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Preface

The 38th Annual Conference of the Australian and New Zealand Regional Science Association International (ANZRSAI) was held in Christchurch, New Zealand from 1st to 4th of December, 2014. A broad range of papers from academics, policy advisors and practitioners was presented to the conference. This publication contains the refereed proceedings of those contributed papers.

Participants who submitted their full paper by the due date were eligible to be considered for these refereed proceedings. There were seven papers submitted to a double blind refereeing process, all of which were accepted for presentation in this publication. As in previous conferences, I am very grateful to referees for their work within a short timeframe.

Three awards were presented at the conference dinner. The John Dickinson Memorial Award for best article in the *Australasian Journal of Regional Science* 2014 was awarded to Bernice Kotey (University of New England) for her article "Small Business Innovation in the Hostile Environment of Australia's Drought-Stricken Rural Communities" published in volume 20(2), pp. 325-350.

The ANZRSAI Award for Best Conference Paper 2014 was awarded to Delwar Akbar, John Rolfe, Garrick Small and Rahat Hossain for their paper "Flood in Blood: Assessing Housing Market Vulnerability within the Fitzroy Basin Region, Australia". This paper is the first paper presented in these proceedings.

The ANZRSAI Award for Best Conference Paper by a Current or Recent Student 2014 was awarded to Ashkan Masouman for his paper "Application of a Dynamic Inter-Sectoral Framework to Estimate Regional Employment". The committee highly commended one other entrant for this Award: Greg Jones and Graham Bowrey for their paper "Local Government Internal Audit Compliance". Both of these papers are also presented in these proceedings.

I thank all the participants for their involvement in our 38th Annual Conference, particularly those who had travelled some distance from overseas to attend. The international community of regional science scholars is strengthened when people gather to share their research and expertise at conferences such as this.

Professor Paul Dalziel
Editor, 38th Annual ANZRSAI Conference Proceedings

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Flood in Blood: Assessing Housing Market Vulnerability within the Fitzroy Basin Region, Australia

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ABSTRACT

Regional communities in Queensland, Australia are the life-blood of the state; contributing more than 80% of exports goods and services, as well as about 16 billion dollars each year to the state's economy. Weather-related disasters such as floods have become more frequent over the last fifty years in those communities. Between December 2010 and January 2011, three-quarters of the state was declared as disaster zone as a result of flooding. At least seventy towns and over 200,000 people were affected by these floods. The Fitzroy Basin is the largest coastal catchment in Queensland and the second largest catchment in Australia; and the most towns in this basin have been affected by this flood. This study examined the vulnerability of the housing market through a case study of Rockhampton region within this basin by using longitudinal data of total house sales, new house and land package sales, land sales before and after the 2011 flood and also tested the results with a key regional economic factor (mining development) whether the flood impact has been relieved by this factor. This study found that the flood has affected the total house sales compared to new house and land sales and land only sales; and also flood impact has relatively relieved by mining impact.

1. INTRODUCTION

The main driver behind the growth of Australian regional towns, especially of those in Queensland is the continuous development of resources such as coal and natural gas. Regional communities in Queensland are the life-blood of the state; contributing more than 80% of exports goods and services, as well as about 16 billion dollars each year to the state's economy (Queensland Government, 2008). However many regional towns and local governments areas in Queensland have been flooded in 2011 and at least seventy towns and over 200,000 people were affected by this flood (Australian Government, 2014). Rockhampton is one of the regional towns in Queensland, which was severely affected by flood in 2011 as it was disconnected from the state's administrative and commercial capital (Brisbane) by road, air and rail for more than one week. Several studies have conducted to identify the flood impacts on housing market in Australia (Eves and Wilkinson, 2014; Small *et al*, 2013) and they found little and short term impact on housing but similar studies elsewhere (Bin and Polasky, 2004; Chou and Shih, 2001) showed that there were significant impacts of flood and inundation events on the housing market; however all of them have failed to identify what segment of the property market was mostly affected. This study focuses on identifying market vulnerability by comparing segments of housing market i.e., overall house sales (old and new houses), new house and land package sales and only land

sales before and after the flood. This study also made efforts to test whether flood impacts had been relieved by the mining impacts in this region.

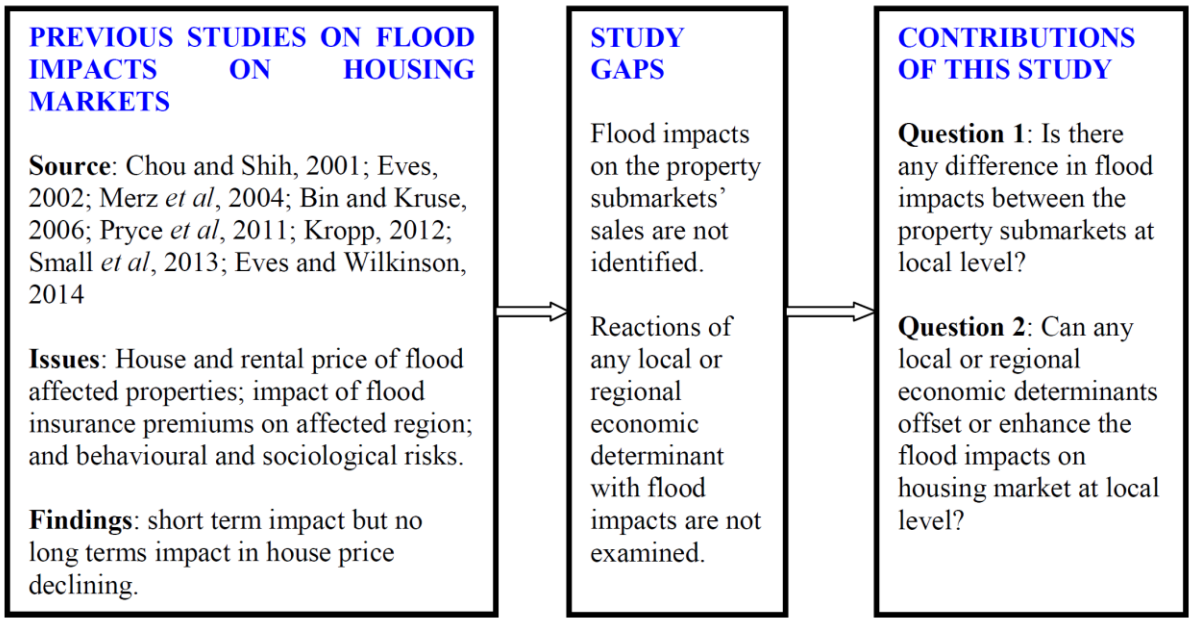
The paper has been organised as follows: Section 2 provides contextual background of study; Section 3 gives a brief background of the study area; Section 4 describes data and methods; and Section 5 provides results of the study. The paper concludes in section 6 with discussions and conclusions.

2. CONTEXTUAL BACKGROUND: FLOOD IMPACTS ON HOUSING

Floods have always had some level of impact on housing markets depending on their severity in inundation level (Worthington 2008; Troy and Romm, 2004). A number of studies have been conducted in the USA, Germany, Taiwan and Australia to find out the effect of flooding on local housing market (Eves and Wilkinson, 2014; Small *et al*, 2013; Kropp, 2012; Bin *et al*, 2006; Bin and Polasky, 2004; Merz *et al*, 2004; Eves 2002; Chou and Shih, 2001) and most of these studies have found that a flood event can decrease the value of inundated property or the inundated part of the town, but not the overall property market at a local or regional level. Also none of them has estimated how long the flood can continue its effects on the local housing market.

Flood affects can be offset by any other local or regional affect such as resource developments, regional population growth, employment level and development of social facilities (Kropp, 2012) but no one has tested all or one of these impacts with the flood impacts. Also within the housing market, there are three types of submarkets (except rental market) such as only house sales (old and new separate houses, flats and units), new house and land packages sales and new land sales and it is yet to be known what submarket are highly affected by flood or any other natural disaster.

Figure 1: Study Context and Contributions



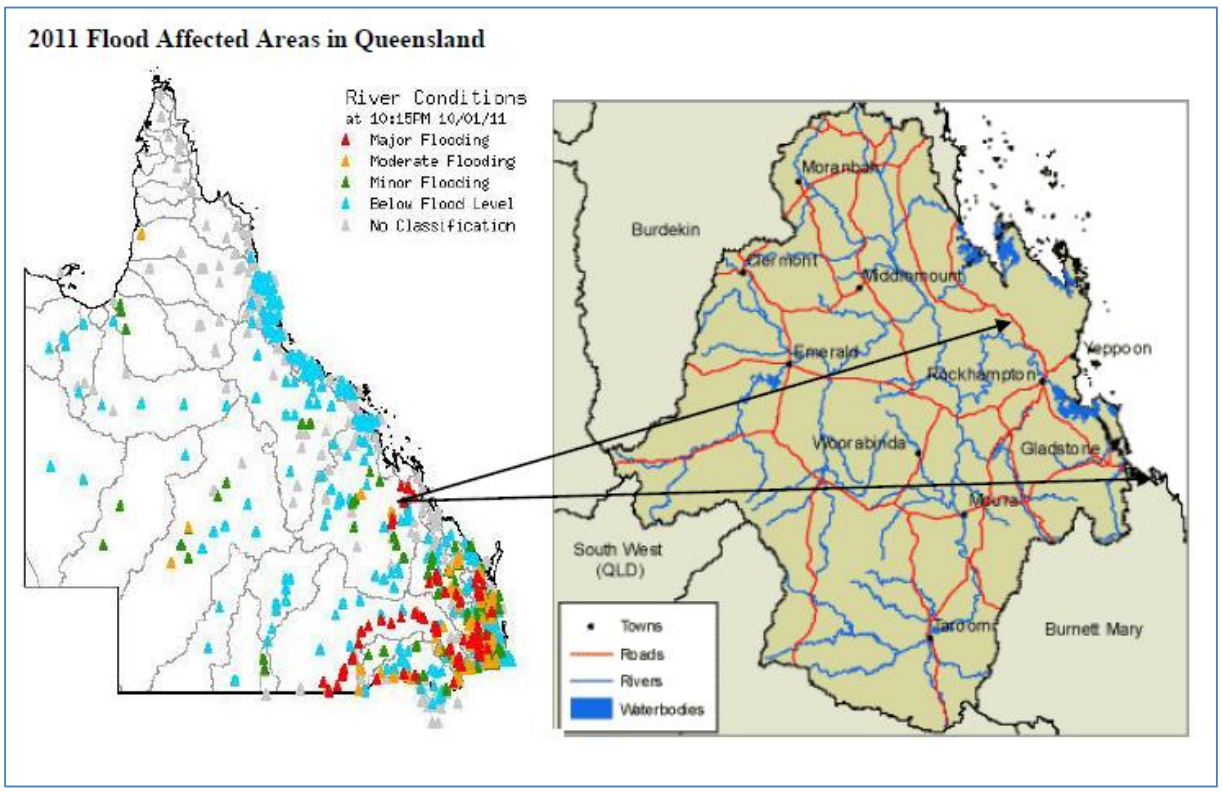
Therefore this study tests first whether there are there any differences in flood impacts between the housing submarkets at local level and second whether any local or regional economic determinants can offset the flood impacts on housing market at local level. Testing these hypotheses is very important in predicting future housing market as well as providing

empirical evidence to policy makers to decide what measures should be undertaken in the aftermath of flooding. This type of research is becoming essential for the community and property investors because major floods previously occurred about every fifty years but now appear to be happening at 10 to 25 year intervals (Kropp, 2012; Small *et al*, 2013).

3. STUDY AREA

This study has chosen Rockhampton Regional Council within the Fitzroy basin in Queensland (Figure 2). The Fitzroy is the largest river basin in Queensland containing the Rockhampton region which was severely affected by flood in 2011 (Figure 2).

Figure 2: Study Area – Rockhampton Region in Queensland

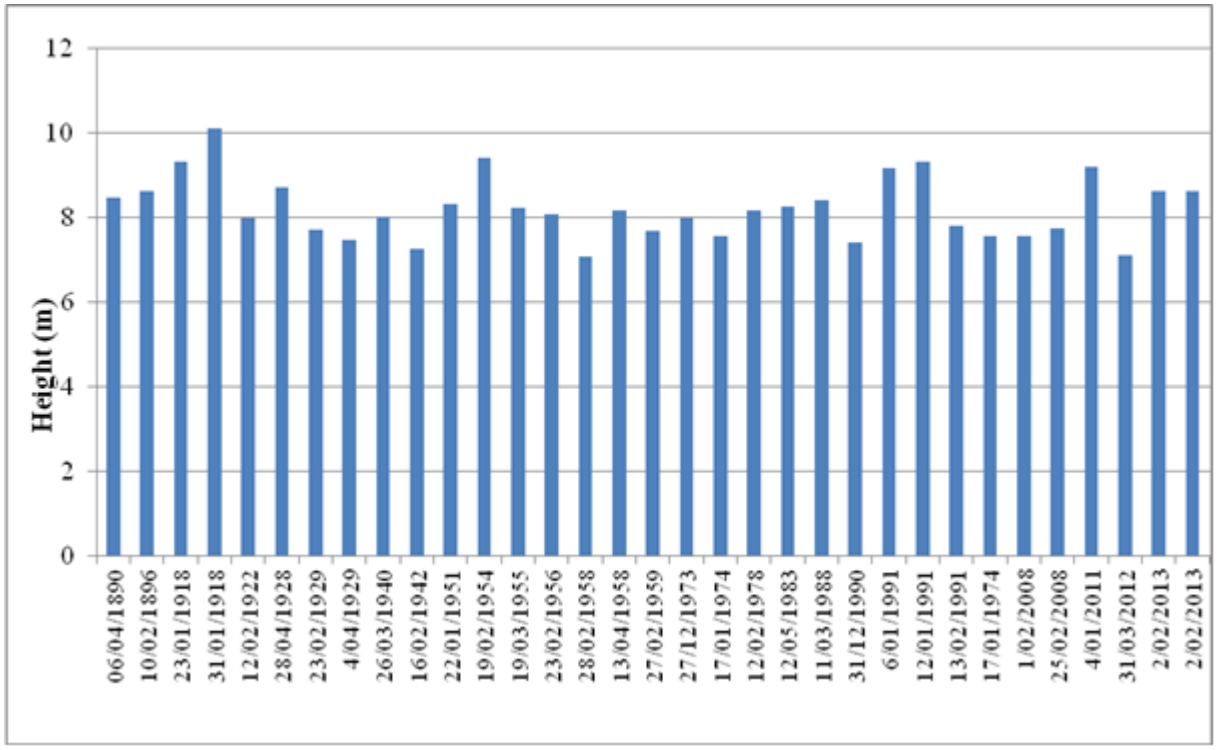


Source: Google Images, 2014.

Figure 3 indicates major and minor flooding in Rockhampton including five inundations since 1890. Small et al (2013) examined resident opinions in comparison to market realities of the impact of flooding on property value. They found that over 50% of respondents believed the flood event had a negative impact on property values of whom the majority believed the impact was a large decrease in values. By contrast they found a weak relationship between floods and the dynamics of housing markets. In contrast, CQIG (2011) found minor to major impacts of flooding in Queensland businesses within the flood affected towns include Rockhampton.

However Rockhampton is the capital of Central Queensland region and its economy has been growing stronger since 2003 because of mining boom in the nearby Bowen Basin region (Akbar *et al*, 2010). Especially just before the 2011 flood, large scale natural gas and infrastructure development projects in a nearby port city of Gladstone contributed to increase the resident population in Rockhampton because Gladstone had been suffering with housing availability and affordability difficulties between 2009 and 2013 (Akbar *et al*, 2013).

Figure 3: Major and Minor Flooding in Rockhampton since 1890



Source: BOM (2013).

This study further examines the flood impacts of housing with comparing with mining impacts by using longitudinal data on house and land prices and number of sales. The next section provides a detail description of the methods.

4. METHODS

A number of studies have used both qualitative or quantitative or mixed methodology to identify the flooding impacts of housing (Table 1). However this study uses a quantitative methodology with longitudinal data of house sales, inundation levels and mining impacts to answer its two questions. Longitudinal data of price and number of three segments of property markets (house sales - old and new, new house and land packages sales and land sales) have been collected from the Queensland Treasury and Trade database on residential land development activity profile (QTT, 2014 and 2008). Flood inundation level data has been collected from Australian Bureau of Meteorology.

Table 1: Methods Used in Flood Impacts on Housing Market Analysis

Author and year	Study Area	Methods and Techniques
Eves and Wilkinson, 2014	Brisbane, Queensland	Quantitative – descriptive
Small *et al*, 2013	Rockhampton, Queensland	Mixed methods
Pryce *et al*, 2011	UK and other areas	Mixed
Lamond *et al*, 2009	UK	Repeat sales
Bin *et al*, 2008	North Carolina, USA	Hedonic model & spatial analysis
Lamond and Proverbs, 2006	UK	Regression
Bin and Pollasky, 2004	North Carolina, USA	Hedonic model

This study first used both linear and multivariate regression models to predict the sales and establish the relationship between actual and predicted property sales before and after the 2011 flood in Rockhampton. It then estimates the level of significance between and among the variables by using t-test with 95% confidence level. We used JMP-Pro software to apply regression models and also used SPSS Package-PASW Statistics 22 to do the relationship test (t-test). The formula and the findings from these models described in the next section.

5. RESULTS

First we used bivariate linear regression model (LRM) to predict the number of sales of all three components of property market sales (Equation 1).

$$Y = \beta_1 + \beta_2 X + u \quad (1)$$

Y is an observed response variable, here the number of sales. X is a conditioning or predicting variable. β_1 is an unknown population parameter, known as the constant or intercept term. β_2 is an unknown population parameter, known as the coefficient or slope parameter and u is an unobserved random variable, known as the error or disturbance term.

Second we carried out independent t-tests to examine whether any significant difference exists between the actual and predicted results of number of total house sales (old and new), number of house and land package sales, and number of land sales. Here, the null hypothesis and the alternative hypothesis (termed as H_o and H_a respectively) are as follows:

H_o = no significant difference between the actual and predicted mean values of a particular type of sales, and

H_a = significant difference between the actual and predicted mean values of a particular type of sales.

The decision rule is given by: if $p \leq \alpha$, then reject H_o.

Considering all the empirical results, the condition satisfies only for the number of house sales. For the case of number of house sales, p is 0.000 which is less than α (0.05). Therefore, it can be stated that there is a significant statistical difference between the actual and predicted values of the number of total house sales. Table 2 shows the t-test results for number of house sales.

Third we used multivariate regression models (MRM) to add flood and mining impacts in different years (between 2000 and 2014) as two more predictors into equation 1 thereby forming equation 2. Our general regression equation for predicting the number of sales is thus:

$$Y = \beta + \beta_1 X_1 + \beta_2 X_2 + u \quad (2)$$

Here X_1 is median price for house sales or house and land package sales or land sales only and X_2 represents either flood impact or mining impact, and the following six equations predicted the number of sales of each market segment either considering flood or mining impact (Equations 3-8)

$$\text{Number of land sales, } Y_L = 1019.5592 - 0.004319*\text{Land price } (x_1) + 92.143938*\text{Flood impact } (x_2) \quad (3)$$

$$\text{Number of house and land sales, } Y_{H+L} = 55.070863 - 0.000003641*\text{House \& Land price } (x_1) - 10.32276*\text{Flood impact } (x_2) \quad (4)$$

$$\text{Number of house sales, } Y_H = 4881.3018 - 0.010216*\text{House price } (x_1) - 343.1981*\text{Flood impact } (x_2) \quad (5)$$

$$\text{Number of land sales, } Y_L = 327.7733 + 0.0001345*\text{Land price } (x_1) + 212.0616*\text{Mining impact } (x_2) \quad (6)$$

$$\text{Number of house and land sales, } Y_{H+L} = 19.053326 + 0.0000706*\text{House \& Land price } (x_1) + 8.5870403*\text{Mining impact } (x_2) \quad (7)$$

$$\text{Number of house sales, } Y_H = 5672.7597 - 0.013275*\text{House price } (x_1) - 149.1522*\text{Mining impact } (x_2) \quad (8)$$

Table 2: Independent Samples t-Test Results for Number of House Sales

Independent Samples Test									
	Levene's Test for Equality of Variances		*t-test for Equality of Means*						
	F	*Sig.*	*t*	*df*	*Sig.(2-tailed)*	*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
								Lower	Upper
Equal variances assumed	1.3	0.3	-8.7	6	.000	-903.5	103.6	-1157.0	-650.0
Equal variances not assumed			-8.7	4.476	.001	-903.5	103.6	-1179.4	-627.6

In these cases, our multivariate regression model indicates that the number of sales (i.e. land, house & land, and house) is a linear function of both the price (i.e. land, house & land, and house) and the impact of flood in different years. The same relationship is also applicable for the case of mining impact in different years. The coefficient of each predictor variable is the effect of that variable, for a given value of the other.

Figure 4a: Mining impact on the number of house sales

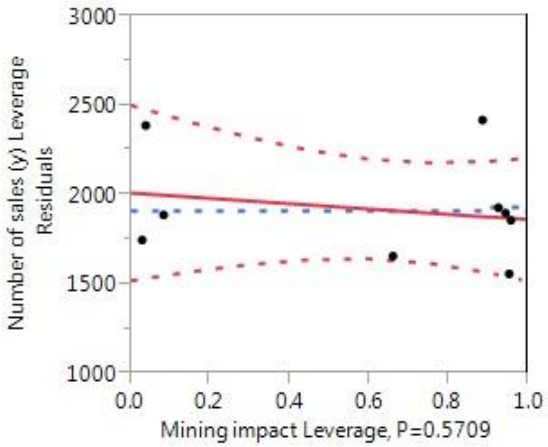
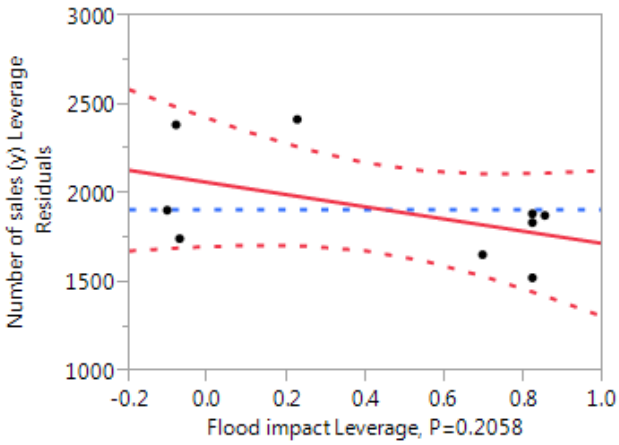


Figure 4b: Flood impact on the number of house sales



*(0.0 = No impact, 1.0 = Highest impact)

Considering all the associated p-values of different cases it is observed that the p values of house prices are 0.005 and 0.019 for the mining and flood impact respectively (Figures 4a and 4b). Provided the significance level $\alpha = 0.05$, the decision rule is given by: if $p \leq \alpha$, then we rejected the null hypothesis H0 ("there is no significant impact of mining or flood on house prices"). That implies that MRM models observe statistically significant impact of mining and flood on the house prices only.

6. Discussion and Conclusion

Flooding appears to impact on the number of sales of all components of the housing market more significantly than on the house prices in Rockhampton. Even within the "all segments of housing market", total number of house sales has been affected very significantly by price of sales compared to the other two segments (i.e., house and land packages sales and land sales only). Eves and Wilkinson (2014) investigated short term house price impact of the same flood in Brisbane and they came to similar conclusions in terms of total house sales. They did not specify the reasons for the low impact of flooding on the property prices which suggests that a separate study on the metropolitan market may be useful given its distinctive characteristics.

It has been further found that flood impacts on housing markets in Rockhampton have been offset by mining impacts which explains why the devastating 2011 flood did not significantly affect house prices. This explains why Rockhampton has behaved differently to some other cases, such as in the USA (Bin and Polasky, 2004).

Lessons we learned from this study are: (1) local development factors can offset any flood or natural disasters impacts on housing markets either partially or significantly at local and sub-regional scale, (2) housing market price revitalisation in regional or rural towns depends on time and geographical scale of inundation as well as ongoing development projects. Therefore the policy makers should emphasise flood recovery infrastructure works immediately after the flood that can help the local economy and help maintain housing markets.

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Does Regional Strategic Management Matter? Health Services in the Rural Communities – The Case of Moura, Australia

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ABSTRACT

This paper examined the performance and need of health services in the mining communities through a case study of the Moura Township in Queensland, Australia. The study involved a case study approach with a survey method to assess the current performance and the need of health services of the Moura residents. This study found only half of the respondents was reasonably satisfied with general physician (GP) and hospital services. They stated a clear demand to involve all development partners to improve these services, in particular to modernise hospital services with basic dental and pre natal services. A regional strategic management model can address this issue, and such a strategic model can be incorporated into the local area development plan or in the regional plan.

1. INTRODUCTION

Accessibility to health services are directly related to community wellbeing and economic development of a nation. The focus of this paper is to assess the accessibility of, and satisfaction with, the health services of the rural towns through a case study from the Moura Township in Queensland, Australia. The paper is organised as follows. A literature review of international and Australian policy initiatives of health services for mining communities and a background of the case study area in Sections 2 and 3, followed by the methodology in Section 4. Stakeholders' perceptions regarding the service accessibility and future service provision are outlined in Section 5, and the case study findings and analysis are detailed in Section 6. The final sections of this paper include discussion, planning and policy implications of the study for other mining towns in Australia and elsewhere in the world.

2. INTERNATIONAL AND NATIONAL (AUSTRALIA) POLICY INITIATIVES FOR HEALTH SERVICES

Currently health of mining communities is in the priority list for many mining companies and governments (Shandro *et al*, 2012) but it did not get much attention until the end of the last century. The International Council on Mining and Metals (ICMM) prepared good practice guidelines for health assessment in 2010 and one of the assessment criteria was to seek continued improvement of community health. Responding to this principle of mine operation, the Canadian government stepped up their health sector budget and pro-active regional planning for the mining and rural communities (Shandro *et al*, 2012). Now this study has been

using this principle in assessing the accessibility of, and satisfaction with, the health service in order to understand the community's need for future service improvement.

Australian health policy focuses sustainability of all health services for all residents living across the country, including regional, remote and mining communities (AIHW, 1998). Currently most health care services have been delivered across Australia with a mix of national, state and territory governments and private funding.

The primary health care service in Australia is based on the publicly funded care system, Medicare. More than 80 percent of the general practitioners (GP) services have been delivered through Medicare system with free of costs to the patients since 2009. The National Healthcare Agreement 2008 has stressed that primary health care comes to both national and state/territory responsibility with significant role of private providers and community organisations. Communities residing in rural and regional areas are experiencing poorer health services and outcomes compared to those living in cities and metropolitan areas (Buykx *et al*, 2012; Tham *et al*, 2009; AIHW, 2008).

Hirst (2005) and Humphreys and Wakerman (2008) highlight that the universal health services are not distributed in an equitable manner and are not accessed fairly by the regional and rural residents. Populations in many rural communities have been increasing over the last 25 years period but health services have not been increased proportionately mostly because of attraction and retention of health professional into those regions (Mann *et al*, 2011; Taylor, 2012). The above literature indicates that there are very few policy initiatives and studies so far have been directed towards providing effective health services in the regional and rural towns, especially in the mining towns in Australia but it is essential to understand of those communities' views on what and how to improve these services. This paper has addressed this issue through a case study of the Moura Township in Queensland.

