BACKGROUND PAPER TO GUIDELINE

Increased Expenditure Arising from the Introduction of Additional Gaming Machines to a Local Community:

Review of the 'Density Hypothesis'

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1. Executive Summary

This report briefly sets out the finding that there is a strong positive relationship between EGM density and per capita expenditure. The relationship is then tested using data for selected LGAs. The data confirms the relationship at this micro level, and in some instances a stronger relationship is found. The hypothesis that there is no relationship between EGM density and per capita expenditure in the particular LGAs is rejected.

Stubbs & Storer (2003) found that there is a relationship between per capita expenditure and gaming machine density. This analysis formed the basis of a submission to the IPART Inquiry Into Responsible Gaming. As at 2001/02, it was found that by knowing the density of gaming machines, one could predict 77% of the variation in per capita expenditure on gaming with a high degree of confidence. Subsequent analysis assuming the existence of heteroskedasticity yielded an R-squared value of 0.86 and increased the confidence in the results. This is considered to be a very high R-squared value in the social sciences.

Several recent SIAs[1] have advanced the hypothesis that there is no relationship between increasing EGM density and increased per capita expenditure. Various claims are made to the effect that the gaming market (either overall or in the particular LGA of the venue in question) is "mature". SIAs prepared by <BLANK> present datasets for each of the years 1994 to 2003 for Parramatta, Blacktown, as well as for several other LGAs.[2] This data is used to test the hypothesis advanced that there is no relationship between increasing EGM density and increasing per capita expenditure in these LGAs. <BLANK> have claimed that the gaming market in Campbelltown is "mature" but have not presented sufficient data for this claim to be tested. This claim may be tested in the future if sufficient data is provided.

When testing the density hypothesis in relation to discrete LGAs in NSW, it should not be forgotten that the findings for the 2003 IPART Submission were made for NSW *as a whole*, using all available data points in the State for the years 1996/97, 2001/02 and 2002/03. That a particular area does not "fit" the general rule as

[1] Deleted.

[2] <BLANK> uses data for per capita expenditure and EGM density in NSW, Blacktown LGA, Leichhardt LGA, Marrickville LGA, Willoughby LGA, Parramatta LGA and Rockdale LGA for the years 1994 to 2003.

closely as another is nothing more than normal variance in the sample. This is already accounted for in the R-squared value and the degree of confidence in the results. That being said, Parramatta and Blacktown LGAs – the specific areas analysed as part of the two <BLANK> SIAs – would appear to "fit" the rule far more closely than NSW as a whole (or more precisely, there is a stronger positive relationship between EGM density and per capita expenditure in those LGAs than is generally the case for NSW).

While it appears that the areas constituting the dataset used in the <BLANK> SIAs have been selected to maximise variance, the results for the combined areas nevertheless yielded an R-squared value of 0.51 with an extremely high degree of confidence that a positive relationship exists. At this level, <BLANK>'s hypothesis (that there is no relationship between the two variables) has less than a 1 in 247 billion chance of being correct. That is, using the SIA's own dataset (seemingly selected for maximum variance), by knowing the density of gaming machines, one can predict 51% of the variation in per capita expenditure on gaming. A stronger R-squared was found in Parramatta and Blacktown LGAs (0.94 and 0.93 respectively) with an extremely high degree of confidence that the relationship exists ($p < 0.0001$). In other words, the data reveals the claim that these LGAs are somehow a special case is patently false.

In summary, our original findings that there is a strong relationship between any increase in GMs and an increase in per capita expenditure, is borne out by a review of this case study SIA.

2. Key Points in IPART Submission

2.1. OVERVIEW

In October 2003 Stubbs & Storer entered a submission with the IPART Inquiry Into Responsible Gaming. Among other things, it was found that per capita expenditure increases with gaming machine density. This largely confirmed the "access thesis" of the Productivity Commission (1999). It is proposed to briefly set out the key results and conclusions of that submission in relation to per capita expenditure and gaming machine density.

2.2. METHODOLOGY

A linear regression analysis was conducted using Microsoft Excel. This analysis used DGR data relating to gaming machines for all available areas in NSW for the periods 1996-97 and 2001-02. All figures were CPI adjusted.

2.3. RESULTS & DISCUSSION

Among other things, it was found that the amount spent per adult on gaming machines increases with increasing density of gaming machines. This confirmed the Productivity Commission's (1999) "access thesis". It was further found that the amount spent per adult on gaming machines increases at a greater rate than the increase in gaming machine density generally, and most markedly in areas of lower existing density. This finding contradicted the industry claim that additional gaming machines would largely result in a redistribution of income from existing machines in the local community.

Analysis of the relationship between per capita expenditure and gaming machine density yielded an R-squared value of 0.63 in 1996 and 0.77 in 2001. That is, by knowing the density of gaming machines, one can predict 77% of the variation in per capita expenditure on gaming (as at 2001/02). The results were obtained with a high degree of confidence.

2.5. SUBSEQUENT ANALYSIS

Subsequent to lodging the submission, the authors have undertaken a more sophisticated analysis accounting for heteroskedasticity (that is, that variance increases as density increases). Applying this correction, an R-squared of 0.86 was obtained and the reliability of the results increased by 4 orders of magnitude.

This analysis was conducted using the Shazam Software Package.

3. Hypothesis – There is no relationship between increasing EGM "density" and an increase in per capita expenditure

> Several SIAs have now advanced the hypothesis that there is no relationship between increasing the number of EGMs per adult ("EGM density") and an increase in the dollars spent per adult in an LGA ("per capita expenditure").
>
> <DELETED>

Where the SIAs have provided data (ostensibly) in support of these claims, the hypothesis that there is no relationship, or that markets are "mature" is testable on the basis of the applicant's own data. <BLANK> has presented comprehensive data in the <BLANK> SIAs (i.e., 10 data points for several LGAs, including Blacktown and Parramatta, and NSW overall). <BLANK> does not present comprehensive data for Campbelltown LGA. Should such data be presented, a similar analysis could be conducted for Campbelltown.

Finally, it should be kept in mind that the findings in the 2003 submission are made for NSW *as a whole*, using *all available data points in the State* for the years 1996/97, 2001/02 and 2002/03. It is not to the point that a particular area apparently constitutes a "special case". That a selective sample within NSW does not "fit" the rule is nothing more than statistical variance in the *overall* sample. The existence of variance in the total sample is clearly accounted for by the r-squared value, and degree of confidence in the results. A selective sample based on a discrete area is not capable of negating the finding that there is an overall positive relationship between EGM density and per capita expenditure *in NSW*.

