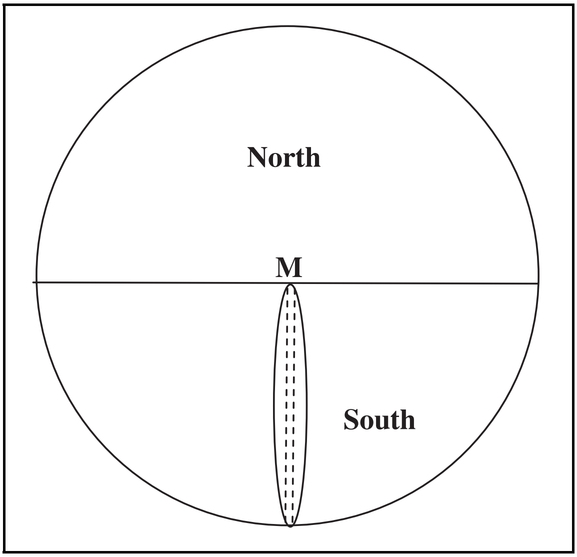

Figure 10: Surrounding area of railroad

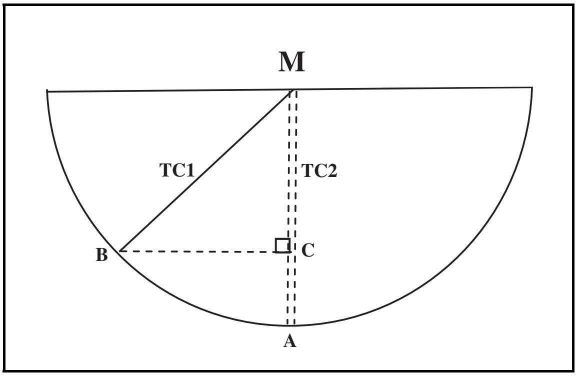

Figure 11: Areas of utilizing train mode.

The cheapest path (minimizing transportation cost) can be found with help from the law of transportation refraction which depends upon the formulation of Snell's Law (sometimes called Refraction Law) for the refraction of light. Figure 12 shows a simple example where there are two areas (A and B) in which there is a farmer (N) who is located at Area B, and the market (M) is located at Area A. The transportation cost in area B is higher than the transportation cost in area A by double. The least cost route is identified as being one in which the ratio of the cosines of the angle α and β (in figure 12) should equal the ratio of the costs $\boldsymbol{t_B}$ and $\boldsymbol{t_A}$.

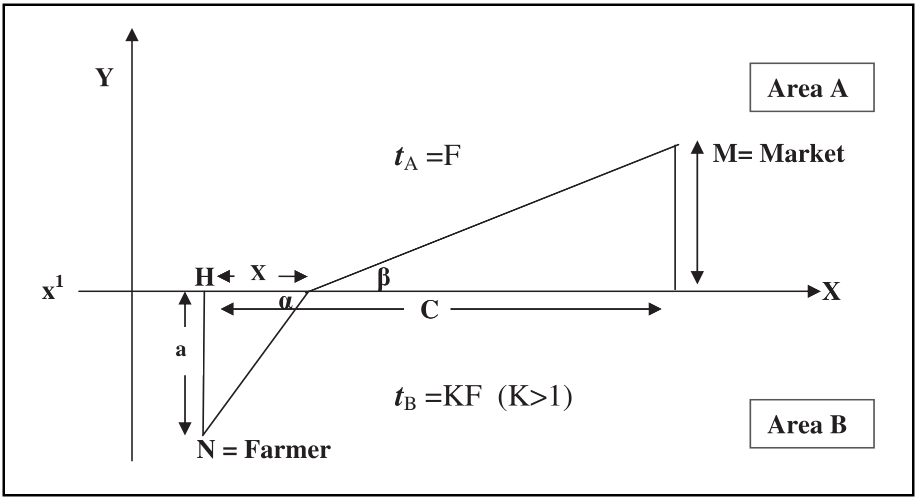

Figure 12: Law of transportation refraction

Given this situation, the transportation cost (TC) from Area A to Area B is:

