



**U.S. Department of
Transportation**
Office of the Secretary
of Transportation

Under Secretary for Policy

1200 New Jersey Avenue, S.E.
Washington, DC 20590

July 9, 2014

MEMORANDUM TO: Secretarial Officers
Modal Administrators

From:

Peter Rogoff
Acting Under Secretary for Policy, x64540

Prepared by:

Roberto Ayala
Economist, Office of Economic and Strategic Analysis; x64825

Subject:

Revised Departmental Guidance on Valuation of Travel Time in
Economic Analysis

The value of travel time is a critical factor in evaluating the benefits of transportation infrastructure investment and rulemaking initiatives. Reduction of delay in passenger or freight transportation is a major purpose of investments, and rules to enhance safety sometimes include provisions that slow travel. As the Department expands its use of benefit-cost analysis in evaluating competitive funding applications under such programs as the TIGER Grant program and the High-Speed Intercity Passenger Rail program, it is essential to have appropriate, well-reasoned guidance for valuing delays and time savings.

This version of the guidance updates the value of travel time savings with median household income information from the 2012 US Census Bureau and salary information from the Bureau of Labor Statistics Occupational Handbook 2012. The household income data are drawn from the Census Bureau's American Community Survey, and are not released until the September following the year in which they are collected; the 2012 data are thus the most recent data available. The percentages of earnings used to determine the value of travel time savings (shown in tables 1 and 2) remain unchanged. The revised dollar values of travel time savings are shown in tables 3, 4, and 5. We have also revised our estimate of future growth in real incomes based on revised projections from the Congressional Budget Office (see page 14).

DOT published its first guidance on this subject, "Departmental Guidance for the Valuation of Travel Time in Economic Analysis," on April 9, 1997, to assist analysts in developing consistent evaluations of actions that save or cost time in travel. That memorandum recommended an array of values for different categories of travel, according to purpose, mode and distance. For each category, the Guidance specified a percentage of hourly income that would normally be used to determine the value per hour of savings in

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travel time, a range of percentages defining upper and lower bounds about the normal value for sensitivity testing, and an average hourly income level. Special values were assigned to walking and waiting time, travel by general aviation, and truck drivers.

Revised guidance, labeled as “Revision 1,” was issued on February 11, 2003. A further revision, labeled “Revision 2,” was issued on September 28, 2011 and adjusted these values for use in 2011, incorporated some additional values and procedures, and redefined the sources of data. In particular, time savings in high-speed rail travel were identified as equivalent to those in air travel and distinguished from intercity travel by conventional surface modes. Although we found no need to alter the normal percentages of hourly income and the ranges of percentages that were assigned in the 1997 memorandum, more recent and appropriate sources were used to specify hourly incomes. In particular, the income data used in that guidance were derived from public and regularly updated sources that allow the Department to update the values annually. Also, the revised guidance projected higher values of time in future years to reflect reasonably anticipated growth in real incomes. This revision also included a bibliography of documents available online that provide an overview of the research literature in the field and the recommendations developed by experts in several countries.

A link to this revised guidance will be found on the Office of Transportation Policy website at: <http://ostpxweb.dot.gov/policy/reports.htm>. Questions should be addressed to Roberto Ayala, (202) 366-4825 or roberto.ayala@dot.gov in the Office of Transportation Policy.

Attachment

cc: Regulations Officers and Liaison Officers

The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations Revision 2 (2014 Update)

Introduction

Many actions by the Department of Transportation and other governmental agencies are designed to benefit travelers by reducing the time spent in traveling. Actions in pursuit of other goals such as improved safety may also have the intended or unavoidable consequence of slowing travel. The purpose of this document is to state the procedures approved for use by all administrations within DOT when evaluating reductions or increases in passenger travel time that result from such actions. The value of travel time savings (VTTS) derived here is to be used in all DOT benefit-cost or cost-effectiveness analyses.

Governments employ benefit-cost analysis to ensure that their regulatory actions and investments in transportation infrastructure will use society's resources most efficiently and to promote transparency in decision-making. Doing so often requires assigning money values to factors that lack observable market prices. As one of the most important of these factors, travel time has been the subject of research in many countries over several decades. Individual experts and official panels have reviewed and summarized this literature repeatedly as it has grown, and this document draws on that body of research and interpretation to establish procedures for use in valuing travel time consistently throughout DOT.

These expert summaries represent only a rough consensus about relevant variables and relationships among values. Because VTTS varies widely, standard values for government decisions must ignore or simplify many important factors. A complete model of real travel choices would require a large number of variables and associated coefficients, yet there are no sources for most of these variables, and the coefficients estimated from available data vary between studies and are subject to considerable uncertainty and interpretation. Combining individual decisions to draw conclusions for an entire society implies subjective assumptions about the influence of incomes and other personal characteristics. Therefore, the object of this guidance must be seen as construction of a useful framework for assigning values to government actions, rather than distilling precise scientific conclusions from the literature or predicting travel behavior.

