Taxes, benefits, careers, and markets

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Abstract

An incomplete markets life-cycle model with indivisible labor makes career lengths and human capital accumulation respond to labor tax rates and government supplied non-employment benefits. We compare aggregate and individual outcomes in this individualistic incomplete markets model with those in a comparable collectivist representative family with employment lotteries and complete insurance markets. The incomplete and complete market structures assign leisure to different types of individuals who are distinguished by their human capital and age. These microeconomic differences distinguish the two models in terms of how macroeconomic aggregates respond to some types of government supplied non-employment benefits, but remarkably, not to labor tax changes.

1 Introduction

This paper appraises two alternative aggregation theories for macroeconomic models with labor supply nonconvexities, namely, models in the style of Hansen (1985) and Rogerson (1988) with employment lotteries and complete insurance markets, on the one hand, and incomplete markets models with self-insurance and time-averaging in the style of Jones (1988) and Mulligan (2001), on the other. Prescott (2002) used the Hansen-Rogerson aggregation theory to justify the stand-in household with a very high labor supply elasticity that anchors his analysis of cross-country differences in employment rates and labor tax rates. Browning et al. (1999), who argue that the Hansen-Rogerson employment allocation mechanism "strains credibility and is at odds with the micro evidence on individual employment histories," presumably have in mind that a more realistic environment would be an incomplete markets models in which households imperfectly smooth consumption over time and across states, making individuals' consumption depends on individuals' histories of luck and participation in the labor market.

At least for a macroeconomist, a respectable reply to Browning et al. (1999) could be to argue that so long as aggregate outcomes are the same across the two aggregation theories, a failure to match microeconomic evidence about individual life experiences is not necessarily bothersome. It would be enough if micro parameters could be set so that the model accurately describes how aggregate outcomes vary across a range of interesting policy interventions.[1] Furthermore, it is conceivable that Jones-Mulligan time-averaging within an incomplete markets model could imply average life-time outcomes for all types individuals that are quantitatively similar to ones that would emerge from a Hansen-Rogerson lotteries model, so that one could potentially make contact with the micro evidence in a way that might please even Browning et al.[2]

This paper addresses these issues by exchanging the pencil-and-paper models of Ljungqvist and Sargent (2006a) for a pair of computable general equilibrium models that are much closer to ones being used today in quantitative macroeconomic research. The models are sufficiently rich that we can use them to study how aggregate and individual outcomes differ between

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[1]According to this argument, the purpose of having 'macroeconomics with microeconomic foundations' is to theorize about how aggregate outcomes respond to policy and other environmental changes within a coherent model with well posed individual optimization problems and a sensible definition of equilibrium. The purpose is not necessarily to make contact with microeconometric evidence, nor to calibrate by importing parameters from micro studies in the fashion recommended by Lucas (1987, p. 46-47).

[2]Ljungqvist and Sargent (2006a) investigated some of these possibilities by using continuous-time partial-equilibrium models that can be solved by hand to study how aggregate and individual outcomes respond to changes in the labor taxes stressed by Prescott (2002). We found that in a simple version of the models without human capital, both aggregate *and* individual outcomes respond to tax changes in the same way in the complete markets model with employment lotteries and an incomplete market model. But outcomes changed in interesting ways when the models were amended to incorporate a household technology for acquiring human capital by experience that in effect creates an endogenous indivisibility in form of careers. Though, after an initial tax range where the career indivisibility might mute the nonemployment effects of taxation in the incomplete markets economy but not in the complete markets economy, we found that the two economies produce similar aggregate nonemployment responses to further tax increases.

the incomplete markets model and the employment lotteries model when the government administers a stylized nonemployment benefit, and we can compare them with the models' responses to changes in the tax wedges featured by Prescott (2002). This is interesting because a point of controversy is whether changes in unemployment and other nonemployment benefits have aggregate quantitative effects similar to those associated with changes in the labor tax rate.[3]

