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# Residential property value impacts of proximity to transport infrastructure: An investigation of bus rapid transit and heavy rail networks in Brisbane, Australia

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ABSTRACT

Public transport investment is normally targeted at increasing accessibility which land rent theory identifies and will in turn increase land values. There is a clear policy interest in how much land values increase following a new transport investment so as to establish if there is sufficient land value uplift to capture and to help pay or contribute to investment plans. Identifying an uplift for residential land has been well studied in the context of new light rail systems and bus rapid transit (BRT) systems in developing countries but there is little evidence for BRT in developed countries. This paper has two objectives. First, to examine long term impact of BRT in a developed world context in Brisbane, Australia. Brisbane's BRT uses an open system design which contrasts with the closed system design of the successful BRT systems in South America and elsewhere, including the BRT in the suburbs of Sydney, Australia. Second, BRT in Brisbane was introduced to a network already dominated by a radial heavy rail network and this investigation recognises that the uplift from BRT introduction may therefore be different to a BRT in a single mode city. A third motivation is to consider the spatial distribution of uplift which is an essential pre-requisite to understanding the distributional impact if uplift is used to contribute to infrastructure provision.
Spatial modelling is used to examine the accessibility impacts of the BRT at a global level. This is followed by Geographical Weighted Regression, used to examine the spatial distribution of accessibility using a local model.
The results show that there is greater uplift in Brisbane, as compared to that identified by studies of Sydney's BRT which is likely due to the greater network coverage of BRT in Brisbane and less strong competition of rail. Land value uplift is also spatially distributed over the network giving higher uplift in some areas than others and lower values than typically found with rail based systems in developed countries. However, the degree of uplift is relatively low, with proximity to BRT stations attracting more uplift than proximity to train stations.


## 1. Introduction

Discussions around land rents and land values have been a feature of urban economics for more than a century. From the nineteenth century, economists like David Ricardo were concerned with the potential outcome of land being a non-produced input and the impact this might have on wages (Ricardo, 1821). More modern economics recognises that land rent, as with the 'return' on other goods, reflects the marginal productivity of land (Trivelli, 1997). Within a transport infrastructure value context, the contemporary interest in land value stems from two related issues. First, can and by how much does land value rise if new transport infrastructure providing enhanced accessibility is implemented? Second, given the increasingly apparent funding constraints faced by governments around the world, can any increase in value of land as a result of implementing new transport infrastructure be "captured" to pay for the investment? This paper addresses the first of these issues as a pre-requisite to informing the second.

Whereas most of the value uplift literature has been concerned with either developing countries or with the introduction of rail based infrastructure, this paper will consider whether and to what extent the value of residential land has increased in the area around a bus rapid transit (BRT) network in a developed country. This paper also adds to the literature by modelling the spatial variation of this uplift. An understanding of the spatial variation of value uplift is necessary to underpin the implementation of value capture or value sharing policies. Understanding the spatial variation is also important for establishing distributional impacts from the introduction of BRT. These may be contrary to expectations with lower income groups not particularly benefitting as shown by Velasquez et al. (2015) and may be moderated or added to by value uplift which was not included in this analysis.

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This paper is concerned with residential properties as it is clear from the literature that there are significant differences between commercial and residential properties. Whilst this paper is concerned with residential properties, the empirical analysis makes a distinction between apartments and houses as different 'goods' in the housing market and so the results also provide a separate commentary on houses and apartments.

Wright and Hook (2007) described two common modes of busway operation, trunk-feeder services and direct services. For trunk-feeder services, using a 'closed system' design means that many passengers must transfer to and from dedicated busway only services at busway stations. In contrast, direct services using an 'open system' design allows passengers to travel along the busway and then continue to reach suburbs distant from the busway itself. This study is concerned with the extensive BRT in the city of Brisbane in Queensland, Australia. Unlike its BRT counterpart in Sydney, and to a lesser extent in cities with BRT in the US, the Brisbane BRT is a major backbone of the public transport system in Brisbane, travelling into the heart of the city with dedicated grade-separated infrastructure. It provides routes that both pick up passengers in suburban neighbourhoods and also enter dedicated rights-of-way to travel all the way through to the CBD. This network design using an open system design and offering single-seat journeys from the suburbs, is distinctively different from the successful systems of developing countries (TransJakarta, Indonesia; TransMilenio, Colombia) which use a closed system design and have services travelling only on the BRT rights-of-way with separate feeder services travelling to and from the BRT.

This paper also makes one further distinction which distinguishes it from other papers in the literature looking at the impacts of new transport infrastructure. This paper considers the impact of a BRT being introduced into a city where the heavy rail network, albeit not well used, has been in place for a significant period. The BRT considered in this paper is therefore a small part of a bigger system. Overall, because the empirical analysis is cross sectional and carried out after all the BRT sections are in place, it provides a long run measure of potential value uplift.

