Valuing Travelers' Time for Border Crossings and Related Activities

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

U.S. Customs and Border Protection (CBP), within the Department of Homeland Security, is responsible for preventing terrorists and terrorist weapons from entering the United States while at the same time facilitating the flow of legitimate trade and travel. A number of its initiatives may affect the amount of time that international business and leisure travelers spend acquiring related documentation and crossing through U.S. Customs. If an initiative is expected to result in an economically significant regulation, CBP is required to assess the costs, benefits, and other impacts of alternative approaches. A key issue in such analyses is how to assign a monetary value to changes in time use, that can be combined with estimates of the other costs and benefits of the policy options to determine their net economic impacts.

Time is unusual when considered in an economic framework because it has the characteristics of both a commodity and a resource. Similar to other commodities, it can be a direct source of utility or disutility; i.e., its consumption or use can be pleasurable or unpleasant. Time is also an input into the production of utility; individuals can allocate their time across different activities so as to maximize their sense of satisfaction or well-being. In this respect, time is a resource. Its value results in part from its scarcity; using time for one purpose means that the same block of time cannot be invested in another activity.

Activities related to travel are generally considered intermediate activities. Unlike leisure (which involves relatively free choice among activities) or work (which involves the productive use of time to create goods and services as well as to generate income), intermediate activities make certain types of leisure and work activities possible. In other words, the demand for travel results largely from the demand for other activities.[1]

Time has been valued in monetary terms in a number of different contexts, such as when measuring the productivity losses associated with illness, the travel costs associated with different recreational opportunities, and the impacts of various transportation programs. In general, the transportation literature is the most relevant to current CBP initiatives; it directly addresses time spent in travel-related activities and includes a well-developed and extensive research base. This literature often divides travel time into several subcomponents, such as in-vehicle vs. wait time. Reductions in wait time are often highly valued because such time is generally not productive or enjoyable.

In this report, we focus on providing example calculations for marginal changes in wait time, based on the available travel and transportation research. A similar approach could be used to apply values from the research literature for other types of time use. We concentrate on wait time because current CBP initiatives are likely to directly affect the amount of time travelers spend waiting at border crossings or in a passport offices. These initiatives may also affect the amount of time spent collecting documentation (e.g., to apply for a passport), which is similar to

[1]Changes in time requirements may affect the demand for travel or other activities (e.g., the number and/or types of trips taken) and related dollar expenditures. This report focuses solely on estimating the dollar value per marginal unit of time; CBP is separately exploring the effects of its requirements on the demand for travel as well as on associated costs.

wait time in many respects: both are generally viewed as undesirable uses of time that preclude the pursuit of more enjoyable or productive activities, and may be uncertain in duration.

A number of researchers have examined the available data on the value of wait time in a travel or transportation context. The most recent of these reviews suggests that changes in wait time are most typically valued at a rate that is roughly 50 percent higher than the value of in-vehicle time, indicating that waiting is the less desirable and more unpleasant activity. This values is likely to vary depending on the specific attributes of the wait. Evidence from the research literature suggests that decreases in wait time (as well as in travel time generally), will be valued more highly if: (1) the duration is uncertain or unpredictable; (2) the surroundings are uncomfortable or unpleasant; and (3) the affected individuals are unable to pursue other more enjoyable or productive activities simultaneously. The effects of the length of the wait and the income of those affected are more uncertain.

These studies do not yield dollar values for wait time that can be directly applied in CBP analyses. Wait time values are often reported as a percentage of the values for in-vehicle time, and the values derived for in-vehicle time vary significantly across studies. Studies also often report the value of time as a fraction of the wage rate; however, they are not always consistent or explicit about how the wage rate is defined. The studies vary in the extent to which they include taxes and benefits in their wage calculations and in the data sources they use to estimate compensation.

However, the U.S. Department of Transportation's (DOT's) recommendations for valuing changes in travel time provide an approach for linking wage rates to the value of in-vehicle time, which can then be linked to the estimates of the value of wait time.[2] For example, DOT indicates that plausible values for surface travel range from 35 to 120 percent of the wage rate depending on the type of travel (i.e., local or intercity) and the purpose of the trip (i.e., personal or business). DOT applies these fractions to different estimates of wages. For business travel during paid work hours, DOT recommends using estimates of total compensation (including taxes and benefits), while for personal travel (commuting, shopping, recreation, etc.), DOT suggests using estimates of pre-tax income excluding benefits.

We combine the DOT guidance with the results of more recent research to develop an example of how changes in wait time (or similar activities) could be valued for CBP regulatory analyses. In 2005, median pre-tax wages were $14.15 per hour; benefits increase this compensation to approximately $20.13 per hour. We apply DOT's percentages for local and intercity travel using surface modes to these wage rates to estimate the value of in-vehicle time, and then further adjust the results to reflect the value of wait time in comparison to in-vehicle time. For waits that occur during paid work time (i.e., for business travelers), this approach leads to values ranging from $23.67 to $35.51 per hour, with a best estimate of $29.59. For waits that occur at other times (i.e., for personal travelers), the approach suggests that the value of wait time savings ranges from $7.28 to $18.72 per hour, with a best estimate of $12.48. The higher

[2]Based on a 1997 review of the literature, DOT recommends that wait time be valued at 100 percent of the wage rate, which is the same as their best estimate for intercity business travel and roughly one-third higher than their best estimate (70 percent of the wage rate) for intercity personal travel. We do not use this wait time value in our analysis because it does not reflect the results of more recent research.

values for effects on business (i.e., paid work) time reflects both lost productivity and the disutility or unpleasantness associated with waiting and similar activities.

1.0 INTRODUCTION AND BACKGROUND

U.S. Customs and Border Protection (CBP) was established in 2003 as part of the Department of Homeland Security. It is now the unified border agency, combining functions previously carried out by three groups: the Immigration and Naturalization Service (including the Border Patrol) from the Department of Justice; the U.S. Customs Service from the Department of Treasury; and the Animal and Plant Health Inspection Services from the Department of Agriculture. CBP is responsible for preventing terrorists and terrorist weapons from entering the United States, while at the same time facilitating the flow of legitimate trade and travel.

Some of CBP's current initiatives are likely to affect the amount of time individual business and leisure travelers spend acquiring related documentation (such as a passport) or crossing international borders. While the change in the amount of time each individual spends on these activities may be relatively small, the number of individual travelers affected may be large. Thus, on a national level, the total effects of these initiatives on time use may be substantial.

As a result, CBP is interested in developing an approach for estimating the monetary value of changes in time use for application in its analyses of the benefits and costs of major regulations. This report reviews the relevant economic theory and empirical research and then proposes a valuation approach based on this literature. It focuses on estimates that can be immediately applied in CBP analyses without requiring substantial new research, while recognizing associated uncertainties.

The remainder of this introductory chapter describes the context for this report, first summarizing the requirements for regulatory analysis and then describing the types of time use that may be affected by CBP regulations. It concludes with an overview of the contents of the remainder of the report.

1.1 Requirements for Regulatory Analysis

The purpose of this report is to describe an approach for valuing marginal changes in time use that is consistent with economic theory and based on currently available empirical research. Such values are needed in part to comply with government-wide guidelines requiring that CBP and other Federal agencies estimate the costs, benefits, and other impacts of economically significant regulations. These regulations include those that may "[h]ave an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities."[3]

[3]U.S. Executive Office of the President, *Executive Order 12866, Regulatory Planning and Review*, 1993, p. 4.

The detailed guidance for conducting these studies is contained in the U.S. Office of Management and Budget's (OMB's) *Circular A-4, Regulatory Analysis.*[4] The *Circular* specifically notes that such analyses should include estimates of the monetary values of "[g]ains or losses of time in work, leisure and/or commuting/travel settings" when they are significant.[5]

The general approach to benefit-cost analysis described in *Circular A-4* is based on the discipline of welfare economics, which focuses on assessing how resources can be best allocated to maximize the well-being of individuals in society. This well-being (or sense of happiness or satisfaction), which economists refer to as "utility," cannot be measured directly.[6] Instead, economists have developed a conceptual framework and a range of empirical methods for estimating the value of alternative resource allocations.

As noted in *Circular A-4*, economic theory suggests that these values should be based on the concept of opportunity costs, which recognizes that (because resources are limited) any decision to use resources for one purpose means that they cannot be used for other purposes. Hence the value of the resource can be determined based on the value of its best alternative use. Furthermore, *Circular A-4* indicates that willingness to pay is the approach used most often to estimate these opportunity costs. Willingness to pay is the maximum amount an individual would voluntarily exchange to obtain an improvement (such as decreased wait times) subject to his or her budget constraints. In some cases, willingness to accept compensation (the least amount of money an individual would accept to forego the improvement) may be the more conceptually correct measure. However, willingness to accept compensation is used less frequently in practice due to problems related to its measurement.[7]

This report focuses on developing a generic approach for valuing changes in time use that is consistent with the requirements of *Circular A-4* and can be applied across various CBP regulations. Ideally, these values would be based on research that directly estimates individuals' willingness to pay for the specific type of change in time use affected by a particular regulation. Yet such studies are rarely available, and Federal agencies generally lack the time and resources necessary to conduct new primary research for individual regulations.

There is, however, a large literature on the value of time in circumstances that are similar in many respects to the situations addressed by CBP's rulemakings. As discussed in more detail in the following chapters, travel time generally (and wait time in particular) has been studied extensively, and the range of values from these studies is likely to provide a reasonable approximation of the range of values for the types of time use affected by CBP requirements. This report focuses on using the studies to develop a valuation approach is consistent with the

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[4]U.S. Office of Management and Budget (OMB), *Circular A-4, Regulatory Analysis*, 2003.

[5]Ibid., p. 37.

[6]For a detailed discussion of this framework see, for example: Just, R.E., D.L. Hueth, and A. Schmitz, *The Welfare Economics of Public Policy: A Practical Approach to Project and Policy Evaluation*, Northampton: Edward Elgar, 2004.

[7]OMB (2003), pp. 18-19. Whether studies of willingness to pay and willingness to accept compensation will result in similar dollar values depends on a number of factors such as the relationship to income; which measure is conceptually correct depends on the characteristics of the scenario under consideration, including assumptions regarding property rights.

underlying economic theory (without requiring investment in substantial new research), while recognizing related uncertainties.

Circular A-4 discusses the need to address a wide array of regulatory impacts. This report focuses narrowly on only one component of the analysis: estimating the dollar value per hour of time use affected. To determine the national impacts of its regulations, CBP considers the value of time in a broader context and assesses a number of other costs and benefits. For example, an increase in the amount of time required to cross an international border is conceptually similar to an increase in the price of such travel (or a travel tax). As would a price or tax increase, the increase in time requirements may reduce the demand for travel (i.e., the number or types of trips taken). Such a change in demand is taken into account in CBP's analysis if it is expected to be significant. In addition, CBP separately assesses the dollar expenditures associated with changes in travel as well as other impacts of the requirements.