In our employment lotteries model with complete markets, there is an infinitely lived representative household, while in the incomplete markets model, there is not. In the complete markets economy, society's labor-leisure choice is made collectively. In the incomplete markets economy, society's labor-leisure choice is made one individual at a time. In the incomplete markets model, there are neither employment lotteries nor contingent consumption claims, and (1) finite life spans imply that agents' decision rules reflect life cycle considerations; (2) human capital accumulation instills an endogenous indivisibility in the form of career decisions; (3) uncertainty about human capital outcomes and life spans implies precautionary savings. Their luck in accumulating human capital and rates of labor taxation determine isolated individuals' choices of career lengths. Higher labor taxes increase the aggregate leisure-consumption ratio by shortening the labor market careers of those who have saved enough to support themselves. As we shall see, this means that the incomplete markets model responds to an increase in the labor tax by assigning more leisure to different individuals than would the representative household in the complete markets model.

1.1   Findings

The incomplete markets model yields aggregate outcomes that respond to labor tax increases in much the same way as does the complete markets employment lottery model. But these similar aggregate outcomes conceal individual behavior that differs markedly across the two market structures. For example, there are large differences in the incidence of nonemployment across skill and age groups in the complete markets economy as compared to the incomplete markets economy. The stand-in household in the complete markets economy efficiently assigns work and leisure across individuals with different skills and ages, and an individual's consumption allocation is independent of his luck and his assignment in the labor market. In the incomplete markets model, an individual's wealth is a critical state variable that intermediates how his history of labor market shocks impinges on his current consumption and labor supply. In the incomplete markets model, how the equilibrium distribution of individual financial wealth adjusts to fiscal policy is an important determinant of employment outcomes.

If we start from low rates of labor taxation in the incomplete markets economy, high-skilled old workers are most prone to shorten their labor market careers in response to increases in labor taxes, then as taxes increase further, high-skilled young workers follow suit. These are the agents who can afford to amass enough funds to go into (privately financed)

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[3]Prescott (2006a) says that distinguishing between the aggregate effects of labor taxes and nonemployment benefits is a 'red herring', a claim that we evaluate in section 5.

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early retirement. At successively higher tax rates, they are joined by low-skilled workers and, once again, first the old and then the young choose to save up for early retirement. In the complete markets economy, the stand-in household will furlough only the latter groups of low-skilled workers into leisure. But despite the different identities of the nonemployed, both complete and incomplete economies yield similar aggregate responses in nonemployment to labor taxes and hence, the models allow us to pronounce our respectable macroeconomic reply to Browning et al. (1999). But we have to recognize the models' disparate implications when it comes to making contact with microeconomic evidence.

We also study the nonemployment effects of two alternative benefit policies. Under the first policy, which entitles all workers to nonemployment benefits, the incomplete markets model and the employment lotteries model deliver similar aggregate responses to benefit levels. These resemble their respective responses to labor tax rates. Again we have a caveat about the different identities of the nonemployed across the two market structures. In the incomplete markets economy, it is mainly well-off high-skilled agents who choose nonemployment by availing themselves of benefits to "top off" their already considerable retirement savings. By way of contrast, in the complete markets economy, the stand-in household continues to assign low-skilled workers to leisure and the benefits are a potent subsidy for such nonemployment. Thus, under our first benefit policy, the models again allow us to pronounce a respectable macroeconomic reply to Browning et al. (1999) while conceding that the models have opposite microeconomic implications.

The second policy stipulates that benefits are paid only to nonemployed who have not been high-skilled. Here we can't make even our respectable macroeconomic reply to Browning et al. (1999) because now the two models deliver different aggregate outcomes. In the complete markets economy, equilibrium outcomes are trivially the same for this second benefit policy as under the first because the stand-in household furloughs only low-skilled workers into leisure. In contrast, the nonemployment effects in the incomplete markets economy are attenuated under the second benefit policy because well-off high-skilled workers are not permitted to use benefits to "top off" their retirement wealth with public nonemployment benefits. Benefits must then be set quite high before low-skilled agents can afford to give up their market earnings and shorten their labor market careers. Hence, the second benefit policy illustrates how the two alternative aggregation theories can produce different identities of the nonemployed and also lead to different aggregate employment responses to tax and benefit packages.

