Urban Design and Economic Growth:
An Analytical Tale of Two Tropical Cities

Taha Chaiechi
https://orcid.org/0000-0002-9976-972X

James Cook University, Australia

Caroline Wong
https://orcid.org/0000-0002-0860-0540

James Cook University, Singapore

Silvia Tavares
https://orcid.org/0000-0002-8405-9717

University of the Sunshine Coast, Australia

Abstract

Federal and local governments around the world usually hail urbanisation as a sign of economic progress. However, the relationship is not that simple. The existence of agglomeration economies does not mean that urbanisation will directly result in positive economic outcomes. Also, there is significant diversity in urban growth patterns, with each pattern resulting in different economic and social outcomes. The diversity in patterns of urban growth and transformation implies that different economies can grow at different speeds in achieving socioeconomic goals. This study explores the urban development of two tropical cities – Cairns and Singapore – with a focus on their different urban growth patterns. Cairns is an expanding tropical Australian city located far from main urban centres, meaning it needs attention to foster positive change that will produce distinctive urban spaces which improve quality of life while providing economic growth opportunities. The city of Singapore is a tropical island-state situated near the equator with limited land and natural resources, and one of the largest urban populations in Southeast Asia. Its landscapes are constantly changing as urban planning plays a key role in formulating and guiding the physical terrains of modern Singapore, thereby shaping the quality of life of its population.

Keywords: urban design, economic growth, sustainable cities, tropical cities, Singapore, Cairns

Increases in urban population have traditionally been linked to increased economic activity in cities. Population movements toward cities have accelerated in the past few decades, particularly in less-developed countries. Globally more than 55% of the world's population lived in urban areas in 2018 (as presented in Figure 1), and this proportion is predicted to rise to 68% by 2050 (United Nations, 2018a). Furthermore, in its 2019 revision of World Population Prospects, the United Nations projected that the world's population would grow from 7.7 billion in 2019, to 8.5 billion in 2030, 9.7 billion in 2050, and 10.9 billion in 2100 (United Nations, 2019).
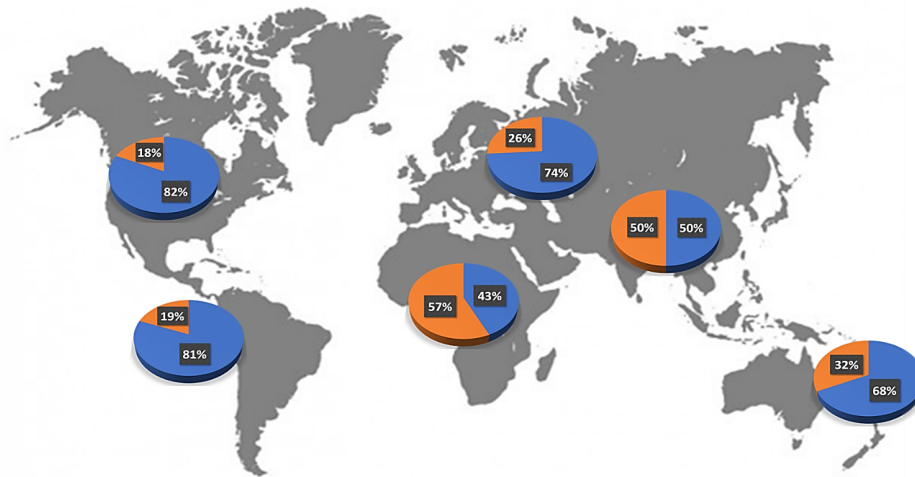
Figure 1 *Global urban population growth*
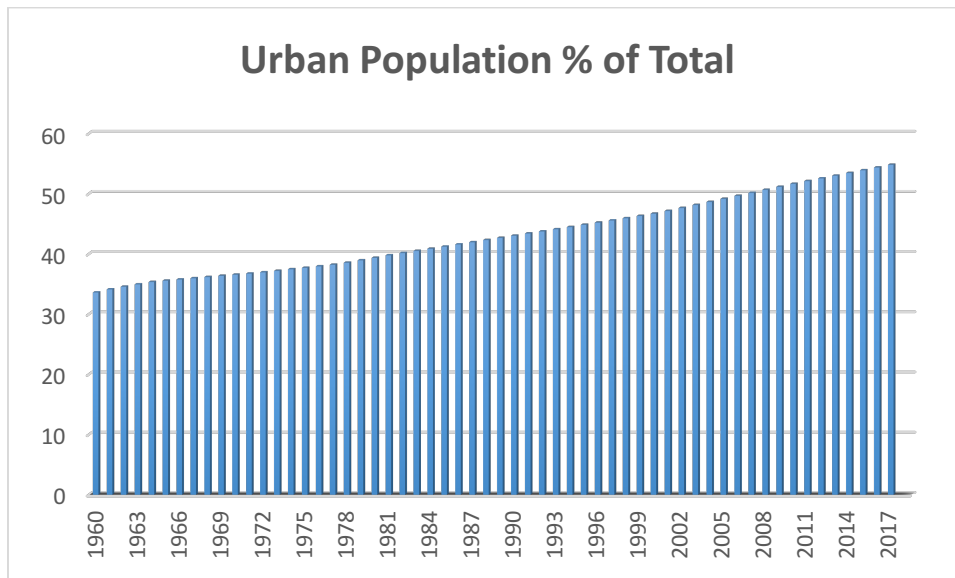
Source: Generated by the authors using data from the United Nations Population Division. 2018 Revision of World Urbanization Prospects

The urban population has grown from 751 million in 1950 to 4.2 billion in 2018. Asia alone is home to 54% of the world's urban population, followed by Africa and Europe with 13% each (United Nations, 2018b). Today, the most urbanised world regions include North America (with 82% urban population), Latin America and the Caribbean (81%), Europe (74%), Oceania (68%), while the level of urbanisation in Asia is now approximating 50% (United Nations, 2018b).

Figure 2 *Proportion of urbanised areas vs rural areas by geographic regions*

Data source: Generated by authors based on data from the United Nations, Department of Economic and Social Affairs, Population Division (2018a). *2018 Revision of World Urbanization Prospects*.

A large body of literature portrays a traditional scenario of an entirely predictable relationship between urbanisation and economic growth, where growing urbanisation has been hailed as a sign of progress and as having a positive impact on the economy (Chang & Brada, 2006; Njoh, 2003; Moomaw & Shatter, 1996). Such arguments are mainly generic and supporting evidence is insufficient and lacks analytical subtlety. Most of these studies fail to pay adequate attention to the dynamic forces of rapid urbanisation and the mechanisms by which they affect sources of economic growth.

Countering this broad literature, Turok and McGranahan (2013) have argued that it is not urbanisation per se that induces economic growth; but rather, infrastructure based on realistic population projections and institutional settings where governments seek ways of enabling forms of urbanisation that contribute to growth, poverty reduction, and environmental sustainability. Thus, economic growth is not a simple equation of encouraging (or discouraging) urbanisation. Likewise, evidence from Nguyen & Nguyen's study on ASEAN countries proposes that there is a non-linear and dynamic relationship between urbanisation and economic growth (2018). Nguyen and Nguyen conclude that any model of urbanisation needs to take into consideration potential socio-environmental goals and outcomes, as well as market-based economic efficiencies. While patterns of growth, planning and design of an urban area are essential in understanding its economic development, qualities of the urban environment also affect and shape the way people live their everyday lives in cities (Tavares & Swaffield, 2017). Moreover, the existence of agglomeration economies does not mean that urbanisation will directly result in increased economic outputs as negative externalities tend to intensify as cities expand, especially if urban

development is haphazard and urban planning and design are not sustainable (Turok & McGranahan, 2013).

