Transit Access to Essential Services, 2013–2025: What Moved, the Network or the Destinations?

Sierra Arnold

Xavier University

Draft: September 11, 2026

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Abstract

A household that depends on public transit must reach not only jobs but the bank, the grocery store, the library, the clinic, and the community college. We construct a multi-service panel of neighborhood transit access designed to be differenced and decomposed: archived transit schedules for 52 U.S. metropolitan areas, routed on one fixed method every quarter from 2013 to 2025, with five administrative destination layers scored on the same block-group travel-time matrices as job access. Each service's within-neighborhood change splits exactly into a transit-network component and a destination component. The mechanisms differ sharply by service. Bank access fell 18.1 percent, driven by branch closures; library access fell 2.5 percent, driven almost entirely by the network; hospital access fell 3.4 percent, split between the two sides; grocery access roughly held (up 1.7 percent on the panel) as store growth raced network decline to a draw; community colleges were flat once record consolidations are not mistaken for closures. The bank and hospital declines survive metro-level clustering; the smaller changes describe these metros rather than a common national process. Deep losses compound: neighborhoods losing at least four of six services, jobs included, are five times as common as independent losses would imply, five or more twenty-eight times, and these neighborhoods are poorer, more carless, and more minority. The side of access that moves depends on the service, not on the era.

Keywords: accessibility; public transit; essential services; transport equity; GTFS; decomposition

1 Introduction

A household without a car reaches the bank, the grocery store, the library, the clinic, and the community college the same way it reaches work: on the transit network. Across this paper's metros, 7.1 million households have no vehicle (4.9 million outside New York; 7.6% of all panel-metro households). Nationally, about 8% of households lack a vehicle, and 19% of lower-income and 21% of Black adults seldom or never drive, against 3% of upper-income and 7% of White adults (Pew Research Center, 2024; U.S. Census Bureau, 2023). For these households the 45-minute transit set is not an abstraction but the practical choice set for daily life.

Where that set thins, consequences follow. Food insecurity worsens when transit contracts in food-desert neighborhoods (Arnold, 2025). Bank branches remain the delivery point for cash services and in-person banking even as consolidation removes a fifth of them (Adams and Sherlund, 2025). College-going is overwhelmingly local, most students enrolling near home, so a community without a reachable public college is an education desert (Hillman, 2016); and spatial access to care is the organizing concern of a large healthcare-access literature (Neutens, 2015; Buchalter et al., 2025). A neighborhood that loses several essentials at once is living the social-exclusion scenario the transport-poverty literature describes (Lucas, 2012), with the fewest private means of escaping it.

Over 2013–2025 both sides of that choice set moved: branch consolidation, supermarket churn and suburbanization, hospital openings and closures, and the pandemic's ridership collapse and service cuts on the networks themselves. So when a neighborhood's access to an essential service fell, which side moved: the network, or the destinations? The distinction matters for policy. A transit agency can do nothing about branch consolidation; a banking regulator can do nothing about a bus-network redesign. A measured access decline is actionable only once it is attributed, and no cross-sectional measurement can attribute it.

Accessibility research has overwhelmingly measured individual destination types in isolation, so relatively little is known about whether different essential services evolve in similar or fundamentally different ways over time. This paper asks exactly that. Using a harmonized longitudinal accessibility database, we compare six services across 52 U.S. metropolitan areas with identical measurement throughout: five essential services, plus job access as the anchor. The differenceable quarterly panel and the network-versus-destination decomposition come from the companion paper (Arnold, 2026); this paper applies that framework to a new question rather than redeveloping it. Three results organize it. Trends differ enormously by service: bank access fell 18.1% over the panel while grocery access rose 1.7%, libraries and community colleges in between. The mechanisms differ even more: an exact decomposition splits each service's change into its transit-network and destination parts, and the six services span the mechanism space, from destination-led collapse (banks) through a two-sided decline (hospitals) to pure network decline (libraries). Which side of access moves depends on the service rather than the era. And losses compound in the deep tail: neighborhoods losing four or more services are five times as common as independent losses would imply, five or more twenty-eight times, and the deep losers are poorer, more carless, more minority, and more central. The claims are descriptive throughout: access itself, not its downstream outcomes.

New York, whose scale and reversed gradients set it apart, is reported separately throughout and placed in national relief before the conclusion; robustness and validation exhibits sit in the appendix.

2 Related literature

Three strands intersect here. First, accessibility measurement: the cumulative-opportunity construct descends from Hansen (1959) and Wachs and Kumagai (1973), with the taxonomy and trade-offs surveyed by Handy and Niemeier (1997) and Geurs and van Wee (2004). The health-geography branch measures access to care with nearest-facility and floating-catchment constructs (Luo and Wang, 2003), and the primal/dual distinction is formalized by Cui and Levinson (2020). Longitudinal measurement exists for jobs: the *Access Across America* series scores transit access to employment annually across roughly fifty metros (Owen et al., 2025), and Foth et al. (2013) track access against social need across two census years in Toronto. Boisjoly and El-Geneidy (2016) find that a constant morning-peak measure is representative of relative accessibility across the day, supporting our fixed departure-time convention, while Farber et al. (2014) document meaningful within-day variability for transit access to supermarkets specifically; we hold the departure time fixed across the panel rather than resolving that question. Published schedule data also support equity assessment directly: Karner (2018) builds route-level accessibility measures from public feeds to evaluate transit service equity. These established repeated measurement; none differences cleanly over a long panel or attributes changes to their sources. Multi-service measurement also exists: the TransitCenter Equity Dashboard (Klumpenhouwer et al., 2021) tracks routed transit access to healthcare and groceries in seven regions from 2020 on, and Li et al. (2022) compute one-date 2SFCA indices for several point-of-interest classes in five cities.

Second, the components of access. The conceptual split of access change into transport and land-use parts is in Geurs and van Wee (2004); longitudinal decompositions exist for European road accessibility (Stępniak and Rosik, 2018; Rosik et al., 2025), and Zhang et al.

(2026) decompose a longitudinal block-group transit panel into network and sorting components for New York alone. In the U.S., Janatabadi and Ermagun established a framework for untangling the place and mobility components of access at a point in time: holding destinations counterfactually uniform isolates the contribution of transit service to spatial inequality. They apply it to employment access in the Washington and Chicago regions (Janatabadi and Ermagun, 2024a,b). In our terms, their "mobility" or "transit service" side is the network component and their "place" or "land use" side the destination component. Ermagun and Witlox (2024) established metro-scale comparison across fifty MSAs, and Ermagun et al. (2025) established fine-grained, time-denominated (nearest-destination) access to six destination types across Chicago, showing that which service binds varies sharply across neighborhoods. Their finding that inequality indices are sensitive to the travel-time budget (Janatabadi and Ermagun, 2024b) is one reason we report the full 15/30/45/60-minute curve.

Third, the service-domain literatures, each with its own convention. For banking, Adams and Sherlund (2025) measure block-level *distance to the nearest branch* through the consolidation decade and find it moved little; our count-based transit measure falls 18%, and Section 5.1 reconciles the two. For healthcare, Neutens (2015) reviews the accessibility tradition for transport geographers and Buchalter et al. (2025) build a multi-modal composite across 56 provider classes in which transit enters only as a commute-share weight and the networks are static. Food access has the USDA food-desert apparatus (Ver Ploeg et al., 2009) and a transit-specific line measuring supermarket access as it varies over the day within a city (Widener et al., 2015; Farber et al., 2014); education has car-based "education deserts" (Hillman, 2016); libraries are benchmarked by average distance to the nearest outlet (Donnelly, 2015); and on the transit side Jomehpour Chahar Aman and Smith-Colin (2020) identify transit deserts by overlaying transit supply on transit-dependent demand. We depart from these nearest-based conventions (Section 4) and report nearest-facility levels as context. The motivating frame throughout is the transport-poverty and social-exclusion tradition (Lucas, 2012; Pereira et al., 2017) rather than spatial mismatch, with Martens (2012) supplying its normative reading: accessibility is the transport good whose distribution is at stake, which is the frame in which losing several essentials at once, not any single service, is the quantity of interest. The equity questions of Section 6.2 follow the U.S. nonwork-accessibility line of Grengs (2015) and the activity-participation reading of transport poverty in Allen and Farber (2020).

This paper adds three things to those literatures. To longitudinal measurement, a differencing design: one fixed method over a 2013–2025 archive, corrected for archive-coverage changes, on which none of the repeated measures above can be differenced. To the components literature, attribution of *change* rather than of levels, at metropolitan scale. And to the service-domain literatures, the cross-service object: six services measured identically, so that the overlap of losses, invisible to any single-domain study, becomes measurable.