1.2   Organization

The remainder of this paper is organized as follows. Section 2 sets out the environment and our two market structures and tells our calibration. Section 3 describes how aggregate and individual outcomes vary across the two market structures. Section 4 studies the effects of labor taxation on outcomes. Section 5 describes how outcomes respond to two types of government supplied non-employment benefits. Section 6 wraps up with some remarks about next steps.

2 A general equilibrium model of careers

2.1 The environment

This subsection describes the physical environment, while subsections 2.2 and 2.3 describe two alternative market structures.

A continuum of agents on the unit interval are divided into three age classes, $x \in \{y, o, r\}$; young workers ($x = y$), old workers ($x = o$), and retirees ($x = r$). An agent faces a probability $\chi(x, x')$ that his age class is x' at the beginning of next period, conditional on currently belonging to age class x. Agents who die are replaced by newborn workers, keeping the total population and the shares of age classes constant over time.

Agents experience stochastic accumulation or deterioration of skills conditional on employment status. Two possible skill levels are indexed by $h \in \{1, H\}$, where $h = 1$ denotes the low skill level normalized to one, and $h = H$ denotes the high skill level where $H \geq 1$. All newborn agents enter the economy at the low skill level. An employed (nonemployed) agent with skill level h faces a probability $p^n(h, h')$ ($p^u(h, h')$) that his skill level at the beginning of next period is h'.

Preferences are ordered by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\log c_t - B n_t + D \frac{(1 - s_t)^{\gamma} - 1}{\gamma} \right], \qquad \text{with } B, D > 0, \ \gamma > -1, \tag{1}$$

where the conditional mathematical expectation operator E_0 is taken with respect to the distribution of future states of employment, nonemployment, retirement and death; c_t is consumption; n_t equals one if the agent is working and zero otherwise; and $s_t \in [0, 1)$ is the agent's choice of search intensity if nonemployed and of working age. The search intensity s_t determines a nonemployed agent's probability s_t^{ξ} of finding a centralized labor market in the next period, where $0 \leq \xi \leq 1$. We borrow the idea of searching for 'the' labor market from Alvarez and Veracierto (2001), who use it as a convenient device to capture forces at play in the search-islands model of Lucas and Prescott (1974).[4]

Aggregate production obeys

$$F(K_t, L_t) = K_t^{\theta} L_t^{1-\theta}, \qquad \text{with } \theta \in (0, 1), \tag{2}$$

where K_t is the aggregate capital stock that depreciates at the rate δ, and L_t is the measure of employed agents weighted by their skill levels. Output can be devoted to consumption and investment in physical capital.

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[4]Computational considerations motivated us to include search in the incomplete-market economy. Search costs remove chattering as an optimal behavior. If chattering were present in equilibrium, it would have caused us substantially to increase the fineness of the asset grid to ensure numerical accuracy. In the complete-market model, we omit the search technology because its inclusion would convey no computational advantages but would only complicate the stand-in household's optimization problem while having no discernable impacts on equilibrium outcomes. (See footnote 6.)

Labor income is taxed at a flat tax rate τ_h. The government wastes a fraction $\zeta \in [0,1]$ of the tax revenues and returns the remaining fraction $(1 - \zeta)$ as lump-sum transfers. Let ϵ and ϵ_r denote the per-capita lump-sum transfer to persons of working age and of retired age, respectively.

The next two subsections describe how we complete the model under incomplete and complete market structures, respectively.

2.2 Incomplete-market economy

In the incomplete-market economy, the only vehicle for savings is a risk-free claim on capital. Agents are subject to a non-negativity constraint on their asset holdings,[5] and any accidental bequests from deceased agents are collected by the government and returned lump sum to the living. We include these bequests in the transfer scheme $\{\epsilon, \epsilon_r\}$ in the same proportions as the lump-sum return of tax revenues.

