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Aggregate Labor Supply*

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ABSTRACT

There have been tremendous advances in macroeconomics, following the introduction of labor supply into the field. Today it is widely acknowledged that labor supply matters for many key economic issues, particularly for business cycles and tax policy analysis. However, the extent to which labor supply matters for such questions depends on the aggregate labor supply elasticity—that is, the sensitivity of the time allocation between market and non-market activities to changes in the effective wage. The magnitude of the aggregate labor supply elasticity has been the subject of much debate for several decades. In this paper we review this debate and conclude that the elasticity of labor supply of the aggregate household is much higher than the elasticity of the identical households being aggregated. The aggregate household utility function differs from individuals' utility functions for the same reason the aggregate production function differs from individual firms' production functions being aggregated. The differences in individual and aggregate supply elasticities are what aggregation theory predicts.

*The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

Introduction

Fifty years ago the labor supply decision was thought of as virtually irrelevant for macroeconomic analysis. The view was that in the aggregate, labor supply was not determined by the factors that determined individual labor supply. Lucas and Rapping (1969) challenged this view. There have been tremendous advances in macroeconomic analysis following the introduction of labor supply into the field. Key among these advances was endogenizing the labor supply decision in the neoclassical growth model, which allowed its use in studying business cycles. This framework can also be credited with introducing the stand-in aggregate household construct, which has proven a very useful abstraction. Subsequently, the methodology originally used for studying business cycles has been used to advance learning in most areas of macroeconomics.

Today we understand that labor supply matters for many key economic issues—not only for the effects of business cycle shocks, but also, for example, for tax policy analysis. However, the extent to which labor supply matters for such questions depends on the labor supply elasticity. While the importance of the labor supply elasticity is nowadays widely agreed upon among economists, the magnitude of the elasticity is not. Labor economists argue that the elasticity is small, based on variations in hours worked and wages of prime-aged males. Macroeconomists, on the other hand, argue that the elasticity is big, based on differences in tax rates and aggregate hours across countries and time, as well as the fact that the neoclassical growth model displays the business cycle facts only if this elasticity is high. This apparent inconsistency is bothersome, as it creates disagreement over the importance of labor supply for many important macroeconomic

issues. What is needed is a theory consistent with both micro- and macroeconomic observations.

In this survey, we demonstrate that such a theory exists. We discuss the issues related to the apparent inconsistency between the micro- and macroeconomic observations and stress that much of the confusion stems from the notion that one can estimate the labor supply elasticity in one context and export it to another. This, however, is ill-advised.

1. Evidence from Business Cycles and Cross-Country Tax Analysis

The modern theory of economic growth evolved from the observation of striking similarity both over time and across countries. The success of the neoclassical growth model can be attributed to its ability to reproduce the so-called stylized facts of growth.¹ Similarly, economic fluctuations display remarkable empirical regularity, commonly referred to as the business cycle facts. These facts are: (1) two-thirds of fluctuations are accounted for by variation in the labor input, while one-third of fluctuations are accounted for by variation in total factor productivity, (2) consumption moves pro-cyclically, and (3) investment is roughly ten times as volatile as consumption. Regardless of this regularity, for a long time the study of short-term economic behavior, namely fluctuations, was divorced from the study of long-term growth. The likely reason for this is that short-term movements in output are in large part accounted for by movements in the labor input, whereas long-term increases in living standards are mainly accounted for by increases in capital service inputs and total factor productivity. The premise of modern business cycle theory,

¹ See Kaldor (1957).

however, is that growth and fluctuations are not distinct phenomena that should be studied with different tools.

Kydland and Prescott (1982) used the neoclassical growth model to study business cycles. The framework introduced an aggregate or stand-in household construct, which has proven a most successful abstraction. The underlying aggregation theory is based on maximizing a weighted sum of individual utilities. The framework also endogenized the labor supply decision. The growth facts state that consumption and investment shares of output are roughly constant and that variables other than labor supply and the return on capital grow over time. This dictates a Cobb-Douglas production function. The growth facts also place restrictions on the utility function. However, they do not pin down the aggregate labor supply elasticity, which turns out to be a key parameter for deriving the predictions of the growth model for business cycle fluctuations.

