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Forecasting population changes and service requirements in the regions: a study of two regional councils in Queensland, Australia

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Forecasting population growth to meet the service needs of a growing population is a vexed issue. The task of providing essential services becomes even more difficult when future population growth forecasts are unavailable or unreliable. The aim of this paper is to identify the main methods used in population forecasting and thereby select an approach to demonstrate that such forecasting can be undertaken with certainly and transparency, barring exogenous events. We then use the population forecasts to plan for service needs that arise from changes in population in the future.

Interestingly, although there are techniques available to forecast such future population changes and much of this forecasting occurs, such work remains somewhat clouded in mystery. We strive to rectify this situation by applying an approach that is verifiable, transparent, and easy to comprehend. For this purpose we select two regional councils in Queensland, Australia. The experience derived from forecasting shows that forecasts for service needs of larger populations are more easily and accurately derived than for smaller populations. Hence, there is some evidence, at least from a service provision point of view, to justify the benefits of council/municipality amalgamation in recent times in Australia and elsewhere. The methodology used in this paper for population forecasting and the provision of service needs based on such forecasts will be of particular interest to policy decision-makers and planners.

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Abstract

Forecasting population growth to meet the service needs of a growing population is a vexed issue. The task of providing essential services becomes even more difficult when future population growth forecasts are unavailable or unreliable. The aim of this paper is to identify the main methods used in population forecasting and thereby select an approach to demonstrate that such forecasting can be undertaken with certainly and transparency, barring exogenous events. We then use the population forecasts to plan for service needs that arise from changes in population in the future.

Interestingly, although there are techniques available to forecast such future population changes and much of this forecasting occurs, such work remains somewhat clouded in mystery. We strive to rectify this situation by applying an approach that is verifiable, transparent, and easy to comprehend. For this purpose we select two regional councils in Queensland, Australia. The experience derived from forecasting shows that forecasts for service needs of larger populations are more easily and accurately derived than for smaller populations. Hence, there is some evidence, at least from a service provision point of view, to justify the benefits of council/municipality amalgamation in recent times in Australia and elsewhere. The methodology used in this paper for population forecasting and the provision of service needs based on such forecasts will be of particular interest to policy decision-makers and planners.

Keywords: Regional Population forecasting, service provision, Box-Jenkins model
JEL Classification: J11, O21, R10 J38

1. Introduction

One of the vexed issues facing policy decision-makers is uncertainty created by lack of credible population forecasts which are an integral part in planning for the provision of services. The task of providing essential services becomes even more difficult when future population growth forecasts are unavailable or unreliable. This is even more acute for the rural regions, be it Australia or elsewhere.

The goal of this paper is to identify the main methods used in population forecasting and select an approach to demonstrate that such forecasting can be undertaken with certainly and transparency, barring exogenous events. We then use the population forecasts to plan for service needs that arise from changes in population in the future. Interestingly, although there are techniques available to forecast such future population changes, as is discussed, government bodies or contractors that undertake such work do not reveal how such forecasts have been made. Hence, such work remains somewhat clouded in mystery. We strive to rectify this situation by applying an approach that is verifiable, transparent, and easy to comprehend. For this purpose we select two regional councils in Queensland, Australia, namely the Southern Downs and Western Downs Regional Councils. We use Queensland Treasury (http://www.oesr.qld.gov.au/) time series population data to forecast population changes for the next one and a half decades and then use such forecasts to predict service needs in the two regions. For this purpose, we use ABS data (http://abs.gov.au). Furthermore, because of the availability of time series population data for the sub regions, we also extend the forecasts to cover sub-regions within the two selected regional councils.

The literature on forecasting population growth reveals that there are two standard methods that can be used to forecast future population growth of a region or sub-regions (see, for example, Alho, 1990; Ahlburg, 1992). They are the cohort-component method and time series or structural equation method. The cohort-component method typically projects future numbers of annual births, deaths, and migration to form a new population vector which is then used to repeat the calculations for each forecast year. Many studies and government reports undertaking population forecasting use this approach. However, this procedure only provides a general bookkeeping framework of population changes (Pflaumer, 1992). One possible reason for the use of this approach is due to its simplicity and because this approach does not require the knowledge of more advanced econometric skills.

Although the cohort-component method has dominated population forecasting, researchers have also attempted to forecast population changes using time series models (see, for example, Ahlburg and Vaupel, 1990). Time series approaches have been used to obtain short to long term forecasts and are typically based on past observations of the variables to be predicted. In these models, the structure of past population status is taken into account in order to extrapolate the future course of a time series in population changes. According to Mahmoud (1984) and Pflaumer (1992) time series methods may perform more accurately - or at least as accurately - as other forecasting methods such as the cohort-component method (stochastic or non stochastic). Furthermore, they argue that quantitative methods are more accurate than qualitative methods. For this reason this study employs the time series approach to forecast future population changes in the above mentioned two regional councils and thereby provide a tool for predicting the required service needs.

The remainder of the study is set out as follows. Section 2 provides a brief introduction to the two study areas while Section 3 presents a theoretical model of the Box-Jenkins approach used to forecast future population growth in the two selected regions and sub-regions until the year 2025. This section also discusses the use of forecasted populations using this approach to predict future service requirements under different population scenarios. The final section summarises and concludes.

