

## HOW DO WE REACH THEM? COMPARING RANDOM SAMPLES FROM MOBILE AND LANDLINE PHONES

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### ABSTRACT

Quantitative studies of nascent entrepreneurs such as GEM and PSED are required to generate their samples by screening the adult population, usually by phone. Phone survey research has recently been challenged by shifting patterns of ownership and response rates of landline versus mobile phones. We report a comparison between samples of mobile and landline phones for the Australian GEM 2010 study. We find a substantial response bias towards younger, male and metropolitan respondents for mobile phones – far greater than explained by ownership rates. We also found this biases the estimates of the prevalence of early stage entrepreneurship by both samples, even when each sample is weighted to match the Australian population.

### INTRODUCTION

Phone survey research that relies on reaching a random sample of the adult population has recently been challenged by shifting patterns of ownership and usage behaviour of landline versus mobile phones (Brick et al. 2006). Although this problem is not unique to entrepreneurship, it is particularly important for studies of nascent entrepreneurship, including two prominent studies in our field – GEM and PSED. These seminal studies identified that the only way to obtain a representative sample of nascent entrepreneurs was through screening a random sample of households or individuals.

The first successful effort to develop a representative sample of nascent entrepreneurs within a well defined population was conducted in Wisconsin in 1992 (Reynolds and White, 1993). This endeavor was the precursor of the first US Panel Study of Entrepreneurial Dynamics (PSED I) and subsequently the Global Entrepreneurship Monitor (GEM) initiative, which applied the PSED sampling technique (Davidsson, 2005). Both studies use random sampling of households because this early stage of entrepreneurship is not captured on any lists of businesses or companies. The most cost effective way of screening a representative sample of the adult population is through phone surveys. The GEM is a large, policy-orientated research initiative that aims to compare and assess the prevalence rate of entrepreneurial activity between countries. GEM aims to investigate the prevalence rate of the adult population involved in business start-ups (nascent entrepreneurs), early stage business, and other entrepreneurial activities. Hence it is important to generate a sample that is as close as possible to a representative, random sample of the adult population.

In most countries GEM employs a telephone based survey approach to investigate the prevalence of such phenomena. Yet it is becoming increasingly challenging to generate a reasonably random sample as the ownership and usage patterns of landline and mobile phones change. GEM guidelines suggest that ownership rates greater than 80% are sufficient to employ a single contact method (either mobile or landline). According to the Australian Communications and Media Authority (ACMA), in 2008 ownership was 88% for landline phones but in decline by approximately 2% per year. Mobile phone coverage was 83% and increasing by about 2% per year. Hence, GEM Australia could have employed 100% data collection via either type of phone.

This paper informs this research method issue by comparing the samples obtained by random-digit-dialing of landlines and mobile phones in Australia, where ownership of both landline and mobile phone are quite high. Although ownership rates vary with age, ownership of either phone type do not drop below 70% and for any age group. Hence, in Australia, random samples of either phone list should give a reasonable representative sample of phone numbers for Australian adults. However, it remains an open question whether there is systematic variation in terms of non-response bias for landline and/or mobile phones.

The paper reports analysis of the GEM data collection for Australia in 2010. Two samples of 1000 adults were generated by random-digit-dialling fixed landline and mobile phone numbers, respectively, across Australia. We compare their demographic composition in terms of age, gender and metro/non-metro residence. We also compare the estimates of the prevalence rates of early stage entrepreneurship obtained from each sample.

## **NASCENT ENTREPRENEURSHIP RESEARCH**

New firm creation represents a central focus of empirical research in entrepreneurship (Davidsson 2004) and estimating the prevalence of nascent entrepreneurs has recently become a critical objective of several prominent studies. It is fair to say that systemic research on the pre-operational stage of business creation started in the early 1990's. More precisely, it was 1992 when the term "nascent entrepreneur" was first coined (Reynolds & Miller 1992), referring to an individual engaged in an on-going but not yet operational business start-up.

The most central feature of research that investigates operational firms at the stage when they have not yet come into existence is that identifies a statistically representative sample of nascent entrepreneurs via screening questions with a very large random sample of adults.

Since the first efforts of longitudinal studies of new venture creation (Reynolds and White 1997) improvements have constantly taken place (Reynolds 2009). Today it is widely acknowledged that random sampling of the population is required to identify nascent entrepreneurs. As a testimony of this statement, the two major research studies in entrepreneurship, PSED and GEM, are sharing the same sampling method. A technique also shared by smaller national longitudinal studies such as the Comprehensive Australian Study of Entrepreneurial Emergence (CAUSEE), the Canadian National Study of Entrepreneurial dynamics, The Chinese Panel Study of Entrepreneurial Dynamics (CPSED), and the German Panel of Nascent Entrepreneurs (GEPANE).