The initial Departmental guidance for the valuation of travel time in economic analysis was published on April 9, 1997, and the first tables of revised values were published on February 11, 2003. Part of the reason for the long intervals between revisions was that certain data were available only from private sources or updated infrequently. The resulting delay and lack of transparency was inconvenient, confusing, and a potential cause of economic inefficiency. Consequently, we revised our guidance in 2011 to derive VTTS from public and regularly published data that permits the Department to

issue annual updates. We use median income levels, rather than means, as consistently as possible. We believe that this approach reflects the valuations of typical travelers in diverse populations more reliably and yields conclusions that are less sensitive to fluctuations in extreme values. We also include a method by which analyses of actions that have long-term impacts should incorporate expected growth in VTTS.

General concepts

The demand for travel is generally derived from the demand for activities it permits at either end of the trip, just as sporting equipment is valued only for the complementary sport it permits. In contrast, travel time must be conceived as having a negative demand, a consumer's willingness to pay to have less of it. This too is derived, not from complements, but from substitutes, i.e., the time available for activities at origin or destination, which may vary greatly in urgency. The value of time saved from travel will depend on the traveler, the circumstances of the trip, and the available transportation options. There can be no assurance in principle that these factors will be stable. A large share of individual trips, however, particularly commuting to work, have similar purposes and are repeated on daily and weekly schedules. By focusing on a few choices of mode and route (e.g., rail transit vs. private auto, toll highway vs. parallel free thoroughfare) researchers have approximated explanations of travelers' decisions with a manageable number of variables yet with some confidence that their conclusions can be applied to a reasonably large share of travel by the larger community.

The values so derived are broadly representative and practically useful for estimating social benefits—the purpose for which this guidance is intended. They cannot be used to predict the number of travelers who would choose a specific mode or route, however. Such predictions depend on the distribution of time values over the population, rather than the most common value, and on the number of travelers who are close to the margin in deciding between alternatives.

The value of reducing travel time expresses three principles. First, time saved from travel could be dedicated to production, yielding a monetary benefit to either travelers or their employers. Second, it could be spent in recreation or other enjoyable or necessary leisure activities for which individuals are willing to pay. Third, the conditions of travel during part or all of a trip may be unpleasant and involve tension, fatigue, or discomfort. Reducing the time spent while exposed to such conditions may be more valuable than saving time on more comfortable portions of the trip. These principles underlie the distinctions among values recommended in this guidance.

Specific topics

Reliability

Closely associated with VTTS, reliability has long been viewed as a source of utility distinct from reduction of the expected trip time. If travelers are uncertain about travel time, they typically include a “buffer” in their schedules, leaving early and sacrificing a known amount of time at the origin to insure against a more costly delay in arriving at the destination. This insurance will be frequently unnecessary or excessive and occasionally inadequate. Alternatively, insuring against delay may mean choosing a more reliable route or mode with a slower expected speed or a higher monetary cost.

There are several ways to measure the travelers’ experience and define their perception of future delay risks, including standard deviation of trip time, difference between the 90th percentile trip time and the median (or between other convenient points on the distribution), or the probability of lateness beyond a fixed target. Furthermore, variation of travel time over some period will differ between origin-destination pairs, depending both on the reliability of travel on each trip segment and on the correlation of delays between segments.

Thus, a “value of reliability” is much more complex to estimate than an average VTTS, since it requires knowledge of the joint distribution of travel times and of the rates of change of value at the margins, rather than just the means. Studies have been conducted in several countries, using different measures of reliability, and suggestive results have been produced. Although it may be possible to derive estimates for specific cases, we are not yet prepared to provide guidance for routine valuation of reliability. In contrast to differences in reliability among modes or routes, however, improvements in reliability on a single route will often be linked to reductions in expected travel time, so that one possible approach is to add an allowance to VTTS to reflect the value of improved reliability.

Size of time change

Another subject of discussion has been whether VTTS should be ignored below some threshold increment of time saved. Some research has suggested the conclusion that discrete, small savings may have negligible benefits. See Australia Bureau of Transport Economics, Fosgerau *et al.*, Mackie *et al.* (2001, 2003).

There is no persuasive evidence of where such a threshold might be for any population or how it could be used to predict an appropriate threshold for another. A more important problem is that all changes in travel time resulting from government actions are composed of many smaller changes, and it would be impossible to identify particular changes considered big enough to affect each individual decision. To evaluate the aggregate impact of any action, therefore, we must assume that the value of each minute of saved time is constant, regardless of the total time required for a trip.

Value of Time in Freight Transportation

Most of the VTTS literature focuses on passenger travel, rather than freight transportation. Estimates have been made of the labor costs of freight vehicle operators (e.g., truck drivers or locomotive engineers) and of the operating costs of freight vehicles that would be affected by changes in travel time. The value of time to shippers (i.e., the owners of the freight that is being transported) cannot be estimated so easily, however. Because freight in transit represents unproductive capital that incurs an interest cost, part of the benefit of saved time will be proportional to the time saved, the interest rate, and the value of the freight. The principal obstacle to estimating this value is likely to be the heterogeneity and uncertainty of freight categories affected by any specific time saving. Each corridor or mode would thus require a specific estimate of the composition of freight carried. The cost of freight transportation time will also be influenced by factors independent of value, such as how quickly products become obsolete (because of fashion or technological obsolescence), whether the products spoil over time (as do agricultural commodities), and whether some production process is dependent upon timely delivery. Various reasons, then, explain why products may be “perishable” in the sense that their value declines appreciably while they are in transit. The cost to shippers may also depend on business practices, such as the amount of inventory kept on hand, and the likelihood of running out of inventory because of shipment delays.