$$TC = KF\sqrt{a^2 + x^2} + F\sqrt{(c - x)^2 + b^2}$$

TC will be a minimum for:

$$\frac{dTC}{dx} = KF\frac{x}{\sqrt{a^2 + x^2}} - F\frac{(c - x)}{\sqrt{(c - x)^2 + b^2}} = 0$$

and since $\dfrac{x}{\sqrt{a^2 + x^2}} = Cos\ \alpha$

and $\dfrac{(c - x)}{\sqrt{(c - x)^2 + b^2}} = Cos\ \beta$

then:

$$KF \quad Cos\ \alpha - F \qquad Cos\ \beta = 0$$

$$or$$

$$\frac{cos\ \alpha}{cos\ \beta} = \frac{F}{KF}$$

Therefore, in order for TC to be a minimum:

$$Cos\ \alpha = \frac{Cos\ \beta}{K}$$

When K = 1 (in case of equality of TC or both regions), the shipment from the farmer (N) to the market (M) will take a straight line. The more K rises, the more the AC line approaches vertical on the x x^1 axis.

Now in the situation where M lies on the xx^1 axis (see figure 13), that is, point M in figure 12 is reduced to the xx^1 axis, then β becomes zero and the transportation costs are a minimum for Cos α = 1/k. Thus, the larger k, the smaller Cos α and the more AC approaches the vertical on the xx^1 axis (Ponsard, 1983, and Werner, 1985).

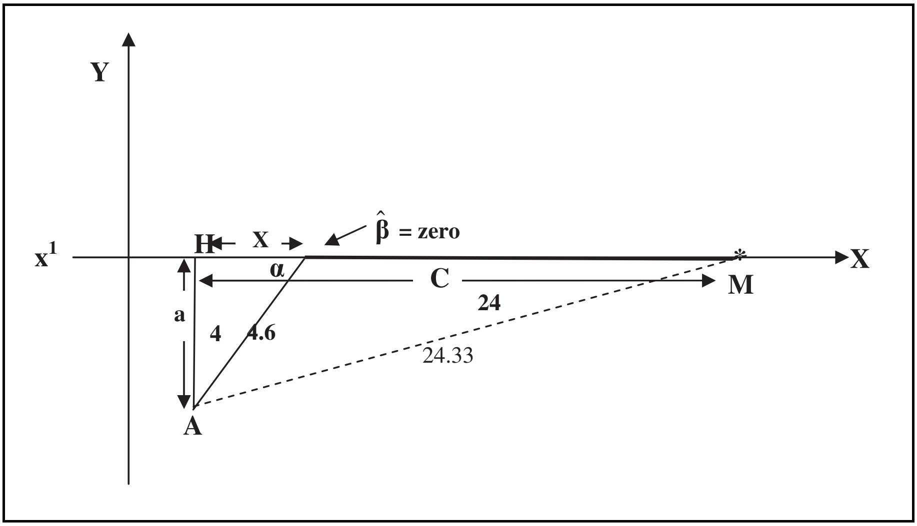

Figure 13: Example of transportation refraction Law.

To make it clear, consider the following simple example.\tab A farmer is located at point A (24.33 miles from the market, and 4 miles south of the railroad (see figure 13), assuming *TR* by truck equals 2 ***SR***and by railroad equal 1 ***SR***, thus $t_t = 2t_r$.

The TC_t from A to M (excluding TFC) is directly equal to 48.66 ***SR***per unit of goods (24.33 x 2). If the farmer wishes to utilize the railroad, the *TC* per unit of goods equals 32 ***SR*** (4 x 2 + 24 x 1). However, although the route AHM is cheaper than the direct one (AM), the least cost path can be obtained by Cos α = 1/k (The Refraction Law). Since K = $t_t / t_r = 2/1$. Then Cos $\alpha = {}^1/_2 = .5$. The angle of Cos α = 0.5 is equal to 60°.

$$Sin\ 60^{\circ} = \frac{a}{AC} = \frac{4}{AC} = 0.866$$

Then $AC = 4/Sin\ 60^{\circ} = 4.62$

$Cos\ 60^{\circ} = \frac{x}{AC} = \frac{x}{4.62} = .5$, then x = 2.31

Now:

$C - x = 24 - 2.31 = 21.69$

Then, least cost path is ACM equal 30.93 ***SR*** (4.62 x 2 + 21.69 x 1).

