COST EFFECTIVENESS OF SUBSTITUTING GROUND TRANSPORTATION FOR SUBSIDIZED ESSENTIAL AIR SERVICES

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ABSTRACT

Since the Airline Deregulation Act of 1978, the U.S. Department of Transportation (DOT) has been subsidizing air service to small rural communities through the Essential Air Service (EAS) program. The original intent of the program was to maintain some level of air service to rural communities that would otherwise not have any and its continuance is fueled by the idea that reliable air services are vital to local rural economies. This idea has been challenged somewhat in recent studies that found little to no economic impacts of air traffic and, ground transportation would have a more frequent, comfortable, and reliable schedule than air service.

This report entertains the hypothesis that intercity traffic volume, and not just air traffic volume alone, is what affects the economic outcomes of certain geographical areas. A cost effectiveness analysis of substituting subsidized air service with a subsidized ground service is presented and concludes that an intercity ground service network can create substantial cost savings on both a per round trip basis and a round trip-seat basis**.** It is found that, on average, one EAS round trip with a bus or shuttle results in $178.96 ~~or~~ $129.94 in cost savings per seat, respectively.

Keywords: Essential Air Services, EAS, Cost Effectiveness Analysis

INTRODUCTION

Prior to Airline Deregulation Act, airlines were required by the Civil Aeronautics Board (CAB) to provide two round trips per day to rural communities that would have otherwise been left without air service. It was argued that deregulating the air service would result in certificated air carriers shifting operations away from small communities and toward more profitable routes, leaving these small rural communities entirely without access to the national air transportation network.

This argument was further supported by the fact that, initially, a community was only eligible for EAS subsidies if it had lost its last certificated air carrier (*1*). Because of this concern, the EAS was established to provide subsidies to carriers in order to maintain at least two to four round trips per day from outlying communities to major airport hubs. It is worth noting that the subsidies went directly to air carriers and not the communities. The original legislation incorporated a sunset provision that set the expiration for the EAS subsidies at 10 years, with the assumption that air traffic would eventually become self-sustaining. This is similar to what happened with the "internal" subsidies for air service to rural areas provided by the CAB between the end of World War II and the late 1950s.

These internal subsidies worked by allowing airlines to set prices that allowed a higher profit margin at the more trafficked routes but also required them to operate in unprofitable rural areas. In that way, the rural areas were having air service "subsidized" by air passengers who traveled the more popular routes.

The EAS was reauthorized by Congress for another 10 years in 1988, and was made permanent in 1996 under the Federal Aviation Reauthorization Act. The rationale for doing so was that the EAS program was essential for the smaller communities to maintain commercial air service.

Over time, as these communities and surrounding areas have developed, the EAS has increasingly become outdated. New roads and highway systems have been built to better connect rural areas, coupled with better ground transportation technologies. Thus, rural communities now have better ground transportation alternatives, such as a bus or a shuttle, and large Interstate-type highways to connect them to the national air transportation network.

However, rural communities like those being served by the EAS program often times have local and collector roads that are lacking in quality. Despite that fact, interstate highways, which are funded by the federal government, have seen many improvements and help contribute to the overall infrastructure. Furthermore, a growing number of residents at these EAS-eligible communities are already choosing to drive directly to a primary airport, which may have lower fares and a greater variety of service options, rather than utilizing their local EAS (*2*).

Additionally, many communities can be grouped such that they can all be served with just one ground route instead of multiple air routes because many current EAS communities are sufficiently close to one another. Trying to serve multiple communities with one air route would not be practical because it is much costlier for a plane to take off and land at three separate airports than it is for a ground vehicle to make extra stops. Ironically, some routes do not even fly to the closest hub; however, while this is a waste of taxpayer resources, this study does not directly examine the operational inefficiencies which is already covered extensively in the literature.

The hypothesis of this study is that a ground service network would be able to connect the EAS communities to not only the national air system, but to all the amenities of a larger urban area, including the public ground transportation system of that area, for a much lower cost. Therefore, this study proposes that the EAS subsidy be altered from an airline subsidy to an intercity transportation subsidy so that communities can decide at the local level which mode of service best fits their collective needs.

The primary purpose of this study is to examine the fiscal viability of substituting a bus or shuttle system for the current EAS in the continental U.S. The results from this analysis will show that there are substantial cost savings on the part of the government. Furthermore, the results can be used to aid EAS community leaders in deciding how to best meet their communities' transportation needs under such a proposed regime. Therefore, the results are reported at the individual community level and the monetary gains and/or losses are reported separately from emission impacts.

Following this section is a cost effectiveness analysis and a discussion of the self-sufficiency potential of the ground transportation service. The final section summarizes the conclusions and policy implications of the findings.

