GROWTH DYNAMICS AND MUNICIPAL POPULATION CHANGE IN AUSTRALIA, 1911-2016

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ABSTRACT: In Australia, empirical analyses of municipal populations are uncommon given its cities are usually conceived of as metropolitan areas. Widespread usage of metropolitan statistics is practical; however, municipal perspectives engage with the machinery of government and can reveal complementary insights about cities as institutions. To develop such insights, this study utilised a statistical model of Australian municipal populations to examine the drivers of growth from 1911 to 2016. Statistically significant long-term positive relationships were identified between population and location specific features such as being coastal, eastern, and near to a seaport or state parliament. The constant and strong involvement of political factors is noteworthy given they are less recognised drivers of settlement. The findings of this paper, which partly elucidate drivers of population growth in Australia, have major implications for the federal government's plan to steer anticipated high population growth into regional centres.

KEYWORDS: Local government; municipality; Australia; urban primacy.

1. INTRODUCTION

What is Australia's most populous city? Since Federation (1901), there have usually been two correct answers. At the 2016 census, Sydney Greater Capital City Statistical Area's population measured 4.64 million, signifying Australia's most populous city, a title Sydney has held since the

first national census (1911). This first correct answer refers to the urban area, a delineation of 'city' that is widely used and key to how Australian cities are understood. The second answer utilises administrative boundaries to define 'city,' officially Local Government Areas (LGA). From this vantage, Brisbane has been Australia's largest city since 1924, whilst Sydney and Melbourne ranked 16th and 53rd respectively in 2016.

The second answer may be somewhat obscure because a lot of what is known about Australian city populations does not engage with cities officially, as government arenas where development manifests. Whilst the prevalence of urban statistics has practicalities, Florida's (2019) research of American municipalities demonstrates how the administrative perspective can stand on its own, providing valuable insights about cities as formal institutions. In the interest of learning more about these institutions, this study conducted empirical analyses of Australian municipal populations to examine drivers of growth.

Time-series analyses of Australian municipal populations are rare for two practical reasons. First, the diversity of LGA size and composition poses limitations to studies purporting to examine cities. LGAs range from geographically small fractions of large metropolitan regions to country-sized, sparsely inhabited geographies. In this study, the term *city* identifies a municipal government and its domain. Comparable implicit usage of the term can be found in studies of municipalities from the Americas and studies of Chinese cities deriving from census data (Forstall *et al.*, 2009). The United Nations (2018) has indicated that 35% of cities with populations over 300,000 are administratively delineated.

The second reason Australian municipal populations are overlooked is because Australia's urban and municipal geographies misalign, rendering urban statistics the rational default in studies of urbanisation and population. As Florida (2019) explains, 'the reality is that most studies that purport to talk about cities are really talking about the performance of broader metropolitan areas.' Indeed, the fact that many urban regions extend beyond their namesake municipalities has led some to question the utility of municipal populations and whether or not such definitions are obsolete (Verhetsel *et al.*, 2018).

Table 1 illustrates the challenge of urban and municipal alignment by juxtaposing the top five urban and municipal populations for Australia, Canada, and the USA, the latter two being similarly wealthy, large federations of British colonial origin sometimes subject to comparative analysis with Australia (Brunet-Jailly and Martin, 2010). In Australia, only Brisbane appears in both rankings, the only capital to do so despite the

dominance of state capitals (in the urban sense) over their states, a phenomenon known as urban primacy (Short and Pinet‐Peralta, 2009). In featuring a largely unfamiliar list, Australia's municipal ranking illustrates why it is little examined empirically because many of the most populous are incomplete urban areas. Meanwhile four Canadian and four American cities appear in both rankings. Furthermore, all Canadian and American municipalities constitute large, central, namesake municipalities of large urban regions. Thus, in Canada and the USA, either ranking serves as a proxy of the city-size hierarchy, whereas Australian rankings tell different stories.

Table 1. Top 5 Population Ranking for Urban and Municipal Definitions of Cities in Australia, Canada, and the USA.

