

How Important Are Idiosyncratic Shocks? Evidence from Labor Supply

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The notion that individuals face idiosyncratic labor-market uncertainty is a common one. Government programs such as unemployment insurance and social security are motivated by such an idea. Economic theory, ranging from labor supply to savings behavior to asset pricing, often presupposes that such risks are important. A number of papers, however, have questioned this orthodoxy. Sumru Altug and Robert A. Miller (1990), for instance, are unable to reject a set of factor-structure restrictions implied by complete markets. John H. Cochrane (1991) and Barbara J. Mace (1991) find evidence of consumption insurance, although not against all types of risks. Robert M. Townsend (1994) documents evidence of risk-sharing in Indian villages. Michael P. Keane and Kenneth I. Wolpin (1997) argue that 90 percent of the labor-market uncertainty faced by a group of males is resolved by age 16.

Other studies have suggested the opposite. Papers by Joseph G. Altonji et al. (1991), Orazio Attanasio and Steven J. Davis (1996), and Attanasio and Guglielmo Weber (1992), as well as some evidence in Cochrane (1991) and Mace (1991), suggest that risk-sharing is far from complete, in particular for low-frequency shocks. Angus Deaton and Christina Paxson (1994) show that inequality in labor earnings, total income, and consumption increases with age. They suggest that this is difficult to reconcile with standard models of complete consumption insurance. In Storesletten et al. (2000) we ask

similar questions using a general-equilibrium life-cycle model. We conclude that increasing inequality with age, consumption inequality in particular, is difficult to explain in the absence of uninsured idiosyncratic shocks received throughout the working years. We argue that between 40 percent and 50 percent of an individual's lifetime uncertainty remains unresolved prior to entering the workforce.

This paper further examines the implications of increasing inequality with age. We begin by asking if a very different model, one which features full risk-sharing, can account for the data. The idea, which Deaton and Paxson (1994) attribute to Steven Davis, is that increasing income and consumption inequality can arise in a perfect insurance setting if (i) dispersion in labor productivity increases with age, and (ii) preferences are nonseparable between leisure and consumption. If this is true, an efficient allocation may feature increasing consumption dispersion, because higher-productivity workers will supply relatively more labor and be compensated with more consumption. We develop a specific model and find that, for plausible parameter values, this is exactly what happens. What also happens, however, is that such an allocation features increasing inequality in hours worked. Using data from the Panel Study on Income Dynamics (PSID), we show that inequality in hours worked is roughly constant across age. This casts doubt on the full risk-sharing model and strengthens the argument in favor of uninsurable idiosyncratic risk.

The remainder of our paper provides a more general discussion of the evidence on inequality and age, and how this suggests an important role for idiosyncratic labor-market shocks.

I. Inequality in Income, Consumption, and Hours Worked

Figure 1 plots the age-dependent cross-sectional variance in nonfinancial income,

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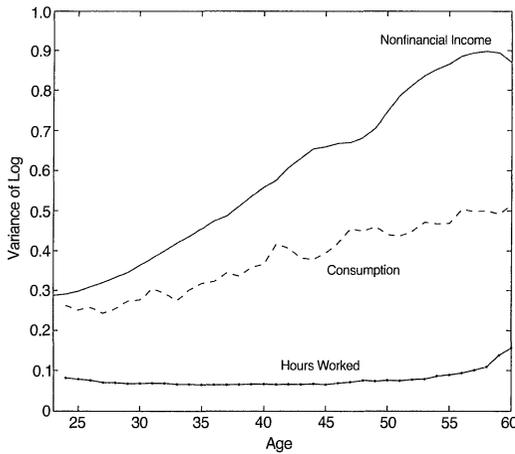


FIGURE 1. CROSS-SECTIONAL VARIANCE BY AGE

consumption, and hours worked. The consumption data are taken directly from Deaton and Paxson (1994) and correspond to Consumer Expenditure Survey (CEX) data on nonmedical and nondurable expenditures on goods and services by urban households over the years 1980–1990. The income and hours worked data are from the PSID, 1969–1992. Nonfinancial income is composed of total household wage income before taxes, plus “transfers” such as unemployment insurance, workers compensation, and transfers from non-household family members. Hours worked for each household are per working adult, per year, subject to the restriction that the total hours are greater than 300 and less than 6,000. All variances in Figure 1 are computed net of “cohort effects” (cross-sectional dispersion which is unique to households born in the same year) using the methods outlined in Deaton and Paxson (1994). Further details regarding data selection and statistical methodology are available in Storesletten et al. (2000).