This paper seeks to explore the relationship between economic growth and indicators of urbanisation specifically within a tropical context. The Tropics is important because it is currently home to over 42% of the world's population (Harding et al., 2016), with this figure estimated to grow to more than 50% by 2050 (State of the Tropics, 2014). Moreover, the Tropics outperformed the rest of the world in terms of economic growth over three decades in a row (State of the Tropics, 2014). Yet the region is not without its challenges, including the scale and speed of urbanisation. The regional city of Cairns and city-state of Singapore are examined as comparative case studies. While both cases are tropical cities, Cairns is a sparsely populated, but expanding, city in the far north east of Australia remote from major urban centres and surrounded by expansive land and sea; in contrast, Singapore is a city-state with limited land and natural resources and the highest urban population in Southeast Asia.

Firstly, this paper briefly outlines locational theories and different urban growth models that are concerned with the geographic locations of economic activities in urban settings. The paper then investigates the constructed landscapes of the city of Cairns and city-state of Singapore to examine whether planning strategies in these cities have efficiently improved the quality of life of the people. Finally, through empirical modelling, the paper examines the perplexing relationship between urbanisation and economic growth within the context of these two tropical cities.

Economics of Location and Patterns of Urban Growth

Locational decisions, as part of spatial strategies, have been explored in an array of disciplines ranging from urban planning, geography, regional sciences, operations research, microeconomics, and urban economics. In line with location theory and the theory of location of industries (Burnett et al., 2017; Fujita & Thisse; 2002; Storper et al., 2002), urban economists often evaluate strategic location decisions taking into consideration space, value, and how geographic locations expound settlements and settlement functions. As such, these theories also help economists in explaining how economic sectors such as households, firms and industries compete for location. In the contemporary context, the economics of location is perceived as a transformational business model that provides location-based intelligence and processes which can be integrated across the entire market ecosystem. Accordingly, understanding the patterns of urban growth and its variants remains important when analysing the relationship between urbanisation and economic growth.

The literature offers four major urban growth models as a distance function by identifying relative positions of urban layouts and allocations of urban resources. They are:

- Concentric Circle Growth (CCG) model
- Axial Growth model
- Sector Growth model
- Multiple Nuclei Growth (MNG) model

The Concentric Circle Growth model (CCG) created by Burgess in 1925, is a theoretical model of urban development inspired by the development patterns of the city of Chicago (Burgess, 1925; 2008). The CCG starts with the Central Business District (CBD) situated in the inner city, which is the central hub of economic activity. The CCG model is based on the bid-rent theory (Alonso, 1964) which demonstrates how the demand for and the value of real estate changes according to distance from the CBD.

The Axial Growth model developed in the 1930s indicates that urban development is primarily determined by transportation infrastructure that extends out from an urban centre (Floyd & Allen, 2002). These transportation lines include highways, railways, seaports and airport facilities. The Axial Growth model builds on the CCG model and is often characterised by a star shape (Balchin et al., 1988; Harvey, 1996). The historical part of the city of Paris is an excellent example of axial urban growth.
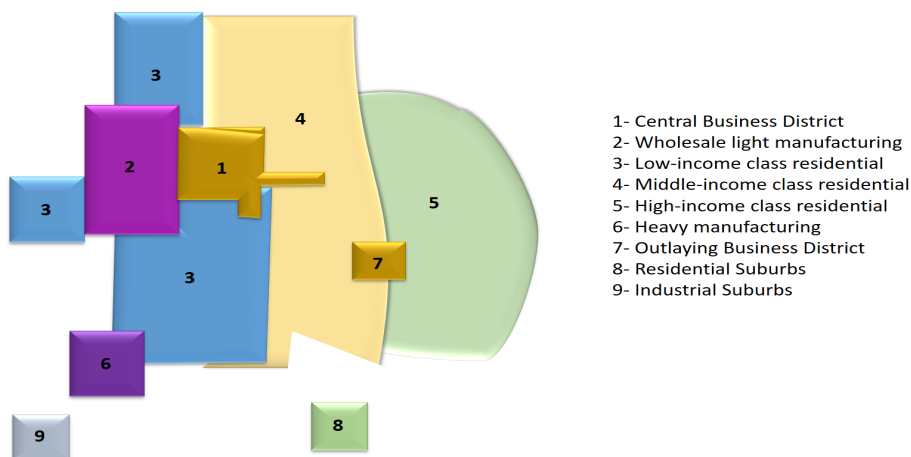
The Sector Growth model introduced by Hoyt (1939), is a modification of the CCG model in that the effects of transportation and communication on a city's growth are identified. More specifically, the Sector Growth model indicates that the trend of economic growth follows an extending-outward transport network. At the same time, specific types of development tend to cluster together in patterns, which implies an outward progression of growth. This model has been extensively applied to British cities (Pacione, 2013).

Similar to CCG, Multiple Nuclei Growth (MNG) models a city that develops around a CBD and expands outward. As a city expands, it begins to change and becomes complex in design as new business activities emerge. In an attempt to explain the new complex structure of cities and their surroundings, the MNG model was developed by Harris and Ullman (1945). Compared to previous models, where the CBD and transportation are at the centre of urban development, the MNG model considered the rise of the (then) new disruptive technology of automobile transportation. Harris and Ullman (1945) indicated that automobile-based inter-urban linkages in new cities

created a multiple-nuclei structure for urban land use, thereby enabling regional areas to specialise in various business activities (see Figure 3).

The complex structure of the MNG model tends to depict a more realistic model of large urban areas (Planning Tank, 2019). The multiple 'nuclei' of the MNG model constitute smaller growth centres each of which has its own metropolitan area, and these nuclei may include parks, universities airports, small businesses and government offices. This corresponds to how commercial activities in many cities occur in clusters thus creating more than one centre of activity, which reduces the importance of CBDs as these other centres begin to accommodate commercial activities. The nuclei with their clusters of activities benefit from being located close to one another as this locational arrangement creates synergies and allows shorter transport links from one economic centre of activity to another, creating several nuclei in parts of the city other than the CBD, hence the name Multiple Nuclei Growth model (Liu, 2018).

Figure 3 *Multiple Nuclei model*

1- Central Business District
2- Wholesale light manufacturing
3- Low-income class residential
4- Middle-income class residential
5- High-income class residential
6- Heavy manufacturing
7- Outlaying Business District
8- Residential Suburbs
9- Industrial Suburbs

Source: Adapted from Harris and Ullman (1945)

Although national and local governments often promote urbanisation as one of the main drivers of economic growth and development, as the models outlined above indicate, the relationship between urbanisation and economic growth is not straightforward. Cities develop differently according to multiple factors – including the city's urban growth pattern, and these require more thorough investigation. This paper undertakes such an investigation by exploring the comparative urban growth of two tropical cities through the type of urban growth exemplified by each city, which, in turn, affects their economic growth and competitiveness.

