Urban Multifunctional Land Use: Theoretical and Empirical Insights on Economies of Scale, Scope and Diversity

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A recent planning device aimed at dealing with land scarcity is the propagation of multifunctional land use. This paper describes the evolution of urban planning concepts and their links to economic theory. We argue that the most distinctive feature of multifunctional land use is its emphasis on return to diversity. This concept is rooted in the modern economic theory of agglomeration. Empirical evidence is shown to provide some support for the quantitative relevance of return to diversity, but is still to a large extent in its infancy. More evidence is required for policy purposes aimed at identifying the optimal extent to which multifunctional land use projects have to be pursued.

1. Introduction

Multifunctional land use can generally be defined as the combination of different socio-economic functions in the same area. This is also the main feature of the planning approach of 'Multifunctional Land Use', as it has developed over the last years (Priemus *et al*. 2000). The goal of Multifunctional Land Use (as a planning concept), just like New Urbanism, Smart Growth and the Compact City Concept, is to save scarce space by intensifying its use. However, it differs from other mixed land use planning concepts in the clear focus on the exploitation of the economies of synergy (Rodenburg *et al*. 2003).

Before we can assess the social desirability of multifunctional land use projects, we need to answer the question as to why various activities cluster in space, and what types of synergy might arise from such clustering. We do so by addressing multifunctional land use (MLU) as an empirical phenomenon instead of a planning concept.

Although MLU encompasses more than the clustering of economic activities (for example also the allocation of land use claims made by housing, transport, water, recreation and nature in this paper we focus on the economic effects of the clustering of economic activities. We do so by focusing on the concept of agglomeration economies in general and 'returns to diversity' in particular. The focus on the latter type of agglomeration economies is justified by the fact that MLU is explicitly aimed at creating synergy effects by combining a diversity of land use functions at the same location. By reviewing the literature on agglomeration economies we gain insights into the economic effects of MLU (via diversity). Furthermore, by means of a simple spatial-economic model (section 3.2) we show the spatial equilibrium impacts of the existence of agglomeration

economies, and we explain the possible role of governments in stimulating MLU.

Since multifunctional land use is a form of mixed and compact land use development, in section 2 we take a look at various mixed and compact land use strategies proposed in the planning literature. In section 3, a concise overview of the theoretical economic foundations of clustering and agglomeration economies is given. We discuss how the subject of agglomeration and clustering is treated in the spatial economics literature. We go back in the history of spatial economics, which stretches from the early days of spatial economic literature (Von Thünen, Marshall, Alonso, etc.) to the 'New Economic Geography' (Fujita, Thisse, Krugman, etc.). In section 4, we provide an overview of empirical studies regarding agglomeration economies and the measurement of effects. The paper concludes with section 5.

2. Multifunctional Land Use as a Planning Concept

Over the twentieth century, spatial planning based on segregation of functions, together with the rapid growth of automobile use, resulted in a low-density, dispersed development, which is often referred to as urban sprawl (see Dieleman and Wegener in this issue). Nowadays, several planning concepts such as New Urbanism, Smart Growth, Growth Management and Multifunctional Land Use (MLU) have been proposed to reduce urban sprawl and to promote spatial and environmental quality (Hall, 1998). One of the solutions emphasized in these approaches is mixed and compact land use (see, for example, Coupland, 1997).

With respect to mixed and compact urban development, we have witnessed three episodes, which differ in spatial focus and the inclusion of land use functions. In the 1970s, planners and designers, influenced by the work of Jane Jacobs (1961), pioneered mixed-use development. Early applications of the concept were mainly based on the redevelopment of attractive but sub-optimally used historic buildings and districts. This was, however, limited to combining office and retail functions. In the 1980s, spurred by the gentrification process, the integration of housing with retail and office functions became more common.

In the 1990s, the concept of 'urban entertainment centres' was introduced. This concept brings together theatres, sports facilities, and restaurants in large-scale projects such as Amsterdam Arena. The Amsterdam Arena is home to the Dutch football giant Ajax, and has car-parking, shopping facilities, movie theatres, a music hall and a highway underneath it. The same multifunctional stadium concept has also been applied in other cities across Europe and the United States, for example Arena auf Schalke in Gelsenkirchen, Germany.

In current design and planning practice more emphasis is put on the relationship between mixed and compact land use, infrastructure and city redevelopment and revitalization (e.g. the new railway station in Leipzig, the Amsterdam South-Axis). This type of development is not only concerned with mixed and compact land use, but also focuses on the creation of synergy between the land use functions that are combined. The planning concept of multifunctional land use belongs to this type of mixed and compact development.

One of the planning philosophies that addresses urban sprawl and mixed land use is New Urbanism. This mainly American movement considers design and planning as essentials for high-quality development of neighbourhoods. New Urbanist neighbourhoods are based on short walking distances and contain a mix of housing and work environments (Congress for the New Urbanism, 2000). New Urbanists claim that compact and mixed development is the best way to reduce travel time and commuting, to increase the supply of affordable housing, and to control urban sprawl.

Parallel to the upsurge of New Urbanism

in the 1990s, the Smart Growth movement emerged. Smart Growth addresses three inter-related subjects, namely, the density of urban development, the spatial separation of land use functions, and the relation between land use, mobility patterns and transport mode choice. Proposed solutions include urban infill development, mixing land use functions and the creation of transit and pedestrian-friendly environments (American Planning Association, 1999).

