



Margin of Error and Household Income

An analysis of the impact of margin of error when making decisions based on household income – Lake County, IL

Prepared for: Educational Purposes

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Problem Statement and Objective

Problem Statement:

Tract-level median household income (MHI) from the American Community Survey (ACS) is widely used to guide high-stakes decisions across sectors—planning and service targeting, public health prioritization, housing and community development investment, education and workforce programming, philanthropic grantmaking, and private-sector market or equity analyses. These decisions often rely on tract rankings or hard thresholds (for example, identifying “high-need” areas, determining eligibility, or comparing neighborhoods). However, ACS estimates carry sampling uncertainty, expressed as margins of error (MOE). When MOE is large or unavailable, the published MHI may be an unstable signal: a tract’s true income could plausibly fall on either side of a decision cutoff, potentially shifting classifications and leading to over- or under-targeting.

This study examines where tract-level MHI in Lake County, Illinois is statistically reliable versus decision-sensitive. By mapping MOE magnitude, confidence-based eligibility relative to county and statewide benchmarks, and the subset of borderline tracts whose confidence intervals cross key thresholds, the analysis provides a practical reality check for users of ACS income data. The goal is not to discourage use of ACS MHI, but to clarify where decisions based on it are robust and where secondary validation with local, administrative, or program data should be required.

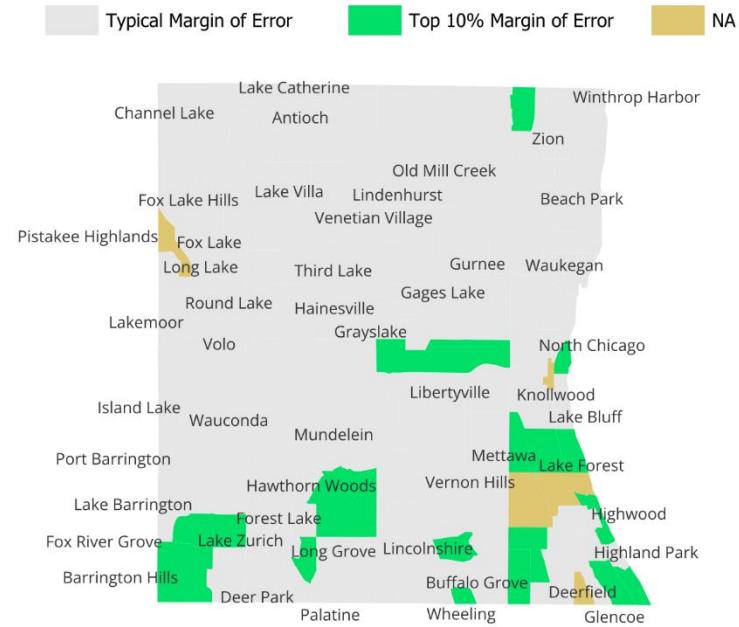
Objectives:

- Identify Lake County tracts with unusually high ACS MHI uncertainty (top decile MOE) or missing MOE.
- Show how incorporating MOE changes tract classifications around common decision thresholds.
- Benchmark Lake County tracts against the Illinois statewide income distribution using confidence intervals.
- Produce a decision-ready list and map of borderline/MOE-sensitive tracts where secondary validation is needed before acting on tract-level MHI.

Results

Lake County, IL Tracts with Highest ACS MHI Uncertainty (2022)