3. BACKGROUND OF THE CASE STUDY AREA

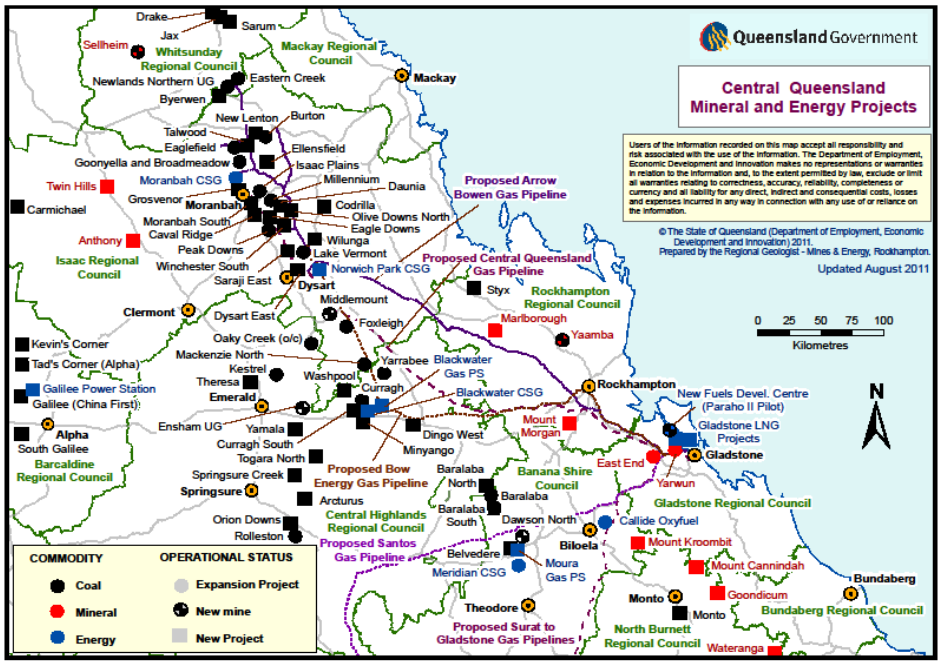
The Moura Township was chosen as a case study from the state of Queensland representing small to medium sized mining towns in Australia, which can represent about two-third of the mining towns in Australia. This allows the findings to be extrapolated to similar towns in this state, and potentially to similar towns elsewhere in Australia and overseas. There are about 150 coal mines, mineral and energy (gas) projects operating in the rural and regional areas of Queensland.

Moura is an almost exclusive mining community with a resident population of 2,000 (ABS, 2012), is situated in the lower Bowen Basin mining region in Queensland. Coal has been mined near Moura since 1961 and this one of the longest-established coal mining projects in Queensland. It is also expected that coal will be mining in or around Moura for another 30 to 40 years. So Moura has an expected resource life for mine is about 100 years, which is bit less than current Australian average (i.e., 120 years; Prior *et al*, 2012).

The median age of Moura residents is 33 with little change over time and average household size is 2.5, which is very similar to many other mining towns in Australia (ABS, 2012). Median personal income has increased by $391 since 2006, which is higher than many other towns in the region (ABS, 2012; ABS, 2008). Moura has a proportion of working age residents (72.5%) compared to other regional and rural towns in Queensland. The township has a high proportion (about 50%) of non-resident population living in the mining workcamps (OESR, 2012). Both residents and non-residents population of this town are taking health services from a private GP practice and a small public hospital.

These socio-demographic characteristics of Moura are very similar to other small-sized mining towns in Australia. Also current and future life time of the Moura community is similar to many other regional communities in Australia, which should deserve accessibility to the basic health services because this is directly related to the wellbeing and productivity of the community. This paper further explores Moura's socio-demographic characteristics and an assessment of its current health services through an in-depth case study research as explained below.

Figure 1: Location of the Case Study Area (Moura Township) and its Adjoining Mining Towns within the Central Queensland Region



4. Approach and Methodology

This study entails a case study approach with a mix methodology of quantitative and qualitative methods for data analysis..

4.1 Case Study Approach

A case study approach mostly makes a contribution in developing a systematic framework to examine a problem, and is well suited to the needs of policy analysis (Finn *et al*, 2000). In view of this, health services in Moura have been selected as the case study for this research to assess performance of the current health services and to understand community's need for upgrading existing services or for new services.

4.2 Scope and Limitation of the Study

This paper only focuses on health services because these services are considered basic social services that are necessary to maintain individual and household wellbeing. The study specifically focuses on understanding the overall performance for current services and potential future service levels and locations. The study did not focus on requirements of specific age or gender groups. Nor did it look in depth at the quality of any particular health service or identify or detail factors affecting the supply of those services. The study did not

examine impacts of the services inaccessibility or unavailability and also did not estimate any cost that the suggested health service would require. Here, 'service optimisation' refers to a reasonable level of service as perceived by the community and stakeholders.

4.3 Data Collection and Analysis Methods

Two sources of primary data were collected. Firstly, interviews with the stakeholders were conducted and secondly a household survey was undertaken of Moura residents. This study interviewed eight stakeholder participants, were selected from health, education, local government and mining sector. The sample size for the surveys was based on the current household size (2.5 people) and total number of households, from 95% confidence level, was estimated at between 46 and 85 households. A total of 91 households' responses were received, of which 83 were valid (the remaining responses were not returned complete). Data analysis was performed by categorising, tabulating and visualising evidence to address the objectives of this study.

4.4 Optimum Health Service Delivery Models and Indicators

To date, a number of studies examined the health service locations and allocation levels, especially in locating hospitals, pre and post natal medical services because a reasonable level of these services is required to maintain a good population health (Harper *et al*, 2005; Glavo *et al*, 2002; Rahman and Smith, 2000; Narula, 1984; Chao, 1998). After reviewing these publications, we investigated how a reasonable level of service had been modelled over time and what the variables were that scholars and service provides considered, in determining a reasonable level of service.

The health facility models that adopt efficiency measures are based on the minimisation of travel distance or time or the maximisation of demand coverage (Cho, 1998). These types of models are constructed under an assumption that the consumers always go to the nearest facility from their residence. On the other hand, Murray and Gerrard (1998) found that quantitative location-allocation models cannot ensure service efficiency. For example, the residents of a community can avail medical services from certain hospitals, even if the hospitals are suffering from staff and medicine deficiencies. So the location allocation model can predict the location of the service point but it is difficult to judge the service quality.

Tien *et al*. (1983) introduced a service hierarchy model for local level service delivery. Narula (1984) also used a hierarchy model to maintain cost-effectiveness of the services, especially in the case of health service delivery. Narula (1984) also suggested two types of service delivery hierarchy: successively inclusive and successively exclusive. In successively inclusive a provider provides a hierarchy of its services in all its branches according to the population base and need. In a successively exclusive hierarchy, a facility of a given type offers services unique to it. Further categorisation of service hierarchy by Glavo (2002) suggested a three level hierarchical model to support perinatal health services from a metropolitan city to rural towns: basic units, maternity centres and neonatal clinics. Here service optimisation has been determined through to a delivery of service hierarchy with an assumption that travel is always to a nearest facility of appropriate level. Since the model is successively inclusive, the location of basic units, maternity homes and neonatal clinics at the same site is prohibited.

Satoh (2007) suggested a hierarchical decision tree model for service delivery. However, hierarchical systems are complex where an effective coordination of services provided at different levels requires integration in the spatial organization of facilities. Syam (2008) developed a comprehensive nonlinear location–allocation model for service system design that incorporates several relevant costs and considerations. These include transportation,

facilities, and waiting costs, queuing considerations, multiple servers, multiple order priority levels, multiple service sites, and service distance limits. This model only supports financial aspects of service delivery but it failed predict future direction in terms of providing essential services.

In Turkey, there has been three levels of health care systems identified (Sahin and Sural, 2007). These are: demand points and local clinics, regional hospitals, and metropolitan hospitals. Patients are first served by a local clinic whose services are usually restricted with diagnosis and treatment of common diseases. For surgeries up to advanced diagnosis and treatment services patients are referred to regional hospitals. Metropolitan hospitals offer advanced specialized surgeries and long-term intensive treatment services, and can accept patients from both local clinics and hospitals or patients can request the initial service directly from a regional hospital. We can classify this setting as a multi-flow system.

Therefore the above studies identified location of service delivery and service hierarchy based on population base, distance and travel time. Based on this information, a flexible practical stochastic geographical simulation model can predict the level and type of service, however, a drawback to this simulation approach is that an optimal solution is not necessarily found. Limitations to location planning are subject to various constraints and other drivers, such as political considerations, road infrastructure and physical amenities. However a few studies have examined people's satisfaction with the services provided nor did they explore the people's opinions when developing new services or upgrading the existing services. Instead they were all based on quantitative location-allocation models.

Mining communities can be short lived, for the life of the resource, 30 to 50 years, compared to an established multi-functional community, such as a regional hub that can function indefinably. In such cases, there is a need to explore the community's characteristics and perception towards service delivery, as well as the stakeholder's perceptions toward the need of such services. Thus, this study focused on identifying the level and location of services based on the same modelling variables as other authors (i.e. demographic characteristics, travel time and distance, and frequency of use) but has also used community perceptions regarding service need and examining stakeholder opinions.

5. STAKEHOLDERS' PERCEPTIONS AND SUGGESTIONS

Stakeholder interviews were conducted at the beginning of the research to understand the overall health services situation in the case study town of Moura and surrounding region. Stakeholders included two health care officials, three education officers, two local government employees and one local mine manager.

Hospital Services in Moura: Moura has one public hospital, which only has emergency based patient care. They offer outpatient services, an emergency department and primary antenatal and postnatal care. Moura hospital has 10 staffed beds, although there are facilities for 16 beds. There is no surgery, aged care or maternity facilities. The current facilities include a number of visiting specialists: psychiatrist (once a month), women's health adviser (twice a month), mental health (at varying intervals), social worker (at varying intervals), occupational therapist (at varying intervals), physiotherapist (at varying intervals) and speech pathologist (at varying intervals). According to Glavo (2002), this can be compared with a lowest level of health service delivery, where the patients received only primary and general health services. The performance of the hospital was rated between 2.5 and 5 (out of a scale of 1-5, while 1 refers to poor and 5 refers to excellent quality of services) by the stakeholders, while hospital staff reported client feedback at 95% positive. Moura does not have a dentist, although the

hospital has the facilities for a dental clinic. A dentist visits twice a year but exclusively for school students' checkups.

Hospital improvements were suggested by up to 40% of stakeholders, and in most cases improvement was related to the performance of the hospital. The hospital buildings are in good condition and have good facilities. There is also a need for more good quality doctors, and better storage facilities for equipment and paperwork. Some stakeholders stated that the hospital needs a maternity facility, but this was countered by the hospital staff, who claim there is limited demand for a maternity unit.

General Physician (GP) Services: Moura has one private GP centre, which has facilities for two doctors; however, there is currently only one permanent doctor and visiting locums. Stakeholders rate the performance of this medical centre as 3 out of 5, but their only criticism was a need for more doctors. The level of improvement needed ranged from 10% (since the building and facilities are relatively new) to 50% due to the lack of doctors.

Ambulance Service: Moura has one ambulance, with the possibly of two as there are two ambulance officers. The service is rated from 3.5-4 (out of a scale of 5), and only 20% of stakeholders think it requires improvement.

Other Services: Moura has a Blue Care service which provides home care and meals on wheels. Performance of these services was rated at 3.5(out of a scale of 5), with a low proportion of stakeholders (10%) suggesting that it requires any improvement, with some stated that the funding was too restricted.

Constraints: There was only one constraint identified, which was regarding population and demographics. The regular mining population were not an issue, but during times of high development, an increase in the volume of outside contractors tends to result in busy times at the hospital. The transient population also limits the hospital's minimum funding. It was also stated that Moura needs a nursing home or similar aged care facility.

Geographically, Moura is a considerable distance from a major centre which is a factor for visiting doctors and specialists. A lack of funds and the remoteness of the area also limits the attractiveness for doctors and other health staff. The limited funding also restricts salary packages of the health staff. Contributing to this issue is the lack of facilities for families, further reducing the attractiveness of living longer in a small town.

Stakeholder's Recommendations for Additional Facilities: Most stakeholders agreed that the hospital in Biloela should be upgraded as a first preference, with only one person stated that Moura hospital should be upgraded as a first preference, and all of them agreed to improve the GP services at Moura. Those who identified Biloela as a first preference usually indicated Moura as a second preference. Stakeholders also identified the need for health services in other centres, such as Taroom or Theodore, due to their similar geographic isolation.

6. CASE STUDY FINDINGS AND ANALYSIS

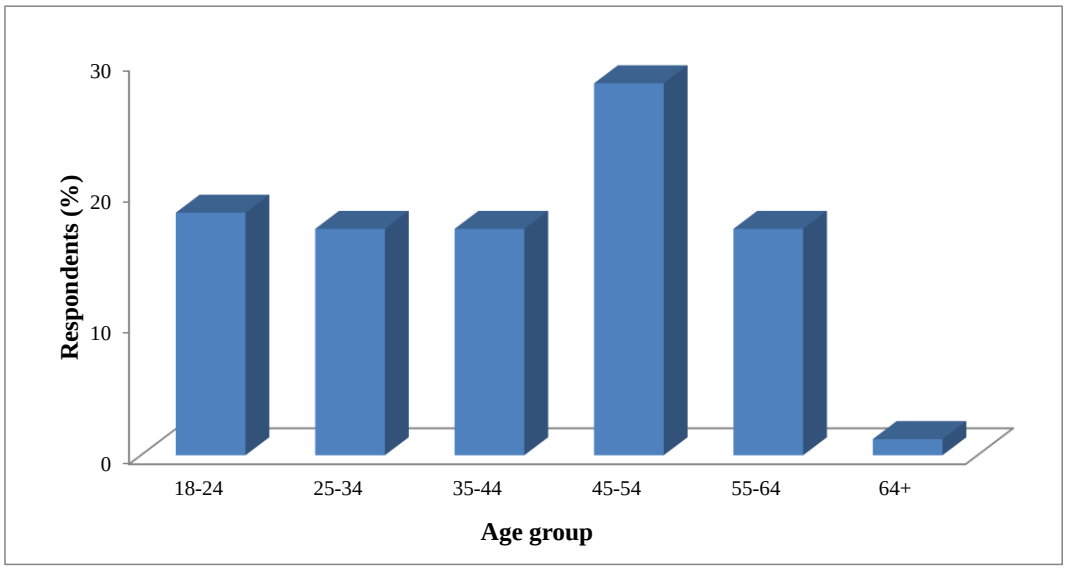
A questionnaire survey was conducted to explore the existing health services in the Moura Township and to understand the perception of the Moura residents about how and where to improve the quality of those services.

6.1 Socio-demographic Characteristics

Households surveyed were randomly selected to include all socio-economic groups and family types, so the study's findings can be generalised over the case study population. Respondents were categorised into six age groups, of which respondents in the 45-54 group

were higher (28%) compared to other groups (around 17%). Respondents over 64 years of age accounted for just 1% (Figure 2). More than three quarter of respondents (76%) were female.

Figure 2: Age of Respondents



Source: Moura Community Survey 2010: Health Services.

Twenty-three percent of households had an annual gross income between $70,001 and $100,000. This is slightly more than the households who earned between $101,000 and $150,000. Approximately one-third of households belonged to the low income group, compared to the census data where approximately 50% of the households in Moura were in the same category (Akbar *et al*, 2011). Households in the low income category are mostly working outside the mining sector or working as a part-time employee. One third of Moura residents surveyed had lived in Moura for more than five years and a further third of the Moura population have been in the town for more than twenty years, and this indicates majority of Moura's residents are stable in terms of their livelihood and they require a standard level of health services at their own locality.

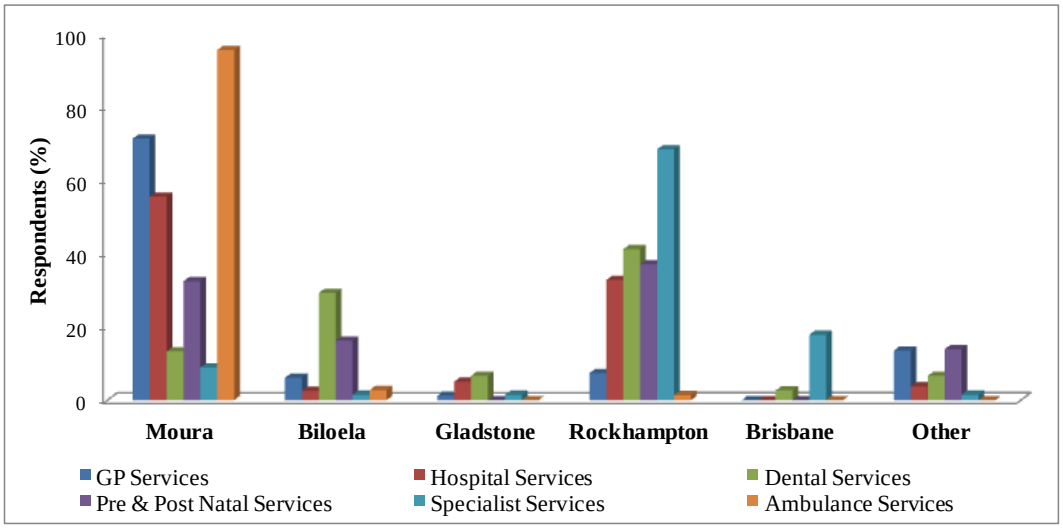
6.2 Performance and Importance of Health Services in Moura

Moura and the communities that surround it are supported by a range of health services, such as a general hospital and private general physician (GP) clinic. This section describes the residents' perceptions about the accessibility of these health services, the condition of services and future service development.

Location for health services sourced by respondents: The majority of residents sourced ambulance, GP and hospital services from Moura. Dental, pre and post natal and specialist services were generally sourced from Rockhampton (a regional level health service centre) (4). Some respondents (about 20%) sourced specialist services from Brisbane (a state or metropolitan level health service centre) while one third preferred Biloela (local level health service centre) for dental services (Figure 3).

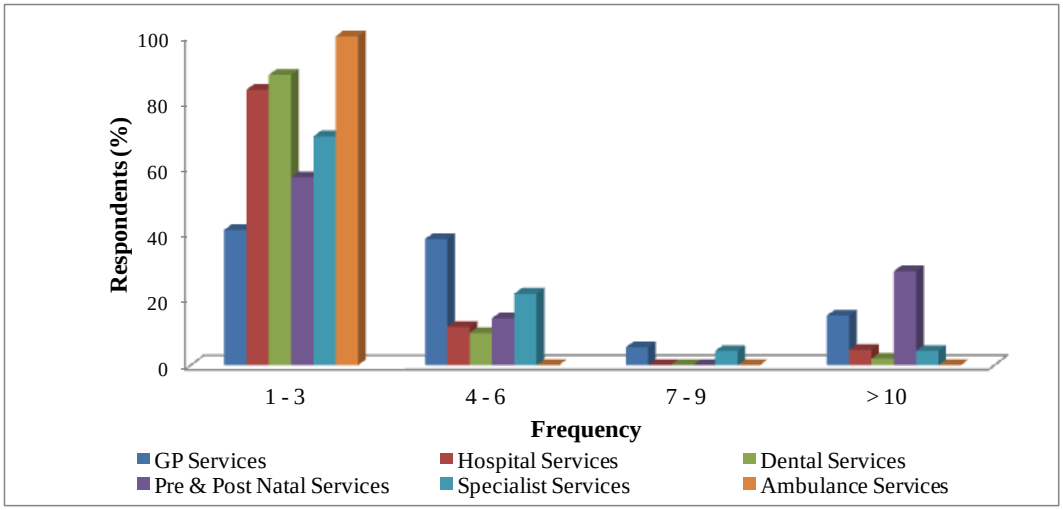
Frequency of using health services: Only about 10% of respondents used pre and post natal services and ambulance services, while up to 90% of the respondents used GP, hospital, dental and specialist services in the last 12 months. All ambulance users utilised this service three or fewer times, while pre and post natal services were accessed up to 12 times in the last 12 months by some respondents (Figure 4).

Figure 3: Location of health services sourced by respondents



Source: Moura Community Survey 2010: Health Services.

Figure 4: Frequency of Use for Health Services for those Respondents Using Each Service in the Last Twelve Months



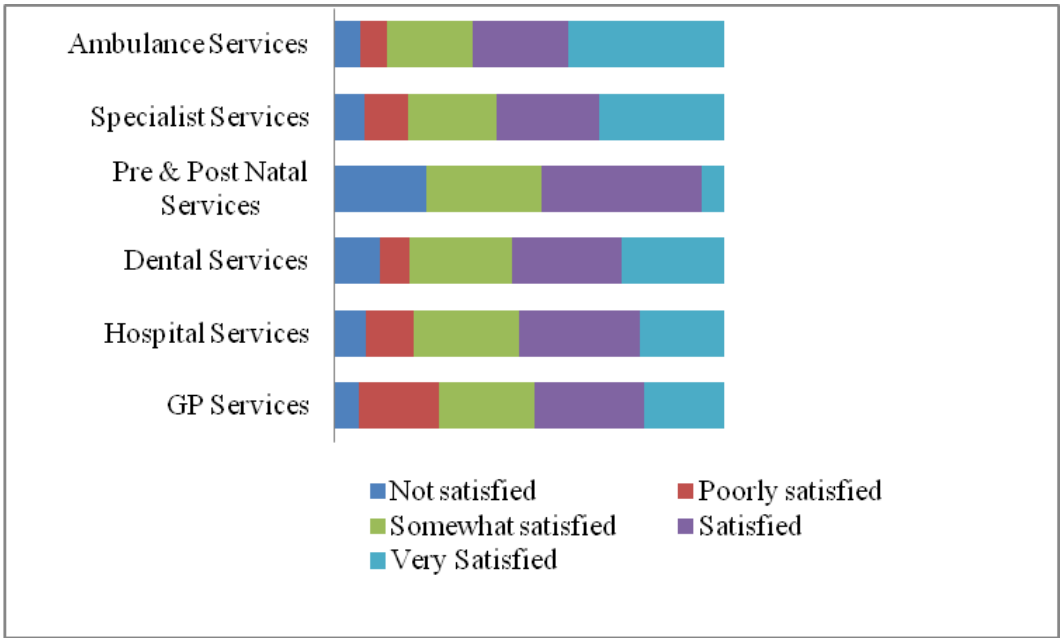
Source: Moura Community Survey 2010: Health Services.

Level of satisfaction with the current health services: Well over 50% of respondents felt the current level of most health services were 'very good' or 'excellent'. Pre and post natal services were less satisfying with fewer rating it as 'excellent', and more (24%) rating it as 'poor' (Figure 6). Less than 10% of respondents rated the remaining health services (excluding pre and post natal services) as 'poor' (Figure 5).

The most highly rated service was the ambulance, with 86% or respondents who had used the service rating it as 'good' or 'better'. If the first three categories are grouped to give an indication of a low to moderate level of satisfaction, then approximately 50% of the respondents felt limited satisfaction with health services in Moura.

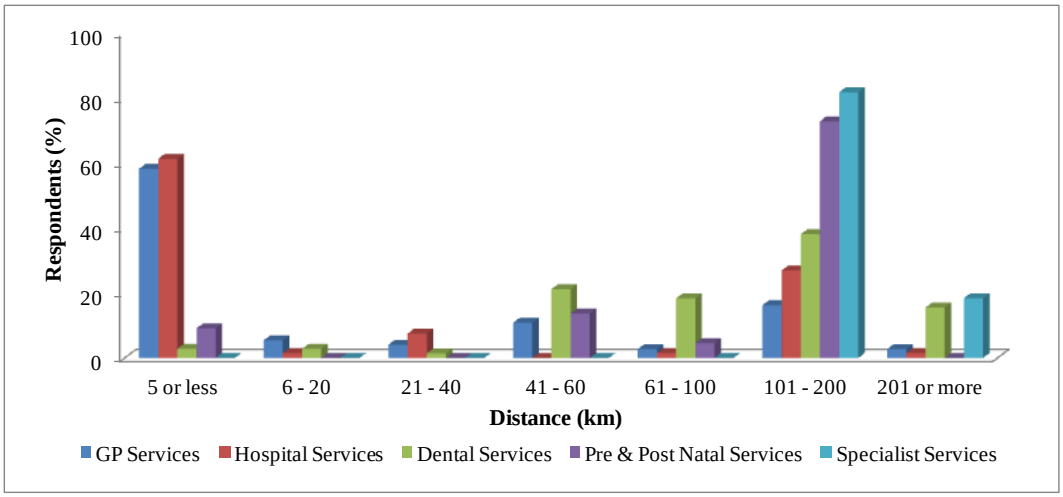
Distance and travelling time to access health services: Among the respondents who used health service in the last 12 months, around 60% travelled up to 20km for up to 15 minutes (driving or walking) to source GP and hospital services. Up to 30% of respondents travelled more than 100 km taking more than an hour to access to these services (Figures 6 and 7).

Figure 5: Level of Satisfaction of the Current Health Services



Source: Moura Community Survey 2010: Health Services.

Figure 6: Distance Travelled to Source Health Services

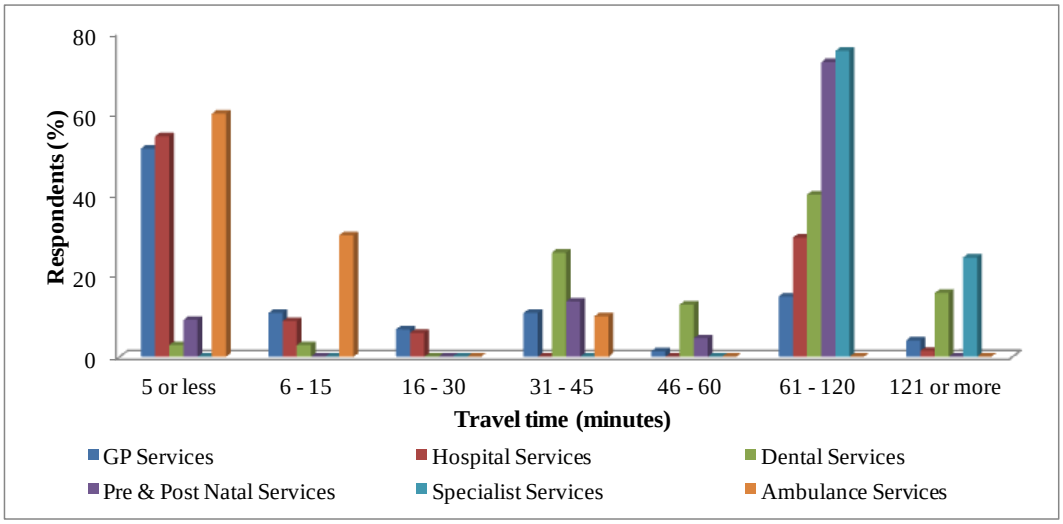


Source: Moura Community Survey 2010: Health Services.

Although GP and hospital services are available in Moura, about 40% of respondents travelled to access these services from Rockhampton, Biloela and Theodore. Additionally, most respondents sourced dental, pre and post natal and specialist services from outside of Moura. This area needs further investigated clearly below to determine what health services need to be established in Moura or what associated services are needed to facilitate access to health services.