	Australia		**Canada**		**USA**	
Rank	Urban	Municipal	Urban	Municipal	Urban	Municipal
1	Sydney, NSW 4,637,436	Brisbane, QLD 1,184,752	Toronto, ON 5,429,524	Toronto, ON 2,731,571	New York, NY 19,232,494	New York, NY 8,336,817
2	Melbourne, VIC 4,546,593	Gold Coast, QLD 575,303	Montreal, QC 3,519,595	Montreal, QC 1,704,694	Los Angeles, CA 13,182,453	Los Angeles, CA 3,979,576
3	Brisbane, QLD 2,282,759	Moreton Bay, QLD 439,292	Vancouver, BC 2,264,823	Calgary, AB 1,239,220	Chicago, IL 9.454,282	Chicago, IL 2,693,976
4	Perth, WA 1,982,270	Canterbury, NSW 361,862	Calgary, AB 1,237,656	Ottawa, ON 934,243	Dallas, TX 7.574,390	Houston, TX 2,320,268
5	Adelaide, SA 1,305,526	Blacktown, NSW 348,030	Edmonton, AB 1,062,643	Edmonton, AB 932,546	Houston, TX 7,063,400	Phoenix, AZ 1,680,992
Sources	Significant Urban Area, Australian Census 2016	Local Government Area (LGA), Australian Census 2016	Census Metropolitan Areas, Canadian Census 2016	Incorporated Cities, Canadian Census 2016	Metropolitan Statistical Area, 2019 estimates (Brinkoff, 2021)	Municipalities, 2019 estimates (Brinkoff, 2021)

The two dynamics outlined above drive the preference for urban statistics. However, the peculiarities of Australian municipalities should not be taken to suggest they are unworthy research subjects. This study's aim is to provide a complimentary empirical view of Australian cities that speaks to the drivers of population in local governments. Given such modelling is uncommon in Australia, the paper contributes novel statistical insights about Australian local governments.

The research questions guiding this study are, *Since Federation how have Australian municipal populations changed? Can statistical relationships between population and location-specific factors be identified?* This

research is important and timely because the Commonwealth government has recently launched initiatives aiming to decentralise projected high twenty-first century population growth out of state capital city regions through infrastructure investment in regions with 'the potential to support economic and population growth,' thereby alleviating congestion (Australian Government, 2015; 2019), what Hugo (2002: p. 1) described as 'one of the most dynamic and policy-relevant dimensions of the contemporary demographic situation.' However, in purporting to advance a settlement strategy (e.g. decentralisation), government initiatives imply known drivers of the current state, which we suggest is not an empirically based/tested understanding.

2. AUSTRALIAN LOCAL GOVERNMENT SINCE FEDERATION

Local government is a fundamental sphere of Australia's public sector. LGAs are creatures of their states and subservient to state legislation. Still, the role of local government is important and complex. Australia's national population (25 million) is dispersed across over 500 LGAs commonly referred to as councils, cities, municipalities, shires or towns (Ryan and Lawrie, 2020). Spatially, in the most populous states municipal geography is reminiscent of a fractal centred on state parliament, each LGA growing geographically larger as the distance from parliament increases. Queensland differs in that its capital city LGA is much larger following the agglomeration of Brisbane with nearby LGAs in 1924. The average size of state capital LGAs is 250km^2 whilst Brisbane's size is 1,338km^2 (Australian Government, 2020).

Given the diversity of municipal size and composition, as well as an absence of a formal tier of regional government in Australia, LGAs might be likened to hybrids of the Canadian and American local and county tiers. The Australian Productivity Commission (2017) discussed the complexities deriving from a system lacking an intermediary tier between states and local, with states doubling as metropolitan authorities and many local governments as counties.

Historically, LGAs were established to service local needs such as public works, community services, emergency services, recreation, cultural facilities, low-level public order, etc. As noted by Wild River (2003), Australian local government functions are internationally distinctive in what they do not cover, such as police, school, and hospital services which are provided by states. Until the implementation of reforms in the 1990s, local government tended to be managed by prescriptive state government

Acts and were service-directed rather than strategic (Aulich, 1999). The prevailing landscape nationally is now one of general competence. LGA's venture into a range of non-traditional activities, counter-balanced by a framework of fiscal constraint, transparency, accountability, and community engagement.

LGAs are varied in their constituent base, geographic and demographic features, their funding sources, and range of functions. They are also relatively weak, a dynamic attributed to being creatures of their states, and lacking federal Constitutional recognition (Grant and Drew, 2017). LGA weakness also derives from state administrative practice and choices. McNeil (1997, p. 21) compares Australian municipalities with American, noting both lack federal Constitutional status, however, American political culture 'favours local political action and participation… giving to local authorities a greater degree of responsibility and autonomy.'

In recent decades a growing local-federal relationship is apparent. Chronic resource shortages facing LGAs are exacerbated by growing concern that the federal government is using the local sector to bypass recalcitrant state governments. In part, this reflects both the problems of vertical fiscal inequality and the peculiar policy and program ambiguities generated by Australian federalism. The Commonwealth has sufficient resources to address the problems of uneven development between regions but as noted by Beer (2000), on occasion federal governments have found it convenient to argue that they lack a clear constitutional mandate for involvement in this arena.