Highlighted areas have the largest margins of error for median household income



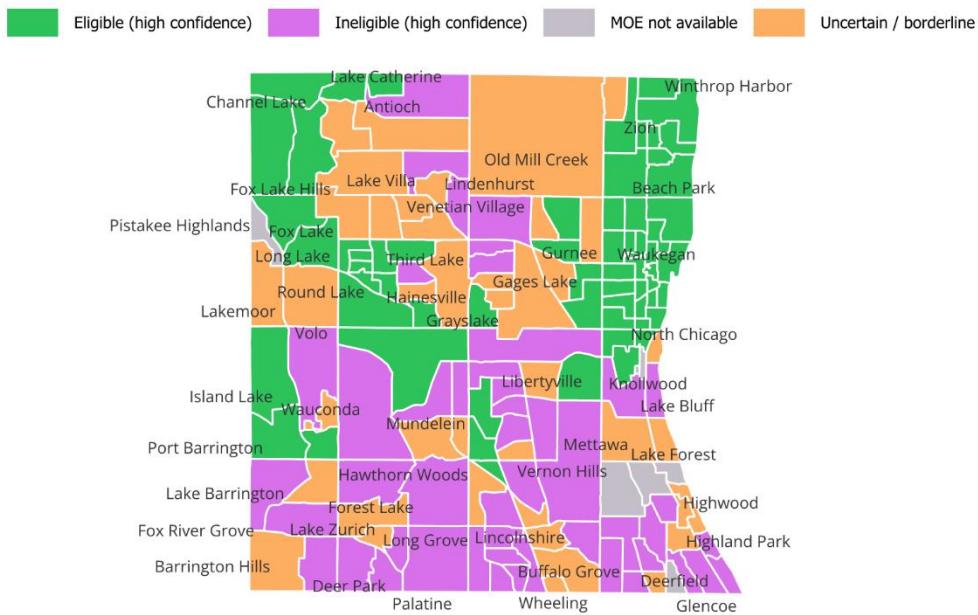
Source: ACS 5-year (2022 MOE shown at 90% confidence. Prepared by DemoAnalytics

Map Description:

This map displays census tracts in Lake County, Illinois, symbolized by the level of uncertainty in 2022 American Community Survey (ACS) median household income (MHI) estimates. Tracts with margins of error (MOE) in the highest 10% countywide are highlighted in green, indicating the greatest statistical uncertainty in the income estimates. All other tracts with typical MOE levels are shown in light gray. Tracts with unavailable or suppressed MOE values are shown in tan. The map is intended to identify where ACS MHI estimates should be interpreted with extra caution due to comparatively large sampling error.

Funding Eligibility by MHI with MOE Confidence (Lake County, ACS 2022)

Uncertain tracts cross the threshold when MOE is considered



Source: ACS 5-year (2022 MOE shown at 90% confidence. Prepared by DemoAnalytics

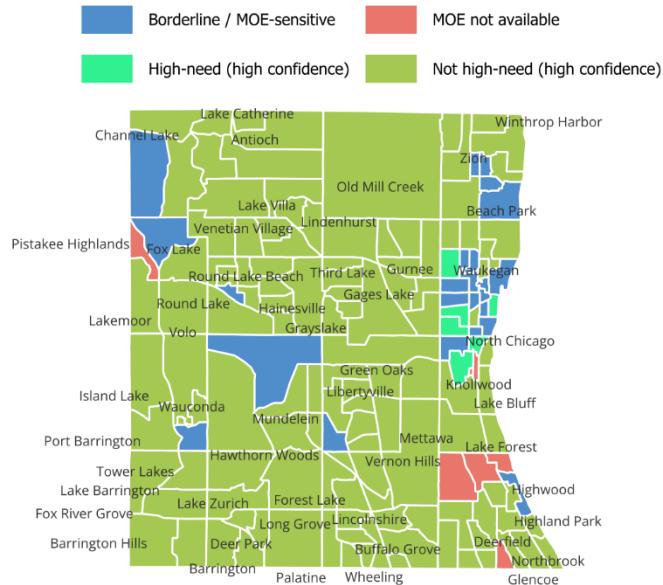
Map Description:

This map shows how accounting for ACS margin of error changes funding eligibility based on median household income (MHI) in Lake County. Tracts are classified against a countywide MHI threshold using their 90% confidence intervals: tracts whose entire interval falls below the threshold are labeled **eligible with high confidence**, while those entirely above are **ineligible with high confidence**. Tracts in the **uncertain/borderline** category have confidence intervals that cross the threshold, meaning their eligibility could flip depending on sampling uncertainty. By separating high-confidence decisions from MOE-sensitive areas, the map highlights where income-based targeting is reliable and where additional validation is warranted before directing resources.

High-confidence eligible and ineligible tracts are clearly identified, while borderline tracts show where MOE can reverse an eligibility decision.

Lake County Tract Income Need vs Illinois Statewide Benchmark (ACS 2022)

High-need defined as bottom statewide tract quartile; blue tracts are MOE-sensitive



Source: ACS 5-year (2022). MOE shown at 90% confidence. Prepared by DemoAnalytics.

