Using A MAF-Based Frame For Demographic Household Surveys

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Abstract

One of the goals of the 2010 Demographic Survey Sample Redesign is to use the continually updated Master Address File as the primary source to develop the sampling frames for current demographic household surveys. To support this goal, the Census Bureau is conducting several evaluations to compare the coverage of a MAF-based frame and the current four-frames. The focus is on the overall quality at the national level as well as in two sub-universes: the sub-universe of new addresses added since the last census and the sub-universe currently covered by an area frame that is primarily in rural areas. This paper will present the most recent findings from these evaluations.

Key words: Mater Address File, survey frame, coverage

1. Background

The U. S. Census Bureau currently uses a four-frame system to support several major demographic household surveys. These surveys include the Current Population Survey (CPS), the Survey of Income and Program Participation (SIPP), the Consumer Expenditure Survey (CE), the American Housing Survey (AHS), the National Crime and Victimization Survey (NCVS), and the State Child Health Insurance Program (SCHIP). The existence of the Master Address File (MAF) provides a simpler and more cost efficient frame option for these surveys. The Census Bureau is currently conducting evaluations to determine what would be the impact to household surveys if we use the MAF as the sole source to construct the sampling frames for the 2010 Demographic Survey Sample Redesign (DSSR).

A common frame system is used to cover housing units and certain group quarters in the U.S. to meet the needs of multiple surveys. For the 2000 Design, the common frame system consists a unit frame, a group quarters (GQ) frame, a permit frame, and an area frame. In most areas of the US, we use the unit frame and the GQ frame for housing units and group quarters existed at the time of Census 2000, and the permit frame to capture new hosing units added after Census 2000. The sources of addresses for these three frames are the address lists from Census 2000 and from building permits. In areas that do not have a high percent of city-style addresses or no building permits coverage, we use the area frame. This final frame obtains addresses from ongoing field listings. The current area frame covers approximately 12% of units in the US. The field listing operations for the area frame and the permit frame are the most expensive of the four described.

The MAF is Census Bureau's inventory of addresses for all known living quarters in the U. S. It contains addresses from Census 2000 and is updated by the Delivery Sequence File (DSF) from the United States Postal Service every six months. There are various smaller scale operations that update the MAF as well. The American Community Survey (ACS) uses the MAF as the source to construct its sample frame.

The Frame Assessment for Current Household Surveys (FACHS) is an evaluation program developed to help make an informed decision on whether the MAF-based frame can be used for current household surveys for the 2010 DSSR. The FACHS has to answer a difficult question: how do the coverage of the MAF-based frame and the current multiple frames compare? The focuses are on the comparisons in the entire universe, in the sub-universe of post-census new construction,

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and in the area frame sub-universe.

To construct an address frame using the MAF, users must define a set of criteria, or a set of filtering rules that will produce a subset of the MAF units that best represents the population of interest for a particular survey. If these filtering rules are not accurate, it would affect survey coverage and increase survey cost of both enumeration and coverage improvement operations. In this paper, a MAF-based frame means an address frame constructed using addresses from the MAF according to a set of filtering rules.

Filtering rules have an impact on coverage measures in this paper. Most FACHS evaluations use filtering rules developed for ACS to construct the MAF-base frame. There are ongoing efforts in the Census Bureau to improve the filtering rules. FACHS also conducted research on filtering rules for current surveys. The readers can refer to Martin and Loudermilk (2008) for some results.

This paper intends to give a high level summary of the projects and current results from the FACHS. The results in this paper mainly come from the National Evaluation (Li, et al., 2008) and the most recent New Construction Study (Flanagan, et al., 2008). Liu (2007) also contains a summary of earlier results.

