

# Supply Methodology Math

## Fixed Line Calculations

### Notation key:

- $i$  an origin Census block (2010 blocks).
- $j$  a transit stop on PACE, CTA, or Metra.
- $k$  a line/route which stops at  $j$ .
- $d_{ij}$  the walking distance in miles between  $i$  and  $j$ .
- $t_{ij}$  the total transit time in minutes (walking and/or riding) between  $i$  and  $j$ .
- $f_{jk}$  the frequency of stops (total stops per week) at stop  $j$  for line  $k$ .
- $s_{jk}$  the percentage of a week covered at stop  $j$  by line  $k$ .
- $W_j$  the walkability score of stop  $j$ , which is a value  $W_j \in [0.2, 0.4, 0.6, 0.8, 1.0]$
- $A_j$  the accessibility indicator of stop  $j$ , equal to:

$$A_j = \begin{cases} 1, & \text{if } j \text{ is wheelchair accessible or has no info} \\ 0, & \text{otherwise} \end{cases}$$

### Count

Count = Sum total of the number of public transit stops (independent of the stop mode, but conditional on the accessibility and walkability of the stop) within  $\frac{3}{4}$  of a mile, network based walking distance from the centroid of a block.

$$Count_i = \sum_{j \in \{d_{ij} \leq 0.75\}} A_j W_j$$

### Connectivity

Connectivity = Sum total of accessible public transit stops that can be reached in 60 minutes, using any mode of transportation (bus, L, metra) after a  $\frac{3}{4}$  mile network based walk to access the system at an accessible stop from the centroid of a block, excluding any stops that could've been reached by a  $\frac{3}{4}$  mile network based walk from the centroid of a block. Weighted by accessibility but not walkability.

$$Connectivity_i = \left( \sum_{j \in \{t_{ij} \leq 60\}} A_j \right) - \left( \sum_{j \in \{d_{ij} \leq 0.75\}} A_j \right)$$

### Walking Distance

Walk Distance = Mean network walking distance (weighted by accessibility and walkability) to all stops within  $\frac{3}{4}$  of a mile, network walking distance from the centroid of a block

$$WalkingDistance_i = \sum_{j \in \{d_{ij} \leq 0.75\}} E[d_{ij} A_j W_j]$$

## Frequency

Frequency = Of the available stops determined by the count, the mean number of times per week all those stops are serviced. Note the following:

- Stops are weighted by accessibility and walkability
- Directional bus stops are considered independent of each other and not joint
- L & Metra stops are considered joint stops

$$Frequency_i = \sum_{j \in \{d_{ij} \leq 0.75\}} E \left[ \sum_{k \in j} f_{jk} A_j W_j \right]$$

## Service Span

Service Span = Of the available stops determined by the count, the mean percentage of the week for which service is available at each stop (weighted by accessibility and walkability). If one stop has multiple lines accessing it, then that stop's value is the mean of the lines servicing that stop.

$$ServiceSpan_i = \sum_{j \in \{d_{ij} \leq 0.75\}} E \left[ \sum_{k \in j} s_{jk} A_j W_j \right]$$

## Tract Aggregation

Block values are aggregated to the Census tract level using a population-weighted mean.

$$V_t = \sum_{i \in t} E[v_i p_i]$$

Where  $t$  is a Census tract,  $i$  is a Census block,  $V_t$  is the aggregate tract-level value,  $v_i$  is the value at block  $i$ , and  $p_i$  is the population-weight of the block.

## Gap Index Calculation

The gap index is calculated at the tract level by subtracting the decile of the demand index from the decile of the supply index.

$$Gap_t = D(Supply)_t - D(Demand)_t$$

Where  $t$  is a Census tract,  $D(Supply)_t$  is the decile of supply at tract  $t$ , and  $D(Demand)_t$  is the decile of demand at tract  $t$ .