Performance of Weighted and Non-weighted Estimators in a Cell-phone based Electoral Poll: An Academic Study of the 2012 Presidential Elections in Mexico.

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The findings and conclusions in this report are those of the authors and are not necessarily a point of view of *Tecnólogico de Monterrey*.

Abstract

Electoral polls and surveys applied to political purposes have being used widely in Mexico for the last two decades. Although most of the methodologies applied are based on multiple-steps cluster sampling procedures and face-to-face interviews, these procedures are becoming of difficult application due to safety related issues.

On the other hand, methodologies based on landline phone sampling frames are known to yield samples with demographic characteristics substantially different from those of the target population –and potentially biased results- due to low coverage of the sampling frame as well as to the presence of other non-sampling errors tied to the logistic of the methods applied.

An alternative telephone methodology was applied in a series of academic studies in the context of the past 2012 Mexico's presidential elections which were based on samples drawn from a cell-phone sampling frame. The cell-phones interviews yielded demographic characteristics such as gender, geographical distribution and urban/non-urban composition comparable to the target population. The only concern from the cell-phone sample representativeness could be raised by the age-group composition since it can be easily understood older citizens -60 years and older- might have lower cell-phone coverage and could become underrepresented by the sample and at the same time younger age groups would be overrepresented.

This paper focuses on the performance of non-weighted estimators and of estimators weighted by age group when compared against official electoral results of the 2012 federal election. Both estimators were found to have an excellent practical performance and, although the weighting procedure could be the best theoretically recommended from a statistical point of view, the non-weighted estimator was slightly closer to the official results. A plausible explanation for this finding is also provided in the context of the 2012 Mexico's presidential elections.

Keywords: mobile-phone surveys; sampling bias; landline telephone; political surveys; sample selection for telephone surveys.

Introduction

Survey studies are widely used in Mexico as is the case of survey studies on electoral processes or in marketing research with the purpose of improving the commercial practices for all kinds of goods and services. In particular, electoral surveys have been used extensively for more than two decades in Mexico and the use of statistically planned methodologies keep improving with time.
This work focuses on the comparison of the performance of two estimators in the context of an electoral survey in Mexico based on a mobile phone sampling methodology. The two estimators are the proportion non-weighted estimator and a weighted estimator when adjusting for age-group representation in the target population.

The electoral survey aimed to estimate the 2012 Mexico's presidential elections' results. The survey methodology was based on a sample of national mobile phones. This methodology has proven to be useful in a series of regional studies in the Monterrey Metropolitan Area since 2011 yielding sample characteristics as gender and geographical distribution similar to those of the adults' target population.

Federal election had four presidential registered candidates, here identified by their name initials in the order of chronological appearance of their political party, which is the order accustomed by the media: JVM, EPN, AMLO and GQT.

The performance of each of the two sets of estimations is obtained by contrasting them to official electoral results of the 2012 federal election taking into account only the votes casted in favor of any of the four registered presidential candidates. For a better appreciation of the estimators' performance their closeness to official results are set along to other sets of estimations published by the media and by the *Instituto Federal Electoral (IFE)*, the federal elections official organism.

Methods

Two alternative interviewing methodologies are of common use for studying adult wide open population: landline based telephone interviews or household face-to-face interviews where household samples are drawn through multiple-steps cluster sampling techniques. Other methodologies like surveys based on postal mail or internet based questionnaires are not used in general. The postal mail is not of practical use and the later one has not enough coverage of the open adult population, although it can be the most appropriate method for covering very specific target populations of internet users.

As mentioned before, electoral surveys directed to the open adult population in Mexico often depend on methodologies based on household sampling procedures and *face-to-face* interviews. However these methodologies confront more obstacles every day to operate. For instance, it can be mentioned that nowadays in major cities in the country there are numerous household communities with restricted or no public access. These household communities have become common not only in wealthy zones but also in the middle class socioeconomic level. At the same time, women in modern and young families have more active roles in the formal economy than they did in the past and often they work out of their house. Empty households, with no persons available for interviews during day time are therefore more common and as a consequence bigger discrepancies are to be found between the target and the sampled population.

With regard to telephone surveys, landline sampling frames are known to have low population coverage. Just as it is the case in other countries (Lavrakas, Shuttles, Steeh and Fienberg 2007; Arthur 2007; Vicente and Reis 2010), the landline telephone coverage in Mexico is dropping in time while the mobile coverage is rising. Statistics from INEGI, the government official statistics organism, reported landline telephone coverage of 53% of households in 2007 (INEGI 2007) and the coverage dropped to 44% in 2011 (INEGI 2011). Similar tendencies show statistics from the Federal Telecommunications Commission (COFETEL), reporting 19% of the population with a landline phone in 2007 and only 17% in 2011 (COFETEL 2013).