2. The New Construction Study

The objective of the New Construction Study is to determine whether the DSF can be used as a proxy of the permit frame as a source for post-census new housing units. The current permit frame system consists of two components, a permit sampling system and the Permit Address Listing (PAL) field operation. The permit sampling system depends on monthly estimated number of building permits of new residential construction from two other Census Bureau surveys, the Building Permit Survey and the Survey of Construction. When a permit office has sample hits in a particular month, we send a field worker to visit the permit office to collect permit addresses according to the survey requirements. Hence, the permit frame does not need to collect all permit addresses issued by a building permit office. Not having to collect all permit addresses saves on survey cost but makes measuring the coverage of the permit frame extremely difficult.

In 2006, a small-scale study was done and collected full lists of permit addresses since 1999 from twenty-two permit offices. This study aimed to make a complete comparison of the post-Census 2000 new construction coverage of the permit frame and the MAF based frame. The results can be found on the report from this study (Johnson et al, 2007). Because of various reasons, we were not able to implement the full-scale study as originally planned. We modified our approach and reduced the scope of the study to only measure the extent to which units on the current permit frame were found on the MAF extracts.

The results in this section are mainly from Flanagan (2008). The main methodology used in this study relied on matching permit frame sample addresses to MAF address. The matching is on house number, street name and zip code. Within structure unit designations are ignored in the matching because building permits may not provide them.

The next analysis matched permit sample addresses that have been interviewed in November 2005 to the MAF extracts. To account for both occupied and vacant units, we use the weight of a CPS supplement, the Housing Vacancy Survey (HVS). In this analysis, a permit sample address is counted as a match if it matched to a MAF address that is a non-commercial delivery point from the DSF. When interpreting the results, it is helpful to keep in mind that about 7% of the entire CPS/SCHIP sample is in the permit frame in November, 2005.

Two reasons may explain units on the permit frame that were missing on the MAF based-frame. One is the lag time that causes some units to temporarily absent from the MAF. These units will appear on the MAF later on. The other is non-coverage by the DSF. These units do not appear on the MAF even a longer time is given.

Throughout this paper, standard errors are shown in parentheses in all tables.

Table 1: Percent of Permit Addresses Visited in Nov 2005 That Matched to MAF Addresses

MAF (DSF) Version	All
Jan 2005 (Sept 2004)	81.3 (1.1)
July 2005 (Mar 2005)	88.0 (0.9)
Jan 2006 (Sept 2005)	92.4 (0.7)
July 2006 (Mar 2006)	93.9 (0.6)
Jan 2007 (Sept 2006)	94.2 (0.6)

Table 1 gave an estimate of 5.8% for the upper bound of the portion of the new construction sub-universe that is not on the MAF due to non-coverage by DSF. Near one half of the permit units not on the January 2007 MAF extract was in rural blocks. The difficulty of matching permit addresses could also contributed to some non-matches. For example, the address verified at the time of interviewing may deviate from the addresses on the building permits at a sample unit.

Table 1 also showed that a major source of the MAF coverage errors is the lag time. The MAF and DSF picked up about 10% of the permit frame addresses in the one-year period before interviewing and continued to pick up some units several months after the interview.

Next, we show more detailed analysis of the permit-DSF lag time. These results are similar to those given by Flanagan (2006). The only difference is that using CPS/SCHIP permit sample units allows us to provide reliability measures for the lag estimates. The permit sample units used for this study are those interviewed in November 2005, March 2007, and July 2006. The permit-DSF lag is the number of months from when the permit was issued to the DSF version month of its first appearance on the MAF. The permit-DSF lag can be calculated for permit sample units matched to MAF addresses. We excluded permits issued in 2004 or later to allow at least 22 months from permit issuing month to interviewing month. This is to avoid downward bias to the lag estimates from recent permits that had a higher proportion of units having a very short lag time. HVS weight is used to account for both occupied and vacant housing units.

Table 2: Permit-DSF Lag Time by Type of Structure in Months

	Median	Mean
All	8.0 (0.4)	6.0 (0.5)
Single units	6.3 (0.3)	4.1 (0.4)
Multi-units	13.9 (0.7)	12.4 (1.7)

According to data released for 2005 from the Survey of Construction, the average number of months it took from permit authorization to construction completion was about 7 for single unit and 13 for multi-units. This suggested that the DSF seemed to be able to capture new construction rather quickly after construction completion, at least at the national level. In other words, the lag time seems reasonable and not excessive.