Case 1: Singapore

Urban Growth Model of Singapore

Singapore best exemplifies the MNG model as the city has multiple nuclei attracting and repelling different activities. As described, MNG is an urban growth model where a city develops around the central metropolitan area and expands outward with several nuclei that form centres of economic activity and other attractions.

The metropolitan centre of Singapore is known as the Central Area, or the City Area. It is the location of global businesses, many recreational and tourist sites, performing arts centres, theatres and museums, as well as extensive shopping malls. The term Central Business District (CBD) has also been used to describe part of the Central Area, however the area is more expansive than just the CBD and includes the Downtown Core, comprised of City Hall, Bugis, Marina Centre, and Nicoll zones (Urban Redevelopment Authority Singapore, 2019a) as well as Marina East, Marina South, the Museum Planning Area, Newton, Orchard, Outram, River Valley, Rochor, the Singapore River and Straits View (Urban Redevelopment Authority Singapore, 2019). A critical mass of prime office spaces, museums, theatres and art galleries, riverfront developments, hotels, retail, and some residential areas are located in these areas.

Within the Central Area, the CBD forms Singapore's business and financial district and is the site of 37,400 international global companies and 7,000 multinational corporations with many operating their Asia-Pacific businesses from the city-state (The Business Times, 2018). According to Singapore's Urban Redevelopment Authority (URA), in 2020 this area will continue to grow by accommodating a wider diversity of activities in various sectors. It is expected that within the CBD more city living options will be provided nearer to amenities, including delightful streets with public spaces that celebrate cultural heritage and green assets, as well as more personal mobility devices and government-built flats. This outlook has been impacted by the COVID-19 pandemic as the coronavirus is changing the way people work, live and play in Singapore (Ng, 2020).

While the CBD and Central Area are sites of business, arts, culture and leisure, the heavy-manufacturing areas have traditionally been located in the western part of Singapore in places such as Boon Lay, Jurong West and Jurong East (see Figure 4). This region underwent rapid industrialisation and urbanisation from the 1960s to 1980s (CLC, 2018). As indicated in the MNG model, the industrial zones are located at a considerable distance from the CBD.

Figure 4 *Singapore urban structure and multiple nuclei model*
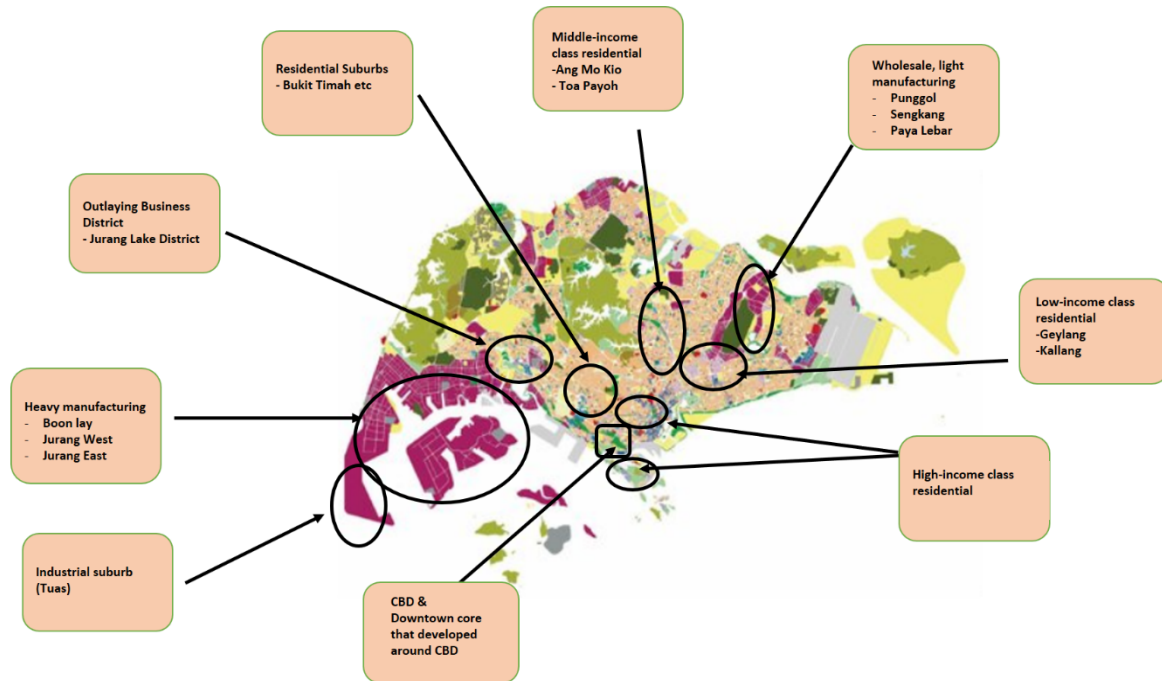
Source: Adapted from the map sourced from Master Plan Legend produced by Singapore Urban Redevelopment Authority (URA)

In the Eastern region of Singapore, Tampines has been developed as the first regional centre, with a significant number of people living in public and private residential areas supported by infrastructure such as international schools and warehouse retail parks for large brand-name companies such as Courts, Giant and Ikea (Fah & Teo, 2019), as well as the Mass Rapid Transit (MRT) – an efficient and growing island-wide public metro or subway system with rail networks that connect with bus, taxi and private vehicle services (Singapore Mass Rapid Transit, 2020).

Currently the area in the West of Singapore is undergoing urban development changes with plans by the Government to develop the Jurong Lake District into a second CBD area. This is part of the URA's decentralisation efforts to move jobs, public amenities and recreational options away from the CBD and closer to residential areas. With these changes, there will be an uptake of business and employment opportunities particularly in Jurong Lake District (JLD), Jurong Innovation District (JID) and Tuas Port (Urban Redevelopment Authority, 2020).

The spread and growth of the population and more efficient allocation of business activities and educational institutions will further increase the demand for residential, commercial and industrial properties, which in turn generates employment for different industries in this demand-based infrastructure. For example, in the western part of Singapore between Kent Ridge and Jurong are the sites of the country's two main

universities, the National University of Singapore (NUS) and Nanyang Technological University (NTU). Nearer to NUS is the research belt of Singapore which houses a vibrant research and business park known as One-North, developed by the Jurong Town Corporation (JTC) a statutory board of the Ministry of Trade and Industry. The research and business park is serviced and connected to the rest of the city through the Buona Vista and One-North MRT rail lines. Surrounding the research, business park and universities, are residential housing (both private and public) in satellite towns each with a central mall (often located above an MRT line) and essential services and shops. These amenities create many job opportunities in these densely populated satellite towns.

The MNG model adopted by Singapore brings together different stakeholders such as industries, residential communities and educational institutions, to collaborate and create within a vibrant environment (Jurong Town Corporation, 2020). This example illustrates that even though urban Singapore may have been founded with a CBD, other smaller business districts have evolved on the outskirts of the city near predominantly residential areas. This phenomenon creates nodes or nuclei in other parts of the city other than the CBD. In turn, these multiple nuclei are serviced by an increasingly integrated transportation network facilitated by the MRT trains and buses. The constructed landscapes of Singapore's urban planning programs in these locations have utilised urban spaces while improving the quality of life of the people and furthering economic growth opportunities.

