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An empirical analysis of the demand for sleep: Evidence from the American Time Use Survey



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ABSTRACT

Using data from the American Time Use Survey, this paper empirically examined the demand for sleep, with special attention to its opportunity cost represented by wages. Variation in the unemployment rate by state was also used to investigate the cyclical nature of sleep duration. We conducted separate estimations for males and females, as well as for those who received a fixed salary and hourly wages. The findings predominantly revealed no relationship between sleep duration and the business cycle. However, an inverse relationship between sleep duration and wages was detected. This is in accordance with sleep duration being an economic choice variable, rather than a predetermined subtraction of the 24-h day. Although the inverse relationship was not significant in all the estimations for salaried subjects, it was consistent and strong for subjects who received hourly wages. For instance, elasticity measures were $-.03$ for those who received hourly wages and $-.003$ for those who received a fixed salary.

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1. Introduction

When asked what determines the wage rate, economists often mention factors such as productivity, the unemployment rate or the price level. While individuals can do very little to significantly affect the price level or the unemployment rate in order to raise their wages, they can increase their productivity in several ways. The two main ways to increase productivity and thus wages are education and experience. However, despite perhaps being the largest determinants of productivity and wages, education and experience are far from being the only ones. Sleep duration might, for example, be one, as sleep has been associated with increased alertness, cognitive performance and decision making abilities, as well as being regarded as vital for health and wellbeing (Amin et al., 2012; Ellenbogen, 2005; Gildner et al., 2014; Van Dongen et al., 2003). Consequently, sleep

not only generates utility, it also generates alertness, which is likely to increase productivity and thus also wages. In fact, a recent study shows that one additional hour of sleep per night causes wages to increase by 16%, making sleep a key determinant of productivity (Gibson and Shrader, 2014). The authors observe that people living in the same time zones devote different amounts of time to sleep, depending on sunset time. They claim that all else being equal, a worker in the east of a given time zone will go to bed earlier than a worker in the west of that same time zone, due to earlier sunset time. However, as a result of synchronized work schedules, the two workers probably wake up at the same time. Thus, the worker who lives further east enjoys more sleeping hours than does the worker who lives further west, making the former more productive. The authors then use sunset time as an instrument to estimate the causal effect of sleep on wages. To put the Gibson and Shrader (2014) results in perspective, the productivity effect, representing the positive causal effect of an extra hour of sleep on wages, is greater than previously reported for one extra year of schooling (Patrinos and Psacharopoulos, 2002).

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However, wages might also cause changes in sleep duration and not just the other way around. Let us take an example of a worker who recently got a raise. The worker's time is now more valuable and the opportunity cost of time spent sleeping has thus increased. As a result, in order to earn even higher income, this worker might choose to spend more time working, therefore reducing the time left available for other activities, which have now become more expensive. This is the substitution effect as the increased cost of sleeping makes the worker substitute time away from sleep, which is now more expensive than before. Given that sleep is a normal good, the income effect works in the opposite direction as the increased consumption possibilities might lead to increased consumption of all normal desiderata including sleep. The causal effect of wages on sleep duration would therefore include both income and substitution effects, running in opposite directions (Asgeirsdottir and Zoega, 2011). Although either effect could theoretically dominate, a dominant income effect would suggest the highly unlikely case of sleep being a Giffen good, in which the demand curve would be upward sloping, leading to higher demand at higher prices.

In order for the empirical evidence that only tests correlation, but not causation, to show that the substitution effect outweighs the income effect, the substitution effect not only needs to outweigh the income effect per se, it also needs to outweigh the productivity effect reported by Gibson and Shrader (2014) that runs in the opposite causal direction. The relationship between sleep duration and wages is therefore not as obvious as it initially appears.

Using data from the American Time Use Survey (ATUS), we examine the demand for sleep empirically, with special attention to its price, namely the opportunity cost of time. Economic fluctuations are of value as an independent variable in and of themselves and that is the main purpose of their inclusion in this paper. However, they are also interesting in the current context, as the causal relationship between sleep duration and wages is difficult to disentangle. Although it is possible to come up with stories about how sleep changes are the cause of decreased labor-market activity in recessions, or even the recessions themselves, those stories would probably be less convincing to most, than the causal explanation that aggregate economic conditions affect sleep. Economic conditions are thus arguably exogenous in this relationship, but with obvious labor-market consequences, such as lowered real wages. Although it should be kept in mind that economic conditions may affect sleep through other mechanisms than wages, it may be suggestive of a causal direction through this channel. If the relationship running from wages to sleep duration was strong enough, we would thus expect people to substitute toward time intensive consumption, such as sleeping, during times of economic hardship. A substantial role of the state unemployment rate, which we use as a proxy for economic fluctuations, would thus lend contingent support to the hypothesis of a causal pathway from wages to sleep duration. A strong relationship between sleep duration and wages, but not between aggregate economic conditions and sleep duration could, however, be seen as circumstantial evidence of other causal pathways playing an important role. Due to

the use of this exogenous variation created by economic fluctuations, this paper relates to two strands of literature; that of sleep and wages, and also to the growing literature on the effects of business cycles on various health and behavioral outcomes.

We divided subjects into two wage groups; subjects who received a fixed salary and those who received hourly wages, as those jobs may be very different along various dimensions, for example with regard to working-hour flexibility. Workers who earn hourly wages are usually more likely to receive lower income and have less education than those who earn a fixed salary. We would thus expect those who earn hourly wages to have less leverage in employment contract negotiations. Furthermore, those who earn a fixed salary are more likely to work full-time, whereas those who earn hourly wages more frequently have part-time jobs or multiple jobs. In a way, this arrangement makes it easier for hourly paid individual to take extra shifts or an additional job, while those who earn a fixed salary are paid a predetermined amount of money for working a predetermined number of hours. Although this could lend support to the hypothesis that salaried jobs might offer less work-hour flexibility than jobs that pay by the hour, the above-mentioned lack of leverage in contract negotiations attenuates the labor-market flexibility of those who earn hourly wages. Nevertheless, we expect those two job types to differ inherently.

This is, to our knowledge, the first paper that uses the ATUS data to explore the association between sleep duration and income from the perspective of the opportunity cost of time, which in this case represents the opportunity cost of sleeping. Further, we examine the related question of how state unemployment rates relate to sleep behavior. The relationship between sleep and the business cycle is understudied albeit gaining increased attention following the Great Recession and this paper contributes to that development.

2. Literature review

When describing the optimal management of time, economists have predominantly neglected the time spent sleeping in their models, often treating it as a predetermined subtraction of the 24-h day. However, there is a growing literature on the subject, encouraging economists to make room for sleep in those models. The first ones to address this topic were Biddle and Hamermesh (1990). They assume sleep has a utility generating effect on individuals and a positive effect on income as well. Their results show that high-income men substitute away from time-intensive commodities such as sleep, resulting in an inverse relationship between sleep duration and income. Using South African data, Szalontai (2006) repeats the analysis of Biddle and Hamermesh and reports similar results. Specifically, he detects a negative relationship between sleep duration and income and concludes that sleep is an economic phenomenon.

Antillón et al. (2014) examine the relationship between sleep behavior and unemployment conditions using the ATUS data from 2003 through 2012. Their findings suggest

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