Descriptive Statistics

To contextualise Australian municipalities, Table 2 features descriptive statistics for LGAs with populations over 2,500 from 1911 to 2016. As data were assembled it became apparent that local government has been subject to continuous change relative to quantity, size, boundaries, and hierarchy, the result of three primary forces. First, in 1911 formal local government was in its nascency and absent across swathes of the country. The first half of the twentieth century was a period of formalisation, with many LGAs established on unincorporated land.

Also apparent in Table 2 is the second driver, state reorganisations of LGAs in the second half of the twentieth century. These reforms, their

Table 2. Descriptive Statistics for Australian Municipalities with Populations Over 2,500, 1911-2016. Source: Australian Bureau of Statistics (1921, 1947, 1966, 2014, 2019) and Australian Government (2009).

NEW SOUTH WALES	**1911**	**1933**	**1954**	**1976**	**1996**	**2016**
LGA Count	197	236	206	192	164	125
Average LGA Population	7,244	10,324	16,217	24,613	37,671	61,807
Median LGA Population	4,638	5,733	5,912	8,105	15,405	26,356
Maximum LGA Population	112,921	88,308	193,145	169,939	239,818	361,862
Most Populous LGA	Sydney	Sydney	Sydney	Warringah	Blacktown	Canterbury-Bankstown
Most Populous LGA as Percent of State Urban Population	10.74%	4.90%	6.83%	4.01%	4.37%	5.16%
Average LGA Area (km2)	NA	1,672	1,983	NA	3,644	4,894
VICTORIA	**1911**	**1933**	**1954**	**1976**	**1996**	**2016**
LGA Count	142	160	161	176	78	79
Average LGA Population	8,496	10,958	14,833	20,343	58,462	78,130
Median LGA Population	4,769	5,385	6,963	8,299	36,901	45,600
Maximum LGA Population	103,593	92,112	93,192	117,144	183,728	312,789
Most Populous LGA	Melbourne	Melbourne	Melbourne	Waverley	Greater Geelong	Casey
Most Populous LGA as Percent of State Urban Population	13.47%	7.74%	4.67%	3.66%	4.59%	5.54%
Average LGA Area (km2)	NA	1,260	1,168	NA	2,891	2,876
QUEENSLAND	**1911**	**1933**	**1954**	**1976**	**1996**	**2016**
LGA Count	82	91	92	95	93	49
Average LGA Population	5,930	9,463	13,611	20,885	35,521	98,262
Median LGA Population	4,286	4,412	5,412	6,240	9,698	29,287
Maximum LGA Population	39,917	299,748	502,353	696,740	819,592	1,184,752
Most Populous LGA	Brisbane	Brisbane	Brisbane	Brisbane	Brisbane	Brisbane
Most Populous LGA as Percent of Urban Population	15.03%	60.08%	52.19%	42.64%	30.39%	27.81%
Average LGA Area (km2)	NA	7,395	6,700	NA	8,908	19,038
WESTERN AUSTRALIA	**1911**	**1933**	**1954**	**1976**	**1996**	**2016**
LGA Count	24	41	47	61	72	70
Average LGA Population	6,507	7,496	10,965	17,171	23,465	35,595
Median LGA Population	3,705	4,138	7,152	8,181	9,997	16,286
Maximum LGA Population	35,767	82,290	97,305	162,313	213,368	220,073
Most Populous LGA	Perth	Perth	Perth	Stirling	Wanneroo	Stirling
Most Populous LGA as Percent of State Urban Population	22.57%	32.62%	21.43%	16.98%	13.88%	9.49%
Average LGA Area (km2)	NA	6,851	5,273	NA	17,370	17,747
SOUTH AUSTRALIA	**1911**	**1933**	**1954**	**1976**	**1996**	**2016**
LGA Count	27	42	58	71	74	54
Average LGA Population	8,431	9,397	11,326	16,121	18,946	31,199
Median LGA Population	5,035	4,807	5,040	6,846	7,953	14,767
Maximum LGA Population	42,294	40,999	57,539	77,477	111,778	169,372
Most Populous LGA	Adelaide	Unley	Woodville	Salisbury	Salisbury	Onkaparinga
Most Populous LGA as Percent of State Urban Population	18.70%	11.26%	9.69%	7.33%	8.81%	11.20%
Average LGA Area (km2)	NA	553	609	NA	864	1,862
TASMANIA	**1911**	**1933**	**1954**	**1976**	**1996**	**2016**
LGA Count	29	28	33	31	26	25
Average LGA Population	5,471	7,081	8,779	12,235	18,053	20,417
Median LGA Population	3,973	4,237	4,583	5,438	12,298	14,482
Maximum LGA Population	27,526	47,054	54,896	50,384	63,896	66,518
Most Populous LGA	Hobart	Hobart	Hobart	Hobart	Launceston	Launceston
Most Populous LGA as Percent of Urban Population	30.71%	40.15%	26.99%	16.69%	18.55%	17.24%
Average LGA Area (km2)	NA	1,161	1,322	NA	2,471	2,248