1.2 Types of Time Use Affected

While it is difficult, *a priori*, to fully predict the ways in which time use could be noticeably affected by future CBP regulations, recent rulemaking efforts provide some insight into the potential impacts. In general, it appears that CBP requirements are often likely to affect the time individuals spend waiting for different international travel-related activities.[8] For example, certain travelers may need to acquire additional documentation or join special programs, which may involve waiting in line for processing or interviews as well as spending time collecting needed materials. Alternatively, CBP regulations may change the amount of time travelers spend waiting to cross international borders or to go through Customs. These changes may be increases or decreases; for example, travel may be slowed if a regulation requires review of additional documentation or more rapid if the regulation increases the use of technologies such as automated passport screening.

At the individual event level, these changes in time use may be relatively short in duration. For example, CBP currently estimates that acquiring an adult passport for the first time requires expending 1 hour and 25 minutes on average on related activities.[9] At land border crossings, CBP estimates that increased use of automated document screening tools may decrease average wait times by amounts ranging from a few minutes to close to two hours at selected points of entry.[10] The total time required for these activities is a function of their recurrence as well as the duration of each event. Some are relatively infrequent; a new passport is required only once every 10 years for adults. In other cases (such as border crossings), certain

[8]Paid work time that is directly related to implementation of the rule (e.g., when a regulation requires that industry staff spend time collecting and transmitting shipping or passenger manifest data) is included separately in CBP's cost estimates. The analysis in this report addresses indirect (or second order) changes in time use that affect individuals' nonmarket (unpaid) work or leisure time or that divert time away from their normal (more productive) work activities.

[9]U.S. Customs and Border Protection, (CBP), Office of Regulations and Rulings, *Regulatory Assessment for the Notice of Proposed Rulemaking, Documents Required for Travel within the Western Hemisphere, The Western Hemisphere Travel Initiative Implemented in the Air and Sea Environments,* August 2006, p. 2-23.

[10]Data from US-VISIT, provided via email by CBP Economist Elena Ryan on July 14, 2006.

individuals (such as frequent travelers) may be affected by the changed requirements several times per year.

Individuals affected by CBP regulations will often include a mix of business and pleasure travelers using varying modes of transportation. For example, in 1999, approximately 25 million U.S. residents traveled oversees in airplanes.[11] Among this group, approximately 27 percent traveled for work, while the remainder traveled for leisure and recreation or other purposes.[12]

Information describing U.S. residents crossing land borders is less comprehensive. In San Diego County, which includes the busiest land point of entry in the country, available data suggest that most U.S. citizens cross the Mexican border for personal reasons such as visiting family or shopping; only nine percent cross for work.[13] The most frequently used form of transportation for inbound land crossings at the Mexican border is privately-owned vehicles (77 percent).[14] The Canadian border has an overall lower rate of crossings, but exhibits similar patterns. For example, a 2003 survey found that those traveling from the United States to Canada usually did so for personal reasons; only five percent crossed for business or employment purposes.[15] For Canada, the most frequently used form of transportation for inbound land crossings is also privately owned vehicles (85 percent).[16]

When completing regulatory analyses, CBP is interested in the changes in these types of time use that are attributable to the options under consideration. In other words, CBP compares conditions without the regulation (the regulatory baseline) to the conditions predicted if different regulatory options are implemented (the post-regulatory scenarios). In some cases, an option may change the frequency of an event (e.g., require individuals to renew travel documents more often), while in other cases the option may change the event duration (e.g., shorten wait times at border crossings).

The actual net change in time use will depend on a number of factors associated with the implementation of new regulatory requirements. For example, processing times will depend on the extent to which affected organizations are able to change their personnel and procedures to accommodate the requirements, such as through hiring additional staff. Some requirements also may affect the overall demand for the activity, as in the case where increasingly onerous requirements discourage individuals from traveling. While CBP considers these types of impacts in its regulatory analyses, discussion of such impacts is beyond the scope of this report. As noted

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[11]International Trade Administration (ITA), Office of Travel and Tourism Industries, "1999 Profile of U.S. Resident Travelers Visiting Overseas Destinations Reported From: Survey of International Air Travelers (IFS)," posted October 2000, as viewed at http://tinet.ita.doc.gov/view/f-1999-101-001/index.html on October 10, 2006.

[12]ITA (2000).

[13]San Diego Association of Governments (SANDAG), California Department of Transportation, District 11, *Economic Impacts of Wait Times at the San Diego-Baja California Border – Final Report*, prepared by HDR/HLB Decision Economics, Inc., January 19, 2006, Appendix C.

[14]U.S. Department of Transportation, Bureau of Transportation Statistics, *TranStats: The Intermodal Transportation Database*, http://www.transtats.bts.gov/, accessed October 9, 2006.

[15]Statistics Canada, *International Travel 2003*.

[16]U.S. Department of Transportation (2006), *TranStats.*

earlier, this report focuses solely on the per unit (i.e., per hour) values of marginal increases or decreases in time use, which is only one of many components of CBP's analyses.

1.3 Organization of this Report

The remainder of this report provides a brief review of the related literature along with references for those interested in exploring these issues in more detail, and suggests a generic approach for valuing changes in time use that can be applied in CBP regulatory analyses. The discussion that follows is divided into two chapters. The next chapter begins by discussing the economic theory that underlies the valuation of changes in time use. It then provides examples of how time is valued in the human capital, recreational, and travel and transportation literature.

The third chapter then looks more closely at how wait time and similar types of time use are valued in the travel context. It begins by discussing criteria for transferring estimates from the available literature to different scenarios. It next summarizes available reviews of the literature and describes how different attributes of time use affect its value. It concludes with an example of how marginal changes in time use could be valued in the context of CBP regulatory analyses, focusing on changes in wait time.

2.0 CONCEPTUAL FRAMEWORK AND VALUATION APPROACHES

Time is unusual when considered in an economic framework because it has the characteristics of both a commodity and a resource. Similar to other commodities (or goods or services), it can be a direct source of utility or disutility; i.e., its consumption or use can be pleasurable or unpleasant. Time is also an input into the production of utility; individuals can allocate their time across different activities so as to maximize their sense of satisfaction or well-being, subject to various real world constraints. In this respect, time is a resource. Because its availability is limited, using time for one purpose means that the same block of time cannot be invested in another activity.

The value of time has been estimated using a variety of empirical methods. The simplest approach involves using wage rates to estimate its value. Other approaches involve conducting stated or revealed preference studies to better reflect the utility or disutility associated with different types of time use. Stated preference methods, such as contingent valuation surveys, generally involve asking respondents what they would be willing to pay for a hypothetical scenario. Revealed preference methods involve exploring data on related market goods to estimate the value of nonmarket goods; for example, by examining the value of time implied by choices among transportation modes or residential locations.

While, as expected, these studies have found that the value of time is often less or greater than the wage rate depending on the intrinsic characteristics of the activity and the choices faced by the individual, researchers often use wage rates as a benchmark. They frequently report their findings as a percentage of the wage rate, but are not always consistent (or clear) about how they are defining these rates; e.g., whether they include taxes or benefits in the calculations. Thus it is often difficult to compare results across studies.

This chapter first reviews the conceptual framework underlying time valuation, then briefly discusses how it has been typically valued in the health care, recreation, and travel and transportation literature.[17] The following chapter then focuses in more detail on valuation of the types of time use most likely to be affected by CBP's current regulatory initiatives.

2.1 Time as a Commodity and a Resource[18]

Conceptually, the starting point for the valuation of time is the basic neoclassical economic model, which assumes that individuals will make choices that maximize their utility given their available resources. Under the simple version of this model, individuals will allocate time between paid work and other activities up to the point where, at the margin, the value of

[17]Portions of this chapter are taken from : U.S. Environmental Protection Agency (EPA), *Valuing Time Losses Due to Illness*, EPA 815-R-05-003, January 2005.

[18]For a more detailed discussion of the underlying theory, see: MVA Consultancy et al., "Research Into the Value of Time," *Cost-Benefit Analysis, Second Edition*, (R. Layard and S. Glaister, eds.), Cambridge: Cambridge University Press, 1994, pp. 235-272; Jiang, M. and T. Morikawa, "Theoretical Analysis on the Variation of Value of Travel Time Savings," *Transportation Research, Part A*, Vol. 38, pp. 551-571, 2004; and, Jara-Diaz, S.R., "Allocation and Valuation of Travel-Time Savings," *Handbook of Transport Modeling*, (D.A. Hensher and K..J. Button, eds), Oxford: Elsevier, 2000.

compensation received is equal to the value of the uncompensated activities. This relationship is often described as the labor-leisure trade-off.

This framework assumes that individuals will take the opportunity cost of time into account in their decision-making, allocating time to the activities that produce the greatest utility. In other words, a individual will work an extra hour if the compensation he or she receives exceeds the value placed on time in alternative activities. This approach is based on a number of simplifying assumptions related to the choices faced by individuals and the operation of labor markets. For example, it assumes that there is perfect competition, firms seek to maximize profits, and unemployment is insignificant. Furthermore, it assumes that individuals are well-informed about their options and have complete flexibility in the number of hours devoted to various types of work and non-work activities.

In the simple economic model, the trade-off between labor and leisure time does not enter into the utility function directly. However, in reality, income clearly depends on the amount of time spent working as well as on other factors such as education and the availability of investment assets. In addition, the consumption of goods and services also requires the use of time; e.g., to eat a meal, go to the movies, or participate in other activities.

A number of researchers have explored the implications of incorporating time more directly into this model by considering both its commodity and resource value.[19] The commodity value of time is associated with the level of utility, or pleasure, one gains while participating in an activity (similar to the consumption of goods or services). While in theory individuals are expected to maximize their utility, real world constraints mean that they may spend time in activities that are not their preferred use of time; i.e., that involve some disutility. For example, the lack of flexible work hours or the need to travel to a recreational site may lead an individual to spend more time engaged in work or travel than he or she would prefer. The resource value of time reflects its value as a production input; from this perspective its value stems largely from its scarcity. Because the total number of hours per day is fixed, time saved in one activity can be used to engage in other activities which may produce a higher level of utility. Conceptually, the resource value of time is equivalent to an individual's willingness to pay to have more time available.

One frequently cited early model that formalizes these relationships was developed by DeSerpa in 1971, who expands the neoclassical model to include three essential features:

> *...(1) utility is a function not only of commodities but also of the time allocated to them; (2) the individual's decision is subject to two resource constraints, a money constraint and a time constraint; and (3) the decision to consume a specified amount of any*

[19]Becker was one of the first to recognize the importance of addressing leisure as well as work time and to develop an approach for incorporating time into the basic economic model. (Becker, G.S., "A Theory of the Allocation of Time," *The Economic Journal*, Vol. 75, No. 299, 1965, pp. 493-517). A number of other researchers contributed to the expansion and refinement of this model. For example, Johnson emphasized the importance of considering both time and budget constraints and of allowing work and leisure to each enter into the utility function. (Johnson, B., "Travel Time and the Price of Leisure," *Western Economic Journal*, Vol. 3, Spring 1966, pp. 135-145.)

