INCORPORATING EQUITY CONSIDERATION IN TRANSPORT PROJECT EVALUATION: THE SAN-FRANCISCO BAY AREA CASE STUDY

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ABSTRACT
In this study, we emphasize the advantages of two new equity measures, developed in previous work, through a real world evaluation of transport project. We use the San Francisco Bay Area case study and its regional activity-based travel model estimation. Our first approach utilize the concepts of accessibility and subjective well-being, rather than value of time, to measure gains from transport investments. We develop the “Subjective Value of Accessibility” (SVOA) measure, a utility-activity based accessibility measure combined with a well-being factor. Our second approach utilizes the “capability approach” (CA), which is derived from the actual opportunities that people have, given their personal and social circumstances. We estimate the “Value of Capability gains” (VOC) as the key benefit taken into account in Cost-Benefit Analysis (CBA). This new VOC measure relies on what we refer to as the Activity-Based Capability (ABC) measure, which is an Activity-Based Accessibility measure (ABA) calculated from the actual opportunities a person can access. Our case study results indicate that the SVOA and the VOC can reveal higher benefits from policies focusing on the needs of more vulnerable social groups, as compared to the result obtained using the traditional measures.

INTRODUCTION
In this paper we demonstrate two new measures for better incorporating equity considerations in transport project appraisal, using the San Francisco Bay Area case study. These equity measures, developed in previous work, draw on the power of activity-based travel demand models, which represents the state-of-the-art in travel demand modeling and forecasting. We use an activity-based travel model to estimate the overall benefits from transport improvements, and then calculate two new transportation equity measures. These measures are distinguished from the traditional logsum-accessibility measure by introducing the concept of capability gains to key social activities, as well as combine social and spatial factors. In previous works (1),(2) we developed and employed a simplistic model of travel behavior and hypothetical planning scenario to demonstrate the advantages of the suggested new measures. In this study, we apply our proposed new equity measures using a real-world case study of the San Francisco Bay Area.

This paper contains four main parts. In Section 2, we present the theoretical background, providing an overview of the new equity measures and their mathematical formulation. Section 3 provides a description of the San Francisco Bay Area Case Study; a brief overview of the transportation system in the Bay area, a description of the 2000 Bay Area Travel Survey data, the travel model description, the setting and the scenarios that were implemented as part of this case study, and the evaluation results. Finally, Section 4 presents the main conclusions and findings of this work.

THEORETICAL FRAMEWORK
This work explores the consumer’s ability to reach opportunities as a key benefit generated from transportation projects. Activity-based travel models (ABM) are extremely useful in assessing the total benefits of transportation improvements for various consumers and calculating the change in accessibility (3),(4),(1). ABMs have two important advantages for equity analysis, which have not been utilized in full so far: first, the ability to analyze results by various groups of the population; second, these models can utilize the Activity Based Accessibility (ABA) measure to estimate the overall benefits from transport investments and policies. The ABA measure allows for individual level measures to be...
calculated, for different choice situations, varying based on individual-level characteristics. We suggest including social and spatial factors in social welfare assessment by introducing the concept of accessibility gains to key social activities. Specifically, it is suggested to use the "Subjective Value of Accessibility gains" (SVOA) measure, and the "Value of Capability gains" (VOC) measure.

The "Subjective Value of Accessibility gains" (SVOA) measure

It is suggested to incorporate subjective well-being effects into a new evaluation framework “Equity Benefit Analysis” (EBA), and use an alternative measure, "Subjective Value of Accessibility gains" (SVOA). The SVOA is based on the ABM accessibility measure as well as on Subjective Well-Being (SWB) measures. The logsum, an expression for the consumer benefits, received at the very top of the hierarchy is the ABM accessibility (ABA) measure as provided by (5). If $ABA_n^0$ denotes the accessibility value for traveler n before implementing any transportation policy, and $ABA_n^1$ denotes the same measure after implementing the transportation policy, then the accessibility gain from the policy in utility units is:

$$\Delta ABA_n = ABA_n^1 - ABA_n^0 \quad (1)$$

The total changes in consumer surplus can be defined as:

$$\Delta CS_n = \frac{1}{\alpha_n} \cdot \left[\frac{1}{\mu} \ln\left(\sum_{j=1}^{j_0} e^{dV_{nj}}\right) - \frac{1}{\mu} \ln\left(\sum_{j=1}^{j_0} e^{dV_{nj}}\right)\right] = \frac{1}{\alpha_n} \cdot \Delta ABA_n \quad (2)$$

where superscript 0 and 1 denote before and after the change in policy, respectively. $\alpha_n$ is the marginal utility of income and is equal to $\frac{dU_n}{dY_n}$ if alternative $j$ is chosen, $U_n$ is the overall utility, and $Y_n$ is the income of person $n$.