The current permit frame system collects building permit addresses issued at least 7 months before the interviewing months. Currently it takes about four months from DSF updates to MAF extracts delivery for the ACS sampling. If we assume three months from MAF extract delivery to survey interviewing, the above permit-DSF lag time can be interpreted as the difference of time intervals from permit issuing to interviewing for the permit based system and the MAF based system. In other words, the MAF based system would capture a new unit about six months later than the permit based system on average under the this sampling schedule assumption. This is consistent with the results shown in Table 1. The six-month lag would translate into about 9% coverage lost for post Census 2000 new construction in November 2005 because there was about 67 months since Census 2000. The November 2005 CPS/SCHIP new construction samples would have been selected for the MAF-based frame from January 2005 MAF extracts in part and from July 2005 MAF extracts in part under current permit sampling schedule.

Now, let's discuss a couple of known reasons why units on the MAF based frame were not on the permit fame. The estimates of the size of the coverage errors from these sources should be considered very rough.

When we use multiple frames, there are gaps and overlaps between different frames. There is no exception when we use the Census 2000 addresses and building permits. For the permit frame, we need to choose a permit frame start day. Building permits issued after this day will be include in the permit frame. For 2000

Design, these start dates are in 1999 and vary by region and structure size. A gap exists when building permit was issued for a housing unit before the permit frame start date and did not complete construction by April 2000. On the contrary, an overlap exists when a building permit was issued after the permit frame start date and completed construction before April 2000. DSF could capture some units that fell in the gap. Flanagan (2008) found that 14.0%, 16.8%, 22.2%, and 53.0% of the permits issued in 1996, 1997, 1998, and 1999 that matched to MAF addresses were not captured in Census 2000. After excluding 1999 permits that issued after the permit frame start date, we estimated that this component of the permit frame undercoverage is equivalent to roughly 5 months worth of new construction growth for the corresponding time period.

One other known reason of units on the MAF based frame not being on the permit frame is that building permits are known not to cover mobile homes well and the current permit frame captures few new mobile homes. In section 3, we will provide some measures of the coverage gains of mobile homes by the MAF based frame (see Table 5).

To conclude this section, we provide some projected estimates based on the results from this section. These projected measures will be used in the analysis in section 4, which will use a reference time of early 2007 when the permit frame was about 9% of the entire universe. For that purpose, we will assume about 84 months after Census 2000. Then, the MAF coverage errors due to lag time (6 months) and the permit frame coverage errors due the permit frame start date (equivalent to 5 months worth of new growth) would be about 7% and 6% of the permit frame sub-universe or 0.6% and 0.5% of the entire universe. The MAF coverage error due to no coverage in unit frame blocks was estimated to be about 5.8% of the permit frame or about 0.5% of the entire universe.

3. The National Evaluation

The National Evaluation is designed to derive national and census region level gross coverage estimates of the MAF based frame. It will also allow us to make coverage comparison of the MAF based-frame and the current unit frame and area frame. The 2007 National Evaluation Sample is a probability sample of about 5,800 blocks. Census Bureau Field Representatives (FR) used current survey area frame procedures and instruments to canvass these blocks. The FRs had access to addresses from the most recent MAF that were geocoded to the sample block and adjacent blocks as well as ungeocoded addresses in the same county. While canvassing the blocks, the FR compared the addresses existed in the block to the addresses given from the MAF. After field listing, additional matching was performed for addresses added by the FR to MAF addresses in the entire county. Information from the field and from matching was used to determine whether an address found in the field existed on the MAF based frame. The listing also validates and invalidates the MAF units in sample blocks. The national evaluation sample blocks were divided into two listing panels of approximately equal sizes. The listing periods lasted three to four months each and ended in January 2007 and August 2007. The results from the National Evaluation shown in this paper should be considered preliminary. There will be additional field listing for the 2008 National Evaluation sample. We will revise the coverage estimates when these data are available,