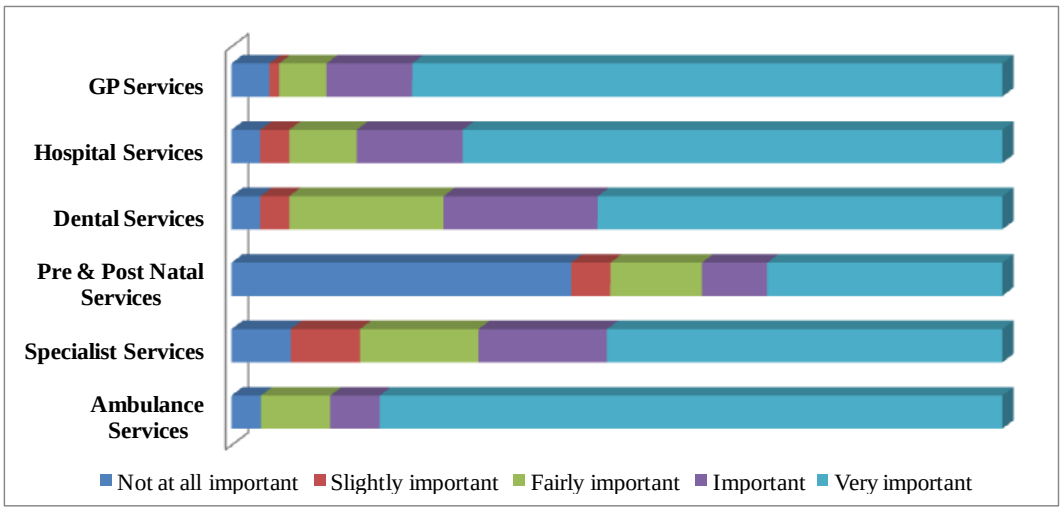
Importance of health services: When respondents were asked about how importance the health services were to the support their personal and their families wellbeing, most respondents felt that all health services were very important, with the exception of pre and post natal services, where approximately half of the respondents considered this service was not at all important. Very few, about 5% of the respondents, felt that they didn't require any of these services (Figure 8).

Figure 7: Travel Time to Access Health Services



Source: Moura Community Survey 2010: Health Services.

Figure 8: The Importance of Health Services to Respondent's Wellbeing



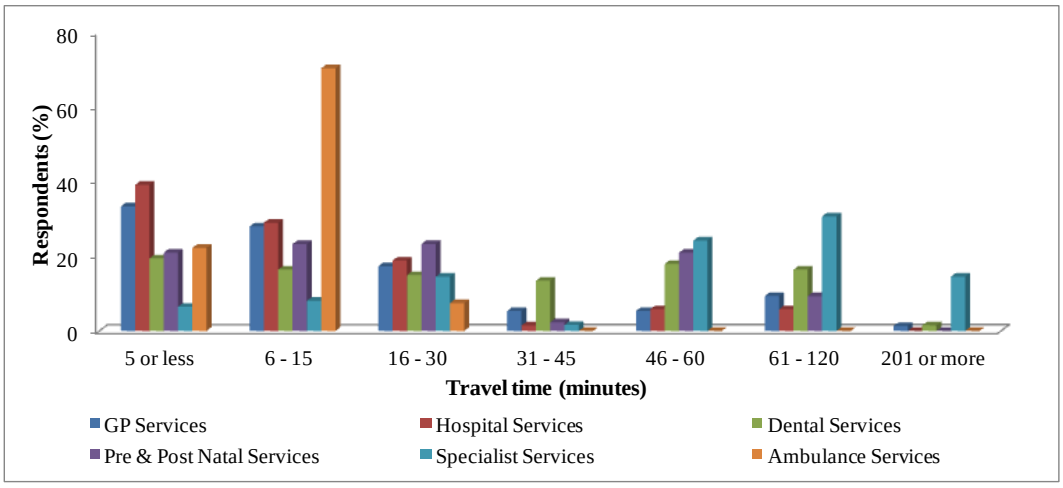
Source: Moura Community Survey 2010: Health Services.

6.3 Proffered Health Service Level and Location by the Moura Community

Respondent preferences for accessing health services: When respondents were asked about maximum travel time and distance to access health services, two thirds of respondents advised that it should not to be more than 15 minute walk or drive to access a GP or hospital services. Some of the respondents (10% to 45%) were willing to travelling about an hour to access to any of these health services. This is the case for dental, specialists, pre and post natal services with most willing to travel for more than 20 km and up to one third willing to travel up to 200 km (Figures 9 and 10). Almost all of the respondents (92%) preferred an ambulance waiting period of less than 15 minutes.

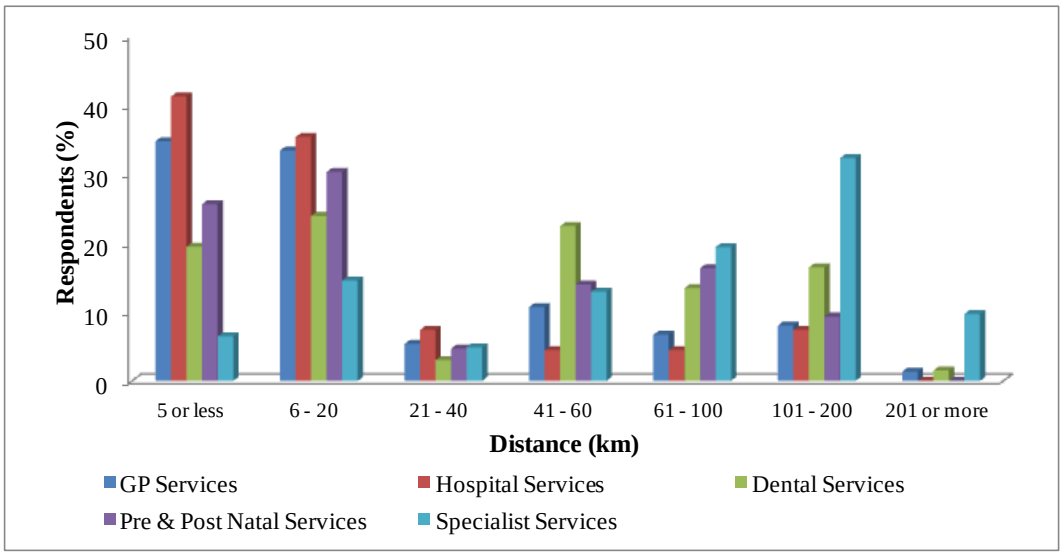
Based on these respondent preferences, it is preferred that GP and hospital services be available in Moura township, while other specialist services, etc. be situated within 60 km of the town (with a travelling time up to 45 minutes).

Figure 9: Maximum Travelling Time Respondents Consider Reasonable to Access Health Services



Source: Moura Community Survey 2010: Health Services.

Figure 10: Maximum Travelling Distance Respondents Consider Reasonable to Access Health Services



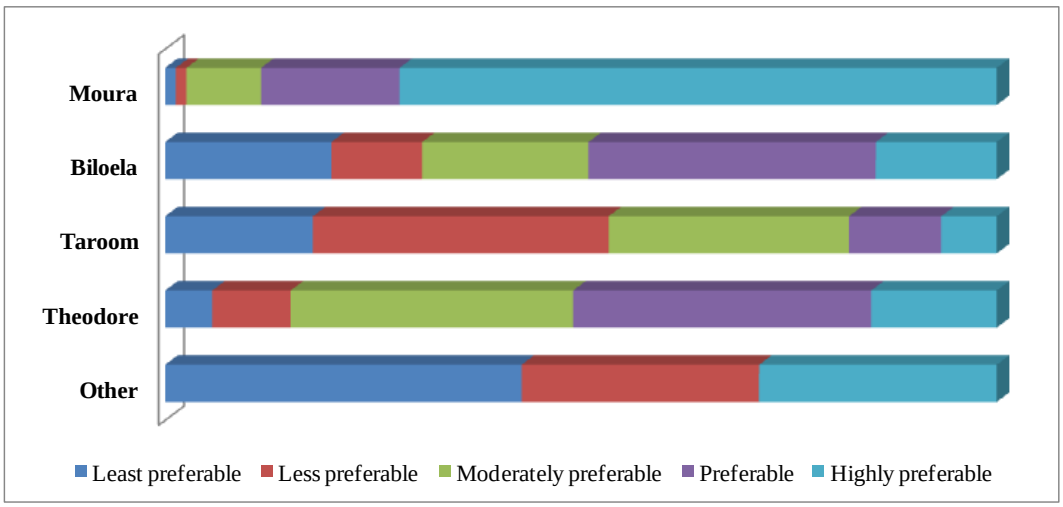
Source: Moura Community Survey 2010: Health Services.

Respondents preferred location to build or upgrade hospital services: From the sections above, we highlighted a clear need to either develop or upgrade some of Moura's health services, particularly GP, hospital, dental, pre and post natal services. The stakeholders interviewed suggested an integration of services, such as dental, pre and post natal and other hospital services be developed in Moura, this could be achieved by upgrading the existing hospital which currently has a reasonable level of services. However the respondents preferred Moura as the location for a new hospital or an upgrade of the existing hospital (Figure 11), mainly because the second preferred town, a regional hub, Biloela is about an hour drive from Moura. Other suggestions for facility upgrades included Banana, Baralaba, Gladstone and Miles townships.

These findings indicate a clear need to develop new hospitals or upgrade the exsting hospital in Moura, with a multifunctional facility offering general health, dental, and pre and post natal

services. Moura residents are satisfied with the current ambulance services. Specialised services need to be within 200km or within two hours driving/travel time. This equates to specilised services offered by the Rockhampton Base Hospital (a regional hospital within 200km of Moura) needs to be made more accessible and available for such communities. Specialised services not currently available at the Rockhampton Base Hospital need to be added to the facility within a reasonable time period.

Figure 11: Preferred Location for Hospital Services Upgrades or New Developments



Source: Moura Community Survey 2010: Health Services.

7. Discussions, Policy and Management Implications

Moura is a typical mining town with a mix of rural and mining activities. Most Moura residents found the overall liveability of their town as moderate. Respondents suggested that liveability can be enhanced through the maintenance and improvement of good health services. The town currently has some health services that despite some shortcoming prove reasonable prospects for the future. Most stakeholders and survey respondents rated the performance of health services, especially the hospital, as moderate to reasonably good. However the satisfaction level varied between the services; for instances most respondents (about 85%) were reasonably satisfied with ambulance services, while only half of them were satisfied with GP and hospital services. So there is a clear need to improve the GP and hospital services to include dental, and pre and post natal services.

Moura Hospital buildings are in good condition and also have good health instruments, but it is lacking enough doctors and better storage facilities for equipment and paperwork. Some residents demanded maternity facility at the hospital, but this was countered by hospital staff, who felt there was not enough demand for such a health unit. The Moura Medical Centre has facilities for two GPs, but currently there is only one. The stakeholders rated this medical centre as average quality. Both the stakeholders and the residents suggested an increase in the number of good quality GPs in this medical centre.

In synthesising community perceptions about the health services in Moura, Figure 9 exhibited that GP services, hospital and ambulance services were very important to the Moura residents. There is a need to improve GP and Hospital services. Community survey results also indicated that most residents were looking for these services either within 15 minutes travel time or within the 20 kilometres of travel distance (Figures 9 and 10); and Moura is the only locality within this travel time and/or distance. Therefore Moura's GP and Hospital services

need to be improved. Further Figure 11 confirmed the need to improve GP and Hospital services in the Moura Township.

Stakeholders suggested that the nearby Biloela Hospital should be upgraded as a first preference, but this was contradicted by survey respondents, who preferred upgrading the Moura hospital, including the addition of some dental, and pre natal facilities. Stakeholders who identified Biloela as a first preference usually indicated Moura as a second preference and vice versa for the survey respondents. A need for health services in Taroom or Theodore, due to geographic isolation, was also noted by some survey respondents. Most stakeholders mentioned that the mining companies should come forward to improve these services, at least with a major share in establishment or refurbishment costs. They also pointed out that there is a need for an integrated framework for providing such service, where the state and local governments, mining companies and the community representatives should decide collectively how the services would be funded and managed. Some of the Moura residents recommended the same framework to improve the current level of GP and Hospital services.

Therefore this study recommend to upgrade Moura Hospital with some additional services of dental, and pre natal facilities and staff. If this is not feasible, as this study did not include a cost effectiveness analysis, then an upgrade to the Biloela Hospital should be considered. This would need to be in conjunction with some additional services and beds and the provision of adequate public transport facilities between Moura and Biloela. Current GP services also need to be updated despite costs. This is the most frequently used service by both residents and the non-resident population. Local government, mining industries and the medical service providers should work together to ensure an adequate quality and quantity of GP services in Moura.

The following strategic policy and planning guidelines can be adopted in order to improve the health services of mining communities and the liveability of the mining towns in Queensland, elsewhere in Australia and overseas:

1. State and local governments, and mining industries should work together to identify the health service needs based on such an established case study, variables of performance and need assessment, with consideration of socio-demographic characteristics.
2. In case of very basic services such as GPs and basic hospital services, government and industry together should provide incentives to retain service delivery personnel in mining communities and to provide joint capital funding to improve the current level of services.
3. A joint (i.e., mining companies, state and local governments) strategic plan supported by a local community group can address this issue, and such a strategic plan can be incorporated into the local area development plan or in regional plan. For instances, Queensland Government (a state government) should make a general planning framework how to provide a basic level of health services to the mining towns but Banana Shire Council (a local government) should implements such plan through consultation with the local communities and the service providers.

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Local Government Internal Audit Compliance

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ABSTRACT

Local Government Councils are reliant on a number of funding sources including State and Federal governments as well as their community constituents to enable them to provide a range of public services. Given these funding sources councils need to have in place a range of strategies and policies capable of providing good governance and appropriately discharge their financial accountabilities. To assist Local Government Councils with meeting their governance and accountability obligations they often rely on guidance from their key stake-holders. For example in the Australian State of NSW, the Office of Local Government has developed a set of guidelines, the Internal Audit Guidelines. In 2010 the NSW Office of Local Government issued revised guidelines outlining that an internal audit committee is an essential component of good governance. In addition, the guidelines explained that to improve the governance and accountability of the councils, these committees should be composed of a majority of independent members and to maintain committee independence the Mayor should not be a member of the committee. However these are only guidelines, not legislated requirements and as such compliance with the guidelines, before they were revised, has been demonstrated to be quite low (Jones and Bowrey, 2013). This study, based on a review of NSW Local Government Councils' 2012/2013 reports, including Annual Reports and associated disclosures, assesses the level of compliance with the 2010 revised guidelines, specifically in relation to internal audit committees, to determine if the guidelines are sufficient to improve Local Government Council governance.

INTRODUCTION

Local councils in Australia were initially established to provide basic public services such as road maintenance, waste removal and water supply to their communities. Over time the councils have evolved to be responsible for providing an increasingly wider range of community services including aged and health care. Local councils have limited capacity to generate revenue and in order to be able to provide an ever increasing range of services they rely on funds generated through rates as well as grants from both State and Federal governments. As trustees of a large quantity of public assets and public funds councils are accountable for their actions to the community and governments who fund their activities. One key governance mechanism implemented to increase the accountability of councils is the provision of an internal audit function, with an independent audit committee. Guidelines for the establishment of the internal audit committee within councils were issued in 2010 (DLG 2010b) and prior research (Jones and Bowrey, 2013) demonstrated that initially there was low

level of compliance by councils with these guidelines. This paper explores the subsequent compliance with these guidelines and encompasses a review the recommendations from the Local Government Review Panel (Sansom *et al*, 2013) on how to enhance accountability and governance with Local Councils.

LOCAL COUNCIL BACKGROUND

Local government in Australia was first established in the early 1800s with the country being divided into counties and parishes along the lines of the British model. However due to the fact that the sparsely populated new continent could not be compared to the densely packed villages of England, did not work very well (NSWEdu, 2002; Parliament of New South Wales, 2014). After Federation in 1901, legislation was introduced by the various State Governments to consolidate the differing forms of local Government which had developed. It was at this time that Australian Local Councils were conceived "as a tool with which to provide basic property services" (Warburton and Baker, 2005, p. 62) to the community living within the local area. Similarly, to the Federal model, Local Governments in NSW were initially established by the NSW State Government as a mechanism for requiring local communities to provide their own local services and reducing State Government duties by delegating them to the local authorities. From the time of the initial white settlement of NSW the Governor had complete authority over all governmental responsibilities, including local government. Subordinate to the Governor were a number of military commanders or civil magistrates who were charged, by the governor, with carrying out the governmental responsibilities. As the early colonial government was unable to provide adequate services to all the local areas, due to a lack of available funds and resources, the opportunity arose for the creation of municipal institutions to carry out some of these duties (NSWEdu, 2002).

The Australian political arena operates under a government system with three distinct levels, consisting of Federal (Commonwealth) Government, State Government and Local Government (Boon *et al*, 2005). The Federal Government oversees a federation consisting of six states and two territories which have been granted authority to operate under the Commonwealth Constitution Act 1900 (Burritt and Welch, 1997). There are however a number of inequities between Federal and State governments which are principally due to their differing capacities to raise revenue and therefore finance their expenditure commitments (Stilwell and Troy 2000). The Federal Government is able to implement and control many expenditure policies by virtue of controlling the bulk of tax revenues granted under the *Commonwealth Constitution Act 1900*, thereby providing the federal government with the power and capacity to exercise a large amount of control over both state and local government expenditure. The Federal Government collects approximately 76% of the nation's tax revenue, the State's 20% and Local Councils 4%, which demonstrates the imbalance of income taxing powers (Stilwell and Troy, 2000, p. 115).

Local councils manage public monies and assets (*NSW Trustees Act 1925*) and accordingly they have a fiduciary responsibility to protect these assets as well as to manage those funds for the benefit of stakeholders. However as the Federal and State Governments possess most of the revenue raising powers Local Governments are heavily reliant on both for funding via Operating and Capital Grants. The funding from the Federal and State Governments is shown in Table 1 which presents the total value of grants provided to NSW Local Government Councils for the financial years 2011/12 and 2012/13. Table 2 highlights the reliance on these funds by comparing the total operating profit of these councils when the operating grants are included and excluded.

Table 1: Total Value of Grants Provided to NSW Local Government Councils, 2011/12 and 2012/13

Operating Grants (000s)		Capital Grants (000s)	
2013	**2012**	**2013**	**2012**
1,550,000	1,690,000	1,430,000	1,220,000

Table 2: Total Operating Profit of NSW Local Government Councils Including and Excluding Operating Grants, 2011/12 and 2012/13

Total Operating Profit ($000s)		Operating Profit Excluding Operating Grants (000s)	
2013	**2012**	**2013**	**2012**
1,150,000	1,150,000	(400,000)	(541,000)

Even though these funds, which are public funds, are generally provided as grants there has only ever been "low levels of accountability and very little performance measurement taking place" (Kloot 1999, p. 571). This has contributed to the Local Councils being perceived as inefficient, and unable to manage the commercial elements of their operations (Barrett, 2002) and proposals have been made that Local Councils should adopt a more business style approach to the management of the local government sector (Hood and Peters, 2004; Modell, 2005; Skalen, 2004; Worthington and Dollery, 2002). Community concerns, which have been continually raised, have encompassed disquiet about the quality and comparability of public sector external reports, while also raising questions about both the efficiency, and the effectiveness of public sector management (*Corporations Act 2001*; Barton, 1999; Hoque, 2004 and 2005). Additionally, one of the major concerns is that Local Governments, because of the level of trust placed in them, are seen to not be appropriately accountable for the funds under their management.

Consequently, the minimal levels of accountability have resulted in demands for additional information on how governments manage and spend public funds (Kent, 2003, p. 11). By the late 1970s, due to the absence of specific standards for the public sector, the Commonwealth and State Auditors-Generals began to apply private sector standards to the public sector (Chua and Sinclair, 1994, p. 690). However, the accounting profession was not unanimous on the applicability of private sector standards being applied to public sector financial reports (idem, p. 689) and suggested that there was not a "one size fits all" standard solution when comparing public and private entities, and that private sector practices and standards may be inappropriate to use in the public-sector (Barton, 2005; Carnegie, 2005; Carnegie and West, 2005).

GOVERNANCE AND ACCOUNTABILITY

There are a variety of definitions of what good corporate governance entails. In Australia, while technically the system of corporate law is state based, in practice the primary legislation is the *Corporations Act 2001*, as the states all provide reference to the Federal Act within their

own legislation (Hill, 2010, p. 1). In recent times the Commonwealth government has increased the focus on corporate governance (Bowrey, 2008) as a means of increasing assurance and demonstrating adequate oversight of government bodies. From the perspective of the Commonwealth, corporate governance refers to (ANAO 2003a, p. 6):

> … the processes by which organisations are directed, controlled and held to account. It encompasses attributes authority, accountability, stewardship, leadership, direction and control exercised in the organisation.

While the attention of corporate governance has been primarily on private sector organisations, it is equally important for public sector organisations to have strong corporate governance structures. Public bodies are responsible for the management and administration of public funds and are therefore expected to have good corporate governance systems in place (ANAO, 2003a; APSC, 2005 and 2007). Edwards (2002) acknowledged that the corporate governance structures in both the public and private sectors have areas of commonality particularly in relation to performance and the roles and responsibilities of their governing boards and executive officers. This has led to a significant push for the public sector to adopt private sector corporate governance processes and structures. In the public sector the increased focus on performance and responsibilities is consistent with the move to "new managerialism" in the public sector (Jackson and Lapsley, 2003, p. 360) and the perceived need of the "public sector to improve its efficiency, effectiveness and accountability" (Barton, 2005, p. 138; Guthrie, 1998, p. 2).

Similarly, Uhrig (2003, p. 2) described corporate governance as "the power of those in control of the strategy and direction of an entity … taking into account risk and the environment in which it is operating". Barrett (2002, p. 8) proposed that the generally accepted meaning of corporate governance encompasses "how an organisation is managed, its corporate and other structures, its culture, its policies and strategies, and the ways in which it deals with its various stakeholders". Likewise, Edwards (2002, p. 51-52) described governance as "dealing with all forms of the organisational relationships", and that good governance is able to "assist performance, provide accountability, transparency, participation and efficiency". She also highlighted that the introduction of private sector practices into the public sector has created the assumption that the corporate (private) form of governance can be readily adapted to the public sector. The focus in recent times on corporate governance has been mainly on the impact of poor corporate governance, which has led to the collapse of a number of organisations (Allan, 2006; Mak *et al*, 2005; Parker, 2005). These events have led to increased interest in "regulatory and other responses to improving corporate governance in the private sector" (ANAO, 2003b, p.6).

While the emphasis of public sector reforms has been on the financial and budgetary measures for financial accountability, the performance of both programs and people are both being measured. The expanding regulation of LGAs has continued to increase the need for disclosure in a wide range of areas so that the actions of LGAs can be scrutinised and allow them to be held to account for those actions (Gray, 2001). These regulations and reliance on funding from state and federal governments impose duties on LGAs to be accountable and provide reports and information to meet both the regulatory requirements of state and federal governments, and to address the needs of a variety of other stakeholders. Accountability is seen as an essential component of good management and practice, particularly as LGAs have the responsibility and duty of managing public money. This has been demonstrated by the requirement of the *NSW Trustees Act 1925* which highlighted that LGAs, as managers of public funds, have a fiduciary responsibility to both protect public money and assets, and to ensure that they manage those funds for the benefit of all their stakeholders.

Much like corporate governance accountability is a broad concept to with a variety of understandings (Bovens, 2007b; Carnegie, 2005; Carnegie and West, 2005; Trippett and Kluvers, 2010) with the general consensus being that in order to be accountable; an essential requirement ought to be that one party must be obliged to provide a full account of events to another party, with an obligation to both "explain and justify his or her conduct" (Bovens, 2007a, p. 447). Within the Local Council context, councils are required to provide a variety of reports and accounts to the State government (via the NSW Office of Local Government), yet does that make them accountable? The providing of information may be an essential component of accountability (ASIC, 2001; Funnell, 1998 and 2003; Funnell *et al*, 2009) however the availability of additional information does not automatically lead to greater accountability (Broadbent and Laughlin, 2003). Accountability requires openness, transparency, that there is someone to whom you are required to report, and that there are consequences for inappropriate actions (Barton, 2005).

One factor highlighted by Brown (2011), was that insufficient controls, such as failure to have an internal audit function, has meant that councillors have had to rely on reports provided from the general manager or other council staff. This has raised concerns about governance weakness within the Local Councils, as there is no check or mechanism in place to confirm the validity of information and reports provided. Gold (2008, p. 51) has proposed that Local Council governance was inadequate, and that stakeholders are being exposed to "imprudent investment decisions and economically sub-optimal outcomes". Even before the Global Financial Crisis and the subsequent credit market crash was apparent, the NSW Department of Local Government was providing information to Local Councils reminding them of their fiduciary duties and responsibilities in respect to financial investments. This communication highlighted to Local Councils that their responsibility was to ensure that investments were made in accordance with the Act with the "onus for investments ... to be on preservation of capital rather than the rate of return" (DLG, 2006, p. 36).

INTERNAL AUDIT FUNCTION AND AUDIT COMMITTEES

Internal auditing is used as a tool to monitor and improve the effectiveness of internal controls within organisations. The primary concerns of internal auditors are to identify areas of risk and determine methods of controlling and minimising those risks. Sound and reliable internal auditing provides a strong mechanism to contribute to the governance and accountability requirements of Local Councils (DLG, 2008) through an independent internal audit committee which in turn contributes to providing objective assurance that the accountability requirements of the NSW State Parliament (Sendt, 2002) have been addressed.

The 2010 Internal Audit Guidelines issued by the DLG outlined a range of accountability and governance requirements. These included recommendations that the internal audit function needed to be independent both in fact and in perception. The primary device to achieve this was through establishing an internal audit committee. The function of the internal audit committee in local councils is to support and oversee the direction of the internal audit activities, to provide independent oversight and separation from management and councillors. However, while these requirements were provided as mechanisms for ensuring good governance and accountability, they were only "strong recommendations" (DLG, 2010b) and there was no capacity nor requirement of the DLG to enforce Local Councils to comply. Sterck and Bouckaert (2006) concluded in their study of audit trends in the public sector that regulatory mandated internal audit functions enhanced corporate governance. Prior research (Jones and Bowrey, 2013) showed that the level of compliance with the requirements to have an internal audit function, an independent audit committee and for the mayor of the council to be excluded from that committee was low. This research demonstrated that only one third of

councils had an internal audit function. This indicated that non-mandated requirements for an audit committee are insufficient instruments to ensure that councils will comply.

The report of the NSW Independent Local Government Review Panel (Sansom *et al*, 2013) indicated that only about half of NSW had any sort of internal audit function and that they tended to focus on compliance, risk and fraud control, while many of those councils that do have internal audit functions are "strongly embedded within the councils and report directly to the General Manager" (Sansom *et al*, 2013, p. 56). This diminishes the capacity of the internal audit function to work and can generate conflicts of interest. Reporting to the General Manager rather than to an independent committee may create circumstances where general Manager may limit or even conceal adverse internal audit reports. An analysis of the NSW local councils' Statements of Financial Performance for the 2012/13 financial year has shown that only 31 of 150 councils have recorded any expense in relation to internal auditing. The average amount recorded as an internal audit expense in 2013 was only $31,380 and in 2012 was $30,710, which is not enough even for one full time internal audit position. One reason for the low expenditure may be that councils contract out the internal audit function to external providers and limit the amount of work they conduct. However, this does suggest that many NSW Local Councils underfund the internal audit function and that there is a perception that the roles undertaken by internal auditor are non-essential.