3 Data

3.1 Travel-time matrices (shared infrastructure)

The routing panel is inherited unchanged from Arnold (2026): archived GTFS schedules for every covered metro, one sample date per quarter, routed door-to-door between 2020-vintage census block-group centroids on OpenStreetMap networks with R5 (Conway et al., 2018). Departures span the 7:00–9:00 morning-peak window, and each pair's value is the median door-to-door time over departures within it: the initial walk, waiting, in-vehicle time, transfers, and the final walk. All routing parameters are engine defaults, held fixed across metros and quarters. Centroid-to-centroid routing coarsens times in large peripheral block groups; the centroids are fixed, so that error is time-invariant and nets out of within-neighborhood change. The archive spans 2013–2025; because the 2013 quarters serve only to date archive regimes, every quoted change runs 2014–2025 (48 quarters). Feed-quality flags (outage and thin-feed quarters) carry over; flagged cells are excluded from value exhibits, with flags-included companions beside each result. The balanced panel covers 52 metros outside New York, described in Section 3.3 and rostered in Appendix Table A.8; New York is reported separately throughout because its gradients differ qualitatively (Section 7).

3.2 Destination layers

Each service comes from a public administrative census of facilities, geocoded and aggregated to 2020 block groups, held constant within calendar years so that sub-annual access movement is network-driven by construction. Table 1 summarizes.

Four definitional choices deserve note, each responding to a measured artifact in the raw administrative categories. *Banks*: the lead counts full-service offices (96.7% of all offices), a variant indistinguishable in trend from all offices. *Groceries*: the lead is full-line food retail (supermarkets, superstores, large grocery stores), the USDA food-desert family; all SNAP-authorized retailers, including convenience and dollar stores, form an upper-bound variant (Section 5.3). *Community colleges*: two artifacts push the same way. IPEDS sector codes reclassify community colleges that begin awarding bachelor's degrees (140 of 1,047 accredited institutions between 2013 and 2024, against only 64 true exits), and consolidations collapse multi-campus systems into single records while the campuses keep operating. The

Table 1: Destination layers.

Service	Source	Definition (lead)	2013/14	2024/25
Bank branches	FDIC Summary of Deposits	full-service branches	96,340	76,120
Libraries	IMLS Public Library Survey	stationary outlets (CE+BR)	16,888	16,875
Groceries	USDA SNAP retailer history	supermarkets, superstores, large grocery stores	42,034	44,027
Community colleges	NCES IPEDS	persistent-campus public 2-year	1,038	1,065
Hospitals	CMS Provider of Services (Dec. vintages)	durable general acute care (geocoded; 91% coverage)	4,726	4,383

National counts are totals over all fifty states; the covered metros hold 35–55% of each layer's national facilities (banks 51%, libraries 38%, groceries 55%, community colleges 36%, hospitals 35%, in 2023).

lead therefore assigns each institution a persistent identity and carries a consolidated system's campuses forward on IPEDS's own merger crosswalk (53 campuses across 22 systems), leaving the national campus count essentially flat, 1,038 to 1,065; Section 5.4 quantifies what the raw categories would have manufactured. *Hospitals*: CMS certified hundreds of temporary facilities during the pandemic (264 new general-acute certifications in 2020 alone, most gone within two vintages), so the lead counts *durable* facilities: certifications active in at least three consecutive December vintages, with facilities present in 2013 and 2024–25 entrants retained (censoring grace at both edges); 184 of 8,440 certifications are excluded as transient, 125 of them first seen in 2020–21. The healthcare object is hospitals because no public site-level history of community health centers exists before 2021. Hospital addresses resolve to coordinates at 91% per year, against ≥98–99% for the storefront services; the ungeocoded set is persistent rather than churning, so within-neighborhood trends compare the same facilities over time and levels are understated by roughly the coverage gap (Appendix Table A.7). We audit every service's classification codes and reporting units for these artifacts; groceries' re-typing flows are small and symmetric, and banks' and libraries' codes are stable within facility. The grocery and library layers reconcile against independent counts, and the weakest layer holds up best: hospital counts correlate at 0.997 with the independent HIFLD facility layer, its 0.90 median ratio matching the 91% geocode coverage almost exactly (Appendix Table A.6). The national totals in Table 1 bound the coverage question from the destination side: over the window the national layers moved −21% (branches), −0.1% (outlets), +4.7% (full-line stores), +2.6% (campuses), and −7.3% (durable hospitals), the same directions as the covered metros' scale components, so destination trends are not artifacts of metro coverage.

3.3 How representative are the 52 metros?

The balanced panel is the set of metros whose archived schedules support routing in at least 36 of the 48 quarters from 2014 through 2025. That is a property of archive coverage, not of the metros themselves. The 52 balanced metros outside New York hold roughly 45% of U.S. metropolitan population and include 30 of the 50 largest metros. The routed panels cover 96 metros in all; 92 of them retain merged census demographic attributes and enter the analysis, and the unbalanced analysis panel spans those 92 metros (189 million residents; Table S1 of the online supplement). Several legacy-transit metros are absent or compromised because their agencies' schedules were not archived: San Francisco, Minneapolis, and Detroit are missing; Baltimore falls below the balance bar; Riverside–San Bernardino, Jacksonville, Palm Bay, and Fairbanks are routed but lack merged census attributes (an inherited attribute-pull gap; supplement Table S1); Washington, DC is present but its Metrorail feed is missing throughout, so its routed access is understated and we read that metro with caution; excluding it changes neither trajectory that survives metro clustering (banks −18.1% unchanged, hospitals −3.4% to −3.3%, identical intervals; Appendix Table A.6). Archive coverage favors larger, better-archived agencies. We therefore read the results as describing transit access in these metros, not in the average U.S. metropolitan area.

4 Measuring access and decomposing its change

4.1 Access measure

Access for block group i, service s, quarter t is the count of s-facilities reachable from i within τ minutes by transit and walking, with $\tau = 45$ as the primary budget; the full 15/30/45/60 curve is in Appendix Table A.4, where every trajectory deepens monotonically with the budget and the 45-minute column reproduces the estimates reported here. One construct serves as both trajectory and decomposition object for every service, which is what makes the cross-service comparison possible on the reported measure itself; the domain conventions are carried as robustness variants. Construct families are correlated near 0.9 once calibrated to a common budget (Santana Palacios and El-Geneidy, 2022), and no variant reverses any service's trajectory sign (Appendix Table A.5).

Departure timing deserves its own statement, because it is the one convention this measure cannot vary. Access is routed in the morning peak, while errands to banks, libraries, groceries, and clinics are spread across the day, and transit accessibility to such destinations varies within it (Farber et al., 2014; Widener et al., 2015). The direction of the resulting bias is not neutral. Agencies facing the post-2020 revenue shock generally protected peak-period commuter service and cut midday and evening frequency more deeply, so a peak-departure measure records the smaller of the two declines. The network components reported here are therefore best read as a conservative floor on the network's contribution for these services, and the same logic applies to the group differences of Section 6.2, since off-peak service supports precisely the trips the transit-dependent make.

All trend estimates are within-neighborhood: we regress log access (plus one) on quarter effects with block-group-by-archive-regime fixed effects, block-group population weights (the fixed 2018–22 ACS vintage, constant over the panel), and standard errors clustered by block group. Composition changes and archive-coverage regime changes therefore do not masquerade as access changes. Quoted endpoints compare the 2025 annual mean of quarter effects to the 2014 annual base, and seasonality is small (Appendix Table A.6).

4.2 Decomposition

For each metro we fix the base network b (the first unflagged 2014 quarter) and base destination vector (2014), and compute access under all four combinations of network era and destination vintage. The observed within-neighborhood log change splits exactly and symmetrically (a two-factor Shapley decomposition):

$$\underbrace{\ln A(n_t, d_t) - \ln A(n_b, d_b)}_{\text{observed}} = \underbrace{\tfrac{1}{2}\big[\Delta_n \mid d_b\big] + \tfrac{1}{2}\big[\Delta_n \mid d_t\big]}_{\text{network}} + \underbrace{\tfrac{1}{2}\big[\Delta_d \mid n_b\big] + \tfrac{1}{2}\big[\Delta_d \mid n_t\big]}_{\text{destination}}, \qquad (1)$$

with the destination part further split into a geometry-free *scale* term and a residual *relocation* term. Scale for metro m in year y is $\ln(T_{my}/T_{m,2014})$, the log change in the metro's total facility count on the fixed block-group universe. Relocation is the destination component minus scale: the part of the destination effect attributable to *where* facilities sit relative to the network rather than how many exist. The term is broader than facilities physically moving; it captures differential closure and entry by location, and Section 5.1 interprets it that way. The jobs anchor used throughout is the companion paper's layer under the identical specification: LODES workplace employment (all jobs), scored on the same matrices, decomposed by the same split (Arnold, 2026). Block-group changes are computed first, population-weighted averages second, and the interaction is allocated symmetrically (Shorrocks, 2013). Archive-regime jumps and the sample rule are described in Appendix A. Corrected series carry every result; because archive entry almost always adds coverage, the uncorrected series is a diagnostic upper bound. Excluding the flagged metros moves levels but not mechanisms: component splits on the wide canonical set are nearly identical to the core's (Appendix Figure A.2). All logs are $\ln(A + 1)$, so zero counts enter at zero and proportional changes are compressed for sparse services.

