External Traditional Factors

* Unemployment
  + Including POP + EMP
* Gas prices
  + Including Gas Price
* Housing and employment density (Greg to catch changes within city – center city versus suburban)
  + Including % of population in transit supportive density.
* Availability and cost of parking
  + Do not have good parking cost data.
* Total population (Greg to catch city to city shift)
  + Have POP + EMP
* Zero-veh households
  + Have this.
* Demographics (race, ethnicity, income)
  + Income: % HH <35k, % HH>100k, median income all insignificant
  + Inflation adjust median income per person. Negative and significant.
  + Immigrant percentage – positive and significant

Internal Traditional Factors

* Amount of service provided
  + Vehicle Revenue Miles
  + Look at lags.
  + Look at rail vs bus cross-elasticity
* Fares
  + Average fare: fare revenue / UPT
* Service allocation (where)
* Reliability & speed (choice models lit review)
  + No reliability data.
  + Speed data – positive correlation between speed and ridership. This is because more riders slow down the bus.
* Accessibility
  + Not really practical.
* Transit-oriented development
  + Not easy to measure.
* Security / image
  + No meaningful data.

External Factors Impacting Recent Changes

* Suburbanization of poverty, gentrification
  + Look at immigration, income, 0 car HH, median income per person. Segmented by TSD vs non-TSD or TSD vs total.
* Telecommuting / working from home
  + Add work at home, taxi + other, walk+bike
* Delivery services
  + No data.
* Shared mobility / ridehailing
  + Bikesharing
  + Carsharing
  + TNCs
  + Scooters (limits on #scooters)
* Congestion (including vehicle vs transit travel times)

Internal Factors Recent Changes (Strategies)

* Maintenance / reliability / shutdowns (not strategy)
* Real-time information
  + Look for list of all agencies with real time information
* Fare technology
  + Look for list of all agencies with smart cards
* Network restructuring
* Coverage vs frequency
* First & last mile demand responsive
* Bus stop consolidation

Partner strategies

* Congestion pricing
* Management and pricing of parking supply
* Microtransit pilots
* Uber / lyft partnerships
* Right-of-way
  + Full BRT / dedicated lane
  + Bus lanes
  + BRT lite
  + Queue jumps / turn management
  + Transit signal priority

Put strategies on a spectrum – agency vs partner in one direction, ridership impact

TCRP – network restructure

Here is the plan for clusters for discussion this afternoon based on the APTA email and the response to the panel call:

1. First run all models without any segmentation
2. Run all models based on agency size – use APTA Low, Mid, High opex

3.       Run all models based on further separation of APTA groups using “external factors & competitiveness” (potentially 12 clusters, but I think 9 is better with High being one group)

4.       Possibly run with GT clusters in addition (8 clusters)

Other things we said we’d try to include:

1. Speed will be included using revenue vehicle miles / revenue vehicle hours.
2. Measures of congestion that would be available on a national level.
3. Population will be included in multiple ways, including several demographic variables such as by age or income.
4. Density
5. NTD security measures

Best,

Kari

***Table A-1: Newspaper Articles regarding Transit System Changes and Ridership***

|  | **Source Title** | **Author** | **Year** | **Relevant Takeaways** |
| --- | --- | --- | --- | --- |
| 1 | Community outraged over MARTA bus changes | Abubey | 2017 | MARTA has faced stiff resistance from residents who rely on bus service as their only mode of transportation. |
| 2 | There’s No Transit But Microtransit For This Sprawling Texas City | Bliss | 2017 | Austin implemented a demand-responsive program that quickly met its ridership goals and exceeded expectations. |
| 3 | VMT hits nominal high, approaches per capita mark. | Davis | 2017 | Total vehicle miles traveled are now at their highest point in history. |
| 4 | Metro plans to reimagine and restructure its vast bus system | Hymon | 2017 | The Los Angeles Metro announced in May 2017 the start of a three-year process to restructure the bus network in response to a 20% drop in ridership over three years. |
| 5 | SEPTA looks to Texas for ideas for bus route redesign | Laughlin | 2017 | SEPTA announced a bus redesign. |
| 6 | Metro is mulling a major redesign of the bus system. But first, officials need to figure out why people aren’t riding | Powers | 2017 | WMATA announced a bus redesign. |
| 7 | Capital Metro takes its bus network realignment to the riders | Pritchard | 2017 | In Austin, a ridership increase following a network redesign is partly attributed to night and weekend bus service expansions. |
| 8 | Dallas Council Members Say Bus Network Overhaul Can’t Wait | Schmitt | 2017 – July | DART announced a bus redesign. |
| 9 | Transit Ridership Falling Everywhere – But Not in Cities With Redesigned Bus Networks | Schmitt | 2017-February | A Streetsblog piece about bus redesigns and their general resilience against ridership declines. |
| 10 | Public Transit Should Be Uber’s New Best Friend | Silver & Fischer-Baum | 2015 | FiveThirtyEight article which investigates Uber usage in New York City, finding that Uber usage is higher near the subway, suggesting a link between the two. |
| 11 | How Seattle Bucked a National Trend and Got More People to Ride the Bus | Small | 2017 | In Seattle, bus ridership increased by 0.4% between 2014 and 2016, during which King County Metro redesigned their bus network. |
| 12 | Bus Network Redesigns Are the Hottest Trent in Transit | Vock | 2017 | In Houston, bus ridership increased by only 1.2% in the first year, which was much lower than the 20% expected, even though the operating budget increased by 4%. |