COST EFFECTIVENESS ANALYSIS

The cost analysis is done individually for each community and explores both the bus and shuttle alternatives. Both bus and shuttle are included to provide a more comprehensive investigation of alternatives as there is a significant difference in capacity between the two. The communities of interest here are only those within the continental US, which means that communities in Alaska and Hawaii are excluded from this study. The analysis uses EAS data taken from the US Subsidized EAS Report for November 2014 (*3*).

This study attempts to measure the total monetary effects of switching over from EAS to either a bus or shuttle service network for each community. The relevant variables can be broken into two main groups: direct accounting costs and nonpecuniary costs. The direct accounting cost is the actual cost to run each service network. The nonpecuniary costs consist of the monetary loss of having additional travel time, effects on local economic outcomes, and the social costs of emissions.

Studies done by Bilotkach (2015) and Brueckner (2003) show that air passenger traffic have small but positive effects on economic outcomes (*4*) and (*5*). The theory that underlies these studies is that intercity travel allows agglomeration benefits from one city to "spill over" to other cities if there is sufficient travel between the two. However, both of the aforementioned studies ignored effects of intercity travel across alternative modes and thus their results likely suffer from omitted variable bias.

Furthermore, urban economic theory suggests that passenger air travel can have positive economic effects but it does not mean that these benefits are exclusive to air travel. As a consequence, the impact on the local economy of a ground transportation substitution is unknown and the impact assumed to be unaffected as long as intercity travel is maintained. Therefore, this study will ignore the relationship between air traffic and economic outcomes due to the possibility that it is intercity travel in general that positively impacts local economic outcomes and not strictly intercity travel by air.

It is also important to note that the following cost analysis only looks at a snapshot in time and does not extrapolate the costs over time; thus avoids the need for any net present value calculations. Another important note is that there are 21 communities within the EAS program that have more than one hub destination. To keep the analysis simple, only one of these hubs were chosen to compare costs with the bus and shuttle.

The EAS destination hubs were chosen based on the authors' opinion of attractiveness. If flight times between the two hubs were similar, then the cheapest destination was used. If there was a slight difference in price but a large difference in flight times, then the hub with the shorter time was chosen. In addition, the chosen driving destinations may be different than the

EAS destinations if there is a closer hub of the same class as the current EAS destination. Otherwise, the drive destinations used will be the same as the current EAS destination if no other airport of the same class or higher is closer to the EAS community. Finally, note that the driving routes in the cost comparisons are from one airport to another to keep the analysis relatively simple. Most likely, in reality this will not be the case. The methodologies of quantifying all relevant variables are each given their own separate subsection below.

Direct Costs

The direct cost analysis compares the cost of running each transportation network on a round trip basis. This is done because each community may not want to adopt only one transportation option and may instead have a combination of air, bus, and/or shuttle. Thus, comparing direct round trip cost and the direct round trip cost per seat would most benefit these communities in their decision making process without loss of utility for policy makers. The calculations for the direct round trip costs are as follows:

$$\text{RT Air Cost per Seat}_i = \frac{Annual\ EAS\ Subsidy_i + (CY\ 2014\ Passengers \times Airfare_i)}{Minimum\ RTs\ per\ Year_i \times Aircraft\ Seat\ Capacity_i} \quad (1)$$

$$\text{RT Bus Cost per Seat}_i = \frac{Drive\ Miles_i \times Bus\ Cost\ per\ Mile \times 2}{Bus\ Seat\ Capacity} \quad (2)$$

$$\text{RT Shuttle Cost per Seat}_i = \frac{Drive\ Miles_i \times Shuttle\ Cost\ per\ Mile \times 2}{Shuttle\ Seat\ Capacity} \quad (3)$$

Note that the emissions costs have not yet been added to the round trip cost calculations. To calculate only the cost per round trip, the same equations are used, except the cost is not divided by seating capacity. The subscript i means that that value is specific for community i, and RT stands for round trip. Equation (1) uses revenue passenger data taken from the U.S. DOT's *Air Carriers: T-100 Domestic Market (All Carriers)* table for the year 2014 (*6*). The round trip passenger level is estimated by taking the minimum of the outgoing and income passenger levels for each origin-destination pair. The minimum airfare is also used for Equation (1) in hopes of obtaining a more conservative estimate. The airfare numbers were taken three months in advance for the month of October, but some communities had an established EAS termination date before then, in which case the price from the last available day of service was taken. If that was not available, the community was dropped from the analysis altogether.

A bus cost per mile estimate that is used was taken from a similar cost study done by Lowell et al. (2011). The authors reported a range of possible values for the bus cost per mile, from $2.61 to $3.27 per mile (*7*). The values already incorporate a thirty percent profit margin and are based on diesel prices that were allowed to range between $3.77 and $3.99 per gallon. The estimated diesel price range is in accordance with the 2014 data provided on the U.S. Energy Information Administration's website. Thus, the estimates taken from this study are not altered in the interest of comparability as the EAS data are taken from 2014 as well. Taking the middle value in the cost range, the cost per bus mile used is $2.94 per mile. Equations (2) and (3) are multiplied by 2 to get the round trip values.