Map Description:

This map benchmarks Lake County tract-level median household income (MHI) against the statewide Illinois distribution using 2022 ACS data, while explicitly incorporating margins of error (MOE). Tracts whose full 90% confidence interval falls within the bottom statewide income quartile are labeled **high-need with high confidence**, indicating places where statewide-relative need is statistically clear.

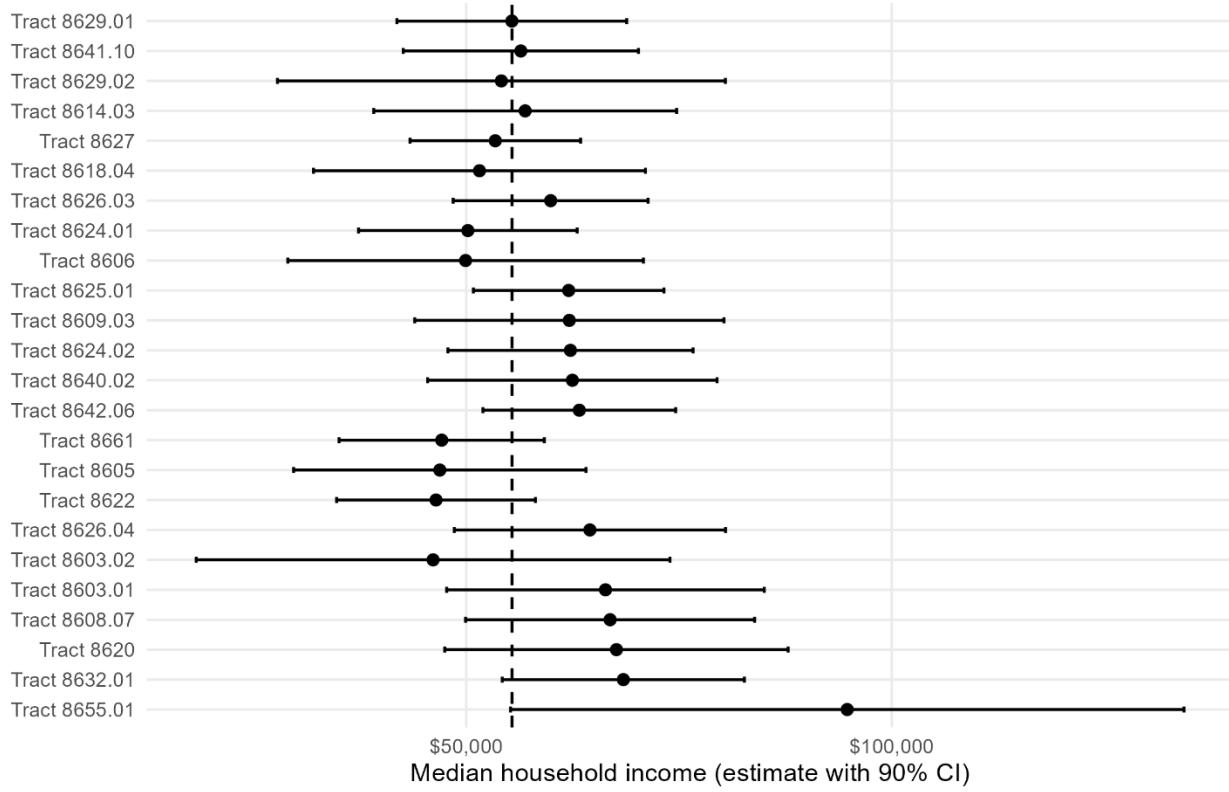
Tracts whose interval is entirely above that quartile are **not high-need with high confidence**, providing a stable signal for comparisons. **Borderline/MOE-sensitive** tracts have confidence intervals that cross the statewide cutoff, meaning their classification could change depending on sampling uncertainty; these are the areas where rankings or threshold-based decisions are most fragile and should be validated with additional local, administrative, or program data. Tracts with **MOE not available** are flagged as uncertainty blind spots where ACS estimates should not be used alone for high-stakes choices.

