American Economic Review 2013, 103(4): 1445–1462
http://dx.doi.org/10.1257/aer.103.4.1445

Nonconvexities, Retirement, and the Elasticity of Labor Supply[†]

By Richard Rogerson and Johanna Wallenius*

A large literature uses life cycle profiles of hours and wages to estimate the intertemporal elasticity of substitution for labor supply, which we henceforth refer to as the *IES*. Virtually all of this literature restricts attention to the prime-age portion of the life cycle, and most of it has concluded that the *IES* is quite small. In this article we argue that retirement, specifically the direct movement of a worker from full-time work to little or no work, also contains important information about the size of the *IES*. The connection between retirement and the *IES* is intuitive. The *IES* determines the extent to which individuals value a smooth profile for leisure over the life cycle. But since retirement represents a very dramatic change in leisure, the fact that individuals willingly incur such a dramatic change in leisure should provide information about their willingness to intertemporally substitute.

We explore the connection between retirement and the *IES* in two settings. In the first setting, individuals face a continuous choice of hours, but the budget set is nonconvex because wages increase with hours and there are fixed consumption and time costs associated with work. We derive simple closed form expressions that link the extent of nonconvexities, the level of hours worked just prior to retirement, and the value of the *IES* that are consistent with retirement representing optimal behavior on the part of the individual. Knowing two of these quantities allows us to make inferences about the value of the third quantity. For example, given empirically reasonable values for the extent of nonconvexities, this expression suggests a value of the *IES* that is 0.75 or greater if an individual is retiring from full-time work (i.e., 2,000 annual hours). Alternatively, if the *IES* is as low as 0.25, then the size of nonconvexities must be larger than existing estimates by almost an order of magnitude in order to generate retirement from this same level of hours worked.

Whereas the first setting assumes that workers face a full menu of hours choices, the second setting captures the notion that there are limited part-time options available to workers by assuming that workers face a limited set of choices for hours of work. If, for example, as in Rust and Phelan (1997), the only choices are full-time

* Rogerson: Woodrow Wilson School, Princeton University, Princeton, NJ 08544 (e-mail: rdr@princeton.edu); Wallenius: Department of Economics, Stockholm School of Economics, Box 6501, 113 83 Stockholm, Sweden (e-mail: johanna.wallenius@hhs.se). We thank three anonymous referees, Eric French, Steve Davis, Yongsung Chang, plus seminar/conference participants at the Minneapolis Fed, Canon Institute (Tokyo), Yonsei University, Sogang University, Korea University, Beijing University, the 2010 Nordic Macroeconomic Summer Symposium, Harvard, University of Zurich, and the 2011 Society for Economic Dynamics. Part of the research reported herein was performed pursuant to a grant from the US Social Security Administration (SSA) funded as part of the Retirement Research Consortium and appears in the working paper "Retirement in a Life Cycle Model of Labor Supply With Home Production." The opinions and conclusions expressed are solely those of the authors and do not represent the opinions or policy of SSA or any agency of the federal government. Rogerson thanks the SSA for financial support. Wallenius thanks the Yrjö Jahnsson Foundation for financial support.

† To view additional materials, visit the article page at http://dx.doi.org/10.1257/aer.103.4.1445.

work and no work, we show in a precise sense that observing workers retire provides effectively no information about the *IES*. However, if there is at least one intermediate option, the fact that this option is not chosen does allow one to make inferences about the *IES*. Assuming one alternative that includes working half time or more, we argue that the results from the previous analysis are robust to consideration of this limited choice set.

Early estimates of the *IES* based on micro data were typically less than 0.30 and often close to zero.[1] Our results are consistent with recent work that has argued for various reasons that the *IES* is significantly larger than suggested by earlier estimates. For example, Domeij and Floden (2006) argue that abstracting from credit constraints leads to a bias that is on the order of a factor two, while Low (2005) argues that precautionary savings motives also create a negative bias. Imai and Keane (2004) argue that the failure to account for endogenous human capital accumulation can result in a bias that is almost a factor of ten.[2] A noteworthy feature of our estimates is that they are robust to the presence of credit constraints for young workers and endogenous human capital accumulation. Chetty (2012) argues that optimization frictions such as adjustment costs could also account for a bias as large as a factor of two and suggests that a reasonable estimate for the *IES* is around 0.5.

A novel contribution of our analysis is to point out that adjustment along the extensive margin has important information about individual preference parameters. In particular, as noted above, in the extreme case in which individual workers can choose only between full-time work (say, at 40 hours) and no work, the individual preference parameter that determines the individual *IES* cannot be identified. Put somewhat differently, models in which all adjustment is along the extensive margin do not allow one to uncover the curvature over leisure in the individual utility function. This has led many researchers to think that one needs to observe adjustment along the intensive margin in order to estimate parameters of the individual utility function for leisure. We show that adjustment along the extensive margin also provides important information about the individual preference parameter that determines the *IES*.

An outline of the article follows. In Section II we present evidence on the nature of retirement. The key result of this section is to show that for a large set of workers, retirement is characterized as a direct movement from full-time work to effectively no work. Section III describes the standard life cycle model without any nonconvexities and discusses why it is difficult to account for retirement in the context of this model, and in particular how the difficulty is inversely related to the *IES*. Section IV extends the standard model to include various nonconvexities and characterizes the level of the *IES* that is consistent with retirement given the degree of nonconvexities. Section V considers the case where only a small set of work hours is available to the worker. Section VI concludes.

[1] See, for example, the early papers by MaCurdy (1981) and Altonji (1986), both of which produce small estimates.

[2] Wallenius (2011) argues that a more plausible estimate of the bias is a factor of two.

Table 1—Distribution of Male Annual Hours by Age, PSID

Age	Annual hours						
	0	$(0, 250)$	$[250, 750)$	$[750, 1{,}250)$	$[1{,}250, 1{,}750)$	$\geq 1{,}750$	$\frac{\text{hours}}{\text{worker}}$
60	0.09	0.01	0.03	0.04	0.11	0.72	2,036
61	0.11	0.03	0.03	0.03	0.13	0.67	1,974
62	0.18	0.03	0.02	0.08	0.09	0.61	1,949
63	0.25	0.04	0.05	0.09	0.06	0.52	1,860
64	0.32	0.04	0.09	0.06	0.07	0.42	1,731
65	0.41	0.06	0.05	0.08	0.08	0.33	1,672
66	0.50	0.09	0.10	0.09	0.06	0.17	1,249
67	0.59	0.07	0.09	0.07	0.06	0.13	1,241
68	0.65	0.07	0.07	0.07	0.05	0.10	1,172
69	0.69	0.06	0.06	0.07	0.03	0.10	1,129
70	0.71	0.06	0.06	0.05	0.04	0.09	1,161

I. Retirement in the Data

At age 60, roughly 60 percent of men work in excess of 1,750 hours over the course of the year, while about 25 percent do not work at all. By age 70, only about 10 percent work in excess of 1,750 hours, while almost 75 percent report working zero hours.[3] In this section we examine the nature of this transition from full-time work to not working. Our main finding is that the dominant transition from full-time work to not working is an abrupt one, with individuals moving from full-time work to little or no work with at most one intermediate value in between. To the extent that individuals may initiate the transition from full-time work to little or no work at various points over the year, having one intermediate value is consistent with individuals moving directly from full-time work to little or no work.