On the contrary, cell phone coverage in Mexico is increasing in time. The Federal Telecommunications Commission reported 64 subscriptions per 100 habitants to December 2007 and 87 is the corresponding figure up to June 2012 (COFETEL 2013). Additional to the population coverage, mobile phones permit reaching citizens in the target population from rural as well as form urban zones and interviews can be made to citizens from practically all

demographic profiles. However, despite the advantages of mobile phone sampling mentioned above, coverage is not perfect. People in the age group of 60 yrs. and older are found less likely to be represented in the effectively interviewed sample and could become underrepresented by the interviewed sample and at the same time younger age groups would be overrepresented. That fact gave rise to this work in order to compare the actual performance of the two estimators, the age-weighted and the non-weighted estimator for proportions, since they are applied to a phenomenon where the population parameters can be observed (or nearly observed) as it is the case in an electoral process.

Although this work does not aim comparing methodologies, relative performance of the mobile phone sampling methodology applied in this electoral survey is also viewed by contrasting the absolute differences of each of the two estimators to the official results to the corresponding differences for estimations published by the media based in other methodologies.

Sample Design

The target population for the electoral survey is that composed by all the 18 years and older citizens in Mexico voting in the presidential elections on July the 1st 2012. The country is divided in 31states and a Federal District. The 32 federal entities are very diverse in their demographic characteristics as well as in political practices and preferences and hence geographic sample representation is an important concern in the sample planning phase. As mentioned before, the methodology based on mobile phone sampling was elected taking into account previous experiences in several metropolitan area studies where phone samples drawn from all possible cell numbers in a *Calling Party Pays (CPP)* modality represented well the demographic and geographic population characteristics.

As a first national experience, sampling from all possible CPP mobile numbers was done in several steps, by generating a random national subsample in every step and mutually exclusive subsamples among the steps. A first random subsample was handed in to the call center to be worked until exhausted. Recalls were to be made at least twice to not contacted persons in a ringing phone. Persons not able to answer in the moment were offered a scheduled call at a more appropriate time. An additional disjoint and randomly ordered subsample was added when a subsample was exhausted. The number of subsamples needed would depend on the effective contact rate and interviewing results, which were also subject to meet time and budget restrictions.

Data Collection

Telephone interviews were carried out between June 25th and 28th from 9:00 to 21:00 hours central time. Data collection took place just a few days before the presidential elections day: July 1st, 2012. Contacted citizens were informed *Tecnológico de Monterrey* was carrying out an *electoral survey* for academic purposes. They were assured of the anonymity of the call (no personal data was available and no personal data was to be registered in the interview). An expected length of the interview was also given (6 to 8 minutes).

It is important to point out that cost was not a concern for the interviewed persons since calls were cost-free for those interviewed in their local area since all cell users are in the *CPP* modality.

After discarding calls classified out of the target population and those who asked to be called in another time, a total of 6648 calls were accounted. From these, 3856 (58%) agreed to be interviewed and 2792 (42%) were persons not willing to answer the electoral interview. Note that since most of the latter gave no information in order to be classified as belonging or not to the target population, this cannot be considered as a nonresponse rate from the target population. Calls to be considered as a true nonresponse from the target population would have to be from the count of the Mexican citizens, 18 yrs. and older, in possession of their voting credential and planning to vote. The 42% could be understood as an upper value for the true, but unknown nonresponse rate.

From the 3856 calls to citizens willing to answer the interview, 3479 (90.2%) counted with the voting credential required to cast their vote and only 3304 (85.7%) were planning to vote or had not completely discarded to do so. Also note that this figure does not constitute an estimate of the percent of voting citizens since the percent is over the number of persons willing to answer an *electoral survey* and many of those not able to vote or not planning to vote had discarded themselves from the beginning by not acceding to the interview. The actual official voting participation in the presidential election is reported as 63.08%; (IFE 2012b).

Sample Description.

Sample description is based on the 3304 citizen interviewed who said were planning to vote (3101) and also those that said they were still undecided (203). Distribution by region of the interviewed citizens who could potentially vote showed fairly close similarity to that of the nominal list. Segmentation into three regions: north, central and south yielded the following numbers: 28.6% of potential voters were from the north of the country, (26.0% citizens in the nominal list are from the north), 49.3% of potential voters were from the central region (47.8% in nominal list) and 22.1% from the south (26.2% in the nominal list). These numbers seem to reflect to some extent a higher degree of participation of central and north regions and a lower participation in the south.