Kydland and Prescott (1982) showed that the neoclassical growth model extended to allow for stochastic shocks to the rate of productivity growth generates real business cycles. However, the model displays the business cycle facts only if the aggregate labor supply elasticity is sufficiently large, around three. Many macroeconomists view this as evidence of a highly elastic labor supply.

Prescott (2004) argues that differences in taxes and labor supply provide further macroeconomic support for the notion of a large aggregate labor supply elasticity. There are striking differences in hours of market work both across countries and over time. To illustrate, aggregate hours worked are currently about 70% of the U.S. level in the continental European countries Belgium, France, and Germany. Simultaneously, we observe large differences in marginal tax rates across countries. Prescott (2004) and Ohanian,

Raffo, and Rogerson (2008) study the role of taxes in accounting for the differences in aggregate hours across countries and over time.

The premise for these studies is an aggregate household construct. Specifically, assume that the aggregate household has preferences over sequences of consumption (c) and hours worked (h) ordered by

$$\sum_{t=0}^{\infty} \beta^t \left[\log(c_t) - \alpha \frac{h_t^{1+\gamma}}{1+\gamma} \right],$$

where t denotes time, β is the discount factor, and α the parameter governing the disutility from working. The key parameter is γ , as it determines the aggregate intertemporal elasticity of substitution of labor. The per-period time endowment is normalized to one. The household owns the capital stock in the economy and rents it to the firm. The law of motion for the capital stock is standard and given by

$$k_{t+1} = (1 - \delta)k_t + i_t,$$

where δ is depreciation and i is investment. A Cobb-Douglas production function for the aggregate firm is assumed:

$$y_t = A k_t^\theta h_t^{1-\theta},$$

where θ is the capital share. The government imposes proportional taxes on income, the proceeds of which are rebated lump-sum back to the household. The period t budget constraint faced by the household is then

$$(1 + \tau_c)c_t + (1 + \tau_i)i_t = (1 - \tau_h)w_t h_t + (1 - \tau_k)(r_t - \delta)k_t + \delta k_t + T_t,$$

where τ_c is the tax on consumption, τ_i the tax on investment, τ_h the marginal tax rate on labor income, τ_k the tax on capital income, w_t the real wage, r_t the rental price of capital, and T_t the transfers.

The labor and consumption taxes can be combined into one effective marginal tax rate on labor income. It is given by the fraction of additional labor income that is taken in the form of taxes:

$$\tau = \frac{\tau_h + \tau_c}{1 + \tau_c}.$$

The two key equations are the first-order conditions for the marginal rate of substitution between consumption and hours worked and the profit maximizing condition that states that individuals are paid their marginal product:

$$\alpha c h^\gamma = (1 - \tau) w$$

$$w = (1 - \theta) \frac{y}{h}.$$

When combined, these equations determine the following equilibrium relation between aggregate labor supply, the consumption-output ratio, and the tax rate at time t :

$$h_t = \left[(1 - \theta) / \left(\frac{c_t}{y_t} \frac{\alpha}{1 - \tau_t} \right) \right]^{\frac{1}{1+\gamma}}.$$

The c/y term is a function of the distribution of future exogenous variables. The $(1 - \tau_t)$ term captures the intratemporal distortion to the relative prices of consumption and leisure.

This equation can be used to predict the impact of taxes on labor supply. The conclusion is that in order for taxes to play an important role in accounting for the cross-country differences in aggregate hours, the labor supply elasticity—namely $1/\gamma$ —must be large.

2. Estimates of Individual Elasticity from Panel Data

Many labor economists argue that the aggregate labor supply elasticities used in the business cycle and cross-country tax studies are not in accordance with the microeconomic evidence. This has led them to question the validity of the business cycle model and to argue that the effect of taxes on aggregate hours is overstated due to the large labor supply elasticity that is assumed. In what follows we outline the microeconomic approach to estimating the labor supply elasticity and argue that the resulting elasticity measure is different from the aggregate labor supply elasticity.