Why it matters across sectors:

Because tract-level MHI is used in planning, public health, housing, education, infrastructure, research, philanthropy, and private-sector market or equity analyses, this confidence-based benchmark helps users distinguish where ACS income patterns are reliable for decision-making—and where uncertainty could materially change conclusions.

Borderline Tracts: MHI Estimates with 90% Confidence Intervals (ACS 2022)

Intervals crossing the statewide Q1 cutoff indicate MOE-sensitive classifications



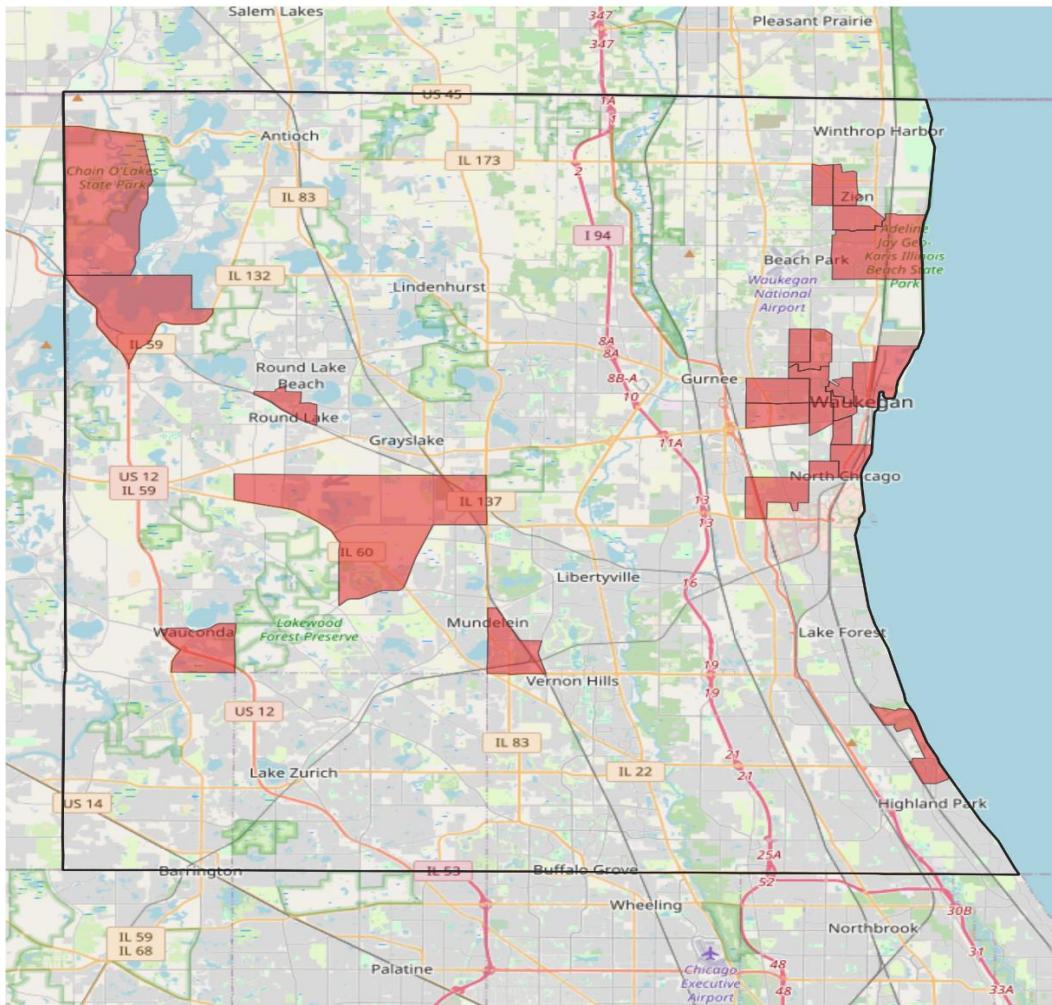
Source: ACS 5-year (2022). Prepared by DemoAnalytics

Chart description:

This dot plot displays the 24 Lake County tracts identified as borderline/MOE-sensitive under the statewide high-need benchmark. Each point shows the ACS 2022 median household income (MHI) estimate for a tract, with horizontal bars representing the 90% confidence interval derived from the margin of error. The dashed vertical line marks the statewide bottom-quartile cutoff. Because each tract's confidence interval crosses this cutoff, its classification as high-need or not high-need can plausibly shift depending on sampling uncertainty. The chart reinforces why these tracts require secondary validation with local or administrative data before tract-level income is used for threshold-based decisions.