2.2.1 Household's problem

We define value functions $V^n(x, a, h)$, $V^u(x, a, h)$, and $V^r(a)$ for an employed agent, a nonemployed agent, and a retired agent, respectively. The state variables are age (x), last period's assets (a), and skill level (h). The value function for an employed agent is

$$V^n(x, a, h) \;=\; \max_{c, a'} \left[\log c - B + \beta \sum_{x'} \chi(x, x')\, V^{n+}(x', a', h) \right], \tag{3}$$

where

$$V^{n+}(x', a', h) = \begin{cases} V^r(a'), & \text{if } x' = r; \\ \sum_{h'} p^n(h, h') \max\{V^n(x', a', h'),\, V^u(x', a', h')\} & \text{otherwise;} \end{cases} \tag{4}$$

subject to

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\begin{aligned}
c + a' &\leq (1 + i)\, a + (1 - \tau_h)\, h\, w + \epsilon\,, \\
c,\, a' &\geq 0\,,
\end{aligned}
$$

where i is the net real interest rate on savings and w is the wage rate per unit of skill. Policy functions $\bar{c}^n(x, a, h)$ and $\bar{a}^n(x, a, h)$ give optimal levels of consumption and savings, respectively. The solution of maximum problem (4) can be expressed in terms of an indicator function:

$$\bar{n}(x', a', h') = \begin{cases} 1, & \text{if } V^n(x', a', h') \geq V^u(x', a', h')\,; \\ 0, & \text{otherwise}, \end{cases} \tag{5}$$

where $\bar{n}(x', a', h')$ indicates whether a worker finds it optimal to keep a job ($\bar{n} = 1$) or to quit ($\bar{n} = 0$).

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[5]Thus, we tighten the borrowing constraint relative to the natural borrowing constraint. See Aiyagari (1994) and Ljungqvist and Sargent (2004) for discussions of the natural borrowing constraint.

The value function for a nonemployed agent is

$$V^u(x,a,h) = \max_{c,a',s}\left[\log c + D\frac{(1-s)^\gamma - 1}{\gamma} + \beta\sum_{x'}\chi(x,x')V^{u+}(x',a',h)\right], \quad (6)$$

where

$$V^{u+}(x',a',h) = \begin{cases} V^r(a'), & \text{if } x' = r; \\ \sum_{h'}p^u(h,h')\left[s^\xi\max\left\{V^n(x',a',h'),V^u(x',a',h')\right\}\right. \\ \left. + \left(1-s^\xi\right)V^u(x',a',h')\right] & \text{otherwise;} \end{cases} \quad (7)$$

subject to

$$c + a' \le (1+i)a + \epsilon,$$
$$c,\, a' \ge 0 \quad \text{and} \quad s \in [0,1).$$

Three policy functions $\bar{c}^u(x,a,h)$, $\bar{a}^u(x,a,h)$, and $\bar{s}(x,a,h)$ describe optimal levels of consumption, savings, and search effort, respectively. The solution of the maximization problem in expression (7) is given by an indicator function $\bar{n}(x',a',h')$, as defined in (5).

The value function for a retired agent is

$$V^r(a) = \max_{c,a'}\left[\log c + \beta\,\chi(r,r)V^r(a')\right] \quad (8)$$

subject to

$$c + a' \le (1+i)a + \epsilon_r,$$
$$c,\, a' \ge 0.$$

Two policy functions $\bar{c}^r(a)$ and $\bar{a}^r(a)$ give optimal consumption and savings, respectively.

2.2.2 Firm's problem

The production side of the economy is as in a standard growth model. Steady-state prices satisfy

$$i = \frac{\partial F(K,L)}{\partial K} - \delta, \quad (9)$$

$$w = \frac{\partial F(K,L)}{\partial L}. \quad (10)$$

2.2.3 Steady state

Time-invariant measures $m^n(x, a, h)$, $m^u(x, a, h)$ and $m^r(a)$ describe, respectively, the cross-sectional distribution of employed, nonemployed, and retired households across individual states. These measures are implied by the optimal decision rules:

$$m^n(x', a', h') = \sum_x \chi(x, x') \left[\sum_{a,h:\bar{a}^n(x,a,h)=a'} p^n(h, h') \, m^n(x, a, h) \, \bar{n}(x', a', h') \right.$$
$$\left. + \sum_{a,h:\bar{a}^u(x,a,h)=a'} p^u(h, h') \, \bar{s}(x, a, h)^\xi \, m^u(x, a, h) \, \bar{n}(x', a', h') \right], \quad (11)$$