## **GENERATING REPRESENTATIVE SAMPLES FROM DIFFERENT SURVEY MODES**

There are a variety of survey modes available to researchers today: face-to-face interviews, telephone interviews, IVR (Interactive Voice Response) surveys, mail surveys, and internet surveys. Each one of these has its own advantages and limitations. In this paper we are particularly interested in phone survey methods, and the challenges faced by changing ownership patterns between landline and mobile phones, together with changing response behaviour over these two types of phones.

Overall, telephone surveys, which once seemed the heir to face-to-face interviews, are no longer an obvious choice for conducting many surveys. Besides the difficulty in obtaining satisfactory response rates (Mokrzycki, Keeter, and Kennedy, 2009), telephone surveys are also negatively affected by the change in connectedness of telephone instruments from household to individuals (Dillman 2002). Because a mobile phone is a personal device, there is tendency to see the sampling unit as the person who answers the phone and not the household as usually done in RDD surveys. This approach can have consequences as adults in mobile-only households who do not have a mobile are undersampled. Therefore, it appears to be a better alternative to maintain the household as the sampling unit with the person answering the phone representing all the adults in the household (Tucker, Brick and Meekins 2007). The second phenomenon we are witnessing is a cultural shift whereby people are able to control the telephone rather than vice versa (Dillman 2002). Through caller IDs and by screening calls using answering machines, people can now decide whether or not to answer the phone.

Recent declining survey response rates, particularly for telephone surveys (Abraham, Maitland and Bianchi, 2006; Groves 2006), have encouraged researchers to use multiple modes of data collection

during the administration of a single cross-sectional survey (Dillman and Christian, 2005). Besides an attempt to increase response rates, other reasons that may contribute to push researchers in mixing survey modes for the collection of data from a single population include an effort to reduce costs and an attempt to generate a sample that is as close as possible to a representative random sample of a single population. Brick et al. (2006) conducted an American study in 2004 using a dual frame survey of landline and mobile numbers in an RDD telephone survey. The researchers allowed for households with both landline and mobiles to be eligible for selection in both sub-samples. Similar efforts to evaluate the feasibility of surveying frames of both mobile and landline numbers have also been described by Steeh (2004) and Fleeman (2006).

While all of the reasons previously mentioned for mixing up survey modes are understandable, they can also carry profound implications. There is considerable evidence that even when survey questions remain worded the same across different modes to collect the same data, the choice of survey mode affects respondents' answers (e.g. de Leeuw and Van Der Zowen 1988; Dillman et al. 1996; Fowler, Roman and Di 1998). With regard to mobile and landline sampling Brick et al. (2007) found that the probability of getting a refusal at the extended level on the first call was higher for the mobile sample than the landline sample, but concluded that their study did not support the hypothesis that interviewing on a mobile has different response characteristics than those that arise when interviewing across a landline. On the other hand, the authors recognised the complexity of the problem and the need for future studies to understand the role of mobile phones as interviewing devices, especially in longer surveys.

A second possible implication of using a multiple frame survey is the possibility of witnessing a systematic variation in terms of which individuals are most likely to answer different survey modes. Brick et al. (2006) found evidence that households with both telephone devices are less likely to respond to their mobile than others. This type of nonresponse might be attributable to the fact that a substantial percentage of households receive very few calls on their mobile (Tucker, Brick and Meekins 2007).

As pointed out by Brick et al. (2007) an important feature of calling mobile numbers is that the respondent may be in any of many different locations, rather than at home (e.g. driving, at work, or out in public) and age groups can determine such a location. They found that 63.4% of respondents in the 55 and over age group answered their mobile from home, compared to only 54% of respondents who were younger than 55 years old. There are strong signals that the proportion of adults with only mobiles is rapidly growing, especially among young adults aged 18-29 years. Studies in the USA have quantified the percentage of young adults who live in wireless-only households to be 24.7 and the group to represent 50.9 per cent of the entire population of wireless-only adults (Blumberg and Luke, 2007).

