

# Revision to Imputation for Multifamily Construction Spending

## Background

After identifying sampled multifamily construction projects with extremely low imputed values for Total Construction Cost, analysis revealed an issue with the imputation methodology for Total Construction Cost (TCC) and Architectural, Engineering and Miscellaneous Costs (AEM). Consequently, these costs have been systematically under-imputing for a significant period of time. The under-imputing of these costs led to the under-imputing and under-estimation of the monthly estimates of construction spending for privately-owned multifamily projects.

It is important to note that while this is a significant change to the private multifamily series, no other series are impacted except, of course, for aggregates that include private multifamily as part of their total.

The imputation methodology for Total Construction Cost and Architectural, Engineering and Miscellaneous Costs was revised and used to re-impute the TCC and AEM for non-respondents starting in January 2009. Monthly estimates of construction spending were then recalculated based on these revised costs. For January 2018 through December 2019, it was possible to use our current processing system to directly calculate revised estimates of monthly construction spending. For estimates of monthly construction spending prior to January 2018, a monthly factor was estimated to adjust the previously calculated values of monthly construction spending. The methodology for these revisions is further explained in the next section.

## Methodology

The methodology for imputing TCC and AEM for multifamily projects is largely unchanged. There are two changes, both of which impact the pool of donors for the imputation factor calculation. The actual calculation and application of the imputation factors remains the same.

The first change comes from updating our definition of outliers. Previously, any project where the sum of TCC and AEM, divided by the number of housing units, was greater than 100 was excluded from factor calculation. That is, in rough terms, saying that any multifamily project where the average cost per housing unit was greater than \$100,000 was deemed an outlier and not used. This resulted in a number of valid multifamily respondents being excluded from the imputation factor calculation. The methodology was revised to use a dynamic upper bound for that average cost, with a different bound used for each unique combination of project size (number of housing units) and geographic region.

The second change comes from the number of years used to calculate the imputation factors. Previously, the methodology used a cumulative total of all project costs going back to at least 1996. This resulted in imputation factors that were not able to reflect current data relationships. The methodology now uses the five most recent years of data. This length was chosen as a balance between shorter intervals giving a more accurate picture of current relationships, and longer intervals giving more stable relationships as well as more reliable donor pool sizes. The net effect of these two changes is to significantly increase the imputed values of TCC and AEM, which results in an increase to the imputed values and estimated totals of monthly construction spending.

After using the methods above to develop revised TCC and AEM imputation factors for multifamily projects, for cases where the respondent did not report the TCC, TCC was imputed as the number of housing units in that project multiplied by the TCC imputation factor. Then if the respondent did not report AEM, AEM was calculated as the (either reported or imputed) TCC value multiplied by the AEM imputation factor. For January 2018 to December 2019, monthly construction spending estimates were then re-imputed by multiplying the current construction spending imputation factors by the revised imputes for TCC.

To calculate monthly construction spending totals for January 2009 through December 2017, the re-imputed values for TCC and AEM, described in previous paragraph, were used to calculate estimated monthly totals of TCC for active cases ("New TCC") for January 2009 through December 2019. The estimated monthly total of TCC using the original values ("Old TCC") was also calculated for this time period. Then the Adjustment Factor for each month was calculated as the ratio of New TCC over Old TCC. These ratios were then used to calculate initial adjusted construction spending by multiplying previously calculated estimates of monthly construction spending for January 2009 through December 2019 by the Adjustment Factor. When comparing this ratio adjustment method of re-imputing monthly construction spending to the production method, for January 2018 through December 2019, the ratio method was found to slightly overestimate the total monthly construction spending, so an additional adjustment was applied to correct for this.

## **Results**

The table below shows the currently published and revised annual estimates of Private Multifamily and the related aggregate series Private Residential, Total Private, Total Residential, and Total Construction Spending. All annual estimates shown for the aggregate series are shown prior to the annual revision for 2018-2019 data released on July 1, 2020. The percent change between the revised and currently published estimates is also included.

Because data for private multifamily construction spending for 2008 and earlier were not revised, note that there is a level shift between the unrevised monthly construction spending estimates for December 2008 and the revised monthly estimates for January 2009. The seasonal adjustment of monthly construction spending estimates accounts for this level shift.

Source: U. S. Census Bureau  
Economic Indicators Division

Last Revised: July 1, 2020

		<b>Annual Total Construction Spending (Millions of dollars)</b>				
		<b>Private Multifamily</b>	<b>Private Residential</b>	<b>Total Private</b>	<b>Total Residential</b>	<b>Total</b>
Previously Published	<b>Year</b>					
	2009	28,538	247,526	591,648	255,542	906,543
	2010	14,686	242,035	505,290	252,328	809,256
	2011	15,037	244,122	501,925	252,646	788,332
	2012	22,510	269,784	571,145	276,057	850,455
	2013	31,500	323,381	637,641	329,217	908,323
	2014	41,553	369,793	731,496	374,860	1,007,624
	2015	52,687	422,300	836,925	429,226	1,130,693
	2016	61,062	467,138	914,421	473,687	1,211,393
	2017	60,012	525,015	969,304	531,755	1,265,843
	2018	59,593	539,607	1,000,154	546,136	1,307,248
2019	61,307	515,436	978,450	521,971	1,306,855	

Revised (Released July 1, 2020)	2009	33,763	252,751	596,872	260,766	911,767
	2010	18,395	245,743	508,998	256,037	812,964
	2011	17,943	247,028	504,830	255,551	791,237
	2012	26,456	273,730	575,091	280,003	854,401
	2013	37,759	329,640	643,900	335,476	914,582
	2014	49,221	377,461	739,164	382,528	1,015,292
	2015	62,157	431,769	846,394	438,695	1,140,162
	2016	73,339	479,415	926,698	485,965	1,223,671
	2017	74,011	539,013	983,302	545,753	1,279,841
	2018	77,544	557,558	1,023,016	563,877	1,333,183
	2019	80,110	544,449	1,030,704	550,942	1,365,137

Percent Change	2009	18.3%	2.1%	0.9%	2.0%	0.6%
	2010	25.3%	1.5%	0.7%	1.5%	0.5%
	2011	19.3%	1.2%	0.6%	1.1%	0.4%
	2012	17.5%	1.5%	0.7%	1.4%	0.5%
	2013	19.9%	1.9%	1.0%	1.9%	0.7%
	2014	18.5%	2.1%	1.0%	2.0%	0.8%
	2015	18.0%	2.2%	1.1%	2.2%	0.8%
	2016	20.1%	2.6%	1.3%	2.6%	1.0%
	2017	23.3%	2.7%	1.4%	2.6%	1.1%
	2018	30.1%	3.3%	2.3%	3.2%	2.0%
	2019	30.7%	5.6%	5.3%	5.6%	4.5%