$$m^u(x', a', h') = \sum_x \chi(x, x') \left\{ \sum_{a,h:\bar{a}^n(x,a,h)=a'} p^n(h, h') \, m^n(x, a, h) \left[1 - \bar{n}(x', a', h') \right] \right.$$
$$\left. + \sum_{a,h:\bar{a}^u(x,a,h)=a'} p^u(h, h') \, m^u(x, a, h) \left[1 - \bar{s}(x, a, h)^\xi \, \bar{n}(x', a', h') \right] \right\}$$
$$+ I(x', a', h') \, (1 - \chi(r, r)) \sum_a m^r(a) , \quad (12)$$

where $I(x', a', h')$ is an indicator function that is equal to one if $x' = y$, $a' = 0$ and $h' = 1$ and is equal to zero otherwise;

$$m^r(a') = \chi(r, r) \sum_{a:\bar{a}^r(a)=a'} m^r(a)$$
$$+ \chi(o, r) \left[\sum_{a,h:\bar{a}^n(o,a,h)=a'} m^n(o, a, h) + \sum_{a,h:\bar{a}^u(o,a,h)=a'} m^u(o, a, h) \right]. \quad (13)$$

The market-clearing condition in the goods market is

$$C + \delta K + G = F(K, L), \quad (14)$$

where C, K, L and G are aggregate consumption, the aggregate capital stock, the aggregate labor supply in skill units, and government tax revenues that are wasted, respectively, as given by

$$C = \sum_{x,a,h} \left[\bar{c}^n(x, a, h) \, m^n(x, a, h) + \bar{c}^u(x, a, h) \, m^u(x, a, h) \right] + \sum_a \bar{c}^r(a) \, m^r(a), \quad (15)$$

$$K = \sum_{x,a,h} a \left[m^n(x, a, h) + m^u(x, a, h) \right] + \sum_a a \, m^r(a), \quad (16)$$

$$L = \sum_{x,a,h} h \, m^n(x, a, h), \quad (17)$$

$$G = \zeta \, \tau_h \, w \, L. \quad (18)$$

The government wastes a fraction $\zeta \in [0,1]$ of the tax revenues, as given by expression (18), and returns the other fraction $(1-\zeta)$ together with accidental bequests as lump-sum transfers to the agents. Since we restrict attention to steady-state equilibria without government debt, the government satisfies the stationary budget constraint:

$$(1 - \zeta)\tau_h\, w\, L + (1 - \chi(r,r)) \sum_{a'}(1+i)a' \sum_{a:\bar{a}^r(a)=a'} m^r(a) = \epsilon(1 - M) + \epsilon_r M^r, \qquad (19)$$

where M^r is the fraction of the population that is retired, $M^r = \sum_a m^r(a)$.

2.3 Complete-market economy

To construct a version of Prescott's stand-in household model, we assume that agents belong to dynastic lineages. Though subject to stochastic aging, each agent *de facto* has an infinite horizon because he cares about his offspring and the survival probability of his lineage is one. A stand-in household consists of a continuum of such lineages indexed on the unit interval. In a steady state, the age distribution of the household's members is the same as the stationary age distribution in the aggregate economy.

The stand-in household's utility over consumption and the work of all of its lineage members is

$$\int_0^1 \sum_{t=0}^{\infty} \beta^t \Big[\log c_t^j - Bn_t^j\Big] dj\,, \qquad (20)$$

where c_t^j is lineage j's consumption at time t and n_t^j equals one if the current member of lineage j is working and equals zero otherwise. Compared to utility function (1), the survival probability is set equal to one, as we have explained, and the term for the disutility of searching is omitted (and so is the search technology). We omit search purely for simplicity; its omission is inconsequential for our numerical results.[6]

2.3.1 Stand-in household's problem

Leaving aside the design of the employment lottery, the stand-in household chooses measures of employed workers within age and skill groups.[7] Let N_{ht}^x be the measure of agents of age

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[6]In the complete-market model, including a search cost would remove some indeterminacies in the design of lotteries by ruling out lotteries that involve switching the identities of employed workers within a given skill and age group. By avoiding unnecessary churning among the employed, total search costs are kept to a minimum. And given our calibration of the search technology and the disutility of searching, the households' total search costs would be negligible and any computed equilibrium with search would not be discernibly different from our computed equilibria without search.

