

*Rounding and the Bill-Size Gradient in Restaurant Tipping*Toby Qin^{1*} and Vrund Gurjar²¹East Chapel Hill High School, Chapel Hill, North Carolina, USA²Marvin Ridge High School, Waxhaw, North Carolina, USA

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Abstract

Background: Restaurant tip percentages often decline as bills increase. Rounding is one proposed explanation because a fixed upward adjustment adds more to the tip percentage on a small bill. We examine how much of the observed decline can be explained by adjustments of up to one dollar.

Methods: We analyzed 22,446 checks with positive recorded tips, no automatic gratuity and bills of \$10–\$200 from three North Carolina restaurant outlets. For checks with a whole-dollar tip or reconstructed final payment, we allowed the pre-rounding tip to fall anywhere from one dollar below the recorded amount to the recorded amount, with a minimum of zero. We calculated the smallest and largest bill-size coefficients across these possible amounts, controlling for outlet, month, guest count, opening hour and weekday. Bootstrap checks resampled dates, weeks and servers. Each scheme used 999 draws, with the rounding bounds recalculated for each resampled dataset.

Results: Tip percentages fell by 4.29 points per bill doubling. Even the adjustments that most reduce this decline leave a coefficient of -1.62 points, which remains negative across all three bootstrap checks. Five-dollar rounding or restricting bills to \$30–\$200 allows the fitted decline to disappear.

Conclusion: Upward dollar rounding cannot fully explain the negative gradient in the primary sample. Larger rounding increments and the exclusion of small bills produce ranges containing zero.

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Introduction

Tipping, the practice of giving extra money to a service worker, is an important component of restaurant servers’ compensation [1]. Research on tipping has examined its role as a social norm and its economic importance in service settings [2]. One characteristic regularly examined in tipping research is bill size. Tip percentages often decline as bills increase, a pattern commonly called the magnitude effect. This relationship has been documented in both hypothetical scenarios and real-world payments [3,4].

Customers may calculate a percentage of the bill and then round the tip, or choose an amount that makes the final payment a whole dollar. Lynn et al. documented clustering of tips and final payments at whole dollars, as well as tips at multiples of five dollars [5]. An upward adjustment adds a larger percent of the bill for small bills when compared to large ones; rounding can therefore produce declining tip percentages even when the percentage chosen before rounding is unchanged. The size of its contribution remains an empirical question. Lynn et al. used payment patterns to question whether customers were simply rounding common tipping percentages to the nearest dollar [6]. We extend that work by measuring the range of bill-size coefficients compatible with a specified rounding rule.

We analyze point-of-sale records from three casual dining outlets in North Carolina. For each check compatible with whole-dollar rounding, we allow an upward adjustment of up to one dollar and calculate the smallest and largest coefficients the possible pre-rounding amounts can produce. The observed coefficient was -4.29 percentage points per bill doubling. Even the adjustments that most reduce this decline leave a coefficient of -1.62 points under upward dollar rounding. Allowing five-dollar rounding or excluding bills below \$30 produces a range containing zero.

Materials and Methods

Data and Sample

We use transaction-level point-of-sale records from Indian Trail, Steele Creek and Waxhaw, North Carolina. The dataset contains 83,977 transaction records from May 2024 through April 2025; November and December 2024 are missing. Available fields include outlet, opening time, guest count, server, table, bill amount, tax, discount, tip and automatic gratuity status.

We examine bills with a valid timestamp, outlet and server; finite, nonnegative monetary fields; an integer guest count of 1–20; and a recorded table. We exclude online and takeout orders. For our primary sample, we require bills to have a positive recorded tip, zero automatic gratuity and a bill of \$10–\$200. Table 1 summarizes the primary sample.

Table 1: Primary sample characteristics

Characteristic	Value
Checks	22,446
Dates	301
Outlet-specific server labels	87
Checks: Indian Trail	4,645
Checks: Steele Creek	9,969
Checks: Waxhaw	7,832
Mean bill	\$43.79
Mean tip	\$9.19
Mean tip percentage	22.52%
Whole-dollar tip or reconstructed payment	16,926 (75.41%)

Source: Authors’ calculations. Reconstructed payment equals the bill, tax and recorded tip.

Regression and Rounding Bounds

Each check receives equal weight. We regress its recorded tip percentage, $100T/A$, on $\log_2(A)$, where T is the recorded tip and A is the recorded bill amount. Controls include outlet-by-calendar-month indicators and categorical guest count, opening hour and weekday. The coefficient measures the conditional association in percentage points per bill doubling.

A check is eligible for whole-dollar rounding when either its tip or its reconstructed final amount, $A + Q + T$, is an exact whole dollar, where Q denotes tax. We identify whole-dollar amounts using their values in cents.

For eligible checks, the pre-rounding component U can lie anywhere in $[\max(0, T - 1), T]$. For other checks, U equals T . The selected pre-rounding percentage and the adjustment can vary freely across checks. The interval includes a one-dollar adjustment, the limiting endpoint of ordinary upward rounding, and permits no adjustment at all.

