Why do firms Agglomerate? Historical thoughts before 1950

Sharad KC

Georgia State University

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Introduction

Why are industries located in the capital? What are the causes of localization of industries? What are the agglomerative and "deglomerative" forces contributing to local distribution of industries? How can we find a general explanation for the sizes, number, and distribution of towns? These are the few questions early thinkers of location economics sought to answer in their writings. While the contemporary literature in agglomeration is quite extensive, its underpinnings were discussed more than a century ago and only by a few prominent economists. The most notable being Alfred Marshall in the late 19th century.

Agglomeration economies, as we know today, are the benefits to firms and individuals from locating close to one another in industrial clusters and urban areas (Glaeser, 2010). Firms and people can benefit through the reduction in transport costs of goods, people and ideas. While the study of firm agglomeration is crucial in the modern era of entrepreneurship, it was equally important in the industrial revolution. Industrial era economists like Von Thunen and Marshall, carefully analyze the geographical concentration of industries and lay a foundation to what today is known as Agglomeration economies.

Why study the history of economic thought?

Keynes, in his concluding notes in General Theory of Employment, Interest, and Money, writes,

"Practical men, who believe themselves to be quite exempt from any intellectual influences, are usually the slaves of some defunct economist. Madmen in authority, who hear voices in the air, are distilling their frenzy from some academic scribbler of a few years back." (Keynes, 1936)

The study of history of economic thought (HET) is one of least sought disciplines in economics. Its importance is ever present, mainly since thinkers in the past often guide the ideas of today. We still quote, get inspiration, look for ideas in the writings of Smith, Marshall, Keynes, and others. Kerr (2002) argues that study of history of economic thought is worthy of being studied for its intrinsic value as it satisfies our intellectual interests. Furthermore, Kerr writes, history of economic thought enriches our understanding of contemporary economics, helps us learn from the errors of the past, and expand our range of hypothesis in economics (Kerr, 2002).

History of economic thought also provides us with a source of useful material in the complex mathematical field. Even if one argues that HET provides little intellectual progress, it is a crucial tool in the education of the researcher (Roncaglia, 1996). Also, Roncaglia claims that HET does not only provide a sense of direction to academics, it is also an essential ingredient in the debates between contending theories. In the mid-twentieth century, the rapid use of mathematics and econometrics sidelined the study of HET in the standard economics curriculum (Kerr, 2002). It is however slowly gaining recognition, at least in the undergraduate level of education in the United States.

Likewise, history of agglomeration thought is essential for all the reasons mentioned above. There are plenty of ideas, and methods to discuss and learn from the early pioneers of this field. The rest of my paper will attempt to educate the reader of historical thoughts on agglomeration. It follows the following course. In the next section, I discuss and compare the ideas on agglomeration of Von

Thunen, Marshall, Weber, and Christaller in a chronological order. In the final part, I relate some of their explanations to the modern understanding of agglomeration and conclude.

Von Thunen on Agglomeration (1783-1850)

Johann von Thunen was a German economist and an agriculturist. He got his formal education from the University of Gottingen. Like his father, Thunen was a gifted mathematician, and his talent is visible in his work. Von Thunen is most notable for this work, "The Isolated state" published in 1826, which was unknown to the mainstream economist until the 20th century. Thunen was well read by 19th-century pioneers such as Marshall, Schumpeter, and Samuelson. They even gave nicknames such as the "great unrecognized" by Alfred Marshall, a "patron-saint of econometrics by Schumpeter, and a "founding god for geographers" by Samuelson (Morency-Lavoie, 2015).

While most literature in industrial agglomeration refer to Alfred Marshall as the early pioneer, Von Thunen is very seldom cited as an early contributor to the discussions on agglomeration (Fujita & Thisse; Clark, 1967; Fujita, 2000). In his early work, The Isolated State, Von Thunen discusses on agricultural land use and rent, agglomeration, and about what today is known as the New Economic Geography (Fujita, 2000). Part I of his work was first published in 1826, whereas part II and III were published after his death in 1863 with the help from his friend, Hermann Schumacher (Morency-Lavoie, 2015).