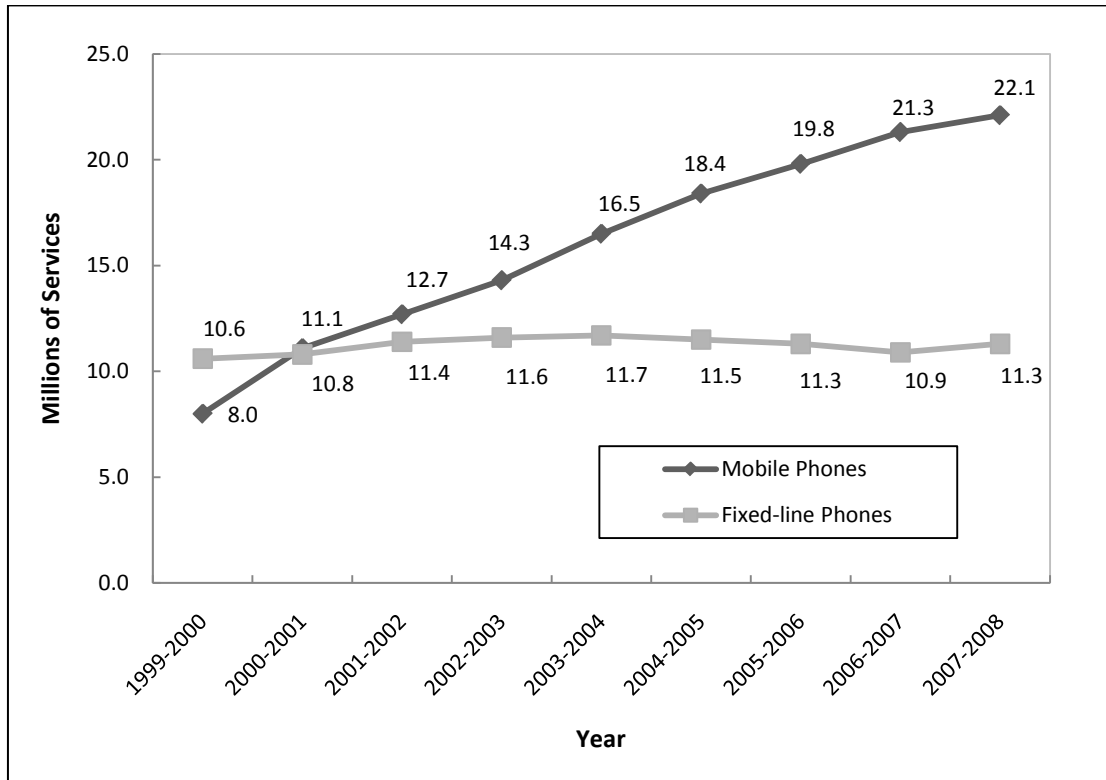
Noncoverage of that portion of the adult population that is reachable only by wireless devices can result in nonnegligible bias for traditional RDD landline telephone surveys even after adjusting for demographic differences (Blumberg and Luke, 2007). Hence, the inclusion of mobiles seems to have become a requirement in generating a reasonably random sample through telephone surveys. However, it is imperative to also understand usage patterns of landline and mobile phones to obtain the representativeness that would otherwise be missed. Variables that need to be controlled include age groups, geographical areas, gender, and income (Tucker, Brick and Meekins 2007).

## **CHANGING TELEPHONE OWNERSHIP PATTERNS**

The Australian communications environment is rapidly changing, providing consumers with a range of alternatives. Figure 1 displays the trend in the number of mobile and landline services across Australia. While landline phones remain the most common choice in terms of voice minutes, Australians are increasingly turning to mobile technology to make voice calls and use their landline service solely to maintain an internet connection. This trend anticipates a surpass of mobile traffic in the near future (ACMA 2009).

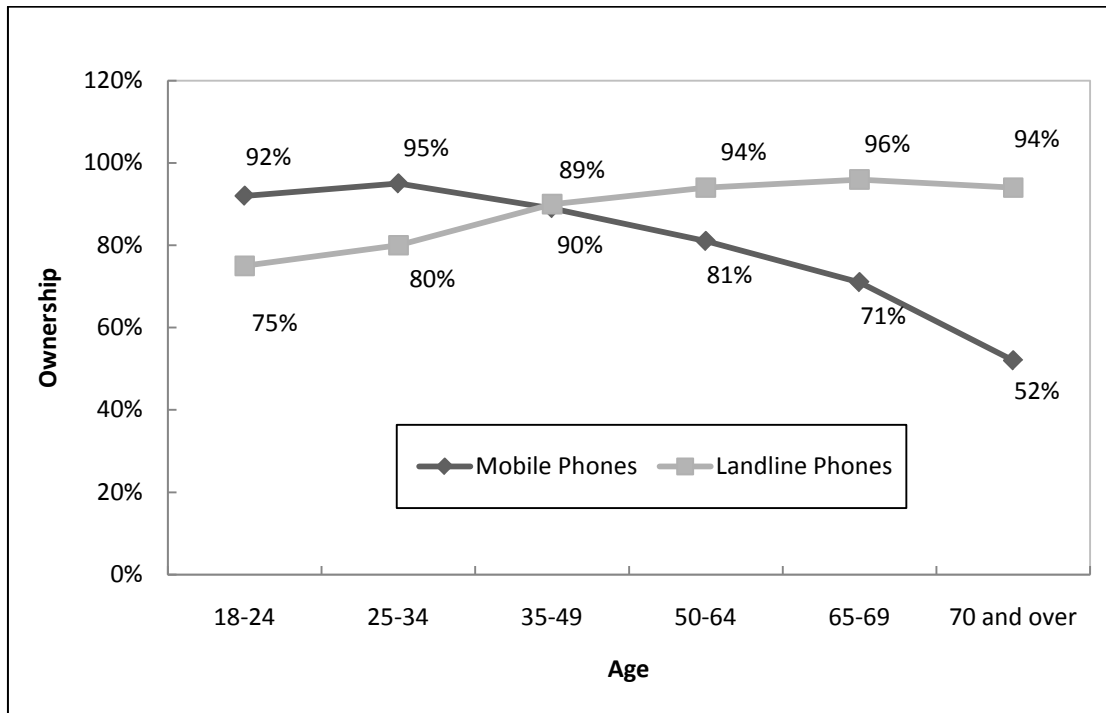
Since June 2007, the number of mobile services operating in Australia has risen by four per cent to 22.12 million. This increase appears to be linked with changes in digital communication services. The closure of the CDMA network in 2008 led to nearly 40 per cent of mobile users to subscribe to a 3G service, indicating the potential for landline users to cancel their service if intended solely as a mean to have an internet connection.