The value of time in freight transportation is thus considerably more complex than is the case in passenger travel. Although we are not yet prepared to offer guidance on this issue, we are conducting research, and hope that additional information will permit concrete recommendations in the future.

Determinants of VTTS

Research into VTTS is conducted, not merely to understand the motives of travel decisions taken by the sampled individuals, but to estimate the influence of measurable factors on other groups, often remote in time and place. Each estimate depends on the demographic characteristics of the traveling population, the mode, time, location, and purpose of travel, and the menu of available alternatives, so the selected explanatory variables must be important for these decisions, practically observable or published, and also obtainable for new samples. Not all relevant factors can be controlled for in a single study or measured consistently for new studies or populations affected by government actions. Our object is therefore to express VTTS in terms of a limited number of variables that have been used in empirical research and are likely to be available for application in new analyses. The sources of variation will inevitably be simplified and distorted, but the result may be a realistic approximation. The variables discussed here are those that are most common in the primary research literature and have been found most useful for applied evaluations.

Trip purpose

The principal distinction in trip purpose is that between “on-the-clock” business travel time, for which a market wage is paid, and personal or leisure time allocated according to the traveler’s preferences. In some cases, commuting is treated as a separate category, intermediate between personal and business, but more frequently it is included in personal travel. Research has typically found VTTS for personal travel to be lower than the hourly earning rate. This conclusion does not imply that leisure is less intrinsically desirable than paid work. In theory, a worker’s hourly wage is equal to his marginal value of time, but with an institutionally fixed working day, this concept can be no better than an approximation. People who earn a salary may have few opportunities to convert saved time into added income, which they would have to do to equate VTTS on and off the clock. Inclusion of commuting in personal travel is consistent with the hypothesis of fixed hours for salaried work. Personal travel may also be undertaken to enjoy the passing scenery or the qualities of a particular mode: a sports car, cruise ship, or steam railroad. In such a case, VTTS could actually be negative, the individual being willing to pay to spend more time traveling.

In business travel, though it may seem paradoxical, the treatment of commercial drivers (whose travel time is spent working) and travelers who are unable to perform work *en route* should be identical. In either case, savings in travel time are made available for additional productive work. When work can be performed during travel by means of a laptop computer, a mobile telephone, documents on paper, or discussion among travelers, time savings may increase productivity only slightly, if at all, implying a lower VTTS.

Personal characteristics

Demographic variables such as age, sex, education, and employment are widely incorporated as explanatory variables in social and economic research and may well influence VTTS. While they are sometimes included in empirical studies, they are unlikely to be practical for appraising the impact of government actions. More closely associated with VTTS are the distinctions between drivers and passengers and between parents and children. Clearly, in a public transit vehicle or a car pool, each passenger may have an independent value of time, and the value of speeding the trip can be conceived as the sum of values for individual vehicle occupants. In private vehicles, the case is more ambiguous. Adult or child passengers may be “along for the ride” and have no pressing business that would influence the driver’s decisions. Alternatively, the driver’s motive for speeding travel may be altruistic or joint with the passengers’ (rushing a child to the emergency room or a group to a show). Without the possibility of distinguishing the composition or motives of ridership, it must be assumed that all travelers’ VTTS are independent and additive.

Hourly income

In theory, hourly income influences VTTS through two channels. The simplest model evaluates savings in paid business travel time. While workers are assumed to be indifferent between travel and other ways to spend time for which they are compensated, employers perceive their employees' gross compensation (including payroll taxes and fringe benefits) as the value of the productivity sacrificed to travel. In general practice, VTTS for business-related travel is not estimated empirically but is defined by the gross compensation.

VTTS for personal travel lacks such a theoretical formulation, and leisure time is seen instead as an object of consumption that can be substituted for other desirable objects according to individual preferences. In general, VTTS is estimated to be lower for personal than for business travel. See Mackie *et al.* (2001).

Suggested reasons include:

- Employers' compensation costs include taxes and benefits excluded from workers' disposable income;
- Working hours are typically fixed by employers, preventing workers from earning more by saving personal travel time;
- Compensation is spread over several family members, including non-earners.

While such rationales are plausible, circumstances may dictate high or low willingness to pay for faster travel by either working travelers or dependents, and only empirical research can yield quantitative estimates. Neither specifying a model of household travel decisions nor obtaining the appropriate data for estimation is a straightforward process. Households include varied numbers of earners and dependents for whom work, school, child care, and other demands on time and income may influence VTTS in unknown ways. Travel by families incurs joint costs of lost time that cannot be assigned to particular members. Besides compensation, unearned income from investments or annuities contributes to travel budgets. Among all of these factors, the compensation level of an individual traveler may not be the most important or the most accessible variable. Research tends to use either a few broad household income bands stated by sampled travelers or the median household incomes of the geographic areas studied. See, e.g., Asensio and Matas (2008) and Small *et al.* (2005).