Figure 1

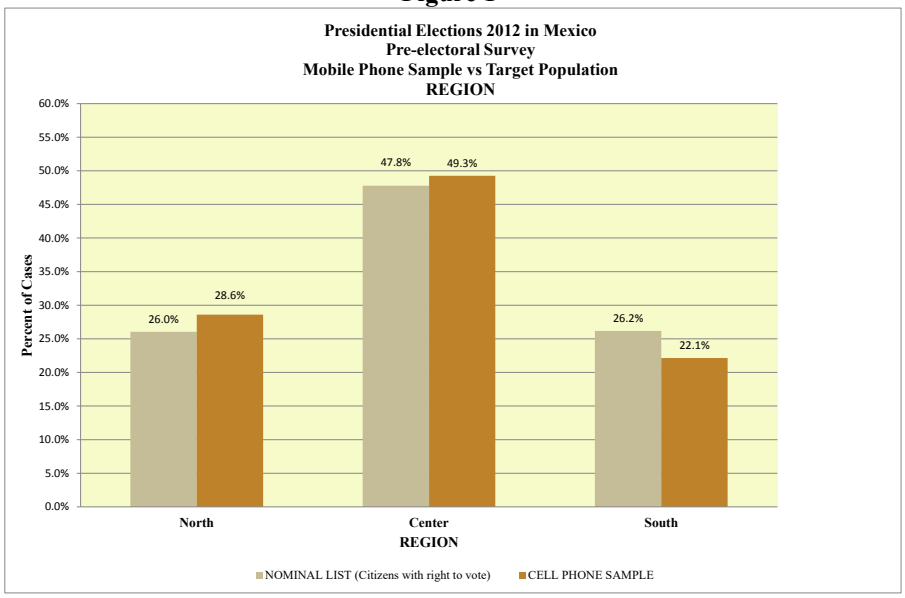


Figure 2

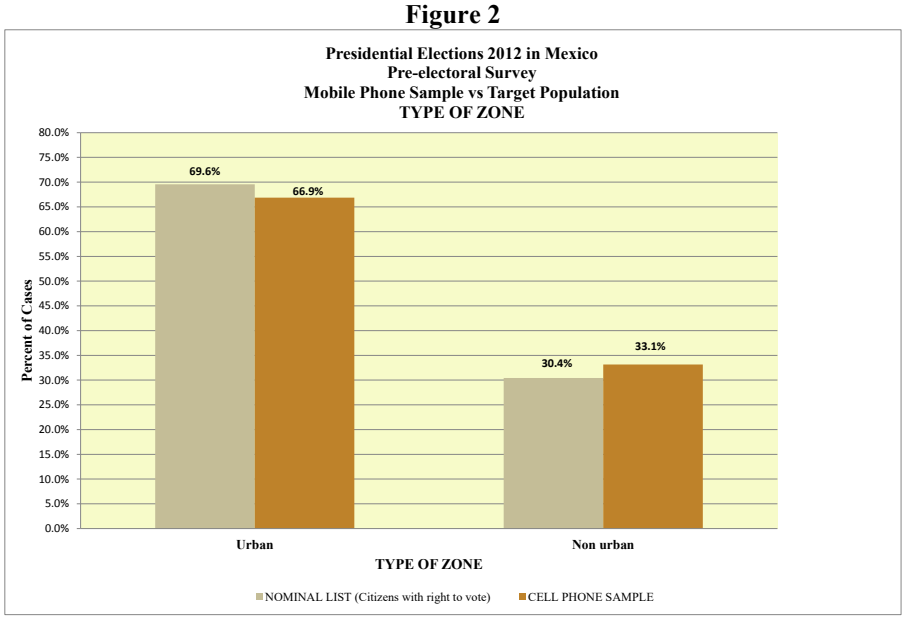


Figure 3

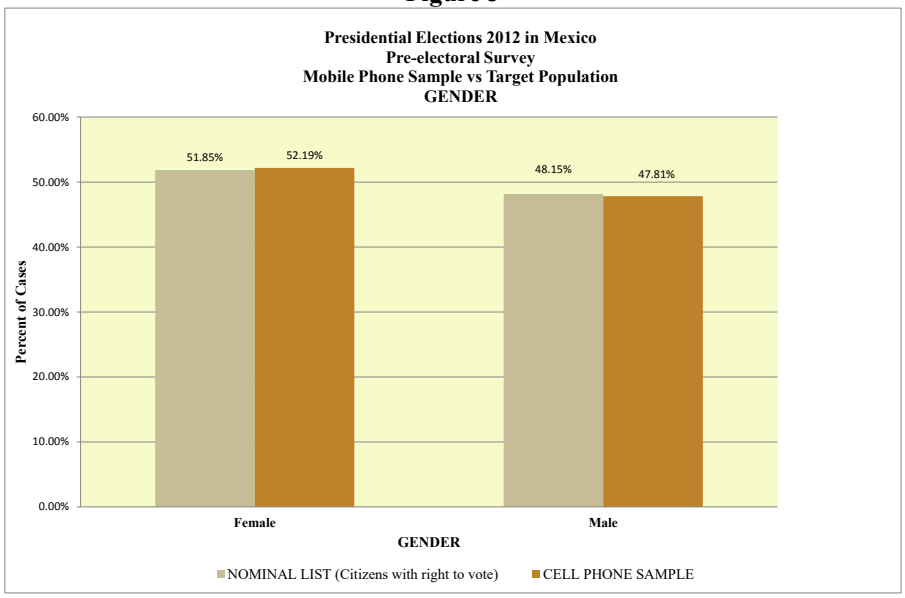
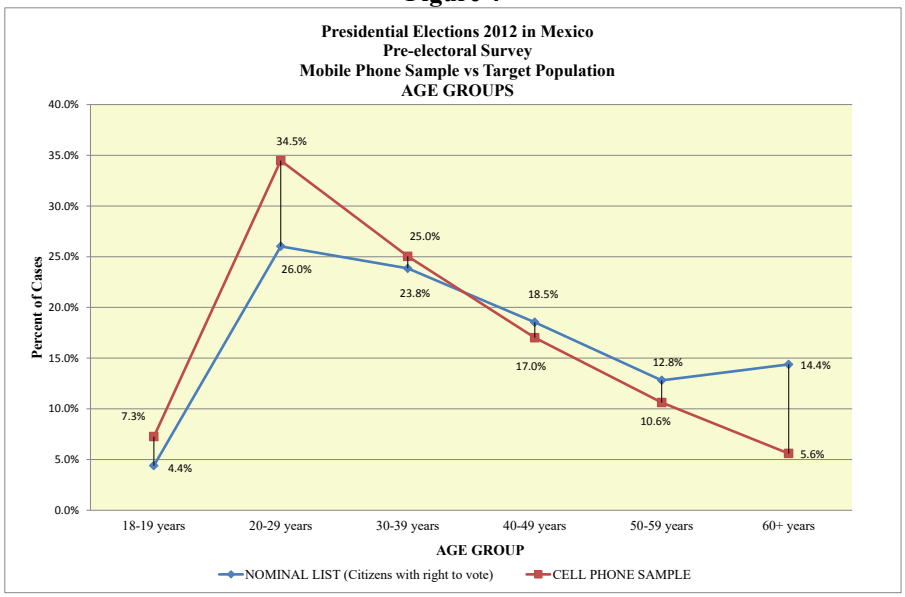


Figure 4



Weighted and Non-weighted estimators

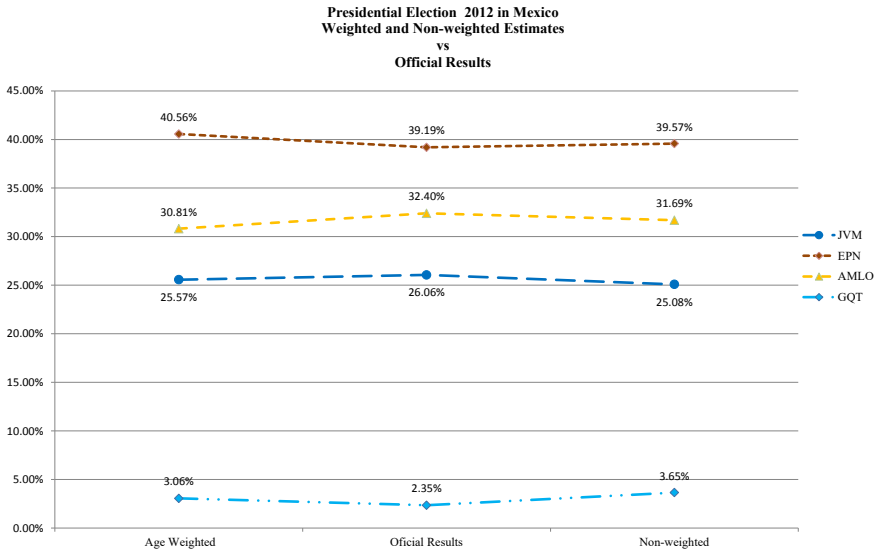
Considering the differences found between the age distribution of the sample and that of the nominal list, a set of weighted estimators were calculated for the four registered candidates. These weighted estimators took into account the nominal list composition for the age groups defined: 18-19 years (4.40%); 20-29 years (26.02%); 30-39 years (23.85%); 40-49 years (18.54%); 50-59 years (12.81%) and 60 years or more (14.38%). The obtained preferences are referred to as the *weighted estimates*. The straight percentages were also calculated for each of the four registered candidates and they are referred to as the *non-weighted estimates*. Both sets of estimates are then compared to the corresponding official results after adjusting only to take into account the votes obtained by the four registered candidates. Both estimation procedures were calculated from the sample taking into account 2436 responses, which corresponded to intended votes for any of the four registered candidates. The *weighted* and *non-weighted* estimations obtained, based on the cell sample methodology designed, are also referred to as the *OCG-Weighted* and the *OCG-Non-weighted* estimations in some comparative graphs below.

