AusPlay

2019/20 Sample Design and Weighting Changes

Submitted to:

Australian Sports Commission

Prepared by:

Dr Phil Hughes

Email: Phil.Hughes@Enginegroup.com

April 29, 2020

1 Overview

Since its inception in quarter four (Q4), 2015, AusPlay had had an overlapping dual frame design, using both a landline and mobile phone frame.

Following a sample design review conducted by ENGINE in early 2019 the design changed to a single frame mobile phone design from Q3, 2019.

The design change required changes in the weighting method. Weighting changes were also required due to the Australian Bureau of Statistics (ABS) releasing revised Estimated Resident Population (ERP) values based on the 2016 census.

This report documents the statistical implications of the design and changes.

2 Moving from a dual frame design to a single frame design

Since its inception in Q4, 2015, AusPlay had had an overlapping dual frame design, using both a landline and mobile phone frame. This design had the benefit of providing close to *full coverage* of Australian residents, covering all phone users.

A sample design review conducted by ENGINE in early 2019 recommended the design be changed to a single frame mobile phone design. The ASC accepted this recommendation and the design change was introduced from Q3, 2019. Set out below is the supporting argument behind this design change.

2.1 The benefits of a single frame design

Whilst dual frame designs have the benefit of increased coverage of the target population, they also have the disadvantage of having higher standard errors, *relative to single frame surveys of the same sample size*. Dual frame samples have a disproportional telephone ownership sample profile and the dual frame weights, in seeking to account for the disproportional sample profiles, are more variable than comparable single frame design weights. The more variable dual frame weights lead to higher standard errors.

An important design issue for dual frame surveys is the optimum mobile share of sample. The optimum mobile share is the share which gives the lowest sample error for a fixed total sample size. The optimum mobile/landline ratio is a function of the telephone ownership structure (landline only; mobile only; and both landline and mobile). In 2015 the telephone ownership structure was such that the optimum mobile share was 50% (a 50/50 design). This share was used for the initial AusPlay design in October 2015 and continued as the design up to the end of Q2, 2019.

The Roy Morgan Telephone Ownership Population estimates[1], used for AusPlay weighting, provide an insight into the changing phone ownership structure in Australia. Between October 2015 and December 2018, the percentage of the population 15+ who were accessible on a landline fell from 69.6% to 49.8%. Over the same period the percentage of the population 15+ with a mobile phone increased slightly from 95.3% to 96.1%.

This large change in the phone ownership profile had implications for the optimum mobile share. The changed phone ownership profile in December 2018 gave rise to an optimum mobile share of 70% (70% mobile, 30% landline). This change in the optimum mobile share from 50% to 70% gave rise to a design review in early 2019. This review initially considered dual frame designs with mobile shares of 65%, 70% (the optimum mobile share) and 80%, as well as the option of a single frame mobile phone design. Initial analyses of these designs led to the discarding of the 65% and 80% mobile share options, with more detailed analyses being carried out on the 70% mobile share and the single mobile phone design options.

The review recommended a move to a single frame mobile phone design because of the beneficial impacts on the child sample sizes and on the standard errors for both adult and child estimates. These benefits are summarised below.

[1] Provided to the ASC by Tourism Research Australia (TRA)

2.2 Increase in child sample size

The table below sets out the average child sample size under the previous 50/50 dual frame design, and the expected sample sizes under a 70/30 dual frame design. The mobile sample has a higher child/adult sample ratio than the landline sample, meaning that any increase in the mobile sample share (from 70% to 100%) will increase the child sample size. It can be seen from Table 1 that moving to a 70/30 dual frame design increases the total child sample by 7% (from 3,157 to 3,373) but moving to a single frame mobile phone design leads to a 17% increase in the total child sample size (from 3,157 to 3,705), although, for both options, the child sample sizes for the smaller jurisdictions would decrease.

Table 1: AusPlay state and territory annual child sample sizes

State	Current (50/50)	Dual frame (70/30)	Single frame mobile
NSW	810	998	1,160
Vic	813	795	930
Qld	585	643	714
SA	175	182	201
WA	411	435	458
Tas	133	120	96
NT	90	86	61
ACT	140	114	85
Total	**3,157**	**3,373**	**3,705**

2.3 Improved standard errors

The tables below set out the expected relative reduction in standard error (SE) values in moving from the previous 50/50 dual frame design to a 70/30 dual frame design or a single frame mobile phone design, for both adult and child estimates. The reduction in SEs of child estimates takes into account the increase in child sample size discussed above.