5 The evolution of access, service by service

Unless noted, every result below is the cumulative 45-minute count, population-weighted, within-block-group, archive-entry corrected, and quoted as the 2025 annual mean against the 2014 annual base. *Trajectories* run on *the panel*, *decompositions* on *the clean-archive core*, with the wide-canonical companion reported beside every core decomposition; both samples are defined in Appendix A, and every exhibit names its own (Appendix Table A.3). The two constructions can differ where flagged metros differ from clean ones, and we flag each such divergence where it occurs. Inference is two-level: the block-group-clustered intervals quoted throughout describe the panel, while the metro-clustered intervals reported with each trajectory gate any claim about a common national process.

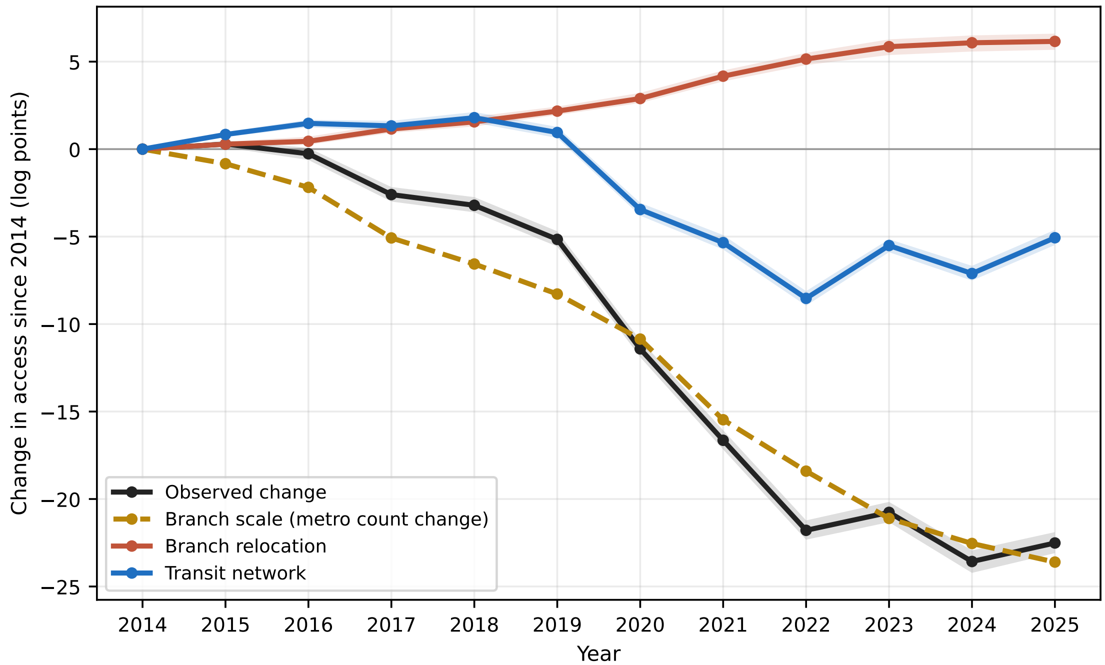
5.1 Banks

Banks are the destination-driven service. Figure 1 decomposes the decade: at the 2025 endpoint the observed −22.5 log-point change splits into −5.1 network, −23.6 branch scale, and +6.2 relocation (full-canonical companion: $-18.5 = -3.8 - 19.9 + 5.2$; the mechanism split is the same, the level deeper in the clean-archive metros). The branch-closure wave, not transit change, removed roughly a fifth of reachable branches from the typical neighborhood's 45-minute set, and the observed line tracks the branch-count line almost exactly.

The *positive* relocation term needs care: it does not mean closures avoided accessible places. At the branch level, closure rates were mildly *higher* in the most transit-accessible quartile of 2014 locations than in the least (35.5% against 31.0%, a 4.5-point difference with a 0.8-point standard error; Table 2). The term instead records redundancy geometry. Accessible areas hold deep branch stocks, so a closure there removes one branch from a large choice set, while in thin areas a single closure can empty the 45-minute set; net destination change therefore harmed access less than a uniform decline of equal size would have, which is what a positive relocation term measures.

In trajectory terms, transit access to full-service branches fell **18.1%** [95% CI: −18.6, −17.6] between the 2014 and 2025 annual means (flags included: −16.1%; all offices: −18.4%; NYC included: −18.7%). The decline survives metro clustering ([−22.5, −13.3]). The decomposition reconciles our finding with Adams and Sherlund (2025), who report distance to the *nearest* branch barely moved over the same era: the nearest branch survives (their result, and our relocation term) while the choice set collapses (our count). The two constructs

Figure 1: Decomposition of 45-minute transit access to bank branches, 2014–2025.



Clean-archive core (28,147 block groups), population-weighted, archive-entry corrected; annual points vs. the 2014 base; shaded bands are 95% block-group-bootstrap intervals; components sum to the observed change.

measure different things, and the decomposition explains why they diverge.

Table 2: Branch closures by 2014 access quartile.

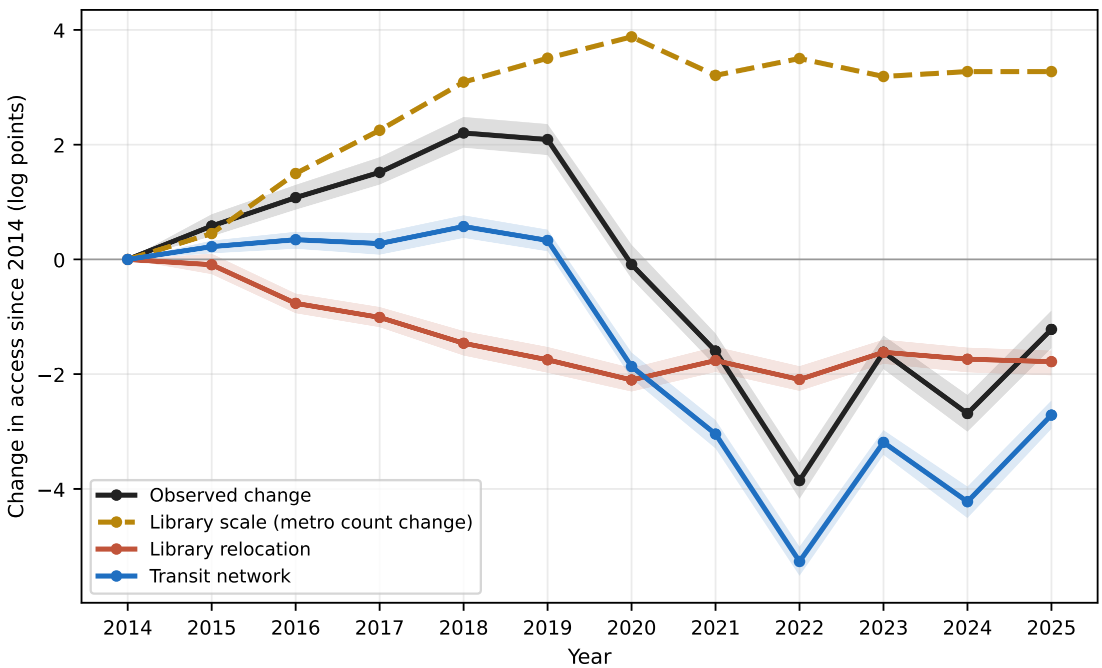
2014 branch location	Branches	Closed by 2025
Q1 (least transit access)	7,191	31.0%
Q2	7,191	31.4%
Q3	7,190	31.3%
Q4 (most transit access)	7,191	35.5%

Full-service branches active in 2014 within the panel's block groups, quartiles of the location's 2014 45-minute transit count, and the share closed by 2025.