The concept of mixed and compact land use development did not remain unnoticed in the Europe. The publication of the *Green Paper on the Urban Environment* revealed the European Commission's commitment to achieve improvements in the quality of the urban environment within the Community (CEC, 1990). The document explicitly spelled out the relation between the quality of urban life, urban planning and sustainable development. Furthermore, it was stated that a mix of land uses at high densities and with good environmental conditions would improve the economic performance and vitality of cities. In addition to its support for mixing different land uses, the Green Paper emphasized that further urban growth should be accommodated within the boundaries of existing urban areas. This type of development is labelled 'Compact City' (for an overview of the Compact City Concept, see, Jenks *et al*. 1996; Jenks and Burgess, 2000; De Roo and Miller, 2000; and Maat, 2001).

The term multifunctional land use emerged in Dutch spatial planning in the late 1990s and it gradually replaced the concept of mixed land use. The concept of MLU promotes a sustainable form of land use by influencing the form of urban development (Laswick, 2002; Rodenburg *et al*. 2003; and Lagendijk, 2001). Major strategies of MLU are to increase density and to mix different land use functions. Density is increased by building on higher and subterranean levels, and by facilitating land use by different users at different moments in time. Furthermore, specific attention is paid to the creation of synergy between the various functions, which are combined in one area (Rodenburg *et al*. 2003). It is especially this aspect which sets MLU apart from other mixed and compact land use concepts.

The planning concepts mentioned above are focused on saving scarce space, open space, and farmland by intensifying and mixing land uses. Furthermore, the concepts promote a change in modal split in favour of non-automotive forms of transport, but differ mainly in the spatial level addressed and the measures taken. The similarities and differences between the concepts are summarized in table 1.

Although MLU and the other planning concepts described above strongly overlap, the origins of the concepts differ. Mixed and compact land use are aimed at accommodating land use claims from housing and industry within an urban context. MLU is a more integrated approach aimed at increasing the efficiency with which land is used in both urban and rural areas on a national, regional, and local level. Furthermore, the most distinctive factor of multifunctional land use is its emphasis on the creation of synergy which may come into existence due to the interaction between activities. This concept is well rooted in the economic theory of agglomeration, which will be reviewed in the following sections.

3. Agglomeration Economies

MLU emphasizes the creation of synergy between various functions. It is therefore interesting, when studying this planning concept, first to review the economic literature regarding the clustering of activities and associated agglomeration economies. We do so in section 3.1. Section 3.2 sketches a simple model that characterizes the essential elements of agglomeration considered in the economic literature. In Section 4 we pay attention to various empirical studies analysing the economic effects of agglomeration.

Table 1. Similarities and differences between various mixed and compact land use concepts.

	New Urbanism	*Smart Growth*	*Compact City*	*Multifunctional Land Use*
Characterization	American planning concept aimed at the mixing of activities at neighbourhood level	American planning concept aimed at the protection of open space and farmland	European planning concept to improve the environmental and economic performance of cities	Planning concept aimed at the sustainable use of land. Especially focused on the creation of synergy between land use functions
Focus on urban revitalization	Yes	Yes	Yes	Yes
Attention to high density development	No explicit attention	No explicit attention	Explicit attention	Explicit attention
Spatial level	Neighbourhood	Neighbourhood and city	Neighbourhood and urban regions	Building, neighbourhood, city
Intended mobility effects	Reduced (car) mobility	Reduced (car) mobility	Reduced (car) mobility	Reduced (car) mobility
Transport mode favoured	Pedestrian friendly	Pedestrian friendly	Pedestrian, bicycle, public transport	Public transport
Space saving	Yes	Yes	Yes	Yes
Attention to resource use conservation	Explicit attention	No explicit attention	No explicit attention	No explicit attention
Creation of synergy	No explicit attention	No explicit attention	Limited attention	Explicit attention

3.1. Agglomeration Economies: A Theoretical Overview

Table 2 presents the major contributions and their findings that will be discussed in more detail in this section. In the first part of this section, we discuss how the subject of agglomeration is treated from a microeconomic or business perspective, while in the last part, modern approaches towards the subject are discussed.

Classical Contributions. Johann Heinrich Von Thünen (1826) is seen as the founding father of regional economics. In his seminal work *Der Isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie*, Von Thünen constructed a theory focusing on transport-cost differentials across locations. His model shows how the existence of a central market is sufficient for a competitive land market to structure the use of space and to allocate it in a regular pattern to different activities. This location of the central market is exogenously determined, and the reason for its existence is omitted from the analysis. The model predicts that in equilibrium, activities are distributed around a market place in concentric rings, with each ring representing a specialized agricultural activity (different crops). Differences in optimal locations are explained

by differences in transport costs, and are sustained in equilibrium by competitive land prices, which drive agricultural profits down to zero. His model thus simultaneously explained the location of economic activities, productivity of land and land rent. Although the theory of Von Thünen describes some essential forces that promote or restrict geographic concentration (centripetal and centrifugal forces), the model cannot explain the existence of multifunctional land use. The Von Thünen model solely produces rings with monofunctional land use.