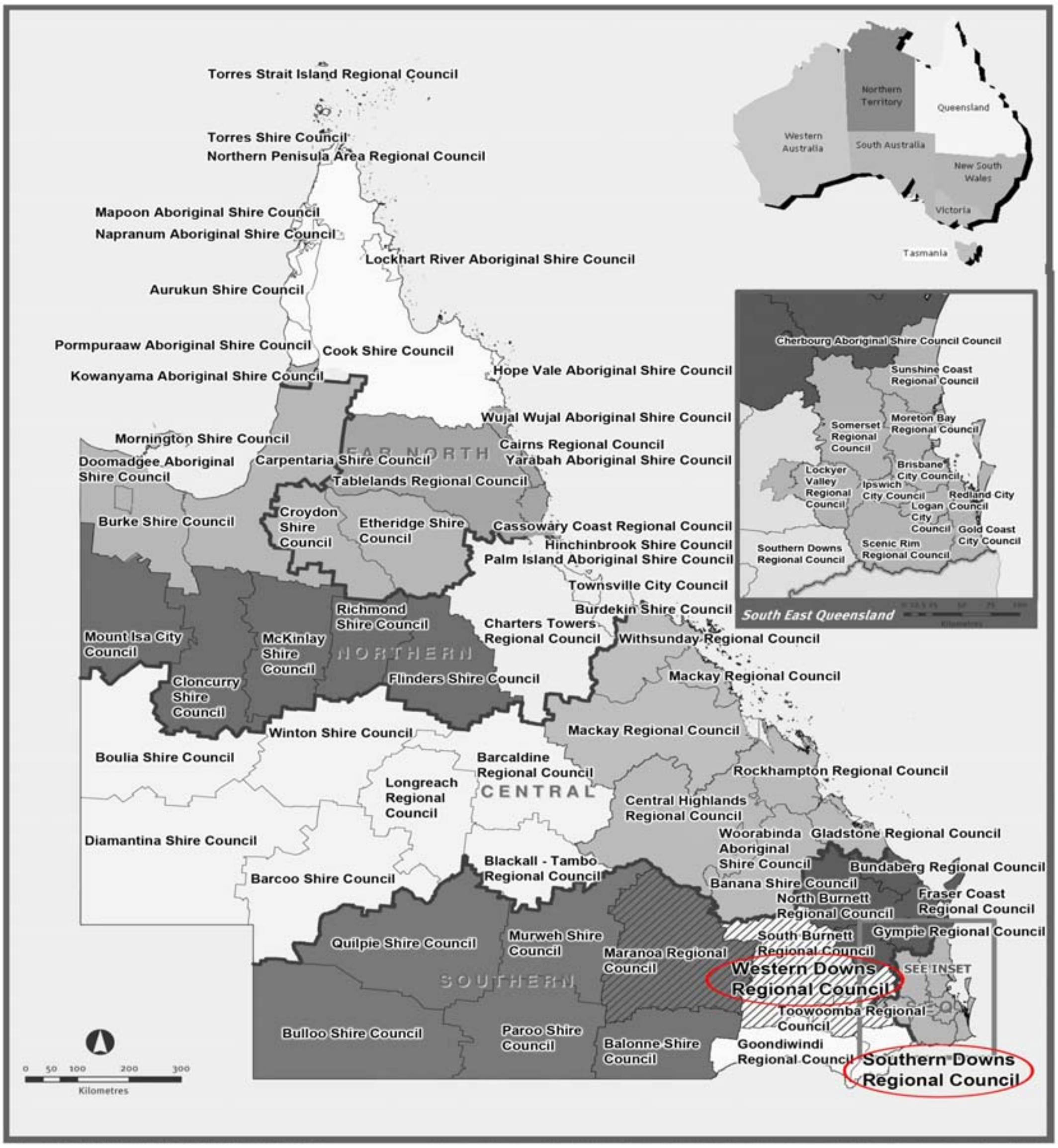
2. A brief introduction to the study areas

As mentioned in the introduction, Southern Downs and Western Downs Regional Councils were selected in this study to forecast future population growth using the Box-Jenkins time series approach (see, for example, Box and Jenkins, 1970; Alan, 1983). Once this approach has been perfected, it can be applied to any region or sub-regions where quality time series population data are available.

As shown in Figure 1, Southern Downs and Western Downs Regional Councils are located just outside South East Queensland. The councils are the product of the amalgamation in 2008 of a number of smaller councils. The Southern Downs Council now consists of the former Warwick Shire Council and Stanthorpe Shire Councils, while the Western Downs Regional Council consists of the Dalby, Chinchilla, Tara Shire, Wambo and Murilla Shire former Councils.

The economy of the Southern Downs Regional Council is predominantly based on agriculture, but is increasingly promoting itself as a tourist destination and business centre (see, for example, http://www.southerndowns.qld.gov.au/). While the economy of the Western Downs Regional Council also has a predominantly agricultural base, in the last two years the region has witnessed a rapid growth in the mining sector (see, for example, http://www.wdrc.qld.gov.au/web/guest/index.shtml). However, the spillover effects of the mining boom are likely to felt by the entire region, including the Southern Downs Regional Council.

Figure 1: Map showing Regional Councils in Queensland, Australia



Source: Adapted from Department of Infrastructure Planning, Qld, Australia (2010)

Economic growth in the two councils in the next few decades will undoubtedly lead to an increase in the population and it is therefore necessary to plan for service needs in the regions. In order to undertake such an attempt we use the Box-Jenkins time series approach to forecast future growth based on past population and thereby predict service needs for the increase in population in the next one and a half decades. As pointed out in the introduction, this approach is theoretically more accurate than alternatives such as the cohort component method. Once the future population forecasts are identified, it is then possible, if necessary, to adjust population growth due to recent exogenous events such as the mining boom in the region and thereby adjust for increased service needs. The existence of the former councils is also an advantage here since past population data collected for them can now be used to forecast growth in the sub-regions which mirror the former council boundaries.

3. Methodology

As mentioned above this study uses the time series approach, namely the Box-Jenkins model to forecast population changes in the two regional councils out to the year 2025. This method depends on the class of autoregressive (AR), integrated (I) and moving average (MA) models (see, for example, Greene, 2000). The AR(1) model uses only the first-order term, but in general, it is possible to use additional, higher-order AR terms. Each AR term corresponds to the use of a lagged value of the residual in the forecasting equation for the unconditional residual. An autoregressive model of order p, AR(p) has the form:

$$Y_t = \rho_1 Y_{t-1} + \rho_2 Y_{t-2} + \ldots\ldots\ldots + \rho_p Y_{t-p} + u_t \ldots\ldots\ldots \quad (1)$$

The second important factor in the forecasting process is the integration order term. Each integration order corresponds to differencing the series being forecast. A first-order integrated component means that the forecasting model is designed for the first difference of the original series. A second-order component corresponds to using second differences, and so on. The order of differencing is denoted as (d).

The third important factor in the forecasting process is the MA, or the moving average term. A moving average forecasting model uses lagged values of the forecast error to improve the current forecast. A first order moving average term uses the most recent forecast error, a second-order term uses the forecast error from the two most recent periods, and so on.

An MA (q) has the form:

$$Y_t = u_t + \partial_1 u_{t-1} + \partial_2 u_{t-2} + \ldots\ldots\ldots + \partial_q u_{t-q} \ldots\ldots\ldots \quad (2)$$

The autoregressive and moving average specifications can be combined to form an ARMA(p, q) specification:

$$Y_t = \rho_1 Y_{t-1} + \rho_2 Y_{t-2} + \ldots\ldots\ldots + \rho_p Y_{t-p} + u_t + \partial_1 u_{t-1} + \partial_2 u_{t-2} + \ldots\ldots\ldots + \partial_q u_{t-q} \ldots\ldots\ldots \quad (3)$$

Although econometricians typically use ARIMA models applied to the residuals from a regression model, the specification can also be applied directly to a series (Gujarati, 1995). This latter approach provides a univariate model, specifying the conditional mean of the series as a constant, and measuring the residuals as differences of the series from its mean.