justification and impacts, have been documented and examined by various scholars (Aulich *et al.*, 2014; Dollery *et al.*, 2008). Reorganisations usually entailed two state actions. First, the abolition and forced amalgamation of LGAs by states. Second, the creation of micro-capitals, referring to states breaking apart large state capital municipalities. With amalgamations, nationally the quantity of LGAs declined from its peak of 626 in 1976 to 402 in 2016. This was particularly transformative to municipal geography in New South Wales, Victoria, and Queensland. Relative to micro-capitals, their creation disrupted the capital city dominance that characterised Australia's early municipal hierarchy. A proclivity for smallness and evenness is conveyed in Table 2 where the most populous LGA is represented as a percent of the state urban population, a common measure of urban primacy (Henderson, 2003).

The third driver of LGA volatility was population growth in municipalities near capitals. Whilst capital city LGAs retained their initial limited size or were split into micro-capitals, surrounding LGAs grew larger. Only Queensland deviated from these trends, evinced by its apparent tolerance of more populous LGAs, comparable in scale to those found in Canada and the USA. Unlike the flat municipal hierarchies engineered by other states, Queensland's municipal hierarchy is reminiscent of rank-size or Zipf's law (Jiang *et al.*, 2015), a power law predicting a city's relative size to be the inverse of rank.

3. A MODEL OF AUSTRALIAN MUNICIPAL POPULATIONS: METHODS

To potentially identify attributes populous LGAs have in common, an empirical model of population was used to test for correlations between location-specific features and municipal populations. The model's design was guided by Galiani and Kim (2011), who tested for correlations between municipal populations and natural, economic, and political factors in the Americas, the aim being to examine the impact of natural endowment, infrastructure, and institutions on population. Similarly, this study adopted a deductive correlational modelling strategy, theoretically grounded in institutional economics, to regress municipal populations with factors that might constitute competitive advantages. Methodologically, the model reflects the entrenched American custom of municipal population data interrogation (Frey, 2020).

Study Sites

The model utilised state LGA population data from Australia's quinquennial census. The dataset included only LGAs with populations over 2,500 in eleven census periods (1911, 1921, 1933, 1947, 1954, 1966, 1976, 1986, 1996, 2006, 2016). A low population threshold and the regional scale of LGAs enabled the model to examine the relationship between population and the natural environment for 40% (3.17 million km^2) of Australia's landmass in 2016. LGA quantity, geographic size, and boundaries changed during the century of analysis. To manage these changes we examined each period separately. The definition of a municipality focused upon political existence, regardless of how the LGA physically morphed through time.

Regression Factors

Table 3 outlines eleven variables identified from the literature utilised in a model of LGA populations and how they were measured. The selection follows institutional studies focused upon foundational, location-specific attributes that condition development (Galiani and Kim, 2011; Kim and Law, 2016). They are grouped into three categories: Natural, economic, and political.

Natural factors: A theory/hypothesis of environmental determinism informed the selection of natural factors. Each LGA was defined as either coastal or non coastal - coastal being within 100 horizontal kilometres of the coast, less than 100 vertical metres above sea level (Small and Nicholls, 2003, p. 585). Kim and Law (2016) examined the presence of major rivers in Canada and the USA, representing a means of aquatic navigation and trade. Due to Australia having few major rivers, a broader tack was taken and the model examined perennial rivers, signifying a source of freshwater, not necessarily a means of navigation. For granularity, the river variable utilised proximate measures (e.g. distance between the LGA administrative seat and its nearest river) due to the fractured municipal geography of some metropolitan areas, whereby an LGA may be near a river however the attribute is not within its boundaries.

Relative to climate, average annual high temperature and average annual rainfall were included given Australia's heat and aridity. Larger municipal populations are hypothesized to occur in more moderate, wetter climates. Finally, positional factors were examined, latitude and longitude, to control for unmeasured natural and historic circumstances that might account for

concentrations of population in particular regions of the continent such as the southeast.

Table 3. Independent Variables Utilized in Model of Australian Municipal Populations. Source: the Authors.