4. Methodology

The purpose of this report is to test the hypothesis that there is no relationship between increasing EGM density and increasing per capita expenditure. The report uses <BLANK>s data tables (<BLANK>), and tests the same areas used as the basis for the conclusions found in the SIA (NSW, Blacktown LGA, Leichhardt LGA, Marrickville LGA, Willoughby LGA, Parramatta LGA and Rockdale LGA). Finally, all the data points are analysed together ("All areas"). For ease of reference, the specific source of the data is <BLANK>, although both of the SIAs prepared by <BLANK> use the same data and LGAs).

Note: <BLANK> expresses GM density data in terms of number of adults per 1 GM. Data in this review is expressed in terms of number of GMs per adult (i.e. for a ratio of 1 GM per 50 adults, number of GMs is 1 / 50 = 0.02). This is done because the way the SIA presents the data takes the form of an inverse exponential curve that reduces the reliability of the linear regression analysis. Rather than transform the data, we have simply taken the inverse, which closely approximates a straight line.

Regression analysis was conducted using Microsoft Excel.

As noted, there is insufficient data available to this author to test Campbelltown LGA. The most reasonable assumption to make without conducting such an analysis is that Campbelltown LGA is "average" (in other words, that it displays the same profile as NSW as a whole). It is unreasonable to assume that an area is a "special case" in the absence of clear data in support of this proposition.

5. Results

Note: All values have been rounded to two significant figures.

5.1. NSW

R-squared = 0.82.

P-value = 0.00029.

In NSW overall, 82% of the variation in per capita expenditure is explainable by the density of GMs (that is, the number of GMs per adult). This result is highly significant ($p < 0.0003$).

There is a less than 1 in 3479 chance that <BLANK>'s hypothesis is correct with respect to NSW.

5.2. Blacktown LGA

R-squared = 0.93.

P-value = 5.63E-06.

In Blacktown LGA, 93% of the variation in per capita expenditure is explainable by the density of GMs (that is, the number of GMs per adult). This result is highly significant ($p < 0.0001$).

There is a less than 1 in 177,641 chance that <BLANK>'s hypothesis is correct with respect to Blacktown.

5.3. Leichhardt LGA

R-squared = 0.70.

P-value = 0.0025

In Leichhardt LGA, 70% of the variation in per capita expenditure is explainable by the density of GMs (that is, the number of GMs per adult). This result is highly significant ($p < 0.003$).

There is less than a 1 in 406 chance that <BLANK>'s hypothesis is correct with respect to Leichhardt.

5.4. Marrickville LGA

R-squared = 0.82.

P-Value = 0.00033

In Marrickville LGA, 82% of the variation in per capita expenditure is explainable by the density of GMs (that is, the number of GMs per adult). This result is highly significant ($p < 0.0004$).

There is less than a 1 in 2992 chance that <BLANK>'s hypothesis is correct with respect to Marrickville.

3.2.6. Willoughby LGA

R-Squared = 0.52.

P-value = 0.019

In Willoughby LGA, 52% of the variation in per capita expenditure is explainable by the density of GMs (that is, the number of GMs per adult). This result is significant ($p < 0.02$).

There is less than a 1 in 53 chance that <BLANK>'s hypothesis is correct with respect to Willoughby.

3.2.7. Parramatta LGA

R-squared = 0.94.

P-value = 3.05E-06

In Parramatta LGA, 94% of the variation in per capita expenditure is explainable by the density of GMs (that is, the number of GMs per adult). This result is highly significant ($p < 0.0001$).

There is less than a 1 in 327,644 chance that <BLANK>'s hypothesis is correct with respect to Parramatta.

3.2.8. Rockdale LGA

R-squared = 0.5.

P-value = 0.023

In Rockdale LGA, 50% of the variation in per capita expenditure is explainable by the density of GMs (that is, the number of GMs per adult). This result is significant ($p < 0.03$).

There is less than a 1 in 44 chance that <BLANK>'s hypothesis is correct with respect to Rockdale.

3.2.9. All Areas

R-squared = 0.51.

P-value = 4.041E-12

When all the data points for areas used in the SIA are combined, 51% of the variation in per capita expenditure is explainable by the density of GMs (that is, the number of GMs per adult). This result is highly significant ($p < 0.0001$).

There is less than a 1 in 247 billion chance that <BLANK>'s hypothesis is correct with respect to the combined areas included in the SIA.

6. Discussion

6.1. DISCUSSION OF RESULTS

In terms of variation, the highest R-squared value was obtained for Parramatta LGA, followed by Blacktown LGA, while the lowest R-squared value was obtained for Rockdale LGA. In NSW as a whole, 82% of the increase in per capita expenditure is explainable by the increase in gaming machine density. In Parramatta LGA, 94% of the increase in per capita expenditure is explainable by the increase in gaming machine density. In Blacktown, 93% of the increase in per capita expenditure is explainable by the increase in gaming machine density. Even in Rockdale LGA, 50% of the increase in per capita expenditure is explainable by the increase in gaming machine density.

The results for each of the areas were highly significant. The lowest level of confidence obtained for a single area was in Rockdale LGA ($p < 0.03$), but this was still within the 97% confidence interval. The highest level of confidence obtained for a single area was in Parramatta and Blacktown LGAs ($p > 0.0001$). In other words, we are more than 99.99% confident that the correlation obtained in these two areas really exists and is not just a result of sampling error.

In concordance with the extremely high significance of our results, we are confident of our position that an increase in gaming machine density will result in an increase in per capita expenditure. Each of the LGAs analysed reinforce this conclusion.

Furthermore, we are confident that <BLANK>'s conclusion that data provided by the DGR "indicates that the amounts people spend on gaming do not depend on the "density" of machines" is fallacious. Using NSW totals data points[3], there is less than a 1 in 3479 chance that <BLANK> is correct. In Parramatta there is a less than 1 in 327,644 that <BLANK> is correct. In Blacktown there is less than a 1 in 177,641 chance that <BLANK> is correct.