Figure 1 indicates that, throughout the working years, the cross-sectional variances of consumption and income increase by factors of 2 and 3, respectively. In contrast inequality in hours worked is roughly constant until retirement. The income profile will serve to calibrate our process for labor productivity. The contrast between the consumption and hours-worked profiles will provide restrictions on our theory.

II. A Complete-Markets Model

Consider an economy populated by H overlapping generations of agents, each generation consisting of a large number of atomistic agents. Lifetimes are uncertain, with φ_h denoting the unconditional probability of surviving to age $h \leq H$. Preferences are defined over lifetime consumption, c , and leisure, ℓ :

$$(1) \quad U(c, \ell) = \frac{1}{1 - \gamma} E \sum_{h=1}^H \varphi_h \beta^h [\delta c_h^\nu + (1 - \delta) \ell_h^\nu]^{(1 - \gamma)/\nu}$$

where β , γ and $1/(1 - \nu)$ denote, respectively, the utility discount factor, the risk-aversion coefficient, and the (intra-temporal) elasticity of substitution between consumption and leisure. The i th agent of age h has labor productivity $e^{u_{ih}}$, where u_{ih} is a stochastic process which is independent across agents. Each agent supplies $1 - \ell_{ih}$ units of labor to a Cobb-Douglas aggregate production function and receives labor earnings of $w(1 - \ell_{ih})e^{u_{ih}}$, where w is the marginal product of aggregate labor. We abstract from aggregate shocks, implying that w is a constant.

Increasing inequality in labor productivity is generated by persistence in u_{ih} :

$$(2) \quad \begin{aligned} u_{ih} &= \alpha_i + z_{ih} \\ z_{ih} &= \rho z_{i,h-1} + \eta_{ih} \end{aligned}$$

where $\alpha_i \sim \mathcal{N}(0, \sigma_\alpha^2)$ is a “fixed-effect” shock, determined at birth, $\eta_{ih} \sim \mathcal{N}(0, \sigma_\eta^2)$ and $z_{i0} = 0$. This process is useful in providing (i) dispersion in productivity which increases with age and (ii) a decomposition of cross-sectional variation into a component known prior to entering the workforce and a component realized throughout the working years. Its unit-root property, however, is not critical for our analysis. Alternative specifications for increasing dispersion in productivity lead to the same answer. In Storesletten et al. (2000) we find empirical support for (2) and obtain estimates of ρ , σ_α^2 , and σ_η^2 which generate income inequality similar to Figure 1.

Assuming complete markets and no externalities, the allocation in this economy can be

characterized by a state-dependent, cohort-specific planning problem:

$$\max_{c_{ih}, \ell_{ih}} \int \hat{\lambda}_i \sum_{h=1}^H \varphi_h \beta^h U(c_{ih}, \ell_{ih}) d\mu$$

subject to

$$\int \sum_{h=1}^H \frac{\varphi_h}{(1+r)^h} (c_{ih} - w(1 - \ell_{ih})e^{u_{ih}}) d\mu = 0$$

where $\hat{\lambda}_i$ is the social planner's weight on household i , μ is the cross-sectional distribution, and r is the marginal product of capital, net of depreciation.

If r equals $(1/\beta) - 1$, the first-order conditions for the i th agent of age h are

$$\begin{aligned} (3) \quad U_c(c_{ih}, \ell_{ih}) &= \delta c_{ih}^{\nu-1} [\delta c_{ih}^{\nu} + (1 - \delta) \ell_{ih}^{\nu}]^{((1-\gamma)/\nu)-1} \\ &= \frac{\theta}{\hat{\lambda}_i} \equiv \frac{1}{\lambda_i} \end{aligned}$$

$$\begin{aligned} (4) \quad U_{\ell}(c_{ih}, \ell_{ih}) &= (1 - \delta) \ell_{ih}^{\nu-1} [\delta c_{ih}^{\nu} + (1 - \delta) \ell_{ih}^{\nu}]^{((1-\gamma)/\nu)-1} \\ &= \frac{\theta}{\hat{\lambda}_i} w e^{u_{ih}} \\ &= \frac{w e^{u_{ih}}}{\lambda_i} \end{aligned}$$

where θ is the multiplier on the aggregate resource constraint and $\lambda_i \equiv \hat{\lambda}_i/\theta$. Thus, the marginal rate of substitution between consumption and leisure depends on the productivity shocks, u_{ih} . This is what generates inequality in consumption and leisure. Rearranging,

$$(5) \quad \ell_{ih} = \left(e^{u_{ih}} \frac{w\delta}{1-\delta} \right)^{1/(\nu-1)} c_{ih}$$

$$(6) \quad c_{ih} = (\delta \lambda_i)^{1/\gamma} \left[\delta + (1 - \delta) \right]$$

$$\left(e^{u_{ih}} \frac{w\delta}{1-\delta} \right)^{w(\nu-1)} \left]^{(1-\gamma-\nu)/\nu\gamma}$$

which allows us to relate inequality in leisure and consumption:

$$\begin{aligned} (7) \quad \text{Var}(\log \ell_{ih}) &= \frac{1}{(\nu-1)^2} \text{Var}(u_{ih}) + \text{Var}(\log c_{ih}) \\ &\quad + \frac{2}{\nu-1} \text{Cov}(u_{ih}, \log c_{ih}). \end{aligned}$$