The shuttle cost per mile used is $2 per mile, which may be considered a high cost for airport shuttle service. However, a larger passenger shuttle is typically used for these types of services and drivers are typically employees, so the fully allocated cost and profit are covered by this higher estimate (*8*).

Travel Time

When choosing a form of transportation, travelers are strongly influenced not only by the price, but also by the amount of time that the various modes take. Changing from air to ground transportation usually means that travelers take more time to arrive at their destination. This section of the cost effectiveness analysis attempts to monetize travel time in order to reflect travelers' preferences with regards to intercity travel time. It should be noted, however, that the lower direct costs of ground transportation could lead to more arrival times at the hub airport, which may also significantly reduce the time travelers wait before the air trip to their final destinations. The same may also be true for returning trips.

In order to measure the cost to travelers for this additional time spent, a model was created to predict the amount of additional time spent when traveling by ground as opposed to air. This model was designed after a similar model in Lowell et al. (2011). The present study assumes that everyone who leaves the EAS community will return, and therefore the time comparisons are measured on a round trip basis for the same reasons as those cited in the direct cost comparisons.

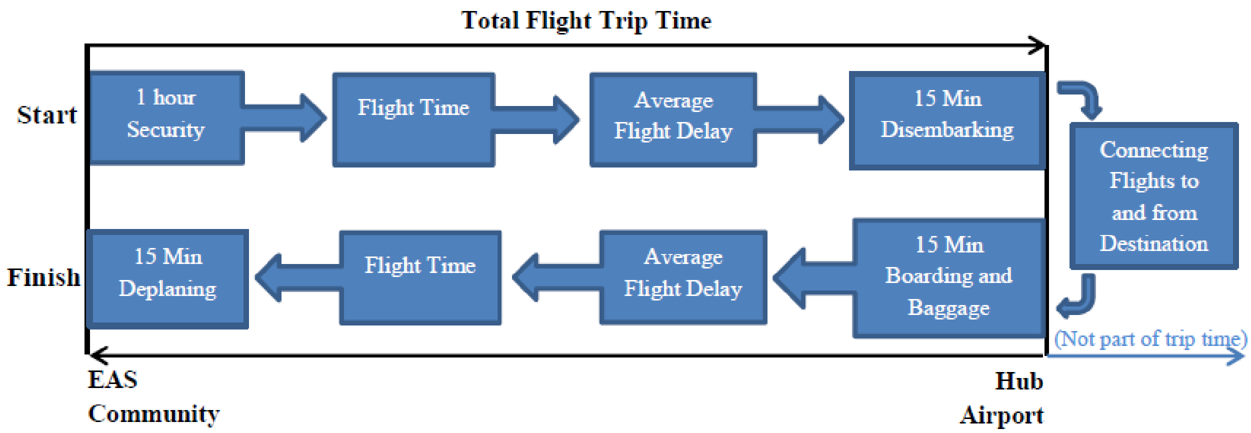

Figure 1.

Figure 1 shows how the calculation of travel time through the EAS is determined. Average flight block times are taken from the Aviation System Performance Metrics (ASPM) – City Pair Analysis Database for the 2014 calendar year (*9*). Block times indicate the time it takes for an aircraft to go from departure gate to arrival gate and includes average delay as well as ground times. Some city pairs of interest were not included in the ASPM database[1]. In such cases, the flight times were taken from the Expedia website, with supplemental data from the Priceline website and Google Flights if they were not available on Expedia. For these specific cities, the average flight delay was calculated using Equation (4), which is based on performance data for each airline providing flights to each EAS community.

$$AVG\ Flight\ Delay = (probablity\ of\ flight\ delay)(avg.\ delay\ when\ delays\ occur) \quad (4)$$

For the bus or shuttle, the total trip time was determined as depicted below in Figure 2. The layout of Figure 2 assumes that the EAS is primarily used as a connecting flight which is why the one hour of security is added to the estimation. In reality, there are many whose final destination is the same as the connecting hub of the EAS. However, data that tracks air travel

[1] Airports not included in the ASPM database include: MCN, GLH, GGW, GDV, HVR, SDY, OLF, MSS, OGS, FKL.

patterns at the individual level do not exist and so there is no way to know what proportion of EAS users have final destinations that differ from the connecting hub. In order to avoid choosing arbitrary proportions, this study can either assume that the EAS serviced hub is the final destination or not. It would seem more reasonable to assume that all users of the EAS have destinations other than the connecting hub. This is because if the probability of each major hub of the same class being the final destination were all equal, then the probability of the final destination being the same as the connecting hub would be very small compared to the its complement probability. Thus, we will assume that the EAS is primarily used as a connecting flight.