Factor	Type	Measured As	Description
Coastal	Natural	Yes (1); No (0)	Coastal is defined as within 100 horizontal kilometers of coast, less than 100 vertical meters above sea level.
Perennial river	Natural	Kilometres	Distance between LGA administrative seat and nearest perennial river
Temperature	Natural	Degrees Celsius	Climate statistic (30 years mean annual maximum temperature) pertaining to respective regression period retrieved Australia Bureau of Meteorology
Rainfall	Natural	Millimetres	Climate statistic (30 year mean annual rainfall) pertaining to respective regression period retrieved Australia Bureau of Meteorology
Longitude	Natural	Decimal	East-west coordinate retrieved from Australian Bureau of Meteorology
Latitude	Natural	Decimal	North-south coordinate retrieved from Australian Bureau of Meteorology
Major Seaport	Economic	Kilometres	Distance between the administrative seat and a major seaport. 1911-1986: 'Major' as identified in respective Australian Yearbook. 1996 onwards: 'Major' signifies greater than 500,000 tonnes handled annually as per Australian trade statistics.
Major Airport	Economic	Kilometres	Distance between administrative seat and a major airport. 1966-1996: 'Major' as identified in Australian Yearbook. 2006 onwards: 'Major' signifies greater than 500,000 passenger movements annually as per Australian trade statistics.
Area	Political	Kilometres squared	Geographic area of LGA retrieved from Australian census records, regional reports and Local Government National Reports. 1911 and 1976 omitted due to incomplete data.
State capital status	Political	Yes (1); No (0)	State capitol located in LGA determined from public record
State capitol proximity	Political	Kilometres	LGA administrative seat distance from state capitol calculated using National Map Australia

Economic factors: Two economic factors, major seaport and airport, were examined. Major ports were included given they are critical components of transportation and trade infrastructure. For ports, proximate data were utilised in lieu of binary data to account for numerous LGAs being near to major ports. 'Major 'was ascertained from trade statistics contemporaneous with the census period. In terms of other economic data, municipality-specific, industry-level productivity data were unavailable for the period of analysis. Still, the model holds central as the dependent variable one such economic productivity measure, population. That is, individuals are valuable economic actors/units. Their concentrations speak volumes about variable productivity. Further, the qualification of ports as

'major 'considers productivity. Conceptually, the focus upon foundational attributes of economic development as opposed to current state productivity outcomes aligns with an institutional focus.

Political factors: Three political factors were measured; geographic area, state capital city status, and proximity to the municipality's respective state capitol. Land area was regressed on the basis that large areas are associated with large populations (Kim and Law, 2016). Land area data were accessed from the national census, state yearbooks, and local government national reports. Relative to capital city status, there are numerous reasons to anticipate high populations in capitals. Whether a capital makes the city, or a city makes the capital, empirical evidence suggests capital city status itself constitutes a competitive advantage (Anthony, 2014). This is explained by capitals' agglomeration of government jobs, lobbying activities, and businesses, which foster growth (Ades and Glaeser, 1995). Given most state capitols are located in geographically small LGAs nestled centrally within metropolitan regions, distance to the capital was included on the basis that the benefits of capital city status may extend to proximate regions. Proximity was measured as the distance between state Parliament and council chambers contemporaneous with the census period. Council chambers and municipal seats were identified following consultation with public records.

Statistical Analysis

Univariate analyses were run for every period, regressing each factor individually with LGA populations. Multivariate models were then run for each year with all factors. Multivariate models were then built by progressively adding additional factors. For each decade the final statistical model regressed the log of LGA populations with all factor data (as per Table 3) corresponding to that year. The following regression equation was estimated;

$$log(pop)i = \beta 0 + \beta 1NATi + \beta 2ECOi + \beta 3POLi$$

In the equation *log(pop)i* is the natural logarithm of the LGA *i* population, NAT*i* corresponds with natural factors (6), ECO*i* corresponds with economic factors (2). and POL*i* corresponds with political factors (3).

4. RESULTS

Table 4 presents the results of eleven multivariate linear regressions, one representing each decade from the 1910s to 2010s. It is important to note

that some factors that appear insignificant in multivariate analyses, often had statistical relationships with population in univariate analyses (results not shown). Specifically, in univariate analyses precipitation positively correlated with population whilst distance to rivers negatively correlated with population in all periods. Meanwhile, temperature negatively correlated with LGA populations in eight of eleven periods. The multifactor model does not indicate that these factors are unimportant but identifies the strongest relationships.

The correlation coefficient is presented for each factor above the standard error and significance code, or p-value. To contextualise this, if x is the coefficient, its impact on city population equals exp(x) – 1 for every unit change in the independent variable. For example, in 2016 coastal locations had a correlation coefficient of 0.32 with a p value less than 0.001, signifying the strongest measurable statistical relationship. The impact of coastal location on municipal population equalled exp (0.32) – 1 = 0.3771 - the coefficient is associated with a 37.71% increase in population.