Urban Plan and Economic Growth in Singapore

Like many tropical destinations, tourism is a major industry in Singapore, contributing around 4% to its gross domestic product in 2019 (Singapore Tourism Board, 2020a). In the 1980s, a SGD 1 billion Tourism Product Development Plan was implemented with places like Chinatown, Little India and Arab Street undergoing preservation, and the Singapore River rejuvenated (Singapore Tourism Board, 2020a). Many significant historic buildings and places such as the former Supreme Court and City Hall, Old Parliament House, and the Padang (central field), are located in Singapore's Civic District in the Central Area (Urban Redevelopment Authority Singapore, 2019b). This area represents the artistic and cultural heart of Singapore and the location of iconic buildings such as the Asian Civilisations Museum, Victoria Theatre and Concert Hall, and the Esplanade-Theatres on the Bay.

Tourism plays an essential role in Singapore's growth as a vibrant global city and a city of the arts (Ministry of Informaton and the Arts Singapore, 2000; Chaudhury & Lundberg, 2018). Tourists are both attracted to this futuristic city, and in turn, tourism further acts to attract capital, business and talent to the city-state (Singapore Tourism

Board, 2020a). The tourism sector of Singapore achieved record highs in international visitor arrivals and tourism receipts for the third consecutive year in 2018. From January to December 2018 international visitor arrivals increased by 6.2% to reach 18.5 million visitors and tourism receipts reached SGD 26.9 billion (Singapore Tourism Board, 2020b).

Over the past six decades since its independence, the Singapore model of urban development has been widely admired for its hugely successful public housing program (Kuah, 2018) as well as its transportation and land use planning, resulting in quality housing and comprehensive mass transit access (Shatkin, 2014). Urban infrastructure enables the Singapore economy to maintain its competitive edge in a highly evolving global market. As the demand for infrastructure such as transport systems, clean water, energy and telecommunications increases, urban planners face significant challenges in meeting demands. However, the Singapore Government maintains a reputation for informed urban projections through engaging in long-term integrated planning to serve commercial, industrial and residential needs (CLC, 2018).

The Government's success in urban and social engineering includes the extensive and efficient MRT system that started in 1987, which, while enticing the use of public transport also works in tandem with restraining private car ownership and use (Teriman et al., 2011). Since 2000, Singapore adopted information and communication technology (ICT) for its urban transformation with an aim for higher productivity and value-added production as well as re-imaging social clusters and economies (Hutton, 2004). For example, in recent years many companies and research institutes have worked together with government agencies such as the Housing Development Board (HDB) to test new urban solutions such as the use of solar technology in public housing precincts. To date, SGD 18 million has been invested in solar energy for 80 public housing blocks in 13 towns (Tng & Tan, 2012).

The Singapore Smart City initiative launched in 2014 (Lee, 2014) is another nationwide approach that encourages the use of digital innovation and technology to drive sustainability and liveability – a vision of local authorities with clearly planned urban policies for economic growth. All these initiatives, past and present, demonstrate ways in which the Government plans for a sustainable Singapore integrated under an environmentally responsible approach. The success of these urban plans has lead many Asian, and other, countries to view Singapore as a model for effective technocratic planning, environmental sustainability, public housing provision and urban redevelopment (Benjamin, 2008; Lee, 2000; Nair, 2000; Marshall, 2003). To this extent, the urbanisation-economic growth relation in the case of Singapore is often portrayed as automatic and inevitable (Turok & McGranahan, 2013).

Re-thinking the Singapore Developmental Model

In the case of Singapore, while the MNG model serves its developmental approach to economic growth insufficient attention is paid to the dynamics of urbanisation, especially when it comes to social and environmental considerations. Apart from negative externalities that tend to intensify as cities expand, the way people live and shape their everyday lives is affected by the qualities of the urban environment.

In Singapore, developmental projects can be controversial in that friction and tension can result from the needs of the local populace versus the national development agenda. A case in point is the Government's intention to build the Cross Island MRT line that would require tunnelling under Singapore's largest nature reserve, the Central Catchment Nature Reserve (CCNR), with 3 hectares of forests next to the reserve marked to be cleared, which could result in the loss of habitat for critically endangered wildlife (Tan, 2019). This has raised concerns among nature groups and environmentalists regarding the developental impact on Singapore's wildlife and nature (Abdullah & Chan, 2019). The Ministry of Transport adopted a utilitarianism approach to explain its decision citing shorter travel time by about six minutes per commuter per trip, as well as reducing public transport fares by about 15% on average due to a shorter and more direct route (Abdullah & Chan, 2019). This decision cited the common good and used an economic justification to quell the voices of the more than 12,000 signatures garnered to petition against the direct route (Tan, 2016).

Likewise, transportation infrastructure development precipitated the the case of Bukit Brown Cemetary, a graveyard over a hundred years old. The threat of its exhumation to make way for an eight-lane highway and futher residential developments sparked widespread citizen concern. This controversy likewise involved resistance from Singapore nature groups, as well as Heritage societies, and was forefront in acknowledging the conundrum of heritage, history, past generations, and urban development (Ocón, 2018, pp. 102-108).

Another case in point concerns the riverfront developments which bring out issues of national identity, local empowerment, and community rights of locals amid the global convergence of tourists, capital, people, and cultures (Chang et al., 2004). Over the years, planning zones such as the Singapore River waterfront and the Orchard Road retail district had to project an image of a global city infused with local cultures and distinctive identities as outlined in the development plan of the Urban Redevelopment Authority (1981), However, this balancing act is not always harmoniously achieved. Issues of global identity and local place meanings confront waterfront developments. For example, while the urban planners seek to project the Robertson Walk (at Robertson Quay) along the waterfront as the only Mediterranean-inspired, upmarket,

riverside commercial development in Singapore comprising residences, offices, commercial units and arts and cultural activities; local public sentiments were for the river to be distinctively Singaporean, citing that any activity carried out has to have a natural demand, bearing in mind the place is in Singapore (Chang et al., 2014). Moreover, many of the businesses along the Singapore River are owned by Singaporeans, and the clientele is also predominantly local. Hence, these developments were criticised for the loss of public spaces favouring cosmopolitan rather than heartlander[1] Singaporeans (Chang et al., 2004). Understanding the transformation of the waterfront provides some insights into the dichotomy between urban development and economic growth. It is not so linear. The quality of life of people cannot be simply equated with economic growth but needs to take into consideration the happiness and welfare of the city's people.

Case 2: Cairns

Urban Growth Model of Cairns

Cairns is a tropical city located in the northeast of Queensland, Australia, and is considered the gateway to Australia's Great Barrier Reef and tropical rainforests. Cairns is located in the wet tropics world heritage area, a living natural wonder and cultural area, that is unique in its landscape and climate. Intensive agriculture was the main economic activity during the last century, however, agriculture faces a long-term decline while the tourism industry has been rapidly developing. The tourism industry now has more economic value and provides more employment in the region (Bohnet & Smith, 2007).