There are four primary stages in building a Box-Jenkins time series model: identification, estimation, validation and forecasting (Pindyck and Rubinfeld, 1998). The first stage is the most difficult and delicate since there does not exist a deterministic approach in the identification process. Hence, the basic task of this step is to focus on a class of models which will then be fitted and controlled to obtain relevant information on p, d and q (Wooldridge, 2006). The parameter estimation step, which is fully automated, may be divided into two stages. The first consists of a preliminary estimation of the parameters by a linear system where the previously estimated autocorrelations are the fixed terms. These preliminary values then become the input of an 'ordinary least squares' procedure that computes the final identification.

The third step in building a Box-Jenkins time series model involves the validation process of the specific data series under examination. In this stage, a large number of statistical tests can be employed, each of them takes into account a specific feature of the model. The statistical procedure proposed by Box-Jenkins is based on the comparison of the function of the residual autocorrelations with the chi-squared distribution (Pindyck and Rubinfeld, 1998). If the diagnostic checking is not passed, the user will then have to return to the first step and start the building procedure again. This means that if the model is appropriate, the necessary forecasts are produced. If not, alternative models should be considered. The final step in the Box-Jenkins time series model involves making the forecast.

Once this is achieved, the next challenge involves estimating necessary service requirements of future populations based on forecasted population changes. It becomes apparent, significant additional infrastructure and resources are required to support forecasted population expansion, the associated business and employment growth, and improving liveability. These requirements include additional infrastructure and resources for sectors such as health (e.g. doctors, nurses and hospital beds), education (e.g. schools, teachers and childcare) and utilities (e.g. water, gas, electricity). Some of the major service needs identified in this study are listed in Table 1.

Table 1: Service categories and measures

Category	Measures
Health	General practitioners (number of GPs) Specialists doctors (number) Dentists (number) Nurses (number) Hospital beds: number of beds in the hospital (number) Health expenditure AUS $ (per person per year)
Education	Schools: number of schools and places Teachers: number of teachers Childcare places (number of the children – less than 5 years of age) Education expenditure AUS $ (per person per year)
Police	Number of police officers
Utilities	Electricity(KWh): Kilo Watt hours(KWh) per annum Gas requirement Gigajoules (GJ) per annum Water requirement litres per annum

Note: Only a few basic services are considered in this study since we are focusing only on two rural regions with relatively small populations. If the population is relatively large, additional services such as transport, communication, social infrastructure, recreation and waste management can be included.

The future requirements for these services clearly depend on projected population changes. It is a common practice to forecast the demand for these services on a per capita basis, which is then multiplied by a forecast of the relevant population to obtain an estimate of the total level of demand (see, for example, Noronha, 2009). For example, a forecast of the total demand for hospital beds can be obtained by multiplying a forecast of the number of beds required per 1,000 in the population of a certain age group by the forecast number in that age group. Based on this approach, we estimate baseline service requirements for the two regional councils. This is discussed in Section 4.

The time series data we use to predict population changes in the two regional councils is for the period 1946 to 2009. This data are obtained from Queensland Treasury (http://www.oesr.qld.gov.au/) while the data used to forecast service needs in the two regions are obtained using ABS data (http://abs.gov.au). In the next section we discuss the results of the population forecasting using the Box-Jenkins time series model and the forecasts of service needs in the two regions.

4. Results and discussion

The Box-Jenkins model discussed in Section 3 assumes the time series is stationary. Therefore, non-stationary data must be differentiated until stationarity is achieved. This study uses the autocorrelation function as well as the Augmented Dickey-Fuller (ADF) test for testing nonstationary of the time series data. The results of the ADF test are shown in Appendix A.1 and indicate that the population data in the Western Downs Regional Council are 1(1), while in the Southern Downs Regional Council it is I(2). Having addressed stationarity, the next step is to identify the order (the p and q) of the autoregressive and moving average terms. The primary tools used are the autocorrelation plot and the partial autocorrelation plot. These are compared to the theoretical behaviour of these plots when the order is known. The results are shown in Appendix A.2, A.3, A.4, A.5 and A.6.

We use the first difference of the Western Downs Regional Council data while the second differences are used for the Southern Downs Regional Council data. The examination of the correlograms of the various differentiated series shows the need to differentiate twice for the Southern Downs Regional Council data since the correlogram of the first differentiated series did not disappear fast enough. The behaviour of correlograms is consistent with an ARIMA (3,1,3) process for the population figures of Western Downs Regional Council, while it is consistent with an ARIMA (1,2,1] for the Southern Downs Regional Council. Having chosen an ARIMA model to fit to the data, the next step is to estimate the parameters from the data. Applying an ordinary least squares regression yields the fitted equations for both data sets. After estimating the parameters of the model, diagnostic checks are required. If the model is appropriate, the necessary forecasts are produced. If not, alternative models should be considered. We estimated different ARIMA models and compared the results. It was found that ARIMA (3,1,3) and ARIMA(1,2,1) models provide the best results for Western Downs and Southern Downs regional Council data[10]. Results of the estimated models are shown in Appendix A.7. Using these estimated models, we predict future population growth, through to the year2025 for both councils. The results of the population projection with the Box-Jenkins time series model are shown in Appendix B.1 and B.2. Population forecasts for years, 2015, 2020 and 2025 under different scenarios for the two regional councils are reported in Table 2. The results show that the population in both regional councils will continue to grow.

[10] When comparing different ARIMA models, the significance of the estimated coefficients namely the AIC and SBC, adjusted R^2 as well as Q-statistics of the correlograms were taken into account.

The current (2009) total population in both the councils is 66,925. By 2025, it is forecasted that their total population will increase to 77,921. A breakdown for the two regional councils is also shown in Table 2. Placing a confidence interval around this point forecast, it is assumed that the population will be in the range of 76,020 to 79,822 with a probability of 95% level of confidence.

Table 2: Population forecast for the two regional councils in selected years

Regional Council	2015	2020	2025
Southern Downs Regional Council			
Lower limit	37,965 (7.71)	40,316 (6.19)	42,489 (5.39)
Point forecast (Business as Usual)	38,794 (7.54)	41,145 (6.06)	43,318 (5.28)
Upper limit	39,623 (7.37)	41,974 (5.93)	44,147 (5.17)
Western Downs Regional Council			
Lower limit	31,621 (3.42)	32,577 (3.02)	33,531 (2.93)
Point forecast (Business as Usual)	32,693 (3.30)	33,649 (2.92)	34,603 (2.83)
Upper limit	33,765 (3.20)	34,721 (2.83)	35,675 (2.75)

Note: The forecasting is based on three population scenarios which is consistent with a 95% confidence interval. The annual population forecast between 2010 and 2025 are shown in Appendix B.1 and B.2. Expected population changes for each five year period are shown in parenthesis. The point forecast refers to the 'business as usual' scenario.