We calculate the smallest and largest log-bill coefficients obtainable from these outcome intervals while holding bills, controls and sample membership fixed. If the entire range is negative, every permitted allocation retains a negative fitted gradient. If the range includes zero, at least one allocation can eliminate it. The appendix provides the endpoint formula and explains the continuous interval assumption.

Uncertainty and Robustness

The primary bootstrap draws dates with replacement within each observed calendar month, retaining all checks on a sampled date jointly across outlets. A second bootstrap resamples observed weeks within May–October 2024 and January–April 2025. After the initial analysis, we also resampled each server’s complete history within its outlet. Each scheme uses 999 draws and recalculates the regression weights and both endpoints. We report the 2.5th and 97.5th percentiles for each endpoint.

We chose the primary specification and sensitivity analyses before calculating the bounds, having already examined the data and earlier results. One sensitivity analysis excludes checks sharing the same outlet, opening time, server and table.

Results

Tip percentages declined by 4.29 points per bill doubling after adjustment for the measured characteristics. Even the upward dollar adjustments that most reduce this decline leave a coefficient of -1.62 points (Table 2).

Table 2: Primary coefficient and endpoint uncertainty

Resampling	Quantity	Estimate	Percentile interval
Date	Observed coefficient	-4.288	[-4.562, -4.013]
Date	Lower endpoint	-5.034	[-5.314, -4.755]
Date	Upper endpoint	-1.622	[-1.885, -1.365]
Week	Upper endpoint	-1.622	[-1.843, -1.361]
Server	Upper endpoint	-1.622	[-2.230, -0.946]

Source: Authors’ calculations. Units are percentage points per bill doubling. Intervals give the 2.5th and 97.5th percentiles of 999 bootstrap draws.

The permitted adjustments can remove at most about 62% of the observed decline; the actual contribution of rounding is unknown. The upper endpoint remains negative in all three bootstrap checks. Five-dollar rounding

or excluding bills below \$30 allows the fitted decline to disappear (Figure 1). The dollar-rounding range remains negative even when every check is allowed an adjustment. The other specification checks retain negative ranges, including the separate outlet and period analyses (Table 3). Excluding tips above half the bill substantially weakens the remaining decline. These are fixed-sample comparisons; bootstrap uncertainty is reported only for the primary specification.

Table 3: Rounding and sample sensitivities.

Specification	N	Observed	Compatible range
Primary: upward \$1	22,446	-4.288	[-5.034, -1.622]
Upward \$0.50	22,446	-4.288	[-4.667, -2.923]
Nearest \$1	22,446	-4.288	[-5.994, -2.583]
Upward \$5	22,446	-4.288	[-6.298, 0.547]
Up to \$1 on every check	22,446	-4.288	[-5.270, -1.040]
Tax-inclusive bill	22,446	-3.996	[-4.692, -1.507]
Additional server indicators	22,446	-4.151	[-4.938, -1.458]
Bills \$20–\$200	19,417	-2.635	[-3.455, -0.541]
Bills \$30–\$200	15,206	-1.769	[-2.612, 0.029]
Bills \$10–\$100	21,689	-4.624	[-5.502, -1.695]
Bills \$10–\$300	22,487	-4.250	[-4.984, -1.608]
Exclude tips above bill	22,390	-3.908	[-4.653, -1.248]
Exclude tips above 50% of bill	21,962	-2.906	[-3.648, -0.299]
No recorded discount	20,796	-3.995	[-4.755, -1.304]
Exclude matching checks	22,438	-4.288	[-5.034, -1.622]
One to five guests	22,117	-4.298	[-5.046, -1.623]
May–October 2024	13,633	-3.911	[-4.708, -1.204]
January–April 2025	8,813	-4.740	[-5.423, -2.121]
Indian Trail	4,645	-4.940	[-5.854, -2.195]
Steele Creek	9,969	-5.181	[-5.948, -2.631]
Waxhaw	7,832	-2.984	[-3.688, -0.222]

Source: Authors' calculations. Ranges describe compatibility under the stated rounding rules; sampling intervals for the primary specification appear in Table 2. The upward \$1 rule applies unless otherwise stated.