In, The Isolated State, Von Thunen writes comprehensively about agglomeration forces. Thunen is curious about where large industries located in the industrial era. He asks the following question to enquire why firms and workers agglomerate,

"Of far greater importance and difficulty is the question: whether industries which draw their raw materials from, and sell most of their products to, the provinces, are also better off located in the capital?" (Thunen, 1966)

Thunen answers the question by first listing reasons for the firm to not establish in the capital. His reasons include expensive raw materials, high cost of transportation of good to rural consumers, high wages due to high cost of living (Thunen, 1966). He then focuses on the agglomeration forces that benefit the location of firm in the capital. He writes,

"1. Only in large-scale industrial plants is it profitable to install labour-saving machinery and equipment, which economise on manual labour and make for cheaper and more efficient production.

2. The scale of an industrial plant depends on the demand for its products.

3. The number of buyers depends, in provincial towns, on the number of countrymen coming in to sell their products or passing through on their way to the capital.

4. For all these reasons, large scale plants are viable only in the capital in many branches of industry. But the division of labour (and Adam Smith has shown the immense influence this has on the size of the labour product and on economies of production) is closely connected with the scale of an industrial plant. This explains why, quite regardless of economies of machine-production, the labour product per head is far higher in large than in small factories." (Thunen, 1966)

In the points mentioned above, Von Thunen claims that large-scale industries are only feasible in the capital due to economies of scale resulting from the use of massive machinery, enough demand for its products, relatively lower transportation costs and division of labor. Thunen also talks about

why workers with an exceptional skill would want to agglomerate to the capital where, in his words, "they will reap ample reward." He argues that availability of capital will entice skilled workers to move to the large city to make full use of their ability along with guaranteed higher demand for their services (Thunen, 1966).

Furthermore, Thunen writes about the linkage between different industries and why they may choose to locate close to co-agglomerate. He argues that machines are produced efficiently only where factories and workshops are close enough together due to high transport costs in case machines need repairment. Thunen firmly believes this is one of the reasons why firms agglomerate. He states,

"Economic theory has failed to adequately appreciate this factor. Yet it is this which explains why factories are generally found communally, why, even when in all other respects conditions appear suitable, those set up by themselves, in isolated places, so often come to grief. Technical innovations are continually increasing the complexity of machinery; and the more complicated the machines, the more the factor of association will enter into operation." (Thunen, 1966)

Here, Thunen even recognizes the catalytic force of technology on agglomeration. His comprehensive discussion of agglomeration forces is fascinating given the limited resources available around that time.

Alfred Marshall (1842-1924)

Although Von Thunen was unknown to most neoclassical economists, Marshall admired Thunen greatly. He once said, "I loved Thünen above all my other masters (Morency-Lavoie, 2015)." Marshall was a prominent British economist from 1890 to 1924. He was born into a wealthy family and got excellent education from his childhood. He, like Thunen, had a strong aptitude for

mathematics. Marshall got his education from St. John's college at Cambridge University. His most notable work, Principles of Economics, mainly focusses on the microeconomics and was widely used as a textbook in universities for an extended period.

Indeed, Marshall's literary work is extensive in the topic of agglomeration. He is also the most celebrated pioneer in this area of study. In his books, Principles of Economics and Industry and trade, Marshall writes extensively about the trinity of agglomeration economies. Firms and individuals agglomerate due to local pool of skilled labor, local supplier linkages and local knowledge spillovers (Potter, Watts, & D., 2012).

In chapter X of his principles book, Marshall starts by stating that, "even in the early stages of civilization the production of some light and valuable wares has been localized." According to Marshall, localized industry is an industry concentrated in certain localities. Localization happens for different reasons such as physical characteristics of the location, patronage of courts and deliberate invitation of rulers.