The NSW Independent Local Government Review (Sansom *et al*, 2013, pp. 56-57) has provided a number of recommendations to revitalise NSW Local Government. In relation to internal auditing these include requiring:

- Extending the concept of internal audit to include adding value and continuous improvement
- ALL councils to have effective internal audit processes
- Internal audit committees with a majority of independent members, an independent chair and preclude the General Manager from membership
- Requiring the chair of the internal audit committee to report at least biannually to a council meeting on financial management, good governance and continuous improvement
- Empowering the Auditor-General to conduct issue-based performance audits in key areas

Suggestions also include presentation and tabling of internal audit information at a public presentation such as the council meetings or annual meeting. All of these recommendations are aimed at providing higher levels of governance and accountability by Local Councils.

CONCLUSION

NSW Local Councils have been provided with a range of recommendations to enhance and improve governance and accountability within the sector. These recommendations have been strongly recommended but have not been made compulsory and have lacked legislative authority to enforce compliance. Even when the DLG required the public release of financial reports (enforceable) (DLG, 2009; DLG, 2010a), this research has demonstrated that there was still not 100% compliance. The NSW Independent Local Government Review (Sansom *et al*, 2013) suggests that it should be compulsory for Local councils to have internal audits and independent audit committees. It appears clear that without legislative force Local Councils will continue to ignore the recommendations and fail to provide adequate levels of governance and accountability.

As trustees of public funds Local Councils have a responsibility to manage them prudently and protect the interests of the community. Safe guards such as an internal audit committee which is overseen by an audit committee, where the majority of members are independent and where the management of councils does not have a role, are essential for providing good governance and accountability. The current position is that many councils do not have an internal audit function at all and where they do have an internal audit function the majority of the internal auditors report to the council general manager. This is a clear problem as there is no separation of roles and there is no capacity to report problems that may have emanated from the general manager or that the general manager may wish to avoid scrutiny over. Therefore there are insufficient mechanisms for independent review and scrutiny. The recommendations from the NSW Independent Local Government Review (Sansom *et al*, 2013) will provide a framework for greater accountability and governance however they need to have legislative powers to enforce compliance and clearly defined penalties for non-compliance as has been demonstrated some Local Councils will need to be compelled to comply.

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Influence of Deteriorating Public Infrastructure in Japanese Economy: Evidence from the Spatial Computable General Equilibrium Model

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ABSTRACT

Under recent budget cuts for public investment, most public facilities including irrigation and drainage facilities become aging and deteriorating, and will negatively affect productivity in Japan. To evaluate macroeconomic effect of changes in public facilities, the current study uses the recursive dynamic computable general equilibrium (CGE) model. This model considers endogenous technological progress changed by the agricultural land improvement projects and road construction projects. The simulation results demonstrated that a decrease in agricultural public facilities causes negative effects of agricultural production as well as Japanese gross regional production (GDP) via changes in prices. Decreased labour and capital stocks in agricultural sector shift to other industries and improve their production, so such shift eases changes in agricultural production. Public capital stocks in roads continue to increase but marginal increase rate will decrease and will diminish an increase rate of production. Maintaining public capital stocks by any counter measures is highly needed for sustainable growth of economy. Different policies on budget source for such measures result in different economic effect, so a CGE model can help decision makers to consider comprehensive effects of policies.

1. INTRODUCTION

Public infrastructure, such as road and irrigation facilities, has been constructed after World War II to improve Japanese economy. However, most of public facilities are aging and have great possibility of deteriorating without any suitable renovation under recent budget cut in public investment. In 2010, total public investment is about 1/3 of its peak budget spent in the 1990s. Facing such serious decrease, many people are worried about whether public facilities were kept in good condition in the future. To answer their questions, policy simulations about influences of future changes in public facilities attract great interest of society as well as academia.

The Japanese Cabinet Office (2012) estimates public capital stocks by kinds. Among several kinds of public facilities, the largest capital stocks are the road facilities, accounting for 40% of total public capital stocks. The second is sewage system accounting for 11%. The third is agricultural base facilities, such as irrigation and drainage facilities and consolidated farmland, accounting for 11%. Road facilities and agricultural base facilities are classified

into production base capital stocks which aim to be constructed for achieving production effects for industries.

Several previous studies analysed the impacts of public facilities by estimating macroeconomic production function with aggregate data in economy. Aschauer (1989) showed that production effects of public facilities accounted for 40 % of total production in the US, and said that long term stagnation was caused because of a lack of public facilities stayed at the low level. Regarding Japanese public facilities, significant positive production effects were measured in most previous studies (Iwamoto, 1990; Mitsui *et al.*, 1995). Nakashima (1989) and Yokoyama and Kataoka (2006) showed that 1% increase in agricultural public capital stocks brought about 0.1 to 0.3% increase in rice production.

These production approaches can show the direct effects of public facilities, but they cannot show the total effects of which people know the concrete effects on their economy, such as changes in GDP, price of products, and income. To consider price effects of all markets, the computable general equilibrium (CGE) model is useful (Hertel, 1990). Ichioka and Tachibanaki (1989), Ichioka (1991) and Tanaka and Hosoe (2009) built the CGE model on Japanese economy and analyzed effects of a reduction in trade barrier of agricultural sector and a reduction in agricultural subsidies. Kunimitsu (2009) used the CGE model with consideration of agricultural public capital to show the effects of the changes in agricultural public investment. This study showed that the equivalent valuation as social welfare effects decreased by 0.39% if the agricultural public capital stocks went down by 1%. Most models used in the previous studies were static type and could not show chronological transition of economy. Based on these previous studies, future impacts of changes in public capital stocks need to be evaluated by making the CGE model dynamic. Also, regional impacts need to be measured to see the differences in regional policies on public projects by using regional CGE model and future effects in economy is important for policy making under deteriorating public facilities.

The current study evaluated comprehensive effects of public facilities in the future in Japanese regional economies as well as industrial influences by using recursive dynamic spatial CGE model. Features of this study were; (i) future situation on public facilities were shown based on the method employed in the Cabinet Office of Japan (2012) which was the first official documents on Japanese public capital stocks, (ii) the dynamic spatial CGE model was used with consideration of endogenous productivity growth by public facilities, and (iii) needed public investment to keep public capital stocks at the peak level was considered and the payment of certain sectors or all industries were considered to secure fund for such investment without an increase in public debts in Japan.

2. METHODOLOGY

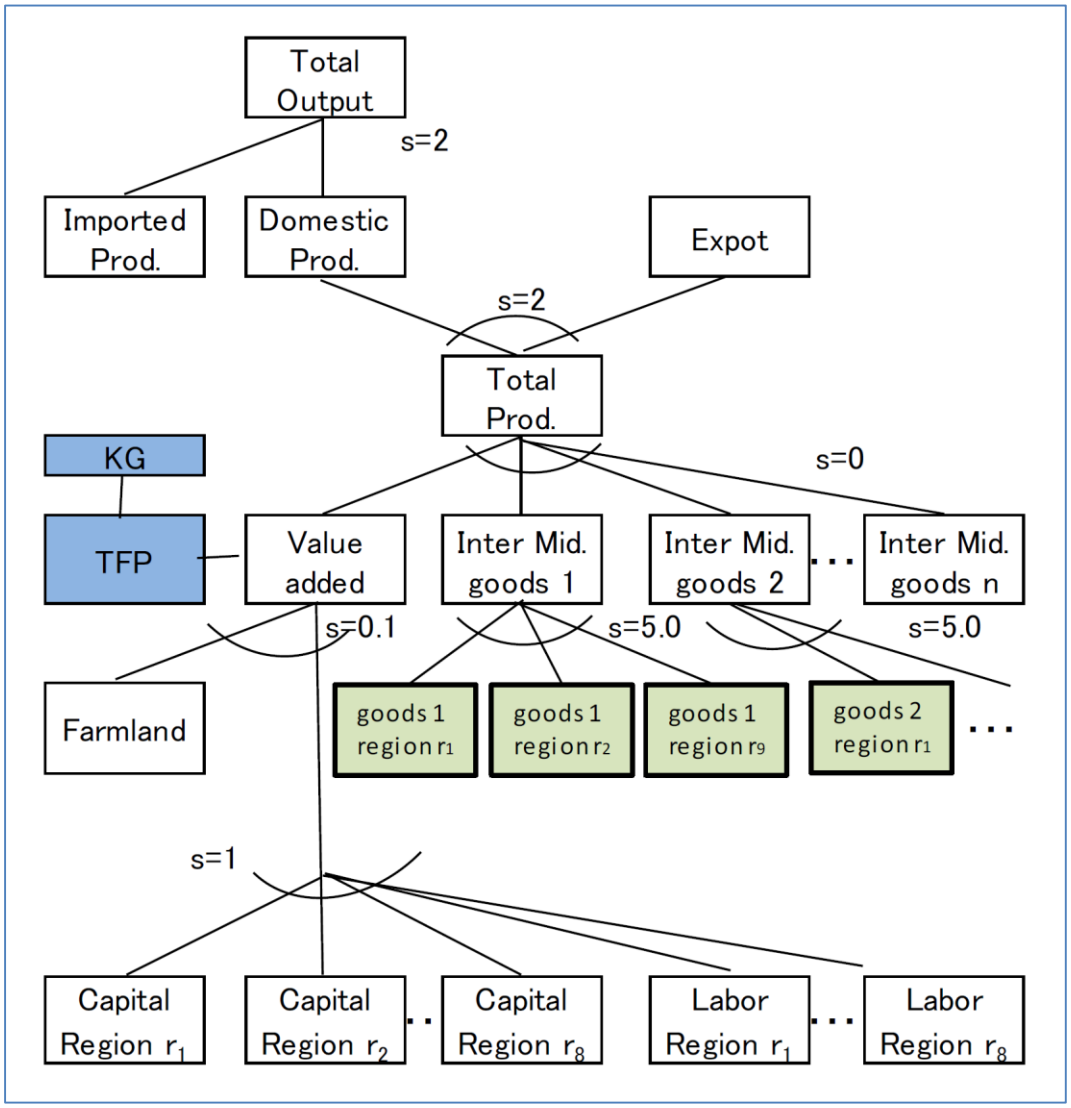
2.1 Structure of the Recursive-dynamic Spatial CGE Model

The model used here is the recursive-dynamic spatial CGE model, with multiple regions and commodity sectors. The structure of our model is based on Bann (2007) and Kunimitsu (2014), which use GAMS (GAMS Development Corporation) and MPSGE (a modelling tool using the mixed complementary problem), as developed by Rutherford (1999). The major modification points of this model are as follows.

The cost functions derived from the production functions are defined as nested-type CES (constant elasticity of substitution) forms. The structure of production part is shown in Figure 1. In this part, degrees of spatial dependence among regional products for intermediate inputs are represented by spatial trade substitution elasticities (σ^r). The spatial substitution

elasticities on commodity flows were measured by empirical studies Koike *et al*. (2012) showed these values were less than one, showing inelastic situation of spatial commodity flows and low spatial dependence. On the other hand, Tsuchiya *et al*. (2005) showed that these values used in previous SCGE models differed from 0.40 to 2.87 and were higher than substitution elasticities between domestic goods and imported goods. There were big differences in these values according to data, methods and kinds of commodities. Furthermore, spatial substitution elasticities differ according to time span considered in the study. In the long run, these values probably become higher than the case of short run. Considering these features of spatial substitution elasticities, this study took adopted two scenarios in which Japanese economy keeps inelastic spatial dependence and elastic spatial dependence for comparison of influences of climate change.

Figure 1: Production Structure of Spatial CGE Model



The elasticity of substitution of farmland to other input factors, which was not used in Bann (2007), is assumed to be 0.2 for agriculture. Egaitsu (1985) concluded that the substitutability of farmland for other input factors was low, but the substitutability between capital and labour was high, according to empirical evidence on Japanese rice production from several studies.

Based on these findings, we assumed that farmland is a semi-fixed input for agricultural production and cannot really be substituted by other factors.

Consumption is defined by the nested type function (Figure 2). The first nest is defined by the linear expenditure system (LES) function derived from consumers' maximization assumption on utility with Stone-Geary form. The second nest shows spatial dependence among commodities produced in different regions. As is the case of intermediate inputs in cost function, the spatial substitution elasticities take two different values, i.e. 0.5 and 5.0, showing low and high spatial dependence in economy. Other elasticity values of substitution in the consumption, import, and export functions are set to be the same as those used by Bann (2007), which were based on the GTAP database. The government consumption and government investment are Leontief type fixed share function.

Figure 2: Consumers' Utility Structure in the Model

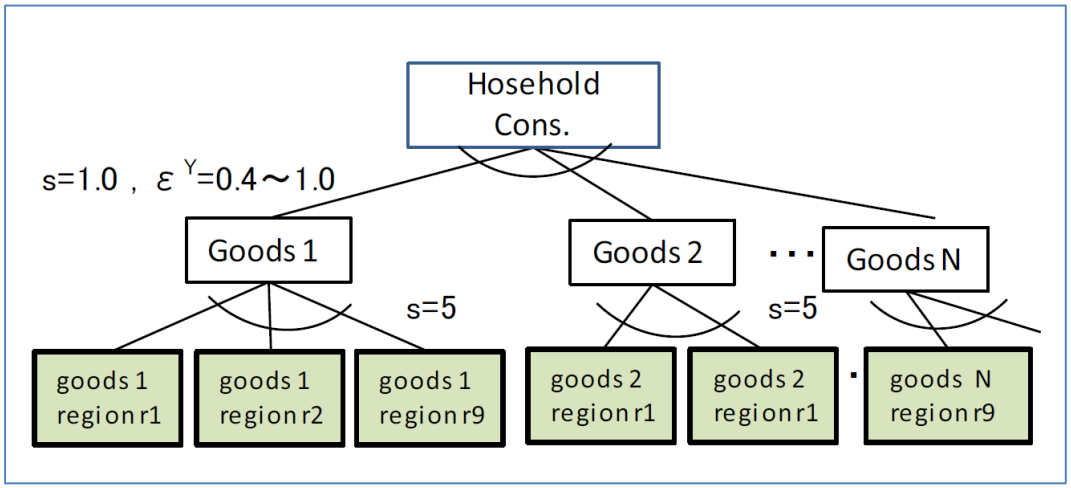
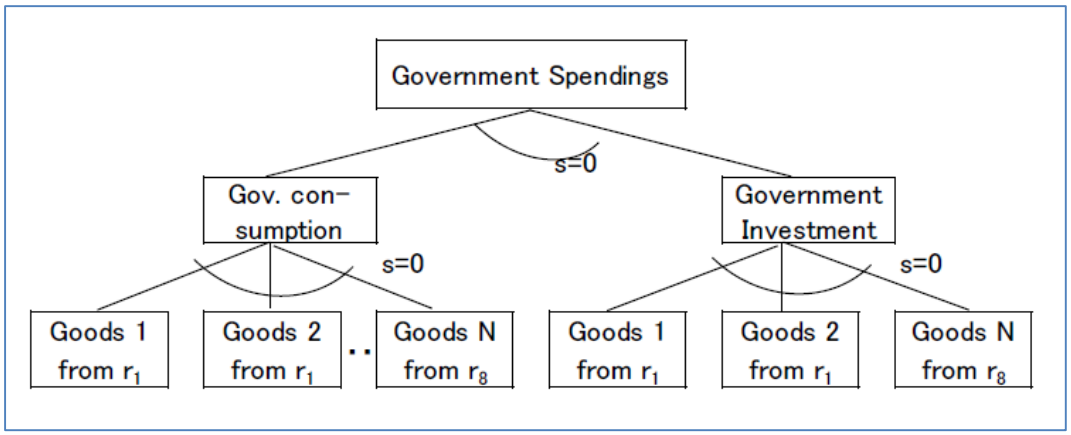


Figure 3 shows the government spending structure assuming Leontief substitution elasticity.

Figure 3: Government Spending



To form the recursive dynamic path, the capital stock equation is defined by annual investment (I) and depreciation rate (δ= 0.04), as follows.

$$K_{i,r,t} = (1-\delta)K_{i,r,t-1} + I_{i,r,t}$$

In this model, $K_{i,r,t}$ shows capital stocks in *i*-th industry of *r*-th region at year *t*, and is defined for every year from *I*, which is endogenously defined by the CGE model as follows.

$$I_{i,r,t} = I_{i,r,t_0}\left(\frac{PK_{i,r,t}}{\overline{PK}_{r,t}}\right)^{0.5}$$

Here, $I_{i,r,t0}$ is initial level of investment in i-th industry of r-th region, *PK* is service price of capital stocks representing rate of return of capital stocks and $\overline{PK}$ is average service price among industries. 0.5 represents the adjustment speed of investment.

2.2 Estimation Method on Amounts of Public Capital Stocks

Estimation of JOC used the perpetual inventory (PI) method which was commonly used for estimation of capitals stocks by many countries in the world. Based on their estimation method, the value of public capital stocks (KG_t) in year *t* can be estimated as follows.

$$KG_t = IG_t + F(1)IG_{t-1} + F(2)IG_{t-2} + \cdots = \sum_{i=0}^{a} F(i)IG_{t-i} \quad (1)$$

Here, subscript *i* was used for manipulating year, IG_t was public investment, $F(i)$ was survival rate of public facilities lived for i years, a was the year when survival rate became zero. The survival rate was based on the Weible distribution showing that public facilities started death just after construction and some could live longer than standard life time.

Public investments for disaster recover could not increase public facilities, because such public investment just reconstructed the same facilities as damaged one. However, public investment for disaster recover can reset the life process of public facilities destroyed and recovered afterward. To make calculation simple, we assumed public facilities were damaged when public facilities spent half of their life time with consideration average situation of chances of disaster incidents. The following equation was used to consider such situation.

$$\begin{aligned} KD_t &= ID_t + F(1)\cdot ID_{t-1} + F(2)\cdot ID_{t-2} + \cdots \qquad -\left\{F(n/2)\cdot ID_t + F(n/2+1)\cdot ID_{t-1} + \cdots\right\} \\ &= \sum_{i=0}^{a}\left[\left\{F(i) - F(i+n/2)\right\}ID_{t-i}\right] \end{aligned} \quad (2)$$

Here, *KD* is public capital stocks accumulated by public investment for disaster recover, *ID*. The right hand side of the first line shows survival value of recovered public capital stocks, the second line shows survival value of old capital stocks which became zero after disaster. In more detail, the public investment for disaster recover corresponds to the same amount of old capital stocks destroyed by the disaster. *i* started from the year when recovered facilities were constructed, so *i*=1 means the year when old facilities past n/2 years of life time.

The needed investment for keeping public capitals stocks as previous year could be calculated by setting investment level, $\hat{I}_t$, as $K_t = K_{t-1}$ in Eq. (1). Hence, needed investment could be shown as follows.

$$\hat{I}_t = \left\{F(0) - F(1)\right\}\cdot I_{t-1} + \left\{F(1) - F(2)\right\}\cdot I_{t-2} + \cdots = \sum_{i=0}^{a}\left[\left\{F(i) - F(i+1)\right\}\cdot I_{t-i}\right] \quad (3)$$

Since, this equation had investments from one to a years before year *t*, changes in needed investment at present year affect future needed investment. Considering these features, recursive calculation was applied to quantify needed investment amounts.

The public investment accumulated public capital stocks and could improve production in each industry. An increase in public capital stocks could increase the total factor productivity of each industry as:

$$TFP_{i,t} / TFP_{i,t0} = \alpha \cdot \left(KG_{s,t} / KG_{s,t0} \right)^{\beta_s} \quad (4)$$

Here, βs is the elasticity value of s-th public facility, KGs, to the TFPi of i-th industry. These values were based on Yokoyama and Kataoka (2008) which estimated production functions by industries and regions with chronological data. The measured elasticity values were shown in Table 1. According to their estimation, an increase in agricultural public facilities was assumed to affect only agricultural sector, but road facilities were expected to change all industries as pure public goods.

Table 1: Estimated Production Elasticities of Public Capital Stocks

Regions	Agricultural KG	Road KG			
	Agriculture	Forestry, fishery	Manufacture	Construction	3rd industry
Hokkaido	0.2844	0.0550	0.2460	0.1090	0.0300
Tohoku	0.1111	0.0560	0.2510	0.1050	0.0290
Kanto	0.1866	0.0596	0.2554	0.1022	0.0228
Chubu	0.1800	0.0618	0.2632	0.1078	0.0293
Kinki	0.2333	0.0680	0.2690	0.1090	0.0280
Chugoku	0.1742	0.0625	0.2600	0.1010	0.0305
Sikoku	0.1319	0.0580	0.2610	0.1000	0.0260
Northern kyushu	0.1878	0.0460	0.2475	0.1000	0.0275
Southern Kyushu and Okinawa	0.2087	0.0420	0.2350	0.1030	0.0250

2.3 Data and Simulation

To calibrate the parameters of the model, the social accounting matrix (SAM) was estimated on the basis of Japan's 2005 inter-regional input-output table. To analyse rice production more precisely, the rice sector was separated from the aggregated agriculture, forestry, and fishery sectors in the IO table, based on regional tables (404 × 350 sectors). Then, the sectors were reassembled into 14 sectors: rice; other agriculture, forestry, and fishery; mining and fuel; food processing; chemical products; general machinery; electric equipment and machinery; other manufacturing; construction; electricity and gas; wholesale and retail sales; financial services; and other services. Regions were assembled into nine regions: Hokkaido; Tohoku; Kanto, including Niigata Prefecture; Chubu; Kinki; Chugoku; Shikoku; and Kyushu and Okinawa, according to the original inter-regional IO table.

The factor input value of farmland, which was not shown in the Japanese I/O Table, was estimated using farmland cultivation areas (Farmland statistics, Ministry of Agriculture, Forestry, and Fishery, and every year) and multiplying the areas and farmland rents. Then, the farmland factor input value was subtracted from the operation surplus in the original IO table. The value of capital input was then composed of the rest of operation surplus and the depreciation value of capital.

To simulate future situation and measure comprehensive effects of public facilities, the following simulation cases were considered with regard to the level of public investment as well as payment level for needed investment (Table 2).

Table 2: Simulation Cases and Their Settings.

Case	Public capital stocks (Agri. Base; KGA)		Public capital stocks (Road; KGR)	
	Public investment	Production effect of KGA	Public investment	Production effect of KGR
BAU	status quo	not considered	status quo	not considered
CASE1	status quo	considered	status quo	not considered
CASE2	Invest needed investment amount, and its cost is payed by only agricultural sector.	considered	status quo	not considered
CASE3	Invest needed investment amount, and its cost is payed by all industries according to production level	considered	status quo	not considered
CASE4	status quo	not considered	status quo	considered
CASE5	status quo	considered	status quo	considered

BAU: Business As Usual or CASE0 was used for the base line of simulation, assuming no production effect of public capital stocks. Exogenous variables, such as farmland supply and labour supply in each region, were fixed at the present levels shown in the SAM data. Other exogenous variables, i.e. government savings, foreign savings, regional transfer, were also fixed at the present levels.

CASE1: This case considered production effects of public capital stocks only in agricultural base. Other settings were the same as CASE0. The differences between this case and CASE0 show effects of public capital stocks for agricultural base. Due to a lack of investment, future public capital stocks for agriculture were decreased after 2014, so agricultural TFP in this case was also decreased according to Eq. (1).

CASE2: This case shows keeping agricultural public capital stocks at the 2010 level by increasing public investment with additional payment as production tax for such costs by only agricultural sector. Farmers would repair and renovate agricultural public facilities to maintain their production by paying extra burden. Other exogenous variables were set as CASE0. Tax rate was calculated as:

$$tax_{agri,t} = \left(\tilde{IGA}_t - \overline{IGA}_t + TAX0_{t0}\right) / X_{agri,t0}$$

Here, tax is the tax rate for agricultural sectors, $\tilde{IGA}_t$ is needed public investment for agricultural base in year *t*, $\overline{IGA}_t$ is public investment and the amount is the same as CASE0, $TAX0_{t0}$ is production tax payment in initial year, and $X_{agri,t0}$ is agricultural gross production.

CASE3: This case shows keeping agricultural public capitals stocks at the 2010 level by additional payment of all sectors as production tax for agricultural public investment. Tax rate for each industry was calculated as:

$$tax_{i,t} = \left(\tilde{IGA}_t - \overline{IGA}_t\right) / \sum_i X_{i,t0} + TAX0_{i,t0} / X_{i,t0}$$

Here, the first term at the left hand side of equation shows an increased tax rate in each industry and the second term shows the original tax rate in each industry.

CASE4: This case was used to show production effects of public capital stocks for roads. The differences between this case and CASE0 show effects of public capital stocks for road. The

level of public investment was set as the same as 2014, so TFP of each industry in this case was also changed according to Eq. (1). Other exogenous variables were set as CASE0.

CASE5: This case was the mixture of CASE1 and CASE4 and shows business as usual in some sense. The level of public investment for agricultural base and road were set as the level in 2014 which shows the present situation in Japan. Other exogenous variables were set as CASE0.

3. RESULTS

3.1 Future Level of Public Capitals Stocks

Figure 4 shows chronological trend of public capital stocks for agricultural base and road by simulation cases, and investment amount needed to keep the level of public capital stocks for agricultural base at the same level as 2010.

Road capital stocks could continue to increase even though its growth rate was decreased. Contrarily, agricultural capital stocks decreased in most regions after 2010. The growth rate of road capital stocks was the highest in Okinawa and Kyushu, but those in Sikoku and Kinki achieved low growth rate. Sikoku and Kinki will experience a decrease in capital stocks after 2030 if this tendency in public investment in these regions will continue.

Agricultural capital stocks remarked positive growth rate in Okinawa, but other regions had negative growth rate after 2010. In order to keep agricultural capital stocks, an increase in public investment for this sector is needed as shown in the right side of the figure. In this figure, the level of needed investment was downed in 2013, because actual public investment was increased after 2013 because of the change of cabinet. Kanto, Tohoku and Hokkaido, where agriculture is relatively large industry, need big amount of needed investment as compared to other regions.

3.2 Production Change

Figure 5 shows chronological changes in total agricultural production and gross regional products (GRP) in each region. Each line was calculated by substituting values of CASE0 from values of each case. The production itself increased in every case, but growth rate was different by cases, so difference between CASE0 and other cases took both negative and positive values. If the difference became negative, it shows that growth rate of such case was lower than CASE0.

A decrease in agricultural capital stocks resulted in negative effects in agricultural production, but road capital stocks increased regional production year by year. Since there are many industries which use road capital stocks, production effects of road capitals stocks are higher than agricultural capital stocks. Although this figure cannot show precise tendency, changes in total production caused by a decrease in agricultural capital stocks can become positive in some cases (CASE2 and CASE3). This is because labour and private capital stocks shift to other industry from agriculture under a decrease in agricultural production caused by a decrease in agricultural capital stocks. These positive effects in other sector cancel out the negative effects in agriculture.

