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A theoretical foundation for investigating the spatial economic attributes of airport-centric developments

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Abstract. Among the various areas of interest on the topic of airports and the geographical distribution of land use, one pertinent theme is the spatial economic analysis of airports and their environs. However, the existing literature predominantly focuses on describing the land-use composition of airport-centric developments, without unpacking the spatial economic forces at play. This gap brings to the fore the need to employ an appropriate theoretical lens to guide the spatial economic analysis of airports and their environs. The aim of this theoretical review paper is thus to identify concepts that are relevant to the analysis of airports and their environs; and to use those concepts to systematically identify the existing theory that is most suitable for investigating the spatial economic forces that drive airport-centric developments. Against the background of globalisation, we scrutinise classical location theories, regional science, growth pole theory and new economic geography against their relational interpretations of the concepts of space, proximity, firm, scale and pattern. Given that it portrays a relational perspective of the aforesaid concepts, the paper concludes that growth pole theory is suitable as the main framework for analysing airport-centric developments. It is therefore recommended that growth pole theory be empirically used to guide the analysis of airports and their environs, and subsequently be used as the basis for developing a theoretical framework tailored for airport-centric developments.

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1. Introduction

Discussions about the nexus between transportation and land use acknowledge that airports can, one way or another, influence the geographical distribution of economic activities. Citing a number of sources, Mokhele and Geyer (2018) note that the literature on this interrelationship can be categorised into five intertwined themes, viz.: the impact of aircraft noise on the distribution of economic activities; the economic benefits of airports, which are typically captured in airport economic impact reports; institutional arrangements that influence development on airports and their environs (hereinafter used interchangeably with "airport-centric development"); normative planning models that advance the ideal spatial form and land-use mix of developments that emanate from airports, epitomised by the airport city and the aerotropolis; and the land-use composition of the environs of airports, including factors that influence the firms' location-choice decisions.

Though the aforesaid themes are all important, the paper intends to contribute particularly to the last category, which is crucial towards comprehending the spatial economic workings of airports and their environs. In turn, such understanding is important towards in part ensuring that airport-related development initiatives (e.g. à la models of airport-led development) are appropriately formulated and directed. Although insightful, the empirical literature on this theme has the limitation that it predominantly focuses on describing the land-use composition, without unpacking the spatial economic driving forces at play (Mokhele and Geyer, 2018). For instance, notwithstanding the arguments advocating a positive influence of airports on the distribution of land use, the location of economic activities in the vicinity of airports does not necessarily imply that such activities either utilise the airport more than those located elsewhere (Kramer, 1988) or locate in the vicinity of airports due to their dependence on the airport infrastructure (see Warffemius, 2007). By and large, the aforesaid limitation calls for improvements to the analysis of the spatial economic forces that drive airport-centric developments, which can arguably be achieved by applying an appropriate theoretical framework (Mokhele and Geyer, 2018). The paper understands theory not as a rigid framework that is used to generate predictions and laws (Wilson, 1980) but rather as a framework or, as it were, analytical lens that assists towards the conceptualisation of a given phenomenon. It is upon this understanding that the paper recommends the use of a well-considered theoretical lens in the analysis of the spatial economic attributes of airports and their environs in general, and the forces that drive airport-centric development specifically.

Against this backdrop, and while understanding that concepts are the building blocks of a theory, the aim of this theoretical review paper is two-fold: one, to identify concepts that are appropriate for analysing forces that drive development in the vicinity of airports; and two, to use that conceptual building block to systematically identify an existing theory that is appropriate for investigating forces that drive development at airports and in their environs.