Table 2 shows three population growth scenarios for each of the five year periods on the basis of a 95% confidence interval. For example, the population growth is expected to be 7.54% for the Southern Downs Regional Council between 2010 and 2015 under a point forecast (base case). The population is expected to be approximately 20% larger than the current level by 2025. The total population in the Western Downs Regional Council will be 3.30%, 6.32% and 9.33% times larger than the current level by 2015, 2020 and 2025 respectively. It is clear that the population changes in the Southern Downs Regional Council are relatively larger than the Western Downs Regional Council.

After forecasting the total population in the two regional councils, the next step is to divide the total population among the sub-regions. This is achieved by using the average population share of each sub-region. For example, the Southern Downs Regional Council has two sub-regions, namely, Stanthorpe and Warwick which were separate councils before the amalgamation in 2008. The share of the population in Stanthorpe and Warwick are 0.414 and 0.586 respectively. Using this figure, we divided the forecasted population shown in Table 2 between these two sub-regions. The same approach was followed to divide the total population forecast for the Western Downs Regional Council into its sub-regions. Population estimates for 2015, 2020 and 2025 in the sub-regions based on 'base case' estimates are shown in Table 3. Annual population figures in each sub-region are shown in Appendix B.3 and B.4.

Table 3: Dividing the 'business as usual' population forecasts among the sub-regions

Regional Councils	2015	2020	2025
Southern Downs Regional Council			
1. Stanthorpe	16,062	17,035	17,935
2. Warwick	22,732	24,110	25,383
Total	38,794	41,145	43,318
Western Downs Regional Council			
1. Dalby	10,446	10,751	11,056
2. Chinchilla	7,110	7,318	7,526
3. Tara Shire	4,165	4,287	4,408
4. Wambo	7,225	7,436	7,647
5. Murilla Shire (P1)	3,747	3,857	3,966
Total	32,693	33,649	34,603

Note: Share of the population in Stanthorpe and Warwick are 0.414 and 0.586 respectively. The share of the population in Dalby, Chinchilla, Tara Shire, Wambo and Murilla Shires (P1) are 0.319, 0.217, 0.127, 0.221 and 0.115 respectively.

From the population forecast shown in Tables 2 and 3 by 2025, the population in these two regional councils is expected to expand by 43,318 and 34,603 persons for the Southern Downs and Western Downs Regional Councils under the 'business as usual' scenario. On average, regional population will increase by 16.43% by 2025 in these two regional councils. When alternative growth scenarios are considered, the population growth outcome for the two regional councils would be expected to be different from the 'point of forecast' scenario - in other words, the 'business as usual' scenario. For example, if we use the 'upper limit' forecast (see Table 2), the two regions secure a 19.2% growth in population from its current level by 2025. Under the 'lower limit' scenario the average population changes in these two regions are 13.58% by 2025 (see Table 2). This implies that the population change from 2009 will be in the range of 13.58% to 19.27% level, with a probability of 95% confidence level of forecasting by 2025.

The above section forecasted the population using the Box-Jenkins time series model. The next part of the study describes the forecast of service needs for maintaining the increased population in these two regions. We forecast the service needs under a per capita level, which is then multiplied by a forecast of the relevant population to obtain a forecast of the total level. This approach is similar to Noronha (2009). The baseline service information, service sectors covered in this study and data sources used to forecast service needs are shown in Table 4.

Table 4: Baseline service requirements

	Services	**Baseline situation**	**Year**	**Sources**
Health	General practitioners (GPs)	128.5 (100,000 people)	2006	ABS
	Specialist doctors	49.6 (100,000 people)	2006	ABS
	Dentists	28.5 (100,000 people)	2006	ABS
	Nurses	1133.4 (100,000 people)	2006	ABS
	Hospital beds	2.7 (100,000 people)	2006	ABS
	Health expenditure AUS $	4200 per person per year	2005	ABS
Education	School places	Students (19.6%)	2006	ABS
	Teachers*	Student/Teacher (16.1)	2005	ABS
	Childcare places*	5% of population	NA	NA
	Education expenditure AUS $	10,000 per student per year	2003	ABS
Police	Number of police officers	22.0 (10,000 people)	2005	ABS
Utilities	Electricity (kWh)	1121.2 per person per year	2005	WRI
	Gas (Gigajoules)	60 per person per year	2009	Noronha
	Water (KL)	183 per person per year	2004	ABS

Note:* The number of teachers required is calculated using the student-teacher ratios. ** It is assumed that a 5% change in population will be less than 5 years of age.

The 'baseline' service needs (based on 2006 data) shown in Table 4 are the existing average level of services provided in Australia. For example, according to ABS data (http://abs.gov.au), 128.5 general practitioners (GPs) are available for every 100,000 population in regional areas in Australia[11]. Furthermore, 49.6, 28.5 and 1,133.4 specialist doctors, dentists and nurses were available for every 100,000 population in 2006 in the regional areas in Australia[12]. Health expenditure in Australia includes expenditure incurred by the Australian Federal, State and Territory governments, by private health insurance and individuals. The average health expenditure in 2005 was $4,200 per person in Australia. This figure is used to estimate future health expenditures in the two regional councils.

Provision of education services is another sector we consider in this study. School places are calculated using general information about children in Australia. According to ABS data,

[11] This number is 207.1 in capital cities in Australia.
[12] They are 116.1, 55.4 and 1,091.9 in capital cities in Australia.

19.6% of the Australian population in 2006 were children. This general information is used to estimate the future possible number of children for the two regions. The student-teacher ratio in 2005 of 16:1 is used to estimate the future number of teacher requirements. In estimating future needs for public utilities additional requirements for electricity, gas and water are estimated using current consumption data per person per year.

To make service provision forecasts for the projected changes in population through to 2025, we start with the existing population (for this purpose the population in 2009 is used) and the baseline services required based on ABS (2006) data. This is shown in Table 5.

Table 5: Service requirements at the 'baseline' level (2006 data)

Service variable	Southern Downs Regional Council	Western Downs Regional Council
Population (2009)	35,456	31,469
General practitioners (GPs)	46	40
Specialist doctors	18	16
Dentists	10	9
Nurses	402	357
Hospital beds	96	85
Health expenditure AUS $ (000')	148,915	132,169
School places	6,949	6,168
Teachers	432	383
Childcare places*	1,773	1,573
Education expenditure AUS $(000')	354,560	314,690
Number of police officers	78	69
Electricity (kWh)	11,221	11,221
Gas (Gigajoules)	183	183
Water (KL)	60	60

Note: It is possible for there to be a difference between actual service availability and base level service requirements. This is because the service requirements at the 'base level' are estimated figures using average service availability in regional Australia.