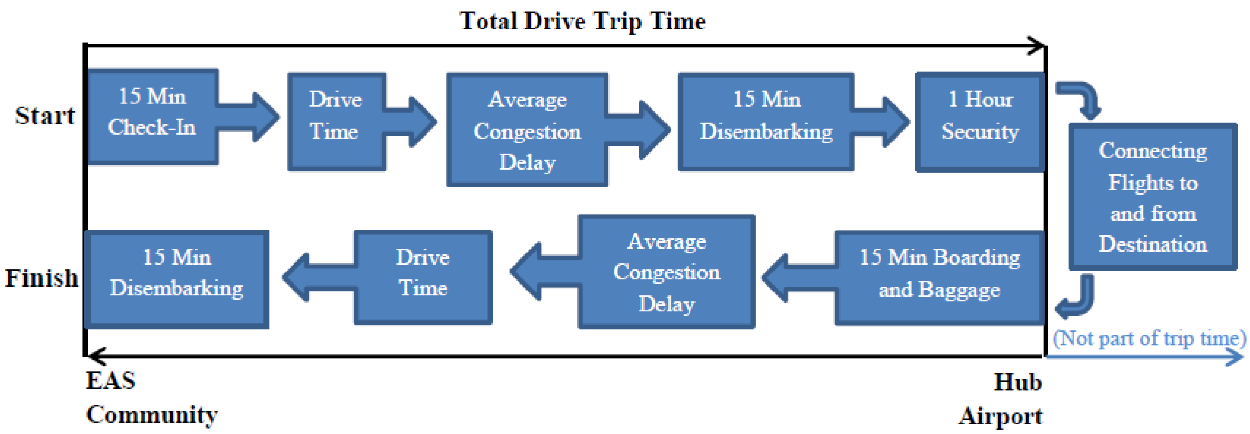

Figure 2.

On the return portion of the trip, the same drive time and delay time were used as the outgoing trip. The average congestion delay for each community was calculated using Equation (10), and data were collected for the Travel Time Index and the number of rush hours for each urban area from the 2012 Annual Urban Mobility Report (*10*). The Travel Time Index is the ratio of travel time during peak congestion times to travel time when no congestion exists and thus measures the intensity of the congestion. The number of rush hours is the number of hours per day that congestion is present in the urban area, which helps determine the probability of hitting congestion.

$$Avg.\,Congestion\ Delay = (congestion\ intensity)(.6)(prob.\,of\ hitting\ congestion) \qquad 5)$$

Once the total times for ground and air services are calculated for each EAS community, the total travel time, for bus and shuttle, is subtracted from the air total travel time to yield the time lost per trip when traveling by ground instead of air. In order to monetize this time, several steps are taken. According to the U.S. DOT, 59.6% of intercity air traffic is personal and 40.4% is business, and the value of travel time saved (VTTS) is equal to 70% of their income for personal travel and 100% for business travel (*11*). Therefore, to discern the monetary value of the time difference spent traveling, the 2013 median annual income of each EAS community was collected from the American Community Survey and converted to an hourly income (*12*). The number of round trip passengers was taken from the same place as before. Equation (6) is used to produce the total monetary value of the annual time difference between traveling by ground transportation as opposed to traveling by EAS flight, measured in U.S. dollars per year.

$$Value\ of\ Time\ Lost\ Per\ Trip = (hourly\ income)(time\ diff.)(enplanements)[(1)(.404) + (.7)(.596)] \quad (6)$$

By using the income figure that is specific to the EAS community, this calculation assumes that only the EAS community constituents travel to and from the EAS designated area. However, in reality this may not be true and thus, these estimates are likely biased but the direction of the bias is not obvious.

Emissions

To calculate aircraft emissions for one flight, many variables are necessary. First, each route serviced for any EAS community has a reported aircraft that is used by the contracted air carrier and is reported on the U.S. DOT's website under US Subsidized EAS Report for April 2015 (*13*). All the reported aircraft fall under one of three engine categories: turboprop, turbofan, and piston. By combining data from various sources it is possible to get estimated emissions indices for each aircraft and calculate the total emissions impact of each EAS route. The pollutants of interest are nitrogen oxide (NO_X), carbon monoxide (CO), and hydrocarbons (HC, sometimes called volatile organic compounds or VOCs). No aircraft emissions databank had an emissions index for carbon dioxide (CO_2), so this emission was left out of the analysis of bus transport as well.

This report follows the guidelines laid out by the U.S. DOT Transportation Investment Generating Economic Recovery (TIGER) *TIGER Benefit-Cost Analysis (BCA) Resource Guide* (*14*). This guide provides a methodology to monetize the negative social impacts of certain pollutants. According to the guide, one short ton (2,000 lbs) of VOCs that are emitted costs society $1,813, and one short ton of NO_X costs $7,147. The CO emissions were monetized according to calculations by the Victoria Transport Policy Institute (2013). The emission values for CO were originally reported in 1989 and for this study were converted to 2015 dollars, yielding a value of $5,223 per short ton of CO emissions (*15*).

