

# Technical Appendix

This Appendix provides more technical details on three issues raised in the blog: comparing the GAO and Urban coefficients, problems with Urban's model specification, and problems with Urban's aggregate impact calculation. Readers without a statistical background can safely skip the following.

## 1. Comparing Coefficients Across Studies

The Urban Institute study found that a \$1 increase in advances (over assets) was significantly associated with an \$0.18 increase in residential real estate loans (over assets) for all banks. The GAO report found that a 1 percent increase in advances (quarter-over-quarter) was significantly associated with a 0.003 percent increase in residential real estate loans for small banks only. Since the Urban coefficient is in dollars and the GAO coefficient is an elasticity, they cannot be directly compared: the dollar equivalent of the GAO coefficient depends on the previous level of advances and real estate lending.

Unfortunately, neither Urban nor GAO make their data publicly available, so we cannot calculate a measure such as the average marginal effect (AME) or the marginal effect at the mean (MEM). However, we constructed several typical FHLBank member banks, applied the marginal effect, and compared the resulting dollar effect to Urban's \$0.18 finding.

We take banks with the following three asset sizes: \$300 million, \$900 million, and \$1.5 billion. These banks roughly represent the median sizes of FHLBank small bank members (those with assets under \$10 billion). We do not include larger banks because GAO's modeling found that the association between advances and loans was insignificant for banks with more than \$10 billion in assets. We vary each of these three bank sizes by two FHLBank advance levels: 1 percent and 2 percent of assets for banks under \$1 billion and 2 percent and 4 percent of assets for banks over \$1 billion. This follows the median ratio of FHLBank borrowing to total assets by bank size, based on information provided in [Table 1 of the GAO report](#). We further vary each bank by two real estate portfolio levels: 20 percent and 30 percent, [following figures from the Federal Reserve Bank of San Francisco](#).

**Figure A-1. Comparing GAO and Urban Associations for Typical Small Banks**

| Bank Assets     | FHLBank Borrowing | 1% Increase in FHLBank Borrowing | Real Estate Portfolio | 0.003% Increase in Real Estate Portfolio | Dollar Association (Urban Coefficient Equivalent) |
|-----------------|-------------------|----------------------------------|-----------------------|------------------------------------------|---------------------------------------------------|
| \$300,000,000   | \$3,000,000.00    | \$ 30,000                        | \$60,000,000.0        | \$1,800                                  | \$0.06                                            |
| \$300,000,000   | \$3,000,000.00    | \$ 30,000                        | \$90,000,000.0        | \$2,700                                  | \$0.09                                            |
| \$300,000,000   | \$6,000,000.00    | \$ 60,000                        | \$60,000,000.0        | \$1,800                                  | \$0.03                                            |
| \$300,000,000   | \$6,000,000.00    | \$ 60,000                        | \$90,000,000.0        | \$2,700                                  | \$0.05                                            |
| \$900,000,000   | \$9,000,000.00    | \$ 90,000                        | \$180,000,000.0       | \$5,400                                  | \$0.06                                            |
| \$900,000,000   | \$9,000,000.00    | \$ 90,000                        | \$270,000,000.0       | \$8,100                                  | \$0.09                                            |
| \$900,000,000   | \$18,000,000.00   | \$ 180,000                       | \$180,000,000.0       | \$5,400                                  | \$0.03                                            |
| \$900,000,000   | \$18,000,000.00   | \$ 180,000                       | \$270,000,000.0       | \$8,100                                  | \$0.05                                            |
| \$1,500,000,000 | \$30,000,000.00   | \$ 300,000                       | \$300,000,000.0       | \$9,000                                  | \$0.03                                            |
| \$1,500,000,000 | \$30,000,000.00   | \$ 300,000                       | \$450,000,000.0       | \$13,500                                 | \$0.05                                            |
| \$1,500,000,000 | \$60,000,000.00   | \$ 600,000                       | \$300,000,000.0       | \$9,000                                  | \$0.02                                            |
| \$1,500,000,000 | \$60,000,000.00   | \$ 600,000                       | \$450,000,000.0       | \$13,500                                 | \$0.02                                            |

Source: Consumer Federation of America

Across all twelve configurations - varying three different asset sizes, two different advance levels, and two different real estate portfolios - the marginal effect from the GAO report results in a dollar association ranging from \$0.02 to \$0.09 (see **Figure A-1**). This is substantially less than Urban's reported \$0.18 coefficient. While we cannot calculate AMEs or MEMs, these results give us confidence that GAO's more robust effect is smaller than Urban's, likely by at least 50 percent.