To address the nature of this transition we consider evidence from the Panel Study of Income Dynamics (PSID). We use the sample created by Heathcote, Perri, and Violante (2010) and focus on male heads of households. We include only those individuals who have data for hours worked for all years from age 60 to age 70. This limits the sample size to 307. Table 1 presents some data on the cross-sectional distribution of hours worked by age. Consistent with the statistics reported earlier based on CPS data, the single most important dynamic as individuals age in the cross-section is the movement from hours of 1,750 or more to zero hours.[4]

Next we examine transitions at the individual level. To do this we focus on those individuals in our sample who have hours of at least 1,750 at age 60 and no more than 250 hours at each of ages 69 and 70. This yields a sample of 151. We then ask how many in this group make a direct transition from full-time work (i.e., $h \geq 1{,}750$) to the state of little or no work (i.e., $h < 250$) at ages 69 and 70. To allow for the possibility that this transition may occur during the middle of a calendar year, we allow individuals to have one year of intermediate hours as part of the transition. We find that 72.2 percent of the subsample of 151 individuals fit this criterion.[5]

[3] These statistics are based on the 2002–2004 March Current Population Survey.

[4] Tables A1 and A2 in the online Appendix show that this same cross-sectional pattern is found in the CPS data based on pooled cross-sections for the years 2002–2004, for both males and females.

[5] We have also considered alternative sample selection rules and criteria. For example, in order to identify persistent full-time workers at age 60 we considered individuals who worked at least 1,750 hours for at least four of the five years between ages 56 and 60. And then to single out individuals who had transitioned to a persistent state of

For this group of 151 individuals, mean and median hours at age 60 are 2,152 and 2,048, respectively. Median and mean hours in the last year of full-time work before transiting to hours less than 250 are 2,085 and 2,010, respectively. These values will be relevant for the calculations that we carry out later. It is relevant to compare these values with those in the last column of Table 1, which reports mean hours per worker for all workers with positive hours. Especially for ages beyond 65, mean hours for all workers are much less than hours for full-time workers. Although the amount of part-time work does not change that much over this age range, part-time work is a greater fraction of total work for later ages precisely because many full-time workers have transited to no work. Given that our goal is to understand the abrupt transition from full-time work to no work that dominates the transitions during this age range, it is important to note that average hours for all workers is not the key statistic of interest.

We conclude that to a first approximation one can think of the typical retirement transition for those individuals still working full time at age 60 as consisting of an individual moving from working around 2,000 hours per year to effectively zero hours.

Blau and Shvydko (2011) find similar behavior using data from the Health and Retirement Survey (HRS). The HRS data also allow them to present some additional correlations of interest. First, while it is true that some of the transitions from full-time work to no work are associated with deteriorating health, the majority of these transitions occur for individuals who report being in good health both before and after the transition. Second, they show that abrupt transitions from full-time work to no work are the dominant pattern even among workers who do not have defined benefit pension plans and have retiree health benefits. So while it is the case that health status and pension benefits may play a role in the labor supply decisions for some older workers, abrupt transitions from full-time work to no work seem to be a more pervasive phenomenon.

II. Retirement in the Standard Life Cycle Model

In this section we consider retirement in a standard life cycle model of labor supply. Motivated by the previous section, we focus on a worker who moves from full-time work to no work. Although movements in relative prices can induce individuals to choose profiles in which leisure (and consumption) change over time, the dramatic change in hours worked associated with retirement makes it potentially puzzling. Here we provide a quantitative perspective on this puzzle.

Consider the perfect foresight utility maximization problem of a finitely lived individual with preferences of the form

$$\sum_{t=0}^{T} [u(c_t) + \alpha_t v(1 - h_t)], \tag{1}$$

little or no work we considered individuals who had less than 250 hours at each of ages 68 through 70. In this case the overall sample size was 108 workers, and of these 75 percent exhibited the direct transition from 1,750 or more hours to no more than 250 with at most one intermediate value.

where T is the length of life, assumed to be known with certainty, and both u and v are assumed to be twice continuously differentiable, strictly increasing, strictly concave and have infinite derivative at 0. The parameter α_t allows for the possibility that the marginal rate of substitution between consumption and leisure changes with age. To simplify exposition we have assumed that the individual does not discount the future but will also assume that the interest rate is zero.[6] The present value budget equation faced by this individual is given by

$$\sum_{t=0}^{T} c_t = \sum_{t=0}^{T} w_t h_t + Y, \tag{2}$$

where Y is the present value of nonlabor income for the individual.

Letting μ be the Lagrange multiplier on the budget equation and assuming an interior solution, the first-order condition for h_t is

$$\alpha_t v'(1 - h_t) = \mu w_t. \tag{3}$$

Given our focus on retirement, we are interested in the case where the solution for h_t is a number corresponding to full-time work, and h_{t+1} equals zero. If the solution for h_t is interior, the solution for h_{t+1} is zero only if

$$v'(1) \geq v'(1 - h_t)\frac{\alpha_t}{\alpha_{t+1}}\frac{w_{t+1}}{w_t}. \tag{4}$$

A simple calculation offers a useful quantitative perspective on this issue. Consider a standard choice for the function v:

$$v(1 - h) = \frac{1}{1 - \frac{1}{\gamma}}(1 - h)^{1-\frac{1}{\gamma}}. \tag{5}$$

The parameter γ denotes the intertemporal elasticity of substitution for leisure. In connecting with the empirical literature it is preferable to consider the intertemporal substitution elasticity for labor rather than for leisure. The implied intertemporal elasticity of substitution for labor is different by a factor of $(1 - h)/h$. In what follows we will use the abbreviation *IES* to *always* refer to the elasticity for *labor*, which as just noted is in general not equal to γ.

To highlight the connection between the value of the *IES* and the difficulty in generating retirement we proceed as follows. Denote the ratio $\frac{\alpha_t}{\alpha_{t+1}}\frac{w_{t+1}}{w_t}$ in equation (4) by R_{t+1}, which can be interpreted as the return to work per unit of disutility in period

[6] Alternatively, we could assume that the individual discounts at a positive rate but that the interest rate is positive and perfectly offsets this discounting. All of our analysis would carry over to this case, but the algebra is somewhat simpler in the zero discounting case. More generally, we could assume that the interest rate and discount factor are not perfectly offsetting. This induces slopes to the life cycle profiles for hours of work and consumption. While there is some empirical support for the presence of these effects they are not central to the issues we focus on here, and so in the interest of simplicity we abstract from them.

TABLE 2—MAXIMUM VALUE OF R_{t+1} TO INDUCE RETIREMENT

$IES = 2$	$IES = 1$	$IES = 0.75$	$IES = 0.5$	$IES = 0.25$	$IES = 0.1$	$IES = 0.05$
0.68	0.46	0.36	0.22	0.04	0.0004	0.0000

$t + 1$ relative to period t. Equation (4) tells us the highest value of R_{t+1} consistent with $h_{t+1} = 0$ given a value of γ and a value of h_t. Assuming a weekly endowment of discretionary time equal to 100 hours and annual hours of work equal to 2,000, we have $h_t = 0.385$. Table 2 gives the maximum value of R_{t+1} that is consistent with inducing retirement at age $t + 1$. Note that this expression does not depend on anything that happened prior to period t (e.g., the level of assets as of period t, or previous wages and hours worked) and does not depend explicitly on where we are in the life cycle.