The covariance term is

$$\begin{aligned} (8) \quad \text{Cov}(u_{ih}, \log c_{ih}) &= \frac{1}{\gamma} \text{Cov} \left(u_{ih}, \log \lambda_i \right. \\ &\quad \left. + \frac{1-\gamma-\nu}{\nu} \log \left[\delta + (1-\delta) \right] \right. \\ &\quad \left. \times \left(e^{u_{ih}} \frac{w\delta}{1-\delta} \right)^{w(\nu-1)} \right). \end{aligned}$$

III. Implications for Inequality

We now ask which, if any, combinations of the preference parameters γ and ν generate patterns of inequality consistent with Figure 1. We calibrate the productivity process, u_{ih} , so that the increase in income inequality matches that of Figure 1 (both the increase and the linear shape). This results in $\rho = 1$, $\sigma_{\eta} = 0.13$, and $\sigma_{\alpha} = 0.52$. Additional details are available in Storesletten et al. (2000). We set the consumption share parameter $\delta = 0.36$ (see Thomas F. Cooley and Edward C. Prescott, 1995). The values of the wage rate w and the interest rate r do not matter quantitatively. Finally, the planning weights are assumed to be governed by the fixed-effect shocks: $\lambda_i = \exp(\alpha_i)$. These weights generate a realistic overall level of inequality in the model and reflect the notion that insurance is unavailable to the unborn.

The covariance term (8) is computed by simulation. Given this, we ask which preference parameters, if any, generate both increasing

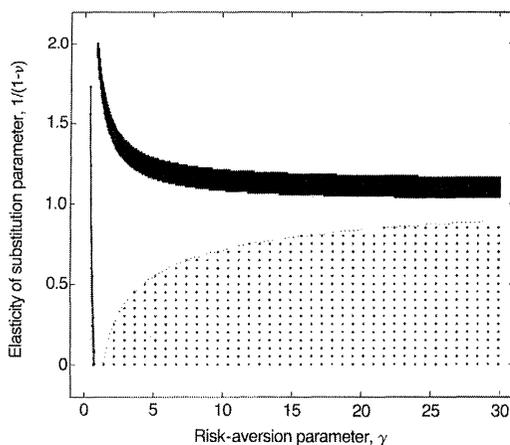


FIGURE 2. ADMISSIBLE PARAMETER VALUES

inequality in consumption and constant inequality in hours worked. Specifically, we characterize the pairs (γ, ν) such that (i) the cross-sectional variance of consumption, over the working years, increases by between 0.25 and 0.35, and (ii) the cross-sectional variance of hours-worked increases by 0.08 or less. The results are presented in Figure 2. The dotted region represents parameter pairs that satisfy the hours-worked criterion. The solid region represents pairs that satisfy the consumption criterion.

The dotted and solid regions in Figure 2 do not intersect. Therefore, there does not exist a parameterization of the utility function (1) that can account for both the consumption and the hours-worked data. Essentially, given the increasing pattern of labor productivity in Figure 1, Figure 2 tells us that a nonincreasing pattern of inequality in hours worked is only consistent with consumption and leisure being relatively nonsubstitutable. This, however, implies consumption inequality which does not increase sufficiently.

IV. The Importance of Idiosyncratic Risk

The previous section casts doubt on a complete-markets interpretation of increasing consumption inequality. Our story is robust to alternative models of increasing income inequality, such as deterministic heterogeneity in wage growth. The following evidence, how-

ever, supports our specification of persistent idiosyncratic shocks.