To adjust past estimates for application to new populations, we require income measures that are nationwide, comparable and stable in definition, and regularly updated and published. The most reliable variable for projecting business VTTS is the median hourly wage for all occupations. Since median fringe benefits are not published, the median wage can be scaled upward to approximate the median gross compensation by multiplying by the ratio of mean gross compensation (including fringe benefits and payroll taxes) to mean money wages. The best variable for projecting personal VTTS is annual median household income. In order to present business and personal VTTS on a

practical and comparable basis, annual household income is scaled to an hourly rate by dividing by 2,080 hours per year, although it should not be inferred that travelers prorate their household incomes by the hour to make decisions.

In using hourly income as a scaling factor to transfer VTTS estimates to new times and locations it has been common to assume an income elasticity of 1.0 (a one percent increase in VTTS per one percent increase in income), implying a constant proportional relationship. Some recent studies have yielded lower elasticities for personal travel, although they have not been unchallenged. Such studies tend to be based on cross-sectional models, which compare travelers of different incomes at the same time and location. Apart from the credibility of particular results, the assumption that parameters derived from cross-section studies are valid for time series is problematic. Furthermore, use of non-unitary income elasticities would raise a serious question. If VTTS for business travel is defined as equal to the cost of employment, it must display a unitary elasticity, growing at the same rate as growing incomes, while VTTS in personal travel, with a smaller elasticity, would display slower growth. As a result, an ever-larger discrepancy would emerge between VTTS for business and personal travel, negating the hypothesis of a stable ratio between them. VTTS could then be defined only for the period of each study and extrapolated to the present or the future only by complex and arbitrary calculations. Instead, we retain the assumption of fixed VTTS relationships for different trip purposes and an income elasticity of 1.0 for all. Beyond updating VTTS estimates to the present, it is appropriate to use this elasticity with the projected rate of real income growth to obtain estimates of future VTTS, particularly when government actions are expected to have long-lasting impacts.

Where travelers of distinct income levels use modes that are not close substitutes, VTTS may be associated with an expected income for each mode. If there are wide and overlapping income ranges in substitutable modes, it is preferable not to differentiate VTTS estimates on the basis of travelers' incomes but to use a single value for all.

Mode and distance

VTTS research is often based on the factors influencing mode choice, including the comfort, privacy, and prestige subjectively ascribed to particular modes, as well as travel time and cost. Since the conclusions of this research are used primarily to evaluate time and cost benefits, analysts must control for the other factors affecting mode choice. The question remains whether differences among modes in VTTS are systematic or are accidents of specification and the data used. For example, should VTTS differ between auto drivers and bus passengers after other factors are taken into account? Should income differences between the groups be assumed to affect the comparative benefits of time savings? As indicated above, where modes are relatively close substitutes in location, purpose, and trip distance, it is appropriate to assume that the incomes and preferences of travelers are distributed identically among and within modes, yielding a common VTTS.

While this uniformity is appropriate among local modes, research has found evidence of a moderate rise in VTTS with trip distance. This tendency may be seen as a consequence of the limited amount of time available for taking a long trip. In addition, it may reflect the high value of time at destinations which justify increased costs of travel and complementary food and lodging. Although some governments have derived VTTS from an estimated distance elasticity, this is an awkward parameter to use, requiring a specific distance for each application, whereas a route segment or mode affected by a government action is likely to support trips of widely varying distance. A more practical approach differentiates trips by broad categories of local and intercity travel.

Certain modes, particularly airlines and high-speed railways, are not close substitutes for conventional surface modes. (High-speed railways are associated with the Core Express Corridors defined in the FRA National Rail Plan as connecting large urban areas up to 500 miles apart with 2-3 hour travel time and speeds between 125 and 250 mph.) Since these modes charge higher fares to travelers who place a greater value on time saving, it is reasonable to derive a distinct VTTS from the higher incomes of their passengers. Although income information on travelers in these markets is limited in detail, estimates from the 2001 National Household Travel Survey of the household incomes of air passengers on personal and business trips permit construction of expected VTTS specific to air travel. Because high-speed rail will often compete with air travel for similar consumers, the same VTTS is applied to both modes.

Comfort

Travelers will vary widely in willingness to pay to shorten the time during which they are subject to uncomfortable conditions such as walking, bicycling, and standing on platforms or in vehicles. Indeed, many other conditions—stressful driving in heavy traffic, exposure to weather, crowding, uncomfortable seating, and lack of personal security—could be included in this list, but it would be difficult to assign values to all of them or measure their severity and duration. VTTS estimates already incorporate assumptions about such conditions. Since shortening walking distances and waiting times and increasing seating are routine options in transportation planning, we assign values to their benefits. A distinction should be noted between actions that shorten the time period during which such conditions are experienced (reducing waiting by more frequent train service) and those that improve conditions during the whole trip (adding cars to permit more passengers to be seated). In the former case, VTTS is fixed at a higher level while the travel time varies; in the latter, travel time is constant, but VTTS varies.