As can be seen, Table 5 shows existing population figures for the Southern Downs and Western Downs Regional Councils in 2009. They are 35,456 and 31,469 respectively. Based on existing average service ratios in regional Australia, the number of GPs, specialist doctors, dentists, nurses and hospital beds required to provide necessary services for people who are living in Southern Downs Regional Council are 46, 18, 10, 402 and 96 respectively. The existing (2006) service needs of Western Downs Regional Council based on ‘baseline level’ requirements are also shown in Table 5.

The ‘base level’ service requirements were set out in Table 4 and this data were used to estimate current service needs in the two councils which was discussed in Table 5. Based on Table 4 ‘base level’ data it is possible to estimate service requirements for the projected population increases for years 2015, 2020 and 2025. Tables 6 and 7 provide the estimated additional service requirements under different population forecasting scenarios. These estimates were arrived at using population forecast figures discussed in Table 2 and baseline information reported in Table 4.

Table 6 shows the service requirements for Western Downs Regional Council under different population scenarios for years, 2015, 2020 and 2025. As can be seen in the table, in years, 2015, 2020 and 2025, the population of the Western Downs Regional Council will be 32,693, 33,649 and 34,603 under the ‘base level’ business as usual forecast. In order to maintain the additional population, the number of GPs required is 2, 3 and 4 respectively. Under ‘lower limit’ forecast, the population increase in the above mentioned years would be 31,621, 32,577 and 33,531. Under this scenario, the additional GP requirements are 1, 2 and 3. Furthermore, under the ‘upper limit’ forecast, the population would be 33,765, 34,721 and 35,675 and the GP requirements are 3, 5 and 6 by 2015, 2020 and 2025 respectively. Table 6 also shows the rest of the forecasted needs for years, 2015, 2020 and 2025.

Table 6: Service requirements for Western Downs Regional Council for years, 2015, 2020 and 2025

Services	2015			2020			2025		
	Lower	Business as usual	Upper	Lower	Business as usual	Upper	Lower	Business as usual	Upper
Health									
GP	1	2	3	2	3	5	3	4	6
Specialists	0	0	1	0	1	1	1	1	2
Dentists	0	0	1	0	1	1	1	1	1
Nurses	1	14	26	12	24	37	23	35	47
Beds	0	3	6	3	6	9	6	8	11
Expenditure ($000')	638	5,140	9,643	4,653	9,156	13,659	8,659	13,162	17,665
Education									
School places	30	240	450	217	427	637	404	614	824
Teachers	2	15	28	13	27	40	25	38	51
Childcare places	8	61	115	55	109	163	103	157	210
Expenditure ($000')	1,518	12,239	22,961	11,079	21,801	32,522	20,617	31,338	42,059
Police (number)	1	3	5	3	5	7	5	7	9
Utilities									
Electricity (kWh 000')	1,703	13,734	25,764	12,432	24,463	36,494	23,134	35,165	47,195
Gas (Gigajoules)	9	73	137	66	130	195	123	188	252
Water (KL 000')	27	223	420	207	398	595	377	573	769

Note: Only additional service requirements are reported in this table. Baseline service requirement ratios are used for this estimation.

It is evident from Table 6 that the demand for school services will increase quite rapidly. Under the 'Business as Usual' scenario, school places requirements will be 240, 427 and 614 in 2015, 2020 and 2025 respectively. As a result, additional teacher requirements would be 15, 27 and 38 in the respective years and the number of children who are expected to enter childcare centres would be 61, 109 and 157. These figures indicate the increase in demand for new childcare services in this region as population increases. At present, the average Australian government expenditure is approximately $10,000 per school age student per year. Using this rate under the 'business as usual' forecast scenario, the estimated additional future education expenditures in this regional council would be $12,239,622, 21,800,951 and 31,338,422 by 2015, 2020 and 2025 respectively. Estimated additional requirements of electricity, gas and water for the Western Downs Regional Council in years, 2015, 2020 and 2025 are also shown in Table 6.

The same approach used to forecast future service needs for Western Downs Regional Council is used to forecast service requirements for the Southern Downs Regional Council under different population scenarios. These forecasted additional service requirements are shown in Table 7. It is clear that the forecasted population changes in the Southern Downs Regional Council are relatively higher than the Western Downs Regional Council. As a result the estimated service requirements are also higher.

Table 7: Service requirements for the Southern Downs Regional Council for years, 2015, 2020 and 2025

Services	2015			2020			2025		
	Lower	Business as usual	Upper	Lower	Business as usual	Upper	Lower	Business as usual	Upper
Health									
GP	3	4	5	6	7	8	9	10	11
Specialists	1	1	2	2	2	3	3	3	4
Dentists	1	1	1	1	2	2	2	2	3
Nurses	28	38	47	55	64	74	80	89	98
Beds	7	9	11	13	15	17	19	21	23
Expenditure ($000')	10,537	14,019	17,501	20,412	23,894	27,377	33,022	181,937	36,504
Education									
School places	492	654	817	953	1115	1278	1379	1541	1704
Teachers	31	41	51	59	69	79	86	96	106
Childcare places	125	167	208	134	284	326	352	393	435
Expenditure ($000')	25,088	387,938	396,229	403,160	411,451	419,742	424,893	433,184	441,474
Police (number)	6	7	9	11	13	14	15	17	19
Utilities									
Electricity (kWh 000')	28,151	37,455	46,758	24,535	63,838	73,142	78,922	88,225	97,528
Gas (Gigajoules)	150	200	250	291	341	391	422	471	521
Water (KL 000')	459	610	762	889	1,041	1,192	1,287	1,438	1,590

Note: Only additional service requirements are reported in this table. Baseline service requirement ratios are used for this estimation.

Table 7 shows the additional service requirements for the Southern Downs Regional Council under different population scenarios in years, 2015, 2020 and 2025. For example, by 2015, 2020 and 2025 the population of the Southern Down regional council will be 38,794, 41,145 and 43,318 under the 'business as usual' forecast and the number of GPs required is 4, 7 and 10 respectively. Under this category, the number of nurses, as well as the number of hospital beds required is relatively significant. The number of nurses required is 38, 64 and 89 by 2015, 2020 and 2025 under business as usual' forecast in the respective years. By 2015, the number of hospital beds required is estimated to be between 7, 9 and 11 and would increase to 19, 21 and 23 by 2025.

In addition to the above service needs that arise due to increase in population growth, we also estimated the total resource requirements of these two regional councils under the 'business as usual' forecast scenario. This considers the existing population service needs plus the expected population growth needs for the two respective regions. The total estimated service requirements are shown in Table 8 for years, 2015, 2020 and 2025. This type of estimation is useful for policy makers in order to plan future service services requirements in any region or sub-regions.