In the above simple example, Transportation Fixed cost (t_{fc}), was assumed to be equal for every farmer, whether he utilized the train or not. However, this is not the case in reality. If we assumed (t_{fc}) is only function of terminal cost, then a farmer who utilized only a truck may pay less than a person who utilized the train. A person who utilized both modes, no doubt, will pay more than others. This extra cost can enter the *TC* formula by adding such amount to the entire *TC*.

$$TC = TC_t + TC_T + \lambda$$

Where: λ is the extra amount of charge that needs to be paid by the farmer who is not located on the track in order to utilize the train. Thus, in considering the cheapest path, farmers should evaluate *TC* in the light of the following criteria: as long as *TC* by train plus *TC* from the farmer to track, plus λ, is less than going directly from the farm to the market by truck, then the farmer will utilize the train. In other words, using figure 11 symbols, if $AC\ TC + CM\ TC + < AMTC$, the farmer, located at A will utilize the railroad, otherwise not.

Reality versus ideality

Towards the end of this paper, a question may be asked: how far is our analysis from reality? All of our analysis disregarded the variation of transportation fixed cost (***tfc***). We assume it is constant over land regardless of the quantity of shipment (Y). Although this assumption is not the case in reality, it made our analysis simple and clear. Yet, it can enter the analysis with more effort and complexity. Around 13% of motor-carrier revenue goes for terminal expense and in railroad sectors, this cost is even higher (Sampson, et al., 1985). Figure 14 below shows a typical cost including the terminal cost for different modes.

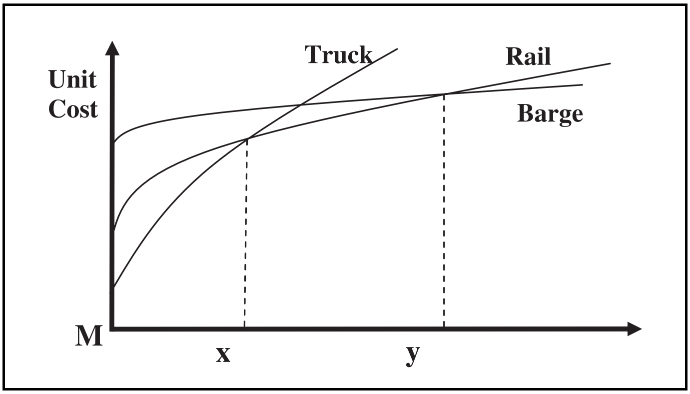

Figure 14: Transportation cost for different modes
Source: after Lowe & Moryadas, 1975.

From this rough graph (figure14), truck is the most competitive mode in area between (M) and (x); from (x) to (y) rail mode is the most competitive one; and then beyond (y), water mode is the most competitive.

Another limitation is the assumption of linearity between transportation rate (***t***) and distance (***d***), which also is not a purely true assumption, but in order to make the analysis simple, the assumption was imposed. Transportation rate structure for freight movement, in reality, falls between our assumption and the rate that does not change at all over distance (e.g. postage stamp rate) (Sampson, et al., 1985). As the distance increases, the linearity between ***t*** and distance become stable. The slight difference in distance will not contribute that much in *TC*. For example, *TC* for X goods shipped from Japan to Alkharj (approximately 100 Km south east of Riyadh) is almost the same as it is to Riyadh. *TC* relation with ***d***may look something like figure 15 below.

