



# On-the-job human capital investment and intertemporal substitution: New evidence on intertemporal substitution elasticity

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## Abstract

This paper argues that estimates of intertemporal elasticity of substitution (IES) obtained from standard life-cycle models are subject to a downward bias because they neglect the life-cycle and demographic patterns of on-the-job human capital investment. Taking into account the fact that part of a worker's time at work goes to acquiring human capital in addition to his main task of producing goods, we extend the standard life-cycle model to include time spent on investing in on-the-job human capital and propose a new framework for identifying the IES. We obtain statistically significant evidence that conventional estimates of IES for total hours at work are biased downward about 20% at the intensive margin. The corresponding IES estimates for production hours are biased downward even more, which provides an explanation for why output fluctuation is greater than hours/employment fluctuation over the business cycle.

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## 1. Introduction

Ranging from business cycles, pensions, and taxes, to welfare policies, the behavior of the intertemporal labor supply has been a central issue in various fields of modern economics.<sup>1</sup> Motivated by its importance, many previous micro-empirical studies have estimated the response of hours to anticipated wage growth over the life cycle using longitudinal data (e.g., PSID) on prime-age working males (MaCurdy, 1981; Altonji, 1986; Lee, 2001, among others). This long tradition, however, overlooks the facts that: (i) a significant fraction of time at work (e.g., about 20% in the time-use data) is spent on acquiring skills along with producing goods and (ii) investment in human capital depends on time and individual characteristics: it tends to occur more actively at the beginning of a worker's career and may be more important for more educated workers.<sup>2</sup>

The time dependence of human capital investment has been noted as a potentially important issue by many economists (Mincer, 1974; Ghez and Becker, 1975; Heckman, 1976; Stafford and Duncan, 1985; Altonji, 1986; Mulligan, 1998, among others).<sup>3</sup> However, the unavailability of longitudinal data on time spent investing in human capital does not permit micro-empirical studies on intertemporal substitution of the labor supply in a life-cycle model with investment in human capital. We extend the standard life-cycle model to include on-the-job human capital investment time and propose an empirical framework for estimating the IES using both longitudinal and cross-sectional data. Empirical results suggest that the conventional IES estimates using the hours variations at the intensive margin are underestimated because the life-cycle and demographic patterns of on-the-job human capital investment are not properly accounted for.<sup>4</sup> With the distinction

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<sup>1</sup>In this paper, the intertemporal elasticity of substitution in labor supply is referred to as the IES. The IES has been a crucial topic in various fields of modern economics since Lucas and Rapping (1969) pioneered a representative agent model emphasizing intertemporal substitution of leisure. For instance, over a typical business cycle, we observe that aggregate labor supply varies substantially, although its determinants, such as wages and interest rates, change relatively little. To explain this substantial fluctuation of labor as a response to mild variations in wages, equilibrium business-cycle models require a large intertemporal substitution in the labor supply.

<sup>2</sup>See Heckman (1976) for a theoretical discussion of the pattern of life-cycle human capital investment. Altonji and Spletzer (1991) show evidence that on-the-job training is positively correlated with both years of education and ability because the more able or educated a worker is, the greater is the chance that he will be given the opportunity for training or be willing to invest in acquiring skills. Educated workers' slope of the human capital investment time function is thus likely to be more negative with respect to time than other workers'. For evidence of on-the-job human capital investment, this paper analyzes in a later section "The Time Use in Economic and Social Accounts: 1975–1976," made available by the Social Research Center (SRC) of the University of Michigan. Information about human capital investment hours is contained in the 1976 data. For detailed information on this database, see Juster et al. (1978).

<sup>3</sup>Mincer (1974) distinguishes between the true market value of time and hourly earnings. He asserts that the non-linear (quadratic) effect of experience on the wage level arises because of a declining percentage of time spent in on-the-job training. Heckman (1976) shows theoretically that the life-cycle path for time devoted to acquiring skills declines with convexity over the life cycle. Stafford and Duncan (1985) provide extensive discussion on time use at work, including on-the-job training, and mention the possible bias in a conventional static labor-supply analysis using the usual hourly earnings measure. Altonji (1986) also acknowledges this point in footnote 11 of his paper. Recently, Mulligan (1998) notes this issue in an aggregate framework using aggregate time-series data on wage and hours that are constructed from a CPS synthetic cohort sample.

<sup>4</sup>There have been a few attempts to find out what causes a downward bias in the estimated IES. A partial list of them include: (i) Hansen (1985), Rogerson (1988) and Rogerson and Rupert (1991), who consider corner solutions in labor supply, i.e., the *extensive margin*; (ii) Chang and Kim (2006) who argue that the reservation wage

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