[3] That is, using the NSW totals (or averages) for per capita expenditure and gaming machine density. This should not be confused with using per capita expenditure and gaming machine density data for *every available area within NSW*.

6.2. DISCUSSION OF SIA RESULTS AND METHODOLODY

In our original analysis in the submission to IPART we included data points for 1996/97 and 2001/02 for *all areas* within NSW. The only areas excluded from our analysis were Canada Bay (a newly formed LGA) and Murrumbidgee, which appeared to be in error (showing 701 GMs in 1996 but only 65 in 2001).

By contrast, <BLANK> only includes data for NSW totals (that is, averages for the state as a "whole" rather than each area within NSW), Blacktown, Leichhardt, Willoughby, Rockdale, Parramatta and Marrickville. No rationale is apparent for the selection of these areas (with the exception of Blacktown, and Parramatta, which are the subject of the two SIAs). It seems that <BLANK> has attempted to maximise variance in the sample by using selective sampling. This could have the effect of reducing the relationship between the variables. Nevertheless, there is a strong to very strong relationship between gaming machine density and per capita expenditure in the areas identified by the SIAs. The impact of the selective sampling is firstly to increase the variance of the test sample, leading to lower R-squared values. Secondly, by selecting small samples (for example 10 points over time), the P-value decreases. Even given the attempts to skew the results, the data do not support the hypothesis that there is no relationship between EGM density and per capita expenditure. The fundamental basis of all statistical sampling is that samples are selected randomly. Any other form of sampling (i.e. selective sampling) renders conclusions meaningless.

A linear regression has not been calculated for the sample. We have tested the hypothesis that there is no relationship between gaming machine density and per capita expenditure. The overwhelming probability is that this hypothesis is false. In particular, there is a less than 1 in 327,644 that the hypothesis is correct with respect to Parramatta LGA, and a less than 1 in 177,641 chance that the hypothesis is correct with respect to Blacktown. Our results demonstrate a strong relationship between any increase in GMs and an increase in per capita expenditure with a high degree of confidence.

Finally, by separating GMs into "club GMs" and "hotel GMs", the <BLANK> SIAs have missed the central thrust of the density thesis. What was in fact suggested in the submission to IPART is that there is a relationship between per capita expenditure and *total* density of GMs in an area. At best, by breaking the data down into clubs

and hotels, the SIA has simply demonstrated that it does not matter whether GMs are in hotels or clubs. The relationship still applies.

7. Conclusion

Data presented in <BLANK> serve to reinforce the conclusions of an earlier analysis of the relationship between the density of GMs and per capita expenditure. There is insufficient data presented in <BLANK> to enable the hypothesis to be tested.

The areas used in <BLANK> display a strong relationship between gaming machine density and per capita expenditure. The weakest relationships are found in Rockdale and Willoughby LGAs. Nevertheless, 50% and 52% of the increase in per capita expenditure in these areas is explained by the increase in GM density. A very strong relationship was found to exist in Parramatta and Blacktown LGAs (94% and 93% respectively). All results were obtained with a high degree of confidence. Conversely, the probability of the SIA's hypothesis being correct is extremely low.

APPENDIX 1: Datasets

NSW (SIA pp. 20-1, All GMs)

Year	GMs per Adult	Per Capita Expenditure ($2001)
1994	0.016393443	527
1995	0.016949153	554
1996	0.018867925	570
1997	0.018518519	600
1998	0.02	713
1999	0.022222222	812
2000	0.021276596	867
2001	0.020833333	859
2002	0.021276596	861
2003	0.020408163	860

City of Blacktown (<BLANK> pp. 25-6, All GMs)

Year	GMs per Adult	Per Capita Expenditure ($2001)
1994	0.01010101	500
1995	0.010638298	534
1996	0.010989011	554
1997	0.013157895	586
1998	0.01369863	697
1999	0.014705882	775
2000	0.015625	858
2001	0.015873016	859
2002	0.015151515	837
2003	0.014925373	840

Leichhardt LGA (<BLANK> pp. 29-31, All GMs)

Year	GMs per Adult	Per Capita Expenditure ($2001)
1994	0.013333333	353
1995	0.014925373	316
1996	0.015625	312
1997	0.018181818	376
1998	0.022727273	628
1999	0.023255814	847
2000	0.023809524	959
2001	0.020408163	894
2002	0.022222222	839
2003	0.018867925	835

Marrickville LGA (<BLANK> pp. 29-31, All GMs)

Year	GMs per Adult	Per Capita Expenditure ($2001)
1994	0.015625	673
1995	0.01754386	703
1996	0.01754386	672
1997	0.020833333	689
1998	0.023255814	858
1999	0.024390244	982
2000	0.025	1123
2001	0.025	1097
2002	0.024390244	1048
2003	0.022727273	1009

Willoughby LGA (<BLANK> pp. 29-31, All GMs)

Year	GMs per Adult	Per Capita Expenditure ($2001)
1994	0.006756757	264
1995	0.007142857	283
1996	0.01010101	284
1997	0.011494253	382
1998	0.012345679	531
1999	0.011627907	595
2000	0.011627907	580
2001	0.011111111	623
2002	0.010526316	617
2003	0.010869565	624

Parramatta LGA (<BLANK> pp. 29-31, All GMs)

Year	GMs per Adult	Per Capita Expenditure ($2001)
1994	0.011494253	525
1995	0.011904762	572
1996	0.012820513	552
1997	0.016129032	737
1998	0.017857143	944
1999	0.019230769	1138
2000	0.020408163	1242
2001	0.019607843	1265
2002	0.019607843	1254
2003	0.019607843	1268

Rockdale LGA (<BLANK> pp. 29-31, All GMs)

Year	GMs per Adult	Per Capita Expenditure ($2001)
1994	0.017241379	639
1995	0.018867925	691
1996	0.018867925	707
1997	0.021276596	746
1998	0.021276596	868
1999	0.020833333	940
2000	0.020408163	994
2001	0.020408163	947
2002	0.020408163	923
2003	0.020408163	924