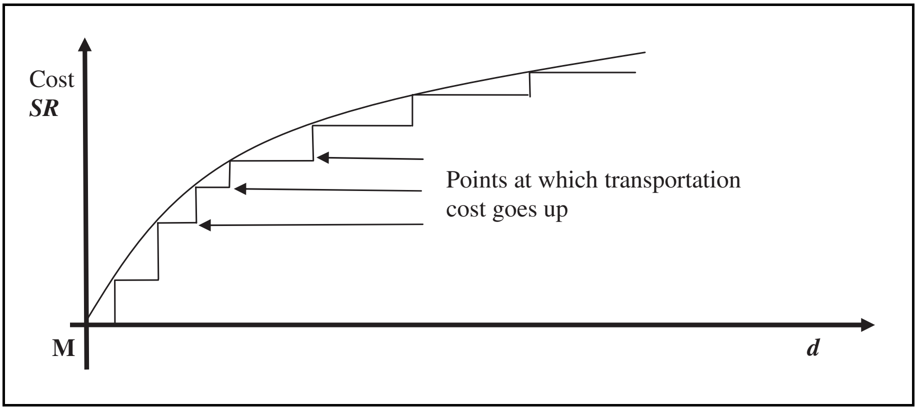

Figure 15: The relation between *TC* and D
Source: after Bradford & Kent, 1977.**(with modification).**

Under some other circumstances, the ***TC*** and ***d*** relationship may follow what is referred to as a grouping or zoning rate. Figure 16 shows the grouping rate situation.

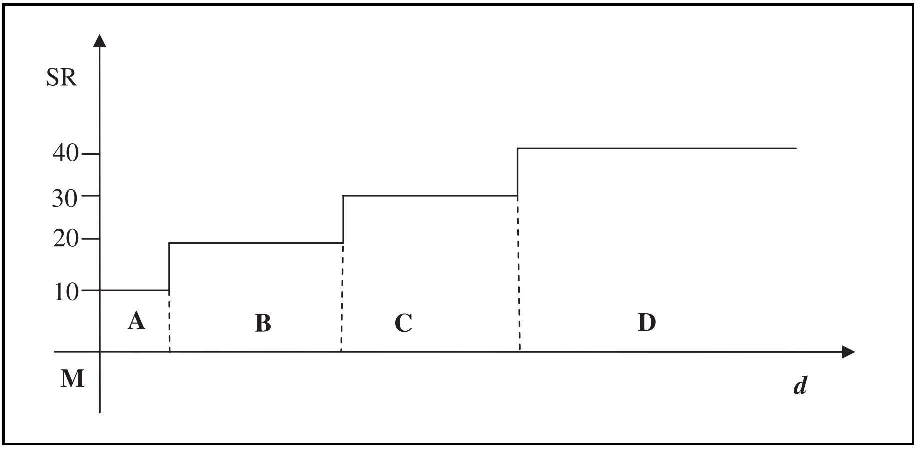

Figure 16: A hypothetical graph of grouping rate profile, in *SR* per unit of shipment from Riyadh to different areas in the Kingdom.
Source: after, Sampson, et al., 1985, p. 237. (with modification).

Figure 16 shows a hypothetical grouping (zoning) rate for shipment, say from Riyadh to any place in the Kingdom. In all of area A (say all cities in the middle region) the transportation rate is 10 ***SR***. The price goes up in area B (say all cities in the Eastern Province) to 20 ***SR*.** In area

C (say the northern region), the rate for shipment from Riyadh to any city there is 30 ***SR***. In area D (say the western region) the rate is 40 ***SR***.

Saudi Context

It is not the attention of this paper to test the validity of Thunen's model in the context of Arab countries. Yet, it would be beneficial to look at an example from Saudi Arabia that demonstrates agriculture land use regarding Thunen's Model, notwithstanding the fact that finding a good past example as well as a present one would be somewhat difficult. That is because most cities (markets) in Saudi Arabia are located at oases in the middle of the desert. As such, area surrounding cites are almost arid, and farming is only located along banks of valleys.