Marshall then goes on to explain the clustering of skilled workers and industries in towns and industrial districts. In one of his famous lines, Marshall writes,

"When an industry has thus chosen a location for itself, it is likely to stay there long: so great are the advantages which people following the same skilled trade get from near neighborhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many from them unconsciously." (Marshall, 1898, p. 350)

He states that the advantages of agglomeration are significant enough to offset any costs that accompany it. His list of advantages includes spillage of skills to one another as well as the next generation, the growth of local supplier linkages, the use of highly specialized industries and a

constant market for skill. Marshall, like Von Thunen, states that the economic use of expensive machinery is only justified where the benefits can offset its costs. However, Marshall reasons that it is possible through a large subsidiary market of small firms making constant use of the machinery to pay for its expenses. Out of the three types of agglomeration forces Marshall discusses, linkages, thick markets, and knowledge spillovers, Thunen only writes about the first two and does not mention the knowledge spillovers (Fujita, 2000).

Furthermore, Marshall writes that the benefits of agglomeration are significant enough for both firms and workers to localize. Firms naturally would like to locate in places where there are skilled workers required for production and workers naturally go to places where there are many employers. However, Marshall is quick to point out the disadvantage of localized industry in that it "makes too extensive demands for one kind of labour." The solution for this he says is co-agglomeration of supplementary industries. Marshall gives an example of iron districts where there are textile factories for women and children to work as well (Marshall, 1898, pp. 350-351).

Marshal also writes about the localization of shops in his principles book. He mentions that consumers,

"...will go to the nearest shop for a trifling purchase; but for an important purchase he will take the trouble of visiting and part of the town where he knows that there are specially good shops for his purpose." (Marshall, 1898, p. 352)

His idea here is that because consumers behave this way, shops that sell expensive products tend to congregate together. Marshall also writes that by being close to one another, different industries in the same neighborhood can help each other indirectly during times of depression. Another factor of agglomeration is the reduction of transportation costs of ideas. Marshall realizes that cheapening

the cost of communication will lead to higher flow of ideas between distant places (Marshall, 1898, p. 352).

Alfred Weber (1868-1958)

Alfred Weber was a German economist, who focused on the regional science and operations research. He was best known for his work, Über den Standort der Industrie (Theory of the Location of Industries) which was published in 1909 and later translated to English in 1929 by Carl J. Friedrich (Fearon, 2002). Weber was also a professor at the University of Heidelberg. In his work, Weber uses spatial factors to explain the agglomeration of companies mainly due to regional endowments and transportation costs (Lang, 2014). Thunen, Marshall and Weber all elaborate on the significance of transportation costs in understanding agglomeration economies.

Like Von Thunen and Marshall, Weber states that agglomeration of firms occurs when there is enough demand and support for the company and the labor force. Also, he emphasizes that the public infrastructures such as schools, hospitals, financial institutions are necessary as well. In contrast to previous writers, Weber also talks about deglomeration, which he argues happens due to over-concentration of industries, wrong types of industries, shortages of labor, capital, affordable land and so on (Friedrich, 1929). The reasons for agglomeration and deglomeration from Weber look like that of Thunen's explanation of the advantages and disadvantages of firms locating in the capital.

Weber first goes on to describe the agglomerative and the deglomerative factors. His agglomerative factors include;

1. Concentration of industry through simple "enlargement of plant" as an agglomerative force. By plant, he means large-scale production relating to economies of scale.

2. Social agglomeration, which Weber terms for other reasons than economies of scale. Under social agglomeration, there is four subcategories
    i. The development of technical equipment. This point can compares to the analysis of Thunen; large-scale plants are not able to make full use of the machinery, so naturally, mutually dependent parts concentrate locally that use the same machinery (technology).
    ii. Development of labor organization; specialization of labor leads to the workers services not being fully realized hence just like the large equipment above; they tend to form specialized partial industries.
    iii. Marketing factors; Localized large industries create their demand for intermediary goods, as result, they don't have to face challenges that a single firm faces during purchasing raw materials and in marketing.
    iv. Finally, General overhead costs; this Weber refers to the lower levels of infrastructure costs such as gas, water mains, streets and the "whole general apparatus (Friedrich, 1929, pp. 127-131)."