> *commodity requires that some minimum amount of time be allocated to it, but the individual may spend more time in that activity if he so desires.*[20]

Under this model, the difference between the commodity value (time in its current use) and the scarcity or resource value (the value of time in its an alternative use – which may be higher or lower) represents the value of time saved. A positive value of time saved suggests that it could be devoted to an alternative activity of greater value to the individual.[21]

DeSerpa notes that one implication of this model is the need to differentiate between time spent in different types of activities. Economists often define leisure as time spent on activities other than work, but DeSerpa suggests that it may be more useful to consider a distinction made by Tipping between leisure and intermediate goods.[22] Leisure involves relatively free choice in the consumption of goods and services (such as recreation), while intermediate goods are activities (such as travel to a recreational site) that make the consumption of this leisure possible. Variations on this conceptual model underlie several of the approaches applied in the recreation literature examined later in this chapter.[23]

This model also suggests that it is important to consider the choices available. For example, as Cesario notes:

> *The value of time for an individual in a given situation is conditioned by what activities are being traded off. If the individual is trading off travel time for work time and there is no marginal utility or disutility associated with work or travel, then there is some basis for valuing travel time at the wage rate. However, it seems farfetched to assume that the recreational tripmaker is trading off time for travel with time for work. It seems much more likely that the trade off is between time for travel and time for leisure activities... The value of travel time in a recreational tripmaking context thus reflects the value placed on alternative uses of leisure time by the individual, for this is the relevant opportunity cost. If we posit that travel per se carries with it a marginal utility or disutility, then it can be shown that the value of saving travel time will diverge from the value of leisure time.*[24]

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[20]DeSerpa, A.C., "A Theory of the Economics of Time," *The Economic Journal*, Vol. 81, No. 324, December 1971, pp. 828-846.

[21]As noted by Jiang and Morikawa (2004), changes in activities may also result in changes in costs. We do not address the latter impact in this report because CBP generally assesses changes in costs separately from the consideration of time expenditures.

[22]Tipping, D.G., "Time Savings in Transport Studies," *Economic Journal*, December 1968, pp. 843-854, as cited in DeSerpa (1971).

[23]For an example of an early theoretical analysis of the implications of this approach for recreation studies, see: Wilman, E.A., "The Value of Time in Recreation Benefit Studies," *Journal of Environmental Economics and Management*, Vol. 7, 1980, pp. 272- 286.

[24]Cesario, F.J., "Value of Time in Recreation Benefit Studies," *Land Economics*, Vol. 52, No. 1, 1976, pp. 32-41.

This theoretical framework, as well as the results of empirical studies (discussed later), suggests that the value of time is likely to vary across individuals and activities and that researchers need to carefully consider the context in determining its value.

In conclusion, the simple labor-leisure trade-off model suggests that the marginal wage rate can be used to value time. However, the more complex view posited by DeSherpa and others suggests that this approach will not fully capture the utility or disutility associated with the use of time for different activities. More direct measurement is likely to result in values that diverge from the wage rate.[25]

2.2 Valuing Lost Productivity: The Human Capital Approach[26]

A number of studies (particularly in the context of valuing the impacts of illness or disability) consider the effects of time losses on productivity; i.e., the decrease in the goods or services produced as a result of reduced work time. The most common procedure for valuing these effects is the human capital approach, which focuses on changes in output over time and assumes that workers are paid the value of their marginal product.[27] Thus worker compensation can be used to estimate the costs associated with absenteeism or reduced productivity. As noted in the above discussion of the labor-leisure trade-off, a number of standard simplifying assumptions regarding individual behavior and the functioning of labor markets underlie this approach and it does not fully account for the utility or disutility associated with different time uses. While applications of the human capital approach typically focus on paid work time, several researchers have extended this approach to encompass unpaid productive work; e.g., in the household or as volunteers.

In the case of market labor or paid work, the selection of a rate for valuing marginal changes in time use is relatively straightforward. Goods or services could not be produced unless the price paid (i.e., the value from the consumer's perspective) covered the costs to the employer. From the employer's perspective, the cost of lost work time is equal to total compensation, which includes taxes, wages, and benefits.[28] This approach is consistent with the simple neoclassical economic model, which suggests that the compensation provided by an employer equals the value of each worker's marginal output. In other words, an employer would not pay an employee more, in salary or wages plus benefits, than that employee is worth to the company.

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[25]For a more complete discussion of this theory, see Bruzelius, N., *The Value of Travel Time*, London: Croom Helm, 1979.

[26]For a more detailed review of this literature, including its relationship to measures of utility and social welfare, see EPA (2005).

[27]Another, less commonly used approach is the friction cost method, which assumes that productivity will decrease temporarily (while the employer implements measures to replace the absent individual) rather than over the full course of the illness. The "friction period" is defined as the time it takes to find and train a new employee or reallocate duties among existing employees. A key assumption of this approach is that there is not full employment (see EPA 2005).

[28]Ideally, analysts would use estimates of the marginal wage rate (i.e., the increment paid for the last hour worked) rather than the average across all hours worked. However, average or median values are generally used due to the lack of data on marginal rates.

Alternative measures are sometimes used in the empirical literature due in part to limitations in the available data. For example, the pre-tax wage rate (without employer-paid benefits) is a less complete measure of compensation but may be applied because more extensive and detailed data are available for individual occupations and geographic locations. In addition, some benefits do not vary with the number of hours worked, and such an approach avoids the difficulties associated with developing accurate measures of the relationship between benefits and reduced (or increased) work hours. Another option, the post-tax wage rate, may better reflect the value of lost time from the perspective of the individual but would not include the full value of the worker's productivity from the perspective of the employer.

Under the human capital approach, time spent engaged in nonmarket labor is considered productive due to the fact that activities such as childcare, cooking, and general home maintenance – if not performed by a member of the household – could be performed by a professional in return for compensation (i.e., as market labor). However, unlike individuals employed in the labor market, those engaged in nonmarket labor activities are not compensated for their work. As a result, the selection of a rate for valuing the time spent performing such activities is less straightforward, although the same concerns about the inclusion of taxes and benefits apply.

Researchers applying the human capital method generally use one of two approaches for valuing nonmarket labor, both of which are based on the concept of replacement costs. The first applies the wage rate of domestic servants or housekeepers to estimate the value of household production. This approach may undervalue true productivity due to the wide range of activities undertaken in addition to housekeeping. A second approach uses a composite of the wage rates paid for the diverse range of activities associated with nonmarket work, such as the payments for cooks, childcare providers, gardeners and others.[29] Under this latter approach, it is possible to include the value of volunteer activities outside the home as well as the value of home-related nonmarket work.[30] Time use studies are applied to allocate nonmarket activities across different job categories to develop this composite.[31] This composite approach, although more complex to implement, is likely to more accurately reflect the true productivity of this labor than the domestic worker approach.

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[29]One early demonstration of this composite market value approach is: Cooper, B.S. and D.P. Rice, "The Economic Cost of Illness Revisited," *Social Security Bulletin*, Vol. 39, No. 2, February 1976, pp. 21-36. A more recent approach is provided in Hoffman, C., D. Rice, and H. Sung, "Persons with Chronic Conditions: Their Prevalence and Costs," *Journal of the American Medical Association*, Vol. 276, No. 18, November 1996, pp. 1473-1479. This later study uses values based on research reported in Douglas, J., G. Kenny, and T.R. Miller, "Which Estimates of Household Production Are Best?," *Journal of Forensic Economics*, Vol. 4, 1990, pp. 25-45.

[30]See, for example, Trewin, D., *Unpaid Work and the Australian Economy: 1997*, Australian Bureau of Statistics, October 2000; and Robb, R., M. Denton, A. Gafni, A. Joshi, J. Lian, C. Rosenthal and D. Willison, "Valuation of Unpaid Help by Seniors in Canada: An Empirical Analysis," *Canadian Journal on Aging*, Vol. 18, No. 4, 1999, pp. 430 - 446.

[31]A recent example of such time use studies is the U.S. Bureau of Labor Statistics' American Time Use Survey, the results of which are available at http://www.bls.gov/tus.

The focus on comparable jobs provides a measure of lost productivity that is consistent with the human capital framework. However, it does not fully account for the opportunity costs associated with choosing to engage in nonmarket rather than market work. In electing to undertake unpaid labor, an individual is not necessarily forgoing a job involving similar activities. For example, if a highly paid individual chooses to stay home to care for a child, his or her opportunity costs (i.e., foregone market wages) may well exceed the costs of hiring a child care worker. Alternatively, some individuals engage in essential nonmarket work because the cost of hiring a replacement worker exceeds their market wage. In these cases, the individuals presumably value nonmarket work time at minimum at their own market wage rate. As noted earlier, this approach does not account for any additional utility or disutility associated with these activities beyond what is reflected in market wages.

The difference between the measurement of productivity and of social welfare can lead to varying assessments of the value of time. For example, in discussing the valuation of nonmarket activities (including household production) in the U.S. National Income and Product Accounts, Abraham and Mackie note:

> *If the designers of an account cannot decide whether it is intended to capture changes in economic output or changes in societal welfare, the end product may be conceptually muddled. Indeed, these objectives may imply opposing valuations. The simple example of how to value time spent commuting illustrates the complication. If the goal is to measure "output," one would likely want to include the value of, say, parents' time transporting kids to school and other activities. The market cost of hiring a driver might be used to price this time, though there are other alternatives. As the amount of driving goes up, so too does the value of this component of household production. Yet, as driving time increases, parents' welfare may actually decrease, as time is taken away from leisure and other utility-generating activities. In this case and many others, measuring output and measuring welfare are separate, although admittedly related, exercises.*[32]

In the context of national accounts, Abraham and Mackie conclude that the appropriate focus is on measures of output and suggest the use of the replacement cost approach to value nonmarket production, while noting a number of ways in which this approach could be improved. However, in the context of regulatory analysis, CBP and other Federal agencies are interested in a more complete accounting of social welfare impacts.[33]

Available research on the extent to which individuals enjoy different activities provides additional evidence that wage rates may be a weak indicator of the value of time. Based on a series of surveys, Robinson and Godbey report that work appears in the middle of the rankings – higher (in terms of enjoyment) than activities such as cleaning and commuting, but lower than

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[32]Abraham, K.G. and C. Mackie, "A Framework for Nonmarket Accounting," *A New Architecture for the U.S. National Accounts* (D.W. Jorgenson, J.S. Landefeld, W.D. Nordhaus, eds.), Chicago: University of Chicago Press, 2006, p. 171.