For some economies, the labor supply elasticity of the aggregate household and the labor supply elasticity of the individuals being aggregated should be the same. This will, for example, be the case if preferences are convex, which means a concave utility function defined on a *convex* subset of the commodity space. For other economies this will not be the case, and the utility function of the aggregate household will be very different from that of the individuals being aggregated. Indeed, if the aggregate labor supply elasticity were *not* significantly higher than the individual labor supply elasticity, the micro labor statistics would lead to the rejection of the conclusions derived using the basic neoclassical growth model for business cycle fluctuations.

The microeconomic approach is to identify individual labor supply elasticity from the variation of wages and hours over the life cycle. A simplified illustration of this approach is as follows. Consider a modified version of the formulation from the previous section, where the individual faces a present value budget equation:

$$\begin{aligned} \max \quad & \sum_{t=0}^{\infty} \beta^t \left[\log(c_t) - \alpha \frac{h_t^{1+\gamma}}{1+\gamma} \right] \\ \text{s.t.} \quad & \sum_{t=0}^{\infty} \beta^t c_t = \sum_{t=0}^{\infty} \beta^t w_t h_t. \end{aligned}$$

Taking first-order conditions one gets

$$\begin{aligned} \frac{1}{c_t} &= \lambda \\ \alpha h_t^\gamma &= \lambda w_t. \end{aligned}$$

The second equation has motivated people to run the following regression:

$$\ln h_t = B_0 + B_1 \ln w_t + \varepsilon_t.$$

Here the coefficient B_1 is the estimate of $1/\gamma$. Heckman and MaCurdy (1980), MaCurdy (1981), and Altonji (1986) are early examples of studies that carry out this estimation on individual panel level data.² These studies typically find very small elasticities for prime-aged males, in the range of 0.3 or less, but much larger estimates for women. Intuitively, the underlying reason for the small elasticity estimates for men is the fact that the hours profile is rather flat over the life cycle, while wages rise quite steeply, resulting in low covariation.

Mulligan (1995) argues that these traditional estimates are biased downward due to a failure to distinguish anticipated wage changes from those that are unanticipated or are artifacts of measurement error.³ More recently, several authors have revised the original estimates in various ways (see, for example, Kimball and Shapiro (2003) and Pistaferri (2003)) and found evidence of a labor supply elasticity in the range of 0.7–1.0 for men.

² For a more complete survey of this literature see, for example, Pencavel (1987).

³ Mulligan (1995) also notes that the approach of MaCurdy (1981), Altonji (1986), and others ignores certain key features of the micro data, such as seasonal variation. Accounting for seasonal variation, he estimated a large labor supply elasticity.

Domeij and Floden (2006) argue that ignoring borrowing constraints can bias labor supply elasticity estimates downward. The intuition is that if an individual is credit constrained, the observation of high hours worked at a low wage does not provide evidence of the individual's willingness to intertemporally substitute labor supply. They find that the bias is of an order of 50%.

Imai and Keane (2004), in turn, argue that the omission of endogenous human capital accumulation will bias labor supply elasticity estimates downward, as wages are not the correct measure of the opportunity cost of market time. Learning-by-doing provides an incentive to work when young at a low wage, as it leads to higher future wages. Thus, the opportunity cost of working is much flatter than the wage schedule. Consequently, the covariation between the shadow wage schedule and hours worked is higher than that between raw wages and hours. Imai and Keane (2004) found a labor supply elasticity in excess of 3. Wallenius (2007), however, argues that this estimate is biased upward, and that adding skill accumulation does not lead to elasticity estimates that are much greater than 1.0, which is in line with the more recent literature. Wallenius (2007) also considers an alternative skill accumulation technology, namely, Ben Porath type training. Contrary to learning-by-doing where human capital accumulation is a by-product of working, with training one must invest in skill accumulation (and thereby forego current earnings). The bias resulting from the omission of human capital accumulation is similar with both skill accumulation technologies.