Looking at Table 2, even with a very large value of the *IES*, say, equal to 2, one would still require a drop of more than 30 percent in the effective return to work between consecutive years to generate retirement. If one focuses on values of the *IES* that are often used in the literature, such as those that are 0.25 and below, one needs almost a 100 percent drop in the return to work.

The previous analysis can also be used to gauge the required change in effective tax rates associated with Social Security in order to induce retirement. In particular, assuming no change in the return to work, i.e., constant wages and disutility of working, Table 2 tells us the required magnitude of the increase in the effective tax rate on earnings to induce retirement. The message is that these rates must be very large. One issue to note regarding implicit tax rates associated with private pension plans is that these rates are specific to the job and so are typically not relevant if the individual considers working for a different employer. In this case the relevant calculation would be the value of R_{t+1} based on the other job opportunities for this individual.

The above calculations were based on the assumption that the individual moves from full-time work to no work at all. These values are not much affected by considering someone who exhibits staged retirement, moving first from full-time to part-time and then later to retirement. For example, using $h = 0.20$ to reflect part-time work, for an *IES* of 0.25, the maximum values of R_{t+1} consistent with movement from full-time to part-time work and then part-time to no work are 0.19 and 0.24, respectively.

In summary, it is difficult to reconcile retirement with the standard model of life cycle labor supply. While this statement seems to apply to all empirically reasonable values of the *IES*, the difficulty is inversely related to the value of the *IES*.

III. Nonconvex Budget Sets as a Source of Retirement

In this section we consider factors that generate nonconvex budget sets. Because such nonconvexities can lead to discontinuities in the decision rule for hours even in the presence of a continuous hours choice, this alternative seems promising as a way to generate the abrupt change in hours associated with retirement. Models with nonconvex budget sets are also able to address another closely related issue with the standard model, which is its difficulty in reconciling the concentration and gaps found in the distribution of hours worked. (See Cogan 1981 for a classic analysis of this issue.) Our main finding is that although nonconvexities ease the tension that we found in the standard life cycle model, it is still very much present. Specifically, the smaller the *IES*, the more difficult it is to generate retirement, in the sense that the required degree of underlying nonconvexity is larger.

A. *Nonlinear Wages*

We begin with a variation of the model in Prescott, Rogerson, and Wallenius (2009) that features nonlinear wages as in French (2005). Because we want to use standard methods to characterize the optimal retirement decision it is convenient to formulate the model in continuous time. While one loses the notion of a period in the continuous time formulation, when it comes time to interpret some of the model features our preferred interpretation is to think in terms of a period being a year, so that we want to interpret labor supply during a period as annual hours of work. Normalizing the length of life to 1, preferences are now given by

$$\int_0^1 [u(c(t)) + \alpha(t)v(1 - h(t))]dt. \tag{6}$$

As in French (2005), we consider a nonconvexity that takes the form of a wage schedule that is increasing in hours worked:

$$w(t) = w_0(t)h(t)^{\theta}, \tag{7}$$

where $\theta \geq 0$. If $\theta = 0$ this reduces to the standard case in which the wage per unit of time worked is independent of the number of hours worked, and the budget set is convex. One advantage of this specification is that there has been some empirical work to guide us in thinking about reasonable values of the parameter θ. (See, for example, Moffitt 1984; Keane and Wolpin 2001; and Aaronson and French 2004.) While there are some important issues involved in estimating this parameter and there is by no means a definitive estimate, the value suggested by this work is $\theta = 0.4$.[7] This is also the value that French (2005) assumed. If $\theta = 0.4$, the penalty for working half time would be just less than 25 percent. If $\theta = 0.5$, the penalty would be 29 percent.

The present value budget equation is

$$\int_0^1 c(t)dt = \int_0^1 w_0(t)h(t)^{1+\theta}dt + Y. \tag{8}$$

Whereas in the previous section one required changes in at least one of $\alpha(t)$ or $w(t)$ to generate retirement, with nonlinear wages one can generate retirement without any variation in these factors. In order to focus on the forces associated with the nonconvexity it is convenient to assume that $\alpha(t) = \alpha$ and $w_0(t) = w_0$ for all t. In

[7] The value of θ is likely to vary across occupations. This would influence the length of the full-time work week across occupations as well as the incidence of part-time work.

the online Appendix we show that our results continue to hold as long as these functions vary continuously. With w_0 and α constant over time, and the interest rate and discount factor perfectly offsetting each other, the optimal timing of work for the individual is indeterminate. That is, the individual could choose to do all of the work at the beginning of life, all at the end of life, or all in the middle, etc… As such, the model may not appear to be a good model of retirement per se.[8] However, this is an artifact of the extreme but useful assumption that there is no change in the return to work over time. If, in contrast, there is even an arbitrarily small positive slope to $\alpha(t)$, or negative slope to $w(t)$ (even if only at later ages), or an arbitrarily small gap between the interest rate and the discount rate, then the indeterminacy would vanish. Although we work with a specification in which the timing of work is indeterminate, our interpretation corresponds to the solution in which work occurs at the beginning of life, followed by retirement.

The optimal consumption decision for this individual is to smooth consumption perfectly.[9] The optimal solution for the hours profile may have positive hours in all periods or only in a fraction of periods, depending on whether the nonconvexity is sufficiently large to overcome the forces that favor smooth leisure. In either case, symmetry implies that hours will be the same in all periods with positive hours.

Assuming an individual works for measure e periods and gives up h units of leisure at each date when working, the utility maximization is

$$\max_{e,h}\; u(ew_0h^{1+\theta} + Y) + e\alpha v(1-h) + (1-e)\alpha v(1). \tag{9}$$

Our main interest is to determine the conditions necessary for an interior solution for e, since this corresponds to there being retirement. Assuming interior solutions for both e and h we obtain the following two first-order conditions:

$$u'(ew_0h^{1+\theta} + Y)w_0h^{1+\theta} = \alpha[v(1) - v(1-h)] \tag{10}$$

$$u'(ew_0h^{1+\theta} + Y)(1+\theta)w_0h^{\theta} = \alpha v'(1-h). \tag{11}$$

Dividing these two equations by each other we obtain

$$\frac{h}{(1+\theta)} = \frac{v(1) - v(1-h)}{v'(1-h)}. \tag{12}$$

This equation is similar in spirit to equation (4) that we derived in the previous section to characterize the conditions necessary to generate retirement in the standard model.

[8] See also Ljungqvist and Sargent (2012) for further discussion of this issue in the context of a model that features learning-by-doing human capital accumulation and depreciation of skills when not working.

[9] Later in the article we discuss how the model can address the documented drop in consumption at retirement. The model could also be extended in different ways to generate a hump shape in consumption during working life, but this does not appear to be central to the issue of generating retirement.