3.1 MAF Gross Coverage Measures

Table 3 shows a total gross undercoverage rate of 6.4% for the MAF-based frame for the US in 2007. These measures were derived using addresses found in the sample blocks at time of listing. These addresses were compared to the MAF extracts closest to the time of listing, i.e., those updated by DSF in March 2007 and September 2007 respectively for the two listing panels. A unit is not on the MAF-based frame if it was not found on the MAF or it was found on the MAF but did not meet ACS filtering rules.

Table 4 shows gross overcoverage measures in 2007. These measures were derived using addresses on the January 2007 MAF extracts that were geocoded to sample blocks and met ACS filtering rules. A unit was an overcoverage if it was deleted by field listing, e.g., duplicate and non-existent units.

Both tables showed that the MAF based frame had the highest gross coverage errors in the South census region, which had relatively large rural areas and had experienced relatively high growths in recent years.

Table 3: Addresses Obtained from Field Listing

	% not on the MAF	% on the MAF but not meeting ACS filtering criteria	Total
US	4.7 (0.3)	1.7 (0.2)	6.4 (0.3)
Northeast	3.9 (0.4)	2.1 (0.4)	6.0 (0.1)
Midwest	3.3 (0.5)	1.1 (0.1)	4.4 (0.5)
South	6.5 (0.7)	2.2 (0.3)	8.7 (0.7)
West	3.5 (0.5)	1.2 (0.2)	4.7 (0.5)

Table 4: Addresses on the MAF Deleted During Field Listing (in %)

US	9.9 (0.4)
Northeast	8.5 (0.7)
Midwest	8.0 (0.6)
South	12.6(0.7)
West	8.3 (0.8)

One caution is that the readers should not attempt to derive net coverage measures by using the gross undercoverage and gross overcoverage measures. For these two sets of measures, ungeocoded units and time references were treated differently. For MAF net coverage results, the readers should refer to Johnson et al. (2008). Some addresses not found in the sample blocks and deleted may exist elsewhere because the field operation used by this study had very limited search.

3.2 Coverage Comparison in the Unit Frame

The National Evaluation can also provide information to compare coverage of the MAF based-frame and the unit frame and area frame. The current unit frame used Census 2000 address list without updates. The MAF based frame will be able to take advantage of the DSF updates. The question is what will be the coverage difference made for the Census 2000 address list by the DSF updates. The next table shows some measures that allow us to answer this question.

Table 5: Addresses Collected from Field Listing in Unit Frame Blocks

HUs in Unit Frame Blocks	100.0%
In Census 2000	83.8% (1.3%)
Post-Census 2000 Adds	10.6% (1.0%)
Mobile Homes (MHs)	0.3% (0.0%)
Built Before April 2000 (Excluding MHs)	2.8% (0.2%)
Added in NE Listing	5.6% (0.4%)

The unit frame sub-universe covers housing units existed at time of Census 2000 in unit frame blocks. Using data from the Census 2000 Housing Unit Coverage Study (Barrett 2003), we estimated that 3.3% of the housing units existed in unit frame blocks at time of Census 2000 were not on the Census 2000 address list. Table 5 showed that the MAF based frame is able to capture much of these housing units missed by the current unit frame. These include non-mobile home units that were built before Census 2000, not in Census 2000, and captured in a post-Census 2000 MAF update. These were approximately 2.8% of the housing units in unit frame blocks (88% of the entire universe), or 2.5% of the entire universe. This measure is likely to under-estimate the truth because of the errors of determining when a unit was built in filed listing (Li et al., 2008). There were also mobile homes that were not in Census 2000 and captured by a post-Census MAF update. Most these units would not be on the current unit frame nor permit frame. The building permits are known not to cover mobile homes well and the current permit frame captures few mobile homes. A conservative estimate for the mobile homes capture by the MAF-based frame but not by the current unit and permit frame is about 0.2-0.3% of the entire universe for 2007.