2. Methodology

The search for the appropriate concepts and existing theoretical framework is framed against the background of globalisation, implying that the paper is particularly applicable to airports that handle great volumes of cargo and passengers. Given that a range of theoretical lenses could be applied to the analysis of airport-centric developments, the following method was devised to identify the most relevant theory (also see Fig. 1):

1. Concepts that are appropriate to the analysis of the spatial economic attributes of airport-centric developments were pinned down – namely, linkages, agglomeration economies and clustering. These concepts are arguably central to the analysis of the location of economic activity generally, and thus considered potential cornerstones of the analysis of airports and surrounds.
2. Concepts that give substance to linkages, agglomeration economies and clustering were identified, viz.: space, firm, proximity, scale and pattern. Intricate connections and interdependencies exist within and between the two sets of concepts.
3. Given that space, firm, proximity, scale and pattern are ambiguous; their relational interpretation was sought in light of the notion of globalisation.
4. It had to be determined which theories could have relevancy to the spatial economic analysis of airport-centric developments. It was established that a theoretical review was befitting human geography's locational school, which proposes a framework for analysing the location of economic activity. The following theories could therefore have relevancy to the analysis of airport-centric developments: classical location theory, regional science, growth pole theory and new economic geography.
5. The aforesaid theories were then evaluated against their understanding of space, firm, proximity, scale and pattern. The following mapping was adopted: strong correlation [S] (if a theory relationally interprets a concept); moderate correlation (M) (if a theory relationally interprets a concept only partially); and no correlation (N) (if a theory does not relationally interpret a concept, does not consider it explicitly or does not consider it at all). It was decided that the most appropriate

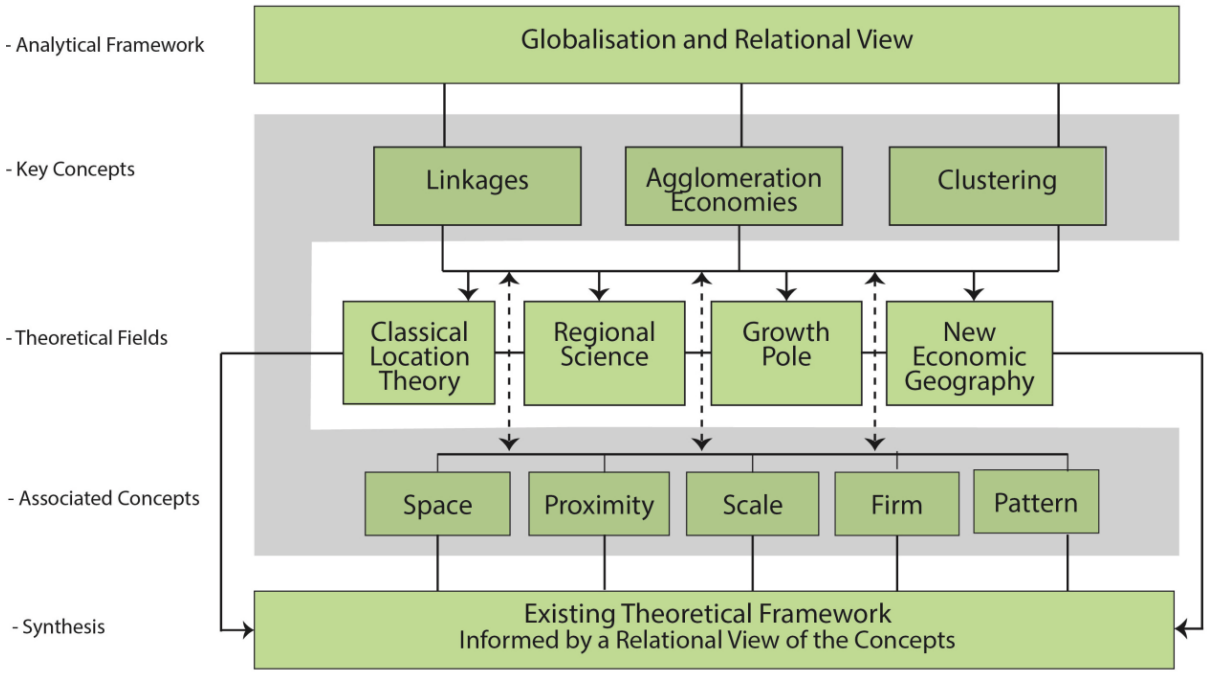

Fig. 1. Assessment method
Source: Adapted from Mokhele, 2016

theory would be the one that exhibited a strong correlation with all the concepts.