Table 3—θ Needed for Retirement

IES:	2.0	1.0	0.75	0.5	0.25	0.1	0.05
$h = 0.385$	0.23	0.48	0.67	1.09	2.64	8.38	18.37
$h = 0.308$	0.16	0.35	0.48	0.76	1.78	5.69	12.77
$h = 0.212$	0.10	0.21	0.29	0.45	1.00	3.13	7.31

Assuming $v(1-h) = \frac{1}{1-\frac{1}{\gamma}}(1-h)^{1-\frac{1}{\gamma}}$, equation (12) becomes

$$\frac{h}{1+\theta} = \frac{1}{1-\frac{1}{\gamma}}\Big[1-(1-h)^{1-\frac{1}{\gamma}}\Big](1-h)^{\frac{1}{\gamma}}, \tag{13}$$

which now gives us a required value of θ given values for γ and h.[10] This expression does not depend on the utility function $u(c)$, the level of nonlabor wealth Y, or the parameter α. Nor does it depend on the optimal value of e. That is, the restrictions required to generate retirement do not depend on the age at which retirement happens.[11]

Before moving to the quantitative results we note a key feature of the above calculation. Although we considered the lifetime utility maximization problem of the individual to derive this expression, we would have derived the *same* expression if we had instead focused on the situation, say, of a 50-year-old worker with accumulated assets Y who is solving for optimal behavior over the remaining part of the life cycle. This is especially relevant given the possibility that credit constraints, human capital accumulation and uncertainty play an important role in shaping choices early in the life cycle. As noted in the introduction, the literature has suggested that these factors are very important for estimates of the *IES*. Because we require only that these factors are not relevant beyond some age, our calculations are less affected by these considerations.[12]

Table 3 shows the implications for θ and the *IES* for three different values of annual work hours at the time of retirement: 2,000, 1,600, and 1,100, which, given an annual endowment of discretionary time equal to 5,200 hours, correspond to values of h equal to 0.385, 0.308, and 0.212. Our analysis will focus on the case in which annual hours equal 2,000 at retirement, since our empirical analysis showed that this represents a substantial part of overall retirement. The other two values are of interest in comparing our results with those in French (2005), since his estimation procedure targeted average hours of all employed workers.[13]

Table 3 shows that the smaller the *IES* and the higher the level of hours at retirement, the larger the nonconvexity needs to be in order to generate retirement as

[10] It is important to note that if the wage depends on hours of work, standard labor supply regressions will produce a negatively biased estimate of the *IES*. Rogerson and Wallenius (2009a) find that this bias is substantial in a simple model with fixed time costs.

[11] Conditional on retirement being optimal, the timing of retirement does depend on the values of parameters such as Y and α, so heterogeneity in these values will generate heterogeneity in retirement ages.

[12] A standard assumption in the literature on human capital is that the incentive for human capital accumulation among older workers is very small, so that wage changes for these workers are effectively exogenous. See, for example, Heckman, Lochner, and Taber (1998) and Huggett, Ventura, and Yaron (2011).

[13] With our utility function, the value of the *IES* depends on the level of hours. In presenting our results we will continue to report the value of the *IES* at annual work hours of 2,000, even if retirement occurs from a lower level.

part of an optimal choice for the individual. If we consider $\theta = 0.4$ as a reasonable magnitude, values of the *IES* below 1.00 are not consistent with retirement if annual hours are 2,000. Note, however, that retirement from a level of annual hours equal to 1,100 requires a value of θ that is less than half as large, so that $\theta = 0.40$ is consistent with an *IES* a bit above 0.50.

B. *Fixed Time and Consumption Costs*

The above calculation considered one source of nonconvexity. The literature has suggested that there are other potential nonconvexities, such as fixed time and consumption costs associated with work. (Cogan 1981 is an early example.) From the perspective of annual labor supply, it is not clear what these fixed costs might be, since many examples of fixed costs (e.g., commuting time, work clothes) would seem to be variable costs if an individual chooses days of work per year. Nonetheless, we report below how the above calculations are affected by the addition of fixed time and consumption costs.

Denote fixed consumption and time costs by $\overline{c}$ and $\overline{h}$ respectively, and assume they are incurred at any time in which hours of market work are positive. The fixed consumption cost yields no utility to the individual, and the fixed time cost does not contribute to the increasing wage schedule.

The individual now solves

$$\max_{e,h} u(ew_0(h - \overline{h})^{1+\theta} - e\overline{c} + Y) + e\alpha v(1 - h) + (1 - e)\alpha v(1). \tag{14}$$

True consumption will be equalized at all dates, but measured consumption when working, c_w, will be greater than measured consumption when not working, c_r, by the amount of the fixed cost $\overline{c}$. Proceeding as before, a necessary condition for an interior solution for e is

$$\frac{(1 + \theta)w_0(h - \overline{h})^{\theta}}{w_0(h - \overline{h})^{1+\theta} - \overline{c}} = \frac{v'(1 - h)}{v(1) - v(1 - h)}. \tag{15}$$

To facilitate calculations, it is useful to parameterize the level of the fixed cost as a fraction $\hat{c}$ of labor income, i.e., $\overline{c} = \hat{c}w_0(h - \overline{h})^{1+\theta}$, which gives

$$\frac{(1 + \theta)}{(1 - \hat{c})(h - \overline{h})} = \frac{v'(1 - h)}{v(1) - v(1 - h)}. \tag{16}$$

The literature offers some evidence for the potential size of these fixed costs. Banks, Blundell, and Tanner (1995, 1998) and Aguiar and Hurst (2008) offer estimates of the importance of categories that they label "work-related expenses" for the United Kingdom and United States respectively. It is important to note that these estimates should be viewed as upper bounds, since these categories do include items that are not necessarily work related (e.g., clothing). Relative to total consumption expenditure, these studies find a consumption share of work-related expenses

Table 4—θ Needed for Retirement with Fixed Costs $(h = 0.385, \overline{h} = 0.1h)$

IES:	2.0	1.0	0.75	0.5	0.25	0.1	0.05
$\frac{c_r}{c_w} = 0.90$	0.07	0.32	0.52	0.95	2.53	8.31	18.24
$\frac{c_r}{c_w} = 0.85$	0.03	0.27	0.46	0.87	2.39	7.95	17.49
$\frac{c_r}{c_w} = 0.80$	−0.02	0.22	0.40	0.79	2.25	7.57	16.71

in the range of 15–20 percent. A distinct but closely related perspective relates to the consumption drop at retirement. Because our individual smooths the part of consumption that does not represent fixed costs, it follows that consumption drops by $\overline{c}$ at retirement. Assuming that an individual spends roughly $2/3$ of his/her life in employment and begins with zero wealth, the ratio of consumption in retirement to consumption when working $\left(\frac{c_r}{c_w}\right)$ is given by $1/(1 + 1.5\hat{c}/(1 - \hat{c}))$. There is a range of estimates for the consumption drop at retirement. Early estimates by Banks, Blundell, and Tanner (1998) and Bernheim, Skinner, and Weinberg (2001) find a drop of roughly 20 percent for the United Kingdom and United States respectively, whereas more recent analyses like Aguiar and Hurst (2008) and Aguila, Attanasio, and Meghir (2011) have argued that there is no evidence of a consumption drop. Because the literature has also pointed out other reasons for the drop in consumption at retirement, we view this method as supplying a very loose upper bound. In any case, we report results for values ranging from 10 percent to 20 percent.