Figure 4: Chronological Trend of Public Capital Stocks and Needed Investment for Agricultural Base

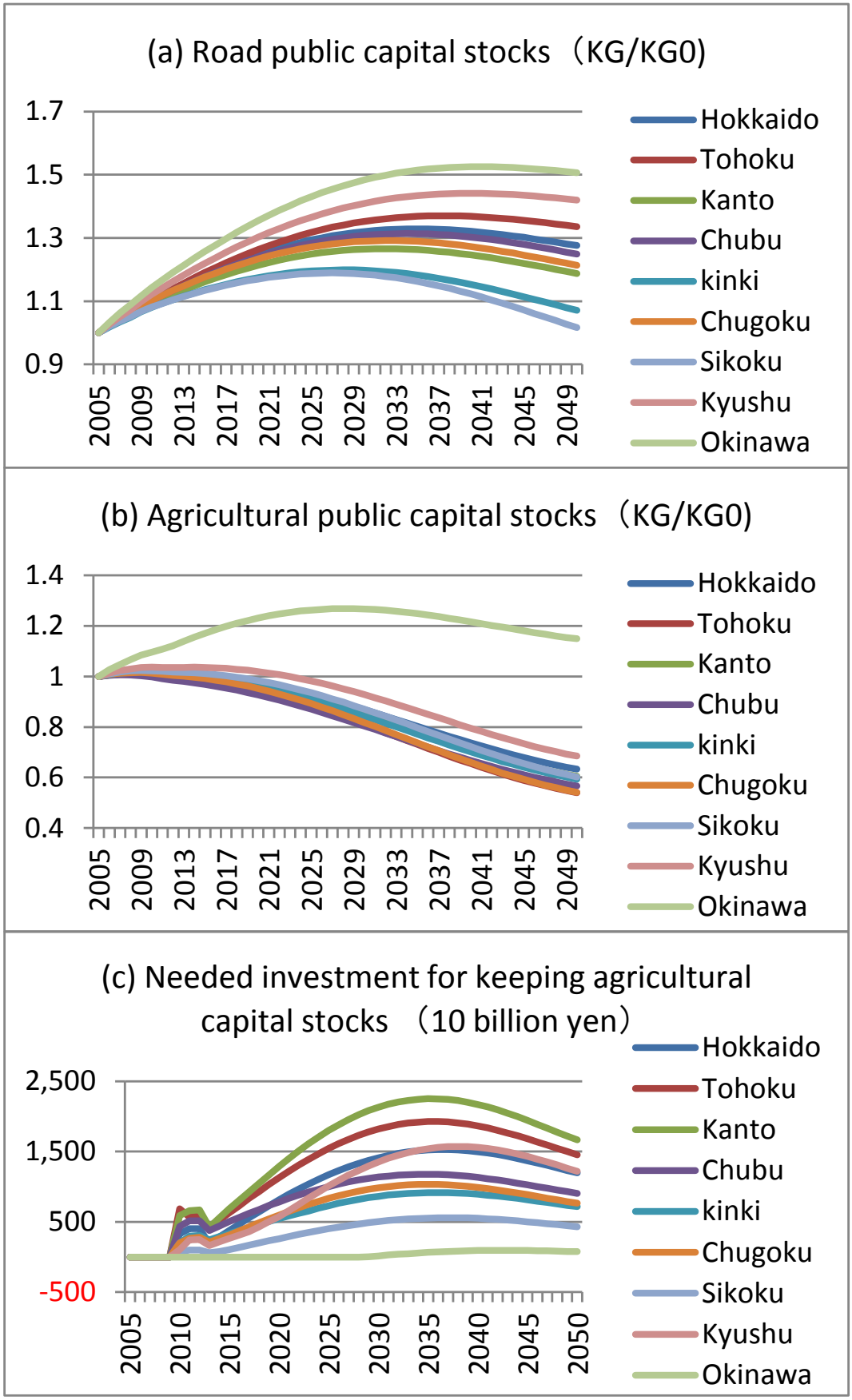


Figure 5: Gross Production in Agriculture (Agri. KG) and Total GRP of All Regions (Road KG)

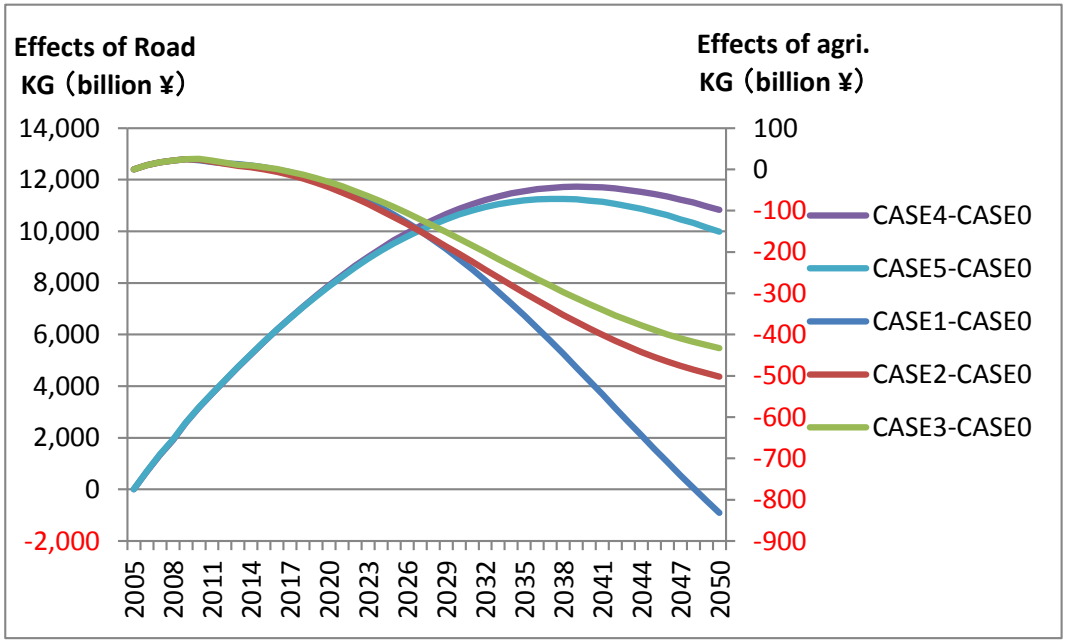


Table 3 shows differences in GRP components between each case and CASE0 in the last year, 2050, of simulation. Private consumption decreased in CASE2 and CASE3 due to burden of additional payment to needed investment and a decrease in agricultural production. However, total public investment can increase owing to additional revenue in government sector, and an increase in public investment overcomes a decrease in private consumption, making total GRP positive. The difference between CASE2 and CASE3 are payment sectors, which is agriculture in CASE2 and all industries in CASE3. This difference of payment sectors appears in export and import. When government taxes all industries, imports related to the energy decrease with export's decrease in the secondary industry due to decline in exports.

Table 3: Changes in GRP Components

(billion yen)

Regions	2030			2050		
	CASE1-CASE0	CASE2-CASE0	CASE4-CASE0	CASE1-CASE0	CASE2-CASE0	CASE4-CASE0
Public cons.	17	769	1,106	32	615	1,186
Private cons.	−181	−904	7,554	−680	−985	7,418
Public inv.	5	1,310	346	9	1,086	371
Private inv.	−67	−335	2,851	−252	−365	2,815
Exports	86	106	2,674	262	65	2,446
Imports	98	123	2,798	302	80	2,568
Total GRP	−239	823	11,733	−931	336	11,668

Changes in total GRP of all regions becomes negative in CASE1 but positive in other cases. This indicates that stopping agricultural capital stocks by an increase in tax totally brings about positive effects in economy.

Table 4 shows changes in gross production, GRP, by regions. In CASE1 and CASE2, all regions except for Okinawa experience decrease in production. Hokkaido and Kanto where agricultural production is relatively larger than other regions marked huge loss in production caused by decrease in agricultural capital stocks.

Table 4: Changes in GRP between CASE Values and CASE0.

(billion yen)

Regions	2030			2050		
	CASE1-CASE0	CASE2-CASE0	CASE4-CASE0	CASE1-CASE0	CASE2-CASE0	CASE4-CASE0
Hokkaido	−106	−40	576	−365	−87	620
Tohoku	−64	−106	1,060	−194	−166	1,206
Kanto	−163	−136	6,085	−573	−262	6,294
Chubu	−65	−91	1,960	−190	−133	2,066
Kinki	−52	−63	1,927	−193	−119	1,504
Chugoku	−37	−55	854	−127	−90	835
Shikoku	−9	−10	293	−41	−24	171
Kyushu	−37	−27	1,545	−239	−83	1,874
Okinawa	9	9	124	6	2	151
Total GRP	−524	−519	14,423	−1,914	−962	14,721

In terms of road capital stocks shown in CASE4, all regions can increase their production, but amount of such regional effects are different. This is because the growth rate of road capital stocks is different by regions and industrial production which is influenced by road capital stocks is different by regions.

3.3 Price Change

Table 5 shows ratio of consumer price index calculated by dividing values in each case by CASE0. Road capital stocks in CASE4 show the effect which lowers the product price of all the industry. On the other hand, CASE1, 2 and 3 shows a little change in consumer price index, because these cases are about agricultural capital stocks which influence only to agricultural sector, even though price change in agricultural sector is relatively high.

If we compare among CASE1, 2 and 3, we see that Hokkaido and Tohoku marked higher price changes caused by changes in agricultural capital stocks. These regions hold larger agricultural production inside the region, so a change in the agricultural productivity easily brings about a change in a price in these regions. However, other regions have relatively small agricultural sector and a change in productivity is hard to cause price change, because a change in productivity is substituted by imports or production in other sectors.

Table 5: Changes in Price of Agricultural Products and Consumer Price Index

(2005=1.0)

Regions	2030			2050		
	CASE1-CASE0	CASE2-CASE0	CASE4-CASE0	CASE1-CASE0	CASE2-CASE0	CASE4-CASE0
Hokkaido	1.024	1.030	0.960	1.075	1.029	0.968
Tohoku	1.018	1.031	0.958	1.056	1.029	0.966
Kanto	1.012	1.018	0.954	1.038	1.017	0.965
Chubu	1.014	1.024	0.953	1.041	1.022	0.963
Kinki	1.010	1.017	0.954	1.033	1.017	0.969
Chugoku	1.016	1.029	0.956	1.050	1.028	0.966
Shikoku	1.016	1.029	0.960	1.052	1.029	0.974
Kyushu	1.015	1.025	0.956	1.052	1.025	0.963
Okinawa	1.005	1.013	0.952	1.032	1.019	0.957
Whole	1.014	1.024	0.956	1.048	1.024	0.966

4. POLICY IMPLICATION AND CONCLUSION

The current study uses the recursive dynamic computable general equilibrium (CGE) model. This model considers endogenous technological progress changed by the agricultural land improvement projects and road construction projects.

The simulation results demonstrated that a decrease in agricultural public facilities causes negative effects of agricultural production as well as Japanese gross regional production (GDP) via changes in prices. Decreased labour and capital stocks in agricultural sector shift to other industries and improve their production, so such shift eases changes in agricultural production. Public capital stocks in roads continue to increase but marginal increase rate will decrease and will diminish an increase rate of production. Maintaining public capital stocks by any counter measures is highly needed for sustainable growth of economy. Different policies on budget source for such measures result in different economic effect, so a CGE model can help decision makers to consider comprehensive effects of policies.

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Spatial Dependence and Regional Impacts of Climate Change: Evidence from CGE Model

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ABSTRACT

After East Japan earth quake and flood in Thailand in 2011, firms try to diversify location of their material suppliers, and this probably increases spatial flexibility, i.e. spatial dependence, in economic structure. Considering such economic structural change, to evaluate impacts of future climate change, which is supposed to influence economy in different direction according to regions, is academically important. This study aims to measure how impacts of climate change differ due to degree of spatial dependence. We used a spatial CGE model with consideration of inter-regional trade function. The simulation results demonstrate that, first, future climate change increased Japanese rice production for the country as a whole, but the price of rice decreased. An increase in regional dependence increased changes in production and decreased price change caused by future climate change. Second, as a result of production and price changes, climate change makes the income of farmers in the rice sector decrease, despite the increase in production. Third, an increase in regional dependence decreased regional inequalities of GRP caused by climate change. As such, impacts of climate change become different according to regional dependence in economy. To consider policy countermeasures against climate change, the spatial CGE model can provide useful information.

1. INTRODUCTION

Agriculture is highly dependent on climate conditions, such as temperature, solar radiation, and precipitation, so future climate change will affect food production and may make food supply ability vulnerable. Stern (2006) said that agriculture in countries at higher latitudes would likely benefit from a moderate level of warming (2–3 ° C), but even a small amount of climate change in tropical regions would cause yields to decline. Japanese land is lengthwise long, spreading out from subarctic zone to subtropical zone, so influences of future climate change may differ by regions. In addition, an increase in yield even in northern Japan does not necessarily mean an economic benefit. To measure the economic effects of climate change, we need to evaluate changes in price and quantity with considering market conditions and regional situations.

Evaluating changes in the quantity and price of agricultural products requires an economic model. Partial equilibrium models can measure such changes, but they assume that agricultural markets do not affect the rest of the economy (i.e., they are treated as exogenous). The computable general equilibrium (CGE) model can depict inter-market relations and trade

flows for the economy as a whole, including the circular flow of income and expenditure. When the long term influences are targeted as is the case of climate change, the CGE approach is better suited to analysing macroeconomic effects caused by agricultural production changes (Palatnik and Roson, 2011). Many previous studies have used the CGE model to analyse the effects of climate change in Europe, the USA, and developing countries, as shown in the next section. However, few CGE studies have evaluated the impact of climate change on the Japanese rice sector.

Furthermore, regional production and market highly depend on flexibility of regional interactions which are shown by inter-regional commodity flows. After 2011 when east Japan earthquake occurred, many companies are trying to diversify location of their assets and partners for a contract, so such tendency probably increases spatial flexibility, i.e. spatial dependence, in Japanese economy. Since future climate change affects regional rice production in different ways, influences of an increase in spatial dependence are still unclear. It is important and interesting to show influences of spatial dependence on effects of climate change by using spatial CGE model.

The present study uses the spatial CGE model to comprehensively evaluate the influence of future climate change on Japan's rice sector and regional economies. The features of this study are as follows: (i) we used the recursive-dynamic spatial CGE model to capture regional differences in climate change; (ii) we conducted sensitivity analysis on spatial trade substitution elasticities to show different effects on regional economies according to these values; (iii) we used empirical results on total factor productivity changes against climate conditions vial crop-growth model, crop quality model and flood indexes in addition to the global climate model (GCM), Model for Interdisciplinary Research on Climate (MIROC).

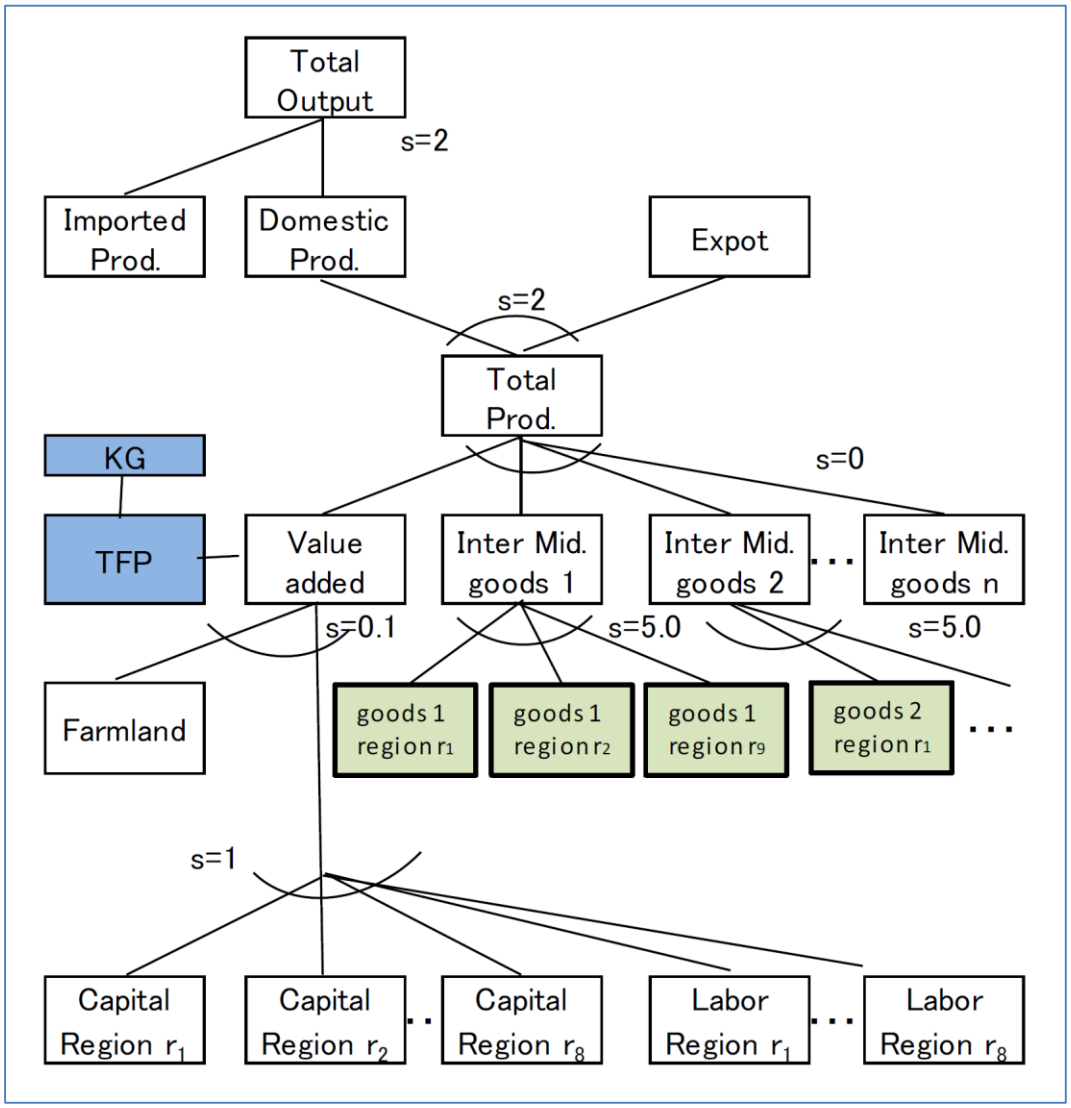
2. METHOD

2.1 Structure of the Recursive-dynamic Spatial CGE Model

The model used here is the recursive-dynamic spatial CGE model, with multiple regions and commodity sectors. The structure of our model is based on Bann (2007) and Kunimitsu (2014), which use GAMS (GAMS Development Corporation) and MPSGE (a modelling tool using the mixed complementary problem), as developed by Rutherford (1999). The major modification points of this model are as follows.

The cost functions derived from the production functions are defined as nested-type CES (constant elasticity of substitution) forms. The structure of production part is shown in Figure 1. In this part, degrees of spatial dependence among regional products for intermediate inputs are represented by spatial trade substitution elasticities (σ^r). The spatial substitution elasticities on commodity flows were measured by empirical studies Koike *et al*. (2012) showed these values were less than one, showing inelastic situation of spatial commodity flows and low spatial dependence. On the other hand, Tsuchiya *et al*. (2005) showed that these values used in previous SCGE models differed from 0.40 to 2.87 and were higher than substitution elasticities between domestic goods and imported goods. There were big differences in these values according to data, methods and kinds of commodities. Furthermore, spatial substitution elasticities differ according to time span considered in the study. In the long run, these values probably become higher than the case of short run. Considering these features of spatial substitution elasticities, this study took adopted two scenarios in which Japanese economy keeps inelastic spatial dependence and elastic spatial dependence for comparison of influences of climate change.

Figure 1: Production Structure of Spatial CGE Model



The elasticity of substitution of farmland to other input factors, which was not used in Bann (2007), is assumed to be 0.2 for agriculture. Egaitsu (1985) concluded that the substitutability of farmland for other input factors was low, but the substitutability between capital and labour was high, according to empirical evidence on Japanese rice production from several studies. Based on these findings, we assumed that farmland is a semi-fixed input for agricultural production and cannot really be substituted by other factors.

Climate factor affects rice production via rice TFP in cost function as shown in Figure 1. *TFP* varies per year, and it is defined in previous studies as follows (Kunimitsu *et al*, 2013):

$$\ln(TFP_{r,t}) = \beta_0 + \beta_1 \ln(MA_{r,t}) + \beta_2 \ln(KK_t) + \beta_3 \ln(CHI_{r,t}) + DR_r \cdot \beta_4 \ln(CQI_{r,t}) + \beta_5 \ln(CFI_{r,t}) + \varepsilon_{r,t} \quad (1)$$

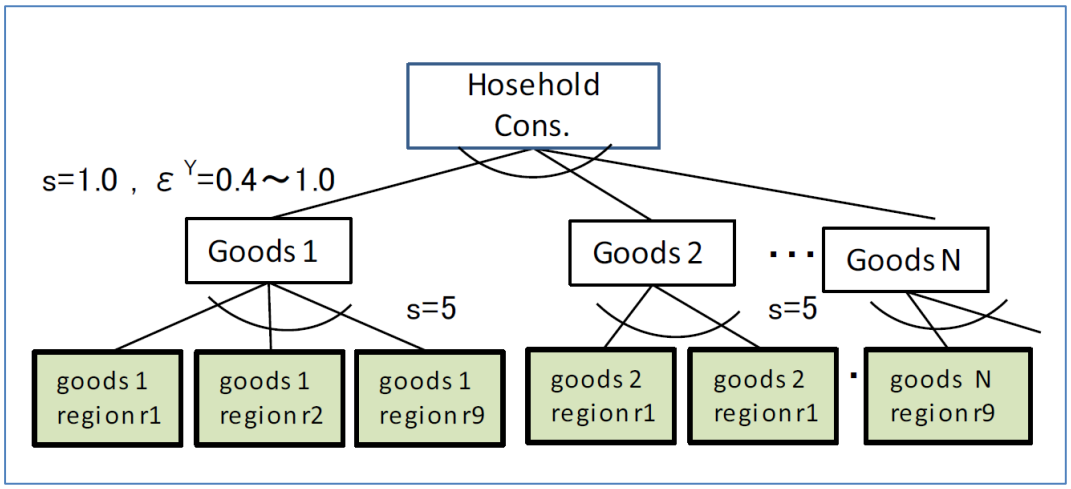
Here, *MA* is the management area per farmer, representing economies of scale, and *KK* is knowledge capital stocks accumulated through research and development (R&D) investments. *CHI*, *CQI*, and *CFI* are the crop-yield index, crop-quality index, and flood index, respectively. The β*'s* represent the coefficients estimated from the panel data regression analysis, with β_0 = –2.7014, β_1 = 0.3285, β_2 = 0.0590, β_3 = 0.1824, β_4 = 0.0863, and β_5 = –0.0277. *DR* is a dummy variable, taking the value 1 for Hokkaido, and 0 otherwise. As explained in Kunimitsu *et al*.

(2013), *CHI*, *CQI*, and *CFI* are also defined by the crop-growth model, crop-quality model, and hydrological model with using climate conditions, such as temperature, solar radiation, and precipitation.

TFP is influenced by both socio-economic factors (*MA* and *KK*) and climate factors (*CHI*, *CQI*, and *CFI*). In general, long term changes in socio-economic factors are difficult to predict and such points are not the subject of this analysis. To remove influences of socio-economic factors on TFP and to simulate the pure effect of the climate factors, the *TFP* in each region was subtracted by $\ln(TFP'_{r,t}) = \beta_0 + \beta_1 \ln(MA_{r,t}) + \beta_2 \ln(KK_t) + \varepsilon_{r,t}$, which shows *TFP* changes resulting only from socio-economic factors, with the same estimated coefficients as Eq. (1). Then ratio of TFP/TFP' is introduced into cost function of rice production.

Consumption is defined by the nested type function (Figure 2). The first nest is defined by the linear expenditure system (LES) function derived from consumers' maximization assumption on utility with Stone-Geary form. The second nest shows spatial dependence among commodities produced in different regions. As is the case of intermediate inputs in cost function, the spatial substitution elasticities take two different values, i.e. 0.5 and 5.0, showing low and high spatial dependence in economy. Other elasticity values of substitution in the consumption, import, and export functions are set to be the same as those used by Bann (2007), which were based on the GTAP database. The government consumption and government investment are Leontief type fixed share function.

Figure 2: Consumers' Utility Structure in the Model



To form the recursive dynamic path, the capital stock equation is defined by annual investment (*I*) and depreciation rate (δ= 0.04), as follows.

$$K_{i,r,t} = (1-\delta)K_{i,r,t-1} + I_{i,r,t} \tag{2}$$

In this model, $K_{i,r,t}$ shows capital stocks in *i*-th industry of *r*-th region at year *t*, and is defined for every year from *I*, which is endogenously defined by the CGE model as follows.

$$I_{i,r,t} = I_{i,r,t_0}\left(\frac{PK_{i,r,t}}{\overline{PK}_{r,t}}\right)^{0.5} \tag{3}$$

Here, $I_{i,r,t0}$ is initial level of investment in i-th industry of r-th region, *PK* is service price of capital stocks representing rate of return of capital stocks and $\overline{PK}$ is average service price among industries. 0.5 represents the adjustment speed of investment.

2.2 Data and Simulation Method

To calibrate the parameters of the model, the social accounting matrix (SAM) was estimated on the basis of Japan's 2005 inter-regional input-output table. To analyse rice production more precisely, the rice sector was separated from the aggregated agriculture, forestry, and fishery sectors in the IO table, based on regional tables (404 × 350 sectors). Then, the sectors were reassembled into 14 sectors: rice; other agriculture, forestry, and fishery; mining and fuel; food processing; chemical products; general machinery; electric equipment and machinery; other manufacturing; construction; electricity and gas; wholesale and retail sales; financial services; and other services. Regions were assembled into nine regions: Hokkaido; Tohoku; Kanto, including Niigata Prefecture; Chubu; Kinki; Chugoku; Shikoku; and Kyushu and Okinawa, according to the original inter-regional IO table.

The factor input value of farmland, which was not shown in the Japanese I/O Table, was estimated using farmland cultivation areas (Farmland statistics, Ministry of Agriculture, Forestry, and Fishery, and every year) and multiplying the areas and farmland rents. Then, the farmland factor input value was subtracted from the operation surplus in the original IO table. The value of capital input was then composed of the rest of operation surplus and the depreciation value of capital.

To simulate the macroeconomic impacts of climate change, we considered the following cases.

CASE 0: This case represents a base line. In this case, farmland supply and labour supply in each region were fixed at the present levels shown in the SAM data. The technological growth rate of the Japanese economy was assumed to be 0 so as to make simulation simple and to show only the effects of climate change. The *TFP* of rice production was also set to 1, showing no progress in technology and no change in climate conditions.

CASE 1: This case represents future climate change that only affects rice production. The exogenous variables other than *TFP* were set to the same values as in CASE 0. $TFP_{r,t}$ was calculated by the future climate factors and changes in climate factors were predicted using the crop-growth model, crop-quality model, and hydrological model, along with the projection results of MIROC, high-resolution version 3.0 (K-1 Model Developers, 2004).

