Transit Oriented Development and its effects
Exploring relationships between TOD, accessibility and labour productivity in Beijing, China
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Chapter 5 Conclusion and Discussion

This chapter starts by summarising the findings and contributions of the previous chapters, followed by reflections on the limitations of the research. Finally, it outlines several future research directions based on the insights from this PhD study.

5.1 Findings and contributions

Our cities of today face several acute problems, including urban sprawl, scarcity of urban land, road congestion and air pollution. While TOD is widely recognised as a promising approach to address these challenges (Calthorpe, 1993; Calthorpe et al., 2014; Cervero et al., 2004; Renne, 2009), it is also criticized as too generic (Thomas et al., 2018). In practice, the interpretation and implementation of TOD policies varies significantly according to the geographic and planning context, as do their effects (Bertolini et al., 2012; Cervero et al., 2004; Chorus and Bertolini, 2016; Curtis et al., 2009; Joshi et al., 2017; Knowles, 2012; Loo et al., 2010; Mu and De Jong, 2016; Pojani and Stead, 2014; Yang and Lew, 2009; Zhang and Liu, 2007). There is a growing need to develop context-specific insights into TOD and its effects, and to develop the methodologies that can deliver these insights. In particular, the specificities of the Chinese context - for example, the scale and pace of the urbanisation and motorisation process or the institutional arrangements around land development and transport provision - demand more context-specific discussion and elaboration on what TOD means in China and which effects does it actually bring. The core aim of this thesis is to contribute to filling these knowledge gaps. Its overarching research questions are: How to develop a context-based TOD typology in a systematic way? And how is TOD related to its effects in a specific context? Both questions have been addressed with a focus on the land use and transport specificities of Beijing.

The first research sub-question (RQ1) that this thesis aimed to answer, namely how to develop a context-based TOD typology for a city in a systematic way, has been addressed in Chapter 2. The basic idea of identifying the TOD type to which a station area belongs is to comparatively evaluate and cluster the characteristics of station areas that can reflect TOD principles (i.e. TOD characteristics). Chapter 2 evaluated the TOD characteristics of all metro station areas in Beijing, classifying them into six types by means of a cluster analysis.

Chapter 2 is the first study to systematically develop a context-based TOD typology for a Chinese city, providing a Chinese example in line with international studies (e.g., Austin et al., 2010; Kamruzzaman et al., 2014; Reusser et al., 2008; Vale,
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2015; Zemp et al., 2011). Furthermore, Chapter 2 made a conceptual contribution to previous studies, extending the node-place model, introduced by Bertolini (1996, 1999), into a model that can chart ‘Transit’ (node), ‘Oriented’ (association between node and place) and ‘Development’ (place) characteristics of metro station areas. The chapter developed a systematic and context-based methodology drawing on publicly available data for building a TOD typology of metro station areas for a city, with application potential in other geographic contexts and other transit systems. The identified TOD area types would allow urban planners, transport experts and policymakers to develop a set of targeted strategies to promote TOD.

The second research sub-questions (RQ2) relate to the relationships between TOD and accessibility (to jobs and inhabitants). Chapter 3 studied how specific TOD characteristics are related to accessibility. It confirmed the anticipated positive association between TOD and accessibility. The results of Chapter 3 highlighted that in the Beijing context a station area’s location relative to the city centre and the land use pattern (e.g., a relatively lower average residential density; a relatively higher average all-job density; a relatively higher average job density in the sector of education, health, and culture; and a relatively lower average degree of functional mixes) around all the stations within the targeted station’s one-hour travel catchment were relatively more important for enhancing the area’s accessibility than improving the area’s transit performance.