If we have utility function: $V = f\{C, T, ...\} \quad (3)$

where $C$ is cost in dollars, $T$ is travel time in minutes and some additional variables, as (3) showed, ABA can be monetized:

$$\Delta CS_n = \Delta ABA_n / \sum P_j c_j \quad (4)$$

We convert the ABA measure to SWB reflecting the magnitude of the income – well-being effect on different population groups, and compensate for differences in income by translating the accessibility benefits into well-being terms. We use income - well-being factor, to reflect the fact that lower income consumers are more sensitive to changes in their well-being level (6). Thus, the consumer’s surplus becomes the Consumer Subjective Well-Being (CSWB):

$$\Delta CSWB_n = \alpha_{SWB_n} \cdot \frac{1}{\alpha_n} \cdot \Delta ABA_n \quad (5)$$

where $\alpha_{SWB_n}$ is the income - well-being factor and is equal to $dSWB_n / dY_n$, which is the slope of the happiness-income relationship and varies as a function of income level. Considering both the change in accessibility calculated at the top of the hierarchy (i.e. ABA), and the
income-well-being effect (SWB), we obtain an alternative measure in well-being (benefit) terms, which we refer to as "Subjective Value of Accessibility gains" (SVOA) (I).

\[ SVOA = \sum_{n=1}^{n} (\alpha_{SWB,n}) \cdot (\DeltaABA_n / \sum_{j=1}^{j} p_j c_j) \]  

(6)

The SVOA is an accessibility based measure combined with SWB factor, which was designed to narrow the gap between income groups caused by the marginal utility of income using SWB weights. Thus, SVOA reflects greater benefits from policies that are geared more toward the less accessible and lower income population. The SVOA, a single value in well-being (benefit) terms, can be integrated into EBA which is a hybrid of CBA and Multi-Criteria Analysis (MCA). EBA allows the comparison of projects based on a single value, while putting more weight on lower income and accessibility-lacking groups, based upon the subjective relationship between income and well-being. The suggested EBA framework, alongside with CBA and a comparison of impacts for various groups, can provide a reliable and approachable information on investment effectiveness. For a complete overview please see (I).

The “Value of Capability gains" (VOC) measure

It is suggested to apply the Capability Approach (CA), which derived from the actual opportunities that people have, given their personal and social circumstances, to transportation. According to Sen’s capability approach, living is seen as consisting of a set of functionings, which could be described as different aspects of life. In the context of transportation, the element of individual functioning is traveling. The vector of functionings, which has been formalized by Sen (7), and discussed by (8), adapted to describe person’s n travel functioning vector is given by:

\[ \bar{b} = f_n (d(\bar{j}) | \bar{Z}_n, \bar{Z}_s, \bar{Z}_e) \]  

(7)

where \( \bar{j} \) is a vector of alternatives out of the set of all possible alternatives J. \( \bar{j} \) is mapped into the space of characteristics via the conversion function \( d \) so that \( d(\bar{j}) \) is a characteristics vector of a given alternatives vector \( \bar{j} \). The characteristics of potential alternatives do not vary across individuals, i.e. they are the same for everyone. What does vary, however, is the way individuals can benefit from these characteristics. This is reflected by the individual conversion function \( f_n \), that maps a vector of characteristics into the space of functionings. This conversion is influenced by the conversion factors, where we can distinguish individual \( \bar{Z}_n \), social \( \bar{Z}_s \) and environmental \( \bar{Z}_e \) influences, which are endogenous constrains.

The set of all feasible functioning vectors for a person \( n \) is the person’s capability set \( Q_n \).