Research and syntheses

The appended bibliography compiles references, accessible via the Internet, that demonstrate the evolution of theoretical and empirical research into VTTS and contain even more comprehensive lists of sources. These include reviews of the research literature and recommended guidance for government agencies in the U.S. and abroad. The history of the economic theory of time valuation is discussed in Mackie *et al.* (2001) and more formally in Jara-Díaz and Guevara (1999). The pioneering articles by Becker

(1965) and DeSerpa (1971) place time-allocation decisions in a context of consumption choice based on utility maximization, subject to constraints on income and the minimum amount of time required by each activity. With its subsequent extensions, this model permits derivation of equilibrium conditions for time allocation and has provided a widely-used basis for estimation of the parameters of VTTS.

Analysts have employed various techniques for estimating travelers' willingness to pay to save time. Where behavioral patterns such as choice of route or mode can be observed and other causal factors can be controlled for, estimates are derived from revealed preference. More frequently, stated preference methods are employed, using questionnaires to elicit hypothetical choices among trips that vary across several dimensions. This approach allows consideration of a greater number of behavioral alternatives and independent variables. Although revealed preference studies observe actual consumer choices, they are subject to error in the specification and measurement of the explanatory variables. Stated preference studies, in contrast, specify explanatory variables precisely but may be subject to errors when respondents predict their own hypothetical behavior unrealistically. Recent research has also combined these methods, using questionnaires to elicit information on the factors influencing real travel choices. Most research employs discrete choice techniques such as logit analysis to estimate the parameters influencing preference for specific modes or routes. As the number of published studies has grown, some investigators have also used meta-analysis to estimate the causes of variation among the conclusions of separate investigations.

Although VTTS was first investigated in English-speaking countries, concerted efforts to develop national models based on systematic data collection have been undertaken in the Netherlands, Switzerland, and the Scandinavian countries, as well as the United Kingdom (U.K.). VTTS has also been the object of research in Latin America and Asia. While several of these studies are cited in the bibliography, we will not analyze all of their conclusions.

There is wide agreement that the VTTS for business travel should equal the gross hourly cost of employment, including payroll taxes and fringe benefits. Because of international differences in tax structures, labor markets, data resources, and analysts' view of the social groups being studied, however, the definition of hourly income varies. In theory, it is equal to the worker's marginal product that would be sacrificed if travel were slower. Productivity may vary during work hours, allowing travel to be scheduled to minimize losses and, as noted earlier, modern technology can combine work with travel. Still, there is no well-accepted basis for estimating how the generalized value of business travel time differs from the simple gross compensation or predicting its variation in applied evaluation. All of the cited syntheses adopt the assumption that business travel time is equal to gross compensation, except for Boiteux and Baumstark (2001), where VTTS on business is estimated at 61 percent of the hourly cost of employment or 85 percent of the employee's gross salary (relating to the French system of accounts). Whether the earnings to which estimates are applied should be averages over broad or

narrow groups (defined by mode, driver/passenger, or type of employment) is often unclear.

For personal travel, the range of recommended values is broader, reflecting the absence of a theoretically compelling hypothesis. Some studies find lower VTTS for auto passengers than for drivers and lower values for shopping or recreational travel than for commuting. Application of such distinctions, even if consistently supported by research, would require data on the specific characteristics and travel purposes of the population affected by government actions. To suggest the values developed in other countries, the following table converts VTTS for commuting auto drivers recommended in several European studies to dollars of the same years as the estimates and projects them to 2008 dollars by the growth in U.S. median household income. These values span a range that is significant but not so wide as to suggest major specification errors or other inconsistencies. It may be observed that the values we now recommend are near the center of this distribution.

Commuter VTTS

Country	Year	VTTS in \$/hr.	US income growth to 2008	Equivalent 2008 VTTS
Denmark	2004	\$10.98	1.13	\$12.46
France	1998	\$10.26	1.29	\$13.27
Norway	1995	\$6.32	1.48	\$9.33
Spain	2005	\$17.06	1.09	\$18.52
Sweden	1994	\$4.34	1.56	\$6.77
Switzerland	2003	\$15.85	1.16	\$18.41
UK	2002	\$7.71	1.19	\$9.15

The U.K. practice, as seen in Mackie *et al.* (2003) and in the U.K.'s Transport Analysis Guidance (TAG) 3.5.6 (the official guidance which Mackie's work informs), is to distinguish modes by mean income but not by distance. VTTS for commuting is set at less than 25 percent of the average for business travel and VTTS for other purposes at 90 percent of the commuting rate. Gwilliam suggests that the World Bank use values of 30 percent of household income per hour for adults and 15 percent for children. Boiteux also recommends 30 percent of total employment cost per hour or 42 percent of gross wages (50 percent of the VTTS on business). The value grows with distance at a rate that diminishes by distance bands. Austroads (the association of Australian and New Zealand road transport and traffic authorities) recognizes a range of 30 to 60 percent of average earnings and suggests a standard of 40 percent. Both Concas and Kolpakov and Zhang *et al.* recommend a rate of 50 percent of the national average wage for both commuting and other personal trips. Boiteux and Baumstark, Mackie *et al.* (2003), and Zhang *et al.* all recommend explicit use of income elasticities of personal VTTS over time: 0.7, 0.8, and 0.75, respectively.