**Figure 1: Take-up of Voice Services: Landline and Mobile Phones**



Source: ACMA (2009)

**Figure 2: Ownership of Mobile and Landline Phones by Age Band**



Source: ACMA (2009)

While the process of moving from landline phones to mobiles is in progress across all age groups of Australians, the ACMA survey suggests a strong correlation between the age of the consumer and substitution: younger Australians are leading the shift away from landline communications, while elders remain generally more attached to landline technology.

Figure 2 indicates a strong relationship between age and ownership of mobiles and fixed-line services. As illustrated, older Australians are more likely to have a fixed-line phone, with 94 per cent of those aged 70 and over maintaining a home fixed-line phone service as opposed to just 52 per cent having a mobile. Conversely, young Australians show a stronger preference towards mobile communications technology. In fact just 75 per cent of 18 to 24-year-olds have a fixed-line service, while 92 per cent have mobiles.

## **DATA COLLECTION**

### **The GEM Study**

The paper reports analysis of the GEM adult population survey for Australia in 2010. The Global Entrepreneurship Monitor (GEM) research program is an annual assessment of the national level of entrepreneurial activity. It was initiated in 1999 with 10 countries, expanded to 21 in the year 2000, with 29 countries in 2001 and 37 countries in 2002. GEM 2009 conducted research in 56 countries.

Every year each national team is responsible for conducting a survey of at least 2000 people within its adult population. The Adult Population Survey (APS) is a survey of attitudes towards entrepreneurship in the general population but it also asks people whether or not they are engaged in start up activity or own or run a business.

The research program, based on a harmonized assessment of the level of national entrepreneurial activity for all participating countries, involves exploration of the role of entrepreneurship in national economic growth. Systematic differences continue, with few highly entrepreneurial countries reflecting low economic growth. There is, further, a wealth of national features and characteristics associated with entrepreneurial activity.

### **Sampling Approach**

The Australian 2010 APS was a telephone survey of 2000 adults 18 years or older. The very high coverage for both mobile and landline telephones in Australia (>80%) means that there is not a natural "primary" sampling frame or a reason for picking one method over the other. More importantly, we did not have information available regarding variation in response rates for each type of phone, and how these might vary with demographic profiles. Therefore, it was decided that a mixed sampling method gives a better approach than either on their own.

We generated two equal sized samples from landline (n=1000) and mobile phones (n=1000) respectively. For fixed lines, the respondent was the adult with the next birthday in the household. The sample framework was the universe of all telephone numbers. The sample was selected using random digit dialling (full RDD for the fixed lines and generate the mobile phone numbers using Australian Communications and Media Authority (ACMA) mobile phone prefixes as the stem, and randomly-generating the remaining numbers).

A phone schedule was developed to include a mix of weekday, week night and weekend calls. There was a minimum of five call-backs to each number if it wasn't answered. For landline numbers, the interviewer asked to speak to the adult in the household with the next birthday. If they were not home, again a minimum of five call-back attempts were made to talk with this individual.

### **The GEM Measures**

The APS uses a harmonized questionnaire across all participating countries. The survey measures a prevalence rate of entrepreneurial activity, and for those who are involved asks them some questions about the nature of their business and the business environment (Reynolds et al. 2005).

The measure of entrepreneurial activity is the Early Stage Entrepreneurial Activity prevalence rate (also called TEA index). This indicator is calculated in an identical way in each country. Respondents are asked three questions that form the basis of the TEA index:

Are you, alone or with others, currently trying to start a new business independently of your work?

Are you, alone or with others, currently trying to start a new business as part of your work?

Are you, alone or with others, currently the owner or manager of a business?

Those who respond positively to these questions are also asked filter questions to ensure they are actively engaged in business creation as owners and managers, how long they have been paying wages to employees, and other questions about cost and time to start up, sources of finance and numbers of jobs created. A distinction is made between two types of entrepreneurs: nascent entrepreneurs (those that have been paying salaries for less than three months) and new business owner-managers (those that have been paying salaries for between three and 42 months). Early-Stage Entrepreneurial Activity is the sum of the nascent entrepreneurs and baby business owner/managers minus any double counting (i.e. those who respond positively to both). The Early-Stage Entrepreneurial Activity rate is comparable across nations and it measures the propensity of a country to be entrepreneurial.