The emissions for ground transportation does not involve as many steps. Because the miles per gallon estimate of the respective vehicles is the only difference between the bus and shuttle emissions calculations, the two were evaluated at the same time. The data for the emissions index (grams per mile driven) are collected and multiplied by the total miles driven per round trip for each EAS community. The data for NO_X, CO, and VOCs were taken from Table 7.1.1 of the H-258 document on the EPA website (*16*). The values are based on a 2001 heavy duty diesel-powered vehicle with 50,000 miles on the odometer. Although data were found for CO_2 and particulate matter (PM) for ground transportation, these figures were left out of the study in order to more accurately compare the air and ground emission costs. Once the emissions emitted per round trip are calculated, the amounts are monetized. Each type of emission is converted from grams per mile into U.S. dollars per ton. This yields the dollar cost placed upon the emissions emitted per round trip for every EAS community. The ground transportation emissions are monetized using the same calculations as those used for the aircraft emissions. The emission types are then summed by community to produce the total emissions dollar value for each EAS community.

RESULTS

The results do not include Kingman, Arizona; Prescott, Arizona; Macon, Georgia; Moab, Utah; and Vernal, Utah because the air carriers at these communities terminated their EAS contracts early, which resulted in the researchers' inability to gather the flight data for these communities. Table 1 shows the 20 communities with the highest round trip cost savings as a result of substituting the EAS with a bus and shuttle transportation service.

Table 1. Communities with the Highest Cost Savings per RT

Bus							Shuttle						
State	EAS Community	EAS Airport Code	Drive Destination Airport Code	Drive Miles	RT Bus Cost Savings	Emissions Impact from Ground Substitution	State	EAS Community	EAS Airport Code	Drive Destination Airport Code	Drive Miles	RT Shuttle Cost Savings	Emissions Impact from Ground Substitution
MI	Sault Ste. Marie	CIU	DTW	337	$13,638.64	$ 1,382.51	MI	Sault Ste. Marie	CIU	DTW	337	$14,272.20	$ 1,382.51
KS	Garden City	GCK	DEN	340	$13,181.55	$ 531.21	KS	Garden City	GCK	DEN	340	$13,820.75	$ 531.21
IA	Sioux City	SUX	OMA	88.7	$13,128.01	$ 660.57	IA	Sioux City	SUX	OMA	88.7	$13,294.77	$ 660.57
MI	Pellston	PLN	DTW	289	$12,382.88	$ 1,494.08	MI	Pellston	PLN	DTW	289	$12,926.20	$ 1,494.08
MO	Joplin	JLN	MCI	166	$12,365.61	$ 516.66	MO	Joplin	JLN	MCI	166	$12,677.69	$ 516.66
KY	Paducah	PAH	BNA	150	$ 9,799.71	$ 1,714.19	KY	Paducah	PAH	BNA	150	$10,081.71	$ 1,714.19
IA	Waterloo	ALO	MSP	190	$ 8,637.79	$ 473.11	IA	Waterloo	ALO	MSP	190	$ 8,994.99	$ 473.11
NY	Watertown	ART	PHL	334	$ 8,308.56	$ 1,318.47	NY	Watertown	ART	PHL	334	$ 8,936.48	$ 1,318.47
WI	Eau Claire	EAU	MSP	91.4	$ 7,942.90	$ 1,505.38	MI	Escanaba	ESC	ORD	300	$ 8,304.88	$ 1,512.50
MI	Escanaba	ESC	ORD	300	$ 7,740.88	$ 1,512.50	WI	Eau Claire	EAU	MSP	91.4	$ 8,114.73	$ 1,505.38
MS	Meridian	MEI	MSY	208	$ 7,605.05	$ 2,092.51	MS	Meridian	MEI	MSY	208	$ 7,996.09	$ 2,092.51
MS	Laurel/Hattiesburg	PIB	MSY	132	$ 7,514.44	$ 2,026.96	MS	Laurel/Hattiesburg	PIB	MSY	132	$ 7,762.60	$ 2,026.96
NE	Grand Island	GRI	DEN	404	$ 6,988.02	$ 689.92	NE	Grand Island	GRI	DEN	404	$ 7,747.54	$ 689.92
WV	Greenbrier/White Sulphur	LWB	IAD	247	$ 6,634.72	$ 82.69	WV	Greenbrier/White Sulphur	LWB	IAD	247	$ 7,099.08	$ 82.69
MN	Chisholm/Hibbing	HIB	MSP	214	$ 6,187.50	$ 1,023.35	MN	Chisholm/Hibbing	HIB	MSP	214	$ 6,589.82	$ 1,023.35
CO	Pueblo	PUB	DEN	131	$ 5,968.82	$ 83.98	WI	Rhinelander	RHI	MSP	238	$ 6,344.48	$ 1,120.57
WI	Rhinelander	RHI	MSP	238	$ 5,897.04	$ 1,120.57	CO	Pueblo	PUB	DEN	131	$ 6,215.10	$ 83.98
NY	Plattsburgh	PBG	ALB	151	$ 5,819.61	$ 92.14	NY	Plattsburgh	PBG	ALB	151	$ 6,103.49	$ 92.14
MN	Bemidji	BJI	MSP	233	$ 5,523.29	$ 1,238.33	MN	Bemidji	BJI	MSP	233	$ 5,961.33	$ 1,238.33
CA	Merced	MCE	SFO	132	$ 5,039.95	$ 116.29	MT	Butte	BTM	SLC	423	$ 5,484.63	$ 1,521.88