Estimates of commuting time vary. Stutzer and Frey (2008) report daily commuting time of 48.8 minutes per day based on the US Census Bureau's 2002 American Community Survey, whereas an OECD (2011) report based on time use data indicates a value of 28 minutes per day. Assuming 250 commuting days, the value of 48.8 minutes per day amounts to 203 annual hours, or roughly 10 percent of full-time work. Juster and Stafford (1991) report commuting times that are a bit less than 10 percent of total time spent working. Consistent with our earlier concern about whether commuting time is a fixed cost at the annual level, these authors report that commuting time as a fraction of working time is relatively constant for men and women despite the fact that men work almost 50 percent more than women. We report results for the case in which commuting time is ten percent of working time.

Table 4 presents the results for the case in which annual hours are 2,000 at the time of retirement. The main message from this table is that while adding these fixed costs of working does make it somewhat easier to generate retirement from annual hours of work equal to 2,000, the effect is not that large. In particular, whereas Table 3 required an *IES* in excess of 1.0, even in the most extreme case in Table 4, with $c_r/c_w = 0.80$, the lower threshold is reduced only to 0.75.

It is interesting to compare these results with those in French (2005). In his estimated model the *IES* for prime aged individuals is around 0.35, $\theta = 0.40$, fixed time costs are 335 hours per year, there are no fixed consumption costs, and he is able to generate an age profile for retirement that is similar to that found in the data. As noted earlier, French's estimation procedure targets mean hours by age but does not specifically target the hours worked of those individuals who retire in the next period. In his estimated model, most retirement will come from the bottom of the hours worked distribution, and the minimum level of hours worked is 1,072. We have already noted in Table 2 that generating retirement from annual hours of

1,100 is significantly easier than generating retirement from annual hours of 2,000. To pursue this further we consider the implications of our framework for the case of retirement from annual hours of 1,100 and assuming a fixed time cost of 335 hours. In this case we find that a value of $\theta = 0.40$ is consistent with an *IES* equal to 0.41. While our framework is considerably simpler than his, we conclude that our findings are consistent.[14] Specifically, while it is possible to generate retirement from relatively low hours worked with a relatively low *IES* and existing measures of nonconvexities, this is not true for generating retirement from levels of annual hours as high as 2,000. Moreover, the difficulty increases quite rapidly as we increase the level of hours worked at retirement. For example, if annual hours are 1,600, the required level of the *IES* assuming $\theta = 0.4$ and fixed time costs of 335 hours is 0.71.

C. *Discussion*

As already noted, we show in the online Appendix that adding age-varying wages or utility does not matter at all for the results derived above if we assume that these profiles are continuous. A different possibility is that age affects the slope of the marginal utility of leisure. In particular, one might argue that relative to younger workers, older workers get tired at a faster rate as hours of work increase. One way to capture this is to assume that the curvature in the utility of leisure function increases with age. Consistent with previous discussion, this has no effect on the expression that we derived, as it characterizes the relationship between preference parameters and hours of work at the time of retirement. Hence, our calculations would then be relevant for the value of the *IES* at retirement. To the extent that the utility function for leisure might exhibit more curvature at older ages than at younger ages, our estimates represent a lower bound for the value of the *IES* at younger ages.

Separability between consumption and leisure does not seem central to our results. Following Trabandt and Uhlig (2009) and Shimer (2010), consider the following specification of preferences that is both consistent with balanced growth and exhibits a constant Frisch labor supply elasticity:

$$\frac{1}{1-\eta}c(t)^{1-\eta}\left[1 - \kappa(1-\eta)h(t)^{1+\frac{1}{\phi}}\right]^{\eta}, \tag{17}$$

where η, κ, and ϕ are all positive. The *IES* is equal to ϕ. In the online Appendix we show that one can again generate an expression linking the magnitude of the *IES* with the magnitude of the nonconvexities and hours worked at retirement. The required nonconvexities are somewhat larger for this specification, but, most importantly, they do not depend on the value of η.[15]

[14] Alternatively, since French has a fixed time cost of 335 hours per year relative to minimum hours worked of just under 1,100, one might conjecture that scaling up both the fixed time cost and hours at retirement might also reconcile the results. This turns out not to be the case. If we assume that annual hours at retirement are 2,000 and the fixed time cost is one quarter of total work plus fixed time costs, then the implied value of the *IES* given $\theta = 0.4$ is approximately 0.94.

[15] This specification has zero disutility of work when hours are zero, thereby making it harder to generate a solution with zero hours of work. In Rogerson and Wallenius (2009b) we show via simulation that the nonseparable case requires similar nonconvexities as the separable case when utility is Cobb-Douglas over consumption and leisure.

The nonseparable specification is also related to the large literature that seeks to both measure and account for the drop in consumption that is associated with retirement (see Laitner and Silverman 2005). If the value of the parameter η is greater than one then one can show that the above specification does entail a drop in consumption at retirement. However, our derivation shows that the value of η has no impact on the extent of the nonconvexity required to generate retirement. In the context of this specification, generating retirement is a completely separate issue from generating a drop in consumption at the time of retirement.

Lastly, our analysis has abstracted from Social Security and private pensions. Here, we argue that our results are robust to the inclusion of these features in the US context. For individuals in the United States who retire at full retirement age (or beyond), Social Security is effectively a lump-sum transfer of income, since for most individuals there is effectively no restriction on the amount of work that they can do. The expressions that we have derived above allowed for the possibility of an income transfer in addition to labor income, and so are consistent with this case. For individuals who retire prior to full retirement age, the situation is somewhat more complicated. In this case individuals are subject to an earnings test, and their Social Security benefits are reduced if earnings exceed a threshold. However, if benefits are reduced because of the earnings test, future benefits are increased in a fashion that is roughly neutral in terms of present value. Hence, even at earlier ages, Social Security is still approximately a lump-sum transfer independent of the individual's labor supply decision. However, this argument does not apply if the individual is credit constrained, either because of low current income or high level of impatience, since he or she cannot borrow against future Social Security payments and will therefore place a higher value on the option that delivers the payments sooner. While our analysis does not cover these individuals, our main message seems to still be relevant: to the extent that credit constraints are the driving force behind their retirement, the individuals have an even greater incentive to work part time up to the point where benefits are not reduced, making it difficult to understand why they would move from full time to no work.

We conclude that given the structure of the Social Security system in the United States, the presence of Social Security is not of first-order importance for our calculations.[16] We note however, that this would not be the case in a country in which Social Security benefits are contingent on not working, since in this case the discontinuity in the benefits system can induce large changes in the effective return to work and, hence, serve as the driving force in generating retirement.

In contrast to the provisions of Social Security in the United States, there are some companies offering private pensions such that at a certain point an individual may have accumulated sufficient experience to be eligible for a pension that is the same as his or her current salary. As documented in Blau and Shvydko (2011), this is not the dominant source of abrupt retirements in the data. Additionally, what is important for our calculations is the change in the return to market work at the time

[16] We have not discussed the role of Medicare. Rust and Phelan (1997) argue that some workers postpone retirement until age 65 due to the fact that Medicare is available at age 65. While there is a spike in retirement at 65, most retirement occurs at other ages. In our model one can think of Medicare as a program that provides a transfer payment (equal to the present value of health insurance) at age 65. In the absence of credit constraints, our results carry over to this case.

of retirement, not simply the return to work at the previous employer.[17] Even if an individual faces little or no return to working at his or her current firm, the relevant quantity for our calculation is to incorporate the extent of the drop in wages that the individual must accept when moving to alternative employment. However, as emphasized earlier in the paper, even wage drops as large as 25 percent have virtually no power to induce retirement for low values of the *IES*.