Table 8: Total service requirements for both regional councils for years, 2015, 2020 and 2025

Service Variable	Southern Downs Regional Council			Western Downs Regional Council		
	2015	**2020**	**2025**	**2015**	**2020**	**2025**
Population	38,794	41,145	43,318	32,693	33,649	34,603
General practitioners	50	53	56	42	43	44
Specialists	19	20	21	16	17	17
Dentists	11	12	12	9	10	10
Nurses	440	466	491	371	381	392
Hospital beds	105	111	117	88	91	93
Health expenditure $(000')	162,934	172,809	181,937	137,310	141,326	145,331
School places	654	1,115	1,541	240	427	614
Teachers	41	69	96	15	27	38
Childcare places	167	284	393	61	109	157
Education expenditure $(000')	387,938	411,451	433,184	326,929	336,490	346,028
Number of police officers	85	91	95	72	74	76
Electricity (kWh 000')	37,455	63,838	88,225	13,734	24,463	35,165
Gas (Gigajoules 000')	610	1,041	1,438	223	398	573
Water (KL 000')	201	341	471	73	130	188

Note: This table show the total service requirement for two regional cities. It has been estimated using average service availability in Australia

According to Table 8 approximately 42, 43 and 44 general practitioners are required to provide necessary services for the population in Western Downs Regional Council in years, 2015, 2020 and 2025. This number would be 50, 53 and 56 for Southern Downs Regional Council in the respective years. The requirements of specialist doctors, dentists as well as nurses are also predicted for both regional councils as shown in Table 8. Approximately 88, 91 and 93 extra hospital beds will be needed by the population in the Western Downs Regional Council by 2015, 2020 and 2025 respectively. However, the total number of required hospital beds for the population living in the Southern Downs Regional Council would be in the range of 105, 111, and 117 by 2015, 2020 and 2025 respectively. The total number of required school places, teachers as well as childcare places is also shown in Table 8. When comparing with baseline (2009) resource requirements shown in Table 5, it is clear that a significant supply of additional resources is required to meet the respective service needs by 2015, 2020 and 2025. This applies for other services such as water, gas and electricity as well. The relevant service needs are shown in Table 8.

5. Conclusions

As discussed in the paper, population forecasting is a complicated issue and is an integral part of future service provision. However, notwithstanding the importance of this work done by policy decision-makers and planners, much of the methodology remains obscure and lacking in rigor.

The paper looked at the main approaches used in population forecasting and selected the Box-Jenkins time series approach to forecast population changes based on past population data. This approach we believe provides certainly and transparency, barring exogenous events. This approach is also more theoretically sound than the cohort-component method of population forecasting which typically projects future numbers of annual births, deaths, and migration to form a new population vector and which is then used to repeat the calculations for each forecast year. Of concern here is that this cohort-component methodology does not utilise more advanced and sound econometric skills.

Two regional councils in Queensland, Australia, namely the Southern Downs and Western Downs Regional Councils were selected to illustrate the efficacy of the Box-Jenkins methodology. The results verify that it is possible to make robust forecasts based on past time series population data. Moreover once the population forecasts have been made it is then possible to adjust for exogenous shocks if the relevant data are available. The population forecasts derived from the Box-Jenkins approach was used to forecast for service needs for the years, 2015, 2020 and 2025. Primary baseline service data were used to forecast service needs for years, 2015, 2020 and 2025 following an approach similar to Noronha (2009). The service forecasts were based on 'business as usual', 'upper limits' and 'lower limits' scenarios. The forecasts were made for the two regional councils and sub-regions which, prior to 2008, were separate councils.

From the forecasting exercise in the paper it is shown that forecasts for service needs of larger populations are more easily and more accurately derived than for smaller populations. This finding adds justification to the recent trends in council/municipality amalgamation in

Australia and elsewhere. We suggest that this paper's use of the Box-Jenkins methodology to forecast future population changes and service provision will be of particular interest to policy decision makers and planners.

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References

Ahlburg, D. A. (1992). Population forecasting: Guest Editors' introduction. *International Journal of Forecasting*. 8: 289-299.

Ahlburg. D. A., and J. W. Vaupel (1990). Alternative projections of the US population, *Demography*. 27:639-652.

Alho, I. M. (1990). Stochastic methods in population forecasting. *International journal of Forecasting.* 6: 521-530.

Alan, P. (1983). Forecasting with Univariate Box–Jenkins Models: Concepts and Cases, New York: John Wiley & Sons.

Australian Bureau of Statistics. *Selected Health Occupation: Australia*. Brisbane: Australian Bureau of Statistics, 2006. Web. 17 June 2008. <http://www.abs.gov.au/>.

Australian Bureau of Statistics. *Year Book Australia*. Brisbane: Australian Bureau of Statistics, 2005. Web. 7 Feb. 2008. <http://www.abs.gov.au/>.

Australian Bureau of Statistics. *Water consumption per capita.* Brisbane: Australian Bureau of Statistics, 2004. Web. 22 Nov. 2010. <http://www.abs.gov.au/>.

Australian Bureau of Statistics. *Australian Social Trends*. Brisbane: Australian Bureau of Statistics, 2003. Web. 20 July 2006. <http://www.abs.gov.au/>.

Box, G., and G. Jenkins (1970). Time series analysis: Forecasting and control, San Francisco: Holden-Day.

Department of Infrastructure Planning (2010), Regional Planning Projects in Queensland – May 2010, Queensland Government, Web 28 November 2010. http://www.dip.qld.gov.au/resources/map/map-regional-planning-projects.pdf.

Greene, W. H. (2000). Econometric Analysis, 4th edition, New York: Macmillan Publishers.

Gujarati, D. (1995). Basic Econometrics, New York: McGraw Hill, Inc.

MacKinnon, J.G. (1996). Numerical distribution functions for unit root and cointegration tests. *Journal of Applied Econometrics*. 11: 601-618.

Mahmoud, E. (1984). Accuracy in forecasting: A survey. *Journal of Forecasting*. 3: 139-1.59.

Noronha, J. (2009). Implications of Population Growth on Infrastructure and Resources in Regional cities, Final Report: Essential Economics Pty Ltd.

Pindyck, R. S., and D. L. Rubinfeld (1998). Econometric model and econometric forecasts, McGraw-Hill.

Pflaumer, P. (1992). Forecasting US population totals with the Box-Jenkins approach. *International Journal of Forecasting*. 8: 329-338.

Queensland Treasury. *Historical Tables, Demography, 1823 to 2008*. Office of Economic and Statistical Research: Queensland Treasury, 2010. Web. 1 March 2010. <http://www.oesr.qld.gov.au/>.