5.2 Libraries

Libraries are the pure network-driven service, the mirror image of banks. In Figure 2 the observed line rides the network line for the whole decade: observed -1.2 splits into -2.7 network, $+3.3$ scale, and -1.8 relocation (full-canonical companion: $-1.7 = -2.5 + 1.9 - 1.1$). The national library network barely moved (16,888 to 16,875 stationary outlets); the access decline is almost entirely the transit network, with the 2022 trough (-5.3 log points) and partial recovery visible in the network component. An access measure without the decomposition would be silent on this, and a library-policy reading of the decline would be wrong.

Figure 2: Decomposition of 45-minute transit access to library outlets, 2014–2025.



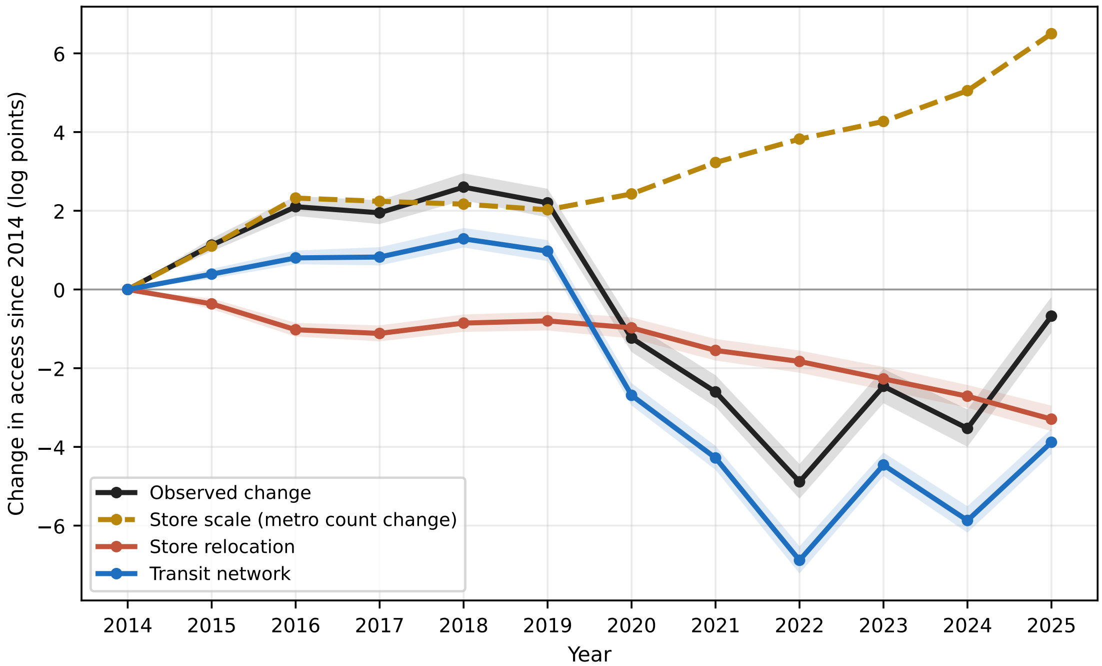
Clean-archive core (28,147 block groups), population-weighted, archive-entry corrected; annual points vs. the 2014 base; shaded bands are 95% block-group-bootstrap intervals; components sum to the observed change.

In trajectory terms, transit access to stationary outlets fell **2.5%** [−2.8, −2.2] (flags included: −1.0%; with bookmobiles: identical; NYC included: −3.0%). The trajectory spans zero under metro clustering ([−5.1, +0.1]), and its uncorrected upper bound is positive (Appendix A); the robust content of this section is the network-led *mechanism*, not the magnitude.

5.3 Groceries

Groceries are the service where destinations race the network and their own geography: a third mechanism. In Figure 3 the store-scale component grows steadily (+6.5 in the clean-metro sample; +8.4 in the full-canonical companion) while the network declines and new stores open disproportionately in transit-poor locations (the suburbanization of supermarkets). The race's outcome is the one result in this paper that depends on the sample: the full-canonical observed change is +1.5 ($= -3.1 + 8.4 - 3.8$), while in the clean-archive metros it is −0.7 ($= -3.9 + 6.5 - 3.3$), where the network fell harder. The mechanism, not the sign, is the robust fact.

Figure 3: Decomposition of 45-minute transit access to full-line grocery stores, 2014–2025.



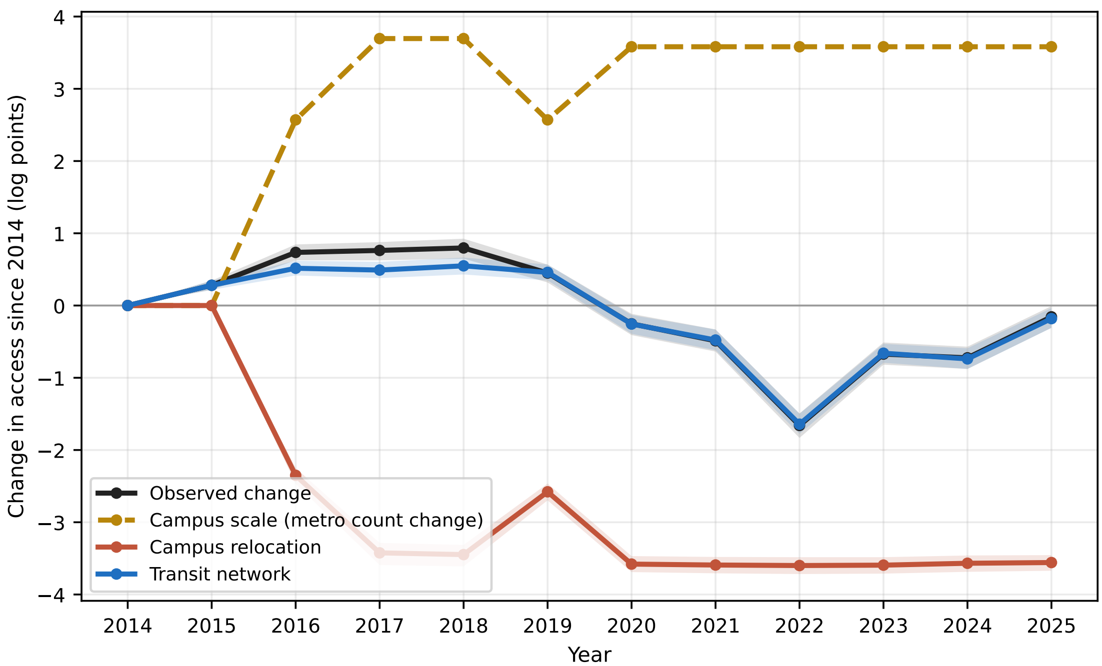
Clean-archive core (28,147 block groups), population-weighted, archive-entry corrected; annual points vs. the 2014 base; shaded bands are 95% block-group-bootstrap intervals; components sum to the observed change.

In trajectory terms, on the full balanced panel, transit access to full-line grocery stores *rose* **1.7%** [+1.3, +2.2] (flags included: +3.8%; NYC included: +1.4%); groceries remain the only service whose panel-wide trajectory rises, though the rise spans zero under metro clustering ([−2.7, +6.4]). The all-SNAP upper bound is flat (−0.2%), so the gain is specific to full-line stores: composition within food retail, not growth of SNAP retail generally.

5.4 Community colleges

Community colleges are the quiet service: near-zero net change with modest offsetting destination components. In Figure 4 the observed −0.2 splits into −0.2 network, +3.6 campus scale, and −3.6 relocation (full-canonical companion: $-0.4 = -0.4 + 1.8 - 1.8$). This section's numbers use the persistent-*campus* definition (Section 3); under the raw reporting-unit count the scale and relocation terms balloon to ∓ 11, an artifact of multi-campus systems consolidating into single records, and we quantify that cascade below.

Figure 4: Decomposition of 45-minute transit access to community-college campuses, 2014–2025.