Findings

Both estimation methods yielded results very similar to the official results and the estimates closer to the official results were the *non-weighted estimates*. The candidate with the highest official result was EPN, who obtained 39.19% of the votes casted among the four candidates. The corresponding *non-weighted estimate* was 39.57% (a difference of 0.38 percent points) and the age *weighted estimate* was 40.56% (a difference of 1.37 percent points).

The candidate in a second highest result was for AMLO who obtained 32.4% of the votes. The estimates were 31.69% (*non-weighted)* and 30.81% (*weighted).* The third place was for JVM, with 26.06% of the votes. The estimates were 25.08% and 25.57% respectively for the *non-weighted* and the *weighted* estimators. The fourth and lowest result was for GQT, with 2.35% of the votes, and the estimates were 3.65% (*non-weighted)* and 3.06% (*weighted).* **Figure 5** presents a visual comparison of these results and shows how similar the official results and their corresponding estimates are.

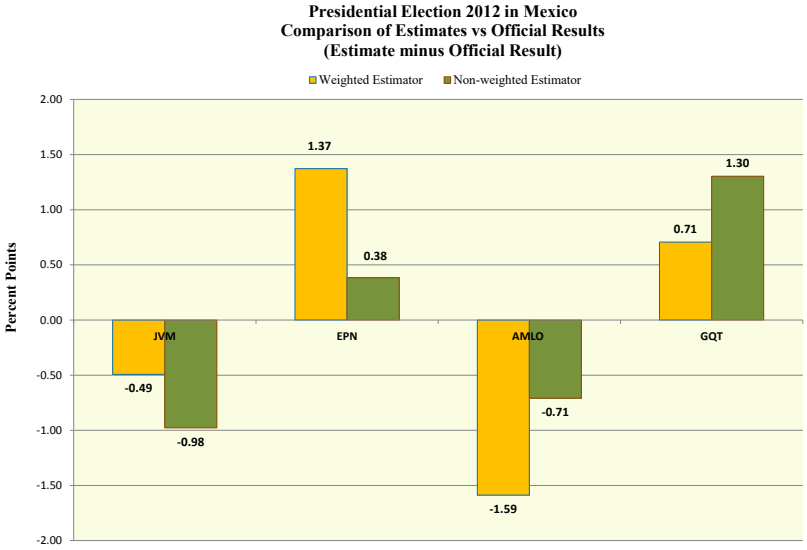
Figure 5



A better comparison between the two estimators performance is obtained from **Figure 6**, which shows the differences between the estimate and the corresponding official result. As it can be seen, the *non-weighted estimation* had differences smaller in magnitude when estimating the top two candidates. The difference was of only 0.38 percent points to the official result for the top candidate (EPN) while the age *weighted estimation* had a difference of 1.37 percent points. On the other hand, for the candidate in second place (AMLO) the respective differences were -0.71 percent points for the non-weighted estimator and -1.59 percent points for the weighted estimator. For the other two candidates the weighted estimation was closer to the official results, although they are closer to each other than in the top two candidates.

As a measure of an overall performance the sum of absolute differences to the respective official result for all four candidates were calculated for each set of estimations. The absolute differences from the *non-weighted estimator* added to 3.38 percent points while those from the *weighted estimator* added 4.16 percent points.

Figure 6



On the other hand, these two estimators were compared to other (thirteen) of the main pre-electoral surveys published (IFE, 2012c). As it is shown by **Figure 7,** the *non-weighted estimation* (identified as *OCG-Non-weighted* in the graphs) was found to be the closest to the official result for the winning candidate (EPN), with 0.4 percent points of difference and the *weighted estimation* (*OCG-Weighted* in the graphs) occupied the fourth place with an absolute difference of 1.4 percent points. Other eleven surveys had larger discrepancies, with eight of them having discrepancies with the official results with magnitudes between 4.7 and 8.0 percent points.