Table 2: Relative reduction in SE values for annual adult estimates

State	Dual frame (70/30)	Single frame mobile
NSW	19.9%	39.6%
Vic	-5.4%	20.9%
Qld	18.5%	24.2%
SA	16.0%	43.0%
WA	23.5%	18.8%
Tas	29.1%	16.2%
NT	55.3%	58.6%
ACT	14.3%	-3.7%
Total	**11.5%**	**25.6%**

Table 3: Relative reduction in SE values for annual child estimates

State	Dual frame (70/30)	Single frame mobile
NSW	22.9%	34.8%
Vic	-1.2%	17.8%
Qld	22.3%	23.6%
SA	23.0%	44.7%
WA	31.2%	25.1%
Tas	38.6%	25.9%
NT	57.8%	52.5%
ACT	18.1%	-5.4%
Total	**17.1%**	**26.0%**

The benefits of the single frame mobile phone design

A decision was made to move to a single frame mobile design from Q3, 2019. The benefits of the revised single frame design are evident from the above tables: very significant reductions in SEs for national and most state/territory estimates for both child and adult estimates.

There are two factors affecting the reduction in child SE values in moving from the current design to a 100% mobile design. For jurisdictions other than Tasmania, NT and the ACT, the design changes will lead to an increase in child sample size. Additionally, the design changes will also reduce the variability of the weights for all jurisdictions, thus reducing the standard errors of child estimates. The overall impact of the design change is the joint impact of these two distinct factors. For jurisdictions other than Tasmania, NT and the ACT, the both factors lead to reduced standard errors, thus leading to reduced standard errors overall for these jurisdictions. For Tasmania and the NT, the impact of the reduced variability of the weights outweighs the smaller child sample sizes, whereas for the ACT the reverse is true, thus leading to a decrease in child standard errors for Tasmania and the NT and a minimal increase in child standard errors for the ACT.

There is an off-setting disadvantage of the design change in not covering the landline-only population. This issue is mitigated by the single frame mobile weights which project the results to the *full population* not the mobile phone population. In this way the weighting *imputes* the responses of the missing landline-only population with the average values of the survey population within the corresponding weighting cells. The relatively small share of the population being imputed in this way (around 3%) means that final under-coverage error is likely to be very marginal.

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3 Weighting the single frame mobile phone frame

3.1 Overview of the previous weighting approach

To provide some context for the revised weighting approach arising from the new single frame mobile phone design it is useful to review the weighting approach for the dual frame design.

3.2 Previous weighting approach under the dual frame design

1. The adult weights were firstly calculated as follows

2. The initial probabilities of selection were calculated. For the landline sample the initial probabilities of selection were proportional to the inverse of the household size (persons aged 15+) to reflect the fact that the random respondent was selected from households selected from the landline sample. For the mobile sample the initial probabilities of selection were proportional to the number of active mobile phones used by the mobile phone respondent (capped at 3).

3. For both the landline and mobile sample, weighting cells were defined by part-of-state x gender x age. The part-of-state and age groups used were as follows:

Table 4: AusPlay part-of-state weighting groups

Part-of-state groups
Sydney
Rest of New South Wales
Melbourne
Rest of Victoria
Brisbane
Rest of Queensland
Adelaide
Rest of South Australia
Perth
Rest of Western Australia
Tasmania
Northern Territory
Australian Capital Territory

Table 5: Age weighting groups

Age
15-24
25-34
35-44
45-54
55-64
65+

3. The combination of 13 geographic strata with 6 age x 2 gender weighting cells resulted in 156 weighting cells for both the landline and mobile samples. In order to avoid unduly variable

weights, weighting cells were collapsed if the sample size was less than 5. Weighting cells were collapsed across adjacent age groups but not across gender or geographic strata.