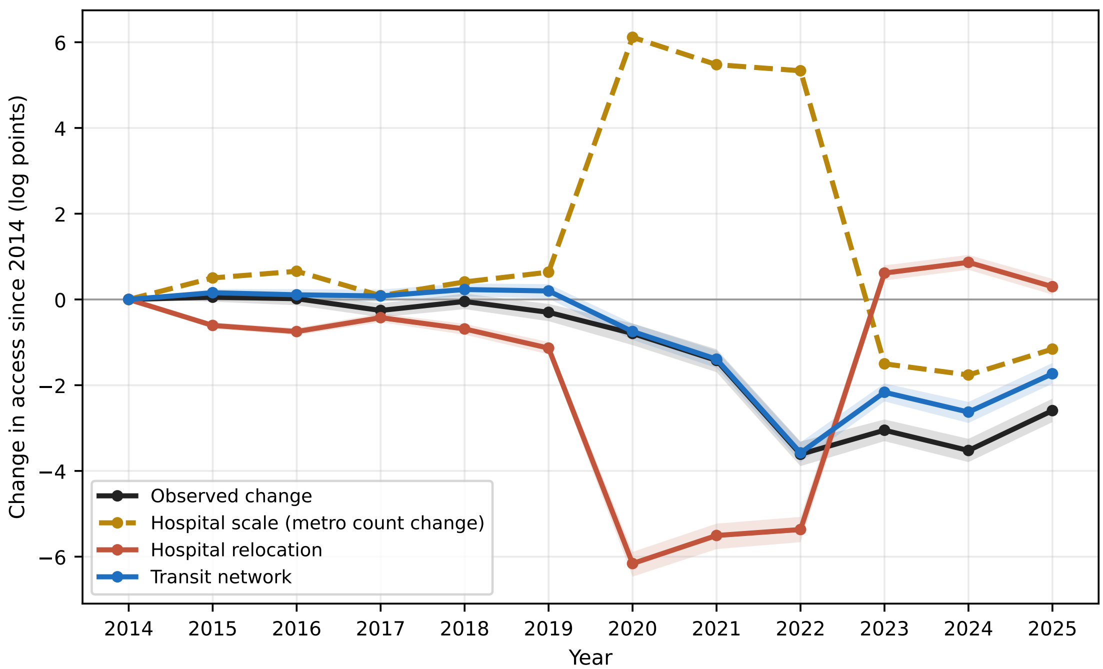
Clean-archive core (28,147 block groups), population-weighted, archive-entry corrected; annual points vs. the 2014 base; shaded bands are 95% block-group-bootstrap intervals; components sum to the observed change. Persistent-campus definition.

In trajectory terms, transit access to community-college campuses was nearly flat: −0.4% [−0.6, −0.3] (flags included: +0.3%; NYC included: −0.5%; spanning zero under metro clustering, [−1.6, +0.7]). The definitional cascade inside the same specification: the persistent-identity companion (records, not campuses) gives −0.6%, and the annual-sector-code count gives −2.2%; each step toward raw administrative categories manufactures more phantom decline. Eleven small metros with no community college in some panel year cannot be log-decomposed for this service (1.7% of the full panel's observations); all sit outside both named samples, so no exhibit here is affected. Community colleges are also the sparsest service: 87% of block-group-quarters reach zero campuses within 45 minutes, so level exhibits for this service lean on the coverage and nearest-time variants (Appendix Table A.5). IPEDS campus identifiers also undercount branch campuses.

5.5 Hospitals

Hospitals sit between the mechanisms, and where they sit depends on the metros. In the clean-archive sample the network carries about two-thirds of the observed −2.6: −1.7 network against a net destination side of −0.9 (−1.2 hospital scale, +0.3 relocation; Figure 5). In the full-canonical companion the banks anatomy reappears in milder form ($-3.3 = -1.5 - 4.8 + 3.0$): hospital counts fell where people are, offset by the transit-favorable location of surviving facilities. Hospitals are the one service whose destination side is quiet in the clean metros and active in the full panel; both samples agree the total decline is moderate. The mirror-image scale and relocation swings over 2020–23 in Figure 5 are the pandemic certification cohort entering and leaving the durable set; the observed line moves little because the two components offset.

Figure 5: Decomposition of 45-minute transit access to durable general acute hospitals, 2014–2025.



Clean-archive core (28,147 block groups), population-weighted, archive-entry corrected; annual points vs. the 2014 base; shaded bands are 95% block-group-bootstrap intervals; components sum to the observed change.

In trajectory terms, transit access to durable general acute care hospitals (short-term acute plus critical access; the lead definition) fell **3.4%** [−3.6, −3.1], surviving metro clustering ([−5.2, −1.5]); all durable hospitals including psychiatric, rehabilitation, and long-term care: −3.7% [−4.0, −3.3]; the all-certification variant is indistinguishable at the endpoints and differs only in the 2020–22 path. Hospitals are sparse: the trajectory describes the roughly one quarter of residents who reach any durable hospital within 45 minutes, with the coverage and nearest-facility variants carrying the rest (Appendix Table A.5).

6 Synthesis: mechanisms, incidence, and compounding disadvantage

6.1 One decomposition, six services

Table 3 assembles the endpoint decompositions on one scale (log points vs. the 2014 base; components sum exactly to observed in every row). The six service rows span the mechanism space, with jobs as the anchor: destination-led growth (jobs), destination-led collapse with transit-favorable relocation (banks), pure network decline (libraries), destination growth against network decline and adverse relocation (groceries), near-stasis (community colleges), and a moderate decline split between both sides, with the balance depending on the sample (hospitals). The dispersion *within columns* is the paper's central fact: on the core sample the network column runs from −0.2 to −6.4, while the destination columns range from −23.6 to +15.9, and the full-canonical companion preserves the same dispersion (Table A.2). Which side of access moves—the network or the destinations—is a property of the service, not of the era.

The thesis survives splitting the panel at the pandemic, and the split is sharp. Over 2014–2019 the network component sits between −0.1 and +1.0 log points for every service while the destination columns already differ by service (bank scale −8.3, grocery scale +2.0, jobs scale +10.5). Over 2019–2025 the network column turns uniformly negative (−0.6 to −6.3) while the same service-specific destination signatures persist (banks −15.3, groceries +4.5). The era moves every service's network together; the service determines the destination side in both eras.

Table 3: Cross-service endpoint decomposition.

Service	Observed	Network	Destination scale	Relocation
Jobs (anchor)	+15.2	−6.4	+15.9	+5.7
Bank branches	−22.5	−5.1	−23.6	+6.2
Public libraries	−1.2	−2.7	+3.3	−1.8
Groceries (full-line)	−0.7	−3.9	+6.5	−3.3
Community colleges	−0.2	−0.2	+3.6	−3.6
Durable general acute hospitals	−2.6	−1.7	−1.2	+0.3

2025 vs. 2014 annual average; never-flagged harmonized sample outside New York; all entries in log points ×100, so the banks observed −22.5 corresponds to −20.1 percent. Components sum to observed; block-group bootstrap 95% CIs for observed, network, and relocation are within ±0.8 of the point estimates shown. Appendix A reports the full-canonical companion for every row. The jobs row is the companion paper's decomposition re-issued under the same sample rule (Arnold, 2026).

6.2 Who has access, and who lost it

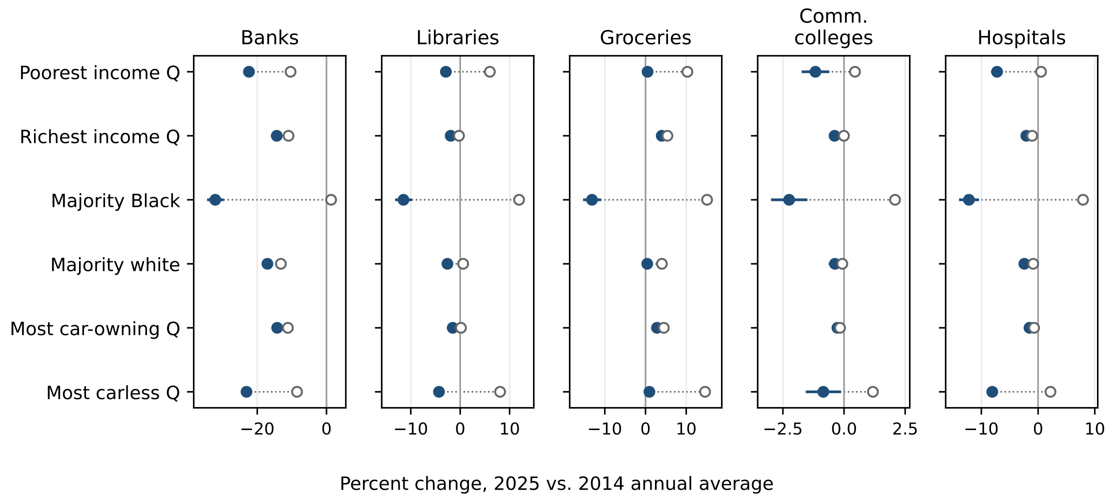
Demographic attributes throughout are the fixed 2018–22 five-year ACS vintage; level exhibits are quoted for 2023, the last year fully inside that window. Majority-race classes are population-share majorities; income quartiles are the inherited ACS block-group quartiles; carless quartiles are block-group quartiles of the carless-household share.

Levels. Outside New York, transit access to every essential service is higher in poor, majority-Black, and carless neighborhoods than in rich, white, car-owning ones: 2023 richest-to-poorest income-quartile ratios run 0.35–0.53 across the six services, white-to-Black majority-neighborhood ratios 0.35–0.56, and the most carless quartile of neighborhoods holds five to nine times the access of the most car-owning, depending on the service. This is the central-city geometry of American transit, and it means the households most dependent on these services start from the strongest access positions.