[33]See Abraham and Mackie (2006) for a detailed discussion of the issues that arise when valuing time in the context of measuring national nonmarket production and the relationship of output measures to measures of social welfare.

activities such as socializing, child play, and sleep.[34] Nordhaus notes that this result appears inconsistent with the conventional approach of using after-tax wages to measure the value of nonwork time; there is no distinct break between the enjoyment attributed to work and nonwork activities.[35] He indicates that this finding could reflect several factors, including whether respondents were focused on average or marginal values, whether they were able to change their earnings by altering the number of hours worked, whether they value time differently during different times of day or times of year, and whether there are methodological problems with the enjoyment surveys used.[36]

In sum, the human capital approach, with its focus on productivity, is not likely to not fully capture the value of time from a social welfare perspective. It largely ignores any utility or disutility that individuals gain from different types of time use, aside from what is captured in the wage rate. In addition, reliance on wages for valuation may be problematic, for example when the labor market does not allow complete flexibility in the number of hours worked. The following sections explore alternative approaches that value time more directly to better reflect the utility associated with different activities.

2.3 Valuing Recreational Opportunities: The Travel Cost Approach[37]

Travel and related uses of leisure time have been studied extensively in the context of recreational opportunities; e.g., the availability of public lands for activities such as fishing or hiking. The fundamental assumption is that the value of a recreational opportunity is at least as great as the value of what one is willing to give up (e.g., the opportunity costs of money and time expenditures) in order to participate.[38] For example, a simple travel cost model may use market data and survey information to determine the money costs (e.g., fuel, tolls, and access fees) and the time costs (e.g., spent traveling and on-site) to make inferences about individual willingness to pay. Other models, such as random utility models (sometimes referred to as discrete choice models), consider the environmental quality variables as well as travel costs that affect an individual's choice between different recreational sites. While the money costs considered in these studies are often observable, the value of time is more difficult to measure and there is no

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[34]Nordhaus, W.D. "Principles of National Accounting for Nonmarket Accounts," *A New Architecture for the U.S. National Accounts* (D.W. Jorgenson, J.S. Landefeld, W.D. Nordhaus, eds.), Chicago: University of Chicago Press, 2006, pp. 156-158.

[35]Robinson, J. and G. Godbey, *Time for Life: The Surprising Ways Americans Use Their Time*, University Park, PA: Pennsylvania University Press, 1997, as cited in: Nordhaus (2006), pp. 156-158.

[36]For national accounts (which, as discussed earlier, focus on measuring productivity rather than social welfare), Nordhaus ultimately indicates that "[i]n the end, we are likely to use some variant of conventional valuations of time in terms of the average after-tax wage, particularly when we cannot measure the output of the hours, but we must recognize that this convention is subject to serious reservations. This is an area ripe for serious empirical work, particularly as new time use data becomes available." (Nordhaus (2006), p. 158)

[37]For a more detailed review of this literature, see: Phaneuf, D.J. and K.V. Smith, "Recreational Demand Models," *Handbook of Environmental Economics, Vol. 2* (K.-G. Maler and J.R. Vincent, eds.), The Netherlands: Elsevier, 2005.

[38]As noted by Wilman (1980), under this approach "[i]t is assumed that a travel-cost increase would be viewed by the recreationalist as being equivalent to a fee increase for an on-site visit."

consensus regarding how it is best valued. Further, disagreement exists regarding the valuation of time spent in travel verses time spent on-site.

Several studies of recreational opportunities value travel time at some fraction of the wage rate, frequently one-third. This approach is fairly arbitrary and appears to have its origins in the early transportation literature.[39] Although some researchers continue to use this approach, a number of others have more directly investigated the value of time in the recreation context.[40] The results of these studies vary due to differences in the modeling approaches used (and the simplifying assumptions they incorporate) as well as in the data sources and types of activities considered. The methods used in these studies have evolved over time, incorporating increasingly sophisticated approaches to valuation.

For example, in a 1981 study of sportfishing, McConnell and Strand directly examined the value of travel time as a proportion of the wage rate in a simple travel cost model.[41] They found that, for the typical angler included in their survey, travel time was valued at approximately 60 percent of hourly income. A study of 43 recreation sites, published in 1983 by Smith, Desvousges, and McGivney, then examined the assumption that the opportunity cost of time could be represented as a fixed percentage of the wage rate.[42] Their tests indicated that neither the full wage rate nor one-third the wage rate was "unambiguously superior to the other as an approach for approximating the opportunity cost" of travel time. They noted that these results may largely reflect the impact of missing data (e.g., on the flexibility of work hours), and suggested that additional research was needed.

Other researchers subsequently examined the effects of work hour flexibility on the value of leisure time, and found that these values varied depending on labor market status. For example, in a 1987 study, Bockstael, Strand, and Hanemann examined the effects of fixed work hours in a study of sportfishers.[43] They found that, for individuals with flexible work hours, the average opportunity cost of time was about equal to their wage rate. In contrast, for individuals with fixed work schedules, the opportunity cost of time was about 3.5 times the wage rate.

A 1999 study of river recreation by Feather and Shaw further examined the impact of inflexible work hours.[44] They found that the shadow wage or opportunity cost of time exceeded the market wage in cases where an individual was working more hours than he or she would prefer, but was less than the market wage in cases where an individual was working fewer hours

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[39]Shaw, W.D., and P. Feather, "Possibilities for Including the Opportunity Cost of Time in Recreation Demand Systems," *Land Economics*, Vol. 75, No. 4, 1999, pp. 592-602.

[40]Shaw, W.D., "Searching for the Opportunity Cost of an Individual's Time," *Land Economics*, Vol. 68, No. 1, 1992, pp. 107-115.

[41]McConnell, K.E., and I. Strand, "Measuring the Cost of Time in Recreation Demand Analysis: An Application to Sportfishing," *American Journal of Agricultural Economics*, Vol. 63, 1981, pp. 153-156.

[42]Smith, V.K., W.H. Desvousges, and M.P. McGivney, "The Opportunity Cost of Travel Time in Recreation Demand Models," *Land Economics*, Vol. 59, No. 3, 1983, pp. 259-278.

[43]Bockstael, N.E., I.E. Strand, and W.M. Hanemann, "Time and the Recreational Demand Model," *American Journal of Agricultural Economics*, Vol. 69, 1987, pp. 293-202.

[44]Feather, P. and W.D. Shaw, "Estimating the Cost of Leisure Time for Recreation Demand Models," *Journal of Environmental Economics and Management*, Vol. 38, 1999, pp. 49-65.

than desired. Where work hours were flexible, the opportunity cost was reasonably close to the market wage rate.

The variation in individual valuation of travel costs was also explored using a somewhat different approach in an earlier (1995) Englin and Shonkwiler study on the value of boating, angling, and swimming trips to freshwater recreation sites.[45] They used a model that treated travel costs as a latent variable which is predicted based on other (observable) factors. Under this approach, they found that time spent traveling was valued at approximately 40 percent of the wage rate.

More recently, in a 2004 study, Larson and Shaikh estimated the marginal value of leisure time for whale watchers in California.[46] They noted that valuing time at the average wage "presumes that the individual faces no constraints on hours worked, derives no utility or disutility from work, and has a linear wage function..." Instead, they estimated these values by applying a model that included both time and budget constraints, and found a complex relationship between the value of time and wages. For individuals working fixed hours, the time constraint was the most important determinant of the value of time. For individuals working flexible hours, the wage rate and the money budget were the most important determinants. Across all individuals, those with low wages tended to value time above their wage rate, while those with higher wages had values that were less than their wage. In other words, the marginal value of leisure time as a proportion of the wage rate decreased as the wage increased.

While each of these successive studies takes into account a wider variety of the factors that may affect the value of time, there are a number of other concerns that potentially could be included in these models. For example, as Phaneuf and Smith note, the value of time is likely to vary depending on the time of day.[47] There are limits on the ability to redistribute time by shuffling one's schedule, and the activities available depend in part on the time of day as well as the season of the year.

In sum, these studies suggest that empirical measures of the value of time for activities related to recreation can vary greatly depending on the data and modeling approach used and the context within which time is studied. The extent to which the value of time can be represented by the wage rate depends on a number of factors, such as the degree to which an individual's work schedule is flexible and their level of income. Other factors affecting the value of time, such as the link between the time of year (or time of day) and the activities available, may be worthy of further exploration.

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[45]Englin, J. and J.S. Shonkwiler, "Modeling Recreation Demand in the Presence of Unobservable Travel Costs: Toward a Travel Price Model," *Journal of Environmental Economics and Management,* Vol. 29, No. 3, 1995, pp. 368-377.

[46]Larson, D.M. and Shaikh, S.L., "Recreation Demand Choices and Revealed Values of Leisure Time," *Economic Inquiry*, Vol. 42, No. 2, April 2004, pp. 264-278.

[47]Phaneuf and Smith (2005), pp. 14-16.

2.4 Valuing Transportation Options[48]

Travel time has been studied extensively by researchers interested in transportation issues because it plays an important role both in forecasting behavior and in determining the value of different options from a social welfare perspective. For example, in the United Kingdom, Mackie et al. indicate that the value of travel time savings has accounted for about 80 percent of the monetized benefits for major roads projects, and that "hundreds, if not thousands" of related studies have been completed.[49] Some of these studies focus on the relative value of different modes of transport (e.g., airplane, car, walking), taking into account comfort and convenience as well as speed and economic costs. Other studies focus more on the value of each time increment spent in travel for different purposes, such as business or leisure activities.

In the travel and transportation literature, business travel is generally valued based on the full cost (to the employer) of employee compensation, including taxes and benefits as well as wages or salary. The rationale for this approach is very similar to the rationale for valuing productivity under the human capital method (see Section 2.2); i.e., it assumes that that each hour spent in business travel represents an hour of lost productivity, which is best represented by total compensation. As discussed in detailed by Hensher, this approach is an oversimplification; the value of business travel time savings should include:

> *...the opportunity cost of travel by an employee to the employer, the disutility cost of travel to the employee, and the net benefit directly to the community from such time savings.*[50]

Transportation researchers interested in broader measures of the value of travel time generally apply methods similar to those described above for recreational demand modeling.[51] Individuals may be asked, in stated preference surveys, to indicate their willingness to pay for the options of interest or to rank their preferences. Stated preference approaches also include transfer price studies, which explore the price at which a consumer would change from one travel alternative to another, trading off trip cost for speed. Alternatively, respondents may be asked to allocate a budget, or rank their preferences, across travel and other activities. In general, stated preference studies elicit values for a range of hypothetical alternatives.

Revealed preference studies may also be used. These studies rely on data from market transactions to estimate the value of time. For example, researchers may investigate the choices

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[48]For more detailed review of this literature, see Hensher, D.A., 1989. "Behavioural and Resource Values of Travel Time Savings: A Bicentennial Update," *Australian Road Research*,. 1989, Vol. 19, No. 3, pp. 223-229; MVA Consultancy et al. (1994); and the literature reviews cited in Section 3.2.