4. Estimated Resident Population (ERP) data classified by state x part of state x age by gender was available on a quarterly basis for the landline population (the population with access to a landline) and the mobile population (the population who use a mobile phone). The initial probabilities of selection were then pro-rated by a calibration weighting method so that they summed to the relevant weighting cell population totals for both the landline and mobile sample.
5. The resultant weights at this stage enabled the projection of the landline sample to the landline population and the mobile sample to the mobile population. A further adjustment was required to enable the sample to represent the *full population*. In this adjustment the weights of records from the landline sample with a mobile phone and the records from the mobile sample with a landline were halved to account for the fact that both the mobile sample and the landline sample represented the population of people with both a landline and mobile phone number. In this way the double-counting of this overlap population was accounted for.
6. A rim-weighting process was then used to ensure consistency of the weights with two sets of Australian Bureau of Statistics (ABS) Estimated Resident Population (ERP) based population data. The first set of population data used was the ERP totals classified by telephone ownership (mobile only; landline only; both landline and mobile) x state/territory. The second set of population data used was the ERP-based totals for the 156 weighting (geographic strata x gender x age).
7. The rim weighting operated in an iterative fashion. The weights were firstly pro-rated so that their sum for the first set of rim weighting cells is equal to the ERP values of those cells. The weights obtained from this process are then pro-rated so that their sum for the second set of rim weighting cells is equal to the ERP values of those cells. This process then re-commences with the weights being pro-rated again to the first rim-weighting totals and then to the second set of rim-weighting totals. This continues until the weights are consistent with both sets of rim weighting totals. Five rim weighting iterations were used in the AusPlay weighting in order to ensure the convergence of the weights. These weights were the final weights for the adult sample.
8. The adult weights were then used to calculate child weights as follows:
9. The starting point for the child weights was the adult weight for respective adult respondent. The probability of selection of children is inversely proportional to the number of children aged 0-14 in the household. In order to account for this probability of selection the adult weight was multiplied by the number of children aged 0-14 in the household. A further weight adjustment was made which divided the child weight by the number of adults in the household who could have reported the selected child. This adjustment accounts for the fact that the adult weights project to all adults in the population, not just the selected adults.
10. The final child weights were calculated by a rim-weighting process using two ABS ERP rim values: (1) the quarterly ERP values by age (0-4, 5-8, 9-11, and 12-14) x gender at the national level; and (2) the quarterly ABS child (0-14) ERP values for states and territories. This ensured the weighted child estimates were identical to the two ABS ERP rim values.

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3.3 Revised weight approach under the revised single frame design

The weighting calculations for the revised design proceeded broadly in the same way as for the previous approach with the following exceptions:

1. The calculations used previously for the mobile sample were applied to the whole sample (as there was no landline sample), using the same weighting cells defined by part-of-state x gender x age. The ERP values used were for the full population, not the mobile phone population.

2. The process of halving the weights of the sample with both a landline and a mobile was not required.

3. The rim-weighting (described in point 6 and 7 above) was still carried out but the rim population of ERP totals classified by telephone ownership was replaced by the ERP population classified by fine age groups x gender at the national level. The benefits of using this fine age x gender rim-weighting process is to ensure, in particular, improved consistency between weighted estimates and ABS ERP values for estimates for younger age groups (15-17, 18-19, 20-24). The interim weights, which are based on ERP values for the broader age group of 15-24, ensure this consistency at this broader level but do not fully account for gender and age imbalance within the 15-24 age group. Whilst this approach is particularly helpful for this lower age group it is also beneficial (providing enhanced consistency) for estimates for all other age groups.

4. The fine age groups used were

Table 6: Fine age weighting groups

Fine age groups
15–17
18–19
20–24
25–29
30–34
35–39
40–44
45–49
50–54
55–59
60–64
65–69
70–74
75–79
80+

5. The weighting approach for the child weights was identical to the approach used in the previous design, although the starting point for these weights, the adult weights, were changed as described above.

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4 Revised ABS Estimated Resident Population (ERP) projections

Quarterly ERP projections at the part-of-state x age x gender level are an integral part of the weighting calculations. The weighting process effectively projects the sample to the ERP values. If the ERP value for a particular weighting cell (eg NSW, males 15-24) increased by x% all weighted estimates of total for that weighting cell will increase by x%. Weighted estimates at higher levels (across weighting cells) would also change according to the contribution of the various weighting cells at that higher level and the changes to the ERP values for those cells.