Many economists proceed as if the estimate of γ from the microeconomic analysis is the value that should be used in aggregate models. In what follows, given micro observations and aggregation theory, we argue the aggregate elasticity of labor supply should

be much larger than the individual labor supply elasticity. In other words, micro observations support rather than cast doubt on the macro findings.

3. Indivisible Labor

There are important counterfactual predictions of the model labor economists use to estimate what they call the individual labor supply elasticity. One such prediction is that everyone will make the same adjustment to hours worked in percentage terms. Empirically this is not the case. Total hours worked is the multiple of employment and hours worked by those who are working. Over the business cycle, most of the adjustment in total hours arises from changes in employment, not hours worked by those who are employed. To be precise, Cho and Cooley (1994) document that three-quarters of the variation in total hours of work arises from movements in and out of the labor force. Many different factors impact employment—the fraction of lifetime worked, weeks of vacation, and holidays, to name a few.

In a model with a standard labor-leisure decision where labor is divisible and the household decides what fraction of the time endowment to devote to work each period, the labor supply elasticity depends on the utility function. Specifically, the parameter governing the curvature of the disutility from working, γ , is the key preference parameter. Rogerson (1984, 1988) proposed a framework with indivisible labor, where people either work some fixed workweek or not at all. In such a framework, the elasticity of substitution of labor across periods for the aggregate economy is independent of the elasticity of substitution implied by the individuals' utility functions. Moreover, the aggregate labor

supply is much more elastic than when labor is divisible. This is true up to the point where all are employed.

Consider a static economy that is populated by a continuum of identical agents of measure one. Each agent is endowed with one unit of time. Time is indivisible, implying that the agent supplies either the entire unit of time to the market or none at all. Agents have an identical utility function given by

$$u(c) - v(h),$$

where c is consumption and h is labor. With labor assumed indivisible, the only values of the $v(h)$ function that matter are $v(0)$ and $v(1)$. Assume that $v(0) = 0$ and that $v(1) = b$, where b is a positive constant.

The individual agent's decision problem is then given by

$$\begin{aligned} \max u(c) - bh \\ \text{s.t. } c = wh, c \geq 0, h \in \{0, 1\}. \end{aligned}$$

There is a decreasing returns to scale production function that uses only labor to produce output $F(H)$.

Rogerson (1984, 1988) introduces lotteries in which a social planner chooses a fraction φ of the population to work. Let c_w and c_n denote consumption for someone who is working and someone who is not working, respectively. The problem now becomes one of choosing φ , c_w , and c_n in the following problem:

$$\begin{aligned} \max \varphi[u(c_w) - b] + (1 - \varphi)u(c_n) \\ \text{s.t. } \varphi c_w + (1 - \varphi)c_n = F(\varphi), c_w \geq 0, c_n \geq 0, 0 \leq \varphi \leq 1. \end{aligned}$$

For a given individual, the probability of working is φ . The first-order conditions for c_w and c_n imply $c_w = c_n = c$. This in turn implies that the social planner's problem can be rewritten as

$$\begin{aligned} \max & u(c) - \varphi b \\ \text{s.t.} & c = F(\varphi). \end{aligned}$$

Since $\varphi = H$, this is simply a special case of the representative agent, divisible labor model with linear disutility from working. The implication is that an economy populated by individuals with identical preferences behaves as if populated by a single agent with preferences unlike those of any individual. In the presence of non-convexities (resulting from indivisible labor supply), the aggregate is very different from the individual entities that are being aggregated. This has a well-known parallel on the production function side.

In mapping this specification to the more standard ones in Sections 2 and 3, one notes that assuming indivisible labor amounts to assuming $\gamma = 0$. If one takes indivisible labor as the starting point, estimating γ from micro data is irrelevant.

Hansen (1985) extended this analysis to the business cycle setting. He found that the economy with indivisible labor displays larger fluctuations than the one with divisible labor.

4. Aggregate Labor Supply Elasticity: Function of Preferences and Technology

The amount of labor supplied by an individual over his or her lifetime is effectively characterized by the fraction of lifetime spent working and hours worked when employed. Instead of thinking in terms of a lottery determining who works and who does not, the problem can be recast as one in which the individual chooses the fraction of his or her lifetime to devote to work. Prescott, Rogerson, and Wallenius (2009) develop a simple, tractable framework that delivers this characterization in equilibrium.