[49]Mackie, P.J., S. Jara-Diaz, and A.S. Fowkes, "The Value of Travel Time Savings in Evaluation," *Transportation Research Part E*, Vol. 37, 2001, pp. 91-106.

[50]Hensher, D.A., *Value of Business Travel Time*, London: Permagon Press, 1977, p. 2.

[51]For more information on these methods, see: Gunn, H.F., "An Introduction to the Valuation of Travel-Time Savings and Losses," *Handbook of Transport Modeling*, (D.A. Hensher and K..J. Button, eds.), Oxford: Elsevier, 2000; and, Hensher, D.A., "The Sensitivity of the Valuation of Travel Time Savings to the Specification of Unobserved Effects," *Transportation Research, Part E*, Vol. 37, 2001, pp. 129-142.

individuals make among different transportation options or residential locations then use statistical models to estimate the implied value of time, controlling for other variables that influence these choices. There is some evidence that stated preference studies conducted in the travel and transportation context result in significantly smaller values than revealed preference studies and may understate the true values.[52] Increasingly, studies combine stated and revealed preference data to estimate the value of time.[53]

Not surprisingly, the resulting values vary depending on the context. Travel time is valued differently depending on factors such as comfort, convenience, crowding, boredom, safety, and stress that affect the pleasantness of the experience. The characteristics of those traveling (such as their income level), the duration and frequency of the activity, and its reliability or predictability may also affect its value. In addition, the extent to which an individual can engage in another activity simultaneously (such as reading for pleasure, working, or viewing scenery) affects the value placed upon the experience.

This variation is evident in the U.S. Department of Transportation's (DOT's) recommendations for valuing changes in travel time attributable to its programs.[54,55] These values (expressed as a percentage of the wage rate) are based on DOT's 1997 review of the literature and summarized in Exhibit 1.

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[52]Brownstone, D. and K.A. Small, "Valuing Time and Reliability: Assessing the Evidence from Road Pricing Demonstrations," *Transportation Research Part A, Policy and Practice*, Vol. 39, No. 4, 2005, pp. 279-293.

[53]Hensher (2001), p. 130.

[54]U.S. Department of Transportation (DOT), *Departmental Guidance for the Valuation of Travel Time in Economic Analysis* (Memorandum from F.E. Kruesi), April 1997, and U.S. Department of Transportation (DOT), *Revised Departmental Guidance, Valuation of Travel Time in Economic Analysis,* (Memorandum from E. H. Frankel), February 2003.

[55]This variation is also reflected in the differences in recommended values across jurisdictions. For example, von Wartburg and Waters report that, as of 2004, Transport Canada recommended valuing savings in business travel time at 100 percent of the hourly employer cost, reducing the cost by 25 percent when the employee can work while traveling. For non-business travel, Transport Canada recommended valuing time for adults at 50 percent of national average wage, with lower values for children. They also note that the American Association of State Highway and Transportation Officials (AASHTO) recommended a value of 100 percent of total compensation (including labor overhead) for business travel. For personal travel, the AASHTO recommended values were 50 percent of the wage rate for commuting or other travel by car or bus, and 70 percent of the wage rate for intercity travel. Waiting, walking, and transfer time were valued at twice the standard rate. (von Wartburg, M. and W.G. Waters II, "Congestion Externalities and the Value of Travel Time Savings," *Towards Estimating the Social and Environmental Costs of Transportation in Canada* (A. Zhang, Project Director), prepared for Transport Canada, December 2004.)

Exhibit 1

U.S. DEPARTMENT OF TRANSPORTATION
RECOMMENDED VALUES FOR TRAVEL TIME SAVINGS
(per person-hour as percent of wage rate)

Type of Travel	Surface Modes*	Air Travel	Truck Drivers
Local travel:			
Personal	50 percent (35 – 60 percent)	N/A	N/A
Business	100 percent (80 – 120 percent)	N/A	100 percent (100 percent)
Intercity travel:			
Personal	70 percent (60 – 90 percent)	70 percent (60 – 90 percent)	N/A
Business	100 percent (80 – 120 percent)	100 percent (80 – 120 percent)	100 percent (100 percent)

Source: U.S. Department of Transportation (DOT), *Revised Departmental Guidance, Valuation of Travel Time in Economic Analysis*, (Memorandum from E. H. Frankel), February 2003, Tables 1 and 2; based on literature review reported in: U.S. Department of Transportation (DOT), *Departmental Guidance for the Valuation of Travel Time in Economic Analysis* (Memorandum from F.E. Kruesi), April 1997.

Notes:

Values in parentheses (under the recommended estimates) represent plausible ranges to be used in sensitivity analysis.

*DOT notes that "[s]urface mode figures apply to all combinations of in-vehicle and other transit time. Walk access, waiting, and transfer time should be valued at 100% of the wage rate when actions affect only those elements of transit time.

DOT uses different fractions of the wage rate for different types of travel to reflect some of the attributes that affect the variation in these values.[56] For example, local trips are likely to be shorter in duration than intercity trips. The differentiation between personal and business travel reflects the assumption that the latter is largely unproductive time that would otherwise be spent in market work. (DOT defines business travel as travel for which the individual is being compensated by his or her employer.) The numbers in parentheses, reported under each recommended percentage, represent the plausible range of values from DOT's literature review for use in sensitivity analysis.

The categories in Exhibit 1 also reflect differing assumptions regarding the wage rate that should form the basis of the estimates. For business travel (during paid work hours), DOT recommends applying the percentages in Exhibit 1 to national estimates of total compensation. Somewhat lower values are used for truck drivers, based on data indicating that individuals in this industrial classification earn less than the national median. For personal travel (commuting, shopping, recreation, etc.), DOT suggests using estimates of pre-tax income, noting that this

[56]See DOT (1997) for a detailed discussion of the rationale for these values.

measure is commonly applied in the literature. For airline travelers, higher values are used based on data suggesting that individuals in this category have incomes that exceed the national median. The wage rates currently used by DOT (which form the basis for the adjustments in Exhibit 1) are reported in Exhibit 2 below.

Exhibit 2

WAGE RATES USED AS BASIS FOR U.S. DEPARTMENT OF TRANSPORTATION CALCULATIONS
(does not reflect adjustments in Exhibit 1)
(2000 dollars)

Type of Travel	Surface Modes	Air Travel	Truck Drivers
Personal	Median pre-tax annual household income divided by 2000 hours ($21.10 per hour)	Average annual income for "other" air travelers divided by 2000 hours* ($33.30 per hour)**	N/A
Business	Total compensation (employer costs); average pre-tax wages plus benefits ($21.20 per hour)	Average annual income for business air travelers divided by 2000 hours* ($40.10 per hour)**	Median weekly earnings for full time truck drivers divided by average hours per week, plus benefits ($18.10 per hour)

Source: U.S. Department of Transportation (DOT), *Revised Departmental Guidance, Valuation of Travel Time in Economic Analysis*, (Memorandum from E. H. Frankel), February 2003, Table 3, supplemented by review of the data sources cited for personal and business travelers using surface modes (http://stats.bls.gov/ncs/ect/sp/ecechist.pdf; and, http://www.census.gov/hhes/income/income00/inctab1.html).
Notes:
* Data for 1998 escalated to 2000 based on increase in median household income.
** For general aviation passengers: median annual income divided by 2000 hours ($45.00 per hour)

As indicated by the exhibit, the wage rates now used in DOT analyses are expressed in current dollars for the year 2000. For example, DOT calculates wage rates for intercity business travel by surface modes based on estimates of the average cost to the employer for total compensation per hour worked in 2000 (including wages and benefits) or $21.20.[57] For intercity personal travel by surface modes, DOT's estimates reflect median income for all U.S. households in 2000 ($42,148), divided by 2,000 hours per year, or $21.10.[58,59] These estimates are very similar although they include different types of compensation and represent different types of travelers.

[57]Taken from Bureau of Labor Statistics, Employer Costs for Employee Compensation, 1986-2001, Table 1, http://stats.bls.gov/ncs/ect/sp/ecechist.pdf. Reflects average hourly costs to employers for wages and salaries and benefits based on the National Compensation Survey.

[58]Taken from U.S. Census Bureau, Income 2000, Table 1, http://www.census.gov/hhes/income/income00/inctab1.html. Reflects household earnings from the Current Population Survey.

[59]For personal travel by surface modes, DOT bases its values on per household (rather than per capita or per wage earner) income, noting that this approach is a common practice in the research literature. However, the Miller (1996) paper, which is the basis for the percentages reported in Exhibit 1, calculates these percentages based primarily on the average pre-tax wage rate of the travelers studied.

As indicated in the footnote in Exhibit 1, DOT recommends a value of 100 percent of the applicable wage rate when only wait time (or walking or transfer time) is affected. Wait time can differ from other types of travel time in a number of respects; e.g., it may be more boring or unpredictable. Related empirical research is discussed in the following chapter.

3.0 EMPIRICAL RESEARCH ON THE VALUE OF WAIT TIME

CBP regulations may affect a variety of types of time use. For example, they may require individuals to acquire documentation, wait for longer (or shorter) times at border crossings, or otherwise change the duration of trips. Review of forthcoming rules suggests that one of the more common impacts may be on wait time or similar types of activities in the context of international travel. Compared to other components of travel time (e.g., in-vehicle time), these types of time uses may reflect additional disutility because they generally preclude involvement in joint activities (e.g., viewing scenery while driving) and are often perceived as boring and unpredictable.

This chapter focuses on available studies of wait time and similar activities primarily from the travel and transportation literature. It begins by discussing the steps involved in transferring estimates from one context to another; i.e., from available research studies to a particular CBP regulatory analysis. It then summarizes selected literature reviews that specifically considered the value of wait time. Next, it discusses in more detail the attributes of time use (such as comfort or predictability) that cause this value to vary. The chapter concludes with an example of how wait time might be valued by CBP in its regulatory analyses.

3.1 Criteria for Transferring Estimates[60]

The available literature generally addresses types of time use that are similar, but not identical, to the specific types of time use affected by CBP rules. Thus time valuation in the CBP context will generally involve a transfer of estimates that address somewhat different scenarios. In analyses of travel and transportation policies, such transfers are relatively common. For example, the DOT guidance discussed in the prior chapter represents an approach that transfers estimates from the available research to DOT regulatory analyses.

Texts describing best practices for such transfers often focus on the valuation of human health and environmental benefits. In these contexts, transfers can be controversial and may lead to highly uncertain estimates due to the widely varying characteristics of the effects considered. Generally, these recommended best practices involve review of both the applicability and the quality of the available studies to determine whether and how to apply them to a specific regulatory scenario. There are no universal, generally accepted standards for determining the appropriateness of transferring a particular value, however. The process relies heavily on the informed judgment of the analyst and requires explicit discussion and assessment of the approach and the resulting uncertainties.