Concas and Kolpakov assign a value of only 35 percent of the wage for reducing seated riding time on transit vehicles but value standing at 100 percent and waiting under unpleasant conditions at up to 175 percent of the wage. Boiteux recommends increasing the VTTS in urban transit by 50 percent in crowded conditions and by 100 percent for walking or waiting. Gwilliam approves a 50-percent increase for both walking and waiting. Both TAG 3.5.6 and Zhang *et al.* prescribe a VTTS twice the normal value for walking or bicycling and 2.5 times the normal value when waiting.

In sum, there is a broad consensus on the approach adopted and the relevant variables and categories, as well as a degree of similarity in the specific values recommended. Still, neither the findings of research nor the judgments of expert panels are sufficiently uniform to eliminate arbitrariness.

Values for DOT applications

All studies have acknowledged the necessity of simplifying the many occasions and determinants of VTTS into a tractable system corresponding to the information available on the sources and targets of valuation. The structure of values that we adopted in 1997 is broadly consistent with those employed in other countries, and it continues to be useful for evaluation of the costs and benefits of government investments or regulations. As stated in the introduction, it is not specific enough to predict travelers' demand for particular modes or routes. In the following tables, the proportions of VTTS to income for personal vs. business, local vs. intercity, and surface vs. air travel are unchanged from our initial guidance of 1997, except for the association of high-speed rail with air travel, rather than with conventional surface modes. Similarly, the ranges of high and low proportions for conceptual testing are identical. Although valuing local personal travel at 50 percent of hourly income and intercity travel at 70 percent places our estimate among the higher ones examined, it is not beyond the range estimated in several studies and commonly viewed as reasonable.

The principal changes that we adopted in 2011 were the sources of income data to which these proportions are applied. We use data exclusively from Federal government sources and median income values whenever possible, considering them more representative of the incomes of typical travelers than the means. We present separate VTTS estimates for different categories of transportation vehicle operators, which can be used together with passenger VTTS to derive the benefits to vehicle occupants or combined with estimates of freight time value from other sources to derive the benefits of time savings in freight shipment. We also calculate hourly values as annual values divided by 2,080, rather than 2,000, for the sake of consistency with the wage figures published by the Bureau of Labor Statistics (BLS). In addition, we give instructions, omitted in our previous guidance, on projecting VTTS to future periods in response to real income growth.

Categories of VTTS

The ratios of VTTS to hourly incomes in Tables 1 and 2, expressed as percentages, must be multiplied by appropriate income estimates to convert them to dollar values. These

estimates are shown in Table 3, and the resulting VTTS estimates appear in Table 4. The appropriate ranges of VTTS for comparison of alternative estimates are shown in Table 5.

The tables present additional rows of “all purposes” values; these are weighted averages of the values prescribed for personal and business travel with weights derived from the 2001 NHTS. Although person-miles of travel are used to weight the surface modes, person-trips are more appropriate for air travel because many government actions that change air travel time will be independent of trip length.

The distributions so derived are:

- Local travel by surface modes: 95.4% personal, 4.6% business;
- Intercity travel by surface modes: 78.6% personal, 21.4% business;
- Intercity travel by air: 59.6% personal, 40.4% business.

Business travel

For “on-the-clock” business travelers over all distances and by every surface mode, VTTS is assumed to be equal to a nationwide median gross compensation, defined as the sum of the median hourly wage and an estimate of hourly benefits. The median wages are obtained from the BLS National Occupational Employment and Wage Estimates. Median benefits are not available from this source and are approximated by deriving the ratio of average total compensation (including fringe benefits) to average wages in the Employer Costs for Employee Compensation and applying it to median wages. This extrapolation is performed for business travelers on all modes, using the share of benefits for all workers. This procedure generates a VTTS estimate of \$24.10 (the actual value is \$24.12; all dollar values are rounded off to the nearest ten cents). For all vehicle operators the benefit share applied is derived from the series for transportation and material moving occupations. Truck drivers’ wages are estimated for a weighted average of heavy and light truck drivers from the National Occupational Employment and Wage Estimates.

In the case of air and high-speed rail travel, high-cost modes used for fast trips over long distances, we conclude that use of a distinct wage is justified. The best source for incomes of air travelers is the BTS National Household Travel Survey of 2001 (no long-distance travel survey has been conducted since 2001). This survey permits estimation of distributions of household money income by trip purpose. The ratio of 2001 median household income of business air travelers (approximately \$105,000) to the U.S. Census Bureau 2001 median household income (\$42,228) represents a factor of 2.5 to be multiplied by the gross median compensation estimate for surface business travelers. Updating median household income information from the 2012 US Census Bureau (\$51,017), the resulting VTTS is \$60.00. Recent confidential survey data suggest that income levels for high-speed rail travelers are similar to those for air travelers, so we apply the same VTTS to high-speed rail travelers.

Personal travel

For local personal travel, VTTS is estimated at 50 percent of hourly median household income. The nationwide median annual household income, \$51,017 in 2012, is divided by 2,080 to yield an income of \$24.50 per hour. The local VTTS is thus \$12.25. We distinguish local from intercity personal travel, estimating a VTTS that rises with distance. For the latter purpose, we have adopted a ratio of VTTS to hourly income of 70 percent. The VTTS for intercity personal surface travel is then \$17.20 per hour.