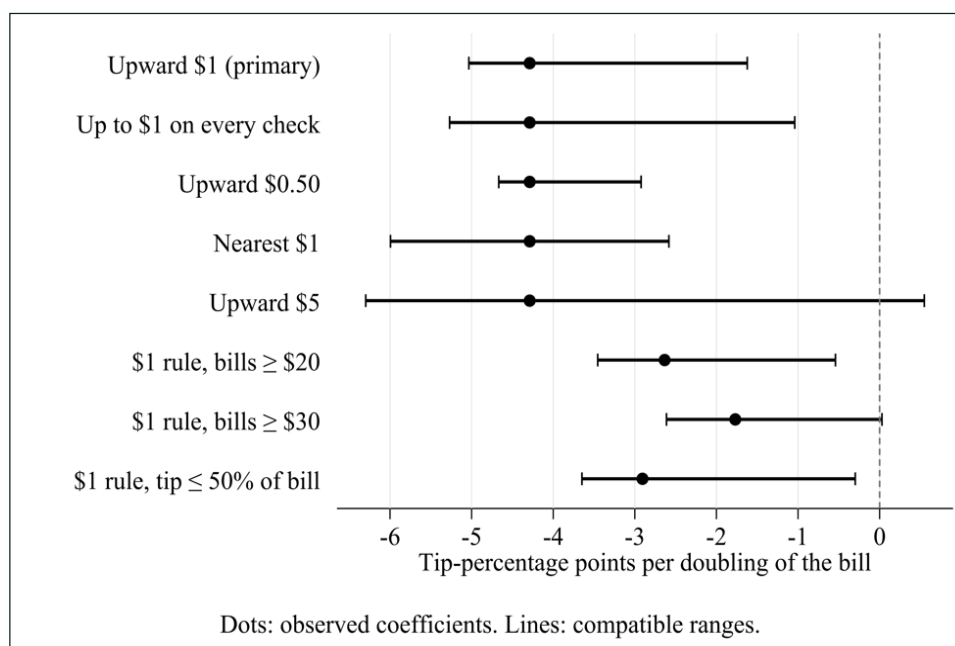


Figure 1: Rounding assumptions and the compatible bill-size gradient
Source: Authors' calculations. The dashed line marks zero.

Discussion

Upward dollar rounding is insufficient in explaining the full decline in tip percentages in the primary sample. Even by giving each eligible check its own adjustment and allowing those adjustments to be assigned in the way most favorable to removing the decline, a negative coefficient still remains. The result adds a quantitative bound to earlier evidence on rounding and the magnitude effect.

However, five-dollar rounding can account for the full fitted decline within the permitted interval class. This is a substantive alternative because tips clustered at five-dollar multiples have been observed in earlier work [5]. The result for bills of at least \$30 also shows that smaller bills matter to the primary conclusion. Other explanations, including a mixture of flat-dollar and percentage tippers, remain plausible [1]. The records do not reveal which payment rule an individual customer used.

Several limitations affect interpretation. Bill size was not randomly assigned: customers with different orders, incomes or service experiences may choose different tips. The coefficient therefore describes an association among selected checks. Cash payments are not separately identified, and the sample includes only positive recorded tips without automatic gratuity. The data cover only three outlets and omit two months, which limits the generalizability of this study.

Managers and researchers should test how much rounding could change the bill-size relationship before using it to explain lower tip percentages on larger bills. Studies that observe payment-screen choices can examine the decision more directly; Cross and Zhang [7], for example, study tip suggestions in New York City taxis. Recording suggested percentages, pre-rounding tips and cash payments would help distinguish these explanations.

Conclusion

The negative bill-size gradient remains after allowing upward dollar rounding in the primary sample. Five-dollar rounding and the restriction to bills of at least \$30 each produce a range containing zero. Rounding scale and sample selection are therefore central to interpreting the magnitude effect. Future work should observe customers' payment choices directly and test whether these results extend to other restaurants.

Declarations

This study uses existing restaurant transaction records and involved no new intervention or customer recruitment. The reported results are aggregate statistics, and individual server names are omitted. Generative AI tools were used to assist with language editing and formatting. The authors reviewed and take full responsibility for all content. The study was not preregistered.

Appendix

Derivation of the bounds

Let r_i be the residual from projecting $\log_2(A_i)$ on the controls, including an intercept. When the sum of squared residuals is positive, the coefficient is a weighted sum of the outcomes, with $w_i = r_i / \sum_j r_j^2$. These weights remain fixed when the possible prerounding amounts vary. Let l_i and u_i denote the lower and upper possible values of $100U_i/A_i$. The coefficient endpoints are

$$\beta_L = \sum_{w_i \geq 0} w_i l_i + \sum_{w_i < 0} w_i u_i \quad (1)$$

$$\beta_U = \sum_{w_i \geq 0} w_i u_i + \sum_{w_i < 0} w_i l_i \quad (2)$$

All minimizing choices, and all maximizing choices, can occur together because the interval class imposes no restrictions linking different checks. Convex combinations of the endpoint allocations generate every intermediate coefficient. The bounds are therefore exact for this continuous, closed interval class. We allow any adjustment up to a full dollar, giving rounding more flexibility than standard upward rounding. If the range stays negative, standard rounding cannot remove the decline either. A range containing zero allows a flat fitted relationship but does not establish constant-percentage tipping.

Alternative Rules and Interpretation

Upward half-dollar and five-dollar alternatives use their respective grids and interval widths. Nearest-dollar rounding permits adjustments of $\pm\$0.50$ on eligible checks, truncating the lower amount at zero. The all-check sensitivity permits an upward dollar

adjustment regardless of roundness. Tax-inclusive models change both the outcome denominator and the log-bill regressor. Sample membership is based on the recorded tip. An allowed pre-rounding component of zero remains part of an observed positive-tip check. Each check has equal regression weight, so the mean tip percentage differs from total tips divided by total sales. Likewise, a declining percentage can accompany an increasing dollar tip.

The compatibility range describes permissible coefficients for fixed data. Bootstrap intervals quantify sampling uncertainty under each resampling scheme. Server labels are operational identifiers, and the absence of customer identifiers prevents clustering repeated visits directly. The date, week and server checks address different sources of dependence.

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