William Alonso's (1964) book *Location and Land Use* is often seen as the starting point in the field of urban economics. In his book, Alonso extended the Von Thünen model and put it within an urban context. The market town in the Von Thünen model is interpreted by Alonso as the city centre to which households must commute in order to work. In Alonso's model, urban activities like industry and housing are located in rings around this city centre. A novelty in Alonso's model is the introduction of factor substitution. The Von Thünen model showed that as a firm moves further away from the central market, the price of land falls. Alonso assumes that the price of non-land inputs stays constant and is not influenced by the distance to the central business district. As a consequence the price of land falls relative to the price of non-land inputs as the distance to the central business district increases and firms substitute in production in favour of land and away from non-land inputs. The inclusion of factor substitution ensures a closer link between the Von Thünen land use model and the standard microeconomic production theory. The concentric rings in Alonso's model are also monofunctional in nature. However, due to the inclusion of factor substitution, we are able explain differences in the intensity of land use in

Table 2. Spatial economic theory, agglomeration economies and relevance for MLU.

Theory	*Findings*	*Relevance for MLU*
Von Thünen	Allocation of land use based on transportation costs	Monofunctional land use allocation
Alonso	Allocation of land use based on transport costs Factor substitution	Monofunctional land use Intensification of land use
Marshall Hoover	Characterization and classification of agglomeration economies	Identification of synergy effects related to MLU projects
Perroux	Growth-pole model	Selection of key cluster members.
Chinitz	Incubator model	Diversity as instigator of growth
Myrdal	Core-periphery model Spatial concentration of economic growth	
Vernon	Life-cycle model. Economic activities are spatially separated according to the stage in the life-cycle of the product concerned	Selection of cluster members on the basis of development stage a firm is in. Focus on innovation and high-tech firms
Porter	Competitiveness of regions/clusters is based on strong localization economies and proximity of industry members	Local competition is vital for an MLU cluster. Theory forms a foundation for the selection of cluster members (competitors)
New Economic Geography	Diversity and demand linkages are important for clustering	NEG explicitly investigates the role of linkages and product diversity in clustering

terms of labour and capital applied to the unit of land. It is especially the latter aspect of Alonso's work which is of interest for the analysis of multifunctional land use, since it endogenously explains the intensity of land use.

The neoclassical economist Alfred Marshall (1890) was the first to investigate how location and proximity to other economic agents influence productivity. Although Alfred Weber (1909) mentioned location-specific economies of scale, it was Marshall who gave a detailed description of the sources of agglomeration economies. Marshall observed that firms often cluster in the same area and concluded that those firms must benefit from some form of increasing returns to scale. In his work he provided four sources of agglomeration economies, which are labelled as *scale economies at the firm level, local non-traded inputs, local skilled labour pool* and *information spillovers.* Although the above sources of agglomeration economies explain why firms within the same industry cluster, in reality we often observe groups of firms in different industries clustered in geographical space.

It was especially Hoover (1936, 1948) who accounted for the inter-sectoral clustering of firms in his classification of Marshallian externalities. In his classification, Hoover distinguished *internal returns to scale, localization economies* and *urbanization economies*.

An important reason for a firm to concentrate its activities at one location is the existence of internal scale economies in production. Internal scale economies arise for two reasons: (1) factor specialization and (2) indivisible inputs. Due to labour specialization, productivity will increase. Indivisibilities are faced when production factors cannot be utilized in small spatially segregated units without incurring diseconomies of scale due to a sub-optimal size of operation. Although the spatial concentration of a firm's activities is typically required to exploit internal scale economies, they do not correspond to the description of Marshall's agglomeration economies as being external to the firm.

Localization economies occur when the production costs of firms in a particular industry decrease when the total output of the industry concerned increases. To benefit from localization economies, a firm must be located close to other firms in the industry. Localization economies depend on the scale of the industry and originate from three principal sources (O'Sullivan, 2003): (1) scale economies in the production of intermediate inputs; (2) labour pooling and; (3) knowledge spillovers.

Urbanization economies originate from the same sources as localization economies and are also external to the firm. However, urbanization economies differ from localization economies in that they result from the scale and diversity of the entire urban economy, and not from the scale of a particular sector (Jacobs, 1969).

Since the differences between internal scale economies, localization economies and urbanization economies depend greatly on the definition of the boundaries of the firms and the sectors, it is especially this aspect of Hoover's classification that is often criticized.

Although the theories mentioned above highlight the forces behind agglomeration, the degree of agglomeration is not unlimited. Immobile factors, in the form of supplier dependency, or agglomeration diseconomies, such as traffic congestion, high intra-urban transportation costs or pollution, restrict agglomeration and the size of cities.

To summarize, according to Marshall and Hoover the spatial configuration of economic activities is the outcome of a process involving two opposing types of forces, agglomeration economies and agglomeration diseconomies. It is especially their characterization and categorization of these forces that is helpful in the economic analysis of multifunctional land use, since they give a systematic overview of possible costs and benefits, in the form of

externalities, resulting from multifunctional land use projects.

Business Perspectives on Agglomeration. Agglomeration theories developed in the twentieth century often tried to explain agglomeration forces from a business management perspective, such as transaction costs theory.