[7]Although the aggregate allocation of labor is unique in an employment lotteries model, many possible lottery designs that randomly assign different tasks to individual workers can implement that allocation and yield the same expected utility to workers. In real business cycle models like the one of Hansen (1985), the identical workers could be randomizing over an arbitrary number of periods of working and leisure, possibly contingent on the phase of the business cycle. In our model with *ex post* heterogeneous agents, the lottery design must be consistent with the optimal work-leisure allocation across age and skill groups.

$x \in \{y, o\}$ and skill level $h \in \{1, H\}$ who are employed in period t. Analogously, let M_{ht}^x denote the total measure of the household's population of age x and skill h in period t, and let M_t^r be the measure of retirees in period t. Given the additively separable disutility of working, the optimal consumption allocation has all agents consume the same amount, c_t. The stand-in household's optimization problem can then be formulated as:

$$\max_{\{c_t, a_{t+1}, \{N_{ht}^x\}_{xh}\}_{t=0}^\infty} \sum_{t=0}^\infty \beta^t \left[\log c_t - B\left(N_{1t}^y + N_{Ht}^y + N_{1t}^o + N_{Ht}^o \right) \right] \tag{21}$$

subject to

$$c_t + a_{t+1} \leq (1 + i_t)a_t + (1 - \tau_{ht})w_t \left[N_{1t}^y + N_{1t}^o + H\left(N_{Ht}^y + N_{Ht}^o \right) \right]$$
$$+ \epsilon(1 - M_t^r) + \epsilon_r M_t^r, \tag{22}$$
$$N_{ht}^x \leq M_{ht}^x, \tag{23}$$

and laws of motion for the measure of retirees, M_t^r, and measures of working-age agents, M_{ht}^x, for $x \in \{y, o\}$ and $h \in \{1, H\}$; for all $t \geq 0$.

2.3.2 Steady state

In our numerical analysis, we will focus on parameterizations where agents can gain but not lose skills at work, i.e., $p^n(1, H) \equiv \pi \geq 0$ and $p^n(H, 1) = 0$, while the skills of nonemployed agents are nonincreasing, i.e., $p^u(1, H) = 0$.[8] It follows immediately that the stand-in household will never furlough high-skilled workers into leisure in a steady state. The laws of motion for measures of age and skill groups in a steady state are

$$M_{1t}^y = (1 - \sigma)\left[M_{1t-1}^y - \pi N_{1t-1}^y \right] + \mu M_{t-1}^r, \tag{24}$$

$$M_{Ht}^y = (1 - \sigma)\left[M_{Ht-1}^y + \pi N_{1t-1}^y \right], \tag{25}$$

$$M_{1t}^o = (1 - \rho)\left[M_{1t-1}^o - \pi N_{1t-1}^o \right] + \sigma\left[M_{1t-1}^y - \pi N_{1t-1}^y \right], \tag{26}$$

$$M_{Ht}^o = (1 - \rho)\left[M_{Ht-1}^o + \pi N_{1t-1}^o \right] + \sigma\left[M_{Ht-1}^y + \pi N_{1t-1}^y \right], \tag{27}$$

$$M_t^r = (1 - \mu)M_{t-1}^r + \rho\left[M_{1t-1}^o + M_{Ht-1}^o \right], \tag{28}$$

where $\sigma \equiv \chi(y, o)$, $\rho \equiv \chi(o, r)$, and $\mu \equiv (1 - \chi(r, r))$, i.e., σ, ρ and μ are the probability of a young worker turning old, an old worker retiring, and a retired agent dying, respectively. And as mentioned, the labor allocation satisfies $N_{Ht}^x = M_{Ht}^x$ for $x \in \{y, o\}$.

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[8]Ljungqvist and Sargent (2006b) formulate a version of our stand-in household model to study labor market institutions and "economic turbulence." We model different amounts of turbulence in terms of a probability that an employed worker loses skills on occasions of exogenous job displacements.