Similarly, his deglomerative factor includes increased expenses due to higher land values and wages. Weber says, "All deglomerative tendencies start from the increase in economic rent (ground rent)." Weber explains deglomerative forces as those weakening agglomerative forces. In his analyses, Weber considered only "pure" agglomeration. He did not examine the impacts of "fortuitous" agglomeration (concentrations that occur for other than reasons associated with spatial economics). For example, transportation facilities concentrate industries near the supplies of raw materials, or at coal fields or near the big markets of consumption (Friedrich, 1929).

In his writings, Weber seems to have been inspired by the works of Thunen and Marshall. A lot of the points mentioned above are discussed in The Isolated State and Principles of Economics. However, unlike Thunen and Marshall, Weber uses mathematical and geometric tools to explain clustering of industries. He builds a theoretical model based on his concept of "Isodapanes." Isodapane is a geometric way of describing location in space in terms of transportation cost. As in an Isodapane below (Figure 1.), point P_0 is the loci of the pane which is equidistance from all four locations, A_1, A_2, A_3, and A_4.[1] Isodapanes of high values of transportation costs are therefore approximately circles.

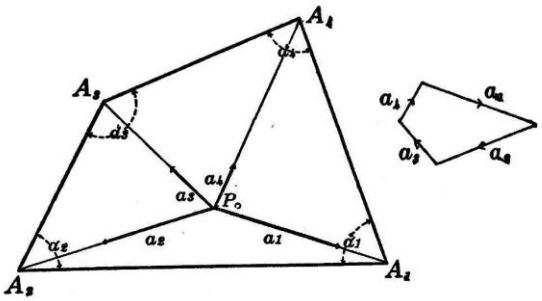


Figure 1. Isodapane (Friedrich, 1929, p. 240)

He uses this idea of Isodapane to build a theoretical model of agglomeration. Considering several units of production producing an identical commodity, Weber asks under what conditions and where will they agglomerate (Isard, 1970). He concludes that several individual units of production will agglomerate when their critical Isodapanes intersect, and together they attain within the common segment the necessary quantity of output. As shown in Figure 2 below, the shaded area represents where agglomeration would happen.

[1] See (Friedrich, 1929, pp. 240-243) for more explanation of isodapanes.

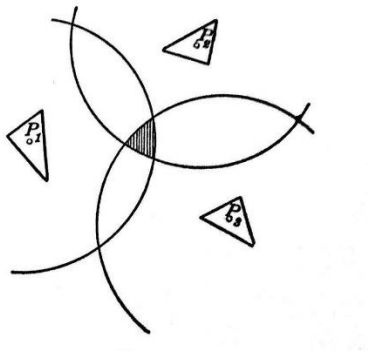


Figure 2. Agglomeration (Friedrich, 1929, p. 129)

Furthermore, Weber also uses mathematical formulae to derive the function of agglomeration. His mathematical derivation is in Mathematical Appendix section of his book. In doing so, Weber marks the beginning of development of theoretical models of agglomeration.

Walter Christaller (1893-1969)

Christaller, although a geographer, has contributed extensively to the field of urban economics through his Central place theory, written in 1933 and later translated to English in 1966 by Baskin. He got his education from the universities of Heidelberg and Munich, which explains the influence of Weber as well as Thunen in his writings. Christaller frequently refers to them in explaining his CPT. Like Weber, Christaller was a theorist, and so he devised a basic model called, Central Place Theory (CPT). His methods are both geometrical as well as mathematical. Christaller firmly believed that the answers lie in some form of common laws of economics. Regarding location theory, Christaller's primary question of interest was,

"Why are there, then, large and small towns, and why are they distributed so irregularly? How can we find a general explanation for the sizes, number, and distribution of towns? How can we discover laws?" (Beguin, 1992)

To answer this question, Christaller introduces the idea of "centrality." Centrality, Christaller, refers to the central functions rather than central spatial location. Goods and services produced at this central place will called central goods and central services. Central goods are goods produced at a few central places and consumed at many scattered places. As a result, places can be ranked based on the level of centrality. Cities are ranked higher than towns, and towns are ranked higher than villages. Goods and services that is found in lower levels of centrality is also found in higher levels of centrality, but some goods and services can only be sustained in the cities and not in villages. Take, for example, hospitals and universities. Hospitals and universities are available in cities, but they cannot possibly locate in villages (Baskin, 1966).