Cairns is located far away from the main urban centres – 1700 km from Brisbane, the state capital – meaning it needs attention to foster positive change that will produce quality urban spaces and improve quality of life, while providing economic growth opportunities. Cairns Esplanade is the focal point for locals and visitors, and it is packed with bars, restaurants and a lagoon in the inner city (Gurran et al., 2006). The Cairns Regional Council leads the city's urban design and planning. It prepared a Local Government Infrastructure Plan (LGIP) that forms part of the planning scheme, and was formally approved on 10 April 2019 and implemented on 15 April 2019 (Cairns Regional Council, 2016). A primary purpose of the LGIP is to integrate infrastructure planning with land use planning, estimate the cost of infrastructure, and ensure that trunk infrastructure is designed and supplied efficiently. The trunk infrastructure

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[1] The 'heartlander' refers to middle to lower income Singaporeans living in suburban HBD blocks, who commute to work on the MRT (or bus). The term originally referred to Chinese-Singaporeans, however, this has changed.

includes five networks that provide essential services for development such as water supply, wastewater, stormwater, transport, public parks and land for community facilities (Cairns Regional Council, 2016).

The current Cairns Plan 2016 from the Cairns Regional Council (2016) is compared to the MNG model, as shown in Figure 5. Cairns urban growth displays the characteristic features of an MNG model with an outward expansion from the nuclei (the Cairns CBD) which merges with other urban areas. As development moved outwards from the CBD area other business districts began to form. These include major outlaying business centres such as Smithfield, Earlville and Edmonton, and more recently, Mount Peter. All are classified in the Cairns Plan 2016 as local centres and described as outlying business districts.

Figure 5 *Cairns Plan 2016 Version 1.3 – Land use*
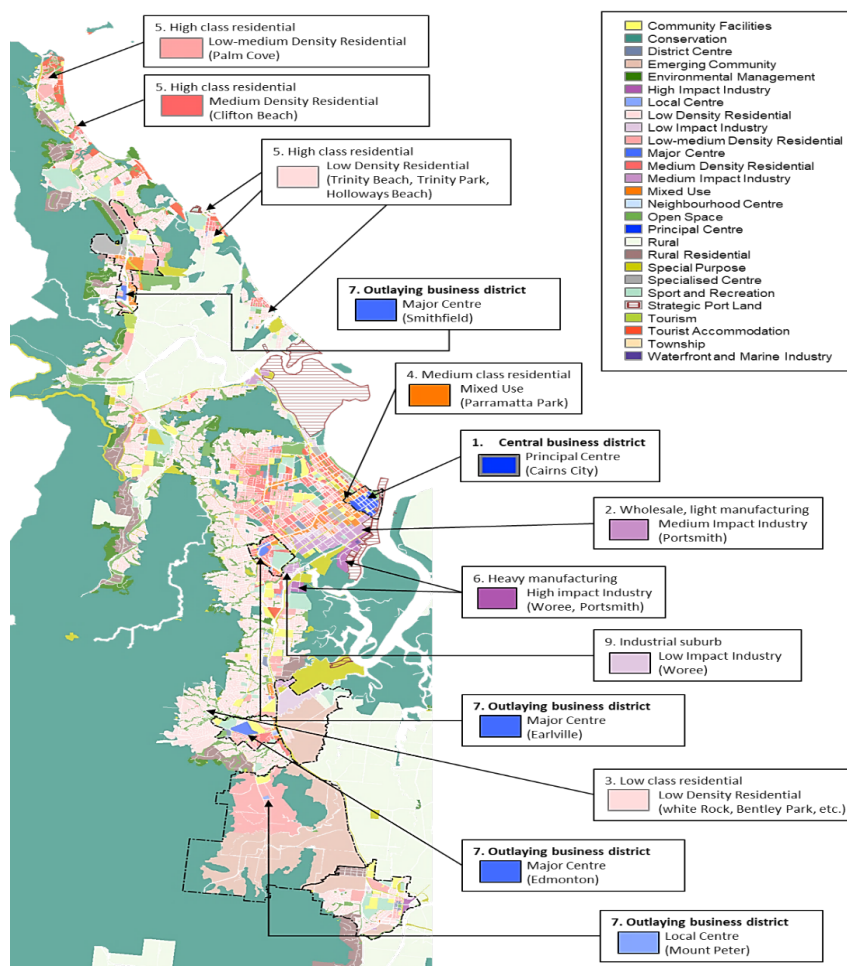
Source: Cairns Regional Council (2016)

As with the MNG model, high-class residential areas (Palm Cove, Clifton Beach, Trinity Beach, Trinity Park, and Holloways Beach) are located outside the CBD and

north of the outlaying business district of Smithfield. Medium-class residential areas (e.g. Parramatta Park) are located close to the CBD and were a response to population spread outwards from the central district. The medium-class residential areas fall under mixed-use areas in the Cairns Plan (Cairns Regional Council, 2016). However, small pockets of residential areas for middle-income households also appear in other areas of the region, but all still maintain access to the CBD.

Residential areas such as Freshwater, Redlynch, Kanimbla, Mooroobool, Bayview Heights, Mount Sheridan, White Rock and Bentley Park which are closer to industry sites are identified as "low-class residential" in Figure 5. It is important to note that the lower-class residential areas sometimes include a proportion of medium-class residential buildings in these estates. Heavy manufacturing areas from the MNG model can be found in the high impact industry areas of Woree and Portsmith, which are close to the lower-class residential households. The area of Portsmith closer to the CBD is the site of wholesale and light manufacturing industries, which fall under the medium impact industry area of the Cairns Plan 2016 (see Figure 5).

According to Bohnet and Pert (2010), historically, the southern area of Cairns developed at a fast pace due to its suitability for agricultural production and residential expansion. The northern part of Cairns was slower to develop due to flood risks that prevented major developments. However, the more recent historical development of the tourism industry and better road infrastructure to the northern beaches has supported the development of these suburbs.

Urban Plan and Economic Growth in Cairns

Over the past 100 years the Cairns economy has been increasingly supported by agriculture and tourism. At the beginning of the 20th century the Cairns Harbour Board and the implementation of railways promoted the region's tourism. The inauguration of the Cairns International Airport (1984) and the scenic Skyrail, which connects Cairns and the rural mountaintop town of Kuranda (1995), have also fostered the tourism industry (Mckenzie et al., 2011). These early inter-regional and more recent international transport systems have played a key role in the city's historical growth. At the same time, tourist attractions around the region have significantly impacted Cairn's urban planning and development. The city quickly expanded through low-rise development, a fact that only started to change in the early 1980s with permission to construct high-rise hotels in the CBD area. Today, Cairns has a well-defined urban centre surrounded by smaller urban centres and more distant suburban developments stretching along the coastline (Gurran et al., 2006). This has implications for transport, for even though regional transport and international connections have played a key

role in the city's economic growth, the urban transport networks within Cairns are compromised due to urban sprawl and concomitant long transit distances.