Change. Over 2014–2025 that advantage eroded regressively. Under the conservative (corrected) treatment, the largest access declines fall on majority-Black neighborhoods in every service (banks −32% against −17% in majority-white neighborhoods; libraries −11.5% against −2.6%; groceries −13.2% against +0.4%; hospitals −12.2% against −2.4%). They also fall on the poorest and most carless quartiles relative to the richest and most car-owning in nearly all services. Each quoted figure is the conservative side of the corrected/uncorrected bracket displayed in Figure 6. The characterizations replicate almost exactly under beginning-of-period (2009–13) classifications (majority-Black bank change −32.3% against majority-white −17.3%; Appendix Table A.6), so the incidence does not depend on who moved in after access changed. The neighborhoods that started with the most to lose lost the most.

A measurement finding attaches to the equity finding. For advantaged groups the corrected and uncorrected estimates nearly coincide: the largest divergence anywhere is 3.9 points (majority-white banks). For disadvantaged groups they diverge by up to 33 points (majority-Black banks: −32 to +1). Archive coverage changes concentrate in the agencies serving disadvantaged areas, so the group *differences* are sensitive to the archive-entry correction treatment in a way the aggregate results are not. The width of that bracket is traceable to a single metro's archive entry, and the corrected series is the one stable to it (Appendix Table A.6). We therefore quote group-level changes as bounds, read the conservative side as the incidence estimate, and treat the asymmetry as a finding in its own right: the neighborhoods whose access history is hardest to measure are the disadvantaged ones.

Figure 6: Access change by neighborhood group and service, corrected and uncorrected.



Percent change in the 45-minute count, 2025 vs. the 2014 base; the panel (52 metros ex-NYC), population-weighted, flagged cells excluded; filled = corrected with 95% block-group-clustered CIs, open = uncorrected upper bound; panel x-scales differ by service.

6.3 Compounding disadvantage

Do the same neighborhoods sit on the losing side of several services at once? We call a neighborhood a loser of service s if its within-neighborhood corrected access change from the 2014 base to 2025 is -5 log points or worse. We then compare multi-service loss rates to the benchmark in which each service's losses (at their observed marginal rates) strike independently. The exercise runs on the clean-archive core; on the panel's full canonical set the corresponding multipliers are $\times 5.2$ and $\times 27$, within a few percent of those below. Shares and multipliers count block groups unweighted. Loss marginals differ widely by service (banks 57%, jobs 31%, groceries 29%, libraries 18%, hospitals 12%, community colleges 3%), which the benchmark respects.

The result is the deep-tail escalation of Table 4: broad co-loss sits at or below independence, and the multiplier escalates from $\times 1.6$ at three services to $\times 28$ at five or more. The escalation survives five re-benchmarks, each aimed at a different artifact: (i) within network-loss strata, which absorbs the network component every service shares in a neighborhood, ≥ 4 holds at $\times 4.7$ and ≥ 5 at $\times 11$; (ii) against each metro's own loss marginals, which absorbs between-metro composition, $\times 3.5$ and $\times 13$, and jointly within metro-by-stratum cells $\times 6.5$ and $\times 42$, so the two artifacts do not combine to produce the escalation; (iii) under population weighting, $\times 6.5$ and $\times 40$; (iv) dropping community colleges (the sparsest layer) or jobs entirely leaves the pattern intact (at ≥ 4 and ≥ 5 of the remaining five services: $\times 5.8/\times 37$ without community colleges, $\times 12/\times 58$ without jobs); (v) dropping the three tail metros entirely (Seattle, Chicago, Denver), the escalation sharpens to ×8.7 and ×62, so the deep tail does not carry the broader pattern. The residual multiplier can still reflect sub-metro clustering of destination shocks, a declining commercial district taking several services with it: compounding of a different kind with the same lived consequence. Metro-clustered intervals are percentile bootstraps over metros (500 draws); network-loss strata are quintiles of the neighborhood's mean network component across the six services.

Table 4: Multi-service loss against the independence benchmark.

Services lost	Observed	Indep.	Mult.	Metro 95% CI	Within strata	Within metro
$\geq$ 2 of 6	39.6%	47.0%	×0.84	—	—	—
$\geq$ 3 of 6	22.9%	14.6%	×1.6	—	—	—
$\geq$ 4 of 6	12.3%	2.33%	×5.3	[3.6, 9.0]	×4.7	×3.5
$\geq$ 5 of 6	4.68%	0.165%	×28.4	[15.2, 64.7]	×11.2	×12.9
All six	0.457%	0.0034%	×134	[60.5, 478.9]	×0.3	×40.1

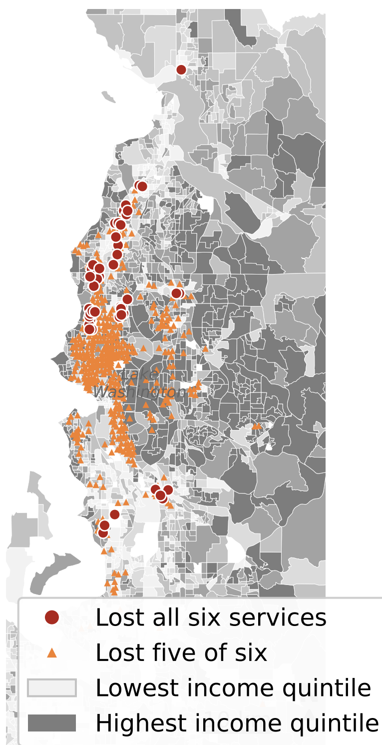
Clean-archive core. Losses: corrected 2014–2025 change ≤ -5 log points. Strata = quintiles of the neighborhood mean network component; within-metro = each metro's own loss marginals. Metro-clustered intervals and conditional multipliers are computed for the deep thresholds (≥ 4) only.

The extreme tail behaves differently and diagnostically: the 129 neighborhoods (0.46%) that lost *all six* services are ×134 over independence unconditionally, but that multiplier vanishes within network strata, and 71% of these neighborhoods sit in just three metros (Seattle, Chicago, Denver); in the full-canonical companion the tail concentrates in a trio led by Boston and Philadelphia, with the identical vanishing-within-strata diagnosis. Losing everything at once is the signature of localized network collapse, one shock taking every essential with it, rather than of destinations independently abandoning the same places. The network reading has an external check: across the 19 core metros, the banks network component correlates at $r = 0.59$ with the change in NTD vehicle revenue miles, both sides restricted to the same metros (Appendix Table A.6). In Seattle, revenue miles rose while measured 45-minute reach fell steeply, a restructuring of connectivity rather than a shrinkage of total service; the agency record matches, with one-seat bus routes deleted, truncated, or converted to rail feeders at the 2021 and 2024 Link openings (King County Metro, 2024). In Denver the two move together. The pattern strengthens under a stricter −10 log-point definition and appears in absolute-threshold form as well: entering three or more of the bank, library, grocery, and hospital "deserts" simultaneously (from positive 2014 access to zero in 2025) is 8.3 times the independence benchmark, though it affects only 0.10% of neighborhoods.

Who are the multi-losers? Moving from neighborhoods losing no service to those losing all six: the low-income population share rises from .21 to .29, the carless household share from .04 to .12, the Black population share from .06 to .13, majority-minority status from 33%

to 45%, and median household income falls from \$106,000 to \$88,000; distance to the metro core falls from 32 to 18 km. The gradient runs monotone through four services lost, flattens in the thin extreme tail, and replicates under beginning-of-period (2009–13) classifications (low-income share .25 to .39, carless .04 to .13, median income \$75,000 to \$54,000). Deep multi-service loss concentrates in poor, carless, minority, relatively central neighborhoods: precisely the transit-dependent population. *Broad* co-loss is approximately at independence; *deep* co-loss is massively over-concentrated and demographically loaded. Figure 7 shows the deep tail on the ground in Seattle, the largest single site of the all-six tail. The deep losers line the low-income transit corridor from Everett through Seattle to Tacoma, and the contrast across Lake Washington carries the incidence finding in miniature: 24.7% of block groups west of the lake lost five or more services, against 4.8% east of it, with data covering every block group on both sides. The corridor's breadth is the mechanism at work: one network shock takes many services at once, and it lands on the neighborhoods with the least income and the fewest cars.

Figure 7: Neighborhoods losing five or six services, Seattle metro.



Income quintile shading (2018–22 ACS; darker = higher income); orange = lost five of six services (452 block groups); dark red = lost all six (48); losses = corrected 2014–2025 change ≤ -5 log points; all 2,733 canonical block groups covered (the metro routes 2,734; one lacks canonical status).