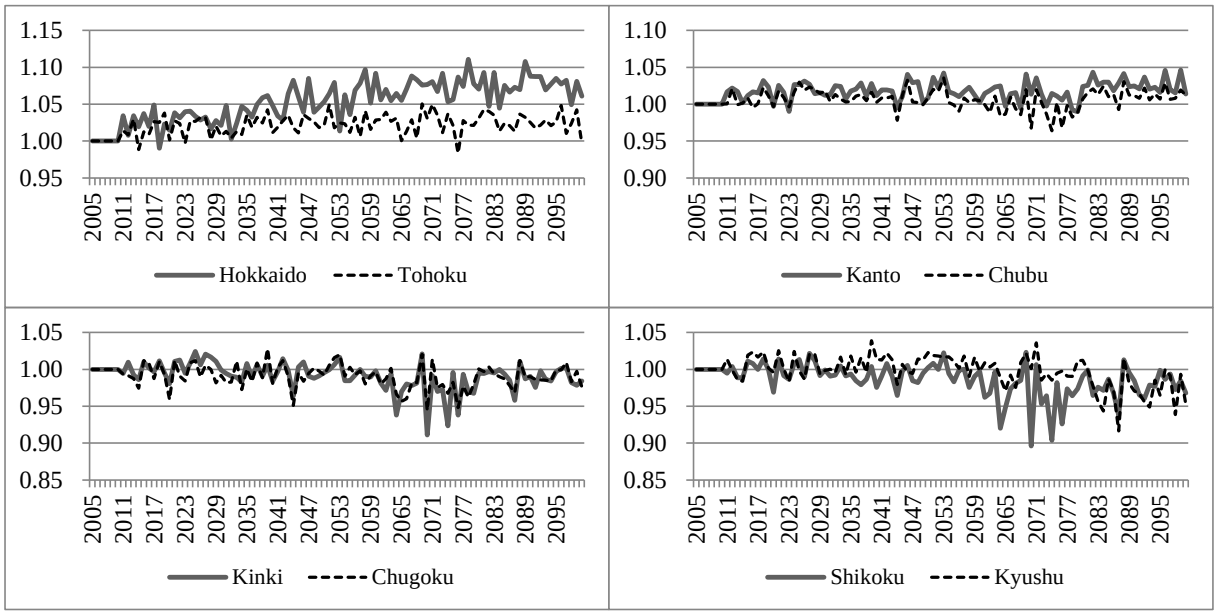
The greenhouse gas emission scenario was A1B which shows balanced growth with rapid economic growth, low population growth, and the rapid introduction of more efficient technology in the Special Report on Emission Scenario (SRES) (Nakicenovic and Swart, 2000). Figure 3 shows ratio of TFP/TFP' indicating influences of only climate change predicted by MIROC.

For both cases, the spatial substitution elasticities were set as 0.5: low spatial dependence (LSD) case, and 5.0: high spatial dependence (HSD) case. Simulation results, shown by the difference between CASE 0 and CASE 1, are compared by LSD and HSD cases.

3. RESULTS

To ensure the stability of the simulation results, a sensitivity analysis was conducted by changing the substitution elasticities of production and income elasticity values. The degree of impact changed, but the directions of the changes were the same for all variables. Therefore, the results presented below are reasonably stable and common, as long as there is no change to the economic structure.

Figure 3: Chronological Change in TFP under Climate Change (TFP / TFP')



3.1 Rice Production and Price

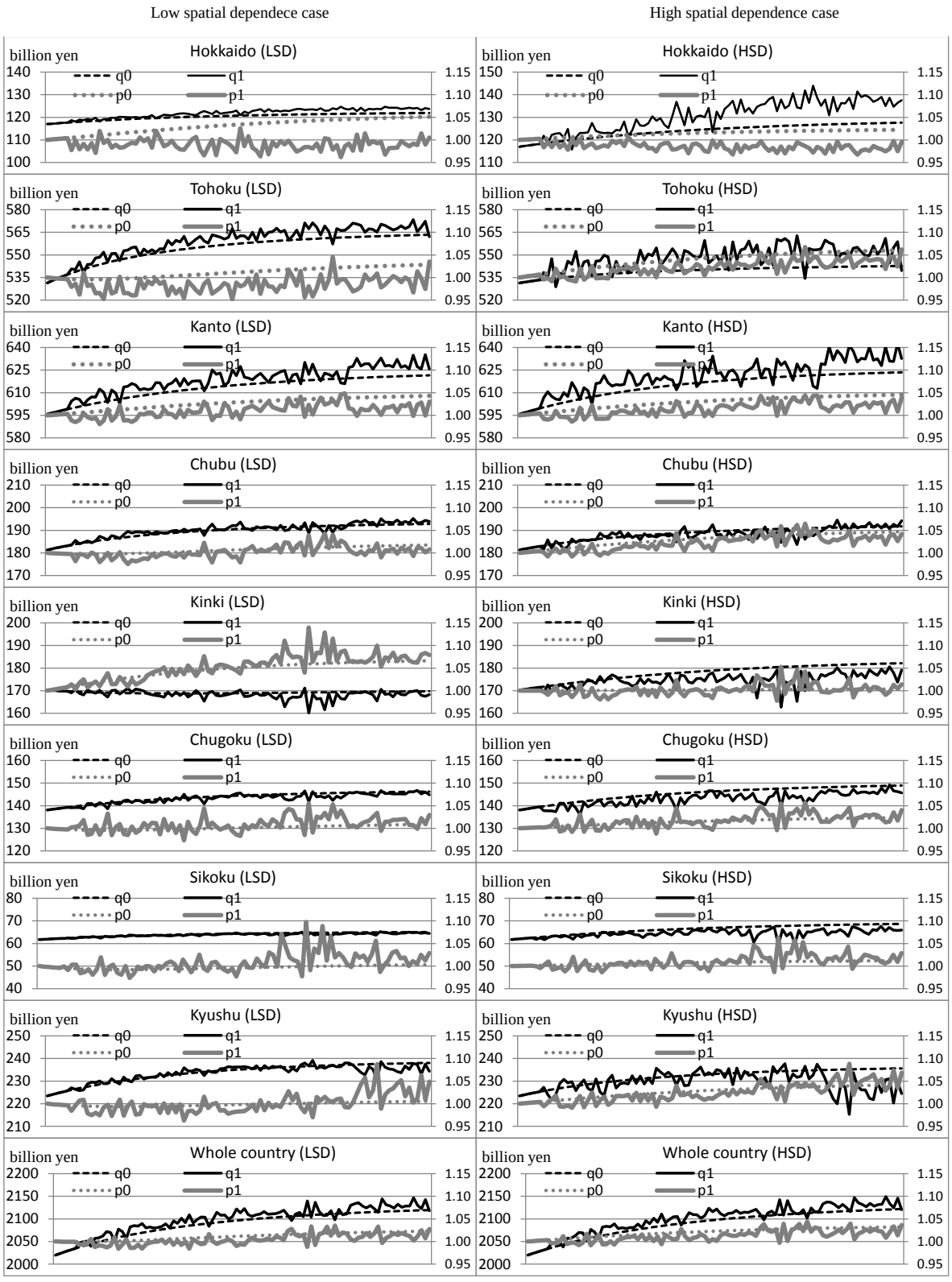
Figure 4 shows chronological changes in rice production and price, which were estimated using the CGE model with TFP changes. Although the exogenous variables were set as the status quo, rice production in CASE 0 increased as a result of an increase in capital stocks, which were endogenously accumulated by annual investment. The difference between CASE 1 and CASE 0 shows only the effects of changes in climate factors.

In accordance with the *TFP* changes shown in Figure 4, climate change increased rice production in the north and eastern regions, such as Hokkaido, Tohoku, and Kanto (including Niigata Prefecture). However, rice production decreased in the western regions, such as Kinki, Chugoku, Shikoku, and Kyushu. Annual production fluctuated under climate change, but the average growth rates in Tohoku and Kanto were higher than other regions, so the scale of vertical axis in these regions was 1.5 times bigger than that of the other regions. In these two regions, rice production amount was relatively large, so there were some capacities for these economies to allocate production resources to other sectors. In contrast, the growth rates of rice production in Kinki and Shikoku were low, because rice production in these two regions was small in comparison to other agricultural sectors and other industries.

Even in the north and eastern regions, production levels fell below the CASE 0 level in some years, with the exception of Hokkaido. Rice production in Hokkaido benefitted in almost all years, even under bad climate conditions. The western regions experienced worse production than CASE 0 in many years, but the difference between CASE 1 and CASE 0 fluctuated over time.

In contrast to production quantity, the price of rice decreased in the northern and eastern regions. Since rice consumption does not really increase, even after a decrease in price, the price dropped in those regions where production increased. This is because price elasticity of rice demand is low, which is common in food, and an imbalance in supply and demand is reflected in a sharp change in price. Such situations may be similar in other agricultural sectors, but no climate simulations were conducted for any other sectors.

Figure 4: Chronological Changes in Rice Production and Rice Price with and without Climate Change



Notes: 1. q0 and q1 are rice quantity in CASE 0 and CASE 1, and p0 and p1 are rice price in CASE 0 and CASE 1.

2. Okinawa is omitted because its rice production is almost zero.

The graphs of low spatial dependence (LSD) case marked larger fluctuation in rice quantities and smaller fluctuation in rice price, but the graphs of high spatial dependence (HSD) case had opposite tendency in quantity and price fluctuations. An increase in spatial dependence tends to equivalent of prices among regions by increasing regional trade.

The degree of fluctuation increased after 2050. Until then, climate conditions tended to increase the crop yield, but decrease crop quality. However, from the 2050s onwards, when temperatures were frequently beyond the threshold level, climate conditions decreased both crop yield and crop quality, showing agglomeration effects. Tohoku, Kanto, and Kyushu showed wider fluctuations in production, because their rice production amounts were larger than other regions. In the western regions, decreases in crop yield and crop quality became serious during the latter period of the simulation. This is largely because of negative agglomeration effects of temperature to rice TFP via rice yield and quality.

3.2 Agricultural Income

Table 1 shows average of changes in farmers' income (deflated by consumer price index), as affected by rental rate, wage, and capital service price. In the case of LSD, farmers' income decreased in the northern and eastern regions, where rice production increased after the climate change, but farmers' income in the western regions (decreased rice production) increased. This happened as a result of rice price changes, because price changed in the opposite direction to the changes in rice production and the degree of price changes was larger than the degree of production changes. This negative impact on overall income also became more serious in the latter period of the simulation. This corresponds to "Impoverishment of farmers because of a bumper harvest" (i.e. "Hosaku Binbo" in Japanese).

Table 1 Income of Rice Farmers (20 Years Average of CASE 1 - CASE 0)

(billion yen)

Regions	2005-2050		2050-2100	
	Low SD	High SD	Low SD	High SD
Hokkaido	−4.0	−0.4	−5.2	0.1
Tohoku	−12.6	−4.7	−13.9	−5.1
Kanto	−6.7	−6.8	−10.3	−6.3
Chubu	−0.7	−1.9	−1.3	−1.9
Kinki	0.2	−2.1	0.6	−2.0
Chugoku	0.3	−1.4	0.7	−1.0
Shikoku	0.2	−0.8	0.7	−1.0
Kyushu	−1.3	−2.1	4.7	−2.5
Okinawa	−0.0	−0.0	−0.0	−0.0
Whole	−24.7	−20.2	−24.1	−19.6
max-min	12.9	6.8	18.6	6.4

In case of HSD, almost all regions experienced negative impacts of climate change in farmers' income. Regional differences shown by maximum value minus minimum value among regions became smaller than LSD. Due to an increase in flexibility of regional commodity flows, influences of climate change equalized more among regions. Unfortunately, total rice production rose in whole country, so farmers' income in total was negative because degree of price decrease was greater than that of yield increase. Overall, climate change results in negative effects in farmers' income and an increase in spatial dependence of commodity trade causes negative effects in regions where farmers' income became positive under climate change in the case of LSD. Under bumper harvest in the whole country, the impoverishment diffuses to all regions via regional trade.

3.3 Gross Regional Production and Social Welfare Level

Table 2 and Table 3 respectively show the sum of gross regional production (GRP) and social welfare level represented by the equivalent variation during the simulation periods. In contrast to farmers' income change, changes in GRP and EV were positive in Kanto and Chubu. Kinki also experienced positive effects at the latter period of simulation. These regions have sizeable manufacturing industries, so the demand for manufacturing and service goods, which could increase by a shift of production factors from rice sector after the increase in rice *TFP*, became concentrated in these regions. Overall, the total GRP and EV values for the country increased due to climate change. However, Chugoku and Shikoku experienced minor losses in GRP after climate change, because the manufacturing sector is relatively weak in these regions. Kyushu turned its GRP and EV into negative in the latter period. This indicates that impacts of climate change in southern part of Japan cannot be overwhelmed by an increase in other industries.

Table 2: Sum of GRP by Regions (20 Years Average of CASE 1 - CASE 0)

(billion yen)

Regions	2005-2050		2050-2100	
	Low SD	High SD	Low SD	High SD
Hokkaido	0.9	3.9	−0.1	6.2
Tohoku	−4.7	4.6	−6.1	6.1
Kanto	29.0	17.2	39.5	22.7
Chubu	1.2	1.9	2.8	2.1
Kinki	4.5	4.1	3.0	2.6
Chugoku	−0.4	−0.1	−1.7	−1.0
Shikoku	0.2	−0.4	0.4	−1.2
Kyushu	0.1	−0.0	−3.2	−3.6
Okinawa	0.3	0.2	0.2	0.2
Whole	31.1	31.3	34.7	34.2
max-min	33.7	17.7	45.6	26.4

Table 3: Equivalent Variation (20 Years Average of CASE 1 - CASE 0)

(billion yen)

Regions	2005-2050		2050-2100	
	Low SD	High SD	Low SD	High SD
Hokkaido	−1.4	3.0	−9.2	18.3
Tohoku	−8.1	3.1	−40.7	17.7
Kanto	21.7	12.6	111.9	69.1
Chubu	2.0	1.5	10.2	7.3
Kinki	5.6	2.2	22.5	6.4
Chugoku	0.7	−0.4	1.1	−4.3
Shikoku	0.6	−0.5	4.2	−4.1
Kyushu	0.3	−0.1	4.3	−7.9
Okinawa	0.3	0.1	1.2	0.6
Whole	21.9	21.5	105.4	103.2
max-min	29.8	13.1	152.6	77.0

4. Summary and Conclusion

This study used the spatial CGE model to comprehensively evaluate the influence of future climate change on Japan's rice sector and regional economies. We built the recursive-dynamic spatial CGE model using multiple regions associated with the crop-growth model, crop-quality model, and hydrological model. This CGE model was used to simulate the future impact of climate change. Based on our simulation results, there are several policy implications.

The simulation results demonstrate that, first, future climate change will increase Japanese rice production for the country as a whole, but the price of rice will decrease. An increase in regional dependence increases changes in production and decreases price change caused by future climate change. Second, as a result of production and price changes, climate change makes the income of farmers in the rice sector decrease, despite the increase in production. Third, an increase in regional dependence decreased regional inequalities of GRP caused by climate change.

As such, impacts of climate change become different according to regional dependence in economy. To consider policy countermeasures against climate change, the spatial CGE model can provide useful information.

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Application of a Dynamic Inter-Sectoral Framework to Estimate Regional Employment

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ABSTRACT

Several attempts have been proposed in the literature to relax the restrictive assumptions of a standalone input-output model. Particularly, endogenisation of the household sector, which exhibits the highest constant returns to scale, has been continuously recognised as a key objective of such attempts. This objective increases in importance as we move from national to regional economies. Most of the studies in the literature collapse the intermediate demand information into a solo composite variable. The intermediate demand information serves as *a priori* data, which represents the inter-sectoral relationships within a regional economy. In this paper, estimation of sectoral employment by embedding *a priori* information into a host econometric model is discussed. In the first section, an input-output model is presented that allows for detailed and extensive data on inter-sectoral structure of the Illawarra economy. In the second section it is shown that use of a holistic embedded methodology in estimating dynamic and intensive labour changes in such a model relaxes some of the restrictive assumptions of the traditional input-output model and provides higher accuracy.

1. INTRODUCTION

In recent years, there has been an intensified decline in the traditional mining and manufacturing economic base of the Illawarra. The formerly recognized development policy design is for the regional planners to focus on analysing the significance of sectors that were once high-growth (Motii, 2005). Nonetheless, such a design undermines the future impact of the sectors with the potential to grow and contribute to the regional economy. Therefore, the need for analysing time-series of economic shifts while measuring the inter-sectoral impacts within the economy rises.[1] In this regard, the Illawarra econometric input-output model (IEIOM), which was developed in the University of Wollongong, plays a lively and critical role in this process (Masouman, 2014). Within academic, business, and government planning circles, IEIOM defines potentially high-growth sectors, and market resources and economic attractiveness in the Illawarra. IEIOM is a 5-component model, comprised of a standalone input-output table, a 5-block econometric model, a composite model, an embedded model and a linked model, all developed for the Illawarra economy. The results of the embedded methodology discussed in this paper are compared and contrasted to the results of the aforementioned models in Table 2 and Table 3 at the end of this paper.

[1] The terms inter-industry and inter-sectoral, meaning between industries/sectors, are interchangeable throughout this paper.

In regional Australia, the analytical attempts to form multipurpose economic tools have been undermined as the focus on traditional standalone models such as input-output (IO) analysis and computable general equilibrium (CGE) has increased. This popularity is partially due to the simplicity of the traditional models compared to more advanced multipurpose tools and partially because of the practical and theoretical differences between time-series and inter-sectoral approaches. There are several setbacks caused by this simplicity that have been criticised (Wilson, 1984; West, 1991; Conway, 1991; Rey, 1998; Motii, 2005). The standalone econometric models, on the other hand, have been criticised for ignoring important sectoral linkages (Freedman, 1981). Although inter-sectoral models can effectively model sectoral linkages within a region, they fail to capture economic shifts through time. Therefore, they are universally associated with poor dynamics and come short in validity testing.

The purpose of this paper is to present an evaluation of experiments with a type of regional model, called an embedded methodology. It is designed to incorporate the *a priori* information from the IO model into the econometric framework within a regional framework. Functionally, this means that a disaggregated inter-sectoral detail of IO is merged together with the flexibility and testability of an econometric model, without compromising the features of either methodology.

2. INPUT-OUTPUT ANALYSIS

The Leontief IO model in its basic form is constructed using a cross sectional set of observed economic data for a particular region. The main objective in IO modelling is capturing the interaction between industries that produce outputs and either the industries that consume those outputs in order to produce their own outputs (intermediate inputs) or the final consumers of those outputs (final demand vector). From a practical perspective the number of industries in an IO model can vary from only a few to hundreds and sometimes to thousands. The type of region can also range from a local government area (LGA) to a statistical division (SD), state, and national or even to international scale. The determining factor would be the desire for complexity over simplicity or vice versa. A more detailed IO model is generally preferable but this requires more data calibration requirements and results in a much more complex model.

The primary data utilised in an IO analysis centres around the expenditure flows related to the supply of products (output) from each industrial sector *i*, to each of the other industrial sectors, including *i* itself, that consume those products (input) in an economy, either to produce their own output (intermediary) or as final consumers (final demand vector). This central data on which an IO analysis is constructed is collected and implemented in an inter-industry transaction table. The construction of the basic IO analysis is the key purpose of this section. In general, an IO model consists of three basic tables, namely, the transaction table; the technical coefficients table; and the independent coefficients matrix (direct requirements table), which are analysed in the following subsections.

2.1. The Transactions Table

As described above, the primary data for construction of an IO model is contained in a transaction table, which is the focal point of an IO analysis. The transaction table depicts a snapshot of all the inter-sectoral transactions within an economy over a specific time period. The value of a particular sector's output that is purchased by other sectors as input is the main requirement for building a transaction table (Leontief, 1986). Although in theory inter-sectoral flows can be intuitively considered as physical units, in practice most IO tables are built based on monetary values of the expenditure flows due to numerous issues related to physical measurement.

The first step in construction of a transaction table is collecting a large volume of quantitative data. There are usually three different types of data, namely, survey-based regional coefficients; national proportion-based coefficients; and randomly generated coefficients, which can be used to build a transaction table. The types of surveys required to collect the survey-based coefficients are expensive and time consuming (West, 1995; West and Jackson, 1998), resulting in coefficients that are outdated before they are presented. As pointed out earlier, there is an inevitable time lag that occurs between the time of accumulation and the collation of large volumes of survey based data and the time that data is implemented in constructing the transaction table. This time lag is usually one year until all the survey based responses are converted to raw data and implemented in the table (Moghadam and Ballard, 1988). Hence by the time the table is built the containing data relates to the economic structure of the previous year. It is also important to note that regular update of IO tables can be highly challenging for regions that are undergoing major and continual structural adjustments and transformations. Therefore, a standalone IO table does not capture possible shifts that may have occurred in the structure of the economy during that one year, leading to the table being old before it is born. This means that not only is using survey-based data costly but, to inevitable time lags, it leads to measurement errors due to not capturing the most recent trends in economic structure.

In the transaction table the rows represent the flows of an industry's output throughout the economy and the columns represent the consumption of inputs required by a particular industry to produce its output. These inter-industry flows of goods and services form the grey portion of the table presented in Table 1. For example, let x_{ij} be an inter-industry transaction, where i is the sector which produces the product and j is the sector which purchases the product.[2] The horizontal figures (the rows) in the table represent the total sales and the vertical figures (columns) represent the inputs or purchases of each sector in relation to the other sectors. Since each figure in any row is also a figure in a column, the output of each sector is also an input in another. The last four columns contain details of Final Demand, consisting of sales to households, investment, government and net exports expenditure, which is the monetary value of exports less imports.

From a practical perspective the output of sector i may be used within the same sector i, sold as an input to sector j, or sold to one of the final demand elements. For example, financial services are sold to the financial services sector itself; it is also sold to all other sectors as business financial facilities as well as to final demand elements as personal financial services. After all inter-sectoral purchases and sales are entered in the table; total sectoral output must equal total sectoral input.

2.2 The Technical Coefficients Table

Although the transactions table provides a detailed snapshot of the inter-sectoral structure of an economy it only considers a trend of inter-sectoral connectedness over a given time period, and is, therefore, not very accurate for economic impact analysis (Moghadam and Ballard, 1988; West, 1995; Rey, 2000). A technical coefficients table is required in order to use IO analysis to investigate how production adjustments in each sector behave in response to a change in final demand.

The technical coefficients table represents the production function for each producing sector in the economy. Such a table depicts the monetary value of inputs purchased from n sectors in the economy per monetary unit of output in sector i. For a given sector i, technical

[2] This is fully explained in the following context.

Table 1: Input-Output Transactions Table

		Producers as Consumers								Final Demand			
		Agri-culture	Mining	Const-ruction	Manu-facturing	Trade	Trans-portation	Services	Other Industries	Personal Consump-tion	Private Domestic Investment	Govtern-ment Purchases	Net Exports
Producers	Agriculture												
	Mining												
	Construction												
	Manu-facturing												
	Trade												
	Trans-portation												
	Services												
	Other Industries												
Value Added	Employees	Employee Compensation								Gross Domestic Product			
	Business Owners	Profit-Type Income and Capital Consumption Allowances											
	Government	Indirect Business Taxes											

Source: The author, based upon the IO Transaction Table used by the US Department of Commerce, Bureau of Economic Analysis, 2010.

coefficients show the value of purchases from each of the n sectors in the economy that is purchased by the sector *i* in order to produce one monetary unit worth of *i*'s output. As a result, technical coefficients can be computed by dividing all entries in each sector's column by the total value of purchases of that sector. In other words, if x_{ij} denotes the value of sales from sector *i* to sector *j*, and x_j denotes the total output of sector *j*, the technical coefficients, symbolized by a_{ij} for each sector is computed by equation (1):

$$a_{ij} = x_{ij}/x_j \quad (1)$$

A technical coefficients matrix, or sometimes called a structural matrix, is a rectangular table composed of a complete set of all sectoral input coefficients in an economy. These coefficients can be adjusted by the adjustments in intermediate demand for output of industry *i*. The technical coefficients table provides a quantitative picture of the internal structure of an economy (Leontief, 1986). The secondary demand on the output of *n* industries that supplies industry *i*'s suppliers can be computed through the sequential outputs in the technical coefficients matrix. In a practical sense, the impacts of any shock in the economy are spread through to the rest of the elements in the economic structure, sector by sector, through a series of transactions that link the whole sectoral structure.

2.3 Independence Coefficients Matrix

The central part of the three IO matrices for economic analysis purposes is considered to be the interdependence coefficients matrix (Miller and Blair, 1985; Leontief, 1986). The independence coefficients measure the total, namely, direct and indirect, required outputs produced by *n* sectors in order for sector *i* to produce, or sell, one monetary unit to any of the elements in the final demand vector. It, therefore, measures the total impact of a change that occurs in final demand for the sector i's output on the output of n sectors in the economy after the entire effects of output increases have been recorded. Algebraically speaking the output flow structure takes the form of equation (2):

$$X + M = A_X + F = A_X + f^C + f^G + f^i + f^V + f^{NE} \quad (2)$$

where $X + M$ on the left hand side, represents the total supply of commodities by a sector and the right side represents the total demand for outputs where:

X denotes an *n*-vector of total sectoral output;

M denotes an *n*-vector of sectoral imports;

A_X denotes an $n \times n$ matrix of technical coefficients, where the a_{ij} denotes the amount by which sector *i*'s output is used as input by sector *j* per unit of output;

F denotes an *n*-vector of sectoral output used by final consumers;

f^C denotes private consumption which includes households and private not-for-profit institutions;

f^G denotes government expenditure;

f^i denotes gross fixed capital formation by production sector, i.e. investment;

f^V denotes changes in inventories plus statistical error;

f^{NE} denotes net exports, i.e. total exports – imports.

Equation (2) determines the total output produced in the entire economy given the level of total final demand for outputs, namely, private consumption, government expenditure, investment, changes in inventory, and net exports. As described before, the inter-sectoral

relationships in the economy was defined by equation (1). Therefore this equation can be rearranged into:

$$x_{ij} = x_j \times a_{ij} \tag{3}$$

This means that x_{ij} (the level of sales from sector i to sector j) is dependent upon x_j and a_{ij} (respectively, the level of output in sector j and the technical coefficient of input requirements of sector j from sector i). Hypothetically, if the Illawarra economy contains only three producing sectors; the final demand vector is denoted by F; the technical coefficients matrix is denoted by A; and the sectoral output vector is denoted by X; the transactions of the producing sectors can be formulated in a set of simultaneous equations as in the following:

$$\begin{aligned} x_{11} + x_{12} + x_{13} + F_1 &= X_1 \\ x_{21} + x_{22} + x_{23} + F_2 &= X_2 \\ x_{31} + x_{32} + x_{33} + F_3 &= X_3 \end{aligned} \tag{4}$$

where x_{ij} denotes sales from sector i to sector j; F_i denotes sales from sector i to final demand; and X_i is the total output of sector i.[3]

Substituting equation (3) into equation (4) and rearranging them to investigate the producing sectors (i = 1, 2, 3) we obtain:

$$\begin{aligned} a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + F_1 &= X_1 \\ a_{21}X_1 + a_{22}X_2 + a_{23}X_3 + F_2 &= X_2 \\ a_{31}X_1 + a_{32}X_2 + a_{33}X_3 + F_3 &= X_3 \end{aligned} \tag{5}$$

Equation (5) represents sectoral interdependence as it depicts the effects of an increase (decrease) in the level of output in all sectors as a result of an increase (decrease) in the level of output in each sector. In other words it depicts the interconnectedness of the economy. Likewise it depicts the relatedness of the input requirements of each sector relevant to the level of its final demand. For example, consider F_i the final demand for sector i, and exogenous to the producing sectors in the following expression:

$$\begin{aligned} X_1 - a_{11}X_1 - a_{12}X_2 - a_{13}X_3 &= F_1 \\ -a_{12}X_2 + X_2 - a_{22}X_2 - a_{33}X_3 &= F_2 \\ -a_{31}X_1 + a_{32}X_2 + X_3 - a_{33}X_3 &= F3 \end{aligned} \tag{6}$$

Factoring the X's from the equations above, we have:

$$\begin{aligned} (1-a_{11})X_1 - a_{12}X_2 - a_{13}X_3 &= F_1 \\ -a_{21}X_1 + (1-a_{22})_2 - a_{23}X_3 &= F_2 \\ -a_{31}X_1 - a_{32}X_2 + (1-a_{33})_3 &= F3 \end{aligned} \tag{7}$$

We can simplify equation (7) into the following matrix format:

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} (1-a_{11}) & -a_{12} & -a_{13} \\ -a_{21} & (1-a_{22}) & -a_{23} \\ -a_{31} & -a_{32} & (1-a_{33}) \end{bmatrix} \times \begin{bmatrix} F_1 \\ F_2 \\ F_3 \end{bmatrix} \tag{8}$$

[3] In the entire matrix mathematical notations throughout this text, the terms i and j take on any value to denote different sectors. For example, in equation 4, x_{11} denotes i = 1 and j = 1; x_{12} denotes i = 1 and j = 2 and so on. Likewise, F_1 denotes i = 1; F_2 denotes i = 2; and so on.

and we can then denote equation (8) by the following expression:

$$(I-A)\times X = F \tag{9}$$

We can then multiply each side of the equation by $(I-A)^{-1}$, which then gives us X (sectoral output) as a function of F (final demand):

$$X = (I-A)^{-1}\times F \tag{10}$$

Equation (10) is the main IO system through which we can find the effects of changes in final demand elements on the level of sectoral output. The $(I-A)^{-1}$ is known as the matrix of interdependence coefficients (inverse Leontief matrix) which measures the direct and indirect output levels produced by each sector in the economy given the levels of final demand components. $(I-A)^{-1}$ is also known as the multiplier matrix because it indicates the direct and indirect requirements of input-output per unit of sectoral final demand.