Because such transfers can be problematic, OMB's guidance for regulatory analysis suggests that they "be treated as a last-resort option and not used without explicit justification."[61]

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[60]For more information on the benefit transfer approach, see OMB (2003) and Desvouges, W.H., F.R. Johnson, and H.S. Banzhaf, *Environmental Policy Analysis with Limited Information: Principles and Applications of the Transfer Method,* Cheltenham: Edward Elgar, 1998.

[61]OMB (2003), p. 24.

However, such transfers may pose fewer difficulties in the context of time valuation than when valuing human health and environmental impacts. As illustrated in Exhibits 1 and 2 in the prior chapter, estimates of the value of time tend to vary within a comparatively narrow range. For example, for local and intercity personal travel by surface modes, DOT suggests that the plausible ranges of values varies from 35 to 90 percent of the wage rate.

Conducting a transfer generally involves five steps:

1. *Describe the Regulatory Scenario*. Describe in detail the effects of the proposed regulation and the characteristics of the affected population.

2. *Identify Existing Relevant Studies*. Search the valuation literature for studies that address similar types of effects.

3. *Review Existing Studies for Quality and Applicability*. Assess the quality of the studies by determining whether they follow generally accepted best practices for the methods used. Assess applicability in terms of: (a) the similarity of the effects; (b) the similarity of the populations experiencing the effects; and, (c) the ability to adjust for differences between the study scenario and the regulatory scenario.

4. *Transfer the Estimates*. Conduct the transfer, making any necessary adjustments to the study estimates and applying them to the regulatory scenario. The transfer may be based on the results of a single study or of several studies.

5. *Address Uncertainty*. Address uncertainties in the estimates both qualitatively and quantitatively; e.g., by conducting sensitivity or probabilistic analysis as appropriate and discussing the implications for decision-making.

The first step, the description of the impacts of CBP regulations on time use, is covered briefly in the introductory chapter of this report and would be developed in more detail in the context of a particular rulemaking. The second step, the literature review, was initiated at a very general level in Chapter Two; this chapter focuses in more detail on the research most relevant to forthcoming CBP rules. For the third step, assessment of the available studies, this chapter relies on the results of the available literature reviews. It then concludes with an example of a process for implementing the transfer, covering steps 4 and 5 from the list above.

In this chapter, we concentrate on the valuation of wait time because current CBP initiatives are likely to directly affect the amount of time that international travelers spend waiting at border crossings or in passport offices. These initiatives may also affect the amount of time spent collecting documentation (e.g., to apply for a passport), which is similar to wait time in many respects: both are generally viewed as undesirable uses of time that preclude the joint pursuit of more enjoyable or productive activities, and may be uncertain in duration. The general approach described above can also be used to apply values from the research literature for other types of time use.

3.2 Literature Reviews

As introduced in Chapter 2, travel and associated wait times are intermediate activities. Unlike leisure (which involves relatively free choice among activities) or work (which involves the productive use of time to create goods and services as well as generate income), intermediate activities make certain types of leisure and work activities possible. In other words, the demand for travel results from the demand for other activities. As noted by Small:

> *Travel is a derived demand: it is normally undertaken not for its own consumption value, but rather to facilitate a complex and spatially varied set of activities such as work, recreation, shopping and home life.*[62]

Travel time in general, and wait time in particular, is one of many components of the decision to engage in travel or other intermediate activities. Other factors, such as dollar costs, will also affect these decisions. In turn, these intermediate activities are one of several components of the decision to engage in various types of leisure and labor activities.[63]

Valuation of travel time is thus a complex undertaking, and the research literature is relatively large. In this section, we rely on the results of available literature reviews to identify studies from the travel and transportation literature that value wait time. Relying on these reviews has several advantages. In particular, the authors of individual studies do not always report their results on a comparable basis, and the review authors often convert the results to more similar measures.

One of the earlier reviews is provided in Bruzelius' seminal 1979 book on the theory and practice of travel time valuation. He identifies eight estimates of wait time from studies published between 1967 and 1975 that focus on travel to and from work. These studies result in wait time values that range from 24 to 258 percent of the wage rate.[64] Generally these values are higher (representing a larger value for time saving) than the value of in-vehicle time. However, Bruzelius notes that most of these studies "are deficient in some respects," that "the wage rate has been calculated differently in the various studies," and that standard errors are often not reported.[65] In addition, these studies use models that assume that the value of time is fixed; i.e., that it does not vary within the population.[66]

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[62]Small, K., *Urban Transportation Economics*, Luxembourg: Harwood Academic Publishers, 1992, p. 5.

[63]As noted earlier, changes in required time expenditures may affect the overall demand for travel or other activities as well as monetary expenditures. While CBP takes these factors into account in its regulatory analyses as relevant, exploration of these relationships is beyond the scope of this report.

[64]Bruzelius (1979), Table 6.1, p. 153.

[65]Ibid., pp. 152-155. Where standard errors are reported for the value of time, Bruzelius notes that they are so large that the results are not statistically significant at the 2.5 percent level.

[66]Ibid., pp. 161, 165-167, 171. Bruzelius also reports the results of a study (by Daly and Zachary) that allows these values to vary, but notes that the study has several critical deficiencies. In addition, he reports the results of his own study, which incorporates only limited information on wait times.

A subsequent review was completed in 1982 by the Australian Bureau of Transport Economics.[67] They identify 20 estimates of the value of wait time, taken from 14 studies published between 1965 and 1978. They find that a higher value was placed on savings in wait time than on savings in in-vehicle time in all but one study; in many cases wait time values were higher by a factor of two or more. However, they did not evaluate the quality of the studies and reported widely varying relationships between the value of in-vehicle time and wage rates.

In 1996, Miller conducted a more careful review of the literature that is one of the key sources supporting the current U.S. DOT guidance.[68] For comparability, to the extent possible he first converts the values from individual studies into a percentage of the average pre-tax wage rate for the travelers studied, while noting that the value of time is not necessarily a constant fraction of the wage rate. (As discussed in the next section, available evidence suggests that, as incomes increase, the value of travel time decreases as a percentage of income.) He recommends that all business-related travel be valued at 100 percent of pre-tax wages plus fringe benefits to represent the employer's cost; i.e., the value of lost productivity as described in the Section 2.2 discussion of the human capital approach.

For personal travel, Miller considers wait time separately. He reviews five studies of traffic congestion completed between 1985 and 1996 and concludes that wait time is valued at roughly 1.5 to 2.0 times the value of travel time. He then considers the relationship of these values to wage rates. For non-work automobile travel, he recommends valuing wait time at 75 percent of the pre-tax wage rate for drivers (with a range from 65 to 110 percent) and 55 percent for passengers (with a range from 45 to 75 percent) for unplanned auto travel delays. He also recommends the use of the 55 percent value for delays when traveling by bus, train, or air. However, DOT did not accept these recommendations due to the difficulties inherent in distinguishing the number of drivers vs. passengers and concerns about the approaches used to separate out different types of time use in the underlying studies. As noted in Section 2.4, DOT instead suggests that, when only wait time is affected, it should be valued at 100 percent of the wage rate.

More recently, Wardman conducted a meta-analysis of British studies completed between 1980 and 1996.[69,70] He identified 13 studies of wait time, which in combination provide 35 values. Across these studies, the mean value for averting wait time was 1.47 times the value of in-vehicle time (with a standard deviation of 0.52). Wardman notes that the conventional practice in Great Britain and other countries is to value wait time at twice the wage rate, while his results are somewhat lower. In his analysis, Wardman differentiates between various types of delays; e.g., separating wait time from in-vehicle delays and from planned gaps between arrival times (i.e., headway).

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[67]Bureau of Transport Economics, *The Value of Travel Time Savings in Public Sector Evaluation*, Canberra: Australian Government Publishing Service, 1982.

[68]Miller, T.R., "The Value of Time and the Benefit of Time Saving," prepared for the U.S. Department of Transportation, 1996.

[69]Wardman, M., "A Review of British Evidence on Time and Service Quality Valuations," *Transportation Research Part E*, Vol. 37, 2001, pp. 107-128.

[70]We do not include the von Wartburg and Waters (2004) literature review in this section, because it relies on largely on Wardman (2001) for its discussion of the value of wait time.

These literature reviews support the practice of placing a higher value on savings of wait time than on savings of in-vehicle travel time, although the exact amount of the increment varies. The more recent reviews suggest that the value of wait time savings may exceed the value of in-vehicle time savings by a factor of about 1.5 to 2.0 on average. As discussed below, the applicability of these values to the changes in time use attributable to CBP programs will depend on the extent to which the types of time use and population affected are similar.

3.3 Valuation of Specific Attributes

The variation in the values reported in the studies discussed above in part results from the different attributes or characteristics of the scenarios each addresses. The following sections briefly discuss some of the key attributes likely to affect the valuation of time, and report the results of related research where available.

3.3.1 Duration and Timing

The studies reviewed in the prior section are primarily concerned with wait time in a transit or transportation context, where in some cases waits (e.g., for a bus or train) may last a few minutes rather than an hour or more. Because these studies often do not report the lengths of the waits considered, it is difficult to be certain about the extent to which the durations differ from the scenarios potentially addressed by CBP regulations.

Many observers have noted that small time savings (e.g., of a few minutes) may be valued differently than larger time savings, in part because small savings may be simply tacked onto adjoining activities while longer time savings can be used to engage in new activities. The value of time savings of different durations also will depend in part on whether the affected individuals can re-arrange their schedules so as to take better advantage of the time available. According to Miller's 1996 literature review, the empirical evidence on the relationship of the value of time to duration is inconclusive and some of the available studies are seriously flawed. The 2004 von Wartburg and Waters review suggests that small time savings may be perceived as less valuable than larger savings, but that the evidence is "not conclusive."[71]

The value of time savings also depends on when it occurs. The time of day, as well as the season of the year, affects the range of activities available.[72] Phaneuf and Smith's 2005 review of the recreational literature (see Section 2.3) indicates that new studies are needed to determine related dollar values; research completed to-date suggests that this relationship is complex. For example, based on information from time diaries, Hamermesh assessed the impact

[71]von Wartburg and Waters (2004), p. 100.

[72]One example of the effect of timing is a Smith and Mansfield study which explored individuals' willingness to accept compensation to participate in a survey. They found that individuals were much less likely to participate if the survey occurred on a weekend. (Smith, V.K. and C. Mansfield, "Buying Time: Real and Hypothetical Offers," *Journal of Environmental Economics and Management*, Vol. 36, 1998, pp. 209-224.)

of different factors on routine (i.e., the extent to which schedules vary from day-to-day).[73] He concluded that diversity is more desirable (at the margin) than routine, and is related to the number of hours worked, earnings capacity, and educational attainment. This research indicates that these relationships are somewhat ambiguous, at least in part because higher earnings increase the "price" or opportunity cost of time while at the same time increasing the demand for variety.