Census Tracts Where Household Income Margin of Error Can Shift Decision-Making

The shaded areas require secondary validation before using tract-level median household income as a stand alone decision point.



Source: ACS 5-year (2022). Prepared by DemoAnalytics
Basemap: © OpenStreetMap contributors.

Final map description:

This map highlights Lake County census tracts where ACS 2022 median household income estimates are most likely to **shift tract classification or decisions** when margins of error are considered. Shaded tracts fall in a borderline zone where the 90% confidence interval overlaps the statewide high-need cutoff, so eligibility or ranking can change depending on sampling uncertainty. These areas should be validated with additional local, administrative, or program data before tract-level income is used as a standalone decision metric.

Conclusion

Conclusion statement:

Across the analysis, tract-level median household income proves useful for targeting and benchmarking, but margins of error meaningfully condition how reliable those decisions are. The first map identifies where ACS MHI is least precise; the second demonstrates how uncertainty can flip county-relative eligibility; the statewide benchmark map separates high-need, non-high-need, and borderline tracts with statistical confidence. The final map synthesizes those steps by isolating the tracts where decisions are most MOE-sensitive, offering a practical “reality check” for any sector using ACS income thresholds, rankings, or comparisons. In these places, secondary validation is not optional — it’s the difference between stable targeting and uncertainty-driven misclassification.

Key Findings

- **ACS MHI is a strong decision signal—until uncertainty gets large.** Most Lake County tracts have typical margins of error, meaning tract-level income comparisons and rankings are generally stable for planning and evaluation.
- **A small set of tracts show exceptionally high uncertainty.** Tracts in the top decile of MOE represent “fragile signal” areas where published MHI can plausibly be far from the true value, so tract-level decisions based on a single estimate are riskier.
- **Uncertainty can change threshold-based classifications.** When 90% confidence intervals are considered, some tracts move from clearly eligible/ineligible to **borderline**, demonstrating that MOE can flip decisions that rely on hard cutoffs.
- **Statewide benchmarking reveals clear high-need pockets—but also a risk zone.** Lake County is affluent overall, yet a cluster of tracts meets bottom-quartile statewide need with high confidence, while nearby tracts fall into an MOE-sensitive band where classification is not statistically stable.
- **The capstone output is a practical validation checklist.** The final “borderline risk” map isolates tracts where ACS MHI is most likely to **shift decisions**, signaling where secondary validation (administrative records, local surveys, program data, or neighborhood knowledge) should be required before using tract-level income as a standalone decision point.

Methodology & Attribution

Methods in brief:

Using 2022 ACS 5-year tract median household income estimates (B19013) for Lake County, margins of error at 90% confidence were converted into confidence intervals and coefficients of variation. Tracts were first mapped by MOE magnitude to flag high-uncertainty areas, then evaluated against (1) a county-median threshold and (2) the statewide bottom-quartile threshold. Tracts whose full confidence interval fell below or above a threshold were labeled high-confidence eligible or ineligible, while intervals crossing the threshold were labeled borderline/MOE-sensitive. Outputs were exported to QGIS for final cartography. Intervals shown are 90% ACS confidence intervals, computed as the tract MHI estimate plus/minus the published 90% MOE ($MOE = 1.645 \times \text{standard error}$).

Attribution / Data & Tools

This brief uses tract-level median household income estimates and associated 90% margins of error from the U.S. Census Bureau's American Community Survey (ACS) 5-year 2022 release, accessed via the Census API. Census tract and place boundaries were drawn from TIGER/Line shapefiles. Data processing, uncertainty calculations, and classification of high-uncertainty and MOE-sensitive tracts were completed in R using the `tidycensus`, `tidyverse` (`dplyr`, `ggplot2`, `readr`), `sf`, `tigris`, and `scales` packages. Cartography, labeling, and final figure layouts were produced in QGIS. Basemap context is provided by OpenStreetMap contributors under the Open Database License (ODbL).