- (i) Estimates of a time-series process for household-level nonfinancial income suggests the importance of shocks. In Storesletten et al. (2000) we attribute cross-sectional variation among the youngest households to a distribution of “fixed effects” and any subsequent increase in dispersion to shocks received throughout the working years. We find that the latter are highly persistent, with estimates of autocorrelation being very close to unity. They are also sizable in magnitude. The fraction of total lifetime uncertainty attributable to shocks is estimated to be between 40 percent and 50 percent.
- (ii) The income locus from Figure 1 is qualitatively the same for different educational cohorts. In Storesletten et al. (2000) we divide the PSID panel underlying Figure 1 into three educational cohorts: those with a college degree, those with a high-school degree, and those without either. Increasing inequality with age remains a striking feature of the within-educational-cohort data. Figure 1 does not appear to be a simple manifestation of higher wage growth for more educated workers.
- (iii) Should increasing income inequality be attributable to heterogeneity which is deterministic across households, many models of consumption choice predict that consumption inequality will not increase with age. The simple reason is the intertemporal smoothing motive. A young worker who anticipates relatively high wage growth will borrow against it, causing future inequality in wages to be reflected in current inequality in consumption. In Storesletten et al. (2000) we develop a particular example. We show that, unless roughly half of the dispersion in income is attributable to shocks received over the working years, our model generates an insufficient increase in consumption inequality. The important caveats are financial frictions such as borrowing constraints which, obviously,

can generate inequality in consumption similar to that of income, irrespective of the reasons for the latter.

V. Last Thoughts

Consumption and income inequality increase with age. This is difficult to associate with an efficient allocation unless inequality in hours worked also increases with age. Data on hours worked, per worker, do not exhibit increasing inequality with age. This casts doubt on the efficient-allocation model and lends some support to an interpretation based upon idiosyncratic shocks. In Storesletten et al. (1999) and Storesletten et al. (2001) we explore several normative implications of these findings, examining Social Security reform and the welfare costs of business cycles, respectively.

Interestingly, inequality in hours worked per adult in the household increases more with age than does hours per working adult. This suggests the importance of the extensive labor-supply margin (the participation and retirement decisions) in addition to the intensive margin emphasized here. Indeed, a number of authors (e.g., Julie B. Cullen and Jonathan Gruber, 2000) have focused on the participation decision as an important vehicle for risk-sharing. An important question for future work is whether inequality along the extensive margin is consistent with an efficient allocation, or whether it constitutes additional evidence supporting the importance of idiosyncratic risk.

REFERENCES

- Altonji, Joseph G.; Hayashi, Fumio and Kotlikoff, Laurence J.** "Risk Sharing, Altruism, and the Factor Structure of Consumption." National Bureau of Economic Research (Cambridge, MA) Working Paper No. 3834, 1991.
- Altug, Sumru and Miller, Robert A.** "Households Choices in Equilibrium." *Econometrica*, May 1990, 58(3), pp. 543–70.
- Attanasio, Orazio and Davis, Steven J.** "Relative Wage Movements and the Distribution of Consumption." *Journal of Political Economy*, December 1996, 104(6), pp. 1227–62.
- Attanasio, Orazio and Weber, Guglielmo.** "Consumption Growth and Excess Sensitivity to Income: Evidence from U.S. Micro Data." Unpublished manuscript, Stanford University, 1992.
- Cochrane, John H.** "A Simple Test of Consumption Insurance." *Journal of Political Economy*, October 1991, 99(5), pp. 957–76.
- Cooley, Thomas F. and Prescott, Edward C.** "Economic Growth and Business Cycles," in Thomas F. Cooley, ed., *Frontiers of business cycle research*. Princeton, NJ: Princeton University Press, 1995, pp. 1–38.
- Cullen, Julie B. and Gruber, Jonathan.** "Does Unemployment Insurance Crowd Out Spousal Labor Supply?" *Journal of Labor Economics*, July 2000, 18(3), pp. 546–58.
- Deaton, Angus and Paxson, Christina.** "Intertemporal Choice and Inequality." *Journal of Political Economy*, June 1994, 102(3), pp. 437–67.
- Keane, Michael P. and Wolpin, Kenneth I.** "The Career Decisions of Young Men." *Journal of Political Economy*, June 1997, 105(3), pp. 473–522.
- Mace, Barbara J.** "Full Insurance in the Presence of Aggregate Uncertainty." *Journal of Political Economy*, October 1991, 99(5), pp. 928–56.
- Storesletten, Kjetil; Telmer, Chris I. and Yaron, Amir.** "The Risk Sharing Implications of Alternative Social Security Arrangements." *Carnegie-Rochester Conference Series on Public Policy*, June 1999, 50(99), pp. 213–59.
- _____. "Consumption and Risk Sharing over the Life Cycle." Working paper, Carnegie Mellon University, 2000.
- _____. "The Welfare Cost of Business Cycles Revisited: Finite Lives and Cyclical Variation in Idiosyncratic Risk." *European Economic Review*, 2001 (forthcoming).
- Townsend, Robert M.** "Risk and Insurance in Village India." *Econometrica*, May 1994, 62(3), pp. 539–91.