IV. Restricted Hours Choices and Retirement

The previous section maintained the assumption that an individual could choose any level of work hours, subject to the constraint that the return per unit of time might vary with the level of hours worked. This approach seeks to identify the nonconvexities that individuals face in order to rationalize the observed discontinuities in their choice of hours from the perspective of optimal individual labor supply. An alternative view is that workers simply face a restricted finite set of work options, so that at any point in time their choice of hours need not satisfy a first-order condition derived from the household optimization problem.[18] In the extreme case in which individuals face two options—work full time ($h = h_f$) at an implied wage per unit of time equal to w_f, or not at all ($h = 0$)—then observing that individuals retire will by itself offer no information whatsoever about the value of the *IES*. In particular, it is easy to show that in this extreme case one can rationalize retirement from any level of hours h_f for any value of the *IES*. To see why, consider as before an individual with lifetime utility

$$\int_0^1 [u(c(t)) + \alpha v(1 - h(t))]\, dt,$$

who can only choose $h(t)$ in the set $\{0, h_f\}$, faces a wage rate per unit time of w_f when working h_f, and has access to complete credit markets. Letting e denote the fraction of life spent in employment, the individual's problem is to solve

$$\max_e \; u(e w_f h_f + Y) + e\alpha v(1 - h_f) + (1 - e)\alpha v(1), \tag{18}$$

where Y is nonlabor wealth as before. This problem is similar to those considered earlier, with the key difference that h_f is not a choice variable. Assuming an interior solution for e (i.e., that retirement occurs), the first-order condition is

$$u'(e w_f h_f + Y) w_f h_f = \alpha[v(1) - v(1 - h_f)]. \tag{19}$$

Assuming $u(c) = \log(c)$ and $v(1 - h) = \frac{1}{1 - \frac{1}{\gamma}} (1 - h_f)^{1-\frac{1}{\gamma}}$, equation (19) becomes

$$\frac{1}{e + A} = \frac{\alpha}{1 - \frac{1}{\gamma}} \left[1 - (1 - h_f)^{1-\frac{1}{\gamma}}\right], \tag{20}$$

[17] As with Social Security, the wealth effect associated with the pension is implicitly incorporated in nonlabor income.

[18] Hurd (1996), for example, argues that this can rationalize retirement.

where $A = Y/w_f h_f$. Even given arbitrary values for the fraction of life spent in employment (e), hours of work while employed (h_f), and nonlabor wealth relative to labor earnings, this expression can be made consistent with any value of γ by choosing an appropriate value of the preference shift parameter α. It follows that if one adopts this extreme case, our approach has nothing to say about empirically reasonable values of the *IES*.

However, even if a given individual does not transition from full-time work to part-time work as part of the retirement process, it seems reasonable to think that some part-time options actually exist; the fact that they were not chosen simply implies that they were not sufficiently attractive. Knowing that a particular part-time option exists but was not sufficiently attractive to be chosen does provide some information about preferences.

In particular, consider the case in which there is one part-time option available, characterized by hours $h_p = 0.5\,h_f$, and that the wage per unit of time for this option is given by $w_p = \left(\frac{h_p}{h_f}\right)^{\theta} w_f$. Similar to the calculations in the previous section, the presence of this single part-time option and the fact that it was not chosen imposes a joint restriction on the values of θ and γ. Specifically, assuming $u(c) = \log(c)$, we show that for given values of γ, h_f, and h_p, there is a lower bound on the value of θ that is consistent with the individual's not choosing the part-time option h_p as part of the optimal life cycle labor supply profile. For each γ we can ask whether the half-time option would be chosen if it were available. Intuitively, given that the utility function is concave in leisure and that the individual is initially choosing to work full time some of the time and not at all in the remaining time, the option of working an intermediate value for at least some of the time is appealing as long as the wage penalty for this option is not too large.

Here we sketch results for one special case; details can be found in the online Appendix. Assume that the values of h_f, γ, and α are such that the optimal value for e, denoted by e^*, consistent with (18) is interior. Denote the maximized utility by U^*. Now we expand the set of options to include working h_p hours, with a wage per unit time of $\left(\frac{h_p}{h_f}\right)^{\theta} w_f$. There are two possible forms that the new solution may take in the event that the individual finds it attractive to use this new option: either the individual uses only h_f and h_p (i.e., does not choose 0), or uses only h_p and 0. In the first case there is no retirement, while in the second case there is retirement but it occurs from part-time work rather than from full-time work.

By way of illustration, here we consider the case in which the parameter values are such that it is optimal to only use the options h_p and 0 (i.e., that gradual retirement is preferable). Denote the resulting maximal utility by U_p^*. Intuitively, this value is decreasing in θ, and so if we solve for the value of θ that equates U^* and U_p^*, this gives the smallest value of θ consistent with the part-time option not being chosen. This value of θ is given by

$$\theta = \left[\log\left(\frac{\left[1 - (1 - h_p)^{1-\frac{1}{\gamma}}\right]}{\left[1 - (1 - h_f)^{1-\frac{1}{\gamma}}\right]}\right) \Big/ \log(h_p/h_f)\right] - 1. \tag{21}$$

Table 5—θ Needed for No Part-Time Work, $h_f = 0.385$

IES:	2.0	1.0	0.75	0.5	0.25	0.1	0.05
$h_p = 0.25h_f$	0.10	0.22	0.30	0.47	1.07	3.34	7.62
$h_p = 0.5h_f$	0.15	0.31	0.42	0.67	1.56	4.94	11.16
$h_p = 0.75h_f$	0.19	0.39	0.54	0.87	2.06	6.59	14.64
$h_p = 0.9h_f$	0.21	0.45	0.62	1.00	2.40	7.64	16.84
$h_p = 0.98h_f$	0.22	0.48	0.66	1.08	2.59	8.23	18.06

Similar to the results obtained in the previous section, this expression does not depend on the values of α or Y, and as a result does not depend on the length of time spent in retirement. In particular, as before, this expression holds if we focus only on the solution to the individual's problem from some age forward, taking their nonlabor wealth at that age as given, so that concerns about credit constraints and human capital accumulation for young workers are not relevant.

Table 5 gives the lower bounds for θ consistent with movement from full-time work to no work for various values of γ and different values of h_p for the additional option.

Note that there is a strong relationship between the results in Table 3 from the previous section and those found in Table 5. In the previous section we assumed a full set of options h_p, with the constraint that wages per unit of time for these options were given by $\left(\frac{h_p}{h_f}\right)^{\theta}$. In particular, it was necessary that the choice h_f was preferable to choices that were arbitrarily close. Not surprisingly, we see in Table 5 that as we let the single option h_p get very close to h_f, the lower bound for θ converges to the values found in Table 3. Looking at the other rows in Table 5, we see that if we take $\theta = 0.40$ as the relevant point for comparison, then even if the only option that an individual had were to work three-quarter time, it is difficult to rationalize values of the *IES* below 1. Even with only a half-time option it is difficult to rationalize a value of the *IES* below 0.75.