Since we used mixed survey modes, we employed an additional two questions. Individuals selected from the landline sample were asked whether or not they also owned a mobile phone, while individuals selected from the mobile sample were asked if they also had a landline number (including VoIP phone used only for incoming calls). This information gave us the ability to adjust through weighting if necessary.

## ANALYSIS AND RESULTS

We conduct two types of analyses to compare the mobile and landline phone samples. First, to get a sense of the extent of bias that exists in each sample, we compare the demographics characteristics of the mobile and landline samples, and also compare these with the actual Australian population figures. Second, to evaluate the impact of biases on the estimates of entrepreneurial activity prevalence rates, we estimate the TEA index from each sample and compare these with the combined sample. We do this for both the unweighted (original data) and for each sample weighted to match the Australian population (for age, gender and metro/non-metro). For all analyses, we test for significant differences between the samples.

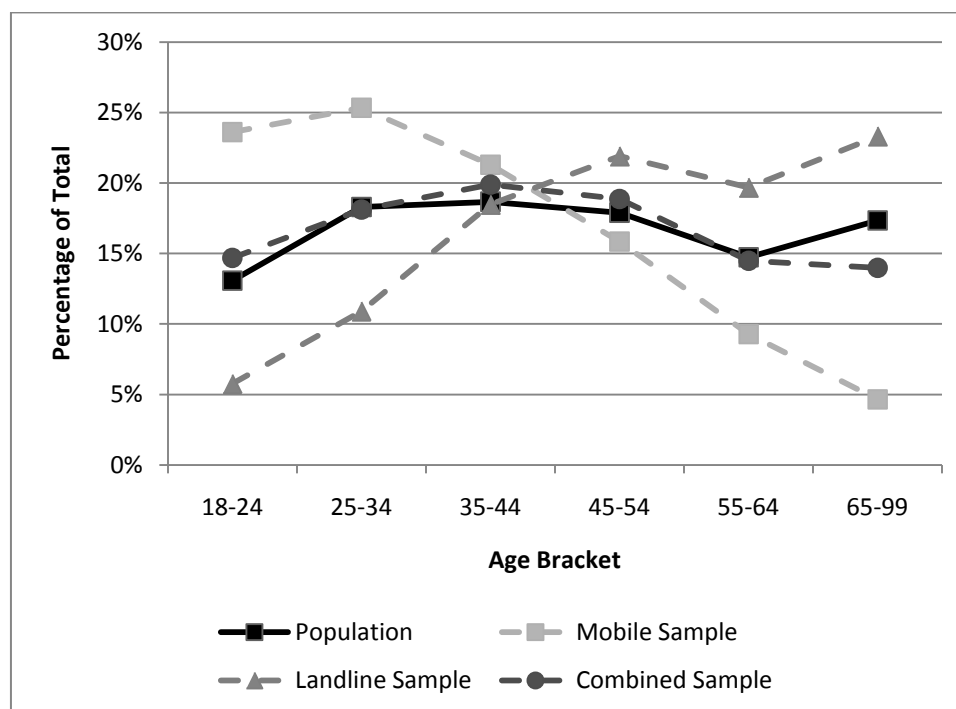
### Demographic Comparison of the Samples

We compare the age distributions, gender and metro/non-metro residential location of each sample with the population statistics for Australia.

Figure 3 displays the age distribution of each sample, the combined sample and the actual population statistics. Table 1 displays the percentages of each sample in each age band and presents z-tests for the proportion of each sample falling into an age band against the population proportion for Australia. Chi-square test for overall difference between the mobile and landline samples are also displayed.

Figure 3 gives a first impression of the results. It is immediately evident that while the combined sample closely matches the Australian population, the mobile sample clearly has a substantially higher percentage of the younger respondents, and conversely the landline sample is heavily biased towards older respondents. Table 1 confirms that most age bands are significantly different to the Australian population for both the mobile and landline samples.