Natural Factors

Similar to coastal location, in all periods longitude correlated with population positively, indicating that cities east of the sample's centre point tended to be larger, reflecting the eastern weighting of Australian settlement. Meanwhile, latitude was largely insignificant, with the exception of 1996 and 2006, when cities south of the sample's centre point tended to be larger. Other natural factors had inconsistent, less significant relationships. In 1911 and 1921 distance from rivers positively correlated with municipal populations, an unexpected result that, controlling for other factors, reflects the fact that some of Australia's earliest, large municipalities were mining centres in the interior. For example, in 1911 Broken Hill was New South Wales's fourth municipality and fourteenth nationally with a population over 30,000. Furthermore, there were many lowly populated municipalities proximate to rivers, rendering the variable not predictive of large populations. From 1933 remote mining settlements faded as capital city regions developed. Distance from a river did not explain population variation again until 2006 and 2016, when it negatively

Table 4. Log of Australian Municipal Populations Regressed on Location Specific Natural, Economic, and Political Factors. Source: Author's Calculations.

	1911	**1921**	**1933**	**1947**	**1954**	**1966**	**1976**	**1986**	**1996**	**2006**	**2016**
Coastal	0.09 (0.03)**	0.17 (0.03)***	0.18 (0.03)***	0.22 (0.03)***	0.26 (0.03)***	0.33 (0.03)***	0.34 (0.04)***	0.34 (0.04)***	0.33 (0.05)***	0.38 (0.05)***	0.32 (0.05)***
Distance from River	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)**	-0.00 (0.00)***
Max Temp	-0.01 (0.01)	0.00 (0.01)	0.01 (0.01)	0.01 (0.01)	0.02 (0.01)*	0.02 (0.01).	0.03 (0.01)***	0.04 (0.01)***	0.03 (0.01)*	0.02 (0.01).	0.02 (0.02)
Precipitation	-0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)*	0.00 (0.00)	0.00 (0.00).	0.00 (0.00).	0.00 (0.00)**	0.00 (0.00)*	0.00 (0.00)
Longitude	0.00 (0.00)*	0.01 (0.00)**	0.01 (0.00)***	0.01 (0.00)**	0.01 (0.00)**	0.00 (0.00)*	0.00 (0.00).	0.01 (0.00)**	0.01 (0.00)***	0.01 (0.00)***	0.01 (0.00)***
Latitude	0.00 (0.01)	-0.00 (0.01)	-0.00 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.02 (0.01)*	-0.02 (0.01).	0.01 (0.01)
Distance from Major Seaport	-0.00 (0.00)**	-0.00 (0.00)***	-0.00 (0.00)***	-0.00 (0.00)**	-0.00 (0.00)***	-0.00 (0.00).	-0.00 (0.00).	-0.00 (0.00)*	-0.00 (0.00)**	-0.00 (0.00)*	-0.00 (0.00)**
Distance from Major Airport	NA	NA	NA	NA	NA	-0.00 (0.00)**	-0.00 (0.00)***	-0.00 (0.00)***	-0.00 (0.00)*	-0.00 (0.00)	-0.00 (0.00)
Land Area	NA	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00).	NA	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)**	0.00 (0.00)***
Distance from State Capitol	-0.00 (0.00).	-0.00 (0.00).	-0.00 (0.00)*	-0.00 (0.00).	-0.00 (0.00)***	-0.00 (0.00)**	-0.00 (0.00)**	-0.00 (0.00)**	-0.00 (0.00)*	-0.00 (0.00)**	-0.00 (0.00)***
Capital City Status	0.89 (0.10)***	0.88 (0.11)***	0.95 (0.12)***	0.96 (0.13)***	0.87 (0.13)***	0.70 (0.15)***	0.50 (0.15)**	0.42 (0.16)**	-0.05 (0.17)	0.13 (0.17)	0.19 (0.17)
R-squared	0.28	0.32	0.31	0.31	0.37	0.38	0.38	0.39	0.39	0.42	0.48
Adjusted R-squared	0.26	0.30	0.30	0.30	0.36	0.37	0.37	0.38	0.38	0.41	0.47
N	501	546	598	581	597	623	626	619	507	467	402

Notes: Each column represents a separate regression. Standard errors are displayed in parentheses.
N = LGAs with populations greater than 2,500

Significant codes: 0 (***) 0.001 (**) 0.01 (*) 0.05 (.) 0.10

correlated with population. In 2016 a one kilometre increase in distance from a river was associated with a 0.13% decline in population.

Temperature positively correlated with population from 1954 to 2006, with a one degree Celsius increase in average annual maximum temperature associated with a 1.98% increase in population in 2006. Mirroring this relationship, rainfall correlated positively with population in five periods. Collectively, these trends indicate disproportionate population growth in warmer, wetter municipalities before 2016, aligning with a late twentieth century migration into tropical Queensland and Western Australia, sometimes referred to as Australia's sunbelt (O'Connor *et al.*, 2001).