Southern Downs Regional Council. *Regional Profile 2010*. Queensland: Southern Downs Regional Council 2010. Web. 01 Dec. 2010. <http://www.southerndowns.qld.gov.au/>

Western Downs Regional Council . *Regional Profile 2010*. Queensland: Western Downs Regional Council 2010. Web. 01 Dec. 2010. <http://www.wdrc.qld.gov.au/web/guest/index.shtml>

WRI. (2005). Electricity Consumption Per Capita, Energy and Resources: World Resource Institution.

Appendix A.1: The result of ADF tests

Region	ADF test statistic for level data	ADF test statistic for first differenced data	ADF test statistic for second differenced data
Western Downs Regional Council	-2.270(0.185)	-6.469(0.000)	-
Southern Down Regional Council	-0.116(0.942)	-2.112(0.241)	-14.133(0.000)

Note: Critical values under 1 %, 5% and 10% level of significance are -3.538, -2.908 and -2.591 respectively. MacKinnon (1996) one-sided p-values are provided in the brackets.

Appendix A.2: Autocorrelation function (level) for Western Downs Regional Council data (1946-2009)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |******|	. |******|	1	0.871	0.871	50.923	0.000
. |***** |	.*| . |	2	0.734	-0.104	87.665	0.000
. |**** |	. | . |	3	0.612	-0.017	113.58	0.000
. |*** |	.*| . |	4	0.479	-0.124	129.72	0.000
. |*** |	. | . |	5	0.358	-0.030	138.92	0.000
. |** |	. | . |	6	0.256	-0.021	143.69	0.000
. |*. |	. | . |	7	0.161	-0.050	145.61	0.000
. |*. |	. | . |	8	0.101	0.065	146.37	0.000
. | . |	. | . |	9	0.044	-0.065	146.52	0.000
. | . |	. | . |	10	-0.006	-0.019	146.52	0.000
. | . |	. | . |	11	-0.041	-0.013	146.66	0.000
.*| . |	. | . |	12	-0.068	-0.010	147.03	0.000

Appendix A.3: Autocorrelation function (first difference) for Western Downs Regional Council data (1946-2009)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*. |	. |*. |	1	0.175	0.175	2.0232	0.155
. |** |	. |*. |	2	0.217	0.192	5.1907	0.075
. |*. |	. | . |	3	0.099	0.037	5.8622	0.119
. | . |	. | . |	4	0.064	0.003	6.1423	0.189
. | . |	.*| . |	5	-0.029	-0.069	6.2007	0.287
. | . |	. | . |	6	0.061	0.061	6.4645	0.373
. |*. |	. |*. |	7	0.084	0.091	6.9765	0.431
. | . |	. | . |	8	0.055	0.019	7.2058	0.515
. | . |	. | . |	9	0.061	0.015	7.4863	0.587
.*| . |	.*| . |	10	-0.109	-0.166	8.4087	0.589
. | . |	. | . |	11	0.001	0.021	8.4088	0.676
.*| . |	. | . |	12	-0.090	-0.041	9.0531	0.698

Appendix A.4: Autocorrelation function (level) for Southern Downs Regional Council data (1946-2009)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*******	. |*******	1	0.956	0.956	61.333	0.000
. |*******	. | . |	2	0.911	-0.039	117.93	0.000
. |******|	. | . |	3	0.865	-0.040	169.73	0.000
. |******|	. | . |	4	0.817	-0.045	216.69	0.000
. |******|	. | . |	5	0.768	-0.028	258.95	0.000
. |***** |	. | . |	6	0.721	-0.015	296.80	0.000
. |***** |	. | . |	7	0.673	-0.036	330.34	0.000
. |***** |	. | . |	8	0.627	-0.005	359.96	0.000
. |**** |	. | . |	9	0.581	-0.024	385.87	0.000
. |**** |	. | . |	10	0.536	-0.023	408.33	0.000
. |**** |	. | . |	11	0.491	-0.023	427.56	0.000
. |*** |	. | . |	12	0.447	-0.024	443.81	0.000
. |*** |	. | . |	13	0.403	-0.034	457.27	0.000
. |*** |	. | . |	14	0.359	-0.035	468.14	0.000
. |** |	. | . |	15	0.314	-0.034	476.64	0.000
. |** |	. | . |	16	0.267	-0.062	482.92	0.000
. |** |	. | . |	17	0.221	-0.029	487.30	0.000
. |*. |	. | . |	18	0.175	-0.028	490.11	0.000
. |*. |	. | . |	19	0.130	-0.028	491.70	0.000
. |*. |	. | . |	20	0.087	-0.024	492.43	0.000
. | . |	. | . |	21	0.044	-0.033	492.62	0.000
. | . |	. | . |	22	0.003	-0.015	492.62	0.000

Appendix A.5: Autocorrelation function (first difference) for Southern Downs Regional Council data (1946-2009)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |**** |	. |**** |	1	0.601	0.601	23.829	0.000
. |**** |	. |*** |	2	0.617	0.401	49.397	0.000
. |*** |	.*| . |	3	0.420	-0.080	61.435	0.000
. |*** |	. | . |	4	0.356	-0.049	70.212	0.000
. |** |	.*| . |	5	0.215	-0.086	73.466	0.000
. |*. |	. | . |	6	0.172	0.003	75.586	0.000
. |*. |	. |*. |	7	0.168	0.139	77.654	0.000
. | . |	**| . |	8	-0.027	-0.291	77.709	0.000
. | . |	.*| . |	9	-0.035	-0.092	77.803	0.000
.*| . |	. | . |	10	-0.115	0.045	78.823	0.000
.*| . |	.*| . |	11	-0.159	-0.069	80.818	0.000
**| . |	.*| . |	12	-0.237	-0.095	85.314	0.000
**| . |	.*| . |	13	-0.242	-0.068	90.124	0.000
**| . |	.*| . |	14	-0.300	-0.111	97.631	0.000
***| . |	. | . |	15	-0.350	-0.047	108.09	0.000
***| . |	. | . |	16	-0.351	-0.054	118.79	0.000
**| . |	. |*. |	17	-0.260	0.148	124.82	0.000
***| . |	**| . |	18	-0.382	-0.265	138.12	0.000
**| . |	. |*. |	19	-0.229	0.109	143.02	0.000
**| . |	. | . |	20	-0.275	-0.021	150.22	0.000
.*| . |	. |*. |	21	-0.105	0.178	151.30	0.000
.*| . |	. |*. |	22	-0.071	0.154	151.81	0.000