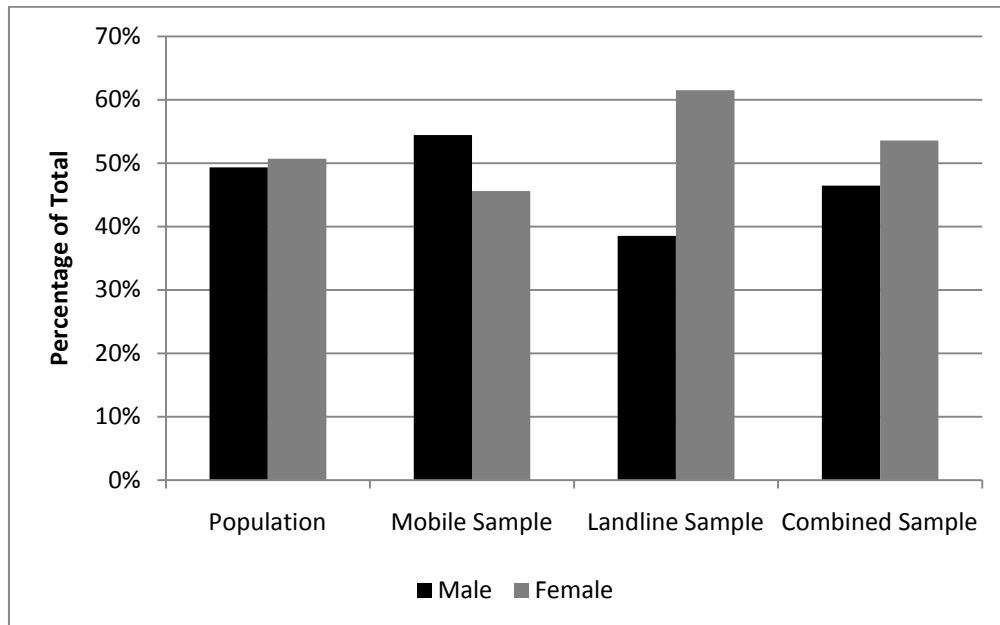
However the combined sample matches the true population reasonably well. Only the youngest age category 18 – 24 is slightly over-represented (1.6%  $p < 0.05$ ) and the oldest age category 65 – 99 is slightly under-represented (3.3%;  $p < 0.001$ ).

**Figure 3: Comparing Age Distribution of Samples with the Australian Population****Table 1: Comparing Age Bands of Samples with the Australian Population**

		Mobile Sample	Landline Sample	Combined Sample	Australian Population
		Column N %	Column N %	Column N %	Column N %
Age Bands	18 - 24	23.6***	5.8***	14.7*	13.1
	25 - 34	25.3***	10.9***	18.1	18.3
	35 - 44	21.3*	18.5	19.9	18.7
	45 - 54	15.8*	21.9***	18.9	17.9
	55 - 64	9.3***	19.7***	14.5	14.7
	65-99	4.6***	23.3***	14.0***	17.3

Test of difference between mobile and landline samples: Chi-square (d.f. 5) 336.7 \*\*\* Table displays z-test of proportion of sample compared with Australian population \*\*\* p<.001; \*\* p<0.01; \* p<0.05.

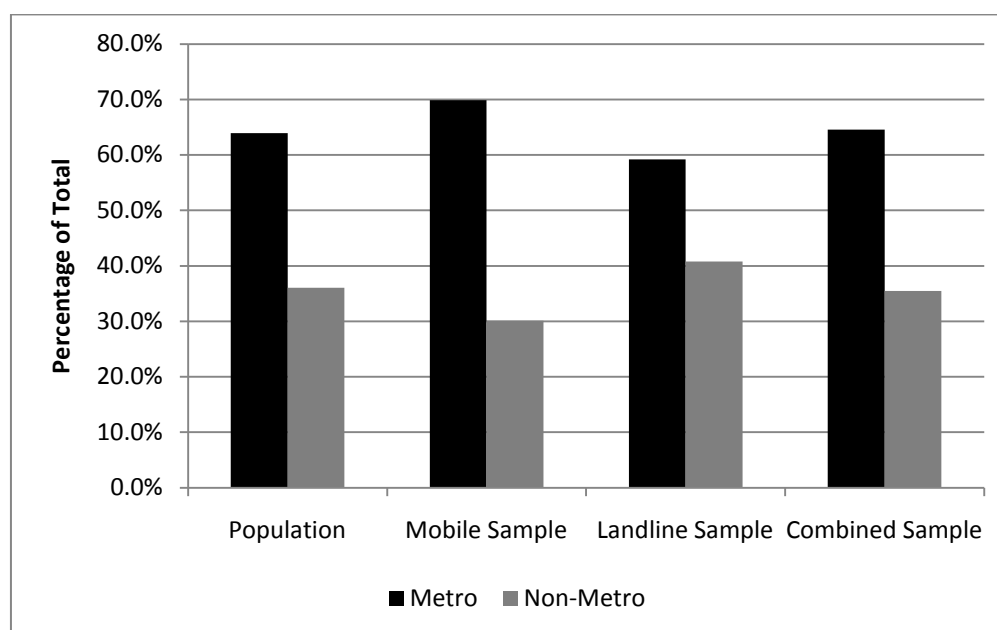
Figure 4 displays the gender balance of each sample, the combined sample and the actual population figure. It is clear that males overrepresented in the mobile sample and females overrepresented in the landline sample. The combined sample is again a closer match to the Australian population – although females are slightly overrepresented. Table 2 reveals that the mobile, landline and the combined samples are all significantly different to the Australian population.