It represents the person’s opportunities to achieve well-being, reflecting the various functionings that are potentially achievable given his/her constraints \( J_n, \bar{Z}_n, \bar{Z}_s, \bar{Z}_e \). This set can be defined as:

\[ Q_n(J_n) = \{ \bar{b}_n | \bar{b}_n = f_n (d(\bar{j}_n) | \bar{Z}_n, \bar{Z}_s, \bar{Z}_e) \} \]  

(8)

Equally, we can limit the number of opportunities recognized by the model to create person’s n capability set.
Out of this person’s capability set, the expected value of an individual’s maximum utility across potentially achievable travel alternatives can be estimated. In other words, we use the Activity Based Accessibility (ABA) measure to reflect only person's abilities to reach alternatives that are potentially achievable, as the CA implies. The principle of diminishing marginal utility can be applied to accessibility as a quantity of good or service. Travelers with initial low levels of accessibility will gain more from an additional unit of accessibility than travelers with initial high levels of accessibility. As more alternatives become available to the traveler, the marginal benefit from another one decreases. Applying a criterion to determine which alternatives are within a person capability, we use the ABA measure in a manner which reflects people’s abilities to reach alternatives that are potentially achievable, unlike classical activity based accessibility indicators that takes into account all opportunities within the network. Thus, the ABA measure becomes the Activity Based Capability (ABC) measure:

\[
\frac{1}{\mu} \ln \left( \sum_{j=1}^{Q_n(J_n)} e^{\mu V_{nj}} \right)
\]  

(9)

where \( V_{nj} \) is the modeled utility that traveler \( n \) obtains from alternative \( j \) \((n = 1, 2, \ldots, N; j = 1, 2, \ldots, Q_n(J_n))\). \( \mu \) is a scale parameter.

To obtain a measure of the actual capability we apply conversion factors and functions on the choice set. Notably, Sen (7) does not address empirical questions such as how actual capabilities can be measured, and defining potentially achievable activities can technically be performed in several ways, representing different interpretations of Sen’s terminology. While this is a central issue for the realization of CA, it is not the focus of this work. We rather focus on how traveler’s limitations affect her realistic choice set, and the way this choice set should be evaluated. If \( ABC_n^0 \) denotes the accessibility value for traveler \( n \) taking into account potentially achievable activities before implementing any transportation policy, and \( ABC_n^1 \) denotes the same measure after implementing the transportation policy, then the value of the capability gain from the policy, in utility units, is:

\[
\Delta ABC_n = ABC_n^1 - ABC_n^0
\]  

(10)

If we have utility functions of the form: \( V = c \cdot C + t \cdot T + \ldots. \)  

(11)

where \( C \) is cost in dollars and \( c \) is the cost coefficient estimated by the model, then ABA can be monetized and used as an expression for the consumer surplus (3).

Thus, the total change in consumer surplus for achievable activities, the ABC, can also be monetize and used as the consumer capability (CC):

\[
\Delta CC_n = ABC_n / \sum P_j c_j
\]  

(12)

where \( P_j \) is the weight of the population that chooses \( j \).

Considering the change in the sum of all ABC’s calculated at the top of the hierarchy, expressing consumer benefits from choosing potential realistic activities in monetary terms, and we obtain the “Value of Capability gains” (VOC):
The VOC is an accessibility based measure designed to reflect benefits according to a person’s basic accessibility level. The basic accessibility level is determined by a person’s capabilities set, which is derived from the chosen conversion factor / restriction defines a person’s set of realistic possibilities. The VOC is a single value in monetary terms, and can thus be integrated into CBA - replacing the traditional measure. For a complete overview please see (2).

Figure 1 illustrates the overall methodology framework.

We demonstrate the use of the SVOA and the VOC measures to evaluate different transportation scenarios using the San Francisco Bay Area case study and the activity-based destination choice model estimated by Bills (9). This model was estimated to resemble the Metropolitan Transportation Commissions model specification and the 2000 Bay Area Travel Survey (BATS).

THE SAN-FRANCISCO BAY AREA CASE STUDY

Background: Transportation in San Francisco Bay area

The San Francisco Bay Area is the region surrounding San Francisco, which includes nine counties and about 100 cities, and has a population of about 7.5 million people. The central business districts (CBDs) of the metropolitan includes areas in San Francisco, Oakland, and San Jose. These CBDs are connected to each other and to residential and suburban locations through a complex multimodal transportation network. This networks includes highway systems, bus services, toll bridges, ferries, and heavy, light, and commuter rail systems.
In comparison to other major metropolitan areas across the United States, the extensive transit network systems of the Bay Area enable a significantly lower expenditure for household transportation (10),(11),(12). However, regarding housing expenditures, the Bay Area is among the most expensive of U.S. metropolitan areas. Haas et al. (10) found that for the Bay Area, 30% of the median household income is spent on housing while another 15% is spent on transportation.