***Table A-2: Transit agency and Government Reports regarding Transit Ridership***

|  | **Source Title** | **Author** | **Year** | **Relevant Takeaways** |
| --- | --- | --- | --- | --- |
| 1 | Understanding Recent Ridership Changes: Trends and Adaptations | APTA | 2018 | Identifies erosion of time competitiveness, reduced affinity, erosion of cost competitiveness, and external factors as major trends in transit ridership. |
| 2 | US population disperses to suburbs, exurbs, rural areas, and of the country metros | Frey | 2018 | Suburbs have outpaced urban cores in growth rate. |
| 3 | State of the American Workplace | Gallup | 2017 | 43% of Americans reported working remotely at least sometimes, a 4-percentage point increase since 2012. Telecommuters also reported working remotely more often; 75% reported working from home more than once a week from 66% in 2012. |
| 4 | Accountability Center | King County Metro | 2017 | King County Metro’s annual performance measures, describing a bus network redesign that took place over several years. |
| 5 | Comprehensive Operations Analysis | Parsons Brinckerhoff | 2016 | A Comprehensive Operations Analysis Study commissioned by MARTA which recommended concentrating service on core corridors. |
| 6 | TNCs Today: A Profile of San Francisco Transportation Network Company Activity | SFCTA | 2017 | Found that TNC trips are concentrated during peak hours and that they contribute 6.5% of all vehicle miles traveled in San Francisco. |
| 7 | Private mobility, public interest | TransitCenter | 2016 | A report that suggest that transit agencies and TNCs partner to share data and serve cities together. |

***Table A-3: Academic Literature on Traditional Causes of Ridership Increases and Decreases***

|  | **Source Title** | **Author** | **Year** | **Relevant Takeaways** |
| --- | --- | --- | --- | --- |
| 1 | Predicting transit ridership at the stop level: The role of service and urban form | Dill et al. | 2013 | Stop-level analysis of transit ridership in three cities in Oregon. Service characteristics were most important determinants of ridership. |
| 2 | Strategies to attract auto users to public transportation | Dueker et al. | 1998 | Parking availability and gas prices are important determinants of attracting riders to transit. |
| 3 | Big-city transit ridership, deficits, and politics: Avoiding reality in Boston | Gomez-Ibanez | 1996 | A Boston case study, confirming that employment correlates positively with ridership overall and that service levels play a significant role. |
| 4 | A note on trends in transit commuting in the United States relating to employment in the central business district | Hendrickson | 1986 | An analysis of changes in transit commuting between 1960 and 1980. Transit commuting is closely tied to employment level in the central business district. |
| 5 | Secrets of success: assessing the large increases in transit ridership achieved by Houston and San Diego transit providers | Kain & Liu | 1999 | Found that increases in service, reduction in fare, and growth in employment and population contributed the most to increasing ridership. |
| 6 | Factors affecting urban transit ridership | Kohn | 2000 | A nationwide Canadian study on transit ridership which finds that changes in fares and service levels can greatly affect ridership. |
| 7 | A time-series analysis of public transit ridership in Portland, Oregon, 1971–1982 | Kyte et al. | 1998 | Compared ridership before and after service changes in Portland, OR. Found that service hours’ effect on ridership varied by route, but that it was significant overall. |
| 8 | Determinants of transit ridership analysis of post WWII trends and evaluation of alternative networks. | Liu | 1993 | Nationwide study of transit ridership post WWII. Found that greater employment is tied to both higher levels of commuting and more vehicle purchases. Found that vehicle revenue miles strongly correlate with ridership. |
| 9 | Modeling the commute mode share of transit using continuous accessibility to jobs | Owen & Levinson | 2015 | Predicted mode share based on accessibility measures and on demographics using data from the Minneapolis-Saint Paul Metropolitan Area at the census block-group level. They found that transit mode was negatively correlated with income and vehicle ownership, even when considering accessibility. |
| 10 | Increasing transit ridership: the experience of seven cities | Sale | 1976 | Service expansions and gas prices played a large role in transit growth in the 1970s. |
| 11 | Public Transportation and Land Use Policy | Pushkarev & Zupan | 1977 | Seminal discussion of the population and employment densities required to support public transportation service. |
| 12 | The effects of population density and income on per capita transit ridership in western American cities | Spillar & Rutherford | 1998 | This study links population density to higher transit ridership, though several other factors are likely at play including income. |
| 13 | The Factors Influencing Transit Ridership: A Review and Analysis of the Ridership Literature | Taylor & Fink | 2003 | A review of relevant literature surrounding public transit ridership. |
| 14 | Nature and/or nurture? Analyzing the determinants of transit ridership across US urbanized areas | Taylor et al. | 2009 | National study of transit ridership against a wide variety of factors. Found that the population of recent immigrants, and the percent of carless households were positively correlated with transit ridership. The correlation between demographic characteristics and transit ridership remains strong even when taking population density and access to transit into consideration. |
| 15 | Traveler Response to Transportation System Changes Handbook | TCRP Report 95 | 2004 | Housing and workplace density, as well as low parking availability, correlate to higher transit ridership. |