In Bohnet and Pert's (2010) study of Cairns, tourism was identified as one of the main drivers of rapid urban growth leading to a fundamental restructuring of the local economy as the service sector dominated over traditional agricultural industries. As in many other Australian cities, the 'sea-change' phenomenon[2] has supported urban growth along the coast resulting in the expansion of tourist facilities from the CBD area to other suburbs, especially northern beach areas. These urban growth changes have also created noticeable environmental pressures as urbanisation increasingly encroaches upon terrestrial and aquatic ecosystems. In response, the State of Queensland released the Far North Queensland FNQ 2031 plan (2009) aimed at addressing the issue of rapid urban growth with a special focus on tourist accommodation zones. A key objective of the FNQ 2031 plan includes the achievement of a compact urban form to promote land use and infrastructure efficiency while protecting the surrounding natural habitats and rural production systems, all of which support the lucrative tourism economy. In 2017 and 2018 the total revenue from the tourism and hospitality industry in Cairns was over AUD 2.2 billion, with total value added at over AUD 1.1 billion.[3] Besides its significant economic contribution, tourism also contributes to employment in Cairns, thereby providing opportunities for both Indigenous and non-Indigenous Australians living in this far north Australian city (Dale et al., 2015). Employment in the tourism and hospitality industries featuring direct and indirect jobs in Cairns increased from 10,983 in 2012/13 to 12,302 in 2017/18.[4]

While the labour market in Cairns is mainly dominated by tourism and hospitality employment, the region's innovation performance lags behind other areas of Queensland (Yigitcanlar et al., 2018). This might be due to lower workforce participation in innovative activities such as information media and telecommunications; professional, scientific and technical services; and education and training, compared to tourism-related activities including accommodation and food services; rental hiring and real estate services; and arts and recreational services.[5] However, the Cairns Regional Council Economic Development Strategy 2018 – 2022 aims to re-strategise its economic development approach to support the growth of new and existing industries, which includes boosting entrepreneurship and innovation (Daniel, 2013; Cairns Regional Council, 2018).

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[2] In Asutralian culture, sea-change phenomenon is an urban-to-rural migration (mostly to coastal areas) to enjoy a better quality of life
[3] https://economy.id.com.au/cairns/tourism-value
[4] https://economy.id.com.au/cairns/tourism-value
[5] https://economy.id.com.au/cairns/Employment-census

Re-thinking the Cairns Growth Model

The low-rise developments widespread throughout Cairns – with the exception of recent CBD developments – imply the need to consider distance travel despite the small population. Even though the regional transport, as well as international air transport, systems play an important role in the development of the Cairns region (Mckenzie et al., 2011), transport within the city boundaries is still primarily based on individual cars and limited bus transit. With a couple of exceptions, the suburbs are not well connected by public transport, thereby compromising travel efficiency. The key traffic connecting areas are the Cairns Central Shopping Centre and Smithfield Shopping Centre; both big-box development types. The big-box development type consists of extensive retail areas which profoundly impact communities visually and economically (Evans-Cowley, 2008). To attract consumers and create markets, they are frequently placed close to expressways (Jones & Doucet, 2000). Big-box development thrives in spread out environments dominated by cars, thereby changing the street environment which impacts travel, spending patterns and neighbourhood desirability (NYCDOT, 2014). While the big-box developments may somehow solve the problem of accessibility to key services, as Cairns expands these spread out environments become an increasingly challenging issue. Sprawl associated with low-density developments means that demands resulting from the rise in population and inbound tourism will continue to generate economic and environmental pressures as urban sprawl creates extra costs and encroaches on productive land (Burchell et al., 2005; Owen, 2009)

In response to these pressures, the FNQ 2031 plan identifies the need to move from new low-density suburbs to geographically-defined areas to accommodate future and denser urban growth requirements (The State of Queensland - Queensland Department of Infrastructure and Planning, 2009). There is a need for higher density development in appropriate areas to support the most efficient use of infrastructure and services and the growth of viable communities.

The improvement of existing urban spread out areas should consider the further development of nuclei centres following the Transit-Oriented Development (TOD) model. TOD promotes smart growth by locating new development in and around transit nodes (National Academies of Sciences Engineering and Medicine, 2004). These nodes bring together public space and health, local retail and community facilities. On average, TODs have 60 persons/ha or more, and are based on mixed-uses: office, hospitality, retail, and housing (UN-Habitat, 2013). By supporting the development of new centres, TOD strategies are useful for existing urban sprawl contexts as they increase public transport use, walkability, proximity to work, and other neccessary urban amenities. In this sense, TOD is a useful strategy to support the

objectives of the FNQ 2031 plan while making Cairns more connected and denser in key urban areas.

Empirical Analysis

To complement the above comparative case studies of Singapore in Southeast Asia and Cairns in far north east Australia, we researched the perplexing relationship between urbanisation and economic growth using the Ordinary Least Square (OLS) linear regression model and associated diagnostic estimations. The OLS analysis was carried out separately for the city of Cairns and city-state of Singapore, with the timescale of both spanning over 20 years. To capture economic growth, we used per-capita gross domestic (regional) products to show the value of goods and services produced in a country or a region concerning their urban population over time. Since the urban population is already embedded in the construct of the economic growth indicator it will not enter our modelling as a stand-alone variable. To capture measures of urbanisation in our selected cities, as indicated in Table 1, we used a set of indicators including the number of registered businesses, the value of residential building approvals, registered motor vehicles, the number of health facilities, the number of international tourist arrivals, and electricity generation output. The choice of variables for each city depends on the existing literature and the availability of data.

Table 1 *Set of Indicators for Urbanisation and Economic Growth*

Singapore	Cairns
Per Capita Gross Domestic Products	Per Capita Gross Regional Products
International Tourists Arrival	Registered Businesses (Units)
Electricity Generation Output (Gwh)	Number of Local Jobs
Residential dwelling Units	Registered Motor Vehicles (Units)
Health Facilities (Units)	Value of Res Building Approvals ($M)

Our econometric analysis begins with investigating the existence of a unit root to test the stationarity of the variables. For robustness, four different unit root tests were applied: the Im-Pesaran and Shin W-stat test; ADF - Fisher Chi-square test; PP - Fisher Chi-square test; and Levin, Lin & Chu t-test. All four tests work under the null hypothesis of a unit root (i.e. variables are non-stationary) and the alternative hypothesis of no unit root (i.e. variables are stationary). The results of all four methods for testing unit roots, as shown in Table 2, indicate that we reject the null hypothesis of the existence of unit root (no difference between the means) and that our variables satisfy the condition of stationarity and they are all integrated at level (i.e. $I(0)$).

Table 2 *Unit Root Test Results*

Methods	Statistic	Prob.**	Observations
Null hypothesis: Unit root			
Levin, Lin & Chu t*	-4.28	0.000	89
Im, Pesaran and Shin W-stat	-2.64	0.004	89
ADF - Fisher Chi-square	23.64	0.008	89
PP - Fisher Chi-square	23.53	0.008	90

** Probabilities for Fisher tests are computed using an asymptotic Chi-square, distribution.
All other tests assume asymptotic normality.