7 New York: the exception

New York is excluded from both named samples and reported here instead. Four facts justify the treatment; all NYC decompositions are uncorrected (the correction is unidentified for a single metro) and stated as such.

Scale. New York contributes 14,472 canonical block groups, a quarter of the national decomposition sample, with population weight to match. Pooled person-weighted results would be statements about New York with a national garnish.

The destination movements are more extreme; the network is quieter. Because the archive-entry correction is unidentified for a single metro, the only like-for-like comparison sets New York's uncorrected changes against the clean-archive core's uncorrected changes (Table 5). The destination-driven services diverge sharply: New York's grocery access rose +10.1 log points against a national +1.0, and its hospital access fell −11.7 against −2.2. Libraries fell −2.6 against −0.4, and community colleges −0.8 against +0.1. Banks are the exception: −19.7 in New York against −20.6 nationally, comparable, because branch consolidation is national.

Table 5: New York against the nation, like-for-like.

Service	New York	Clean-archive core
Bank branches	−19.7	−20.6
Public libraries	−2.6	−0.4
Groceries (full-line)	+10.1	+1.0
Community colleges	−0.8	+0.1
Durable general acute hospitals	−11.7	−2.2

Uncorrected endpoint change in the 45-minute count, 2025 vs. the 2014 annual average, log points ×100; New York = 14,472 canonical block groups, nation = the clean-archive core; population-weighted.

The decompositions are more extreme. The bank decomposition sharpens the national pattern: the network contributes essentially nothing (+0.7), the branch decline is steeper (−28.3), and the transit-favorable relocation of surviving branches is larger (+7.9). The grocery gain is nearly all store growth (+12.1 scale against −2.0 relocation), and the library decline runs through location rather than the network (−2.0 relocation, network ≈ 0). In a metro where the routed network barely moved, destination geography does the work.

The gradients reverse. Outside New York, access *levels* favor poor and minority neighborhoods for every service (Section 6.2). New York flattens every gradient and reverses the race gradient's sign for jobs and banks (white/Black 1.08–1.12): majority-white neighborhoods reach more by transit there, the opposite of the rest of the country. Any pooled "who has access" exhibit would average two regimes with opposite signs.

8 Conclusion

Between 2013 and 2025, transit-dependent U.S. households saw their reachable set of essential services move in every direction at once, each service for its own mix of reasons. The attribution is the point: identical-looking access declines can be a transit story, a destination story, or both, and the policy response differs accordingly. And beneath the averages, a small, identifiable set of disadvantaged central neighborhoods lost deeply across the board. A cross-sectional access literature cannot see either fact; a differenceable panel sees both.

The limits of the measure bound these claims. It is potential access, silent on facility capacity, service quality, in-window frequency, and transfer burden; it is measured at the morning peak (Section 4) on an archive that favors larger agencies (Section 3.3); and destination vintages are annual, so within-year destination movement is invisible. In the two metro-years where service and archive coverage expanded together, the archive-entry correction may absorb some real gain, biasing corrected changes downward. All claims are descriptive; nothing here identifies the effect of access on outcomes.

For practice, the attribution assigns the work. Where the network component dominates (libraries; the collapse corridors), service restoration is the lever, and the map's corridor shows where restored service buys back several essentials at once. Where the destination side dominates (banks; hospitals in the wide sample), transit policy cannot reverse the trend, but siting policy can shape it: the positive relocation terms show that surviving facilities already lean toward transit-accessible locations, a margin that facility-siting standards and community-reinvestment review could use directly. And the deep-tail geography gives metropolitan planners a short, specific list: the neighborhoods losing many essentials at once are few, identifiable, and concentrated where transit dependence is highest.

Acknowledgements

This paper uses public data from the Federal Deposit Insurance Corporation (Summary of Deposits, via BankFind), the Institute of Museum and Library Services (Public Library Survey), the USDA Food and Nutrition Service (SNAP retailer history), the National Center for Education Statistics (IPEDS), the Centers for Medicare and Medicaid Services (Provider of Services files), the Department of Homeland Security (HIFLD), the Federal Transit Administration (National Transit Database), the U.S. Census Bureau (American Community Survey and TIGER products), OpenStreetMap contributors, and the transit agencies and archived-feed providers whose GTFS schedules underlie the travel-time panel. The travel-time matrices are shared with a companion paper by the same author on transit access to

jobs; the destination layers, the access panels, and all exhibits here are new.

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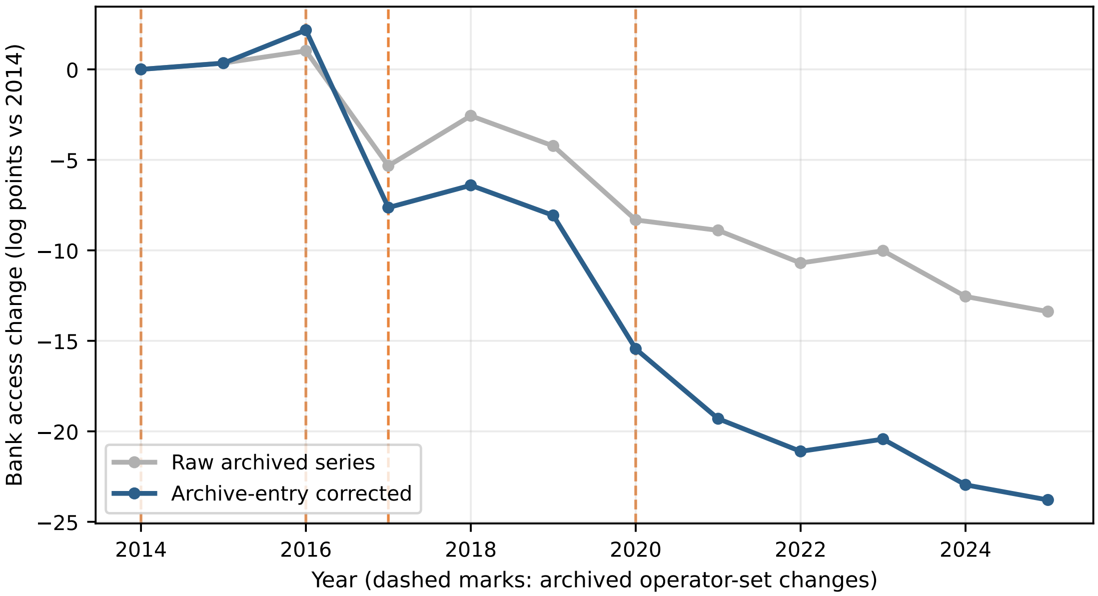
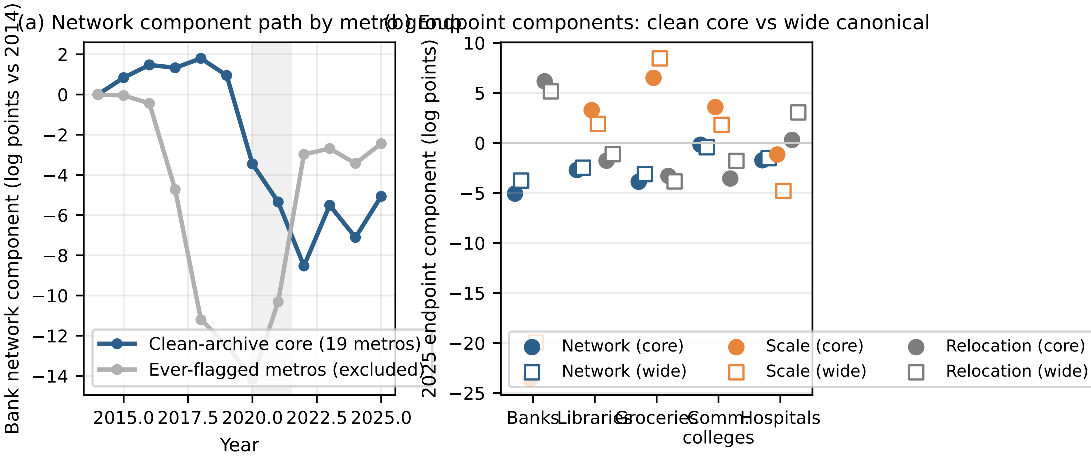
Appendix A Supporting exhibits

Figure A.1: The archive-entry correction in one metro (Cincinnati, bank access).