3.3 Coverage Comparison in the Area Frame Sub-Universe

The current area frame is developed using field dependent listing starting from MAF addresses. The question is what is the coverage difference made by this field listing. The next two tables show coverage comparison of the MAF-based frame and the area frame using data from the National Evaluation. It is similar to Table 3 and Table 5, but is for blocks in the current area frame.

Table 6: Addresses Obtained from Field Listing in Area Frame Blocks

	% not on the MAF	% on the MAF but ineligible for ACS	Total (%)
US	9.9 (0.8)	3.2 (0.4)	13.1 (0.8)
Northeast	11.3 (2.5)	2.7 (0.7)	14.0 (2.5)
Midwest	5.7 (1.0)	2.6 (0.5)	8.3 (1.1)
South	10.9 (1.1)	3.7 (0.6)	14.6 (1.2)
West	11.5 (2.2)	2.2 (0.6)	13.7 (2.3)

Table 7: Percent of Addresses on the MAF Deleted by Field Listing in Area Frame Blocks

US	13.8(0.6)
Northeast	11.4 (2.2)
Midwest	10.4 (1.2)
South	16.0 (0.8)
West	11.1 (1.8)

Table 6 showed a total gross undercoverage rate for the MAF based frame was about 13.1% (0.8%) of the area frame or 1.6% of the entire universe in 2007. Using data from the Census 2000 Housing Unit Coverage Study, we found that the gross undercoverage rate for the area frame was about 6.7% (s.e. 0.5%). This, combined with earlier results from the Area Frame Study (Corlett and Kennel 2005), we estimated that a 0.9 percentage points gross undercoverage errors may have added to the MAF based frame in the area frame sub-universe each year since Census 2000.

In area frame blocks that have permit coverage, post-census 2000 new construction is captured by the permit frame. But our coverage estimates for the area frame blocks in Table 6 included these units.

The size of the area frame of the current household surveys has decreased over time. The percentage of addresses in the area frame for current household surveys was 100% in pre-1960 designs, about 30% in 1990 design, and about 12% in 2000 design. We expect this national trend of more and more areas being converted to using city-style addresses to continue. But the situation could be different in different parts of the nation. For the 2000 Design, over 50% of the area frame addresses are in the South Census Region and two states, Vermont and West Virginia, have over 50% of their addresses in the area frame.

4. Summary of Coverage Comparisons

We now give a summary of the discussions of comparing the MAF based frame and the current frames. The GQ frame consisted of less than 1% of the entire frame and is insignificant in this analysis. The percentages shown are the percent of the entire universe for 2007.

Table 8: Coverage Comparison by Frame for 2007

On current frame but not on MAF based frame	On MAF based frame but not on current frame
The sub-universe of new construction housing units in unit frame blocks (about 9% of the four frames)	
- Error due to DSF lag time (about 0.6%)	- Error due to permit frame start date (about 0.5%)
- Noncoverage by DSF (about 0.5%)	-Others, unable to provide measure
The sub-universe of current area frame (about 12% of the four frames)	
- On current area frame but not on MAF-based frame (1.6%)	
The sub-universe of the current unit frame (about 78% of the four frames)	
	-Census misses that appear on post Census DSF (2.5%)
Mobile homes in the unit frame or permit frame sub-universe	
	-Not in Census 2000 and appeared on post Census DSF (0.2-0.3%)

Our evaluations mainly focus on what was in the current frame but not on the MAF based frame. Although the quantitative coverage estimates provided in the second column of the above table are mostly rough

estimates, they tend to be conservative estimates (or lower bounds). This suggests that the MAF-based frame and the current frame have coverage differences and that the MAF-based frame will be able to maintain comparable over-all coverage in 2007.