Appendix A.6: Autocorrelation function (second difference) for Southern Downs Regional Council (1946-2009)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
****| . |	****| . |	1	-0.544	-0.544	19.236	0.000
. |** |	. | . |	2	0.300	0.006	25.196	0.000
.*| . |	. | . |	3	-0.173	-0.011	27.219	0.000
. |*. |	. | . |	4	0.125	0.036	28.292	0.000
.*| . |	. | . |	5	-0.131	-0.065	29.481	0.000
. | . |	.*| . |	6	-0.020	-0.178	29.509	0.000
. |*. |	. |*. |	7	0.201	0.207	32.424	0.000
**| . |	. | . |	8	-0.234	-0.038	36.439	0.000
. |*. |	.*| . |	9	0.090	-0.157	37.049	0.000
. | . |	. | . |	10	-0.038	-0.011	37.158	0.000
. | . |	. | . |	11	0.033	-0.001	37.242	0.000
.*| . |	. | . |	12	-0.087	-0.044	37.846	0.000
. |*. |	. | . |	13	0.084	0.011	38.416	0.000
. | . |	. | . |	14	-0.038	-0.062	38.535	0.000
. | . |	.*| . |	15	-0.061	-0.078	38.846	0.001
.*| . |	**| . |	16	-0.119	-0.268	40.058	0.001
. |** |	. |*. |	17	0.270	0.165	46.494	0.000
***| . |	.*| . |	18	-0.369	-0.203	58.768	0.000
. |** |	.*| . |	19	0.252	-0.105	64.637	0.000
**| . |	**| . |	20	-0.292	-0.291	72.707	0.000
. |*. |	**| . |	21	0.186	-0.211	76.070	0.000
.*| . |	.*| . |	22	-0.195	-0.103	79.850	0.000
. |*. |	. | . |	23	0.174	-0.048	82.917	0.000
. | . |	.*| . |	24	0.007	-0.090	82.923	0.000
. | . |	. |** |	25	0.069	0.228	83.431	0.000
. | . |	.*| . |	26	-0.023	-0.068	83.488	0.000
. | . |	. | . |	27	-0.002	-0.019	83.489	0.000
. | . |	.*| . |	28	0.020	-0.087	83.536	0.000

Appendix A.7: Results of the ARIMA models

Regions	Variable	Coefficient
ARIMA(3,1,3) model for Western Downs data	AR(3) MA(3)	0.712 (0.080) -0.897(0.032)
ARIMA(1,2,1) model for Southern Down data	AR(1) MA(1)	0.946(0.056) -0.433(0.138)

Note: Standard errors are shown in parenthesis. The number of observations is 60 and 62 for Western Downs and Southern Downs Regional Councils after adjustments.

Appendix B.1: Results of the ARIMA (3,1,3) model with 95% confidence intervals (Western Downs Regional Council data)

Year	Lower limit of a 95% C.I	Point forecast	Upper limit of a 95% C.I
2010	30,575	31,647	32,719
2011	31,065	32,137	33,209
2012	31,233	32,305	33,377
2013	31,420	32,492	33,564
2014	31,428	32,500	33,572
2015	31,621	32,693	33,765
2016	31,803	32,875	33,947
2017	32,088	33,160	34,232
2018	32,266	33,339	34,411
2019	32,451	33,523	34,596
2020	32,577	33,649	34,721
2021	32,764	33,836	34,908
2022	32,947	34,019	35,091
2023	33,164	34,237	35,309
2024	33,347	34,419	35,491
2025	33,531	34,603	35,675

Note: Table provides the population forecast under three scenarios for Western Downs Regional Council.

Appendix B.2: Results of the ARIMA (1,2,1) model with 95% confidence intervals (Southern Downs Regional Council data)

Year	Lower limit of a 95% C.I	Point forecast	Upper limit of a 95% C.I
2010	35,245	36,074	36,903
2011	35,833	36,662	37,491
2012	36,396	37,225	38,054
2013	36,937	37,766	38,595
2014	37,459	38,288	39,117
2015	37,965	38,794	39,623
2016	38,456	39,285	40,115
2017	38,936	39,765	40,594
2018	39,405	40,234	41,063
2019	39,864	40,693	41,522
2020	40,316	41,145	41,974
2021	40,761	41,590	42,419
2022	41,200	42,029	42,858
2023	41,634	42,463	43,292
2024	42,064	42,893	43,722
2025	42,489	43,318	44,147

Note: Table provides the population forecasts under three scenarios for Southern Downs Regional Council.

Appendix B.3: Dividing total population forecast between Stanthorpe and Warwick sub-regions

Year	Stanthorpe	Warwick	Total population in SDRC
2010	14,936	21,138	36,074
2011	15,179	21,483	36,662
2012	15,412	21,813	37,225
2013	15,636	22,130	37,766
2014	15,852	22,436	38,288
2015	16,062	22,732	38,794
2016	16,265	23,020	39,285
2017	16,464	23,301	39,765
2018	16,658	23,576	40,234
2019	16,848	23,845	40,693
2020	17,035	24,110	41,145
2021	17,220	24,371	41,590
2022	17,401	24,628	42,029
2023	17,581	24,882	42,463
2024	17,759	25,134	42,893
2025	17,935	25,383	43,318

Note: Share of the average population forecast between Stanthorpe and Warwick are 0.414 and 0.586.

Appendix B.4: Dividing total population forecast between sub-regions in the Western Downs Regional Council

Year	Dalby	Chinchilla	Tara Shire	Wambo	Murilla Shire(P1)	Total in Western Downs
2010	10,112	6,883	4,032	6,994	3,626	31,647
2011	10,268	6,990	4,094	7,102	3,683	32,137
2012	10,322	7,026	4,115	7,139	3,703	32,305
2013	10,382	7,067	4,139	7,180	3,724	32,492
2014	10,384	7,068	4,140	7,183	3,725	32,500
2015	10,446	7,110	4,165	7,225	3,747	32,693
2016	10,504	7,150	4,188	7,265	3,768	32,875
2017	10,595	7,212	4,224	7,328	3,801	33,160
2018	10,652	7,251	4,247	7,368	3,821	33,339
2019	10,711	7,291	4,271	7,408	3,842	33,523
2020	10,751	7,318	4,287	7,436	3,857	33,649
2021	10,811	7,359	4,311	7,477	3,878	33,836
2022	10,870	7,399	4,334	7,518	3,899	34,019
2023	10,939	7,446	4,362	7,566	3,924	34,237
2024	10,997	7,486	4,385	7,606	3,945	34,419
2025	11,056	7,526	4,408	7,647	3,966	34,603

Note: The share of the average population in Dalby, Chinchilla, Tara Shire, Wambo and Murilla Shire are 0.319, 0.217, 0.127, 0.221 and 0.115 respectively.