Figure 7

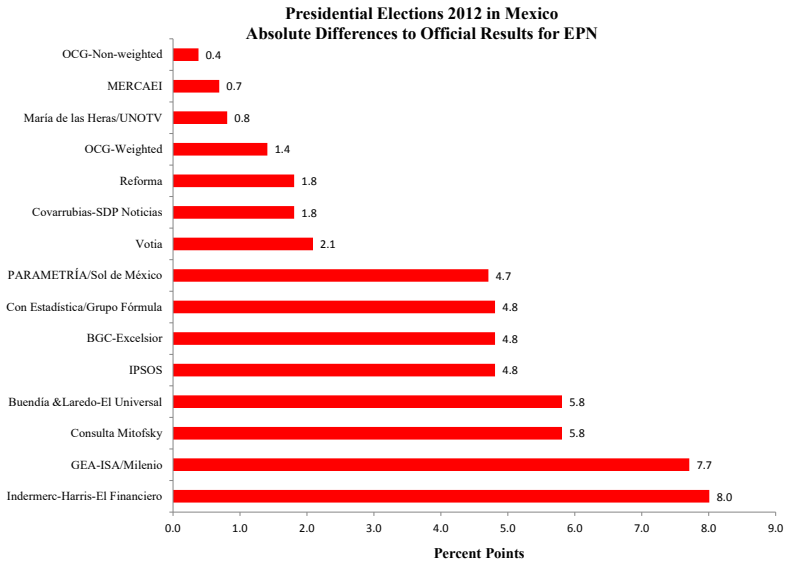


Figure 8 shows that, with regard to the second candidate (AMLO), the *weighted estimation* was also one of the two top estimations while the *weighted estimation* dropped to the sixth place although the absolute difference to the official result is only of 1.6 percent points. As it can be seen from **Figure 9**, for JVM both of the estimations, weighted and non-weighted, were among the three estimations with smaller discrepancies. **Figure 10** shows that the non-weighted estimation is not among the best for estimating the fourth candidate (GQT). In fact the best

performing estimations for the winning candidate (EPN) are among the estimations with a greater distance to the official results for this candidate, although the differences are in all the cases below 1.7 percent points.

From **Figure 7** to **Figure 10** it can also be appreciated that while for EPN the maximum discrepancy to the official result was as high as 8.0 percent points, discrepancies are reduced to a maximum of 5.4 percent points for AMLO, 3.7 for JVM and to 1.7 for GQT.

Figure 8

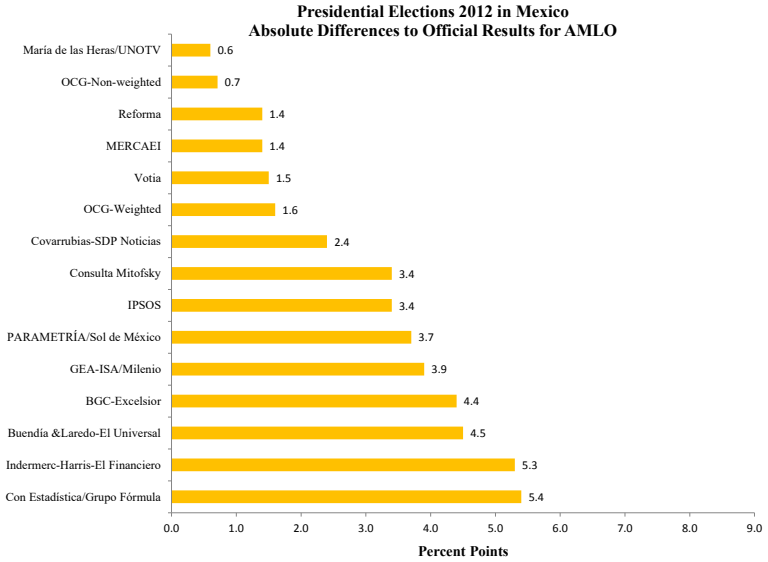
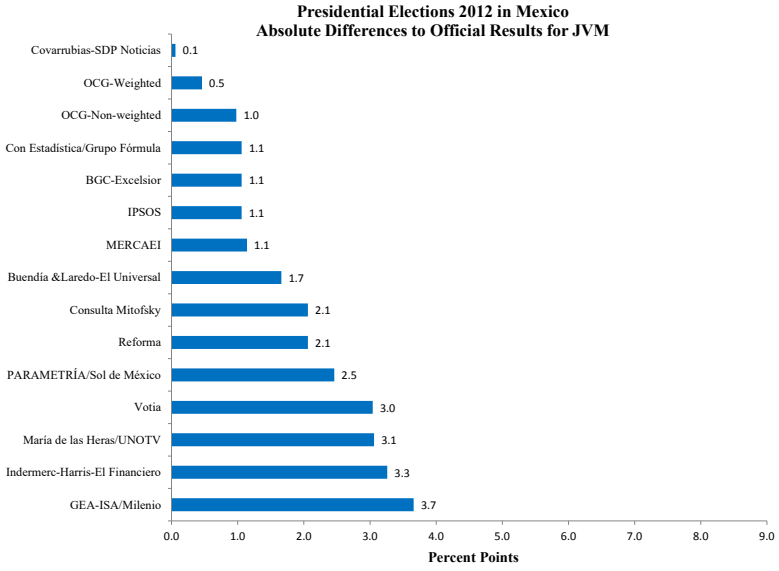


Figure 9



A comparison of the overall performance of the fifteen estimators can be made from **Figure 11**, which shows the total sum of discrepancies to official results of the four registered candidates. As can be seen from **Figure 12**, among the fifteen estimations, the two estimators worked here based on the methodology designed with the use of cell-phone sampling were the two estimations with the lowest sum of total absolute discrepancies to the official elections results for each of the four candidates.