Looking beyond 2007, the major MAF improvements done during the 2010 Census operations will significantly improve the coverage of the MAF based frame. The current frame will continue to be used until the next redesign in 2013 to 2015. Thus, we expect the measures in the left column of Table 8 will slightly increase and the measures in the right column of Table 8 will significantly decrease. In the 3 to 5 years after the next census and before the next redesign, the MAF based-frame is expected to provide better overall coverage than the current four-frame.

5. Effects of Frame Coverage Errors on Survey Estimates

Results in previous sections showed that there will be some coverage differences for the current frame and the MAF based frame. We are interested in knowing how these coverage differences could affect the survey estimates. For the CPS sample interviewed in November 2005, March 2006, and July 2006, we identified permit frame sample units that did not appeared on the MAF in January 2005, July 2005, and January 2006, i.e. six to ten months before the interviewing and area frame sample units that were added to the MAF-based frame from field listing. In the following discussions, we simply call them area frame or permit frame non-matches. The questions is whether these units have characteristics that are different from other sample units and what are the impacts of missing these units on estimates of interest produced from the surveys.

The next table shows major labor force characteristics collected for CPS in November 2005, March 2006, and July 2006 interviewing at the non-matched addresses and other addresses. CPS second stage weight was used. The civilian labor force participation rate is the weighted number of persons in combined labor force divided by the weighted total number of persons 15 years or older. The unemployment rate is the weighted number of unemployed persons divided by the weighted number of persons in combined labor force. These results indicate that the labor force characteristics of permit frame non-matched units are different from those of a typical unit in the full frame and are not quite different from those of a typical unit on the permit frame.

Table 9: Civilian Labor Force Participation Rate and Unemployment Rate
CPS November 2005, March 2006, and July 2006

	Civilian labor force participation rate	Unemployment rate
Unit/GQ	66.5 (0.2)	4.9 (0.1)
Area frame-	62.0 (0.4)	4.8 (0.2)
Area – non-matches	64.0 (1.3)	4.9 (0.6)
Permit frame	72.6 (0.5)	3.3 (0.2)
Permit- non-matches	72.4 (1.6)	3.1 (0.4)
Full sample	66.5 (0.1)	4.9 (0.1)

We further removed the area frame or permit frame non-matches for the CPS sample that were interviewed in November 2005, repeated the survey weighting procedures through second stage controls, and reproduced the estimates using the new weights. The persons at non-matched households in the area frame and in the permit frame were 1.1% and 0.9% of all CPS persons respectively for the November 2005 interviewing.

Table 10: Civilian Labor Force Participation Rates for the US (in %), CPS, November 2005

	Original estimate	Change
Original	66.33 (0.15)	
Reweighted after removing area frame non-matches	66.38 (0.15)	+0.05 (0.04)
Reweighted after removing permit frame non-matches	66.33 (0.15)	0.00 (0.04)

Table 11: Unemployment Rates for the US (in %), CPS, November 2005

	Original estimate	Change
Original	4.93 (0.11)	
Reweighted after removing area frame non-matches	4.92 (0.11)	-0.01 (0.03)
Reweighted after removing permit frame non-matches	4.95 (0.11)	+0.02 (0.03)

These results did not show significant changes for national level estimates when removing the non-matches. Results based on March and July 2006 interviewing are similar. At the time of writing this paper, we are in the process of performing additional analysis for selected domain estimates and state level estimates.

6. Conclusions and the Next Steps

Preliminary results from our evaluations showed that there would be some coverage differences between the current four-frame and the MAF-based frame and that the MAF-based frame would be able to maintain comparable overall coverage at the national level. We also expect the field operations related to the 2010 Census will significantly improve the coverage of the MAF-based frame.

We will complete all FACHS coverage evaluations by the end of 2008. We will then make a formal decision on the frame for the 2010 DSSR. If we use the MAF as the primary source of sample units, we will also need to determine whether improvements are needed, e.g., in rural areas. The decision will depend on what improvement options are available, their effectiveness, and the associated cost. We will conduct research to provide information for making that decision.

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