3. A relational understanding of concepts

Unlike absolute space, which is essentially a fixed frame, relative space is defined by flows and interrelations (Friedmann & Alonso, 1964; Garretsen & Martin, 2010), while in relational terms, space does not exist without relationships and linkages (Massey, 2005). Space cannot be comprehended without the concept of proximity, wherein a distinction can be made between geographical and organisational proximity (Boschma, 2005). While the former denotes the physical distance between actors, the latter, which is relational, refers to the closeness of actors regardless of the physical distances between them.

Howitt (1998) and McMaster and Sheppard (2004) argue that scale is one of human geography's fundamental concepts, which according to Howitt (1998) has facets of size, level and relation. The paper resonates with the latter conception, which is based upon the premise that scale should be expressed relationally rather than hierarchically.

Spatial economic analysis would be incomplete without firms. In the milieu of human geography, Taylor and Asheim (2001) categorise perspectives on the firm into two sets: the rationalist and the socio-economic. The paper is aligned with the socio-economic view (see Taylor & Asheim, 2001), which is based upon the premise that (unlike in the rationalist view) the function of the firm is not simply to maximise profits while minimising costs, but to provide a framework within which the very calculus of output-cost relationships is played out. Importantly, it is not only individual firms that matter, but the system of firms (Taylor & Asheim, 2001; Taylor, 1996).

The activities of firms are expected to create particular patterns in space. The geographical pattern includes points, lines and areas; it is understood through the measures of point pattern, nearest neighbour analysis and quadrant sampling (Coffey, 1981). Given the relational view of space, proximity, firm and scale, the paper takes a position that the driving forces of airport-centric developments do not create patterns that are necessarily observable in geographical space.

4. Identifying a relational theoretical framework

4.1 Classical location theory

While Von Thünen is hailed as the overarching father of location theory, Alfred Weber is regarded as the father of industrial location theory (Aoyama, Murphy & Hanson, 2011; Essletzbichler, 2011). Weber (1929) analysed factors that cause the movement of industrial activity in space. Although the theory could at face value be relevant in exploring reasons behind the location of manufacturing firms around airports, it has weaknesses on the interpretation of key , as follows: firstly, Weber's theory focuses on the influence of geographical distance on the location of economic activity (Tidswell, 1978; Haggett, 1965). Secondly, it considers the location of industry at fixed points in space (McCann, 2002), reflecting a reliance on the absolute view of space. Thirdly, because Weber believes the goal of entrepreneurs is to minimise costs, his theory simplistically regards firms as rational economic actors that strive to minimise transportation costs (Essletzbichler, 2011; Harrington & Warf, 1995; Chapman & Walker, 1987; Haggett, 1965). Fourthly, the pattern of economic activities is reflected by a logical, calculable and mappable locational triangle wherein the optimum location is a balance between the forces of material sources and consumption area. Given its non-relational interpretation of the concepts, Weber's theory is not appropriate as the main framework for analysing airport-centric developments.

Building on the work of Von Thünen and Weber, Christaller (1966) formulated central place theory (extended by Lösch) to explain the size, number and distribution of towns. According to Christaller, economic distance is important in determining the range of goods or services. Economic distance is understood as: cost of freight, insurance and storage; time; loss of weight in transit; and (as regards passenger travel): cost of transportation; time required; and discomfort of travel. Although

insightful, it can be argued that economic distance is a derivative of geographical distance, thus restricting the analysis to geographical proximity. The reliance on physical distance is evident in Christaller's adoption of Zopfl's principle, which expresses economic distance as equal to geographical distance converted into transportation advantages or disadvantages.

As regards scale and pattern, central place theory's understanding is that settlements and urban centres are ordered hierarchically. The landscape is divided into absolute spaces and scales of uniform, calculable hexagons per size and function. The theory therefore views the scale, which emerges from the logic of economic forces, as algebraic (Herod, 2011). Finally, according to central place theory, entrepreneurs are rational actors who choose locations to maximise turnover, a factor which involves them locating as close as possible to their customers (Johnston, 1983). The foregoing limited interpretation of the concepts makes the theory less suitable to guide the analysis of airport-centric developments. At this juncture, it should be noted that, with particular reference to central place theory, Richardson (1973) argues that one limitation of models that build up the spatial structure from nothing is that they result in a distribution of economic activity that is not realistic. To remedy the problem, Richardson (1973) introduces the concept of locational constants, which are fixed locations that act as a focus for the agglomeration of activity. Airports could be viewed as locational constants.