Based on ideas of Schumpeter (1934), Perroux (1950) described in his 'growth pole model' relationships between firms as based on financial linkages. In Perroux's theory, decisions made by key large firms ('growth poles') have major implications for other firms, which are linked to these firms (both forward and backward). Boudeville (1966) gave the growth pole concept a spatial dimension, and argued that the spatial organization of an area is affected by the location behaviour of certain major firms or plants.

Based on the analysis of the industrial structure of Pittsburgh and New York, Chinitz (1961) developed a variant of the growth pole model. According to Chinitz's *incubator model,* highly diversified industrial clusters are 'incubators' for the development and growth of new firms. Chinitz argues that these clusters offer a variety of business services to small firms, facilitating their growth. This model suggests that the size distribution and diversity of firms within the cluster is important for the growth of the cluster. The growth pole and incubator models highlight the selection of cluster members and diversity as essentials for the development of multifunctional land use projects.

The basic assumption of Myrdal's (1957) core-periphery model is the spatial concentration of economic growth in one location. According to Myrdal, the tendency for growth to concentrate is sustained by the tendency of capital and labour to move towards the highest return in a free market. The increased competitive advantage that the growing region attains from economies of scale leads to a process of circular and cumulative growth.

In his product lifecycle model, Vernon (1960) argues that activities are spatially separated according to the stage in the lifecycle of the product concerned. If activities benefit from Marshallian economies, they will be located in clusters. In contrast, if a product and the production process concerned are standardized, and no longer rely on agglomeration economies such as knowledge spillovers, these activities will be located in more peripheral areas, with lower labour costs.

Inspired by the transaction cost theory of Williamson (1975), Porter (1990, 1998) argues that clustering of activities is an alternative organizational form. Porter argues that clustering offers individual firms an alternative way of organizing transactions and that this form of spatial industrial organization maximizes the transfer of information and technologies between firms. Proximity to competitors encourages firms to improve their competitiveness. The process of this localized competition is an enhanced competitiveness of the cluster at hand.

Modern Approaches to Agglomeration. Currently much attention in research is devoted to the influence of Information and Communication Technologies (ICT) on the location decisions of firms and households (see, for example, the seminal work of Castells, 1996).

The spatial-economic implications of ICT are, however, still difficult to predict. On the one hand, it is believed that ICT may overcome barriers of space and time, so that the space-economy becomes more footloose with equal opportunities for all localities as supported by the concept of 'death of distance' (Mitchell, 1995). On the other hand, it is also argued that economic and political power centres will not decrease and that the concentration of knowledge will favour cities (see, for example, Gillespie and Williams, 1988; Graham, 1999; and Linders *et al*. 2004).

The upsurge of the New Economic

Geography (NEG) in the 1990s renewed the interest in the processes of agglomeration. Fujita *et al*. (1999) argue that Marshallian externalities explain why cities and central business districts exist, but that they do not explain the nature of those external economies. An important purpose of the New Economic Geography is to explain the self-reinforcing character of spatial clustering, and the associated returns to scale. In short, this field in economics tries to model the centrifugal and centripetal forces in agglomeration, welfare effects of product variety, the productivity of firms, and transportation costs following the iceberg approach of Samuelson (1952). NEG has its roots in urban economics, (new) growth theory and (new) trade theory. Progress in these fields of economics was spurred by the development of the Dixit-Stiglitz (1977) model of monopolistic competition, which also forms the foundation for NEG (see Brakman and Heijdra (2004) for progress in all fields building on the seminal Dixit-Stiglitz model of monopolistic competition). One of the most important models of the NEG is the core-periphery model. This model shows how a two-region economy can become differentiated in an industrialized core and an agricultural periphery. In the NEG models, agglomeration may be the result of demand linkages between firms or may result from the mutually reinforcing interplay between cost-of-living (for consumers) and market access (for suppliers) (Krugman, 1991). Scale economies in NEG are therefore internal to the firm and the externalities related to clustering arise endogenously from the location decisions of economic agents. Fixed production costs imply that firms prefer to serve consumers from a single location, while transport costs imply that firms prefer to be near large consumer markets (Hanson, 2000). These two forces create demand linkages that contribute to spatial agglomeration. Firms are attracted to densely concentrated regions by the possibility of serving a large local market from a single plant at low transport costs; the more firms that move to the region, the more attractive the region becomes. To conclude, NEG explicitly investigates the role of product diversity in the clustering process and therefore forms an interesting perspective for the analysis of multifunctional land use.

3.2. Clustering of Firms in an Alonso Setting: An Analytical Perspective

Urban economics textbooks typically explain the market forces behind the development and spatial organization of the monocentric or core-dominated city based on the models developed by Von Thünen and Alonso. Here we concentrate on the location of a multifunctional activity cluster in an Alonso setting. We focus on this relatively simple setting not because it is the most representative situation for contemporary cities, but because it is the simplest possible set-up for showing the spatial equilibrium impacts of the existence of agglomeration economies in an analytical setting that will be familiar to most readers. Here we take a closer look at two situations. The first situation concerns the clustering of activities within an industry. The second situation is related to the clustering of firms originating from different industries. Since in MLU projects various different economic functions are combined, it is especially the latter situation that interests us.

Clustering of Firms within an Industry (Localization Economies). The reasons for firms belonging to the same industry to cluster have been discussed extensively in the literature on the monocentric city. We will explain this type of clustering by means of an example (see figure 1).