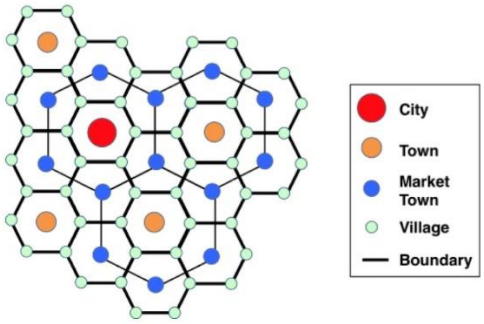


Figure 3. Christaller's ordering of central locations[2]

Christaller's ideas on agglomeration are implicit in his writings. He does not provide direct discussions on this matter. His statements are sparse and vague like in his first chapter, Christaller says, *"goods and services are, as a rule, offered centrally in towns, or at other central places, because it is most advantageous from an economic standpoint."*

Furthermore, Christaller states that agglomeration occurs at central places often due to reduction in distance between consumers and producers. Like the three previous authors in this paper,

[2] Source: https://www.aboutcivil.org/Chrystaller-Central-Place-Theory

Christaller focuses transportation costs to explain the clustering of businesses and people in an area. Similarly, Christaller also mentions the disadvantages of central production such as higher wages, higher land prices and higher rents (Beguin, 1992).

One of the more elaborative discussions on agglomeration by Christaller is that of the multipurpose shopping behavior of consumers. He writes,

"Someone who would buy something from the apothecary will, on the same trip (that is, with the travel costs already expended) consult the doctor at the place of the apothecary rather than the doctor who lives at a nearer place, but who could be reached only at the cost of another special trip. Therefore, the central place of a higher order directly draws customers away from the central place of a lower order." (Baskin, 1966, p. 43)

CPT explains local agglomeration in the form of specialized marketing and manufacturing districts (Mulligan, 1984). Mulligan also states that the Christaller system predicts that firms in the same industry tend to multiply and as population increases and likewise the demand. Unlike in previous discussions, Christaller argues here that consumer behavior can also lead to the clustering of similar economies. Co-agglomeration occurs not only because industries benefit from one another but because consumers benefit as well.

Conclusion

Many of the ideas discussed by the early thinkers of agglomeration are studied by contemporary researches today. New methods and tools may have been used to study them, but the underlying ideas remain the same. The first four agglomeration factors outlined by Thunen are also the primary argument for geographic concentration by Paul Krugman in his New Economic Geography (Fujita, 2000). Krugman states,

"The basic story of geographic concentration that I will propose here relies on the interaction of increasing returns, transportation costs, and demand."

Thunen's ideas on intra-industry specialization, Marshall's views on linkages and knowledge spillovers, and Christaller's joint shopping trips are all studied extensively in the modern location economics. Marshall's explanation of clustering of people through deliberate invitation of rulers is just like specialized recruiting of immigrants through the STEM program here in the United States[3]. These authors were also quick to recognize the ongoing effects of agglomeration such as agglomeration based technological change as well as the home market effect that we discuss in new trade theory.

We find from the works of these four great thinkers that ideas take time to develop. Each of these authors contributed to the discussion and thus set up a solid foundation for later researchers to develop new theories as well as improve the existing ones. One can also see the evolution in different methods used by authors. While Von Thunen and Marshal use the simple language with examples to illustrate their ideas, Weber and Christaller use geometric diagrams and mathematical models along with the explanation.

I would like to conclude with the idea that "dead men tell no tales" is certainly not true in the case of history of agglomeration thought. By reading historical writings, we are not just gaining knowledge but also paying our due respect for their foundational contributions. We all are in one way or the other, standing on the shoulders of these giants.

[3] Under an F1 visa, recent international graduates with certain STEM degrees can extend their work permit for a total of 29 months instead of just 12 for others. More info on https://www.ed.gov/stem.

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