As shown in Table 1, the round trip bus and shuttle benefits are very close together in value, with the shuttle benefits being just slightly larger. This result seems reasonable, considering that there is only a 94 cent difference between the costs per mile of the two modes. It may be striking for some that there are communities in Table 1 with drive miles as high as 404 miles. This is due to the fact that the regions' median income from 2013 may not be very high, and if a community also happens to have a low level of passenger traffic, then the net monetary effects per round trip of having a longer travel time will be very low. The numbers from Table 1 can be interpreted as being the average cost savings from each round trip when the EAS is substituted by either ground transportation mode. These cost savings per round trip may seem exaggerated. This is because the number of round trips used for the calculation is the minimum number of round trips imposed by the U.S. DOT. This means that if a community has a high enough traffic volume, then its actual number of round trips made in year would be well above the minimum and would thus inflate the benefits per round trip calculation. The benefit per round trip is a valuable measure for communities that experience a low level of intercity travel because they will most likely have low ridership. As such, these low-trafficked communities do not need to consider the added benefit of being able to transport more seats per dollar.

Table 2. Communities with Highest Cost Savings per RT per Seat

Bus								Shuttle							
State	EAS Community	EAS Airport Code	Drive Destination Airport Code	Drive Miles	RT Bus Cost Savings per Seat	Emissions Impact from Ground Substitution		State	EAS Community	EAS Airport Code	Drive Destination Airport Code	Drive Miles	RT Shuttle Cost Savings per Seat	Emissions Impact from Ground Substitution
NM	Clovis	CVN	ABQ	233	$463.46	$ 96.76	NM	Clovis	CVN	ABQ	233	$ 410.70	$ 96.76
ME	Bar Harbor	BHB	BOS	271	$448.10	$ 1,330.50	ME	Bar Harbor	BHB	BOS	271	$ 386.74	$ 1,330.50
MT	Wolf Point	OLF	BIL	315	$426.33	$ 1,383.94	MT	Glendive	GDV	BIL	225	$ 360.91	$ 1,555.78
MT	Glendive	GDV	BIL	225	$411.85	$ 1,555.78	MT	Wolf Point	OLF	BIL	315	$ 355.00	$ 1,383.94
MT	Havre	HVR	BIL	254	$401.89	$ 1,224.35	MT	Havre	HVR	BIL	254	$ 344.37	$ 1,224.35
MT	Glasgow	GGW	BIL	278	$388.43	$ 1,518.11	MT	Glasgow	GGW	BIL	278	$ 325.48	$ 1,518.11
MO	Fort Leonard Wood	TBN	STL	139	$323.16	$ 846.04	MO	Fort Leonard Wood	TBN	STL	139	$ 291.69	$ 846.04
NY	Massena	MSS	SYR	161	$322.75	$ 1,032.43	NY	Massena	MSS	SYR	161	$ 286.29	$ 1,032.43
MI	Ironwood/Ashland, WI	IWD	MSP	230	$321.79	$ 192.35	CA	Merced	MCE	SFO	132	$ 279.12	$ 116.29
CA	Merced	MCE	SFO	132	$309.01	$ 116.29	PA	Lancaster	LNS	PHL	83.2	$ 276.84	$ 1,129.23
NY	Ogdensburg	OGS	SYR	123	$304.12	$ 1,159.95	NY	Ogdensburg	OGS	SYR	123	$ 276.27	$ 1,159.95
PA	Lancaster	LNS	PHL	83.2	$295.68	$ 1,129.23	MI	Ironwood/Ashland, WI	IWD	MSP	230	$ 269.71	$ 192.35
IA	Mason City	MCW	MSP	129	$287.51	$ 177.22	IA	Mason City	MCW	MSP	129	$ 258.30	$ 177.22
MT	Sidney	SDY	BIL	272	$286.82	$ 1,600.88	IA	Sioux City	SUX	OMA	88.7	$ 243.42	$ 660.57
SD	Huron	HON	MSP	287	$280.13	$ 72.88	MD	Hagerstown	HGR	IAD	73.7	$ 230.27	$ 808.74
MI	Sault Ste. Marie	CIU	DTW	337	$276.38	$ 1,382.51	MT	Sidney	SDY	BIL	272	$ 225.23	$ 1,600.88
NY	Saranac Lake/Lake Placid	SLK	BOS	323	$274.48	$ 1,465.00	MO	Kirksville	IRK	MCI	175	$ 221.84	$ 1,077.22
KS	Garden City	GCK	DEN	340	$267.27	$ 531.21	NY	Jamestown	JHW	PIT	183	$ 220.28	$ 1,111.96
IA	Sioux City	SUX	OMA	88.7	$263.51	$ 660.57	SD	Huron	HON	MSP	287	$ 215.14	$ 72.88
NY	Jamestown	JHW	PIT	183	$261.71	$ 1,111.96	MO	Joplin	JLN	MCI	166	$ 211.50	$ 516.66