Raw and corrected series, log points vs. 2014; vertical marks = archived-operator-set changes; population-weighted canonical block groups. An archive regime is a maximal span of quarters over which a metro's set of archived feeds is stable; boundaries are dated from the companion panel's feed inventory (Arnold, 2026), and a metro has one to four regimes. For each series, each block group's cumulative cross-regime jump against its 2014 base is removed from the observed and network sides equally, preserving exact additivity. Corrections are nonzero for 2.7–7.7% of block-group years. Validation against agency-reported revenue miles is the archive-entry row of Table A.6.

Figure A.2: Component paths by sample.



(a) Banks network component, clean core vs. excluded metros; (b) destination components, clean core vs. wide canonical sample; population-weighted, corrected, log points vs. 2014. Sample definitions. *The panel*: the balanced core of 52 metros outside New York with at least 36 of 48 quarters routed; all trajectory and group-level estimates. *The clean-archive core*: the panel's canonical block groups (observed and unflagged in every year) in the 19 never-flagged metros, 28,147 block groups, constant by construction; the same rule defines the companion paper's re-issued jobs decomposition. The core holds 32.5% of the panel's population and skews toward mid-sized systems; its roster is Table A.8 and its wide-canonical companion is Table A.2. Metros are excluded at the metro-era level by the quality flags of Table A.1.

Table A.1: Quality flags: classes, detection rules, and coverage.

Flag class	Detection rule	Cells caught	Share
Feed outage	metro-quarter with a missing or unroutable archived feed	210 metro-quarters	6.4%
Thin feed	routable feed with implausibly sparse service	0 beyond outages	0.0%
Metro-years touched by any flag		70 of 606	11.6%
Metros ever flagged (excluded from the core)		29	

Table A.2: Endpoint decompositions under both samples.

	Never-flagged metros (headline)				Full canonical (companion)			
Service	Obs.	Net.	Scale	Reloc.	Obs.	Net.	Scale	Reloc.
Bank branches	−22.5	−5.1	−23.6	+6.2	−18.5	−3.8	−19.9	+5.2
Public libraries	−1.2	−2.7	+3.3	−1.8	−1.7	−2.5	+1.9	−1.1
Groceries (full-line)	−0.7	−3.9	+6.5	−3.3	+1.5	−3.1	+8.4	−3.8
Community colleges	−0.2	−0.2	+3.6	−3.6	−0.4	−0.4	+1.8	−1.8
Durable general acute hospitals	−2.6	−1.7	−1.2	+0.3	−3.3	−1.5	−4.8	+3.0

2025 vs. 2014 annual average, log points ×100 (the banks observed −22.5 corresponds to −20.1 percent). Components sum to observed within rounding.

Table A.3: Per-exhibit samples, units, and weights.

Exhibit	Sample	Units	Weights
Figs. 1–5 (decompositions)	clean-archive core (19 metros; 28,147 BGs)	log points	population
Trajectories (§5)	the panel (52 balanced metros ex-NYC)	percent	population
Fig. 6 (group bounds)	the panel	percent	population
Fig. 7 (Seattle map)	Seattle metro (2,733 BGs)	loss tiers	—
Table 3 (cross-service)	clean-archive core	log points	population
Table A.2 (two samples)	core + panel canonical set (55,359 BGs)	log points	population
Compounding (§6.3)	clean-archive core	BG counts	unweighted
NYC section	New York (14,472 BGs; uncorrected)	log points	population
Figs. A.1–A.2 (appendix)	core vs excluded metros; Cincinnati	log points	population

Reconciling trajectories and decompositions, in named steps: the paper quotes two endpoint objects, and for banks they differ (trajectory −18.1% = −20.0 log points; core decomposition endpoint −22.5). Construction and coverage (fixed-effects quarter averages on the panel → annual means on the panel's canonical block groups): −20.0 to −18.5, +1.5 log points. Archive-quality composition (canonical set → clean-archive core): −18.5 to −22.5, −4.0 log points. For groceries the same steps run +1.7 → +1.5 → −0.7.

Table A.4: Trajectory endpoints by travel-time budget.

Service	15 min	30 min	45 min	60 min
Banks	−5.6	−12.8	−18.1	−21.2
Libraries	−0.1	−1.0	−2.5	−4.3
Groceries	+1.6	+1.8	+1.7	+1.3
Community colleges	−0.0	−0.2	−0.4	−1.0
Hospitals	−0.2	−1.2	−3.4	−5.4

Percent change, 2025 vs. 2014 annual average, the panel, corrected, population-weighted.

Table A.5: Construct grid.

	Coverage: % reaching ≥1 in 45 min			Nearest facility (min)	
Service	2014	2025	Change (pp)	Median 2023	Change
Banks	75.5	72.2	−3.3	28	+2.0
Libraries	48.8	48.3	−0.5	48	+0.0
Groceries	71.1	71.3	+0.2	29	+0.0
Community colleges	10.0	10.5	+0.5	>120	+0.0
Hospitals	24.2	22.7	−1.5	76	+2.0

Coverage (share of population reaching at least one facility in 45 minutes, pp change) and nearest-facility (population-weighted minutes to the closest facility) variants, the panel, 2025 vs. 2014. The nearest-facility sweep reads the same travel-time matrices under a 120-minute cap; medians beyond it are reported as >120, and nearest-facility changes are reported at nearest-minute precision.

Table A.6: External checks on the destination layers, the network component, and the demographic attributes.

Check	Comparison	Result
Groceries vs. Census CBP 445110	state store counts, 2023	corr. 0.976 (logs); median ratio 0.78
Hospitals vs. HIFLD	state durable-GA counts	corr. 0.997 (logs, 56 units); ratio 0.90
Libraries vs. PLS system files	outlet counts	exact (1.000)
Network component vs. NTD	Δlog revenue miles, 19 core metros	corr. 0.59
Archive-entry correction vs. NTD	Δlog VRM at archive-entry events (516 metro-years)	uncorrelated ($r = -0.1$; median 3.5 vs. 3.1 background)
Washington, DC exclusion	banks and hospital trajectories	unchanged (−18.1/−18.1; −3.4/−3.3)
Philadelphia exclusion	majority-Black bank change, corrected vs. uncorrected	corrected −32.1 to −30.3; uncorrected +1.3 to −18.6
Equity cuts, 2009–13 attributes	profile and incidence contrasts	replicate (e.g. banks −32.3/−17.3)
Seasonality	quarter-of-year effects ex-2020/21	≤0.9 log points

Philadelphia supplies 84% of the archive-entry correction carried by majority-Black block groups, its SEPTA feeds entering the archive mid-panel. Excluding it, the corrected majority-Black bank change moves from −32.1 to −30.3 percent and the uncorrected change from +1.3 to −18.6; majority-white estimates move from −17.1 to −16.9 corrected. Philadelphia has no National Transit Database series, so the archive-entry row above excludes it.

Table A.7: Hospital layer: active facilities and geocode coverage by year.

Year	Active hospitals	Geocoded	Coverage
2013	7,193	6,565	91.3%
2014	7,181	6,551	91.2%
2015	7,168	6,542	91.3%
2016	7,175	6,552	91.3%
2017	7,164	6,548	91.4%
2018	7,120	6,508	91.4%
2019	7,063	6,448	91.3%
2020	7,241	6,602	91.2%
2021	7,298	6,651	91.1%
2022	7,270	6,629	91.2%
2023	7,044	6,421	91.2%
2024	7,038	6,411	91.1%
2025	7,023	6,391	91.0%
Geocode sources (unique addresses): Census 7,684, HIFLD 789, OSM 251.			

December Provider of Services vintages, category-01 facilities. Three universes nest: 8,440 distinct certifications ever active as category-01 hospitals across the vintages; roughly 7,000–7,300 active in any December vintage (this table); and the durable general acute subset of Table 1 that defines the lead. Geocoding is a four-source cascade: Census batch and single-address geocoders, the HIFLD facility layer, and OpenStreetMap. The ungeocoded set is persistent, not churning: 91.2% of certifications geocode in every year they appear and only 1.1% ever switch status.

Table A.8: Panel metros: summary.

	Metros
Routed	96
With merged census attributes	92
Balanced panel (ex-NYC; ≥36 of 48 quarters)	52
Clean-archive core (never flagged)	19

The full 96-metro roster (quarters covered, block groups, population) is Table S1 of the online supplementary material. The clean-archive core comprises Albuquerque, Austin, Champaign–Urbana, Charleston, Chicago, Cincinnati, Denver, Kansas City, Madison, Oxnard, Phoenix, Portland (OR), Rochester, Sacramento, San Antonio, Santa Rosa, Seattle, Spokane, and Stockton. Four routed metros (Fairbanks, Jacksonville, Palm Bay, Riverside–San Bernardino) lack merged census attributes and enter no attribute-based exhibit; the two Connecticut metros are routed but their attribute values did not merge.