In our example, four different sectors are present. We distinguish agriculture, manufacturing, housing and offices. All sectors considered are exporting their products. Hence, the output prices are those prevailing on the world markets. Exporting the products

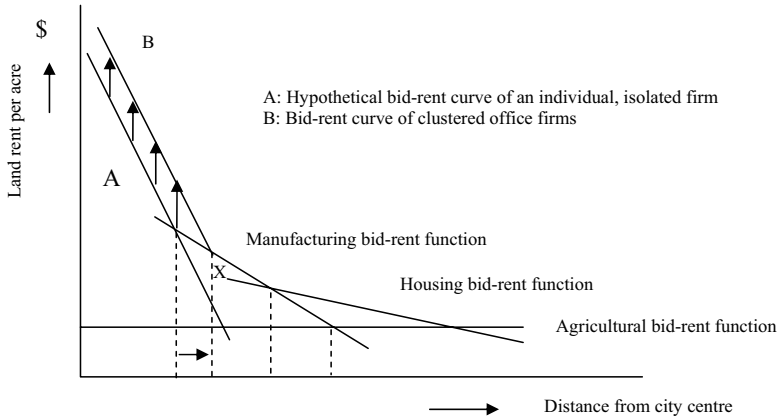


Figure 1. Localization economies and clustering.

can only take place at the central export node. So the sectors are oriented towards the central export node. We assume that the factor prices for non-land inputs (such as labour) are exogenously determined and are therefore given. Rent paid by each sector is determined by the left-over principle:

Rent = output revenue – non-land inputs costs – transport costs

We assume that transport costs per unit product per mile are constant for each sector and firms do not have possibilities for factor substitution. More specifically, land inputs cannot be substituted by non-land inputs. This results in bid-rent curves that are linear for all sectors.

In our example, we assume that only the office sector enjoys localization economies. These localization economies are internal to the cluster but external to the firms belonging to that cluster. For convenience, we assume that distance to the cluster matters only in a binary sense. A firm is either in or out of the cluster.

The clustering effects are reflected by an increased productivity of factor inputs used by firms in the office sector. As a result, the costs of non-land inputs decrease resulting in an increased profitability of firms in the office sector. Due to the increased profitability, firms in the office sector are able to pay higher rents for a location and the bid-rent curve shifts upwards (from A to B in figure 1). However, the slope of the bid-rent curve does not change. Due to the shift from A to B, the office sector can outbid part of the manufacturing sector and occupies a larger area at the expense of the manufacturing sector.

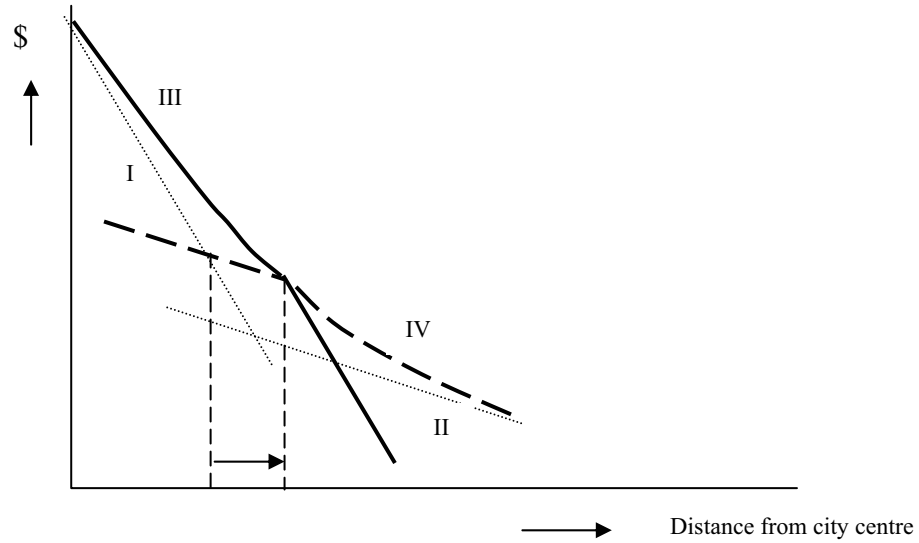
To summarize, positive localization economies, in our example in the form of knowledge spillovers, result in an increased productivity of non-land inputs used by the cluster. As a consequence, the costs of input factors decrease and the profitability of the cluster increases, leaving more room for the cluster to pay a higher rent. This results in a higher bid-rent curve for the office sector than the one associated with an individual isolated firm, in the absence of clustering. In this situation the clustered firms can outbid competing land use functions over a larger range.

Clustering of Firms Originating from Different Industries (Diversity). The analysis becomes more complicated when we consider externalities across firms belonging to different sectors (see figure 2). We will illustrate these complications by means of an example. In our example we consider two firms belonging to different sectors (Firm A and Firm B). We assume in our analysis that:

- Transport costs for both firms are constant per unit product per mile.
- The firms do not have possibilities for factor substitution.
- Both firms are exporting firms operating in a perfectly competitive world market hence, the out prices for their products are given.
- Export takes place via the central export node, so both firms are oriented towards this central export node.
- Rent paid by both firms is determined according to the left-over principle described in the previous example.
- The clustering effects, in this example of urbanization, are again reflected in increased productivity, resulting in lower unit costs.