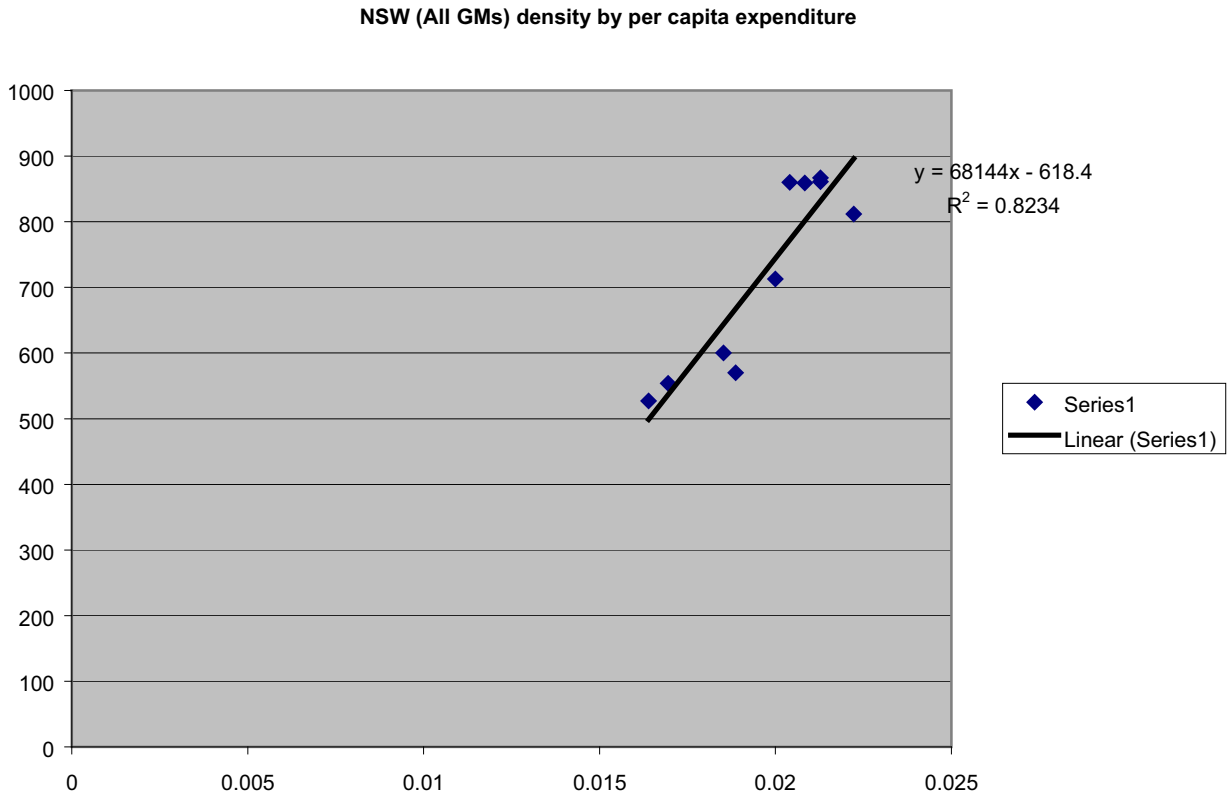
ALL <BLANK> DATA POINTS (<BLANK> pp. 20-31, All GMs)

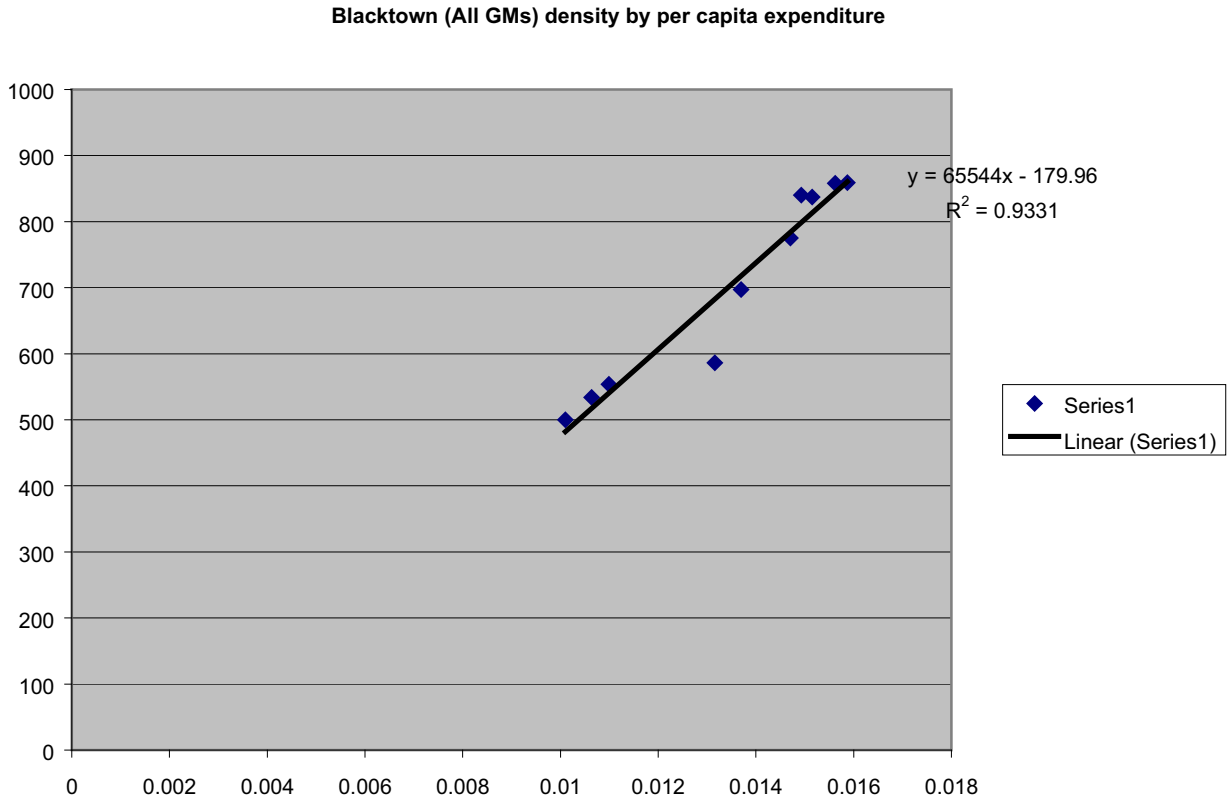
Area	Year	GMs per Adult	Per Capita Expenditure ($2001)
NSW	1994	0.016393443	527
	1995	0.016949153	554
	1996	0.018867925	570
	1997	0.018518519	600
	1998	0.02	713
	1999	0.022222222	812
	2000	0.021276596	867
	2001	0.020833333	859
	2002	0.021276596	861
	2003	0.020408163	860
Blacktown	1994	0.01010101	500
	1995	0.010638298	534
	1996	0.010989011	554
	1997	0.013157895	586
	1998	0.01369863	697
	1999	0.014705882	775
	2000	0.015625	858
	2001	0.015873016	859
	2002	0.015151515	837
	2003	0.014925373	840
Leichhardt	1994	0.013333333	353
	1995	0.014925373	316
	1996	0.015625	312
	1997	0.018181818	376
	1998	0.022727273	628
	1999	0.023255814	847
	2000	0.023809524	959
	2001	0.020408163	894
	2002	0.022222222	839