Taking Riyadh as an example, historical evidences tell us that the old city of Riyadh was surrounded by farms (see figure 17). In fact, the

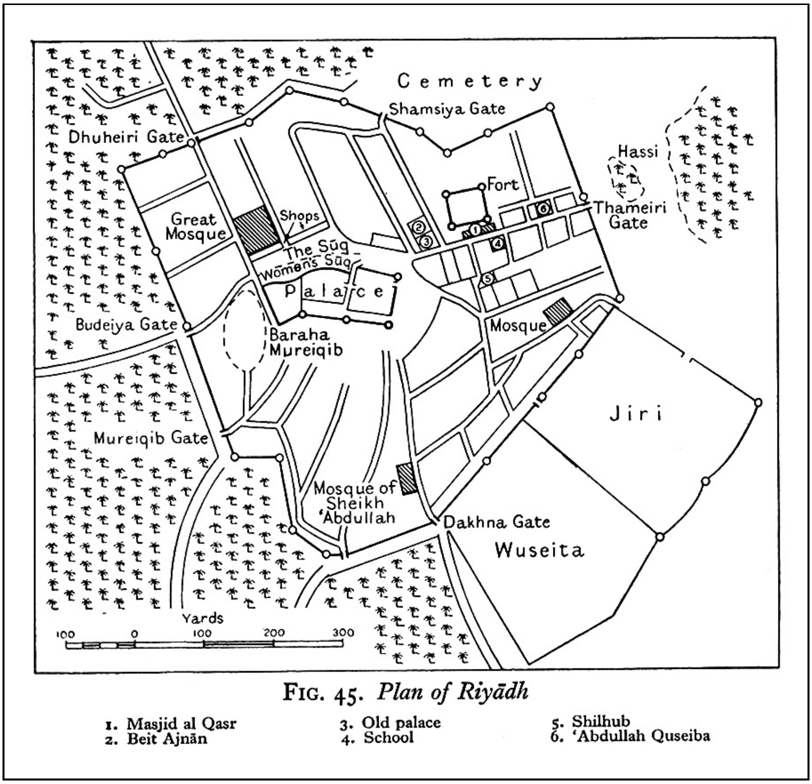

Figure 17: Riyadh in 1946.
Source: after The University of Texas at Austin, 2006.

name of Riyadh means "the gardens" and refers to the date palm plantations along Wadi Hanifa to the west of the city. Agriculture land use in Riyadh is affected by the formation of city landscape. Wadi Hanifa is the main physical feature of Riyadh, which goes through the city from the northwest to the southeast (see figure 18). The length of Wadi Hanifa is approximately 120km. The valley is fed by sub-valleys; mainly Batha (approximately 25km length), and Alisen (about 35km length). Wadi Hanifa is characterized by residential compounds of villages, agricultural activities such as nurseries, palm gardens, vegetables and fruits. The valley also includes antiquities and historical remains of old human civilizations such as houses and dams (HCDA, 2005A).

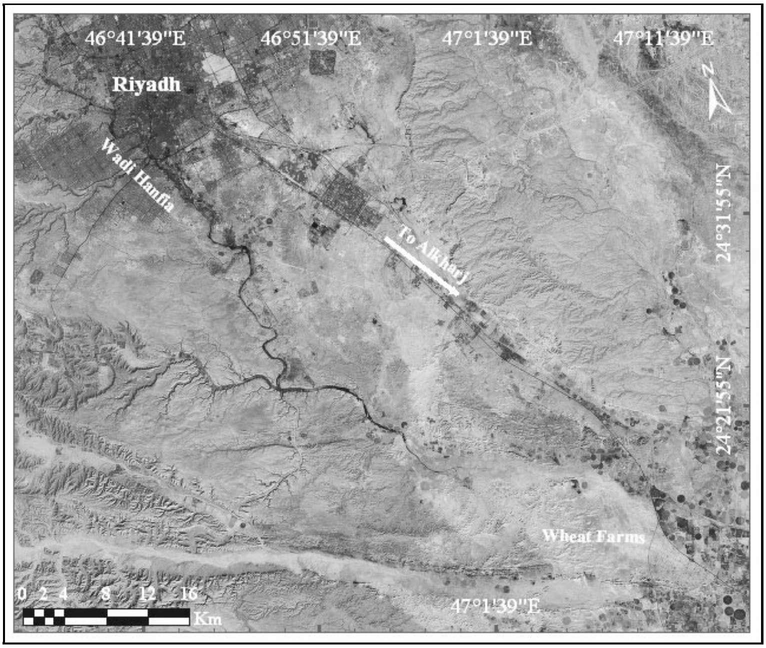

Figure 18: Riyadh - 2000
Source: Applied Sciences Directorate, 2004.