Chapter 3 relates to the international debate on the relationships between TOD components and accessibility (e.g., Levine et al., 2012; Papa and Bertolini, 2015) and provides insights for this specific context. Furthermore, it contributes to the policy debate by offering arguments for a focused policymaking effort in specific intervention areas. Chapter 3 extended the focus of previous international studies to include land use patterns along the metro station network within reach of the station area (within its one-hour catchment area), suggesting that the accessibility of a given metro station area could be enhanced by improving a combination of characteristics (e.g., a relatively lower average residential density; a relatively higher average all-job density; a relatively higher average job density in the sector of education, health, and culture; and a relatively lower average degree of functional mixes) of all the station areas within the given metro station area’s one-hour travel time catchment. The extension of the geographic focus to the catchment of a station area is a distinct methodological contribution of this chapter. Furthermore, the methodology used in Chapter 3 considered spatial autocorrelation, which had not been included in previous studies (e.g., Levine et al., 2012; Papa and Bertolini, 2015). Similarly to Chapter 2, the
methodology developed in chapters 3 can be applied to other geographic and planning contexts.

Although Chapter 3 confirmed a general positive relationship between TOD and accessibility, the relationships between TOD and its effects on people and firms might not be that simple. Chapter 4 investigated one such relationship as an illustrative example (i.e. the relationship between the area’s TOD characteristics and its labour productivity), to show how TOD might be related to indirect effects (i.e. effects mediated by accessibility). It developed a methodology to assess the values and the clustering of labour productivities in different area types across different types of industries. Furthermore, it explored the relationships between TOD and the clustering of labour productivities in certain industry sectors. It found that TOD was only one of the many factors that can be related to labour productivities. For most industry sectors, the distribution of labour productivity had no significant association with TOD. Only within certain tertiary industry sectors (wholesale and retail; accommodation and catering; and culture, sports, and entertainment) was labour productivity significantly higher in a more transit oriented developed area. It further found that, in order to foster the clustering of labour productivity of a station area, densification and diversification of development around a station area or along transit network might be relatively more important than improving the area’s transport connection. These findings are in line with the insights from Chapter 3 on accessibility effects and the elaboration of targeted strategies to foster the clustering of labour productivities in certain industries of a given station area in Beijing.

Chapter 4 represents a rare attempt to explore the connection between TOD and the economic efficiency of areas (operationalised in this thesis as labour productivity) (for others see Broersma and Oosterhaven, 2009; Fedderke and Bogetić, 2009; Reggiani et al., 2011). Its results are a stark reminder that TOD policies do not simply and directly deliver economic benefits, as claimed by several TOD advocates (e.g., Calthorpe, 1993; Calthorpe et al., 2014; Renne, 2009; Renne and Wells, 2002; Yang et al., 2016; Zhang et al., 2014). Many other factors are at play (e.g., the degree of innovation or ICT use of the company), and there are differences between economic sectors (e.g., service sector seems to be more affected by TOD policies than manufacturing sector). The complexity of the relationship between TOD and labour productivity further accentuates the need for undertaking context- and effect-specific studies prior to taking TOD policymaking decisions.
5.2 Limitations of the study

The study’s methodology and findings are qualified by two groups of limitations: (1) the data and how the data were generated, and (2) the methodological choices made (e.g., the case selected or the specific methods used).

Because of the aim of developing methodologies that others could freely pick up and apply, the PhD study relied on publicly available spatial and statistical datasets: OpenStreetMap (Geofabrik GmbH and OpenStreetMap Contributors, 2015), Baidu Maps Place API (Baidu Inc, 2015), Google Maps Distance Matrix API (Google Inc., 2016), and Beijing’s census data on population (Beijing Municipal Statistics Bureau, 2012) and on the economy (Beijing Municipal Statistics Bureau, 2016). A drawback is that the level of detail or bias of these datasets might influence the reliability of the results. For example, Chapter 2 used the number of economic entities (from Baidu Maps Place API) to approximate the number of jobs. The results of this thesis are also limited by the modifiable areal unit problem (MAUP) (Openshaw, 1984), a statistical bias that can significantly impact the results of statistical hypothesis tests. MAUP affects results when smaller-scale measures of spatial phenomena (e.g., housing, economic entities, small census tracing zone) are aggregated into larger-scale measures (district-based measures such as station areas, districts, cities, or regions) and is present throughout this thesis. For instance, in Chapter 2, MAUP is an issue with regard to the spatial delineation of areas such as the metro station area for which TOD indicators were summarised. In Chapter 3 and Chapter 4, some TOD indicators of the metro station areas were re-aggregated according to the given metro station area’s one-hour travel time catchment (a catchment is defined here as the area covered by travelling one hour by means of public transport from a given metro station area). Such an aggregation also suffers from the modifiable areal unit problem. Strong efforts were taken to minimise its impact by using the most disaggregated publicly available data, by selecting a meaningful unit for the analyses, and by aggregating data in the most theoretically and empirically sound way. Nevertheless, this potential bias should be kept in mind.