Although the dynamic types of IO analysis are much closer to the actual processes of an economy compared to the static (traditional) type, it requires data on the flow of building allowances;[4] capital equipment; dwellings; goods; household stocks of durable consumer goods; and inventories of goods (work in process and in finished form). This type of data may be available at the national and state levels, but are impossible to find at the regional level. Furthermore, it requires unconventional mathematical approaches such as linear differential equations instead of ordinary linear equations to run such dynamic IO models. As a result the static method described above is integrated with a regional econometric model, which will be discussed in the subsequent sections, to track the dynamics of the Illawarra economy.

3. EMBEDDED METHODOLOGY

In the embedding strategy, the intermediate demand components of an IO model are incorporated into a host econometric model. Most of these models disintegrate the intermediate demand information into a single composite variable and reflect them as prior information. This prior information represents the inter-sectoral interactions among industries of a regional economy.

Moghadam and Ballard (1988) developed an Integrated-Small Area Modelling of the Industrial Sector (I-SAMIS) for Northern California, aiming to gain the benefits or dynamic qualities of EC as well as the precision of inter-industry matrices from IO. The data applied in their model are time-series and matrix data. Moghadam and Ballard (1988) chose employment data only for their particular sub-state region, albeit output data is more comprehensive and preferable for larger regions. Because of their long-term forecasting they used annual data from 1962 to 1985. Although they faced two issues for their model, namely a shortage of adequate data and significant mixture of economic facets along the chosen region and its consisting sectors, the outcome of the analysis proved the embedded approach to be quite practical for regional modelling in terms of forecasting and impact analysis.

In a similar study to Moghadam and Ballard (1988), Coomes *et al*. (1991) implemented the I-SAMIS approach for evaluating the impacts of taxation policies and economic development proposals on different levels, i.e. city, county and state, for the economy of Louisville. They applied a non-survey regional IO model and used information obtained from the direct requirement coefficients of an IO table to estimate the input linkages between a certain industry and all other industries at any point of time. As suggested by Moghadam and Ballard (1988), Coomes *et al*. (1991) used regional employment as a substitute for output to calculate inter-industry linkages. They concluded that although I-SAMIS is not currently the main

[4] The terms building allowances and building approvals are used interchangeable throughout this text.

influential factor for policy makers to weigh their options, it is unquestionably an appropriate method for policy makers to use in selecting policy alternatives and it is also appropriate for urban regions with similar characteristics.

Following the embedding approach, Stover (1994) argued that coefficients of an IO model change as a result of relative changes in technology, demand, prices, flows of trade, etc. Stover implemented an I-SAMIS technique and applied Inter-industry Demand Variables (IDV) to measure the use of an industry's output by other industries in the region, and applied an IO model to calculate the amount of the output. The model employed annual employment data for the manufacturing sector in the St. Louis metropolitan area. The findings showed that applying a single year IO account ignores structural changes over time when analysing highly aggregated regional industries, which leads to the occurrence of measurement errors. This study showed that the use of several annual IO models significantly increases the necessary computations to break down the coefficients for the regional level. This factor suggests that unless there is evidence of significant changes in input usage between sectors over time, it is not recommended putting much effort into the enormous calculations.

Most recent studies have highlighted the combined benefits of IO and EC in an embedded approach, as a response to the growing concern over non-inter-industry modules of regional economies such as consumption, investment, government, labour demand, expenditures, and income distribution. Rey and Jackson (1999), for example, add to the literature focused on the methodological issues associated with the integrated framework. The embedding approach of Moghadam and Ballard (1988), IDV, has been developed by a line of studies in the integration framework (West and Jackson, 1995; Israilevich *et al*, 1996; Rey, 1998). The IDV method has one drawback: there is no multi-dimensional consistency among its model components (Rey and Jackson, 1999). Rey and Jackson (1999) substitute a Dynamic Inter-industry Employment Demand Variable (DIEDV) for the original IDV in order to address the productivity variations in the model through an embedded IO-EC model, performed on the San Diego metropolitan area. Their findings show that inter-industry linkages, local and export final demands are important in determining regional employment; however, a collinearity problem occurs between these drivers. The study results show that extending the static regional labour productivity in the embedded model is useful to take changes into account and thus provide more accuracy. Also, dynamic adjustments are necessary to avoid overestimation of impact effects in labour productivity (Rey and Jackson, 1999). The issue of multicollinearity between inter-industry variables and macro-variables is not fully addressed in their study. Also labour productivity is practically endogenous, which requires further research in this area.

One of the most recent works on the embedding strategy is the Dynamic Integration Approach (DIA), which is essentially an extension to the work of Moghadam and Ballard (1988) mentioned earlier (Motii 2005). Motii (2005) applies regionalized coefficients in his approach and implements time-series variables to examine the connectedness of the industrial sectors within the economy. Data applied in this model is quarterly adjusted employment levels in the private sector (excluding farms) for the state of Oklahoma over the time period 1972 to 1994. Motii (2005) extends the embedding model by applying a dynamic Intermediate Employment Demand Requirement (IEDR) component, a Cost Adjustment Factor (CAF), and final demand (final local and national demand, or activity variables) component. There is a noticeable decrease in multicollinearity due to the variance inflationary factor. The outcomes of the analysis suggest that the precision of the projected figures provided by the DIA model places it in a superior position compared to that of ADIA and other integrated embedded models. However, there is still room for improvement in terms of pragmatic examination for different time periods or different regions.

All the existing embedded models can be grouped into two different classes with respect to the treatment of inter-sectoral linkages that are incorporated from the IO module into the econometric host. The first class would apply an overall methodology, where intermediate input demand information is embedded into the econometric framework as one variable, which works as a proxy for all the inter-sectoral demand linkages. The second class, namely the partial methodology, would only embed the inter-sectoral linkages that are considered significant and relevant. These linkages are disaggregated before being incorporated into the econometric module. Building an overall methodology is less complex than the partial methodology. Nevertheless, models in partial methodology are argued to be more accurate (White and Hewings, 1982; Glennon *et al*, 1987; Glennon and Lane, 1990; Magura, 1990). There is an extensive literature on the embedded models classified on this basis.

To summarize this section, a review of the embedding approach literature suggests that it is less data intensive than the composite approach of integration (Conway, 1991; West, 1991; Motii, 2005). It is more suitable for less diversified economies for employment forecasting and one of its features is that it generates estimated impacts that are concentrated in specific industries within particular regions where it is of interest.

4. ILLAWARRA EMBEDDED APPROACH

The Illawarra embedded approach can be viewed as an extension of a regional econometric model. Among the integrated models available in the literature, the embedded approach uses the least amount of time-series regional data and thus is most suited towards modelling a region with the characteristics of the Illawarra. Hence it is necessary to re-review some of the important characteristics of the current operational embedded models before we begin discussing the procedure for the Illawarra embedded models. A characteristic common among all the embedded models is their objective of representing the inter-sectoral linkages that represent the foundation of a regional economy. Embedded models attempt to model these linkages within a dynamic framework.

Inter-industrial linkages indicate the network through which each sector services the other. Firms purchase goods and services (inputs) from firms within the same region in addition to the firms outside the region (White and Hewings, 1982). The original notion of such linkages is formed by regional IO models, albeit regional IO models are limited to a single temporal observation and thus fail to capture the dynamic structure of changes in technology as the regional economy evolves through time (Czamanski, 1971; hUallacháin, 1984; Howe, 1991). On the other hand, regional econometric models are dynamically oriented in that they provide a mechanism for incorporating technical change;[5] nonetheless, they are criticised for not explicitly reflecting inter-industry transactions that take place within the economy (Moghadam and Ballard, 1988). It is argued that regional econometric models' representation of the economy is an overly simplistic view of economic interactions and does not address or incorporate many critical variables (Wilson, 1984). Hence the objective of developing an embedded approach is to capitalize on the merits of the two mainstream models, namely the detailed inter-industry analysis and the dynamic representation of market variables, so as to relax the restrictive assumptions of each.

The reason why this integration methodology is called embedding is because the *a priori* inter-industry linkage from an IO module is "embedded" into an econometric framework to improve its forecasting accuracy (Moghadam and Ballard, 1988). Hence, another characteristic common among such models is their domination by an econometric module.

[5] This means that they are based on time-series data and track structural changes through time.

The only input from the IO analysis, the *a priori* information, is solely employed to identify important inter-industry linkages. After incorporating the linkages in the econometric equations we can estimate sectoral employment EMP_i and sectoral output X_i. Since the main channel of integration in the embedded methodology is based on an employment/output estimate the extent of integration is much less significant compared to the composite methodology (Conway, 1991) referred to earlier. Here, the channels of integration are restricted to demand-production and production-income yet, unlike the composite methodology of integration, there is no income-demand channel in the embedded methodology. This is because of a dearth of data on consumption and non-residential investment for the Illawarra region. The main objective for building an embedded framework for this paper is to investigate the impacts of hypothetical policies on employment and income with superior accuracy derived from the *a priori* information.

As pointed out earlier there are three reasons why the embedded approach has gained increased popularity compared to the other two integrating methodologies. Firstly, the embedding methodology is the least data intensive compared to the other two integrating methodologies. Also, the focal point of the embedding approach in the existing models has been on employment (Moghadam and Ballard, 1988; Coomes *et al*, 1991; Stover, 1994; Rey, 1998; Motii, 2005). This explains the second reason for its popularity, as employment is by and large the main policy variable and a key element of the income variable. Finally, due to the dearth of sectoral output data at the regional level, models applying employment data are more widely feasible. Hence, there are a number of extensions and modifications of this methodology in the regional science literature (Duobinis, 1981; Moghadam and Ballard, 1988; Coomes *et al*, 1991; Stover, 1994; Rey, 1998; Motii, 2005). In this study, the embedded model's algebraic notation, which aside from the regional econometric model is an extension of Moghadam and Ballard's (1988) work and another methodological contribution of this study, is based on the following specification:

$$EMP_t = \beta_0 + \beta_1 V_t + \beta_2 Z_t + \beta_3 ID_t + \varepsilon_t \quad (11)$$

where EMP_t is employment at time *t*,[6] estimated by a function of local V_t, external Z_t and inter-industry ID_t variables. V_t represents local macro economy variables, both endogenous and exogenous, such as total personal income, population, wage rates, etc. Z_t represents national and other external variables that can impact the region. These variables can be either sectoral estimated coefficients that establish the elasticity between the region and the nation as well as certain policy variables that are important in industries where the Illawarra significantly differs from the rest of the Australia, such as steel or the education industry. Finally, ID_t represents inter-sectoral values and IO linkages, which measures the demand for the output of one industry from the other industries within the region.

In the embedded approach the number of sectors (denoted by *n*) can be equal to or greater than the number of time series observations (denoted by *t*) available for estimation.[7] Therefore, there can be an unlimited number of estimations for all the inter-sectoral coefficients in equation (11) albeit this would be impractical. Thus restrictions are to be placed on the inter-sectoral coefficients in an attempt to limit the number of unknown parameters that are estimated. As a result the models in the embedded category can be separated based on two main methodologies. The criterion for forming these methodologies relates to the role that the *a priori* information plays in specification of these restrictions.

[6] EMP_t can also be replaced with X_t which denotes output.

[7] In the case of the Illawarra this number is 20.

The methodologies are formed based on the degree of inter-sectoral linkages that are incorporated in the specification of the equations. The methodologies can be either partial or overall with respect to the treatment of the inter-sectoral relationships.[8] There can be a further categorization of these two methodologies based on the relative extent of the restrictions that are imposed on the coefficients that represent the inter-sectoral linkages in each methodology. There are two forms of restrictions on coefficients: light and fixed. The overall decision is made based on two criteria. The first criterion relates to the number of inter-sectoral relations that the restrictions determine should appear in equation (11). The second criterion relates to the form of each of the inter-sectoral relations that is included in equation (11). As discussed in earlier sections, the partial methodology requires a highly complex procedure due to the unlimited number of inter-sectoral linkages that can be involved and suffers from a lack of regional data. Therefore, it was decided to apply an overall methodology for incorporating inter-sectoral linkages from the Illawarra IO table into the econometric host module for this paper.

There are four different forms of the embedded models developed for the Illawarra region (all applying an overall methodology for the treatment of inter-sectoral linkages). The distinction is in the approach is based on the inter-industry linkages which are defined. The four different forms are:

1) Dynamic intermediate demand variable (DIDV)
2) Dynamic intermediate employment demand variable (DIEDV)
3) Illawarra dynamic intermediate demand variable (IDIDV)
4) Intermediate employment demand requirement (IEDR)

The first two forms employ the national IO coefficients in determining the relevant demand variables. The third form substitutes the national coefficients with regional IO coefficients that are developed by the location quotients (LQ) approach explained in the following text. The last form employs a cost adjustment factor to account for the relative wage and productivity differences between a specific year's regional and the benchmark year's national economy. In both DIEDV and IEDR models an element is added to account for labour productivity adjustments denoted by E. In DIDV and IDIDV models the inverse productivity term is eliminated. All the embedded models for the Illawarra are dynamic. Each model is thoroughly discussed in the following text.

The four different versions of the embedded model represent different embedding approaches appearing in the literature, providing insight on four key characteristics with respect to the specification of the IDV and cost adjustment factor in the model. These characteristics relate to the model's performance in terms of:

1) The choice of coefficients being from national or a regional IO table in developing the IDV.
2) The choice of including labour productivity adjustments for differentials across sectors in developing the IDV.[9]
3) The choice of including a cost adjustment factor in developing the IDV.

The estimates in Table 2 show the forecast MAPEs for total employment obtained from the four different IDV approaches compared to the composite and econometric models. A review

[8] Partial and overall are called partitive and holistic by Rey (1997) and Motii (2005), respectively.

[9] This refers to the labour productivity adjustments specified in the embedded model equations discussed earlier.

of the estimated MAPEs indicates that there is a noticeable improvement in the forecasting performance when we shift from a standalone econometric model to the integrated framework. Section 5 provides a detailed discussion of the results obtained from the embedded model and the other four component modules of the IEIOM, which was mentioned in the introduction section.

5. DISCUSSION OF THE RESULTS AND CONCLUSION

In embedding *a priori* information from inter-industry linkages into an econometric host one has to choose between national proportion based coefficients or regional proportion based coefficients. The relative performance of the two versions differs very subtly if both versions are based on static forecasting. Nevertheless, this property does not fare as well when the coefficients are specified dynamically as is the case for the Illawarra embedded models; where the national proportion based version (DIDV) shows superior performance compared to the Illawarra proportion based coefficients (IDIDV) in forecasting total employment. To top the superior performance of the DIDV we include labour productivity adjustments to obtain the dynamic national model (DIEDV), which clearly dominates the comparison in forecasting total employment.

The superior performance obtained from using dynamic coefficients indicates the importance of capturing variations in IO coefficients over time. The dynamic IO coefficients in these versions of the embedded model are based on extrapolation of past annual national tables from the Australian Bureau of Statistics. Nonetheless, the results in other studies indicate that not all the models applying dynamic coefficients show superior performance compared with models applying static coefficients. Studies show that in forecasting total employment regionalized versions of the IDV in static versions show a lower MAPE than the dynamic version, such as IDIDV. Due to the ability of dynamic models to track adjustments through time, dynamic models top comparison studies in forecasting. This indicates that the DIEDV version shows a lower MAPE than the static models of the IDV. These findings are in general agreement with those reported by Stover (1994), Rey (2000) and Motii (2005) which show that capturing the dynamic characteristics of IO coefficients will not necessarily always result in enhanced accuracy of the model.

Attention now turns to the comparative performance of the embedded versions with respect to the inclusion of labour productivity adjustments and cost adjustment factors. Among the four embedded models chosen for this study, namely DIDV, DIEDV, IDIDV and IEDR, the models applying labour adjustment perform more accurately in total employment forecasts. These results are in line with those from Coomes *et al*. (1991), Rey (2000) and Motii (2005) showing that forecasting performance is not sensitive to labour productivity adjustment yet sensitive to cost adjustment factors. This paper is concluded by Table 4, which provides the results from the ex-post forecasts with regards to employment, income, and output for 2011.

In the two versions of the embedded model for this analysis the estimated industrial linkages are less extensive because the employment demand equations depend on econometric specifications rather than on the deterministic inter-industry identities of the IO. This resembles the structure of the variation in the performances of the composite and embedded models across different sectors reported in the previous section. Nonetheless, with respect to policy implications,[10] which will be discussed in the next section, it is wise for modellers to substitute the less disaggregated total employment forecasts of the embedded models with a

[10] In policy analysis, a detailed picture of the distribution of impacts across industries is important. This is because designing a mechanism for structural adjustment needs to consider the realistic impacts of potential policies (e.g. education and training conversion mechanism).

more disaggregated mechanism of the composite model, subject to data availability. This is because of a twofold advantage that the composite model offers. Firstly, the higher level of inter-sectoral details and re-iterative process of estimating the sectoral information for 20 annual observations; secondly the socio-economic block of the econometric model applied in the composite, both of which lead to higher accuracy for a more realistic policy impact analysis.

Table 2 depicts the difference between the total employment estimates from the baseline and impact simulations for each model. For example, according to the impact analysis based on the DIA model there would be a total of 11,928 more jobs in the Illawarra economy over the two-year period. This amounts to an average annual difference of 5,964 more jobs due to the increase in expenditure.

Table 2: Mean Absolute Percentage Errors for 2011-2013 Forecasts of Total Employment

	Econometric	Composite	IDIDV	DIDV	DIEDV	IEDR
MAPE	5.094	3.913	6.322	1.718	1.667*	1.531**

Notes: ** The model with the lowest MAPE. * The model with the second lowest MAPE.
Source: Estimated and created by the author.

Table 3: Mean Absolute Percentage Errors for 2011-2013 Forecasts of Sectoral Employment

	Econometric	Composite	IDIDV	DIDV	DIEDV	IEDR
Median Sectoral Employment MAPE	6.941	3.519**	5.172	6.525	5.754	4.425*
No. of Sectors with lowest MAPE	4	9	7	5	3	8

Notes: ** The model with the lowest MAPE. * The model with the second lowest MAPE.
Source: Estimated and created by the author.

Another set of conclusions drawn from the estimated results is to consider the ex-post forecasts of employment, income, output, population, gross regional product (GRP) and personal consumption expenditure (PCE). Table 4 depicts the results of the ex-post forecast for 2011 based on the n=20 observations from 1990 to 2009 compared with the actual data for 2011. The demographic data on cumulative employment and population are derived from the econometric module of the Illawarra embedded model. It is essential to note that these estimates are not regarded as multipliers in the conventional sense, because the *a priori* information is introduced in the region in a way that the models exclude domestic inter-regional linkages (employment migration from Sydney and neighbouring regions). Hence, the estimated forecasts do not represent the exact intra-regional or inter-regional effects. Yet, the forecasted results feature a high level of accuracy and are more beneficial for regional planning and economic forecasting purposes compared with traditional models.

Table 4: Comparison of the Results of the Integrated Model with Actual Results

	Summary Data from the Integrated Framework	Actual Data
Illawara	*2011*	*2011*
Employment	115,343	119,441
% Australia	1.147%	1.187%
Personal Income	$5,978,345,000	$6,306,265,000
Output	$26,983,742,983	$27,533,932,000
Population	279,392	290,648
% Australia	1.220%	1.269%
Gross Regional Product	$13,569,535,444	$14,214,545,000
Personal Consumption Expenditure	$10,183,920	$10,914,610

Source: The integrated results are estimated by the author; the actual results are obtained from Australian Bureau of Statistics (ABS 2013).

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Understanding the Australian Organic Food Consumers

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ABSTRACT

The average Australian expenditure on fresh fruits and vegetables is only about 0.1% per week of total food and non-alcoholic beverage expenditure. This has a current challenge towards a long-term sustainability of the organic farms and organisation. The aim of this paper is to segment the Australian consumer markets by taking the four major market segmentation dimensions, including, demographic, geographic, psychographic and behavioural dimensions. A number of variable of each of these dimensions were considered, and subsequently, a nationwide survey was conducted and various statistical tools were used to analyse the dataset. The key market segmentation variables for the Australian organic food market are: gender, age, annual household income, educational qualification, state-territories, metro-regional, retail outlets, personal values, self-image and personality traits, perceptions about organic foods, usage rate, loyalty status and user status. This study has explored and identified the key segmentation variables for the Australian organic food market. The Australian organic farms and organisations aiming for a sustained presence could consider this study as a basis of the future and strategic marketing plan.

INTRODUCTION

The Australian organic industry continues to command a relatively small percentage of total market value within the conventional food and beverage industry in Australia that worth an estimated value of $130.3 billion, as opposed to the organic food market with an estimated market value of 1.56 billion (Monk *et al*, 2012). The current organic food market share, in comparison to total food and beverage consumption is small, and this is 0.8 to 1.2 per cent (idem). The average Australian expenditure is just over A$20 per week (or about 0.1 per cent of food and non-alcoholic beverage expenditure per week) on fresh fruit and vegetables, and over A$95 on alcohol, tobacco products, soft/carbonated drinks, and takeaway and confectionary food items (ABS, 2012). The organic food market share is relatively lower in comparison to total food and beverage consumption across many countries. For example, the current literature estimates that the sales of organic food relative to total food sales hold an estimated market share of 0.08 per cent in China (Zhou *et al*, 2013) and 4 per cent in the United States of America (Organic Trade Association, 2011).

Over the last two decades, studies in marketing of organic foods have been based on a number of theoretical approaches that may broadly be classified into demographics, marketing mix variables, product attributes, and consumer values, attitudes and behaviours. These studies demonstrated empirical evidences from the USA, the UK, Denmark, China, Hong Kong, Australia and many other countries. However, research in organic food market segmentation

is relatively scarce. This paper aims to segment the Australian consumer markets by taking the four major variables: demographic, geographic, psychographic and behavioural variables following the suggestions of the current studies (Kotler *et al*, 2013; Liu *et al*, 2014).

2. LITERATURE REVIEW

Market segmentation is the division of the total market into homogenous segments of consumers with similar needs and wants (Liu *et al.*, 2014). Jain, Haley, Voola, & Wickham (2012) discussed about a number of factors that contribute to segment a consumer market, such as, demographic factors (age, income, sex, etc.), socio-economic factors (social class, stage in family life cycle stage), geographic factors, psychological factors (personality traits, lifestyle), consumption patterns (heavy, moderate and light users), perceptual factors (benefit segmentation, perceptual mapping) and brand loyalty patterns. However, research states that consumer personalities, values and lifestyles are some of the important variables that also contribute in segmenting a consumer market (Liu *et al.*, 2014). The aim of market segmentation is to serve the needs and wants of each subgroup more effectively and efficiently, and it helps marketers to target one or more segments and positioning their products and brands (Kotler *et al.*, 2013).

Demography–wise, the current research finds that generally wealthy families, empty nesters and women tend to buy organic foods (Padel & Foster, 2005). Particularly, women were found to be the core buyers of organic food though health conscious men were also found to be increasingly interested in organic foods (Lockie, Lyons, Lawrence & Mummery, 2002).

In relation to marketing mix variables, the current research is inconclusive. For example, Fearne (2008) found that the most frequently cited barriers are price, availability and appearance. However, some studies also stated that affordability, lower income and high organic food price may not act as barriers to commitment to organic food purchasing behaviours (Chang & Zepeda, 2005; Grunert, 2007). Affordability and high price of organic foods are often dependent on per capita income, attitudes toward organic food products, personal values and commitments, availability, retail structure and storage facilities, climatic and geographic conditions and cost of producing organic foods. A number of studies also found availability as a commonly stated barrier to organic food products purchases (Lockie *et al.*, 2002; Shepherd, Magnusson & Sjödén, 2005). Organic food production, warehousing and distribution also require special care. As a result, the final organic food product is often priced at a high level for its niche and small market relative to a conventional food item for its mass market. As a result, marketing mix variables and their contributions toward organic food consumption may vary across nations and the evidence in current literature in relation to price, availability and appearance is anecdotal.

The current literature also stated that a lack of information about organic food act as one of the major barriers to consumer purchasing more of it (Harper & Makatouni, 2002; Yin, Wu, Du, & Chen, 2010). Research shows that consumers would like organic foods to have marketing information, such as, nutritional and country of origin information on product labels as opposed to conventional food items (Caporale & Monteleone, 2004; Kihlberg, Johansson, Langsrud, & Risvik, 2005). However, due to the fragmented nature of production, distribution and limited consumer base, most of the marketing communications for organic foods are conducted in a limited scale and most of this is concentrated in product packaging and labelling.

A number of studies have used consumer demographics and marketing mix variables as analytical bases to explain organic food purchases in a number of national/cultural contexts, such as, the USA, the UK, Hong Kong, and other European countries (Davies, Titterington &

Cochrane, 1995; Fotopoulos & Krystallis, 2002; Padel & Foster, 2005; Wier & Calverley, 2002). The review of current literature finds inadequate evidence in regard to organic food consumers' market segmentation, especially in the context of Australia. Therefore, the current research aims to segment and characterize the Australian organic food consumers based on a nationwide survey finding.

RESEARCH METHOD

This paper is a part of a larger study that collected data from a nationwide online survey during November 2012. The design of the online survey questionnaire followed the suggestions of Dillman, Smyth, and Christian (2009). A Sydney based independent market research company was recruited and a sample of 17,615 respondents were randomly recruited from a national research only panel by the market research company; considering all the states and territories of Australia. The prerequisites for qualifying for this project were that the qualified respondents had to be 18 years or above, and have purchased organic food products sometime in the past. Although the online survey is methodologically appealing due to its advantages such as access to large sample, low cost and time efficacy (Dillman *et al.*, 2009; Wright, 2005), online survey generates a low response rate. For example, the online survey for this research generated 1011 completed responses (5.7% response rate); excluding incomplete responses (508 responses) and screened out responses (351 responses); and this is consistent with the current literature (see, for example, Sax, Gilmartin, & Bryant, 2003; Sultan & Wong, 2012, 2014).