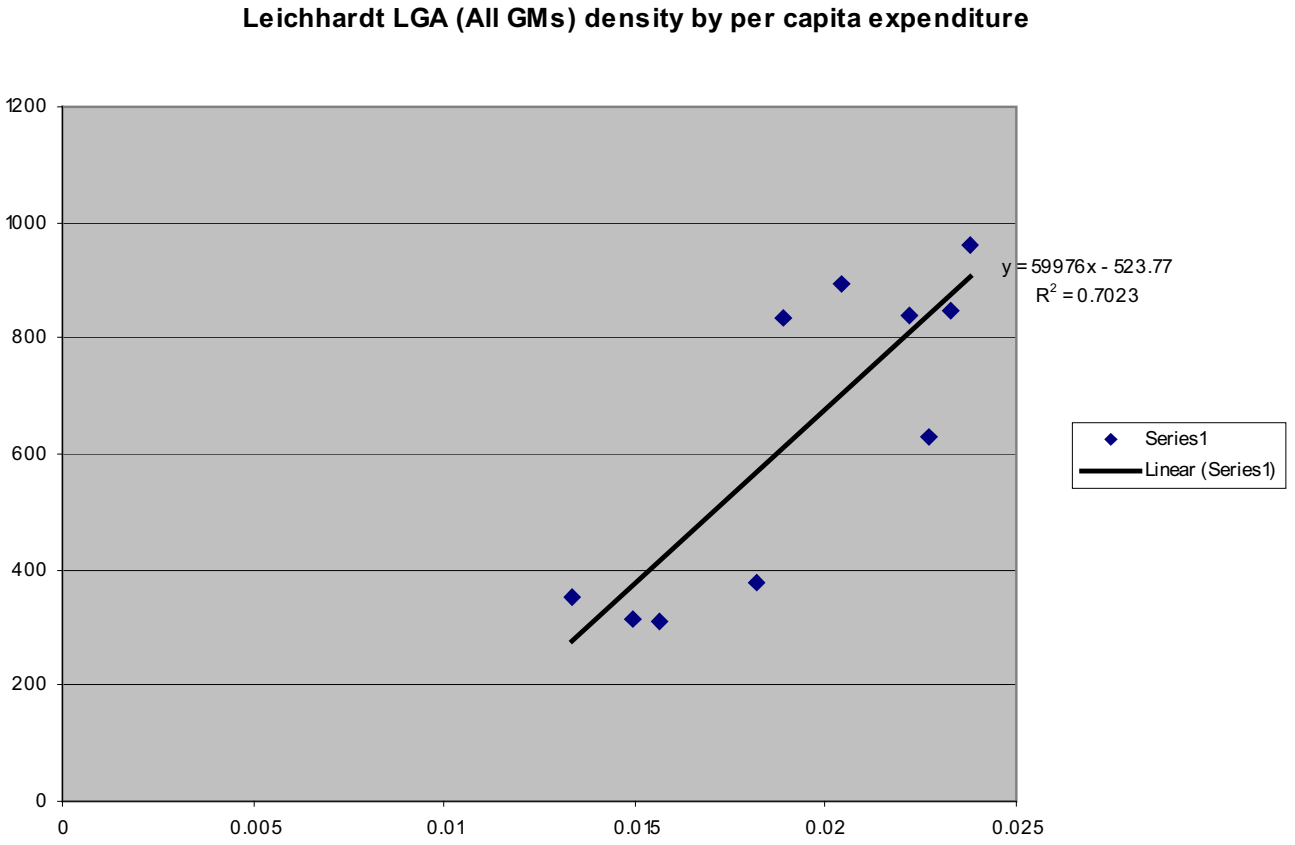
ALL <BLANK> DATA POINTS (<BLANK> pp. 20-31, All GMs)