What is interesting to us is that farming along Wadi Hanifa consists of palm gardens, vegetables and fruits, which were supplied to the Riyadh market at that time. It is obvious that vegetable and fruits (perishable commodities) were cultivated nearby, while durable produce grew beyond that. Recently, not much of a change has occurred in this picture; land use of Wadi Hanifa continues to be dominated by agriculture activities (see figures 19 and 20). Wadi Hanifa is still the main source of leafy vegetables, notwithstanding the fact that the Riyadh market nowadays receives vegetables from different places around the world due to transportation facilities.

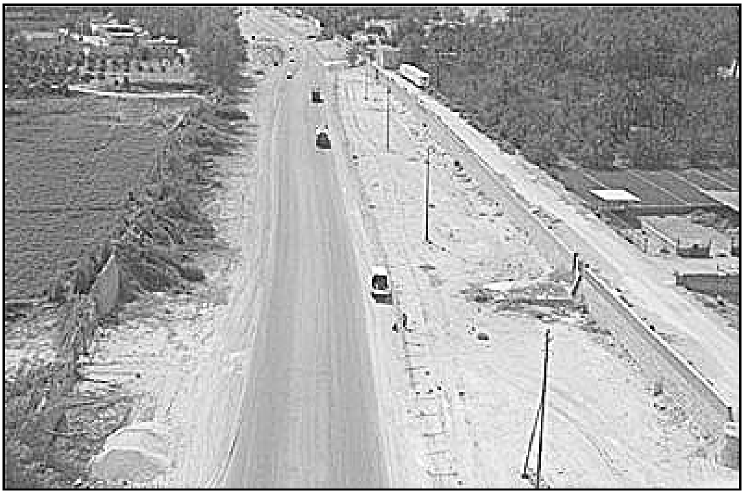

Figure 19: Traditional Farms in Wadi Hanifa.
Source: HCDA, 2005B.

Figure 20: New Farms in Wadi Hanifa.
Source: HCDA, 2005B.

Conclusions

Thunen's Model is a major theoretical ground for most research and studies dealing with land use. Yet, no great attention has been given to the aspect of transportation in Thunen's Model. Needless to say, transportation impact is not only limited to agriculture land use. While Thunen's model was originally applied to agricultural land use, it is commonly used to explain urban land use patterns. Two main conclusions from Thunen's Model can be drawn: (1) land values decrease as distance from the central point of attraction increases and (2) different activities of land use are limited in equal rings related to distance from the central point of attraction based on transportation cost (Amos web, 2005).

Profit maximization depends upon how far farms are from the market. Since everything else is equal, farmers can only maximize their profit by saving in transportation expenses. Reduction in transportation costs means to be located as close to the market as possible. The goal of farmers is to maximize profit, which is simply the market price minus the transportation cost. As such, Thunen's model may be regarded as an assessment of transportation impact upon the land use.

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Submitted: December 2005
Approved: July 2006

تمثيل تكلفة النقل بيانياً في نموذج ثونن

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ملخص: يقدم هذا البحث نظرة جديدة لـ"نظرية قديمة" تسمى "نموذج ثونن" التي تعتبر مهمة جداً للاقتصاد الزراعي والجغرافيا الاقتصادية. ومن ثم، فإن مراجعة النموذج باستخدام التمثيل البياني ذات فائدة. هذه الطريقة المتميزة في النظر إلى نموذج ثونن سوف تساعدنا على فهم أكثر للنموذج وبأسلوب سهل، وكذلك تلقي هذه الطريقة الضوء على أهمية نظام النقل في حياتنا. وفي الحقيقة، فإن هذه الورقة ذات منهج مبتكر للنظر إلى نموذج ثونن بطريقة تثبت أن نموذج ثونن لا يعدو أن يكون إلا "نموذج نقل". وفي نهاية البحث تم عرض مثال من الحالة السعودية لإثبات مدى مطابقة نموذج ثونن للواقع.

المصطلحات الأساسية: نموذج ثونن، النقل، تكلفة النقل، سعر النقل، استخدامات الأرض الزراعية.

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