For personal travel by air or high-speed rail, the above estimate of VTTS for personal intercity surface travel is multiplied by 1.9, the ratio from the NHTS of the 2001 median household income of air travelers on personal business to the nationwide median household income in 2001. Updating median household income with 2012 information from the US Census Bureau yields a VTTS estimate of \$32.60.

Special issues

In application, vehicle-hours are to be converted to person-hours by multiplying by average passenger occupancy of vehicles. Although riders may be a family with a joint VTTS or passengers in a car pool or transit vehicle with independent values, these circumstances can seldom be distinguished. Therefore, all individuals are assumed to have independent values.

Except for specific distinctions, we consider it inappropriate to use different income levels or sources for different categories of traveler. Neither the incomes associated with published research nor the stability of the relationship between income and VTTS are certain enough to imply that fine adjustments would yield more realistic estimates. The first distinction we recognize is that between personal and business (on-the-clock) travel; the second is that between surface travel by conventional modes and travel by air or high-speed rail. While VTTS for business travel is correlated with an estimate of passengers' employment compensation, for vehicle operators on several modes we have provided VTTS estimates based on median compensation data by employment category as reported by the Bureau of Labor Statistics. The scale of income levels developed here is applicable nationwide, and analysts should not attempt to substitute incomes for particular modes or locations. Nevertheless, estimates derived by reliable and focused research may be superior for predicting behavioral responses in specific cases.

Personal time spent walking or waiting outside of vehicles, as well as time spent standing in vehicles or bicycling, should be evaluated at 100 percent of hourly income, with a range of 80 to 120 percent to reflect uncertainty. As stated above, reducing the time during which uncomfortable conditions are experienced provides a benefit equal to the product of this VTTS and the reduction in time, while the benefit of improved travel conditions (such as additional seating) is equal to the product of the difference in VTTS (50 percent of hourly income) and the total time during which discomfort would have been experienced.

Uncertainty in the recommended values

The ratios in Table 1 represent the best single figures for defining VTTS as a fraction of hourly income. These figures, like all parameters of travel behavior, are subject to uncertainty. Table 2 summarizes a plausible range for each trip category, not necessarily symmetric about the point estimates in Table 1. The corresponding high and low dollar estimates are shown in Table 5. In addition to evaluations based on the most likely estimates, alternative calculations using these ranges should be presented to test the sensitivity of analyses to potential errors in estimation.

Impact of income growth on VTTS

The values presented here are suitable for evaluation of impacts in 2014. As stated earlier, we include an income elasticity factor to incorporate the expected growth of VTTS in response to projected growth in real incomes. With an assumed elasticity of 1.0 for both business and personal VTTS and a 1.2 percent projected annual growth rate of real median household income over the next 30 years, as used by the Congressional Budget Office, future values of benefits of real travel time savings should be augmented by 1.2 percent per year before discounting to present values.¹

Updating the estimated values

The Office of the Assistant Secretary for Transportation Policy will publish annual updates of VTTS to reflect growth in hourly incomes, using the data sources cited above. No updating of the percentages developed in Tables 1 and 2 is required. We will monitor and interpret available research on travel behavior and issue new guidance as appropriate.

¹ Congressional Budget Office, *The 2013 Long-Term Budget Outlook, Long-Term Budget Projections, September 2013 Release* (September 17, 2013). CBO staff have informed us by private communications that they project that the growth in the median real wage will be about 0.5 percentage points smaller than the growth in the mean real wage for the period 2014-2024, and about 0.3 percentage points smaller than the annual growth in the mean real wage during the period 2025-2045.

Table 1 (Revision 2 - corrected)

Recommended Values of Travel Time Savings (per person-hour as a percentage of total earnings)		
Category	Surface Modes* (except High-Speed Rail)	Air and High-Speed Rail Travel
Local Travel -		
Personal	50%	--
Business	100%	--
Intercity Travel -		
Personal	70%	70%
Business	100%	100%

Vehicle operators- 100% on all modes

* Surface figures apply to all combinations of in-vehicle and other time. Walk access, waiting, and transfer time should be valued at 100% of hourly income when actions affect only those elements of travel time.

Table 2 (Revision 2 - corrected)

Plausible Ranges for Values of Travel Time Savings (per person-hour as a percentage of total earnings)		
Category	Surface Modes* (except High-Speed Rail)	Air and High-Speed Rail Travel
Local Travel -		
Personal	35% - 60%	--
Business	80% - 120%	--
Intercity Travel-		
Personal	60% - 90%	60% - 90%
Business	80% - 120%	80% - 120%

Vehicle operators- 80%-120% on all modes

* Surface figures apply to all combinations of in-vehicle and other transit time. Walk access, waiting, and transfer time should be valued at 80%-120% of hourly income when actions affect only those elements of travel time.