Economic Factors

In all time periods, distance from a major seaport had a strong, negative impact on population. Specifically, a one kilometre increase in distance between a municipality and major port was concomitant with a 0.07% decrease in population. Similarly, distance from a major airport had a strong, negative relationship with population from 1966 to 2006, in 1996 associated with a 0.04% decrease in population (0.0004, $p<0.05$) for every one kilometre increase in distance from a major airport.

Political Factors

From 1911 to 1986 capital city status strongly, positively correlated with municipal populations. In 1947 capital city status peaked in significance and impact, associated with municipal populations 160% larger than non capital municipalities. Comparable orders of impact were apparent in all periods from 1911 to 1966 and remained large until 1976 when it sharply declined following the emergence of large capital proximate municipalities and microcapitals. As capital city status declined in importance, the distance between a municipality and its state capital grew in importance. In all periods distance to state capitol significantly, negatively correlated with population, signifying that large municipalities are usually proximate to their capitals. By 2016, a one kilometre decrease in distance from the state capitol was associated with a 0.07% increase in population, a sevenfold increase from the early 20th century. Finally, in 1966, and from 1986, geographic area positively correlated with population, albeit the magnitude was weak, with a $1km^2$ increase in size being associated with a

0.0004% population increase. Not surprisingly, the relationship between municipal area and population aligns with the timing of amalgamations.

5. DISCUSSION

At the time of Australia's first census in 1911, typical large municipalities were state capitals, inland mining settlements, or coastal, eastern locations near to their capitals or a major seaport. A century later, with the exception of Brisbane, the capitals and remote mining settlements disappeared from the top of the municipal hierarchy. Today, the largest municipalities are geographically large, capital proximate, coastal, eastern locations near major seaports or rivers. They are also relatively obscure. However, we see evidence in recent periods that this may be changing.

According to the 2016 census, three Australian cities (Gold Coast, Sunshine Coast, Qld; Central Coast, NSW) ranked among the top ten most populous cities for both urban and municipal definitions. The emergence of large-scale LGAs in capital proximate regions follows the 1980s when many Australians embarked upon sea-change, e-change, and more recent flee-change lifestyle migrations into regional Australia as a result of retirement, remote work, and COVID 19 (Burnley and Murphy, 2004). Counter urbanisation trends present all tiers of government with opportunities to meet the consumptive demands of lifestyle migration (Benson and O'Reilly, 2016), and it appears the municipalities of Gold Coast and Sunshine Coast have already seized upon them. Generally, capital proximate regions have boomed across Australia in recent decades.

Part of the (population) success of regional municipalities can be attributed to their large geographic catchment of population, whereas urban municipalities are usually fractions of large metropolitan areas. Another competitive advantage is the ease of engagement large, regional municipalities provide to states. Unlike most of Australia's large urban areas, which depend upon state-led metropolitan coordination across many LGAs, regional municipalities present states with a single point of contact, simplifying developmental coordination across a large area. This was the strategy adopted by Queensland when it amalgamated the Greater Brisbane region in the 1920s, creating a microcosm of strong localism, evinced by Brisbane's adoption of unusual administrative responsibilities including public transport. In summary, absent of further municipal restructures, the profile of some regional, capital proximate municipalities is rising.

Institutional Factors

The evolution and consistent involvement of political factors at the state level in all periods is noteworthy given institutions are less recognised sculptors of Australian settlement. The statistical results suggest state capital regions are significant magnets of population and that whatever powers Australian municipalities have to attract population they are secondary. For example, in 2016 seven of Australia's top ten most populous municipalities were part of capital city urban areas and the administrative seats of the remaining three were within seventy five kilometres of their respective state parliaments.

The importance of state capitals differentiates Australia from its institutional siblings, Canada and the USA, where the role of state/provincial capital cities is less pronounced (Kim and Law, 2012; 2016). As per Table 1, in Canada three of the top five most populous municipalities in 2016 were capitals. However, two (Montreal, Calgary) are not capitals nor capital proximate. The USA provides a stronger contrast, wherein 2019 the top five most populous municipalities included only one state capital, Phoenix, and no municipalities that could be described as capital proximate.

In institutional economics, the gravity of capital cities is indicative of political centralisation. As Kim and Law (2016, p. 134) explain,' In the decentralised scenario… locations are allowed to independently set taxes and local public goods [so] the geographic distribution of population between the capital city and hinterland will be determined by differences in economic productivity. In the politically centralised scenario… population distribution between capital city and hinterland depends on the relative weight the central government places on the welfare of capital city versus hinterland residents.' Put another way, strong local governments possess the autonomy to develop whilst weak localism renders development beholden to and bottlenecked in higher tiers. The statistical results suggest this logic is applicable in Australia, that its settlement pattern is influenced by the centralisation and weak localism that characterise Australian federalism (Grant and Drew, 2017). Granted, the results do not refute the importance of natural and economic factors, however, the presumption that these alone explain the gravity of state capitals was not supported.