***Table A-4: Academic Literature on Impacts of New Trends on Transit Ridership***

|  | **Source Title** | **Author** | **Year** | **Relevant Takeaways** |
| --- | --- | --- | --- | --- |
| 1 | Taxicabs as public transportation in Boston, Massachusetts | Austin & Zegras | 2012 | Showed that heavy rail stations generated less trips than surrounding areas, but that the opposite was true for light rail and BRT services. |
| 2 | Employee Transportation Benefits in High Transit Mode Share Areas: University Case Study | Block-Schachter & Attanucci | 2008 | Parking and driver mileage benefits correlated with decreased transit use, while transit benefits and discounted passes correlated with higher transit use in Boston, MA. |
| 3 | Invest in the ride: A 14 year longitudinal analysis of the determinants of public transport ridership in 25 North American cities | Boisjoly et al. | 2018 | A large study summarizing transit ridership effects, showing that service levels are the primary determinant of ridership. Also found that the presence of Uber in a city was not a significant factor in ridership. |
| 4 | Understanding the effects of transit benefits on employees’ travel behavior: Evidence from the New York-New Jersey region | Bueno et al. | 2017 | Parking and driver mileage benefits correlated with decreased transit use, while transit benefits and discounted passes correlated with higher transit use in New York and New Jersey. |
| 5 | Shared-Use Mobility in the United States: Current Adoption and Potential Impacts on Travel Behavior | Clewlow | 2016 | A survey of TNC and carsharing users, with mixed effects on transit usage. |
| 6 | Disruptive transportation: the adoption, utilization, and impacts of ride-hailing in the United States | Clewlow & Mishra | 2017 | Survey of TNC users found that overall, users decreased bus usage but increased commuter rail usage, and many made trips they would not have made without the availability of TNCs. |
| 7 | Understanding Changes in Demographics, Preferences, and Markets for Public Transportation | Coogan et al. | 2018 | Critical factors for predicting future transit markets are age, race, and foreign-born status. There is substantial variation in transit usage by region of the US, residential neighborhood type, and employment location. Attitudes and perceptions significantly affect transit usage and residential and employment location choice. |
| 8 | Promoting sustainable travel modes for commute tours: A comparison of the effects of home and work locations and employer-provided incentives | Dong et al. | 2016 | Parking and driver mileage benefits correlated with decreased transit use, while transit benefits and discounted passes correlated with higher transit use in Portland, OR. |
| 9 | The Effect of Demographic Changes on Transit Ridership Trends | Driscoll et al. | 2018 | Modeled the impact of population age on transit ridership since 1989. Found that a contributing factor to the decline in ridership per capita was an aging population that makes less trips on average. Authors also point to slower rates of population growth in US counties with abundant transit service than in counties with little transit available. |
| 10 | TCRP Report 188: Shared Mobility and the Transformation of Public Transit | Feigon & Murphy | 2016 | Large study on TNC usage that primarily finds that users utilize the services for recreation or social activities, and that the services have allowed users to postpone auto ownership or sell their car. |
| 11 | The new urban crisis: How our cities are increasing inequality, deepening segregation, and failing the middle class and what we can do about it. | Florida | 2017 | Details gentrification effects on transit ridership. While cities are becoming denser, their populations are becoming whiter, have higher-incomes, and more cars. |
| 12 | On the Factors Influencing the Choices of Weekly Telecommuting Frequencies of Post-secondary Students in Toronto | Habib | 2017 | Study focused solely on post-secondary students in Toronto, and found that owning a transit pass correlates negatively with high-frequency telecommuting. |
| 13 | Is Uber a Substitute or Complement for Public Transit? | Hall et al. | 2018 | Found that Uber presence and intensity correlated with ridership decrease in MSAs with smaller population sizes and ridership increase in MSAs with large population sizes. |
| 14 | A Framework for Understanding the Impacts of Ridesourcing on Transportation | Henao & Marshall | 2017 | A report explaining the complexities in understanding TNCs’ effects, due to data availability and confounding trends. |
| 15 | Transit Systems and the Impacts of Shared Mobility | Iacobucci et al. | 2017 | Largely duplicative study to TCRP Report 188. |
| 16 | Falling Transit Ridership: California and Southern California | Manville et al. | 2018 | Increasing auto ownership especially among lower-income households was found to have a significant effect on falling transit ridership in the Southern California region. Transit ridership fell sharply in the past several years despite heavy investments in service. |
| 17 | The impact of carsharing on public transit and non-motorized travel: an exploration of North American carsharing survey data | Martin & Shaheen | 2011 | Households that utilize carsharing have been use transit less than before joining carsharing. |
| 18 | In Portland, Economic Displacement May Be a Driver of Ridership Loss | Mills & Steele | 2017 | Compared bus stop-level changes in the real-estate values with ridership changes and found a significant overlap. This suggests that focusing service entirely on highest-density areas may not yield the maximum ridership. |
| 19 | Implications to Public Transportation of Emerging Technologies | Polzin | 2016 | An overarching view of how to handle TNCs’ effects, adving that agencies monitor the impact of technology on travel behavior, redefine transit’s role as mobility options change, and position transit to address emerging issues. |
| 20 | Just a better taxi? A survey-based comparison of taxis, transit, and ridesourcing services in San Francisco | Rayle et al. | 2016 | Found that 33% of rideshare users would have made the trip by transit, 39% by taxi and only 6% would have driven their own car. |
| 21 | North American carsharing: 10-year retrospective | Shaheen, Cohen, & Chung | 2009 | A report combining 15 studies, finds that car sharing members’ transit usage increased between 13.5 to 54% after joining carsharing. |
| 22 | How carsharing affects the travel behavior of households: a case study of Montréal, Canada | Sioui et al. | 2012 | Zero-car households that utilize carsharing use transit less than zero-car households in general. |
| 23 | Incorporating online shopping into travel demand modelling: challenges, progress, and opportunities. | Suel et al. | 2018 | Delivery services such as Amazon and GrubHub have made shopping and dining delivery possible. This study reviews recent literature surrounding these online providers and their potential effects on travel demand. |
| 24 | A new market segmentation approach: evidence from two Canadian cities | Van Lierop & El-Geneidy | 2017 | Develops a conceptual framework to segment the market for marketing efforts. |
| 25 | New Potential for Multimodal Connection: Exploring the Relationship Between Taxi Trips and Transit in New York City | Wang & Ross | 2016 | Taxi services are about equally split between competing with and complementing transit trips. |
| 26 | Modeling taxi trip demand by time of day in New York City | Yang & Gonzales | 2014 | Transit access increases taxi usage in New York City even when controlling for population and employment density. |
| 27 | Comparison of mode cost by time of day for nondriving airport trips to and from New York City's Pennsylvania Station | Yang et al. | 2014 | Cost prohibited the utility of taxi trips for all times of day except overnight, when transit service frequency dropped significantly. Transit was most valuable during peak periods, when headways were shortest and vehicular traffic was highest. |