While it is perhaps difficult to argue that workers face a full menu of options for hours of work, it perhaps seems more difficult to argue that they do not have a menu of options that includes a few isolated alternatives that are close to half or three-quarter time. The results from this section suggest that the implications of this setting are fairly similar to those from the continuous options case in terms of the joint restrictions that it imposes on θ and the *IES*.

V. Conclusion

The typical pattern of retirement consists of a worker making an abrupt transition from full-time work to no work. We have studied two types of models that generate this type of transition. The key element that gives rise to this abrupt change in hours worked are nonconvexities in the problem that an individual worker faces. We show that generating retirement in these models implies sharp restrictions on possible combinations of values for hours of work prior to retirement, the intertemporal elasticity of labor supply, and the extent of nonconvexities. A novel aspect of our analysis is the observation that in a model that features both intensive and extensive margins, adjustment along the extensive margin is also an important source of information about curvature over leisure in the individual utility function.

We argue that based on existing estimates of the size of nonconvexities and measures of full-time work prior to retirement, it is hard to rationalize values of the *IES* that are less than 0.75. Our estimates are robust to allowing for human capital accumulation and credit constraints, factors which the previous literature have argued are important sources of negative bias in earlier estimates of the *IES*.

We have explored the connection between retirement and the *IES* in a simple model in order to facilitate transparency. It is of interest to explore this connection in richer settings that include idiosyncratic shocks, incomplete markets, and policy. Another extension of interest is to include a decision regarding time devoted to home production, since this provides an alternative use of time for people who retire from market work.

REFERENCES

Aaronson, Daniel, and Eric French. 2004. "The Effect of Part-Time Work on Wages: Evidence from the Social Security Rules." *Journal of Labor Economics* 22 (2): 329–52.

Aguiar, Mark, and Erik Hurst. 2008. "Deconstructing Lifecycle Expenditure." National Bureau of Economic Research Working Paper 13893.

Aguila, Emma, Orazio Attanasio, and Costas Meghir. 2011. "Changes in Consumption at Retirement: Evidence from Panel Data." *Review of Economics and Statistics* 93 (3): 1094–99.

Altonji, Joseph G. 1986. "Intertemporal Substitution in Labor Supply: Evidence from Micro Data." *Journal of Political Economy* 94 (3): S176–S215.

Banks, James, Richard Blundell, and Sarah Tanner. 1995. "Consumption Growth, Saving and Retirement in the UK." *Ricerche Economiche* 49 (3): 255–75.

Banks, James, Richard Blundell, and Sarah Tanner. 1998. "Is There a Retirement-Savings Puzzle?" *American Economic Review* 88 (4): 769–88.

Bernheim, B. Douglas, Jonathan Skinner, and Steven Weinberg. 2001. "What Accounts for the Variation in Retirement Wealth among US Households?" *American Economic Review* 91 (4): 832–57.

Blau, David, and Tetyana Shvydko. 2011. "Labor Market Rigidities and the Employment Behavior of Older Workers." *Industrial and Labor Relations Review* 64 (3): 464–84.

Chetty, Raj. 2012. "Bounds on Elasticities with Optimization Frictions: A Synthesis of Micro and Macro Evidence on Labor Supply." *Econometrica* 80 (3): 969–1018.

Cogan, John F. 1981. "Fixed Costs and Labor Supply." *Econometrica* 49 (4): 945–63.

Domeij, David, and Martin Floden. 2006. "The Labor-Supply Elasticity and Borrowing Constraints: Why Estimates Are Biased." *Review of Economic Dynamics* 9 (2): 242–62.

French, Eric. 2005. "The Effects of Health, Wealth, and Wages on Labour Supply and Retirement Behaviour." *Review of Economic Studies* 72 (2): 395–427.

Heathcote, Jonathan, Fabrizio Perri, and Giovanni L. Violante. 2010. "Unequal We Stand: An Empirical Analysis of Economic Inequality in the United States, 1967-2006: Dataset." *Review of Economic Dynamics*. http://ideas.repec.org/c/red/ccodes/09-214.html (accessed March 22, 2010).

Heckman, James J., Lance Lochner, and Christopher Taber. 1998. "Explaining Rising Wage Inequality: Explorations with a Dynamic General Equilibrium Model of Labor Earnings with Heterogeneous Agents." *Review of Economic Dynamics* 1 (1): 1–58.

Huggett, Mark, Gustavo Ventura, and Amir Yaron. 2011. "Sources of Lifetime Inequality." *American Economic Review* 101 (7): 2923–54.

Hurd, Michael D. 1996. "The Effect of Labor Market Rigidities on the Labor Force Behavior of Older Workers." In *Advances in the Economics of Aging*, edited by David A. Wise, 11–58. Chicago: University of Chicago Press.

Imai, Susumu, and Michael P. Keane. 2004. "Intertemporal Labor Supply and Human Capital Accumulation." *International Economic Review* 45 (2): 601–41.

Juster, F. Thomas, and Frank P. Stafford. 1991. "The Allocation of Time: Empirical Findings, Behavioral Models, and Problems of Measurement." *Journal of Economic Literature* 29 (2): 471–522.

Keane, Michael P., and Kenneth I. Wolpin. 2001. "The Effect of Parental Transfers and Borrowing Constraints on Educational Attainment." *International Economic Review* 42 (4): 1051–103.

King, Miriam, Steven Ruggles, J. Trent Alexander, Sarah Flood, Katie Genadek, Matthew B. Schroeder, Brandon Trampe, and Rebecca Vick. 2002–2004 March Supplement. Integrated Public Use Microdata Series, Current Population Survey: Version 3.0. [Machine-readable database].

Minneapolis, MN: Minnesota Population Center [producer and distributor], 2010. https://cps.ipums.org/cps-action/variables/group/work (accessed March 3, 2010).

Laitner, John, and Dan Silverman. 2005. "Estimating Life-Cycle Parameters from Consumption Behavior at Retirement." National Bureau of Economic Research Working Paper 11163.

Ljungqvist, Lars, and Thomas J. Sargent. 2012. "Career Length: Effects of Curvature of Earnings Profiles, Earnings Shocks, and Social Security." Unpublished.

Low, Hamish W. 2005. "Self-Insurance in a Life-Cycle Model of Labour Supply and Savings." *Review of Economic Dynamics* 8 (4): 945–75.

MaCurdy, Thomas E. 1981. "An Empirical Model of Labor Supply in a Life-Cycle Setting." *Journal of Political Economy* 89 (6): 1059–85.

Moffitt, Robert. 1984. "The Estimation of a Joint Wage-Hours Labor Supply Model." *Journal of Labor Economics* 2 (4): 550–66.

Organisation for Economic Co-operation and Development. 2011. *How's Life? Measuring Well-Being*. Paris: OECD.

Prescott, Edward C., Richard Rogerson, and Johanna Wallenius. 2009. "Lifetime Aggregate Labor Supply with Endogenous Workweek Length." *Review of Economic Dynamics* 12 (1): 23–36.

