On the role of sleep in time use models

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ABSTRACT

For centuries, sleep has been considered to be a passive state of unconsciousness, a simple suspension of activities that individuals must undertake to achieve necessary physical and mental conditions to perform activities when awake. However, the true and active nature of sleep not only is important to health, productivity and overall well-being, but it also substantially impacts on how individuals allocate time to other important activities such as work and leisure. This passive-active duality led researchers to question the purpose of sleep. Is the time spent sleeping a resource that can be traded on another, more rewarding activities? Or is it best to consider sleeping as something valuable, something that one can benefit from?

Even though sleep takes more time, on average, than any other single activity (individuals spend a third of their lives asleep), it is generally viewed as only a mandatory activity from which to take time if needed, i.e. a trade-off activity. This has certainly impacted how researchers acknowledge the need to study sleep time allocation and its role in everyday life, societal roles, and individual relationships: the number of studies conducted is still relatively small in absolute terms compared to research on other activities such as labor, transport, leisure, and domestic work.

There are two main reasons, in our opinion, for the lack of sufficient appreciation of sleep as a driver of time assignment. First, there is the generalized public opinion that sleeping is “invariant” over time and between groups, due to the common assumption that, in general, people should sleep around 8 hours (Hegarty, 2012). This contrasts with most research that states that the sleep need of individuals varies with age, lifestyle, and health factors (National Sleep Foundation, 2016). Second, sleep duration analysis has been limited by poor measurements, such as misestimations in data collection methods, the differences between sleep time and time in bed, and the lack of acknowledgment of sleep interruptions during the night (Thompson, 2014). These factors, among others, might explain why the availability of time for activities with active participation (being awake) is usually considered to be a fixed quantity.

Sleep has been the subject of research in several disciplines and for different purposes, such as the analysis of health issues, alertness, sleep deprivation, demand for sleep, quality of sleep in Medical and Health sciences; gender division, age differences, racial diversity, expenditures in markets for specific sleep aids in Sociology; productivity and the relationship between work and sleep, in Economics. This is significantly and paradoxically contrasted with the common public opinion that sleep duration is fixed and should be treated as such. **In this paper we first review the literature on sleep from this three-discipline perspective and extract those elements that pertain to the**

construction of a general model to understand sleep within a time use framework. We show that there are at least four elements that are necessary to account for: the impact of sleep time on the perception of other activities, its role within the time constraint, the effect on productivity and the relation with goods consumption. Then we propose a model that captures these elements, we examine its theoretical properties and we set up the steps to proceed with econometric estimation.

Time use studies have shown that the importance individuals assign to their sleep time differ according to sociodemographic and sociological factors such as occupation and age (Venn and Arber 2011; Bryan 2011), gender (Meadows et al., 2008), relationship status (e.g. Brochu et al. 2012; Troxel et al., 2010); race/ethnicity (e.g. Paine et al., 2016; Ertel et al., 2011); presence of children in the household (e.g. Sinai and Tikotzky, 2012; Boergers et al., 2007); socioeconomic status and health (e.g. Moore et al., 2002; Hall et al., 1999); quality of life (e.g. Hamilton et al., 2007; Khaleque, 1999).

Within the biological and medical sciences, sleep has been shown to be related with cognitive performance, memory, decision making, alertness, reasoning, accidents and problem solving (e.g. Van Dongen et al., 2003; Turner et al., 2007), obesity (e.g. Golley et al., 2013; Olds et al., 2011; Lyytikäinen et al., 2011; Cappuccio et al., 2008; Taheri, 2004), and overall health (e.g. Hale, 2014; Gottlieb et al., 2006, 2005; Ellenbogen 2005). For short, physical and mental health are related with duration and timing of sleep timing of sleep. However, while the duration of sleep can be straightforwardly measured in time use surveys, its quality cannot. At most, individuals can experience the interruption of sleep (Burgard 2011); time spent with insomnia is recorded mostly as sleeping in time use diaries even though individuals with insomnia spend time in bed without sleeping.

If the marginal cost of sleep is high enough, individuals would rather prefer to be awake and perform an income-generating work activity or a utility-giving leisure activity. However, this is limited by the fact that sleeping is required to produce the energy needed for waking activities. Dinges et al. (2005) and Basner (2007) examined the relationship between sleep time and other activities finding that sleep is seen as an adjustable and temporal commodity which can be traded for other activities, such that sleep time had the strongest reciprocal relation with working time, travel time and time spent on housework. While quality sleep provides focus and alertness (Asgeirsdottir et al., 2016; Asgeirsdottir and Zoega, 2011), giving workers a better performance (Metlaine et al. 2005; Kripke et al., 2002), higher wages increase the opportunity cost of sleeping, making sleep more expensive and thus less desirable. The decision to sleep is therefore, at least to some extent, an economic decision (Biddle and Hamermesh, 1990). Recently, Asgeirsdottir et al. (2016) and Asgeirsdottir and Zoega (2011) extended the formulation of Biddle and Hamermesh (1990) by modeling the decision to sleep as an investment in the level of alertness that the individuals enjoy during the day.