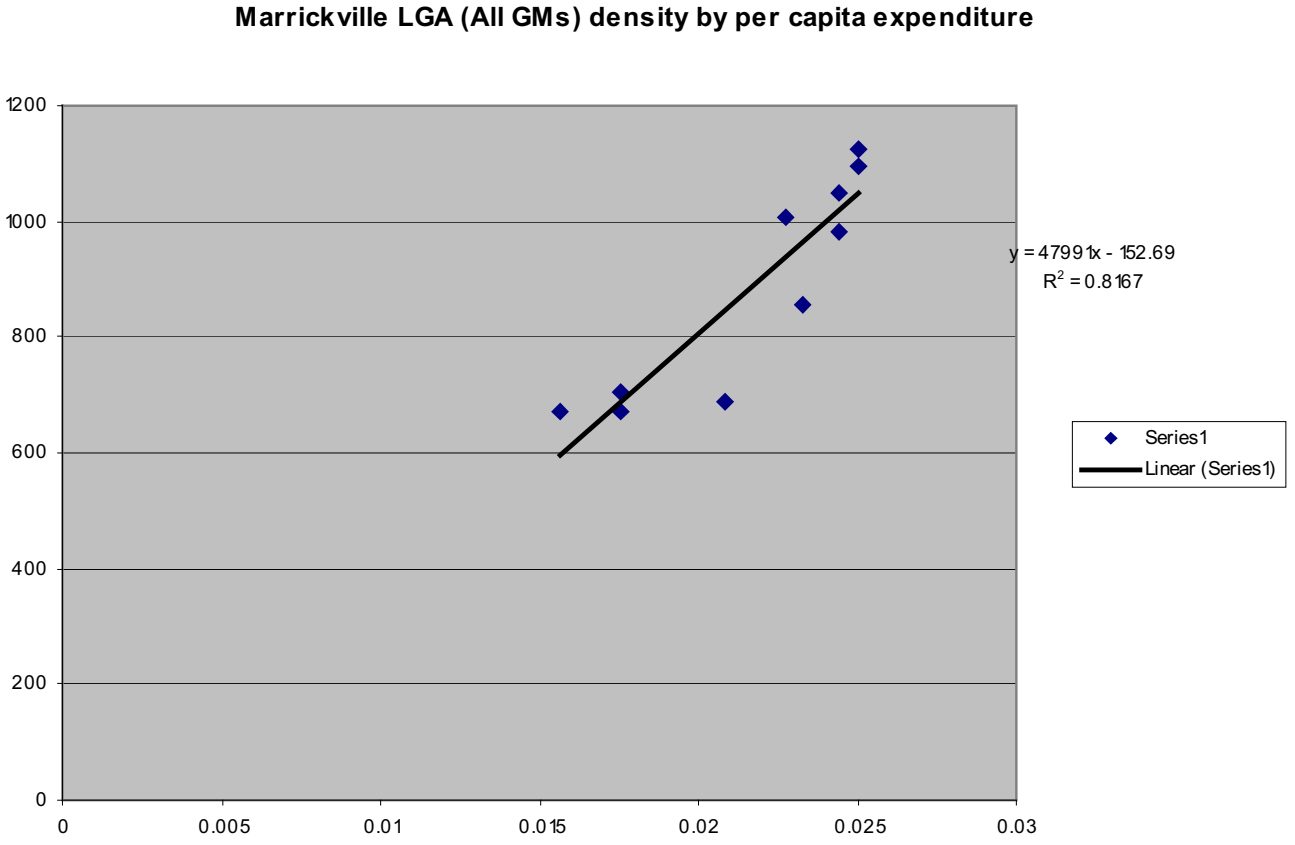
Area	Year	GMs per Adult	Per Capita Expenditure ($2001)
	2003	0.018867925	835
Marrickville	1994	0.015625	673
	1995	0.01754386	703
	1996	0.01754386	672
	1997	0.020833333	689
	1998	0.023255814	858
	1999	0.024390244	982
	2000	0.025	1123
	2001	0.025	1097
	2002	0.024390244	1048
	2003	0.022727273	1009
Willoughby	1994	0.006756757	264
	1995	0.007142857	283
	1996	0.01010101	284
	1997	0.011494253	382
	1998	0.012345679	531
	1999	0.011627907	595
	2000	0.011627907	580
	2001	0.011111111	623
	2002	0.010526316	617
	2003	0.010869565	624
Parramatta	1994	0.011494253	525
	1995	0.011904762	572
	1996	0.012820513	552
	1997	0.016129032	737
	1998	0.017857143	944
	1999	0.019230769	1138
	2000	0.020408163	1242
	2001	0.019607843	1265
	2002	0.019607843	1254
	2003	0.019607843	1268
Rockdale	1994	0.017241379	639
	1995	0.018867925	691
	1996	0.018867925	707
	1997	0.021276596	746
	1998	0.021276596	868
	1999	0.020833333	940
	2000	0.020408163	994
	2001	0.020408163	947
	2002	0.020408163	923
	2003	0.020408163	924