Table 2 shows the top 20 communities with the highest cost savings per round trip per seat. These values can be interpreted as the net round trip benefit of transporting one seat by bus or shuttle instead of through the EAS program. This perspective allows communities with high intercity traffic to interpret the per seat costs as per passenger costs; this measure can lead to additional savings by allowing communities to choose the alternative with the higher total cost but higher seat capacity.

Both Table 2 and 1 report the monetized effects of emission differences between air and ground modes on a round trip basis. Positive values in this column indicate a net cost savings. Expectedly, all communities in the analysis have positive cost savings regarding emission differences.

Note that the round trip benefit values per seat of shuttle are lower than the round trip benefits per seat from a bus substitution. This is because the difference in seating capacity between EAS and shuttle is much greater than the difference in the cost per mile figures used.

The communities in both shuttle and bus from Table 2 are the top 20 candidates for substituting EAS with a ground transportation service network based on the round trip benefits per substituted seat. The main results tables and calculations can be acquired by contacting the authors of this study.

POTENTIAL SELF-SUFFICIENCY

The potential for the ground transportation service to reach a level of self-sufficiency rests on the ability for a community to meet the minimum level of bus or shuttle ridership at the maximum price level. The maximum price level is determined in Equation (7).

$$Price\ Airfare_i - VTTS_i = Maximum\ Bus \text{ or } Shuttle\ Price_i$$

7)

The idea is that the maximum bus price has to be less than the price of a plane ticket, all else being equal. This is because the price of the bus ticket has to be set such that it successfully compensates the consumer for the longer travel time associated with the ground alternative. The level of compensation then depends on how much the community “suffers” as a result of the extra travel time, or, in other words, its value of travel time saved (VTTS). Only the VTTS data for business travelers were used because the VTTS is highest for business travelers. This restriction gives the least upper bound on price and provides a justification for the assumption that both personal and business travelers would use the ground service because the maximum price for business travelers is lower than for personal travelers.

For Equation (8), the analysis assumes that the total cost of driving either a bus or shuttle (which includes a profit margin) for any particular route is equal to the minimum level of revenue required for the ground service to be profitably maintained. Therefore, the minimum required revenue (which is the total driving cost) divided by the maximum price results in the minimum level of ridership.

$$\text{Minimum Ridership} = \frac{Total\ Drive\ Cost_i}{Maximum\ Bus \text{ or } Shuttle\ Price_i} \tag{8}$$

Table 3 shows the 20 communities with the highest sustainability potential with regards to the bus and shuttle substitution. All values are rounded to the next greatest integer (e.g., 0.02 would be rounded to 1).

Table 3.