Figure 10

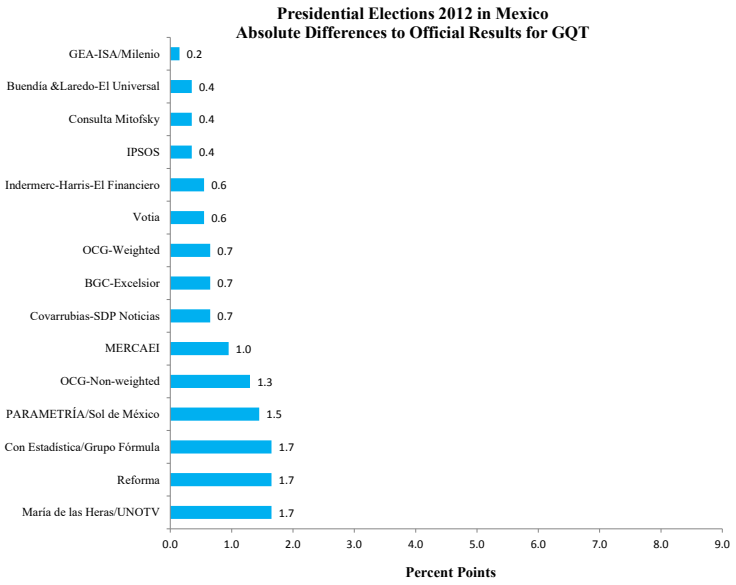
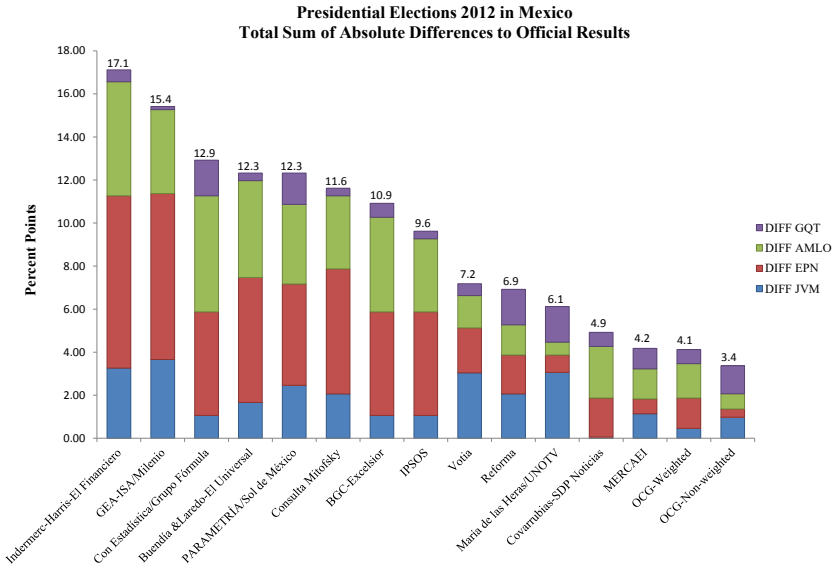


Figure 11



The sum of total absolute discrepancies for the *weighted estimator (OCG-weighted* in the graph*)* was 4.1 percent points, and was again surpassed by the *non-weighted estimator (or OCG-non-weighted)* which had the lowest total among all sets of estimations, with only 3.4 percent points. Adjusting the estimation to correct the age distribution according to that in the nominal list did not improve the performance of the estimation; on the contrary, in this case it had an adverse effect.

It is of common practice the adjustment of estimators to correct possible sample bias with respect to the characteristics of the target population, weighting not always gives an unbiased estimator if the assumptions are not appropriate (Peytchev; Carley-Baxter and Black, 2011). This could be the case in this application if the *true* target population, composed by all the citizens voting in the 2012 presidential election, had an age distribution different to that of the nominal list.