## 2. The Urban Institute Model is Misspecified

Throughout their report, the Urban Institute uses the following first-difference fixed effects model to estimate the effect of FHLBank advances on loans:

$$\Delta Y_{i,t} = \beta \Delta FHLBadvs_{i,t} + \delta \Delta Cash_{i,t} + X_{i,t-1} + \pi_t + S_i + \varepsilon_{it}$$

Where outcome  $\Delta Y_{i,t}$  is the differences in loan balance between the current period (t) and previous quarter (t-1), normalized by the lagged value of total assets at t-1 to control for size. Predictor  $\beta \Delta FHLBadvs_{i,t}$  is the difference in the FHLBank advances between t and t-1 divided by the total asset value at t-1, and the remaining variables control for changes in cash, bank characteristics, year, and state, respectively.

This model does not directly regress change in lending on change in advances; it regresses change in lending *over assets* on change in lending *over assets*. While this may seem like a trivial difference, it is not.

As explained in the *American Journal of Epidemiology*, using a ratio measure in any stage of a regression model (exposure, covariate, outcome) is problematic. When the

researchers define their outcome as the change in loan balance over lagged assets, they end up modeling an interaction term [change in loan balance x (lagged assets)<sup>-1</sup>] rather than their actual outcome of interest. If we multiplied both sides by lagged assets to isolate loan balance, we end up turning the error term into an interaction, which presents additional problems.

There are two standard and appropriate ways to account for member bank size that don't rely on ratios. First, run a weighted regression, where the *residuals*, not the variables, are adjusted. This approach would ensure that larger banks are assigned more importance when estimating parameters. The second way is the approach utilized in the GAO study: run the model on different subsets of the data filtered for different bank sizes. In doing so, the GAO uncovered the important finding that there is no association between advance borrowing and real estate loans for large bank members (who borrow the vast majority of bank member advances).

### **3. The Urban Institute Aggregation Methodology Artificially Inflates Overall Impact**

There are also problems with the Urban Institute's aggregation methods. The Urban Institute report found that a \$1 increase in advances was associated with \$0.18 of additional residential real estate loans for banks. The report models change in lending on change in advances (controlling for other factors), meaning their model is directionally neutral and their coefficient is symmetric. While a \$1 increase in advances was associated with \$0.18 of additional residential loans, a \$1 *decrease* in advances was associated with \$0.18 *less* in residential loan holdings. This is ignored when calculating the aggregate impact.

Researchers are generally hesitant to calculate aggregate impacts from statistical models. Statistical models measure the association between two variables (in this case: FHLBank advances and residential loans) while controlling for third variables that may be associated with both (e.g., the interest rate that quarter). The real world is messy, and we cannot control for all these factors when multiplying the coefficients from our models by our observations. Likely for these reasons, the GAO report does not attempt to calculate aggregate impacts.

Putting aside this general concern, the methodology used in the Urban Institute study artificially inflates the aggregate impact. For each bank in the sample, the researchers "aggregate the quarterly positive changes in FHLBank advances at member banks for each year from 2002 through 2024 and calculate the annual average. For example, if a member bank increased advance borrowing in the first quarter and repaid a portion of the advance in the second quarter, our calculation reflects only the increase in advances in the first quarter" (p. 10) and then multiplied this by the effect from their

model (\$0.18 for each \$1 in advances). This methodology effectively ignores quarters where advances decreased, which their model found would decrease overall lending. In other words, the report does not acknowledge that this coefficient is symmetric

**Figure A-2: FHLBank Advances for a Fictional Bank**

|                           | Q1    | Q2    | Q3    | Q4    |
|---------------------------|-------|-------|-------|-------|
| FHLBank Advances          | \$100 | \$120 | \$90  | \$110 |
| Quarter-to-Quarter Change |       | +\$20 | -\$30 | +\$20 |
| “Positive” Changes        |       | +\$20 | +\$0  | +\$20 |

*Source: Consumer Federation of America*

For example, take the fictional bank in **Figure A-2**. Over the course of a year, the bank takes the following advances: \$100, \$120, \$90, and \$120 again. Using the Urban report’s methodology, we would effectively ignore the third quarter where advances decreased (see the “Positive” Changes row). Instead of the aggregate impact being \$1.80 ( $\$20 \times 0.18 - \$30 \times 0.18 + \$20 \times 0.18$ ), the aggregate impact instead becomes \$7.20 ( $\$20 \times 0.18 + \$0 \times 0.18 + \$20 \times 0.18$ ). Since this methodology was used throughout the report, all of the reported aggregate impacts are artificially inflated.