Communities with Highest Sustainability Potential										
Bus					**Shuttle**					**Average EAS Ridership per RT**
State	**EAS Community**	**Drive Destination(s)**	**Drive Miles**	**Min Bus Ridership (based on price)**	**State**	**EAS Community**	**Drive Destination(s)**	**Drive Miles**	**Min Shuttle Ridership (based on price)**	
IA	Sioux City	OMA	88.7	2	IA	Sioux City	OMA	88.7	1	47
CO	Pueblo	DEN	131	2	CO	Pueblo	DEN	131	1	9
MS	Laurel/Hattiesburg	MSY	132	2	MS	Laurel/Hattiesburg	MSY	132	2	3
WI	Eau Claire	MSP	91.4	4	WI	Eau Claire	MSP	91.4	2	35
TN	Jackson	MEM	82.6	4	TN	Jackson	MEM	82.6	3	3
MO	Joplin	MCI	166	4	MO	Joplin	MCI	166	3	49
AR	Jonesboro	MEM	76.9	4	AR	Jonesboro	MEM	76.9	3	6
MS	Meridian	MSY	208	5	MS	Meridian	MSY	208	3	5
WV	Morgantown	PIT	89.3	5	WV	Morgantown	PIT	89.3	3	12
KY	Paducah	BNA	150	5	KY	Paducah	BNA	150	4	40
WV	Clarksburg/Fairmont	PIT	107	6	WV	Clarksburg/Fairmont	PIT	107	4	7
CO	Alamosa	ABQ	204	6	CO	Alamosa	ABQ	204	4	5
PA	Johnstown	PIT	90.4	6	PA	Johnstown	PIT	90.4	4	6
IA	Waterloo	MSP	190	7	IA	Waterloo	MSP	190	5	43
NE	Kearney	OMA	187	7	NE	Kearney	OMA	187	5	11
MI	Sault Ste. Marie	DTW	337	7	MI	Sault Ste. Marie	DTW	337	5	40
WV	Beckley	CLT	214	7	WV	Beckley	CLT	214	5	6
NY	Ogdensburg	SYR	123	8	NY	Ogdensburg	SYR	123	5	7
MI	Pellston	DTW	289	8	MI	Pellston	DTW	289	6	54
KS	Garden City	DEN	340	9	KS	Garden City	DEN	340	6	49

Tables 3 shows the 20 EAS communities with the lowest estimated minimum ridership required for the ground transportation to operate without the need for subsidy dollars. Communities whose existing average EAS ridership per round trip is less than the estimated minimum level of sustainable ridership for the ground modes are filtered out. The driving destination columns are expressed as the three-letter airport codes. Remember that the cost of transportation has multiple dimensions: price, time, convenience, and comfort. Therefore, these minimum ridership estimates are most likely biased downwards because they only incorporate the compensation for increased travel time. This study has also made the assumption that ground transportation out competes the EAS in the convenience dimension because more round trips can be made with the ground service network. However, it does not account for the possibility that a community can have a combination of air, bus, and shuttle. Unless it is assumed that if and when a community adopts a ground transportation alternative they use only that alternative, it is not certain that the ground transportation service will outcompete the EAS on the convenience factor. The comfort factor is ambiguous because it is the most subjective. For example, a very tall person may find that a coach bus is exponentially more comfortable than a packed nine-seat Cessna airplane. Or if someone is more susceptible to colder temperatures, this person may find ground transportation to be much more comfortable because small regional airline fleets do not always have ideal cabin temperatures.

In fact, the shuttle estimates may be even more biased downwards than the bus estimates due to the fact that shuttles do not have restrooms built into them. This will cause the shuttle to be inferior to EAS with respect to the comfort factor. This relative discomfort will only increase as the driving distance and travel time increases.

Regardless of the likely downward bias, the communities that are listed in both Tables 4 and 5 are the most likely to be able to maintain intercity ground services without the need for government subsidies.

CONCLUSIONS AND POLICY IMPLICATIONS

The aim of the recommendations provided in this paper is to provide the most useful information to policy makers and the individual communities that are part of the EAS program so they can decide how to optimize their intercity transportation subsidy dollars. Almost all of the communities under study would result in a net savings for the government if the EAS were substituted. The only exception is Cody, WY which would result in a net round trip loss of $1,111.04 and $255.64 for bus and shuttle, respectively.

There are two reasons why the benefits of substitution would be inflated. The first is that the subsidized air services are reimbursed on a per flight basis, which means that the subsidy dollar amount in the U.S. DOT report is the dollar value that is set aside to be disbursed later in the year. Thus, the appropriated subsidy amount that is reported is not the actual subsidy amount that is received by the air carrier, which leads to an overestimation of the cost of providing subsidized air service. Second, the number of round trips per weekday reported by the U.S. DOT is only the minimum number of round trips required of the air carriers. If a community has a high level of traffic, then it is very likely that the community will make more round trips than the reported number. This would then lead to a higher estimated EAS cost per round trip.

Future studies may want to update fuel prices and air service costs as both of these values have trended down over the years since 2014. It is also possible to use historical cost values and forecast them into the future to obtain an overall picture of the cost implications of restructuring the EAS program. Lastly, this study failed to evaluate personal driving as an alternative to the EAS program. Personal driving is arguably the biggest competitor to short haul flights and thus, future studies can improve upon this research greatly by incorporating that.

A ground transportation system would have the potential to reach a larger group of people and would more effectively benefit many communities currently being served by the EAS. Furthermore, the process for selecting a qualified certificated air carrier to operate at these rural communities is cumbersome. Early contract terminations are not uncommon among the EAS communities, and the process of finding a new eligible carrier can take months. Finally, the authors recognize that all of these conclusions hinges on the assumption that intercity air traffic itself does not provide any clear economic benefits. Rather, it is intercity traffic in general that is the source of positive economic outcomes and thus are not factored in the cost benefit analysis.

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