In case of urbanization economies, the location decision of a firm is no longer solely based on access to the central export node but also on the proximity to the other sector. As argued before, the agglomeration economies resulting from clustering are reflected in increased input productivity. This results in lower costs for these inputs and a higher profitability for the firm concerned. This increased profitability offers the firm a possibility to bid a higher rent for a location.

In case of the existence of a central export node and urbanization economies, the firms face a trade-off between transport costs and the benefits resulting from the proximity to the other firm. Since proximity to the other firm matters for both firms, the bid-rent curves are influenced by the distance (transport costs) to the central export node and the distance to the other firm. If, for example, Firm A (see bid-rent curve III) moves away from the central export node towards Firm B, transport costs will rise, but this effect is to some extent mitigated by the increased productivity of inputs. The situation is somewhat different for Firm B. If Firm B moves in the direction of Firm A, its transport costs decrease as well as the costs of the inputs (see bid-rent curve IV). In general, with increased productivity the bid-



I: Bid-rent curve of Industry A in absence of urbanization economies
II: Bid-rent curve of Industry B in absence of urbanization economies
III: Bid-rent curve of Industry A in presence of urbanization economies
IV: Bid-rent curve of Industry B in presence of urbanization economies

Figure 2. Urbanization economies and clustering.

rent curve shifts upwards, and the size of this shift increases with proximity. This process continues until both bid-rent curves intersect. After this intersection, the bid-rent curves of both firms become linear again. Note also, that bid-rent curves I and II function as asymptotes for the curves reflecting the effects of urbanization economies. This can be explained as follows. If Firm A moves closer towards the central export node, it will benefit less from the proximity to Firm B and its profitability declines. However, the profitability of Firm A is never lower than in a situation without urbanization economies, hence the lowest rent Firm A will bid is reflected by bid-rent curve I.

In this example, an odd situation may occur. When Firm A benefits more from clustering than Firm B, the area Firm A occupies expands at the expense of Firm B, from which proximity it benefits.

If we take a close look at the outcomes of this simple model, we can see that the total land-rents generated in the city are higher than in a situation without agglomeration economies. As elsewhere in the literature, agglomeration economies are assumed to be externalities, which may cause the market outcome to deviate from the social optimum. This deviation might be a reason for governments to intervene in the land market. However, in this paper we do not investigate the possible policy instruments that could be used by governments in attaining the social optimum.

Evaluation. In this section we presented two illustrative cases of clustering in the Von Thünen/Alonso land use model. The first case concerned the clustering of firms belonging to the same industry and involved localization economies. The second case concerned the clustering of two different industries benefiting from proximity to each other and the associated urbanization economies.

The incorporation of agglomeration economies in an Alonso/Von Thünen setting may clarify some aspects of clustering, but the outcome is still a monofunctional allocation of land use in concentric rings. A multifunctional 'ring' could arise only if equilibrium bid-rents happen to coincide. Other types of models may therefore be more useful to explain the presence of areas with multifunctional land use in a spatial equilibrium.

The two examples showed us the importance of agglomeration economies in the clustering process. When agglomeration economies are external to the firms, they are considered to be externalities. The presence of externalities results in an equilibrium outcome that generally differs from the social optimum, and this might be a reason for governments to intervene in urban land markets.

In the second example we observed the clustering of two industries. It will be more complicated to determine a unique equilibrium if we include more than two industries in our analysis. For example, if a third industry is added that does not benefit from any agglomeration economies or diseconomies, while Industries 1 and 2 do benefit from proximity to Industry 3, a unique equilibrium need not exist. A situation might occur wherein the multifunctional conglomerate (consisting of Industries 1 and 2) outbids the third industry on a location. As a consequence, Industry 3 needs to relocate to a more distant location, but will then be 'followed' by the other two industries. In case Industry 3 experiences agglomeration diseconomies from the proximity of the multifunctional setting, the 'chasing' as indicated above may take on an even more extreme form. These two examples clarified the clustering process as well as the effects of agglomeration economies. However, it only constituted a rudimentary type of analysis. More attention should therefore be devoted to the development of models incorporating all characteristics of MLU and shedding some more light on the process and effects of clustering.

4. Empirical Studies regarding Agglomeration Economies

The literature on spatial agglomeration emphasizes increasing returns to scale or increasing returns to diversity as reasons for spatial agglomeration. However, the externalities that contribute to spatial agglomeration, such as knowledge spillovers between workers, learning across firms, or cost and demand linkages between local industries, are difficult to observe, and empirical researchers therefore have to rely on indirect measures such as wages, employment, output and growth to investigate them. Figure 3 gives an overview of relevant analytical approaches that have been used for the identification and measurement of agglomeration economies (see for an overview of studies Rosenthal and Strange, 2004). We will discuss the various approaches and their findings here in more detail in order to investigate useful approaches to measure the economic effects of MLU and to gain insight into the magnitude of these effects.

From the economic literature it is well known that wages and rents are, controlling for other factors, higher in urban areas than non-urban areas (Glaeser and Mare, 1994). For firms to be willing to be in those urban areas such locations apparently have advantages that outweigh the above-mentioned higher costs. Several researchers have examined these advantages (table 3).