The housing costs of the Bay Area would indicate that only 4% of the area's housing would be affordable to low income households (11), who are about 30% of the region’s population. These residential areas are mostly concentrated in eastern San Francisco and some parts of Oakland. These places significantly constraint on where low income households are able to reside, in comparison to higher income households. These costs have a direct and significant impact on household budgets, including the ability to save and create wealth (11). Furthermore, these constraints on residential location choices have a great influence on the quality of services and amenities low income households are able to receive, as well as accessibility to desired activities and destinations.

The 2000 Bay Area Travel Survey (BATS) data

The 2000 Bay Area Travel Survey (BATS) was used for the model estimation. This survey is a regional scale household travel survey collected by MTC to support modeling and evaluation of travel across the Bay Area. For this survey, travel diary data for over 14,000 households was compiled, including household population data (location, income, household size, number of workers, number of children, number of vehicles, etc.) and personal travel records over a two-day period (travel destinations, time-of-day, purpose, travel mode, etc.). Bills (9) used the San Francisco Metropolitan County Authority’s (SFCTA) version of the BATS data that processed trips into tours (linked trips from primary origin to primary destination) and added corresponding level-of-service skims (travel times and costs) to estimate a joint destination and mode choice model. For the model estimation, 26763 work tours from across the Bay Area were used in total. We focus on work tours as the most important tours and based on the literature, which discusses the limit by which people are willing to travel to reach their work opportunities (13). Of these work tours, 12% were made by low income commuters (defined as those earning less than $30,000 annually) and 30% were made by high income commuters (defined as those earning more than $100,000 annually).

The Mode and Destination Choice Models

Bills (9) specified and estimated a tour-level mode choice model for home-based work tours. The metropolitan area includes nine-counties and is spatially divided by MTC to 1454 traffic analysis zones. The residential and employment locations of commuters are scattered across the region. There are a number of travel modes available. There include three auto modes, which are distinguished by occupancy level: single occupancy (Drive-Alone), double occupancy (Shared-Ride 2), and three or more occupants (Shared-Ride 3). The transit modes are distinguished by access mode: drive-to-transit or walk-to-transit. Walk and bike modes are also included in the mode choice set. As with MTC’s model and other mode choice models used in practice, the choice set varies across individuals. Further, travel takes place at various times-of-day, based on individual needs. As shown by Bills (9), there are significant differences across income groups - the low income group is much more likely to take Transit and Walk/Bike modes, relative to the high income group. In an attempt to capture the less-accessible, and low-income group’s influences, we chose to focus on travel time changes applied to Transit and Walk/Bike modes, as accessibility
improvements targeted to these groups, which are expected to reflect higher benefits using the suggested new measures.

The mode choice model structure is nested logit with three nests. Within it, the first nest includes Drive alternatives, the second nest includes Drive-Transit and Walk-Transit mode alternatives, and the third nest includes Walk and Bike mode alternatives. This nested logit specification allows for a more realistic correlation structure between the choice alternatives, relative to multinomial logit. The destination choice model includes 1454 destinations representing the region zones, as shown in Figure 2.

![Destination 1 2 3 ................................. 1454](image)

**Figure 2: MTC’s Model Structure**

**Setting and Planning Scenarios**

Two transportation project scenarios were tested; the first one simulates infrastructure improvements for Active (A) modes: walk or bike modes by assuming a reduction of 20% in travel time (door to door) for all destinations which can be reached using this mode. This represents a policy of improving bike paths, giving pedestrian priority in signals etc. The second scenario simulates walk-to-transit (WT) improvement, by assuming 20% reduction in travel time (door to door) for all destinations which can be reached using this mode. As ABM’s are characterized by random selection, the represented destinations are usually selected randomly for every iteration. This would result in inconsistencies in the ABA’s calculation and also in difficulty in comparing among individuals and alternatives. As a solution, we randomly chose only 20 representative destinations and these were constant for all scenarios. As for population distribution, we tried to classify the population by income levels, and found that this division does not necessarily indicates traveler’s available opportunities in this region. Since the purpose of any transportation system is to provide accessibility, it was decided to classify the population according to four levels (more or less equal in terms of population) of initial accessibility levels (before implementing any scenario), as defined by the logsum obtained at the top of the model, at
the destination choice level. Specifically, Level 1 represents the lowest basic level of accessibility, while Level 4 represents the highest basic level of accessibility.