Table 3 (Revision 2 - corrected)

Recommended Hourly Earnings Rates for Determining Values of Travel Time Savings (2012 U.S. \$ per person-hour)		
Category	Surface Modes (except High-Speed Rail)	Air and High-Speed Rail Travel
Local Travel -		
Personal	\$24.50	
Business	\$24.10	
Intercity Travel -		
Personal	\$24.50	\$46.60
Business	\$24.10	\$60.00

Truck Drivers	\$25.40
Bus Drivers	\$26.40
Transit Rail Operators	\$45.20
Locomotive engineers	\$37.70
Airline Pilots and Engineers	\$82.30

Table 3 (Revision 2, continued)

Sources:

- (1) Local and intercity personal travel by conventional surface modes: median income for all U.S. households in 2012 (\$51,017), reported in U.S. Census Bureau, Table H-8. Median Household Income by State: 1984 to 2012, divided by 2,080 hours per year.
https://www.census.gov/hhes/www/income/data/historical/household/2012/H08_2012.xls
- (2) Local and intercity business travel by conventional surface modes: Bureau of Labor Statistics, May 2012 Occupational Employment and Wage Estimates, median wage for all occupations, http://www.bls.gov/oes/oes_dl.htm multiplied by the ratio of mean total compensation to mean wage from BLS Employer Costs for Employee Compensation, average over four quarters of 2012, <ftp://ftp.bls.gov/pub/special.requests/ocwc/ect/ececqrtn.pdf>
- (3) Intercity personal travel by air or high-speed rail: median hourly household income from (1), multiplied by 1.9.
Intercity business travel by air or high-speed rail: median hourly household income from (1), multiplied by 2.5 and by the ratio of median national employee compensation to median household income.
- (4) Truck Drivers: weighted average of May 2012 median hourly wages of heavy- and light-truck drivers (\$16.97) from BLS National Occupational Employment and Wage Estimates; expanded to total compensation by the ratio of total compensation to wages for transportation and material moving occupations from the 2012 Employer Cost for Employee Compensation series.
http://stats.bls.gov/oes/current/oes_nat.htm#b53-0000
<http://data.bls.gov/PDQ/outside.jsp?survey=cm>

Other vehicle operators: May 2012 median hourly wages from BLS National Occupational Employment and Wage Estimates; expanded to total compensation by the ratio of total compensation to wages for transportation and material moving occupations from the 2012 Employer Cost for Employee Compensation series.

Table 4 (Revision 2 - corrected)

Recommended Hourly Values of Travel Time Savings (2012 U.S. \$ per person-hour)		
Category	Surface Modes* (except High-Speed Rail)	Air and High-Speed Rail Travel
Local Travel-		
Personal	\$12.30	
Business	\$24.10	
All Purposes **	\$12.80	
Intercity Travel -		
Personal	\$17.20	\$32.60
Business	\$24.10	\$60.00
All Purposes **	\$18.70	\$43.70

Truck Drivers	\$25.40
Bus Drivers	\$26.40
Transit Rail Operators	\$45.20
Locomotive engineers	\$37.70
Airline Pilots and Engineers	\$82.30

Table 4 (Revision 2, continued)

* Surface figures apply to all combinations of in-vehicle and other time. Walk access, waiting, transfer, and standing time should be valued at \$24.50 per hour for personal travel when actions affect only those elements of travel time.

** Weighted averages, using distributions of travel by trip purpose on various modes. Distribution for local travel by surface modes: 95.4% personal, 4.6% business. Distribution for intercity travel by conventional surface modes: 78.6% personal, 21.4% business. Distribution for intercity travel by air or high-speed rail: 59.6% personal, 40.4% business. Surface figures derived using annual person-mile (PMT) data from the 2001 National Household Travel Survey. <http://nhts.ornl.gov/>. Air figures use person-trip data.

When projecting future benefits of travel time savings, values should be augmented by 1.2 percent per year before discounting to present values.

Table 5 (Revision 2 - corrected)

Plausible Ranges for Hourly Values of Travel Time Savings (2012 U.S. \$ per person-hour)				
Category	Surface Modes* (except High-Speed Rail)		Air and High-Speed Rail Travel	
	Low	High	Low	High
Local Travel-				
Personal	\$8.60	\$14.70	--	--
Business	\$19.30	\$29.00	--	--
All Purposes **	\$9.10	\$15.40	--	--
Intercity Travel -				
Personal	\$14.70	\$22.10	\$28.00	\$41.90
Business	\$19.30	\$29.00	\$48.00	\$72.00
All Purposes **	\$15.70	\$23.60	\$36.10	\$54.10

	Low	High
Truck Drivers	\$20.30	\$30.50
Bus Drivers	\$21.10	\$31.60
Transit Rail Operators	\$36.20	\$54.20
Locomotive engineers	\$30.10	\$45.20
Airline Pilots and Engineers	\$65.80	\$98.70

Table 5 (Revision 2, continued)

* Surface figures apply to all combinations of in-vehicle and other transit time. Walk access, waiting, and transfer time in personal travel should be valued at \$19.60 - \$29.40 per hour when actions affect only those elements of travel time.

** Weighted averages, using distributions of travel by trip purpose on various modes. Distribution for local travel by surface modes: 95.4% personal, 4.6% business. Distribution for intercity travel by conventional surface modes: 78.6% personal, 21.4% business. Distribution for intercity travel by air or high-speed rail: 59.6% personal, 40.4% business. Surface figures derived using annual person-mile (PMT) data from the 2001 National Household Travel Survey. <http://nhts.ornl.gov/>. Air figures use person-trip data.

When projecting future benefits of travel time savings, values should be augmented by 1.2 percent per year before discounting to present values.

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