A first strategy to analyse whether firms expect to be more productive in areas where other firms in their industry are located is to examine the location decision of new firms. Carlton (1983) found that new firms are more likely to choose a city when own-industry employment is large in that city. Wheeler and Mody (1992) examined foreign investment decisions of US multinationals. They found that foreign investment is higher in countries with larger markets, a larger initial concentration of foreign firms, and a

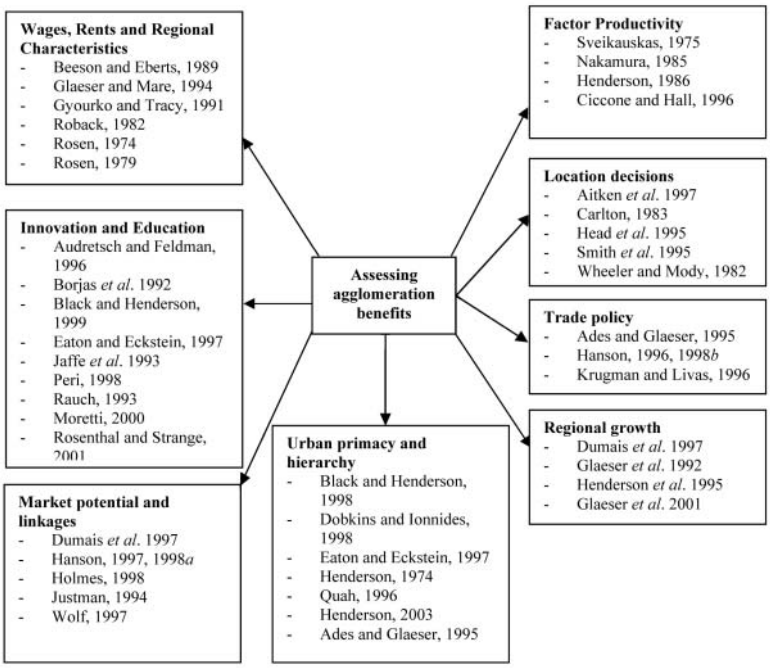


Figure 3. Empirical studies of agglomeration economies.

higher quality of industry. Firms are attracted to locations that have large concentrations in their own industry or related industries.

Various researchers who measured the extent of agglomeration economies have focused on productivity gains accruing to activities that are located in larger urban areas. The idea is that by the comparison of labour markets associated with cities of different size, it might be possible to isolate the contribution of urbanization economies to labour productivity. Henderson (1986) used this approach and measured localization economies as the elasticity of output per worker with respect to industry output. The results of Henderson's study indicate that urbanization economies are very small and that an increase in city size does not increase labour productivity. He concludes that larger cities are more productive because they have large concentrations of specific industries (localization economies), not because they are large (urbanization economies).

In contrast, Sveikauskas (1975) claims that urbanization economies do matter, and found that an average productivity gain of about 6 per cent could be expected with each doubling of city size. In a more recent study, Ciccone and Hall (1996) analysed the relationship between labour productivity and density. They find that doubling the employment density in a region raises labour productivity by 6 per cent. This is consistent with the view that proximity of workers to each other makes them more productive.

Another strategy to assess empirically the effects of agglomeration economies on industry location is to examine variation in industry growth or innovation across regions. By examining the growth process, one can control for the time-invariant characteristics of regions that influence firm behaviour (Hanson, 2000). Glaeser *et al*. (1992) find that employment growth in a city industry is positively correlated with initial diversity (urbanization economies) of industrial activity in the city, but not with initial own-industry employment in the city. The results can be interpreted as that the benefits firms derive from agglomeration come from interaction with many different types of firms rather than from interacting with firms in their own industry.

Henderson *et al*. (1995) studied annual employment growth for a subset of manufacturing industries across US cities. They find that for new industries employment growth in a city is positively correlated with initial diversity in a city, but for mature industries employment growth is positively correlated with initial own-industry employment in the city and not correlated with initial diversity. They interpret these results to imply that the benefits of agglomeration depend on the stage of development of the industry (lifecycle approach).

Dumais *et al*. (1997) studied the regional characteristics that influence industry location and focused on employment growth. They conclude that industry employment growth is higher in cities where industries, (1) use workers in similar occupations (possibly due to labour pooling), and (2) are relatively specialized in inputs demanded or supplied by the industry in question (non-traded goods).

Jaffe *et al*. (1993) studied the geographical localization of US patents citations. They found that new patents and cited patents are much more likely to have originated in the same city. This means that location-specific spillovers associated with innovation exist, which contribute to industry localization. Audretsch and Feldman (1996) find that innovations are concentrated in locations with relatively high spending on R&D, employment of skilled labour and spending on university research, suggesting that innovations cluster near knowledge intensive activities.

Another explanation of spatial wage differences is that through location-specific externalities, the return to skills of workers is raised and that firms are therefore willing to pay higher wages. Some theories suggest that if there are spillovers in the accumulation

of human capital, a worker will be more productive, the more educated the workers are with whom he or she shares a given location (Eaton and Eckstein, 1997 and Black and Henderson, 1999).