***Table A-5: Academic Literature on Transit Agency Strategies***

|  | **Source Title** | **Author** | **Year** | **Relevant Takeaways** |
| --- | --- | --- | --- | --- |
| 1 | Metropolitan Transit Agency's Experience Operating General-Public Demand-Responsive Transit | Becker et al. | 2013 | The Denver Regional Transit Authority has been providing dynamic rides with their own vehicles and operators since 2000. |
| 2 | The impact of real-time information on bus ridership in New York City | Brakewood, Macfarlane, & Watkins | 2015 | Found that the introduction of real-time information correlates with a 2.3% increase in bus ridership in New York City. |
| 3 | Best Practices for Transportation Agency Use of Social Media | Bregman & Watkins | 2013 | A book describing potential strategies for transit agencies to create an online presence. |
| 4 | Comparing Fixed-Route and Demand-Responsive Feeder Transit Systems in Real-World Settings | Edwards & Watkins | 2013 | In low-density areas, demand-responsive transit can service short trips at a lower cost than fixed routes. |
| 5 | Demi-flexible operating policies to promote the performance of public transit in low-demand areas | Qiu et al. | 2015 | In low-density areas, demand-responsive transit can service short trips faster. |
| 6 | UpRouted: Exploring Microtransit in the United States | Westervelt et al. | 2018 | The Kansas City Area Transportation Authority and Santa Clara Valley Transportation Authority both offered demand-responsive transit programs operated by their own staff, but the programs were discontinued due to insufficient ridership. |