The paper is structured as follows, Section 2 summarises the literature on value uplift theory; Section 3 introduces the case study area of Brisbane, Australia and discusses how the newer BRT fits into the wider transport network; Section 4 discusses the methodology and Section 5 presents the results of the geographically weighted regression analysis to determine the extent of value uplift associated with the BRT development before Section 6 which discusses the policy implications of the findings.

## 2. Literature review

Land rent theory provides the theoretical link between accessibility and land values with land rent reflecting the underlying accessibility. As a result, those locations which are more accessible as a result of new infrastructure will command a higher rent reflecting the underlying land value and include the value uplift. A complication is that the theory is developed in the context of unimproved land, referring to a land with no structures on it whereas in an urban context we observe primarily land with structures. This means that a methodology needs to be developed that controls for the improvements of land so as to expose the changes in land values due to accessibility changes arising from new transport infrastructure. Issues concerning methodology are discussed in the Methodology section below.

There is significant international interest in determining uplift that can be delivered by the implementation of new transport infrastructure, as a baseline for understanding what values may be 'captured' in specific ways by local and state agencies for funding and financing purposes. Although the earliest studies were more qualitative (Knight and Trygg, 1977), there have been a plethora of studies since 2000 which have been concerned with identifying the value uplift. RICS (2002); Smith and Gihring (2006) and Smith et al. (2009) have provided major reviews of the studies examining value uplift. Billings (2011) identifies the presence of at least 20 studies across five countries on the impact of rail investments with Debrezion et al. (2007) and presents meta-analyses from the real estate literature. Debrezion et al. (2007) used 73 studies and focused on the impact of railway stations on land values and the results suggest that for every 250 m closer to a station, house prices increase by 2.4% whereas commercial properties only increase by 0.1%. This points to a major difference between residential and commercial properties with the latter probably internalising the uplift from before the operational phase or, alternatively, reflecting the way planning rules extract much of the uplift with judicious use of planning gain with new commercial build. Zhang (2009) separates houses from apartments and found that single family homes appeared to benefit much more from value uplift although with considerable variability with for example, the impact for an apartment in 1990 US$ being $0.30 uplift but for a single family home this varied between $0 and $38 for every meter further away from the BRT. This stark difference suggests that there is a difference between the different types of property's ability to benefit from uplift and that any analysis should take this into account. A more recent update, concerned with specifically Asian cities, is provided by Salon and Shewmake (2011), and this highlights the great variability in conclusions of the different studies, in part due to the method adopted in investigating value uplift (this issue is expanded upon in the Methodology section below). In addition, studying the value uplift associated with vacant land resulting from the greater accessibility of new public transport infrastructure identifies big differences in land value uplift with vacant land showing a very high potential for land use change and price appreciation (Kittrell, 2012). Cervero and Duncan (2002a) found that the price premium for vacant land is >120% in Santa Clara County, California. The implications of the increase in value achievable with vacant land mean that a value capture tax framework should include all land, not just land with structures on it.

Most of the literature cited above, or used in the meta-analyses, are based on the introduction of new infrastructure for rail based systems: light rail, heavy rail or metro. This paper is focused on the contribution of bus rapid transit (BRT). The contribution this relatively new mode can make to value uplift is an area that is neglected in the literature with few notable exceptions. There have been studies on the BRTs in large cities in developing countries with studies by Rodríguez and Targa (2004) finding an uplift of between 6.8% and 9.3% for every five minutes closer to a station on the Transmilenio in Bogota, Columbia and Munoz-Raskin (2010) finding very variable results both close and further away from Transmilenio. Rodríguez and Mojica (2009) investigated the impact of the BRT extension in Bogota and found that properties in the environs of the extension had values 13–14% higher than in control areas but no appreciable difference between prices close and not so close to the BRT. As the appeal of BRT has spread, so have the studies investigating value uplift from BRT and now there is evidence from Beijing, China (Deng and Nelson (2010) finding 2.3% annual growth premia for properties close to the BRT), and Seoul, Korea (Cervero and Kang (2011) finding up to 10% uplift for residential properties and Jun (2012) finding negative premia in suburban areas). The results of Jun (2012) suggesting lower uplift in suburbia tie in with one study from Australia (Mulley, 2014) which looked at a BRT that was part of a wider network of 'ordinary' buses set in the suburbs of Sydney, NSW. Other developed country studies have found very variable results with reported uplift in Pittsburgh, US, of around 16% (Perk and Catala, 2009) and between 2.9% and 6.9% in Quebec, Canada (Dubé et al., 2011).

It should be noted that there are other studies that have sought to see the uplift of land that follows particular developments. An early paper looking at the impact of zoning on house prices used hedonic prices and time series data and concluded that some of the expected negative externalities may not exist (Mark and Goldberg, 1986). This has prompted to a number of studies including the impact of residential development (Jackson, 2016), the impact of public goods such as an art