We applied the model to estimate destination and mode choice changes resulting from each of these two policies. We estimated the consequent changes in consumer’s benefits by calculating: (a) the consumer surplus using monetized ABA changes calculated at the top of the hierarchy, for each passenger; (b) the consumer subjective well-being using ABA changes calculated at the top of the hierarchy along with the income - well-being effect, for each passenger, in well-being (benefit) terms (i.e. SVOA); and (c) the consumer capability using monetize ABC changes calculated at the top of the hierarchy, for each passenger, which is the monetize ABA calculated for realistic destinations only (i.e. VOC).

We defined capable destinations as those within 60 min ride by transit and within 20 min ride by active modes. This restriction imitates a conversion factor, translating work opportunities as a resources into actual abilities (13). As average travel time in this region was found to be relatively long, 55 minutes on average by all modes, we tested a number of decision rules. A barrier of 60 min ride by transit and 20 min ride by active mode was chosen, as it reflects the limit by which people are willing to travel to reach their work opportunities. For the purpose of calculating the consumer surplus and the consumer capability in monetary terms, we used the cost coefficient obtained by the model (0.249). All consumer benefits in the sample, were multiplied by the appropriate weights to represent the consumer benefits in the population.

Results and discussion

Table 1 presents the overall changes in consumer’s benefits from the two scenarios using three different measures, the CS, the VOC and the SVOA. Note that the CS and the VOC are comparable and presented in dollars. The SVOA is presents in SWB terms, therefore it cannot be directly compared to the CS and VOC, and can only be used to compare between accessibility groups, and between projects within this measure.

<table>
<thead>
<tr>
<th>Accessibility levels</th>
<th>Scenario 1: 20% reduction in walk and bike travel times (A)</th>
<th>Scenario 2: 20% reduction in walk-transit travel times (WT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average CS</td>
<td>Average SVOA</td>
</tr>
<tr>
<td>1</td>
<td>0.060</td>
<td>2.467</td>
</tr>
<tr>
<td>2</td>
<td>0.423</td>
<td>0.099</td>
</tr>
<tr>
<td>3</td>
<td>0.935</td>
<td>0.220</td>
</tr>
<tr>
<td>4</td>
<td>1.716</td>
<td>0.417</td>
</tr>
<tr>
<td>Total consumer benefit</td>
<td>0.473</td>
<td>0.929</td>
</tr>
</tbody>
</table>

The results indicate that for the first scenario, which included a reduction of 20% in travel time by active (A) modes, the changes in consumer’s benefits using the CS, the higher the consumer’s level of accessibility, the higher his benefit from the transport improvement. This is due to the fact that more accessible consumers, also carry a larger number of trips; thus their impact on the economic evaluation is stronger. The results obtained using the
VOC are mixed. Accessibility level 1 and 2 are characterized by a high share of riders who live in the suburbs. For them, the number of achievable destinations is small, and the transport improvement we applied is not significant enough to add new destinations to their capability set. For these accessibility levels, the changes in the capability sets were relatively small. Accessibility level 3 and 4 are characterized by a high share of passengers who live close to CBDs. For them, the number of potentially achievable destinations is bigger, as these destinations are relatively closer, thus they encouraged to walk and ride.

Considering the SVOA results we identify mixed trend. As a reminder, this measure is derived from the CS and consists weights according to income levels. Accessibility level 1 comprised of a high share of low-income passengers who receive high weight, this is why their benefit is high. It is 5 times higher than the benefits received for accessibility level 4. Accessibility level 2-4 contain a mix population in terms of income levels, and therefore our weights fail to change the trend obtained using the CS. Examining the results of improving walk-to-transit (WT) scenario shows that the benefits measured by the VOC are larger as the basic accessibility is lower. That is to say, the fewer the traveler’s achievable destinations, the greater his benefits from achieving more capabilities. The results using the CS reflects exactly the opposite trend. The higher the consumer’s level of accessibility, the higher his benefit from the transport improvement. Again due to the fact that more accessible consumers, also carry a larger number of trips; thus their impact on the economic evaluation is stronger. As for the SVOA the results are similar to what obtained for the first scenario. Low-income passengers who belong to accessibility level 1 receive high weight, and their benefit is 14 times higher than the benefits received for accessibility level 4, while accessibility level 2-4 contain mix income population and therefore the trend for these groups is the same as obtained using the CS.