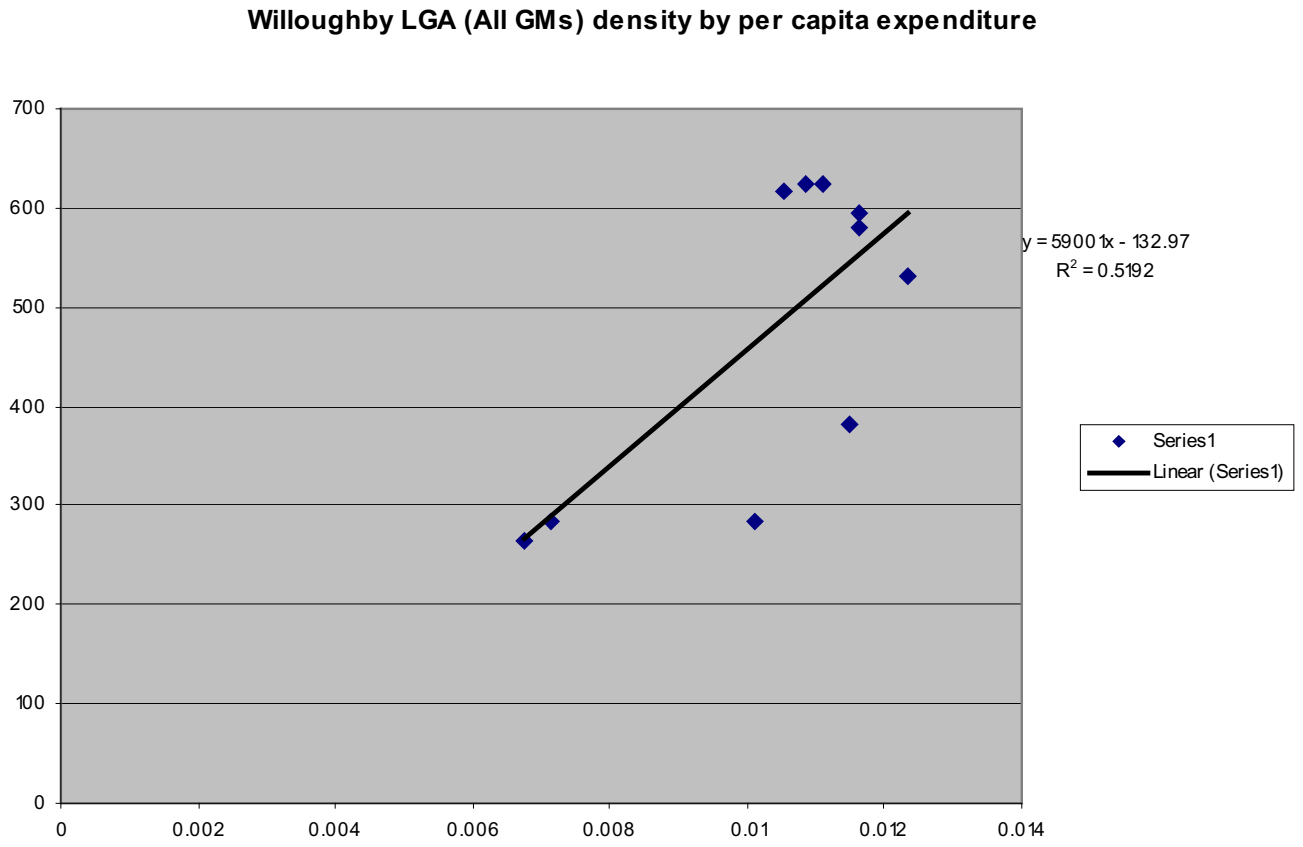
APPENDIX 2: Graphs

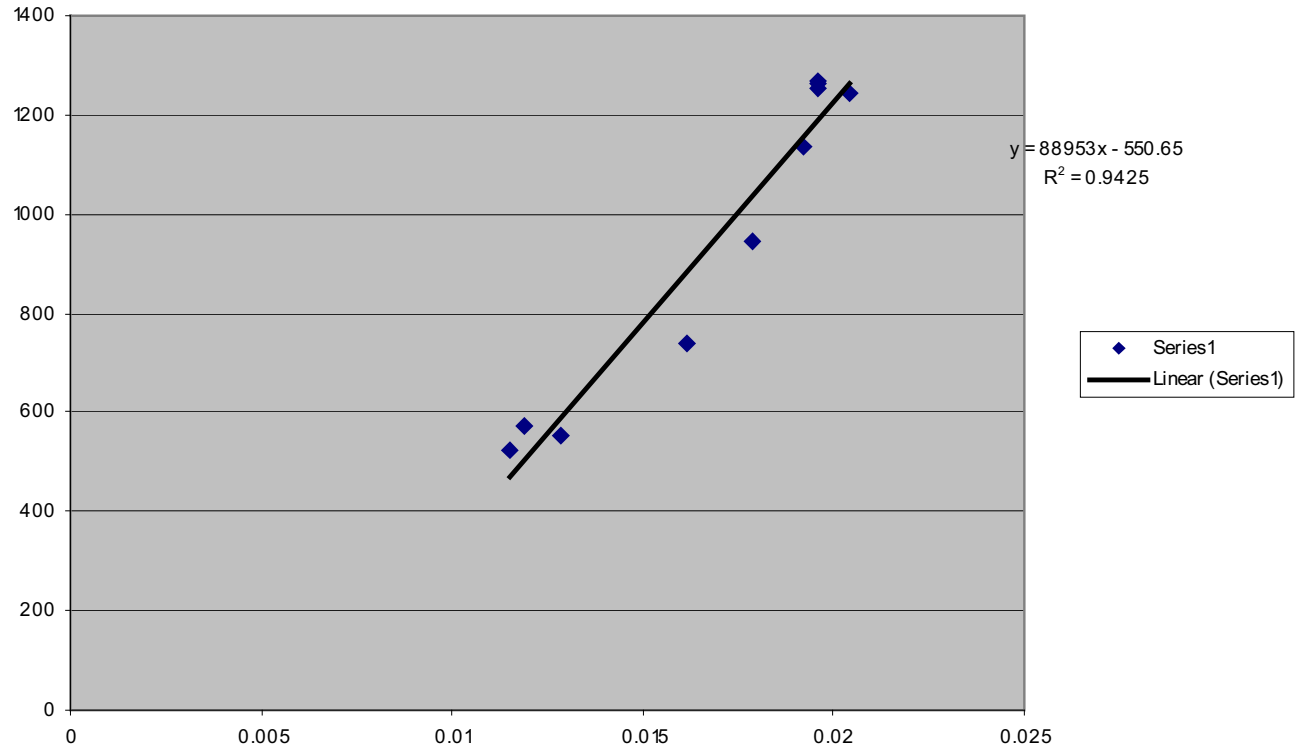


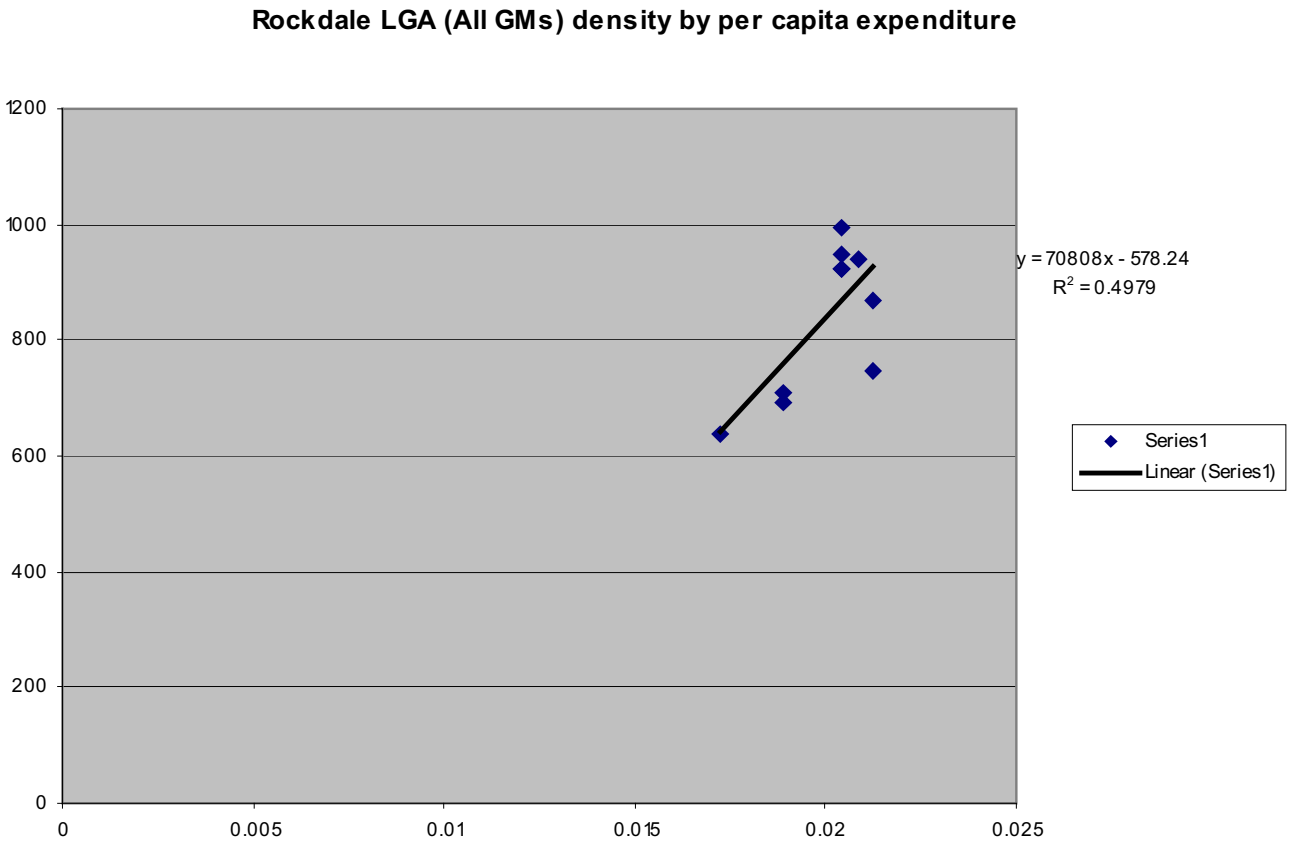


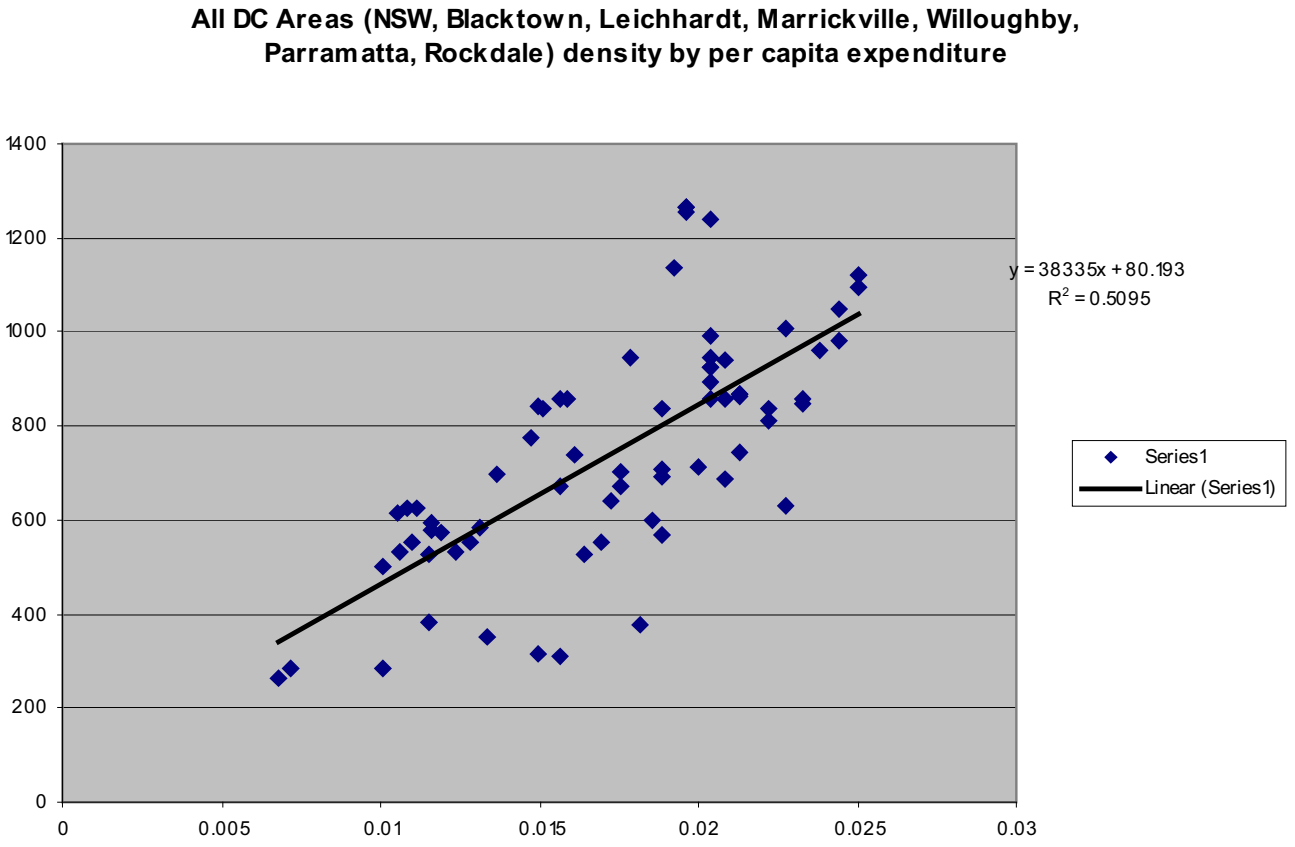

Leichhardt LGA (All GMs) density by per capita expenditure
1200
1000
800
600
400
200
0
0
0.005
0.01
0.015
0.02
0.025
y = 59976x - 523.77
R2 = 0.7023
Series1
Linear (Series1)


Marrickville LGA (All GMs) density by per capita expenditure
1200
1000
800
600
400
200
0
0
0.005
0.01
0.015
0.02
0.025
0.03
y = 47991x - 152.69
R2 = 0.8167
Series1
Linear (Series1)


Willoughby LGA (All GMs) density by per capita expenditure
700
600
500
400
300
200
100
0
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
y = 59001x - 132.97
R2 = 0.5192
Series1
Linear (Series1)


Parramatta LGA (All GMs) density by per capita expenditure
1400
1200
1000
800
600
400
200
0
0
0.005
0.01
0.015
0.02
0.025
y = 88953x - 550.65
R2 = 0.9425
Series1
Linear (Series1)


Rockdale LGA (All GMs) density by per capita expenditure
1200
1000
800
600
400
200
0
0
0.005
0.01
0.015
0.02
0.025
y = 70808x - 578.24
R2 = 0.4979
Series1
Linear (Series1)


All DC Areas (NSW, Blacktown, Leichhardt, Marrickville, Willoughby, Parramatta, Rockdale) density by per capita expenditure
1400
1200
1000
800
600
400
200
0
0
0.005
0.01
0.015
0.02
0.025
0.03
y = 38335x + 80.193
R2 = 0.5095
Series1
Linear (Series1)