A key feature of their model is a non-convex mapping from hours worked in the market to labor services supplied. In particular, they assume that if an individual works h units of time in the market sector, this yields l units of labor services, where

$$l = g(h).$$

The aggregate production function is

$$C = L,$$

which implies that the equilibrium wage rate is 1. The function is initially convex and later concave. The former is intended to capture the fixed costs associated with getting set up in a job and being supervised, while the latter is included to allow for fatigue.^{4,5}

With this mapping, people will choose to work some fraction of their lifetime, instead of spreading work evenly throughout their lifetime. What gets determined is the fraction of people working at each point in time and the fraction of lifetime a person works. There is indeterminacy as to who works when. The individual choice problem can be formulated as choosing a fraction e of his or her lifetime to work and the hours of work h to be supplied when working. Each individual, therefore, solves

$$\begin{aligned} & \max \{ \log(c) - \tau e v(h) \} \\ & \text{s.t. } c = (1 - \tau) e g(h) + T, 0 \leq e \leq 1, 0 \leq h \leq 1. \end{aligned}$$

⁴ Note that in Rogerson (1984, 1988) the non-convexity was due to a discrete choice in hours, whereas in Prescott et al. (2009), hours worked are a continuous choice variable, despite the presence of the non-convexity.

⁵ This nonlinearity implies that workweeks of different lengths are not perfect substitutes in generating labor services. This is similar to Hornstein and Prescott (1993), where workweeks of different lengths are different commodities, and one decision of the aggregate firm is how to allocate its capital across workers supplying workweeks of different lengths. In neither example are preferences convex, as people must choose a workweek length, of which there are a continuum of possibilities, or choose not to work in each period.

The assumption is that the government taxes all labor income at the constant rate of τ and uses the tax revenues to fund a lump-sum transfer T . The authors also assume that the government balances the budget, implying that

$$T = \tau e g(h).$$

Using the first-order conditions to derive expressions for the optimal length of the workweek and the fraction of time spent in employment, one gets

$$\frac{v'(h)}{v(h)} = \frac{g'(h)}{g(h)}$$

$$e = \frac{1 - \tau}{v(h)}.$$

From these expressions it becomes apparent that the model implies large aggregate labor supply elasticity in response to changes in tax and transfer programs. In fact, the elasticity of eh with respect to $1 - \tau$ is equal to 1.

At the same time the model predicts zero elasticity for hours of work of continuously employed individuals. In this respect, the model mimics the indivisible labor model discussed previously. A key message of the study is that the aggregate labor supply elasticity with respect to changes in taxes is a function of both preference and technology parameters. In particular, the mapping from hours supplied to the market to labor services is critical in determining the aggregate labor supply elasticity.

5. Life Cycle Model with Extensive and Intensive Margins of Labor Supply

Rogerson and Wallenius (2009) imbed the Prescott et al. (2009) framework into a life-time cycle setting. Non-convexities in the mapping from time devoted to market work to labor services again give rise to allocations where individuals choose both the fraction of

lifetime to devote to employment (extensive margin) and hours worked when employed (intensive margin).

Imbedding the analysis in a life cycle model enables them to generate standard life cycle profiles for hours of work, most notably the fact that hours of work drop *discontinuously* to zero at older ages. Note that the theoretical framework used by labor economists to estimate the individual labor supply elasticity is inconsistent with this feature of the data.⁶ Note that in this life cycle framework the timing of work is no longer indeterminate as was the case in the Prescott et al. (2009) framework.