Focusing on the aggregated results, for the VOC measure, the walk-to-transit (WT) improvement provides 1.1 times more benefits than active (A) modes investment scenario. Conversely, the CS measure reflect 1.07 times more benefits in favor of the active (A) modes. The SVOA measure indicates a similar project assessment for both investments. Since the VOC is sensitive to destinations gain, it manages to reflect greater benefit for the WT scenario, which is capable of producing more new attainable destinations, as this region is characterized by large travel distances. The active mode (A) policy mainly benefited the high accessible groups, which made more short trips and saved more time, due to their location near city centers. This is why the CS pointed to greater benefit associated with this scenario in project selection level.

**CONCLUSION**

In this paper we demonstrated the effectiveness of two new equity measures, developed in previous work, through a real world, full scale case study. The case of the San Francisco Bay area reflects the complexity involved in equity evaluation. It allows us to examine whether and to what extent the new indicators are able to reflect greater benefit to the less-accessible population, what are their advantages and disadvantages in reflecting traveler’s benefits in a real and complex system such as the San Francisco Bay transportation system. This case study also allows us to compare the effectiveness of the two measures in reflecting consumers' benefits, and to examine weather this benefit is reflected within accessibility classes or by looking at the overall project’s score. In this complex real world case study, the consumer surplus which was calculate based on the ABA, clearly prioritizes the more accessible population groups. The SVOA relies on the CS, therefore its ability to correct the bias arising from wage levels, which is built-in the CS measure, is limited and depends on the assigned weights and population income composition. In addition, it is not
directly comparable to the consumer surplus.

The consumer capability measure is sensitive to policies that will add capabilities for travelers, expressed in destinations gain, and the less accessible the population is the higher its benefit as reflected in the Walk to Transit scenario. However, it can also result in a divers trend. If a population is located very close to city centers, were the number of opportunities is large, they can experience significant improvement in their benefit as they able to gain access to many new targets. This benefit often exceeds the benefits received by remote consumers, for them, the transport improvement is not significant enough, so they cannot gain new capabilities.

The approach presented in this paper is not free of limitations, which should be considered in further development and applications. First, in developing the SVOA, the conversion to well-being is a key factor that affects the relative weight for the equity consideration. In our specific demonstration it is based on the weights obtained in previous empirical studies, and thus depends on the specific sample and data collection method. Much more research is needed to base and validate the relationships between income and well-being and potentially developing a method to better develop them for specific locations and populations. Second, the conversion of benefits into monetary terms is based on the assumption that the marginal utility is linear with income. Obviously, this is not the case in reality. One practical way to overcome this problem may be to estimate the ABM by income group obtaining different marginal value of income for different income groups thus reducing the impact of this problem.

Furthermore, we would like to address issues that require further examination and investigation when using the VOC. Individual differences in converting resources into functioning in the form of “conversion factors” have been stressed by many theoretical studies on the CA. Conversion factors are notoriously difficult to capture empirically, and have not been studied at all in transportation. Therefore, a thorough investigation of this topic is required, possibly with questionnaire design methods. Such investigation would allow the examination of key elements of Sen’s theory of capabilities in transportation, such as how far people are willing to travel to fulfill various desires and needs? How well can people use different options and activities? What are the personal, environmental and social barriers they face accessing various activities? Etc.

Another issue is the conversion of benefits into monetary terms. The translation of ABCs into monetary terms can disrupt the gaps in benefits which are obtained using the new measure. Therefore, the transition should be done out of the model estimation using cost coefficient, as proposed in our previous work (1). The cost coefficient is used as an equivalent for the marginal utility of income to allow the preservation of the gap in benefit. Finally, the ABM is usually based on the logit models for its various choice elements. This model has two mathematical advantages, first being relatively simple, but more important it has a simple term, the logsum, that represents the maximum expected utility from the choice situation. This second characteristic is what enables the calculation of expected benefit changes as a result of policy interventions. However, the logit model also suffers from the assumption of Independence of Irrelevant Alternatives (IIA) which can cause some irrational behavioral changes, and thus can provide bias in estimates of travelers’ behavior. The Nested Logit model provides a reasonable solution to this problem, that while somewhat complicate the model still provide the ability to calculate the expected maximum utility. However, in practice, constructing a full ABM with a full nested logit structure is still computational complex and various shortcuts are common, which their bias is unknown.