**Figure 4: Comparing Gender Balance of Samples with the Australian Population****Table 2: Comparing Gender Balance of Samples with the Australian Population**

	Mobile Sample	Landline Sample	Combined Sample	Australian Population
	Column N %	Column N %	Column N %	Column N %
Male	54.4***	38.5***	46.5**	49.3
Female	45.6***	61.5***	53.6**	50.7

Test of difference between mobile and landline samples: Chi-square (d.f. 1) 50.8\*\*\*  
 Table displays z-test of proportion of sample compared with Australian population  
 \*\*\* p<.001; \*\* p<0.01; \* p<0.05.

Figure 5 displays the metro/non-metro balance of each sample, the combined sample and the actual population figure. It is clear that metro is overrepresented in the mobile sample and non-metro overrepresented in the landline sample. The combined sample is again a very close match to the Australian population. Table 3 reveals that while both the mobile and landline samples are significantly different to the Australian population and the combined sample is not.

**Figure 5: Comparing Metro/Non-Metro Balance of Samples with the Australian Population****Table 3: Comparing metro/Non-Metro Balance of Samples with the Australian Population**

	Mobile Sample	Landline Sample	Combined Sample	Australian Population
	Column N %	Column N %	Column N %	Column N %
Outside Capital City	30.1***	40.8***	35.5	36.0
Capital City	69.9***	59.2***	64.6	64.0

Test of difference between mobile and landline samples: Chi-square (d.f. 1) 25.0\*\*\* Table displays z-test of proportion of sample compared with Australian population  
 \*\*\* p<.001; \*\* p<0.01; \* p<0.05.

### Estimates of Entrepreneurial Prevalence Rates

We now turn our attention to assessing the impact of the sample biases on the estimation of entrepreneurial activity prevalence rates.

First we estimate the TEA index, and its two sub-components – nascent entrepreneurship rate and early stage business owner-manager rate. Our first analysis shows a naïve estimate without any weighting applied to match the demographics of the population. The second analysis weights each of the samples to the Australian population – as the GEM study does. We used three demographic variables to generate the weights – age, gender and metro / non-metro residence. We did not have age data for 18 of the respondents, 9 from each sample. These respondents were not used for the weighted analysis.

Table 4 and Table 5 shows the point estimates and 0.05 confidence interval for each sample for the unweighted and weighted analysis respectively. Z tests indicate whether the landline and mobile samples are significantly different. Figure 6 displays these rates graphically.

A first impression can be gained from Figure 6 that the mobile sample provides higher estimates of the TEA index and its sub-components than the landline sample.

Table 4 confirms that when the data is not weighted that this difference is significant for the TEA index (8.3% vs 5.4%;  $p < 0.01$ ), and significant at the 0.1 level for the prevalence rate of early stage business owner managers. The difference is not significant for the prevalence rate of nascent entrepreneurs, but this is most likely due to the low power of the test – the sample sizes of 1000 each is not quite large enough to reveal difference in the low prevalence rate in the range of 2-4%.

Importantly, it can be seen from Table 5 that weighting each sample to the Australian population in attempt to correct for the observed biases in age, gender and metro/non-metro does little to improve the bias in the estimates of entrepreneurial activity prevalence. The TEA remains significantly higher for the mobile sample than the landline sample (7.6% vs 5.2%;  $p < 0.01$ ), with the difference between the two estimates only marginally reduced from 2.9% to 2.4%.

**Table 4: Unweighted Estimates of Prevalence of Entrepreneurial Activity across Different Samples**

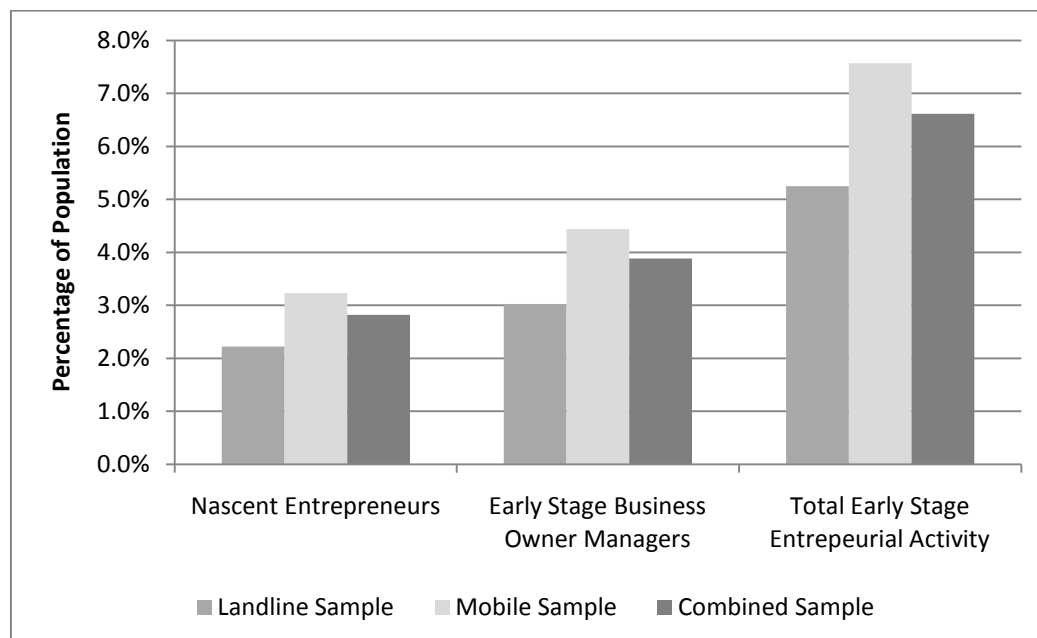
	Percentage of Population		
	(Confidence Interval)		
	Landline Sample	Mobile Sample	Combined Sample
Nascent Entrepreneurs	2.2 (1.3 - 3.1)	3.4 (2.3 - 4.5)	2.8 (2.1 - 3.5)
Early Stage Business Owner Managers	3.3 <sup>†</sup> (2.2 - 4.4)	5.0 <sup>†</sup> (3.6 - 6.4)	4.2 (3.3 - 5.0)
TEA: Total Early Stage Entrepreneurial Activity	5.4** (4.0 - 6.8)	8.3** (6.6 - 10.0)	6.9 (5.7 - 8.0)