Consider a continuous time overlapping generations framework in which a unit mass of identical, finitely lived individuals is born at each instant of time. Letting a denote age, individuals have preferences over paths for consumption ($c(a)$) and hours worked ($h(a)$):

$$\int_0^1 \left[\log c(a) - \alpha \frac{h(a)^{1+\gamma}}{1+\gamma} \right].$$

An individual who devotes $h(a)$ hours to market work produces $l(a)$ units of labor services, where $l(a) = e(a)g(h(a))$. The $e(a)$ function denotes an exogenous, age-varying productivity profile, which results in hours worked varying over the life cycle. For simplicity, it is assumed to be piecewise linear. The $g(h)$ function is again a non-convex mapping from hours worked to labor services, which serves to endogenize the length of the working life. Hours worked exhibit a reservation property, with people choosing to work above a certain productivity and not to work below it.

⁶ See Rogerson and Wallenius (2010).

Given a value of γ , the size of the non-convexity, the productivity profile, and the disutility from working parameter are chosen to match three target values: working life of two-thirds, peak hours of 45 hours per week, and a doubling of wages over the life cycle.

Rogerson and Wallenius (2009) are interested in studying how the value of γ affects the life cycle profile for hours and how it in turn responds to changes in labor tax rates. The value of γ is therefore varied over a wide range. Given a value of γ and the calibrated parameters, the model generates life cycle profiles for hours and wages. The framework therefore allows Rogerson and Wallenius (2009) to reproduce micro estimates of the labor supply elasticity based on life cycle variation for prime-aged workers. More importantly, they are able to simultaneously carry out standard macro estimation based on variation in aggregates across steady states as tax rates are altered. They find that *macro elasticities are virtually unrelated to micro elasticities*, and moreover that macro elasticities are large. While the micro elasticity is virtually irrelevant for the aggregate elasticity with respect to taxes, it does matter for how the tax response is broken down between the extensive and intensive margins of labor supply. Specifically, the smaller the micro elasticity is, the larger the share of the action on the extensive margin.

There has been a need for a theory that is consistent with both micro- and macroeconomic observations. This paper presents such a framework.

On a related note, Chang and Kim (2006) construct a model of household labor supply, where households are made up of a husband and wife who each face random productivity shocks. They assume indivisible labor supply. The labor supply decision is characterized by a reservation wage, i.e., a wage at which the individual is indifferent between working and not working. The reservation wage depends on the asset position of

the household and the spouse's productivity (earnings potential). In this framework the individual labor supply elasticity, which is governed by the curvature parameter of the disutility from working function, is by construction the same for everyone. The aggregate labor supply elasticity, however, depends on the heterogeneity of the cross-sectional reservation wage distribution. Chang and Kim (2006) find that aggregate and individual elasticities are significantly different, with aggregate elasticities considerably larger than individual elasticities. Note that in their framework all adjustment takes place along the extensive margin of labor supply. In this respect it is similar to Rogerson (1984, 1988) and Hansen (1985).

The key message from these analyses is that we should not estimate parameter values in one setting and apply them to a different one, unless aggregation theory implies that the parameter values should be the same in the two settings. Rather, we should work with frameworks in which the choice problem of an individual is explicitly formulated and try to identify the underlying structural parameters of that problem. This message is similar in spirit to that of Browning, Hansen, and Heckman (1998).

6. Retirement

6.1. Relating Life Cycle Model to Representative Household Model

We have seen that in a life cycle model with an extensive and intensive margin of labor supply, individual and aggregate elasticities are virtually unrelated. Given that the aggregate household model has proven to be a useful abstraction in many settings, suppose one wanted to mimic a life cycle model with a single agent model with no intensive and extensive margin. What is the labor supply elasticity that should be used in such a model?

Rogerson and Wallenius (2009) show that a stand-in household model with a relatively high labor supply elasticity can reproduce the steady state effects of taxes on aggregate hours that they find in their life cycle model. It is worth mentioning that the elasticity of the stand-in agent model is not the labor supply elasticity of any given individual, but rather it is capturing the heterogeneity in the data.

6.2. Connection between Retirement and Intertemporal Elasticity of Substitution

The typical retirement pattern is a transition from full-time work directly into little or no work. In a recent paper, Rogerson and Wallenius (2010) argue that this transition contains important information on the value of the intertemporal elasticity of substitution. The intuition underlying their argument is that since retirement represents a very large change in leisure, the fact that individuals willingly incur such a significant change in leisure should provide information about their willingness to intertemporally substitute.