Rauch (1993), using hedonic pricing techniques, finds that both wages and rents are higher in cities with higher average education levels. This means that workers benefit in terms of higher productivity from being close to educated workers, and that in regions with a highly educated labour force, this is reflected in higher wages and higher demand for housing. Peri (1998) investigated the Rauch relationships in more detail and found that most of the effect of average education on wages is due to the fact that the returns to education of individual workers are increasing in the average local education level. The benefits in terms of higher labour earnings from additional years of education appear to be higher in cities with a more educated labour force. This gives educated workers a stronger incentive to be established in cities than less-educated workers, and may be considered as a source for agglomeration (see Borjas *et al*. 1992). Glaeser *et al*. (1995) find, based on US data, that cities endowed with a more educated population have a higher population growth in the future.

Various researchers focus in their empirical studies on cost and demand linkages to explain agglomeration. They claim that agglomeration may raise the productivity of firms if it expands local demand for their goods, either through market size effects or input-output linkages between industries (pecuniary externalities). One of the assumptions in this type of empirical research is that firms are willing to pay workers higher wages in regions that are close to large consumer markets, since firms in these regions are able to deliver goods to markets at lower transport costs.

Hanson (1997, 1998*a*) finds that controlling for other factors, wages are indeed higher in locations that are closer to large consumer markets. These results suggest that demand linkages between firms and consumers can create location-specific externalities that contribute to spatial agglomeration.

For demand linkages to influence agglomeration, most output must be traded locally due to transport costs or other trade costs. Wolf (1997) finds in his study that downstream firms tend to locate near upstream supplier industries (and *vice versa*). Furthermore, Wolf finds that trade between two states is higher if production patterns are more similar in those states. Holmes (1998) finds that plants in more localized industries tend to have a higher ratio of purchase inputs to sales, suggesting that plants in these industries are less vertically integrated than other plants and thus purchase a higher fraction of their inputs locally.

That regional input-output linkages do exist is no evidence that such linkages raise productivity or promote spatial agglomeration. Dumais *et al*. (1997) and Hanson (1998*a*) both find evidence that regional demand linkages contribute to spatial agglomeration. Davis and Weinstein (1999) find an excess concentration of production in regions where demand for a good is relatively high. Furthermore, Justman (1994) finds a strong relationship between local supply and local demand for manufacturing industries in US cities.

To conclude, spatial variation in wages and rents contains important information about the benefits of agglomeration that accrue to firms and households. The observed variation in the exogenous characteristics of regions appears to be insufficient to explain the spatial variation in wages and rents (see for example studies of Rosen, 1974, 1979 and Roback, 1982). Empirical studies suggest that spatial wage differences are consistent with benefits from proximity to more educated workers, dense concentrations of economic activity, and areas of high consumer or industrial demand. One limitation of existing empirical research is that most studies tend to explain the role of one factor in spatial agglomeration, in isolation from

other possible effects. In this case, we are not sure whether there are multiple types of externalities that contribute to agglomeration or whether each of these effects simply captures a different aspect of a single unified force behind the location of economic activity. Furthermore, empirical studies focusing on diversity, in the way NEG does, are scarce. Specifically the results of research focusing on the role of diversity in clustering are of importance for the assessment of MLU projects.

5. Concluding Remarks

Multifunctional land use is a type of mixed and compact land use with explicit attention to the creation of spatial synergy between functions. It is therefore necessary to include the effects of clustering of different land use functions in the evaluation of MLU projects. For a proper assessment of clustering effects associated with such projects it is crucial to identify and measure agglomeration economies. Although the theoretical literature highlights the role of diversity in clustering, significant attention to diversity is still often missing in empirical studies. It is especially this aspect that is crucial for the assessment of MLU projects.

Agglomeration economies often take the form of externalities and this might be an argument for governments to play an active role in the development and co-ordination of multifunctional land use projects. Intervention of governments should

Table 3. Empirical studies regarding agglomeration economies and their findings.

Focus	*Studies*	*Findings*
Location decisions	Carlton, 1983 Wheeler and Mody, 1992	Firms (foreign) are attracted to own industry
Productivity	Sveikauskas, 1975	Urbanization economies are significant. Doubling of city size results in a productivity gain of 6%.
	Nakamura, 1985 Henderson, 1986	Localization economies are significant.
	Ciccone and Hall, 1996	Doubling of employment density raises labour productivity by 6%
Growth	Glaeser *et al*., 1992	Diversity does matter for economic growth
	Henderson *et al*., 1995	Diversity does only matter for new firms to grow.
Innovation	Audretch and Feldman, 1996	Innovations and knowledge centres are spatially clustered
	Jaffe *et al*., 1993	Innovations, patents have a clustered pattern
Education and human capital	Rauch, 1993	Wages and rents are higher in regions with higher educated inhabitants
Market potential Demand linkages	Davis and Weinstein, 1999 Dumais *et al.*, 1997 Hanson, 1998*a* Wolf, 1997	Regional demand linkages contribute to agglomeration.

be focused on the internalization of agglomeration economies. By internalizing the agglomeration economies, investors or firms have more possibilities to compensate the higher costs of MLU projects and the chances are higher that these projects will be developed via market forces.

This paper focused on the clustering of firms in a MLU setting as well as on the benefits in the form of agglomeration economies. In order to create a complete picture regarding agglomeration and benefits, we should extend the analysis to the clustering of households. Furthermore, attention was paid to the associated economic benefits of firm clustering. In further research, attention should be devoted to non-economic effects of MLU projects, such as social and environmental effects, which are often not marketed and are therefore harder to incorporate in economic evaluation tools such as cost-benefit analysis.

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