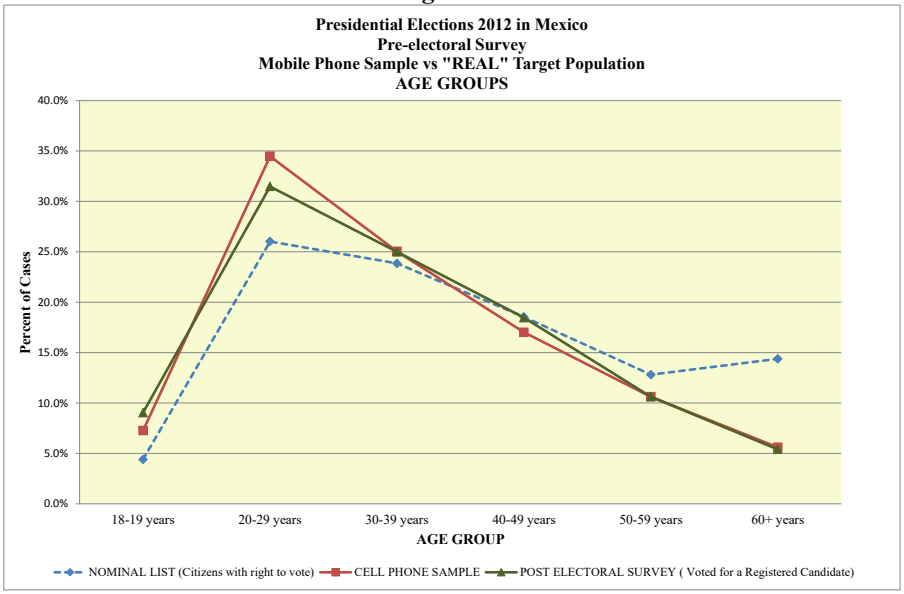
Discussion

Although the age-adjusted *weighted estimator* of population proportions could be thought as a more appropriate estimator due to the differences found in the distribution of age categories of the sample to that of the target population, a better performance was obtained from the straight *non-weighted* estimator. The *non-weighted* estimator yielded a closest result for the main proportion to be estimated, that corresponding to the winning candidate. It also gave estimations on the overall closer to the four proportions when measured by the total sum of the four absolute discrepancies with the elections official results. The *non-weighted* estimator summed 0.78 percent points less than discrepancies corresponding to the *weighted* estimation (3.38 vs 4.16).

A plausible explanation for the results obtained is that the *real* target population, the one of actual voters for one of the registered candidates, had age characteristics more similar to those of the sampled population than the age characteristics of the nominal list. In order to investigate this, age distribution of the group of citizens who said had casted their vote in favor of one of the registered candidates in a post electoral survey carried out after elections.

Distribution of age groups from the self-reported voting interviewed citizens was compared to age distributions of the potentially voting persons in the pre electoral survey and in the nominal list. As **Figure 12** shows, age distribution of voters registered by the post electoral sample is more similar to the age distribution in the pre electoral survey than to the age composition of the nominal list. This similarity in age distribution of potential voters in the pre-electoral sample and the self-reported voters in the post-electoral survey may be due either to the fact that both surveys were based on the same methodology or could be also that the actual target population (actual voters) was composed with higher proportion of the younger voters (29 years or younger) than the corresponding proportions in the nominal list.

Figure 12



A possibly higher participation of younger voters in the 2012 presidential electoral process could be thought as being related to a very active participation of citizens in the use of social networks and other different forms of internet communications with electoral content. The four presidential candidates participated in events at the largest and main universities in the country and university students participated very actively in the electoral process. During the electoral campaigns period arose the "*#YoSoy132"* students' movement, which was composed by students from many private and public universities. This movement got an abundant coverage from the media all over the country and had a very active participation through social networks and other forms of internet communications. At this time, however, there is not a concrete measure to conclude if young voters, in particular younger than 30, had a significantly higher participation on the elections day. A definite answer will be known once the report on the voters' characteristics of the 2012 federal election is published by the *Instituto Federal Electoral*, expected sometime during 2014 agreed in IFE (2012a).

Conclusions

A first conclusion of this work is that under the methodology and conditions applied in the electoral survey reported here, the cell phone sampling methodology does work very well for interviewing the open adult population in Mexico. For the practical purposes of a national electoral survey, rural and geographic composition of the sample of potential voters fairly reproduced the nominal list composition.

On the other hand, the gender composition of the sample of potential voters was almost identical to that of the nominal list but age groups did not coincide with the age group composition of the nominal list, showing a higher composition from the youngest adults and a lower presence of the eldest. This could be due to a tendency of the cell-phone methodology of lower coverage of the 60 years and older population segment or due to a higher electoral participation of the younger citizens or a combination of both. The degree of accuracy of the age distribution of potential voters in this survey to the real target population of voters will eventually be known once the IFE release the reports on the federal elections 2011-2012.

It was also found that for the application of this work, the 2012 presidential elections in Mexico, and with the designed cell phone methodology, the simple, *non-weighted* proportions estimator had a better performance than the age adjusted weighted estimator. This implies that adjusting to the assumed characteristics of the target population may not improve the estimation precision. In particular, if the adult population under study is *"younger"* than the census population as in the pre-electoral survey case age adjustment may not be necessary.

It was also shown that under the cell phone methodology used, the usual proportion estimator had a better performance than estimators based on other methodologies.

Future research

A future research topic is to study to have a better understanding of any need of age-adjustment to the proportion estimator under the cell-phone based methodology used in this work once the demographic characteristics of the citizens voting in the 2012 presidential elections are revealed by the IFE report.

Acknowledgements

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