According to Isard (1969), one of the problems that long characterised location theory was the question of interdependent location decisions: a consideration that could be useful in analysing the role of an airport as a force that pulls firms, given its function as freight collection and delivery location. Smith (1971) notes that the locational interdependence school includes, among others, Hoover (1948) and Hotelling (1929). Hotelling created an illustration involving two competitive sellers of a homogenous product, each locating in a market uniformly distributed along a line, where location costs are assumed to be zero. Thus, the absolute space is understood to be a line on which a concentration of firms develops at symmetrically placed locations. Space along the line is homogenous, meaning that the two locations of interest are identical (Sheppard, 2000). To purchase supplies in bulk, the firms must locate at some single delivery location, which could in the context of the paper be airports and their environs. Alternatively, one or both of the firms could travel from its location to the airport to pick up supplies. However, the cost of loading and transporting freight to a separate location, the customers lost during this time, and the general inconvenience outweigh the savings from the quantity purchased (Isard, 1969), resulting in the concentration of firms around the collection and delivery point. This situation reflects Hotelling's reliance on geographical proximity, which influences the location decisions of firms as rational economic entities that make decisions exclusively to reduce costs. Notwithstanding its apparent relevance, due to the limited understanding of the concepts, Hotelling's work is not suitable to be the main framework for analysing airport-centric developments.

Table 1. Evaluation of the classical location theories

Authors	Year	Factors addressed	Correlation				
			Space	Proximity	Scale	Firm	Pattern
Weber	1929	Industrial location	N	N	N	N	N
Hotelling	1929	Locational interdependence	N	N	N	N	N
Hoover	1948	Locational interdependence	N	N	N	N	N
Christaller	1966	Size, number and distribution of towns	M	N	N	N	N
Lösch	1956	Size, number and distribution of towns	N	N	N	N	N

*S – strong; M – moderate; and N – none
Source: Authors' analysis

Hoover (1948) argues that though the economies of freight tend to favour locations at material sources and markets, intermediate locations are advantageous when they are trans-shipment points. Given the airfreight transportation role of airports, Hoover's work could be used towards understanding airports as locations that accommodate trans-shipment firms. However, in Hoover's work, firms are rational economic actors that seek to reduce costs by locating at points with better access to materials or by moving to points with better access to markets. Space is therefore understood in its absolute form, given that the material sources, markets and intermediate points are absolute locations, and distances between them can be measured in metric units that are deducible to transfer costs. In this regard, in attempts to reduce transfer costs, the view is limited to geographical proximity. Although potentially relevant in understanding airports as trans-shipment locations, due to its non-relational understanding of the concepts, the theory is not appropriate to be the primary framework for analysing airport-centric developments. Table 1 summarises the relevancy of the classical location theories against their interpretation of space, proximity, scale, firm and pattern.

4.2 Regional science

Regional science synthesised the work of, among others, Von Thünen, Weber, Hoover and Lösch; and also formulated techniques of analysis (Isard, 1960, 1975). As a method of analysis, regional science was associated with spatial science (Barnes, 2003), whose proponents believed that the geometric conception of space is key to understanding the spatial distribution of activities (Barnes & Gregory, 1997). This implies reliance on an absolute view of space (Unwin, 1992) and physical proximity that could be reduced to coordinates and geographical distance. Nonetheless, Isard (1975) asserts that a region that is understood only in terms of longitudes and latitudes is meaningless, thus reflecting regional science's improved thinking of space compared to spatial science.

Regional science converged models of patterns and flows (Johnston, 2009), and employed gravity models from physics, making it possible to describe the distribution of activities in terms of the potential of a particular mass (Isard, 1971). This potential represents the total influence at each point in space of all mass components, and the influence is lessened by a change in geographical distance. The values of such potential at each location indicate its proximity to the system of locations, and the interaction between the masses is inversely proportional to distance. Isard (1971) acknowledges that the usefulness of gravity models is unsatisfactory and as a result, he argues for the use of relativity physics, reflecting a revised understanding from absolute space towards relative space.