Finally, it is possible that the value of time varies depending on whether the change represents an increase or decrease. Relatively few studies have focused on this issue. However, von Wartburg and Waters note that recent research suggests that there is little difference in the value of time gains vs. losses.[74]

Thus the available research suggests that both the duration and timing of changes in time use may affect its value. However, the available empirical research is not adequate to support quantitative adjustments to the value of time to reflect these considerations.

3.3.2 Predictability and Reliability

Another attribute that affects individual's valuation of time savings is the associated predictability, variability, or uncertainty. Much of the work on this issue addresses traffic congestion.[75] For example, as summarized in a 1999 study by Cohen and Southworth:

> *"...a number of empirical studies have demonstrated the importance of also considering travel time variability in the derivation of traveler cost functions...These studies indicate that under the right circumstances, notably during congested peak period travel, reducing the variability, and hence the uncertainty, associated with trip times can offer significant traveler benefits...*
>
> *...In particular, a number of studies were found to have used stated preference (SP) surveys to capture and quantify traveler perceptions about the day-to-day reliability of their travel options. While numerical results from these studies vary a good deal, they indicate that travelers involved in repetitive trip-making are likely to place a significant premium on consistency in day-to-day trip times."*[76]

In their more recent (2005) review, Brownstone and Small also find that the research supports the use of higher values for averting unreliable travel time.

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[73]Hamermesh, D.S., "Routine," *The Economics of Time Use* (D.S. Hamermesh and G.A. Pfann, eds.), Oxford: Elseveir, 2005.

[74]von Wartburg and Waters (2004), pp. 99-100.

[75]For more detailed information on the theory and empirical evidence related to the valuation of reliability in both the traffic congestion and public transport context, see: Bates, J., J. Polak, P. Jones, and A. Cook, "The Valuation of Reliability for Personal Travel," *Transportation Research, Part E,* Vol. 37, 2001, pp. 191-229.

[76]Cohen, H. and F. Southworth, "On the Measurement and Valuation of Travel Time Variability Due to Incidents on Freeways," *Journal of Transportation and Statistics,* December 1999, pp. 123-131.

The value placed on predictability or variability may vary from day-to-day or from trip-to-trip depending on the context. As Miller notes:

> "*For example, reliability is much more important when the traveller has an early meeting. When the traveller is late, a small saving in travel time may become very valuable, inducing acceptance of more discomfort, stress, safety risk, and out-of-pocket cost."*[77]

In their review, Brownstone and Small note that the value of reliability appears greater for women than men, perhaps because of their larger role in childcare and the resulting lack of schedule flexibility.

The available studies suggest that the dollar value placed on the predictability of wait time is likely to vary depending on the context. While these studies address scenarios (such as traffic congestion) that differ in some respects from the scenarios addressed by CBP rules, their findings suggest that higher values are likely to be placed on averting delays or reducing wait times that are more uncertain or unpredictable.

3.3.3 Comfort, Convenience, Stress, and Safety

Travel time generally, and wait time specifically, has a number of attributes that determine how pleasant or unpleasant the experience is likely to be. It is very difficult to disentangle the effects of these various characteristics and to assess their individual impact empirically. Few, if any, studies provide separate estimates of the value of factors such as comfort or convenience. However, it seems self-evident that the more unpleasant the experience, the higher the value of saving time is likely to be.

3.3.4 Ability to Engage in Simultaneous Activities

The value of time also depends in part on whether the individual can simultaneously pursue other activities while traveling. For example, a business traveler may work when traveling by plane or train, or use his or her cell phone for work-related calls while driving. A leisure traveler may enjoy listening to music or viewing the scenery. These productive or pleasant uses of time may mean that time savings have a lower value than would be the case if the activity had no positive aspects.[78]

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[77]Miller, T.R. (1996), pp. 1-2.

[78]Nordhaus (2006) recommends developing a "value-theoretic" approach for dealing with activities that are pursued simultaneously, when accounting for nonmarket production in the context of national accounts. This approach would allocate the time among the component activities on the basis of their value. In contrast, the research reviewed in this report generally provides values that reflects the net effect of all of the activities performed during a particular period (i.e., while traveling), distinguishing in some cases between components such as wait time vs. in-vehicle time.

The types of time use affected by CBP regulations may provide few opportunities for these types of joint activities.[79] The extent to which individuals can engage in enjoyable or productive activities while waiting at border crossings may be limited. The activities related to acquiring a passport (collecting documentation, waiting at the passport office) also seem to provide little opportunity for these types of positive joint activities.

3.3.5 Relationship to Income

There are a number of reasons to expect that the value of time may vary by income level. For example, a higher income implies a higher opportunity cost for time use, while also providing funding that can be used to engage in a wider range of activities. However, a larger income may also allow an individual to work fewer hours. In addition, income may be correlated with other factors that potentially affect the value of time, such as age. The relationship between income and the value of time is likely to be complex for these and other reasons.

Available research suggests that increases in income do not result in proportionate increases in the value of time savings. Wardman's recent meta-analysis suggests that 0.5 is a reasonable estimate of income elasticity; i.e., a one percent increase in income will lead to a 0.5 percent increase in the value of time savings.[80] However, this result is not statistically significant. The subsequent von Wartburg and Waters review suggests that the overall empirical evidence suggests an income elasticity of around 0.75, in particular once additional work by Mackie et al. is taken into account.[81]

Other types of research further support the view that the value of time varies by income level. For example, Deacon and Sonstelie explored the willingness to wait in line for lower priced gasoline for a small sample of motorists.[82] They found that the value of this waiting time was close to the after-tax wage rate in most cases, but that the lowest income group had values that exceeded the wage rate.[83] This result is consistent with the 2004 Larson and Shaikh recreational demand study summarized in Section 2.3, which also found that the value of time exceeded the wage rate for lower income individuals.

The relationship between income and the value of time savings is important for two reasons. One has to do with the use of different values for different segments of the population;

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[79]The increasing use of cell phones may be one exception; however, the impact of cell phone usage on the value of wait times has not yet been explored in detail.

[80]Wardman (2001), pp. 116, 125.

[81]von Wartburg and Waters (2004), pp. 103-104.

[82]Deacon, R.T. and J. Sonstelie, "Rationing by Waiting and the Value of Time: Results from a Natural Experiment," *Journal of Political Economy*, Vol. 93, No. 4, 1985, pp. 627-647.

[83]This finding for wait time cannot be directly compared to the DOT percentages for personal travel reported earlier in Exhibit 1, which are based on pre-tax rather than post-tax wages. Taxes as a percent of wages vary over time and across locations; however, in 1980 (the year in which the Deacon and Sonstelie data were collected) mean national post-tax income was about 77 percent of pre-tax income. (U.S. Bureau of the Census, "Table RDI-1. Household Income Before and After Taxes: 1980 to 2003," http://www.census.gov/hhes/www/income/histinc/rdi1.html, as viewed September 29, 2006.)

i.e., cross-sectional variation in values. For example, as discussed in the prior chapter, the current DOT guidance uses different wage rates for air travel than for other travel modes (because air travelers have noticeably higher incomes than the general population), but applies the same percentages in both cases. In other words, DOT assumes that the value of time savings is a constant proportion of wage rates as wages rise. A lower (less than proportional) income elasticity would decrease the value of time as a percentage of wages for the higher income group.

More generally, cross-sectional adjustments for different income levels (regardless of the elasticity estimate used) raise concerns about the appropriate treatment of equity issues in regulatory analyses.[84] For example, in some cases a regulation may disproportionately affect a group whose earnings are less than the U.S. median (e.g., the elderly, minorities, women). Using the earnings rate specific to this group as a benefit measure is consistent with the focus of welfare economics on individual preferences and economic efficiency.[85] However, such an approach may raise concerns about equity, since it implies that society values benefits to these groups at a lower rate than it values benefits to other groups.[86] Thus whether to base the analysis on different income levels for different groups, or use average or median values, can be a difficult policy decision for regulatory agencies.

The other issue has to do with changes in value as the national average (or median) per capita income or gross domestic product increases over time; i.e., longitudinal variation in income. It is common in the travel and transportation literature to apply a fraction of the wage rate, derived from older studies, to current wage rates when valuing time savings. This approach (which is also reflected in the DOT guidance) assumes that the value of time is a constant percentage of income as income increases over time.

As noted earlier, the empirical evidence does not fully support this assumption. The use of constant percentages may be more an issue of convenience, due to the analytic complexity of applying elasticity estimates over time. Longitudinal adjustments would require determining the appropriate income elasticity estimate for different time periods (separating out the effect of inflation from real income growth), and then applying this estimate to the results derived from each individual study. This in turn would require determining the year in which the data for each study was collected (which is not always reported) as well as the appropriate elasticity estimate for the period between the study date and the present time.

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[84]For example, Mackie et al. (2001) argue for the use of a weighting scheme to adjust individual values for time saving to reflect social values in policy analyses, particularly to eliminate the effects of income constraints on these values. Such weighting schemes are generally not used in U.S. regulatory analyses due to the difficulties inherent in determining generally acceptable and appropriate weights.

[85]Economists often argue that it is more efficient to address income inequalities directly (e.g., though tax and welfare programs) rather than through regulatory programs primarily designed to achieve other goals.

[86]For example, for the valuation of health and safety impacts in cost-effectiveness analyses, OMB (2003) recommends the use of average values rather than values that vary by income or other demographic group.

3.3.6 Summary

The reviews of the empirical research summarized in the prior section suggest that wait time savings are valued more highly than savings in in-vehicle time. This section explored some of the attributes that lead to these higher values and may cause the value of wait time to vary across different situations. The evidence from the research literature suggests that decreases in wait time (or similar types of time use) will be valued more highly if the activity has the following characteristics:

- Its duration is uncertain or unpredictable.
- It occurs in uncomfortable or unpleasant surroundings
- Affected individuals are unable to pursue other more pleasant or productive activities simultaneously.

The effects of the length of the wait and the income of those affected is more uncertain.

As noted earlier, CBP initiatives are likely to affect the amount of time that international travelers spend waiting at border crossings or in a passport offices, in which case the estimates of the value of wait time from the travel and transportation literature may be directly relevant. In addition, these initiatives may affect the time needed to collect documentation (e.g., for a passport application), which appears similar to wait time in terms of the many of the attributes discussed above. Both types of time use are generally viewed as undesirable, often preclude the joint pursuit of more enjoyable or productive activities, and may be uncertain in duration.