Rogerson and Wallenius (2010) consider models in which retirement is an optimal property of life cycle labor supply, and moreover, where non-convexities are the key feature generating retirement. In other words, in the presence of non-convexities people find it optimal to concentrate work in some fraction of their lifetime, as opposed to spreading it evenly throughout. They consider different sources of non-convexities, namely, fixed time and consumption costs associated with work, and nonlinear wage-hours schedules. Rogerson and Wallenius (2010) show that while non-convexities in production can generate retirement, the size of non-convexities needed to do so increases sharply as the intertemporal elasticity of substitution for labor decreases. It is therefore

very difficult to rationalize values of the intertemporal elasticity of labor supply that are below .75, given empirically reasonable values for the extent of non-convexities.

6.3. Fraction of Lifetime Worked

Prescott et al. (2009) and Rogerson and Wallenius (2009) define the aggregate labor supply elasticity as the responsiveness of aggregate hours to a change in tax rates. Both studies model tax and transfer programs simply as a proportional tax accompanied by a lump-sum transfer. A natural extension is to model tax and transfer programs in greater detail. In particular, it is of interest to study whether modeling the earnings dependence of certain transfers, such as social security, greatly affects the results.⁷

Despite the success of the stand-in household construct in addressing many questions, it is not a good abstraction for thinking about retirement and social security reform. For these questions, one needs a life cycle model. We have already established that the extensive margin of labor supply is a very important margin for understanding both business cycles as well as differences in aggregate labor supply across countries and time. When looking at the data, it is apparent that differences along the extensive margin are dominated by the young and the old. This naturally points to social security as a potential source of differences in the labor supply behavior of older workers.

Wallenius (2009) builds a general equilibrium model of life cycle labor supply that features endogenous retirement and human capital accumulation, which is parameterized to match U.S. data on life cycle profiles for hours worked and wages. The model is used to study the extent to which differences in social security, and more generally tax

⁷ Rogerson (2007) stresses that what the government does with the tax revenue affects the distortive effects of labor taxes on labor supply.

and transfer programs, can account for the cross-country differences in aggregate hours worked between the United States and continental Europe. Wallenius (2009) finds that differences in social security account for 35% to 40% of the cross-country differences in aggregate hours between the United States and Belgium, France, and Germany. Once other differences in labor taxation in addition to social security are included in the analysis, the model implies that tax and transfer programs account for roughly 60% of the difference in aggregate hours worked between the United States and continental Europe. Similar to Rogerson and Wallenius (2009), the aggregate responses are not sensitive to the micro labor supply elasticity.

On a related note, Imrohoroglu and Kitao (2009) show that the effects of various forms of social security reform are invariant to reasonable values of the labor supply elasticity.

Note that the extensive margin is important not only at the individual level in determining the fraction of lifetime spent in employment but also at the household level. In particular, the effect of changes in tax policy can have large implications for the secondary wage earner in the household. See Guner, Kaygusuz, and Ventura (2010).

7. Conclusions

Today we understand that labor supply matters for many important economic issues. The effects of business cycle shocks and tax policy analysis are key among them. The extent to which labor supply matters for such questions, however, depends on the labor supply elasticity. Labor economists traditionally argue that the elasticity is small, based on variations in hours worked and wages of prime-aged males. Macroeconomists, on the other

hand, argue that the elasticity is big, based on differences in tax rates and aggregate hours across countries and time, as well as the fact that the neoclassical growth model displays the business cycle facts only if this elasticity is sufficiently high. This apparent inconsistency is bothersome. What is needed is a theory providing consistency with both micro- and macroeconomic observations.

In this paper we survey recent advances in the literature and show that such a theory now exists. The micro evidence along with aggregation theory predicts that the aggregate labor supply elasticity will be much higher than the elasticity of the individuals being aggregated. The labor economists' estimates would be good estimates of the aggregate elasticity of labor supply only in empirically uninteresting worlds such as a Robinson Crusoe world with limited ability to transform current consumption into future consumption.

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