After confirming the stationarity of the series, we proceeded to establish an ordinary least square (OLS) regression model which expects to assess the connection between the indicator for economic growth and determinants of urbanisation. To evaluate this connection, we began with modelling the theoretical relationship using a linear functional form of the dependent variable and a set of explanatory variables following the principles of the least square method.

$$EG_{it} = \alpha + \beta_1 BIZ_{it} + \beta_2 JOB_{it} + \beta_3 VEH_{it} + \beta_4 BUIL_{it} + \epsilon_{it} \qquad \textit{(Cairns model)}$$

Where EG is Per Capita Gross Regional Products, *BIZ* is the number of registered businesses, *JOB* is the number of local jobs, *VEH* is the number of registered motor vehicles, and *BUIL* is the value of residential building approvals.

$$EG_{it} = \delta + \gamma_1 ELEC_{it} + \gamma_2 TOUR_{it} + \gamma_3 HF_{it} + \gamma_4 RES_{it} + \epsilon_{it} \qquad \textit{(Singapore model)}$$

Where EG is Per Capita Gross Domestic Products, *ELEC* is Electricity Generation (Gwh), *TOUR* is the number of international tourist arrivals, *HF* is health facilities, and *RES* is the number of residential dwellings.

The symbols β and γ are the slope coefficients, *t* represents the time series, *i* is the cross-sections, α and δ are equation constant terms and ε represents the error term.

Initially, seven urbanisation variables were identified for the OLS analysis. However, some of the variables were omitted during the process either because they did not exhibit a statistically significant relationship with the dependent variable (economic growth) or they generated the problem of multicollinearity. Hence, they are not reported in this study.

Table 3 *Results of the Ordinary Least Square (OLS) Estimation*

Cairns OLS Model dependent variable: Per Capita GRP	Coefficient	Standard Error	t- Stat	P-value
Constant	-16914.27	5440.80	-3.11	0.007*
Registered Motor vehicles	-0.34	0.04	-8.45	0.000*
Registered Businesses	6.62	0.84	7.87	0.001*
Value of Residential Building Approvals	0.02	0.007	4.56	0.002*
Number of local jobs	1.23	0.10	2.42	0.03**
Singapore OLS Model dependent variable: Per Capita GRP	**Coefficient**	**Standard Error**	**t- Stat**	**P-value**
Constant	-9724.31	11887.34	-0.82	0.43
Electricity Generation (Gwh)	0.87	0.36	2.38	0.03**
International Tourist Arrival	0.02	0.01	3.08	0.01*
Residential dwelling Units	0.02	0.01	1.98	0.09***
Number of Healthcare facilities	5.7	2.4	2.38	0.03**

Adjusted R^2 = 0.96 for Cairns model and 0.98 for Singapore model, based on the ordinary least square (OLS) analysis where Per Capita Gross Domestic or Regional Product is used as a dependent variable and indication of Economic Growth and the rest of variables are used as independent variables (Level of significance: *$p<0.01$; **$p<0.05$, ***$p<0.1$)

Cairns

Estimated parameters of our Cairns (top panel) and Singapore (bottom panel) models are presented in Table 3. The estimated parameters in the Cairns model (based on t-test) reveal that there is a positive and statistically significant relationship between per-capita Gross Regional Product (GRP) as an indication of economic growth and three of the urbanisation indicators. In particular, the findings reveal that per-capita GRP increases by $6.62 for every new local registered business. This result is in line with the overall role of small businesses in the Australian economy which account for 35% of the country's GDP, employing 44% of Australia's workforce.[6] In terms of the number of local jobs, the findings indicate that per-capita GRP increases by $1.23 for every newly created job in the region. The statistical significance of this relationship is not surprising as the number of local jobs indicates more wages for the community's workforce which is directly linked to the construct of the GRP measure. The last urbanisation variable in our model with a positive and statistically significant relationship with the indicator of economic growth is the value of residential building approvals. The finding here is reasonable as the pervasive impact of the housing market on the Australian economy is well understood (Saunders & Tulip, 2019). The

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[6] https://www.asbfeo.gov.au/sites/default/files/documents/ASBFEO-small-business-counts2019.pdf

result indicates that per-capita GRP increases by two cents for any additional approved dollar value of new residential buildings in the region.

The only statistically significant yet negative relationship in our model is between the number of registered motor vehicles and the indicator of economic growth. This finding is curious at first, but it is not surprising. May et al. (2019) estimated household wealth effect from house prices. They found that while car sales create a relatively small multiplier benefit to the economy (due to massive industry shut down), reduction in new car sales is instead a leading indicator of looming economic contraction. If consumers find themselves in a financial predicament, there will be a significant fall in new car sales nationwide. While this reduction in sales would be devastating for car dealers, it could be positive for other retailers and service providers until the rest of the economy catches up with the impending recession.

Singapore

In our comparative case of the small densely populated city-state of Singapore, estimated parameters of the model reveal that there are statistically significant relationships between the indicator of economic growth (per capita GDP) and urbanisation indicators of electricity generation. This indicator is an essential measure for urbanisation as it captures the electricity consumption by all different economic units, including the heavy-manufacturing sector. In Singapore, heavy-manufacturing is energy-intensive with over 42% of the electricity being consumed by industries, followed by commerce and service sectors (36%), and finally households (14.3%).[7] Empirical findings from the estimated OLS model support the general notion of close links between the production of electricity and the wealth of nations (i.e. GDP and per capita GDP). This relationship is expected to be stronger for developing countries than for developed countries. In this case, it seems that per capita GDP increases by 87 cents for every additional gigawatt-hour of annual generated electricity. Another statistically significant relationship is observed between the indicator of economic growth and international tourist arrivals as an indicator for urbanisation. Singapore Government's pro-tourism policy, promotion of urban tourism infrastructure, and urban renewal plans, appear to corroborate our result. In this case, any additional international tourist arriving in Singapore is expected to increase per-capita GDP by two cents.

The relationship between the housing sector and economic growth is well understood in the literature. The success of Singapore's housing model with more than 90% of home ownership in 2019 with a per capita GDP of USD 65,142 (Singapore

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[7] https://www.ema.gov.sg/Singapore-Energy-Statistics-2019/Ch03/index3

Department of Statistics, 2020) demonstrates what can be achieved with strategic planning to mobilise resources and guide key investments (Phang & Kim, 2013). It is not surprising to observe a positive and statistically significant relationship between per-capita GDP and the number of residential dwellings in Singapore. However, the impact is minor (only a two-cent increase in per-capita GDP for any additional residential housing), and this could be explained by Singapore's unique geographical challenges which are explicitly impacted by land and territorial water constraints. Land availability for development is scarce, unless it becomes available either through recycling existing land and buildings or through land reclamation projects which expand coastlines outwards or create islands in the surrounding sea.

The last indicator of urbanisation in the Singapore model is the number of health facilities. This indicator is crucial as not only is there a considerable body of evidence confirming that substantially improving health, especially amongst wage earners, contributes to long-term economic growth and prosperity; but also, since uncontrolled urbanisation is linked to a wide range of health issues and diseases in cities[8] the number of health facilities would indicate the extent of controlled urban growth and access to health services. Our finding seems reasonable as it shows a strong, statistically significant relationship between the number of health facilities and economic growth. Per-capita GDP appears to increase by SGD 5.7 for any additional health facility.

A Note on Diagnostic Analysis

We should, however, be cautious in accepting these results without additional diagnostic analysis, particularly analysis pertinent to the residuals of the regression equations. The residual analysis consists of a set of robust tests that help with the evaluation of the goodness of the fitted models. Checking underlying assumptions such as 'no serial correlation', 'no heteroskedasticity' and the assumption of 'normal distribution' among residuals is required to ensure regression functions are correctly specified. For the detailed analysis of these diagnostic tests refer to the Appendix.