Municipal Hierarchy 1911-2016

In 1911 Australia's municipal population ranking resembled its current urban centre ranking. By 2016 it was transformed. Whilst Australia's ranking of metropolitan regions has been mostly stable, its municipalities are volatile, fractured, and arguably nascent. One outcome of volatility is a tendency toward small populations and evenness. The latter characteristic is reminiscent of a study of Chinese cities by Au and Henderson (2006), where an even municipal hierarchy was associated with political interventions and federal ideology. Au and Henderson (2006) concluded China's urban hierarchy was artificially flat and suggested political interventions undermined productivity. Previously, Henderson (2003) had modelled 'optimal' city-size distributions, based upon a geography's size, wealth, and population and found deviations above or below the optimal undermined growth. Considering this logic in Australia, while an even municipal hierarchy may give the appearance of a 'fair go' and equity, arguably aligning with ideology, given the critical role municipalities play in development, it is worth considering the economic impact of holding local governments down.

Also noteworthy is the way in which many small evenly sized municipalities came to exist, via sweeping, forced restructures. These actions suggest states consider an even population distribution desirable perhaps for the purposes of expedient financial management, or as Sansom (2009, p. 18) pointedly suggests, 'to ensure the state's political and administrative dominance.' Supporting this hypothesis is the fact that regional municipalities are spatially configured to encapsulate larger regions (e.g. Greater Geelong, Greater Geraldton, Newcastle, Albany). That is, the centre-and-surrounds spatial model of local government is not foreign to states, they apply it everywhere *except* capitals. This reality speaks to a renowned cultural trait (egalitarianism) and suggests successive state governments have taken steps to curb the dominance of any one municipality.

Municipal Analyses in Australia

Given the peculiarities of Australian municipalities, three considerations should be emphasesed relative to the interpretation of results. First, municipal volatility directly impacted and steered the statistical results, as evinced by the declining significance of capital city status through time. That populations have been subject to numerous, significant political shifts

is part of the story, not grounds for discarding these data altogether. Each regression stands on its own as a point in time reflection of statistical relationships between populations and location-specific factors. Second, likening LGAs to municipalities or cities-proper, admittedly North American terms, whilst politically true, should be done with the explicit understanding that Australian municipalities cover a wider spectrum of forms, from micro-capitals to Germany-sized shires; this however does not negate their relevance as municipal units. Third, Australian municipalities exist at the state level and this might seem to disqualify an analysis of a national municipal hierarchy. However, national municipal analysis is commonplace in other countries and complementary to urban perspectives. To conclude that the challenges of municipal analysis in Australia render such efforts meaningless is dismissive and speaks volumes about weak localism in Australia.

Finally, whilst the model used in this study provided novel statistical insights about relationships between population and location specific factors, discussion of its weaknesses may support future research. Specifically, amongst the independent variables there was some multicollinearity, signifying a linear relationship between explanatory variables. For example, this was apparent between the 1954 and 1966 when the introduction of major airport data significantly reduced the explanatory power of the seaport variable, indicating that the two factors have a linear relationship to some degree. Every effort was made to minimise multicollinearity, such as a rigorous process of independent variable development and selection. Future studies might address this challenge by considering a different range of more broadly constructed variables and/or analyses designed for highly correlated variables, such as principal components analysis or partial least squares regression.

6. CONCLUSION

This paper presents time-series, quantitative analyses of population change in Australian municipalities from 1911 to 2016. Australia's municipal hierarchy has an interesting history, particularly the dismantling of capital city municipalities and the creation of microcapitals. Such deliberate actions spark conversation about, and perspective of, Australian federalism and its impact on economic geography. This history also brings into focus Brisbane and Queensland as relatively innovative institutional geographies, perhaps Australia's strongest version of local empowerment.

Numerous statistical relationships between population and location-specific features were identified, such as being coastal, eastern, near to seaports and rivers. Particularly important was the influence of state capitals on municipal populations, suggesting state-led drivers of settlement patterns, and less involvement of local governments in the cultivation of population growth. The results provide a quantitative link between weak localism and Australian settlement, an interpretation of the drivers of settlement, and implications relative to planning for growth (Australian Government, 2019). That is, the federal government has selected target growth centres while advancing a means of redressing primacy via upgraded regional transportation. However, the results of this study suggests effective decentralisation will need to address institutional factors, such as weak municipalities, and therefore require political reform; a consideration absent from current plans.

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