In discussing the locational framework, Isard and Reiner (1966) note that points are seen to define locations in bounded space; and although the authors are of the view that distances can be expressed in many ways (such as physical, time and cost), they argue the various expressions can be translated into each other. This implies that all forms of distance can be linked back to geographical proximity. As regards the understanding of the firm, two approaches of regional science are noted, namely optimising models and non-optimising models. The former represents a view wherein an entrepreneur is seen as a decision-maker who wants to maximise returns over costs (Isard & Reiner, 1966). In this way,

Table 2. Evaluation of regional science

Authors	Year	Factors addressed	Correlation				
			Space	Proximity	Scale	Firm	Pattern
Isard	1971, 1975	Location and space economy	M	N	N	N	N
Isard & Reiner	1966	Locational framework	M	M	N	S	N

*S – strong; M – moderate; and N – none
Source: Authors' analysis

Leyshon (2011) argues that regional science under-theorises the firm as an atomistic entity. Isard and Reiner (1966) reflect an alternative understanding of the firm by noting that the optimising models do not correctly depict the decision-making processes of entrepreneurs. The authors acknowledge that the entrepreneur operates under constraints of imperfect knowledge. Furthermore, the behaviour of one actor may affect other actors in a region and beyond. Reflecting a relational view of the firm, the notion of interdependence stresses not only the economic interrelations of firms, but also individuals interacting with each other and with various institutions (Isard & Reiner, 1966).

Besides the relational interpretation of firm, and partially space and distance, regional science's interpretation of the concepts is not relational (Table 2), making it unsuitable to be the main framework for analysing airport-centric developments.

4.3 Growth pole theory

As noted by Lasuen (1969), growth pole theory emerged as a reaction to the classical location theory wherein Perroux argued that geography had incorrectly been regarded as a container that conditions economic forces. In Perroux's view, geography does not constrain economic forces (Perroux, 1988; Lasuen, 1969) and thus his contribution goes beyond absolute space. Growth pole theory was formulated to analyse why economic development tends to be concentrated in certain parts instead of occurring uniformly across space (Keeble, 1967). In the context of airport-centric developments, the theory appears relevant for analysing reasons for the location of firms on and around airports. However, its relevancy is assessed below.

Growth pole theory must be viewed against Perroux's thoughts on space (Campbell, 1974). Perroux (1950) makes a distinction between banal space and economic space: the former referring to the specific location of materials and manpower; the latter to the spatial range of the firm's economic activities, which cannot be contained by political or geographical boundaries. Reflecting a relational understanding of space, economic spaces are defined by the relations between economic actors regardless of their geographical location. Such spaces are categorised into three groups: economic space defined by a plan, economic space as a field of force, and economic space as a homogenous aggregate (Perroux, 1950).

The plan of a firm refers to relations that exist between the firm and the suppliers of input as well as the buyers of the firm's output. In this situation, proximity is measured in relational and monetary terms, implying that the economic space and distance escape geographical boundaries. In a second consideration, the firm has a space defined as a field of forces, whereby the economic space consists of centres from which centrifugal forces emanate and to which centripetal forces attract. Each centre acts as a point of attraction and repulsion, and the firm attracts economic elements into the space of its plan or it removes them. Although the firm can be located in a particular area, its economic zone of influence defies geographical boundaries. The firm in a third aspect has a space defined as homogenous aggregate, where it has, or does not have, a structure more or less homogenous with those of other firms that are its neighbours geographically or economically. Such firms are therefore in the same economic space regardless of their physical locations (Perroux, 1950), thus dismissing the notion of scale as hierarchy, and resulting in a pattern that is not necessarily observable. The foregoing review shows

Table 3. Evaluation of growth pole theory

Authors	Year	Factors addressed	Correlation				
			Space	Proximity	Scale	Firm	Pattern
Perroux	1950	Economic space	S	S	S	S	S
Perroux	1988	Pole of development	S	S	S	S	S

*S – strong; M – moderate; and N – none
Source: Authors' analysis

that growth pole's understanding of the concepts is relational (Table 3), implying that it has potential to be the main framework for analysing airport-centric developments.