Confidence intervals are two-side 0.05. Table displays z-test of difference between mobile and landline samples. \*\*\*  $p < 0.001$ ; \*\*  $p < 0.01$ ; \*  $p < 0.05$ ; <sup>†</sup> $p < 0.1$ .

**Table 5: Weighted Estimates of Prevalence of Entrepreneurial Activity across Different Samples**

	Percentage of Population (Confidence Interval)		
	Landline	Mobile	Combined
	Sample	Sample	Sample
Nascent Entrepreneurs	2.2 (1.3 - 3.1)	3.2 (2.1 - 4.3)	2.8 (2.1 - 3.5)
Early Stage Business Owner Managers	3.0 <sup>†</sup> (2.0 - 4.1)	4.4 <sup>†</sup> (3.2 - 5.7)	3.9 (3.0 - 4.7)
TEA: Total Early Stage Entrepreneurial Activity	5.2** (3.9 - 6.6)	7.6** (5.9 - 9.2)	6.6 (5.5 - 7.7)

Confidence intervals are two-side 0.05. Table displays z-test of difference between mobile and landline samples. \*\*\* p<.001; \*\* p<0.01; \* p<0.05; <sup>†</sup>p<0.1.

**Figure 6: Weighted Estimates of Entrepreneurial Activity Prevalence Rate for Each Sample**

## DISCUSSION AND CONCLUSIONS

While theoretically, the use of single survey mode should be preferred because reduces responses biases, in our case the use of mixed methods has successfully served the purpose of generating a sample that is as close as possible to a representative random sample of the population. The systematic variation in terms of which individuals are most likely to answer different survey modes, which can sometimes be seen as a limitation of mixed methods, was in this case the cause that generated a reasonable representative sample of the Australian population. The use of either sample alone would have produced biased results.

Our comparison of the demographic composition of the landline and mobile phone samples reveal substantive and significant differences compared with the Australian population. In particular, the age distribution of the two samples differed markedly – far more than expected by the previously reported ownership rates. For example, the 18-24 age group represented 24% of the mobile sample, but only 5% of the landline sample. In contrast, the over 65 age group represented 25% of the landline sample, but only 5% of the mobile sample.

These demographic biases in the two samples are far greater than explained by ownership rates of mobile and landline phones. Therefore we conclude that there are systematic differences in response rates between mobile and landline phones according to the age, gender and metro/non-metro residence of respondents. Younger, male and individuals who reside in metropolitan location are more likely to respond on mobile phones, with the reverse being true for landline phones.

Our analysis also revealed that either sample alone would have produced biased estimates of the prevalence rates for involvement in start-up ventures. This is true even if each sample was weighted to match the demographic profile of Australian adults according to age, gender and metro/non-metro – following the methodology for the GEM study. Prevalence rates were overestimated from mobile phones and underestimated from landline phones.

It appears that in Australia, using a combination of mobile and landline phones is likely to yield a more representative sample of individuals. The combined sample matched the age distribution of the Australian population very closely.

Hence this study further validates the notion that it is becoming increasingly challenging to generate a reasonably representative sample through telephone surveys as the ownership, and even more importantly usage patterns of landline and mobile phones is rapidly evolving. However, understanding these patterns can help in properly mixing up various survey modes to obtain the representativeness that would otherwise be missed. More specifically, in the case of which individuals are more likely to answer their landline or mobile phones, this research determined that younger people are more prone to answer their mobiles, while elders illustrate a similar trend for landlines.

This research has implications for all telephone-based survey research that aims to generate a random sample of individuals. However it is particularly relevant for research that intends to identify the prevalence rate of entrepreneurial activity in the population – such as the GEM research project.

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