A number of major studies suggested about market segmentation variables (Kotler *et al.*, 2013; Liu *et al.*, 2014; Jain *et al.*, 2012). The current study, however, considered four major dimensions of market segmentation, such as, demographic, geographic, psychographic, and behavioural dimensions. Table 1 demonstrates the segmentation dimensions and the associated variables that are considered in this study for market segmentation purposes.

Table 1: Segmentation Dimensions and Associated Variables

Demographic dimension	Gender, Age, Marital status, Annual household income, Employment status, Educational qualification, and Country of birth.
Geographic dimension	State – territories, metro – regional, and location of purchase or retail outlets.
Psychographic dimension	Personal values (five items), self-image and personality traits (eight items), and perceptions about organic foods (twelve items).
Behavioural dimension	Average weekly household expenditure for organic foods (WHEFOF) or usage rate, Length of period consuming organic foods (LPCOF) or loyalty status, Grocery shopping decision maker, Purchase frequency of organic foods (PFOF) or user status.

A seven point Likert-type scale was used to collect data for each of the variables of the psychographic segmentation and followed the suggestions of the current literature (Churchill, 1979, 1999; Churchill & Surprenant, 1982). The items of the personal values (five items), self-image and personality traits (eight items), and perceptions about organic foods (twelve items) were drawn from the current studies (Aertsens *et al*, 2011; Aertsens, Verbeke,

Mondelaers, & Huylenbroect, 2009; Chen, 2009; Hennig-Thurau, Langer, & Hansen, 2001; Krystallis & Chryssohoidis, 2005; Lea & Worsley, 2005; Roitner-Schobesberger, Darnhofer, Somsook, & Vogl, 2008; Sultan & Wong, 2012, 2014; Zanoli & Naspetti, 2002; Zeithaml, Berry, & Parasuraman, 1996).

This study used SPSS version 20 for data analyses. In this context, frequency distribution, cross-tab analyses and Person Chi-square (χ^2) difference test were performed within and across the dimensions of market segmentation in order to evaluate differences between the two variables across populations. A significance level of 0.05 was used to identify important differences (Chismar & Wiley-Patton, 2002, 2003).

The cluster analysis was used to identify groups of organic food buyers that are relatively homogenous in terms of the attributes they seek from the organic foods and the way the organic consumers characterise them in terms of their values and self-image and personality traits. A hierarchical cluster analysis was used as a preliminary to the *k*-means cluster technique to determine the number of clusters, and the Dendrogram, Ward linkage method and squared Euclidian distance measure were employed (Liu *et al.*, 2014).

Although there are several advantages of the cluster analysis, such as, simplicity, speed of analysis, no need of pre-screeding the data set, result driven, availability of a wide variety of applicable similarity measures, the current studies also found some limitations of cluster analysis, such as, lack of distinct groups (Dolnicar, 2003; Hair, Black, Babin, & Anderson, 2010; Liu *et al.*, 2014). However, a thorough understanding of the clustering procedures could improve the quality of empirical data-driven market segmentation studies (Dolnicar, 2003).

FINDINGS AND DISCUSSION

Demographic Segmentation

Table 2 shows the demographic profiles of the respondents (*N*=1011). Females are slightly over represented in this survey, with 50.5% of females as compared to 49.5% males. This is consistent in a number of studies that used online survey technique found that females were consistently found to be represented with a higher response rate (Sultan & Wong, 2012, 2014; Liu *et al*., 2014). The Australian census data also shows that there are more females (50.2%) than males (49.8%) (ABS, 2013). The results of the age distribution show that organic consumers are mostly between 25 and 64 (77.6%), though 22.4% of the organic consumers are found to belong 18–24 and 65–85 age groups.

Although the literature reports that the median annual household income in Australia is A$66,820 (Bruwer & Rawbone-Viljoen, 2013), the weekly average (gross) household incomes are A$704 and A$3,581 for the low and high income categories, respectively (ABS, 2012). In the current study, the annual household income (gross) of the organic consumers was classified in nine categories. The sample was skewed towards the low annual household income (below A$44,999) and the high annual household income (A$105,000 and above), and these were 25.2% and 17.3%, respectively; though there was 14.5% of the respondents who preferred not to disclose their annual household income information.. The results also show that 25.2% of the organic food consumers' sample had an annual household income of below A$44,999, compared to the national representation of 20% of total population who fall in the low annual household income category. The results also show that 87.9% of the organic consumers' sample spends below A$100 for household organic food purposes in an average week.

Table 2: Demographics of the Australian Organic Consumers

Variables	%	Variables	%
Gender		***Employment Status***	
Female	50.5	Full-time	36.1
Male	49.5	Retired	23.3
Age		Part-time	13.8
18-19	1.3	Unemployed/Currently seeking work	10.5
20-24	5.1	Self-employed	6.2
25-29	10.4	Casual	5.9
30-34	17.9	Student	4.2
35-39	7.9	***Level of Qualification***	
40-44	9.3	No formal qualifications	2.6
45-49	9.2	Year 10 or year 11	12.0
50-54	10.1	HSC, VCE, Year 12 or UAC	16.0
55-59	6.9	TAFE/Trade qualifications	31.2
60-64	5.9	University degree	25.1
65-69	5.3	Postgraduate qualification	13.1
70-74	4.4	***Length of period consuming organic foods (LPCOF)***	
75-79	3.5	For less than one year	18.3
80-84	1.8	For one year	13.2
85+	1.0	For two years	16.4
Marital status		For three years	8.4
Married/partnered with children	32.2	For more than three years	43.7
Married/partnered	26.5	***Main grocery shopper***	
Single	19.1	Myself	62.8
Empty nesters	11.1	We do grocery shopping together	22.7
Widowed/divorced/separated without children	5.3	My partner/wife/husband	12.6
Widowed/divorced/separated with children	3.9	My parents	1.7
Single with children	1.9	Other	0.2
Annual household income		***Country of birth***	
Below 44,999	25.2	Australia	72.2
45,000-54,999	8.5	United Kingdom	9.0
55,000-64,999	7.2	India	2.2
65,000-74,999	9.2	China	2.1
75,000-84,999	4.7	New Zealand	2.0
85,000-94,999	5.7	Malaysia	1.1
95,000-104,999	7.7	Prefer not to say	1.0
105,000 and above	17.3	Philippines	0.8
Prefer not to say	14.5	Germany	0.8
Average weekly household spending on organic food (WHEOF)		South Africa	0.6
Below $100	87.9	Netherlands	0.5
$100-$199	9.6	Italy	0.3
$200-$299	1.6	Vietnam	0.2
$300-$399	0.4	Other	7.2
$400-$499	0.2		
$500 and above	0.3		

Only 2.6% of the total sample was found to have no formal educational qualification, and the remaining (97.4%) was found to have formal educational qualifications ranging from year 10 to postgraduate degree qualifications. The sample included 36.1% full-time and 13.8% part-time workers, and 23.3% retirees. There were also self-employed (6.2%), causal (5.9%), students (4.1%) and unemployed/currently seeking work (10.5%). Of them most of the respondents (62.8%) stated that they are the main grocery shopper in their household, and that most of them (43.7%) have been consuming organic foods for the last three years. Overall, the sample is dominated by the Australia born consumers (72.2%).

Key Demographic Variables Contributing to Organic Food Purchase

The cross-tab analyses including the Pearson Chi-square difference tests was performed in a number of key demographic variables, such as, gender, age, marital status, annual household income (AHI) and level of educational qualifications (LEQ) against the two behavioural variables, such as, the weekly household expenditure for organic foods (WHEFOF) and the length of periods consuming organic foods (LPCOF) to examine the relationships between data and variables, and to test the differences in the demographic variables.

*Gender–vs–*WHEFOF/LPCOF

The results show that the differences in gender variables and WHEFOF variables are statistically insignificant. For example, the number of males and females who spend <A$100 for organic foods in an average week are 432 and 457, respectively; and males and females spending $100–$199 are 52 and 45, respectively. The differences in the number of males and females diminish as it progresses towards the higher average weekly expenditures. The results of the Pearson Chi-square difference test show that the difference is statistically insignificant: χ^2(df=5, N=1011)=4.672, p=0.457. Similarly, the relationship between gender and LPCOF are also found statistically insignificant, χ^2(df=4, N=1011)=3.794, p=0.435. Overall, this signifies that ‘gender’ variable is statistically insignificant when considering WHEFOF and/or LPCOF for organic food consumption in Australia.

*Marital status–vs–*WHEFOF/LPCOF

The cross-tab analyses between marital status variables and WHEFOF variables are also found statistically insignificant, χ^2(df=30, N=1011)=27.41, p=0.602. A statistically insignificant relationship also exists between marital status variables and LPCOF, χ^2(df=24, N=1011)=30.015, p=0.184. Thus, the organic consumer’s ‘marital status’ has an insignificant relationship both with WHEFOF and/or LPCOF for organic food consumption in Australia.

*Annual household income–vs–*WHEFOF/LPCOF

A statistically significant difference exists between annual household income variables and WHEFOF variables, χ^2(df=40, N=1011)=73.613, p=0.001. In particular, the organic food consumers are found to be skewed towards low and high annual household income levels, such as, 25% of organic consumers belong to annual household income of <A$44,999 and 17% belong to ≥A$105,000. Similarly, the relationship between annual household income and LPCOF are also found statistically significant, χ^2(df=32, N=1011)=56.301, p=0.005. One of the important findings is that 11% and 38% of the total respondents consumed organic foods for three years, and these two groups’ annual income were <A$44,999 and below A$44,999–A$105,000 above, respectively. The beginners (<01 year) holds about 18% of the total respondents. Overall, this signifies that ‘annual household income’ variable is statistically significant when considering WHEFOF and/or LPCOF for organic food consumption in Australia.

*Level of educational qualifications–vs–*WHEFOF/LPCOF

There is a statistically significant difference between the level of educational qualifications and WHEFOF variables, χ^2(df=25, N=1011)=49.950, p=0.002. The cross-tab analyses results show that the most organic consumers are TAFE/Trade and university degree qualified. The second group has year 10-12/HSC/VCE/UAC qualifications. The third and fourth groups are those who have postgraduate degree qualifications and no formal education, respectively. The results also show that 88% of the entire organic consumer groups spend <$100 per week for organic food products. However, the relationship between the level of educational qualifications and LPCOF is statistically insignificant, χ^2(df=20, N=1011)=28.960, p=0.089.

*Age–vs–*WHEFOF/LPCOF

The cross-tab analyses between age variables and WHEFOF variables are also found statistically significant, χ^2(df=70, N=1011)=115.581, p=0.000. Although the results show that 88% of the entire organic consumer groups (18–85+) spend <$100 per week for organic food products, the most important segment belong to 25–79 years old. A statistically significant relationship also exists between age variables and LPCOF, χ^2(df=56, N=1011)=106.179, p=0.000. Thus, age has significant relationships both with WHEFOF and LPCOF.

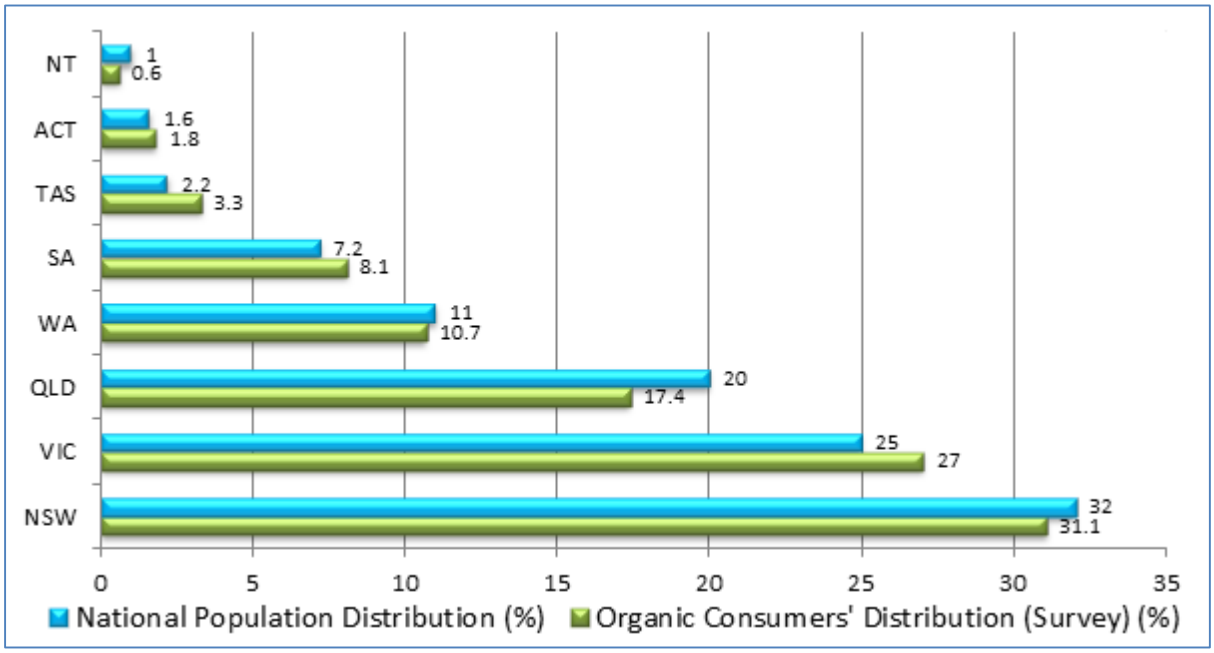
Overall, the key demographic variables are: age, annual household income and educational qualifications that have statistically significant relationships with the length of periods consuming organic foods and the weekly household expenditure for organic food purchase.

Geographic Segmentation

Geographic segmentation variables include region, city size, density and climate (Kotler *et al*., 2013). Geographic segmentation plays an important role, especially, in regard to resource allocation, determining product launch area and location of sales promotion, and to decide about the most profitable market area. In the initial stage of marketing planning, a good geographic segmentation can also help marketers to predict the market size, and the basic resources required for sales penetration and sales promotions. Figure 1 demonstrates the geographic distribution of the organic food consumers in this study in comparison to national population distribution (currently 23.5 million) across all the states and territories of Australia: New South Wales (NSW), Victoria (VIC), Queensland (QLD), Western Australia (WA), South Australia (SA), Tasmania (TAS), Australian Capital Territory (ACT) and Northern Territory (NT). Overall, the Figure 1 shows that NSW, VIC, QLD, WA and SA are some of the highly potential markets for organic food products in Australia.

The cross-tab analyses among states–territories, metro–regional, purchase frequency of organic foods (PFOF), WHEFOF and LPCOF variables were conducted. The results show that a cross-tab analyses in states–territories and purchase frequency, states–territories/metro–regional and WHEFOF variables, states–territories/metro–regional and LPCOF variables are statistically insignificant. However, the results between states–territories and metro–regional, and metro–regional and PFOF are statistically significant. These are: χ^2(df=7, N=1011)=70.806, p=0.000 and χ^2(df=3, N=1011)=11.68, p=0.009, respectively. The results also show that consumers located in metro/city areas across all the states and territories, particularly, NSW, VIC, QLD, WA and SA, purchase significantly more and with a high frequency relative to that of rural/regional consumers.

Figure 1: Distribution of Organic Consumers and National Population in Australia (%)



Source: Organic consumers' distribution (survey data), national population distribution (ABS, 2014), developed for this study

Psychographic Segmentation

Organic food consumers' personal values, self-image (as personality traits) and perceptions about organic foods (as attitudes towards organic foods) are considered for psychographic segmentation in this study following the suggestions of a current study (Kotler *et al*, 2013). Using the hierarchical cluster analyses within the Dendrogram, Ward linkage and squared Euclidian distance measure methods, the current study finds two clusters (segments). Table 3 shows the two segments–wellbeing and excitement, and the segments' attributes and segment specific personalities.

Table 3: The Australian Organic Food Market Segments, Segment Characteristics and Personalities

Segments	*The Australian organic food market segments and their characteristics*
Wellbeing (*n*=97)	Seeking: improved health promoting effect, healthy lifestyle, enhances health, superior quality and taste, no harmful effect to health and environment, and produced ethically-without any chemical-and-with high food safety standards. Personality: health conscious, maintain healthy work-life balance, and considers buying organic foods as up-to-date and fashionable.
Excitement (*n*=76)	Seeking: feeling good when buying and spending money for organic foods, and eating organic food items, pleasure/joy from organic food items, excitements in shopping and consumption experience. Personality: accept new consumption experiences, treat thyself-family-and-friends.

Table 4 shows the ANOVA test results for these two segments and the identified demographic, geographic and behavioural variables, such as, age, gender, annual household income, educational qualification, LPCOF, WHEFOF, and location (i.e., state/territories). The 'wellbeing' segment consists of the 'perceived value' items, one item (Q6-2) of the 'self-image' construct, and nine items of the 'perceptions of organic food' construct. In contrast, the 'excitement' segment holds seven items of the 'self-image' construct and three items of the 'perceptions of organic food' construct.

Table 4: One-way ANOVA Test in Psychographic, Demographic, Behavioural and Geographic Variables

Segments	Codes and Variables	LPCOF	WHEFOF	Gender	Age	Income	Education	Location
WELLBEING SEGMENT	Q5.1 Organic food has health-promoting effects	Y	Y	Y	X	X	X	X
	Q5.2 Organic food helps me to live a healthy lifestyle	Y	Y	Y	X	X	X	X
	Q5.3 Organic food enhances my health	Y	Y	Y	X	X	X	X
	Q5.4 I consider myself very health-conscious	Y	Y	Y	Y	X	X	X
	Q5.5 I try to keep a healthy work life balance	Y	Y	Y	X	X	X	X
	Q6.2 It is trendy to buy organic food products	X	X	Y	Y	Y	Y	Y
	Q7.1 Organic foods are in fashion	Y	X	Y	X	X	X	X
	Q7.2 Organic foods have superior quality	Y	Y	Y	X	X	X	X
	Q7.3 Organic foods have no harmful effects to health	Y	Y	X	X	X	X	X
	Q7.4 Organic foods have a superior taste	Y	Y	Y	X	X	X	X
	Q7.5 Organic food is good for the environment	Y	Y	Y	X	X	X	X
	Q7.6 Organic foods are produced more ethically	Y	Y	Y	X	X	X	X
	Q7.10 Organic food is free of chemical residuals	Y	Y	Y	X	X	X	X
	Q7.11 Organic food is not contaminated by chemicals	Y	Y	Y	X	X	X	X
	Q7.12 Organic food maintains high food safety standards	Y	Y	Y	X	X	X	X
EXCITEMENT SEGMENT	Q6.1 Purchasing organic food makes me feel good about myself	Y	Y	Y	Y	X	X	X
	Q6.3 I enjoy spending money on organic food products	Y	Y	X	Y	X	X	X
	Q6.4 I eat organic food not because I have to but because I want to	Y	Y	Y	X	X	X	X
	Q6.5 I enjoy being immersed in exciting new experiences of trying organic foods	Y	Y	Y	Y	X	X	X
	Q6.6 I can treat myself by eating organic foods	Y	Y	Y	Y	X	X	X
	Q6.7 I get pleasure from eating organic foods	Y	Y	Y	X	X	X	X
	Q6.8 The best time for me to enjoy organic foods is during meals with family or friends	Y	Y	X	X	X	X	X
	Q7.7 Shopping for organic foods is truly joyful	Y	Y	Y	Y	X	X	X
	Q7.8 It is a pleasure to shop for organic food	Y	Y	Y	Y	X	X	X
	Q7.9 Shopping for organic food is an exciting experience	Y	Y	Y	Y	X	X	X

X=There is no statistically significant difference in the mean scores
Y=There is statistically significant difference (significance level, at $p<0.05$) in the mean scores.

The one-way ANOVA test results show that most of the psychographic variables have statistically significant differences with each of the LPCOF, WHEFOF, gender and age variables. For example, perceptions about organic food's superior taste (Q7.4) significantly vary with the demographic variable, such as, gender; and the behavioural variables, such as, the degree of weekly expenditure for organic foods (WHEFOF) and the length of period consuming organic foods (LPCOF). The one-way ANOVA test results are: $F(1,1009)=10.575$, $p=0.001$ for gender, $F(5,1005)=4.845$, $p=0.000$ for WHEFOF, and $F(4,1006)=15.646$, $p=0.000$ for LPCOF. However, Q7.4 was found statistically insignificant with the other demographic variables, such as, age, income and education; and the geographic variable, such as, location. This implies that the organic consumers did not find any significant taste difference across age, income, education and location variables, and that a significant taste difference was only found in gender, WHEFOF, LPCOF variables. This has an impact on the design of marketing communication campaigns with appropriate appeals,

package and label designs and colour selection, and commendations of the reference/organic consumer groups.

Behavioural Segmentation

This study considers several variables for behavioural segmentation, such as, length of period consuming organic food (LPCOF) or loyalty status, weekly household expenditure for organic food (WHEFOF) or usage rate, purchasing frequency of organic foods (PFOF) or user status (Kotler *et al.*, 2013), and location of purchase or retail outlets.

The χ^2 difference test results show that the difference between weekly expenditure's (usage rate) variables and loyalty status's variables are statistically significant, χ^2(df=20, N=1011)=31.841, p=0.045; suggesting that the Australian organic food consumers can be segmented based on consumers' length of period consuming organic foods (LPCOF) or loyalty statuses and weekly household expenditures for organic foods (WHEFOF) or usage rates.

Over half of the respondents in this sample were former (9%) and occasional (45.2%) organic food buyers. Another 30.1% buy organic food products 1-3 times a fortnight while the remaining 15.7% are regular buyers. Table 5 shows the organic consumers' purchase frequencies (FPOF) across the major retail outlets in Australia. The results show that organic consumers who purchase organic foods for at least 1-3 times in a month prefer to buy organic foods mainly from a range of retail outlets, including, Aldi, IGA, Coles, Woolworths, farmers' market, health food stores, and directly from producers. As their purchase frequency increases, such as, PFOF≥1-3 times/fortnight and PFOF≥1-3 times/week, organic consumers are found to be more reliant upon the supermarkets, such as, Coles and Woolworths, and farmers' market.

Table 5: Organic Consumers' Purchase Frequencies across the Retail Outlets in Australia

Retail Outlets	Frequency of purchasing organic foods (FPOF) and percent			
	Not at all	**Rarely/Occasionally (FPOF≥1-3 times/month)**	**Often (FPOF≥1-3 times/fortnight)**	**Regularly (FPOF≥1-3 times/week)**
Aldi	664 (65.7%)	*244* (24.1%)	82 (8.1%)	21 (2.1%)
IGA	690 (68.2%)	*227* (22.5%)	66 (6.5%)	28 (2.8%)
Coles	251 (24.8%)	*436* (43.1%)	*210* (20.8%)	*114* (11.3%)
Online	912 (90.2%)	80 (7.9%)	16 (1.6%)	3 (0.3%)
Costco	944 (93.4%)	51 (5.0%)	14 (1.4%)	2 (0.2%)
Supabarn	960 (95.0%)	30 (3.0%)	17 (1.7%)	4 (0.4%)
Woolworths	215 (21.3%)	*496* (49.1%)	*201* (19.9%)	*99* (9.8%)
Farmers' Market	584 (57.8%)	*292* (28.9%)	*103* (10.2%)	32 (3.2%)
Health Food Stores	674 (66.7%)	*226* (22.4%)	85 (8.4%)	26 (2.6%)
Directly from producers	796 (78.7%)	*159* (15.7%)	47 (4.6%)	9 (0.9%)

Table 5 also shows that there are decreased frequencies of organic food purchases across all of the retail outlets in an average month. The organic consumers are found relatively reluctant to buy organic food items more than 1-3 times in a month. This implies that most of the organic food consumers are still in their 'trial' stage, and are reluctant in making a long-term commitment to purchase organic foods.

The results also show that most respondents use Coles and Woolworths with 32.1% and 29.7% of consumers' repeat purchase shares that include often and regular purchases, respectively. Interestingly, farmers' market and direct purchases from the producers were cited by 13.4% and 5.5% of the respondents and this supports anecdotal evidence regarding the rising popularity of these sources. Health Food stores are accounted for 11% of the regular and often purchases of organic foods. In contrast, Aldi and IGA are ranked in 5th and 6th places, respectively, with approximately one in ten respondents claim repeat purchase shares from these retail outlets.

According to the Australian Organic Market Report 2010, the estimated market size was about A$947 million in 2010. In 2012, it has increased another A$329 million, totalling the estimated market size of $1.276 billion with a growth rate of about 17% per annum (Monk *et al.*, 2012). Our results of the cross-tab analyses between LPCOF or loyalty status and WHEFOF or usage rate demonstrate that 88% of the total organic consumers' sample spends below A$100 in an average week only for organic food purposes. According to our study, this provides an estimated organic food consumers' spending of A$2.02 billion in 2013 for organic food products in Australia, and this could reach as high as A$5 billion according to Monk *et al.*'s (2012) study.

IMPLICATIONS

Market segmentation is one of the most fundamental and basic strategic marketing concepts. The better the segment(s) chosen for targeting by an organic farm/organisation, the more successful the farm/organisation is assumed to be in the marketplace (Dolnicar, 2003). Overall, the current study found several key segmentation variables, such as, gender, age, annual household income, educational qualification, state-territories, metro-regional, retail outlets, personal values, self-image and personality traits, perceptions about organic foods, usage rate, loyalty status and user status.

In a report, it was found that Australia has one of the most concentrated grocery sectors in the world with the two brands, Coles and Woolworths, dominating the overall market with approximately 80% market share of an industry valued at A$80+ billion (Sultan, Anisimova, Henryks, & Pearson, 2013). Within this context, the current research found about 62% of respondents who often and regularly buy organic food products from Woolworths and Coles. Thus, more committed buyers are likely to shop from these two large supermarkets. Overall, our study is also consistent with Monk *et al.*'s (2012) report that states that supermarkets, such as, Aldi, IGA, Coles, Woolworths and farmers' market dominate the total organic sales in Australia, driven by the permanent positioning. This has particular implications in terms of distribution and retail management. In addition, a dedicated organic food sections, similar to that of Woolworths and Coles, might also be useful for the health food stores, Aldi and IGA.

One of the reasons for a low level of sales volume is that the organic food market consists of a small market (Lockie, Lyons, Lawrence, & Grice, 2004) and often with occasional consumers without much information and motivation to purchase organic foods. The findings of our study are also consistent with Lockie *et al.*'s (2004) study in that it shows that about 88% organic food consumers spend ≤A$100.00, and only about 16% of the organic consumers buy regularly (at least 1-3 times per week). This signifies that the Australian organic consumers

are still in the 'trial' stage and that appropriate communication strategies; pack size could further improve this situation.

CONCLUSION, LIMITATIONS AND FUTURE RESEARCH

The aim of this paper was to segment the Australian consumer markets by taking the four major market segmentation dimensions, including, demographic, geographic, psychographic and behavioural dimensions. A number of variable of each of these dimensions were considered, and subsequently, a nationwide survey was conducted and statistical tools were used to analyse the dataset. The study reports the key market segmentation variables for the Australian organic food market and these variables are: gender, age, annual household income, educational qualification, state-territories, metro-regional, retail outlets, personal values, self-image and personality traits, perceptions about organic foods, usage rate, loyalty status and user status.

There are several limitations, for example, this study considered panel only consumers who have had experience in purchasing and consuming organic foods sometime in the past though this was a nationwide survey. Future study should incorporate random sampling technique, and compare and generalise the findings.

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