Rogerson, Richard, and Johanna Wallenius. 2009a. "Micro and Macro Elasticities in a Life Cycle Model with Taxes." *Journal of Economic Theory* 144 (6): 2277–92.

Rogerson, Richard, and Johanna Wallenius. 2009b. "Retirement in a Life Cycle Model of Labor Supply With Home Production." University of Michigan, MI Retirement Research Center Working Paper 205.

Rogerson, Richard, and Johanna Wallenius. 2013. "Nonconvexities, Retirement, and the Elasticity of Labor Supply: Dataset." *American Economic Review*. http://dx.doi.org/10.1257/aer.103.4.1445.

Rust, John, and Christopher Phelan. 1997. "How Social Security and Medicare Affect Retirement Behavior in a World of Incomplete Markets." *Econometrica* 65 (4): 781–831.

Shimer, Robert. 2010. *Labor Markets and Business Cycles*. Princeton, NJ: Princeton University Press.

Stutzer, Alois, and Bruno S. Frey. 2008. "Stress That Doesn't Pay: The Commuting Paradox." *Scandinavian Journal of Economics* 110 (2): 339–66.

Trabandt, Mathias, and Harald Uhlig. 2009. "How Far Are We From The Slippery Slope? The Laffer Curve Revisited." National Bureau of Economic Research Working Paper 15343.

Wallenius, Johanna. 2011. "Human Capital Accumulation and the Intertemporal Elasticity of Substitution of Labor: How Large Is the Bias?" *Review of Economic Dynamics* 14 (4): 577–91.

This article has been cited by:

1. Rachel Moore, Brandon Pecoraro. 2019. Macroeconomic implications of modeling the Internal Revenue Code in a heterogeneous-agent framework. *Economic Modelling* . [Crossref]
2. William B. Peterman, Kamila Sommer. 2019. HOW WELL DID SOCIAL SECURITY MITIGATE THE EFFECTS OF THE GREAT RECESSION?. *International Economic Review* **84**. . [Crossref]
3. Irina Merkurieva. 2019. LATE CAREER JOB LOSS AND THE DECISION TO RETIRE. *International Economic Review* **60**:1, 259-282. [Crossref]
4. Yongsung Chang, Sun-Bin Kim, Kyooho Kwon, Richard Rogerson. 2019. 2018 KLEIN LECTURE: INDIVIDUAL AND AGGREGATE LABOR SUPPLY IN HETEROGENEOUS AGENT ECONOMIES WITH INTENSIVE AND EXTENSIVE MARGINS. *International Economic Review* **60**:1, 3-24. [Crossref]
5. Thomas F. Cooley, Espen Henriksen, Charlie Nusbaum. 2019. Demographic Obstacles to European Growth. *SSRN Electronic Journal* . [Crossref]
6. Zhigang Feng, Kai Zhao. 2018. Employment-based health insurance and aggregate labor supply. *Journal of Economic Behavior & Organization* **154**, 156-174. [Crossref]
7. Richard W. Evans, Kerk L. Phillips. 2018. Advantages of an Ellipse when Modeling Leisure Utility. *Computational Economics* **51**:3, 513-533. [Crossref]
8. Alessio Moro, Solmaz Moslehi, Satoshi Tanaka. 2017. MARRIAGE AND ECONOMIC DEVELOPMENT IN THE TWENTIETH CENTURY. *Journal of Demographic Economics* **83**:04, 379-420. [Crossref]
9. Eric French, John Bailey Jones. 2017. Health, Health Insurance, and Retirement: A Survey. *Annual Review of Economics* **9**:1, 383-409. [Crossref]
10. Abdoulaye Ndiaye. 2017. Flexible Retirement and Optimal Taxation. *SSRN Electronic Journal* . [Crossref]
11. Christos Andreas Makridis, Maury Gittleman. 2017. Does Performance Payy Pay? Wage Flexibility Over the Great Recession. *SSRN Electronic Journal* . [Crossref]
12. Scott French. 2017. Returns to Experience and the Elasticity of Labor Supply. *SSRN Electronic Journal* . [Crossref]
13. Xiaodong Fan, Ananth Seshadri, Christopher Taber. 2017. Understanding Earnings, Labor Supply, and Retirement Decisions. *SSRN Electronic Journal* . [Crossref]
14. Oksana M. Leukhina, Stephen J. Turnovsky. 2016. PUSH, PULL, AND POPULATION SIZE EFFECTS IN STRUCTURAL DEVELOPMENT: LONG-RUN TRADE-OFFS. *Journal of Demographic Economics* **82**:04, 423-457. [Crossref]
15. Tobias Laun, Johanna Wallenius. 2016. Social insurance and retirement: A cross-country perspective. *Review of Economic Dynamics* **22**, 72-92. [Crossref]
16. Michael R. Caputo, Martin Forster. 2016. Optimal plans and timing under additive transformations to rewards. *Oxford Economic Papers* **68**:2, 604-626. [Crossref]
17. Richard Rogerson, Johanna Wallenius. 2016. Retirement, home production and labor supply elasticities. *Journal of Monetary Economics* **78**, 23-34. [Crossref]
18. Lukas Inderbitzin, Stefan Staubli, Josef Zweimüller. 2016. Extended Unemployment Benefits and Early Retirement: Program Complementarity and Program Substitution. *American Economic Journal: Economic Policy* **8**:1, 253-288. [Abstract] [View PDF article] [PDF with links]
19. William B. Peterman. 2016. RECONCILING MICRO AND MACRO ESTIMATES OF THE FRISCH LABOR SUPPLY ELASTICITY. *Economic Inquiry* **54**:1, 100-120. [Crossref]

20. R. Blundell, E. French, G. Tetlow. Retirement Incentives and Labor Supply 457-566. [Crossref]
21. Domenico Ferraro, Giuseppe Fiori. 2016. The Aging of the Baby Boomers: Demographics and Propagation of Tax Shocks. *SSRN Electronic Journal* . [Crossref]
22. Tobias Laun, Johanna Wallenius. 2015. A life cycle model of health and retirement: The case of Swedish pension reform. *Journal of Public Economics* **127**, 127-136. [Crossref]
23. Peter Rupert, Giulio Zanella. 2015. Revisiting wage, earnings, and hours profiles. *Journal of Monetary Economics* **72**, 114-130. [Crossref]
24. Dean Scrimgeour. 2015. Dynamic Scoring in a Romer-Style Economy. *Southern Economic Journal* **81**:3, 697-723. [Crossref]
25. Jim Been, Susann Rohwedder, Michael D. Hurd. 2015. Home Production as a Substitute to Market Consumption? Estimating the Elasticity Using Houseprice Shocks from the Great Recession. *SSRN Electronic Journal* . [Crossref]
26. Jim Been, Michael D. Hurd, Susann Rohwedder. 2014. Responses of Time-Use to Shocks in Wealth During the Great Recession. *SSRN Electronic Journal* . [Crossref]
27. Peter Rupert, Giulio Zanella. 2012. Revisiting Wage, Earnings, and Hours Profiles. *SSRN Electronic Journal* . [Crossref]
28. Rodolfo E. Manuelli, Ananth Seshadri, Yongseok Shin. 2012. Lifetime Labor Supply and Human Capital Investment. *SSRN Electronic Journal* . [Crossref]