Conclusion

Cities grow in many different ways, hence understanding the patterns of urban growth and their determining factors remain essential in comprehending the channels through which economic growth is induced. To facilitate deeper understading, this paper looks at different urban growth models as a tool to better understand the relationship

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[8] https://www.theguardian.com/sustainable-business/2017/feb/24/how-can-health-services-keep-pace-with-the-rapid-growth-of-cities

between urbanisation and local economic growth. In exploring this relationship, the two case studies of Singapore and Cairns are introduced, and their urban planning and potential sources of economic growth investigated both theoretically and empirically. Our analysis indicates that economic activities in these cities are influenced by the approaches taken to urban and economic planning.

The intricate MNG pattern has resulted in the reduced significance of the CBD as the only financial-business-commercial centre in both the cities of Cairns and Singapore. Instead, the growth of multiple nuclei have created additional synergies between suburbs by allowing the attraction and formation of diverse commercial activities close to one another (and away from the CBD). Accordingly, each nucleus seems to have grown into viable and vibrant neighbourhoods where people can work, live and play. The analysis also indicates that suburban environments in each of these cities generate a certain kind of economy: in Cairns this is primarily based on big-box developments and car-based commutes; while in Singapore there is a public-transport-based commute (the MRT) that connects people living in various satellite towns supported by various infrastructures such as schools, universities, business parks, research institutions and shopping malls that will further increase the demand for residential, commercial and industrial properties and generate employment for different industries. Even though urban Singapore may have been founded with a CBD, other smaller business centres have emerged near predominantly residential areas, thereby creating nodes or nuclei in other parts of the city.

In Singapore, authorities and city planners have been successful in promoting sustainable transportation by providing an efficient public transport system and restraining private car ownership. Moreover, there is evidence that the drivers of economic growth are moving away from the manufacturing-oriented sectors to technology and innovation-based industries. This appears to be a direct result of focusing on innovative and smart city planning, combined with a substantial investment in technological infrastructure that gives rise to economic productivity. In Cairns, our investigation indicates that the future development of urban settlements and the shape of the city is determined by explicit urban policies of local authorities, their success in attracting new businesses, and targeted construction activities. With an MNG pattern of urban growth in Cairns, these developments seem feasible through careful planning and providing strong directions influencing sources of economic growth and distributions.

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Figures

Figure 1 *Global Urban Population Growth.*

Figure 2 *Percentage of urbanised areas Vs rural areas by geographic regions.*

Figure 3 *Multiple Nuclei Model.*

Figure 4 *Singapore urban structure and multiple nuclei model.*

Figure 5 *Cairns Plan 2016 Version 1.3 – Land use.*

Appendix

The residual analysis consists of a set of robust tests that help with the evaluation of the goodness of the fitted models. Checking the underlying assumptions such as 'no serial correlation', 'no heteroskedasticity' and the assumption of 'normal distribution' among residuals are required to ensure regression functions are correctly specified.

Accordingly, serial correlation in residuals is tested using the Breusch-Godfrey Serial Correlation LM test to ensure the validity of the estimates of standard error and the coefficients. The results, as shown in Table 4, indicate that we cannot reject the null hypothesis, and there is no serial correlation amongst the residuals.

In addition, to avoid model misspecification and to ensure the efficiency of the model estimates, we tested for heteroskedasticity in the residuals. This is because while OLS estimates are consistent in the presence of heteroskedasticity, the computed standard errors will not be valid. Consequently, we used The Breusch-Pagan-Godfrey test to verify the probability of departures from heteroskedasticity. The results shown in Table 4 indicate that the null hypothesis of homoskedasticity cannot be rejected (there is no heteroskedasticity among residuals).

Table 4 *The results of Serial Correlation tests and Heteroskedasticity tests*

Breusch-Godfrey Serial Correlation LM Test- Null hypothesis: No serial correlation				Heteroskedasticity Test: Breusch-Pagan-Godfrey, Null hypothesis: Homoskedasticity			
Cairns equation				**Cairns equation**			
F-statistic	0.04	Prob. F	0.91	F-statistic	0.13	Prob. F	0.96
Obs*R-squared	0.14	Prob. Chi-Square	0.85	Obs*R-squared	0.68	Prob. Chi-Square	0.95
Singapore equation				**Singapore equation**			
F-statistic	0.04	Prob. F	0.91	F-statistic	1.54	Prob. F	0.23
Obs*R-squared	0.14	Prob. Chi-Square	0.85	Obs*R-squared	5.8	Prob. Chi-Square	0.21

Finally, to test for normality of residuals, we carried out the Jarque-Bera test, under the null hypothesis of normally distributed errors. The results of this test, as shown in Table 5, indicate that the assumption of normal distribution amongst residuals is satisfied.

Table 5 *The results of the normality test*

Normality condition	Cairns equation	Singapore equation
Jarque-Bera test statistic	0.155	1.29
Probability	0.92	0.52

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Acknowledgement

Dr Taha Chaiechi is Associate Professor of Economics in the College of Business, Law and Governance where she is also Australia Director, Centre for International Trade and Business in Asia (CITBA). Currently Taha is serving James Cook University as Expert Member on the Academic Board. Previously she has contributed to the governance and the Teaching & Learning profile of the College in different capacities. She is also Associate Editor-in-Chief, Bulletin of Applied Economics (ABDC ranked). Taha is an expert in systematic modelling of dynamic relationships between economic, environmental and social variables. Her research attitude is holistic and inspired by issues in climate change and natural disasters, and their impacts on different economic sectors such as health, tourism, environment, energy, and cities. At the core of her research philosophy is sustainable development, and she uses the 2030 Agenda as a malleable guide throughout her research. Taha's multidisciplinary research approach has resulted in numerous collaborative projects over a broad spectrum of research topics, with the intention to enhance methodological approaches that are especially suitable for sustainability analysis.

Dr Caroline Wong is the Associate Dean of Learning and Teaching (ADLT) and a Senior Lecturer at James Cook University Singapore. Her research in knowledge management takes on a multidisciplinary approach that extends into knowledge-based cities, smart cities, creative cities, and creative industries with special focus on Singapore. She was a founding member of the International Scientific Committee of the Knowledge Cities World Summit in Monterrey (Mexico) in 2007 and a member of the International Advisory Board on knowledge-based cities 2007-2009. She has published in the *Journal of Competence-Based Strategic Management, International Journal of Knowledge, Culture and Change Management, Journal of Knowledge Management and the Journal of University Teaching and Learning Practice*.

Dr Silvia Tavares is an urban designer with a background in architecture, urbanism, and building and city science. She is a lecturer and researcher at the University of the Sunshine Coast, Australia, and has fifteen years experience working as a researcher in institutions in Australia, New Zealand, Germany and Brazil. She is currently a member of research groups in Brazil and Australia, as well as research teams with colleagues from the Netherlands, USA, Ecuador, Singapore, Belgium and Kenya. Silvia recently delivered a keynote at the International Conference on Architecture in Tropical Environments at the École Nationale Supérieure d'Architecture de Montpellier in La Réunion (France). Her research focuses on providing evidence to produce public open spaces that are thermally comfortable and promote the good health of users and the natural environments that surround them.