The second group of limitations comes from the author’s methodological choices. The first limitation comes from the case selection, the city of Beijing and within Beijing the focus on the metro network. The findings and the associated policy implications are constrained by the specific characteristics of the case (e.g., a relatively monocentric distribution of jobs, inhabitants and metro network). Second, some specific methods used in the PhD study have inherent drawbacks. For instance, the statistical methods used in Chapter 3, and Chapter 4 do not allow relationships of causality to be examined. Another example is the use of the contour method to measure accessibility.
(Geurs and Van Eck, 2003) in Chapter 3. This type of accessibility measurement was selected because of its transparency and ease of communication in the planning context (Bertolini et al., 2005). However, it neglects many aspects of accessibility, such as the distance decay and competition effects of accessibility (e.g., Cheng and Bertolini, 2013; Shen, 1998; Weibull, 1976), or the more qualitative aspects of accessibility (e.g., comfort, safety, and cleanliness of travel). Accordingly, the findings from Chapter 3 cannot reflect on the relationship between TOD and accessibility with respect to these unconsidered aspects.

5.3 Potential future research directions

Based on the overview of the entire thesis and its limitations, the following potential research directions are put forward for future efforts. On the empirical side, the methodologies developed in this thesis can be applied to different geographic and planning contexts (e.g., according to the structure and functioning of the property market, roles and power relationships in land use and transport planning, city size and morphology, transport network, type of urban economy, or broader political context). Therefore, future research could conduct a series of context-specific TOD studies to see how the results vary in different contexts. It might yield insights into whether TODs produce generalisable patterns or knowledge about experiences and also highlight the possibilities and limits of TOD policy transfers (Thomas et al., 2018). The methodologies developed in this thesis could provide an apt instrument for such systematic comparisons.

The thesis only explored the relationship between TOD and accessibility (as a direct effect) and the relationship between TOD and labour productivity (as an example of indirect effects). Future research could aim to quantify the spatial relationships between TOD and effects other than accessibility and labour productivity, in particular in the Chinese context. For example, the international TOD literature ascribes positive effects on spatial equity (Fernandez and Creutzig, 2017; Jang et al., 2017), social inclusion (Waintrub et al., 2016), and individual health (Langlois et al., 2016; Solitare et al., 2012). These findings are yet to be well supported by empirical studies in the Chinese context.

On the methodological side, future research could explore the relationship between TOD and accessibility (or labour productivity of areas or other effects) over time. Such longitudinal studies may provide new insights into how the causalities between TOD and its effects play out, thus addressing the issues of endogeneity that still engross the international academic community (e.g., Higgins et al., 2014; Kasraian
et al., 2016). The focus on changes over time, and thus a better grasp of causalities, is likely to offer crucial insights for developing effective TOD strategies.

On the policy side, it could be interesting to extend TOD studies centred on the metro system to TOD studies centred on other transit systems and scales (e.g., bus rapid transit, intercity railway). This would provide policy insights related to the effects of TOD planning of other transport systems. Furthermore, the study’s focus on the station area could be extended to neighbourhoods or the entire city, to support transit oriented community and city planning beyond station areas. Finally, future research could also focus on how the findings in this thesis could be used to support the process of policy- and strategy-making, how the findings could be applied by planning professionals in practice but also how the knowledge of planning professionals could, in turn, be fed back into academic research, for example via an ‘experiential case study’ research design (Straatemeier et al., 2010).
References of Chapter 5


Geofabrik GmbH and OpenStreetMap Contributors (2015) Download OpenStreetMap data for this region:
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TOD and its effects: studies in Beijing, China

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