3.4 Data Sources And Example Calculations

The previous sections indicate that a number of studies have addressed the value of wait time and similar activities as well as the effects of different attributes on these values. However, these studies often report their results as a percentage of the wage rate or as a percentage of in-vehicle time. Because the value of wages and in-vehicle time varies across studies and is not always reported consistently (or explicitly), it can be difficult to compare the results across studies. Yet the fact that the value of wait time is often linked to in-vehicle time or wage rates provides a starting point for estimating values for use in CBP analyses.

In this section, we estimate the value of wait time based on the literature discussed in this report. We use the DOT guidance described in Section 2.4 as the basis for our calculations because it reflects a long- standing, generally accepted approach to valuing transportation or travel-related time in the context of Federal regulatory programs. However, rather than following all of the DOT assumptions, we build on the approach to reflect the more recent research summarized in this report and to focus more explicitly on wait time and similar activities.

Our calculations follow a three-step process.

- First, we determine wage rates that are relevant to the valuation of time for business and personal travelers under DOT's approach.

- Second, we use the range of DOT adjustment factors for surface intercity and local travel to estimate the value of in-vehicle time for each type of traveler.

- Third, we use the wait time adjustment factor from the recent Wardman meta-analysis to estimate the value of wait time for business and personal travelers.

Below, we describe each step in more detail, then summarize the results in an exhibit at the end of the section. As discussed in the previous sections of this report, there are a number of uncertainties associated with these calculations. Hence we provide a range of values rather than reporting a single best estimate.

Step 1 - Determine Wage Rates: The goal of this step is to develop wage estimates that are consistent with the approach used to develop the DOT adjustment factors reported in Exhibit 1 (which we next use to estimate the value of in-vehicle time). As does DOT, we rely on estimates of pre-tax income for personal travel and pre-tax income plus benefits for business travel.

Ideally, the value of time used in regulatory analysis would measure the change in utility that would accrue to the particular individuals affected by the rulemaking. Extending this logic to the selection of a wage rate suggests that analysts should base their calculations on the wages of those affected. However, national wage rates are frequently used in these analyses for several reasons. First, it may be difficult to identify the subpopulation affected by the rulemaking, and its wage rates, with much precision. Second, many rules have broad impacts throughout the population, and the wages of those affected may be best approximated by overall U.S. wage rates.[87] Third, the percentages that DOT uses to link wages to the value of travel time for surface modes are intended to be applied to national estimates. Applying these percentages to different wage groups may introduce additional uncertainties into the analysis because (as discussed in Section 3.3.5) the value of time is not likely to be a constant fraction of income.

As result, in this example we use national U.S. wage data in our calculations. However, in cases where a regulation disproportionately affects certain wage or income classes, it may be preferable to use the wage rates for the affected subpopulation if available. For example, DOT recommends different wage rates for air travelers and truck drivers than for surface mode travelers, because their average wages are respectively much higher and lower than the average for the general population (see Exhibit 2 above). The decision to use national wage rates or the rates for the affected subpopulation needs to be made on a case-by-case basis however, because it involves a trade-off between the accuracy of wage measurement and consistency with how the DOT percentages were derived.

[87]As noted in Section 1.1, this report is designed to support benefit-cost analysis for economically significant rules, which often have these sorts of wide-ranging impacts.

For this example, we also rely on median (rather than average or mean) U.S. wage rates.[88,89] Whether the median or average is the best central tendency estimate of wages depends on extent to which the distribution of income levels for those affected by the regulation is expected to mirror the overall U.S. distribution. The U.S. income distribution is very skewed due to the small number of people who are very highly compensated, hence the average is significantly above the median. Thus the best estimate of the wage rate for the relatively small fraction of the U.S. population affected by most rulemakings may be better reflected by the median (which is in the center of the income distribution) than by the mean (which is closer to the upper tail of the distribution).

In our calculations, we update the DOT estimates to reflect wage data for the year 2005, which was the most recent year for which median pre-tax wage data were available at the time when this report was prepared. In addition, we use per person-hour estimates for personal travel (rather than dividing per household values by 2,000 hours), consistent with the research that underlies the DOT guidance (especially Miller 1996) and with the approach used for business travel.

We rely on the most recent and comprehensive estimates of hourly income per wage earner available. There are several data sources that can be used for these estimates, including the Bureau of Labor Statistics' (BLS') National Compensation Survey (NCS) and Occupation Employment Statistics Survey (OES).[90] The OES is a more comprehensive survey and thus more likely to be suitable for this type of national analysis. According to this survey, in May 2005 median hourly pre-tax earnings were $14.15 across all reported occupations.[91] We use this estimate directly in our calculations for personal travel.

For business travel, the DOT percentages are based on pre-tax earnings plus benefits. Because per wage earner benefits data cannot be easily retrieved from the OES, we instead rely on BLS' Employer Costs for Employee Compensation (ECEC) report, which is based on the NCS.[92] The ECEC reports the average (not median) cost per employee hour worked, including wages, salaries and benefits paid by the employer. In 2005, wages and salaries averaged $18.33

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[88]If data on the wages of the specific population affected are available, then the analysis should be based on the average since it is generally the best estimate of central tendency.

[89]The DOT guidance uses a mix of average and median values.

[90]The U.S. Census also collects data on earnings in several of its surveys. The Annual Social and Economic Supplement to the Current Population Survey (CPS ASEC), conducted by Census for BLS, is generally its most comprehensive, timely, and accurate source of national data. However, it is difficult to access data on median hourly income for wage earners from this survey; its results are generally reported on different bases (e.g., per household rather than individual, per week or year rather than per hour, or per capita for all family members including non-wage earners). Thus it requires more adjustments and is more difficult to use than the OES. See: http://www.census.gov/hhes/www/income/newguidance.html#summary.

[91]Date reported at: http://www.bls.gov/oes/current/oes_nat.htm#b00-0000 as viewed September 29, 2006. See http://www.bls.gov/ncs/ocs/comfaq.htm for more information on the types of employees and wage data included.

[92]See: http://www.bls.gov/ncs/ect/home.htm; data extracted on January 9, 2007.

and were 70.3 percent of total compensation.[93] If we apply the resulting ratio to median hourly pre-tax earnings of $14.15, we find that total median compensation is $20.13.

Step 2 – Estimate the Value of In-Vehicle Time: Our next step involves applying the DOT percentages from Exhibit 1 to the wage rates estimated above. A key assumption in this step is that the DOT percentages (which are for all travel time) largely reflect the value of in-vehicle time. We focus on in-vehicle time for surface modes because this is the type of time most often used as the basis for the wait time estimates discussed under Step 3 below. As discussed in Section 2.4, DOT indicates that the range of plausible estimates depends on the whether the trip is local or intercity. We use the range of percentages for both local and intercity travel because it is unclear whether the estimates of in-vehicle time used to develop the wait time estimates are more similar to local or longer distance travel. We apply these estimates separately for personal and business travelers.

Exhibit 1 indicates that the value of travel time by surface modes ranges from 35 to 90 percent of the wage rate for personal travel and from 80 to 120 percent of the wage rate for business travel. Applying these estimates to the wage rates derived under Step 1 yields a range of values for personal in-vehicle time from $4.95 to $12.74 per hour and, for business time, from $16.10 to $24.15 per hour.

Step 3 – Estimate the Value of Wait Time: The final step involves determining the value of wait time based on the estimates of in-vehicle time that result from Step 2. Rather than adhering to DOT's recommendation that wait time be valued at 100 percent of the wage rate, we rely on the results of the more recent (2001) Wardman review summarized in Section 3.2. This review has the advantages of using meta-analytic techniques to estimate values and of carefully distinguishing between various types of travel-related time uses, including different types of waits or delays.

Wardman finds that the mean value of averting wait time is 1.47 times the value of in-vehicle time.[94] Applying this factor of 1.47 to the estimates of the value of in-vehicle time (derived under Step 1) yields a range of values for personal wait time from $7.28 to $18.72 per hour and, for business wait time, from $23.67 to $35.51 per hour.

The estimated value of averting waits that occur during paid work time is higher than the value for personal time because it includes both lost productivity and the disutility (or unpleasantness) associated with the wait. Including an adjustment for disutility when valuing wait time is common for personal travel, but unusual for business travelers. However, it provides a more complete measure of the impacts on the individual beyond the productivity loss. Wardman's 2001 literature review appears to support this approach. He finds that the wait time adjustment factor for business travelers is greater than for personal travel (1.80 compared to

[93]As noted earlier, average U.S. earnings are higher than the median. In this calculation, we assume that the relationship between pre-tax wages and benefits is the same at the median and mean points in the income distribution.

[94]The Wardman analysis results in wait time values that appear somewhat lower than the conventional approach of valuing wait time at twice the value of in-vehicle time. This factor of 2, and/or the standard deviation of the Wardman result ($\pm$0.52), could be used for additional sensitivity analysis if desired.

1.47); however, we do not use this higher value in our analysis because it is based on a very small sample of studies that focus on types of time savings that tend to be highly valued.

The results of each step in our analysis are summarized in Exhibit 3 below. This exhibit provides a range of values that can be used for sensitivity analysis as well as best (central tendency) estimates.

Exhibit 3

CALCULATION OF THE VALUE OF WAIT TIME
(per person-hour, 2005 dollars)

Type of Time Affected	Low	Best	High
Step 1 - Determine Wage Rates			
Personal	\$14.15		
Business	\$20.13		
Step 2 – Estimate the Value of In-Vehicle Time			
Personal	\$4.95	\$8.49	\$12.74
Business	\$16.10	\$20.13	\$24.15
Step 3 – Estimate the Value of Wait Time			
Personal	\$7.28	\$12.48	\$18.72
Business	\$23.67	\$29.59	\$35.51
Note: See preceding text for detailed information on data sources and calculations.			

The range of estimates in the exhibit primarily reflects uncertainty in the estimates of in-vehicle time, based on the plausible ranges recommended by DOT for sensitivity analysis. We do not apply low and high values for the other values used in these calculations (i.e., median wages, benefits, and the wait time adjustment), because simultaneously applying such estimates for each of these factors would lead to unrealistically wide ranges. In other words, its unlikely that all of the values for each step in the calculations would concurrently be at the low (or high) end of their range. The effects of uncertainty in these other estimates can be instead be captured by sensitivity analysis that examines the impact of varying each parameter value individually, or by constructing a probabilistic model that incorporates estimates of the likelihood of each value.

In sum, ideally the value of marginal changes in time use would be based on research that directly estimated individuals' willingness to pay for the specific types of changes attributable to particular regulations. Given time and budget resources, government agencies are not able to conduct such research for each individual regulation. However, the large literature on the value

of time can be used to estimate these values for those types of time uses most likely to be affected by forthcoming CBP rulemakings. In particular, these initiatives are likely to affect wait time for international travelers as well as other types of time use with somewhat similar attributes (such as the time needed to collect documentation). Based on currently available data and research, the value of changes in these types of time use may range from $7.28 to $35.51 per person-hour affected, depending on whether the change affects work or personal time.

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