The ABS produces quarterly ERP projections at the completion of each census, with updated projections being released about two years after the conduct of each census. The ERP values used for AusPlay weighting from the initial Q4, 2015 survey were based on the 2011 census. In December 2018 the ABS released revised quarterly ERP projections based on the 2016 census.

In order to ensure ongoing consistency with ABS estimates it was necessary to change the ERP values used in AusPlay weighting from the quarterly projections based on the 2011 census-based to those based on the 2016 census.

The revised ERP projections were considerably different to the previous, 2011 census-based, values. The table below shows the impact of these revised projections for June 2018. Cells with relative differences in excess of 5% are shaded. It can be seen that these updated projections have a significant impact for some states (an 11.1% reduction for WA, a 4.0% reduction for the NT and a 3.5% increase for Victoria). The change also impacts at the age and gender level: The national male value has decreased by 1.0% and the 35-44 age group has decreased by 2.4%.

Table 7: ERP changes June quarter, 2018

June quarter 2018 - compare 2016 census base to 2011 base									
	15-24	25-34	35-44	45-54	55-64	65 +	M	F	**Total**
NSW	4.0%	5.9%	0.6%	-0.4%	-0.5%	-1.0%	1.3%	1.5%	**1.4%**
Vic	9.3%	7.7%	1.1%	1.1%	1.0%	0.9%	3.5%	3.5%	**3.5%**
Qld	-2.7%	-3.4%	-4.6%	-2.4%	-1.6%	0.3%	-3.2%	-1.6%	**-2.4%**
SA	0.7%	-2.0%	-3.9%	-1.8%	-0.7%	-0.8%	-1.8%	-0.9%	**-1.4%**
WA	-12.2%	-18.2%	-13.6%	-9.3%	-6.8%	-4.0%	-12.5%	-9.7%	**-11.1%**
Tas	0.2%	3.6%	-2.0%	-0.5%	0.0%	0.0%	-0.3%	0.7%	**0.2%**
NT	-9.9%	0.8%	-3.5%	-3.3%	-3.8%	-6.4%	-4.0%	-3.9%	**-4.0%**
ACT	1.9%	-2.8%	1.0%	-2.5%	-0.7%	0.8%	-1.4%	0.5%	**-0.4%**
Total	**1.5%**	**0.6%**	**-2.4%**	**-1.6%**	**-1.1%**	**-0.5%**	**-1.0%**	**-0.1%**	**-0.6%**

Revised ERP values were introduced to the AusPlay weighting calculations in Q3, 2019 to coincide with the introduction of the revised weighting for the new single frame mobile phone design.

5 Impact of the changes on the AusPlay outputs

The statistical impact of the design and weighting changes on the AusPlay outputs are as follows:

1. The change to a single frame design will significantly reduce the standard errors for both adult and child estimates as shown in tables 2 and 3 above.
2. The change to a single frame will lead to non-coverage of the landline only population. The impact of this is likely to be marginal as this population accounts for less than 3% of all phone users. Further, by weighting the mobile sample to the full population ERP values, the survey characteristics of the landline-only population is effectively imputed.
3. The changes to the weighting approach is a consequence of the design changes and has no inherent benefits other than to ensure that best practice weighting design which reflects the sample design has been used.
4. The use of revised ERP projections ensures consistency of AusPlay estimates with ABS ERP values.
5. The use of the fine age x gender rim weighting for adult weights in the revised weighting approach will ensure better consistency with ABS ERP values for finer age groups (eg 15-17, 18-19, 20-24).

Whilst it is not possible to provide an indication of how these changes will influence the AusPlay time series, it is possible that they may have an impact. The ASC has published its own analyses of how overall participation estimates and rates may be impacted by the changes on the Clearinghouse for Sport.

In any case, it is important to note that all the above design and weighting changes were:

- Necessary due to factors external to the survey, such as the changes to phone ownership and ABS ERP values outlined above; and
- Purposefully made simultaneously to minimise the overall impact on the AusPlay time series.