4.4 New economic geography

New economic geography (NEG) draws from classical location theories, regional science and growth pole theory. It aims to explain the emergence of a core–periphery structure at regional, national or international scales, which reflects a reliance on scale as a level. The theory explains the agglomeration of economic activity, by exploring how the geographical structure of the economy is shaped by the tension between centripetal forces that pull economic activity together, and centrifugal forces that push it apart (Fujita & Mori, 2005; Fujita & Krugman, 1995; Krugman, 1991; 1998).

The NEG is characterised by modelling strategies associated with the phrase "Dixit-Stiglitz, iceberg, evolution and the computer". Introduced by Samuelson (1954), the iceberg transport-cost function assumes that a portion of a product that is shipped melts in transit. NEG's assumption that melting takes place at a constant rate with increasing distance (Fujita & Krugman, 2004; Krugman, 1998) shows dependence on geographical distance and proximity.

The theory is arguably based upon the absolute conception of space, given that the discussion of an iceberg refers to the movement of goods between two absolute points of supply and market, and hence the proximity between them is purely geographical. Corpataux and Crevoisier (2007) further outline the following aspects relating to NEG's understanding of space: firstly, space operates as a neutral container, which is external to economic processes, with no influence over such processes (Corpataux & Crevoisier, 2007). Plummer and Sheppard (2007) add that in congruence with classical location theory, the NEG understands space as a homogenous platform within which a set of discrete entities are equally spaced on a line, circle or plane; an understanding which abstracts from relative or relational locations. Secondly, in NEG analysis, absolute space is taken as given, and its contents cannot be altered. Thirdly, this container and content framework is characterised by Euclidean geometric shapes (Corpataux & Crevoisier, 2007).

NEG's understanding of the firm is based on a rationalist view. This is because the information flows, networks and interactions between firms are excluded (Storper, 2011) and economic actors are understood to have the ability to calculate optimal locations. According to Plummer and Sheppard (2007), spatial patterns, which constitute a general equilibrium, are derivable from these rational actions. Though relevant, the limitation of the NEG in interpreting the concepts (Table 4) makes it unsuitable to be the primary framework for analysing airport-centric developments.

5. Synthesis and conclusion

The aim of this theoretical review paper was two-fold – that is: to identify concepts that are appropriate for analysing forces that drive development in the vicinity of airports; and to use those concepts to systematically identify an existing theory that is appropriate for analysing forces that drive airport-centric developments or the spatial economic attributes of airports and

Table 4. Evaluation of new economic geography

Authors	Year	Factors addressed	Correlation				
			Space	Proximity	Scale	Firm	Pattern
Fujita & Mori	2005	Geographical structure of the economy	N	N	N	N	N
Krugman	1988	Geographical structure of the economy	N	N	N	N	N

*S – strong; M – moderate; and N – none
Source: Authors' analysis

their environs generally. The assessment presented herewith shows that among the relevant human geography theories, growth pole theory displays a relational interpretation of the concepts of space, proximity, firm, scale and pattern. The theory is thus considered the most appropriate framework for analysing the spatial economic attributes of airport-centric developments. Nonetheless, relevant elements of other theories cannot simply be brushed off. As such, due to their centrifugal and centripetal effects, airports could also be analysed as trans-shipment locational constants that attract related and unrelated firms. In light of the findings of the paper, it is recommended that growth pole theory, underpinned by the concepts explored herein, be empirically used in the analysis of airport-centric developments (this would extend the work of, *inter alios*, Mokhele, 2018), and subsequently be used as the basis for developing a theoretical framework that is tailored for airport-centric developments (Mokhele and Geyer, 2018 took a stab at this). It should be acknowledged that the growth pole theory has been applied elsewhere in the analysis of airports (for instance, Hoare, 1974). What sets the paper apart is the nuanced consideration of the theory's relational interpretation of space, proximity, firm, scale and pattern; and particularly of their interconnections with linkages, agglomeration economies and clustering. Analyses that explore these interconnections can indeed bring to light important insights into the spatial economic workings of airport-centric developments.

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