The stand-in household's first-order conditions with respect to consumption and savings are

$$c_t^{-1} - \lambda_t = 0, \tag{29}$$
$$-\lambda_t + \beta\lambda_{t+1}(1 + i_{t+1}) = 0, \tag{30}$$
$$\tag{31}$$

where λ_t is the Lagrange multiplier on the one-period budget constraint at time t, as given by (22). In a steady state where only low-skilled workers can be nonemployed, the first-order conditions with respect to N_{1t}^o and N_{1t}^y are

$$-B + \lambda_t(1 - \tau_{ht})w_t + \pi\left\{\sum_{j=1}^{\infty}\beta^j\left[-B + \lambda_{t+j}(1 - \tau_{ht+j})w_{t+j}H\right]\right.$$
$$\left.\cdot(1 - \rho)^j\right\} - \phi_{1t}^o \leq 0, \tag{32}$$

$$-B + \lambda_t(1 - \tau_{ht})w_t + \pi\left\{\sum_{j=1}^{\infty}\beta^j\left[-B + \lambda_{t+j}(1 - \tau_{ht+j})w_{t+j}H\right]\right.$$
$$\left.\cdot\left[(1 - \sigma)^j + \sigma\sum_{i=1}^{j}(1 - \sigma)^{i-1}(1 - \rho)^{j-i}\right]\right\} - \phi_{1t}^y \leq 0, \tag{33}$$

where ϕ_{ht}^x is the Lagrange multiplier on feasibility constraint (23). These first-order conditions reflect that if a low-skilled agent becomes high-skilled after working one period, the stand-in household will optimally assign that agent to lifetime employment. In general, the presence of human capital adds a term representing the continuation value to what would have been an *intratemporal* marginal condition for period t labor supply in a model without human capital.[9] Note that the continuation value in braces is larger for a low-skilled young agent in (33) than for a low-skilled old agent in (32), since the expected remaining time in the labor force is longer for a young agent. It follows that if *some* low-skilled *old* agents are working, i.e., first-order condition (32) holds with equality and $\phi_{1t}^o \geq 0$, then *all* low-skilled *young* agents must be working because $\phi_{1t}^y > 0$ in (33).

After evaluating first-order conditions (29)–(33) at a steady state, we can compute the following equilibrium expressions. The steady-state interest rate is

$$1 + i = \beta^{-1}. \tag{34}$$

In terms of the steady state wage rate w and consumption c, the employment of low-skilled agents N_1^x of age $x \in \{y, o\}$, is characterized by

$$-B + \frac{(1 - \tau_h)w}{c}\left[1 + (H - 1)\beta\pi\Omega^x\right]\left\{\begin{array}{ll} > 0, & N_1^x = M_1^x; \\ = 0, & N_1^x \in (0, M_1^x); \\ < 0, & N_1^x = 0. \end{array}\right. \tag{35}$$

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[9]For studies of labor supply when there is human capital accumulation on the job, see Shaw (1989) and Imai and Keane (2004).

The second term in square brackets captures the effect of human capital and the age-specific factor Ω^x is

$$\Omega^o \equiv \frac{1-\rho}{1-(1-\pi)\beta(1-\rho)}, \tag{36}$$

$$\Omega^y \equiv \frac{[1-\beta(1-\rho)](1-\sigma)+\sigma}{[1-\beta(1-\rho)]\{1-(1-\pi)\beta(1-\sigma)\}+\beta\sigma\pi}, \tag{37}$$

where $\Omega^y > \Omega^o > 0$. Once again, in the presence of human capital accumulation, the stand-in household will assign leisure first to low-skilled old agents and if all those are nonemployed, to low-skilled young agents.

2.4 Calibration

We set the model period to one quarter. We set the discount factor $\beta = 0.99$, making the annual interest rate in the complete-market economy 4.1 percent. There are two working age classes. The probabilities of remaining within an age class equal $\chi(y,y) = 0.99$ for the class of young workers and $\chi(o,o) = 0.9833$ for the class of old workers. The time spent in an age class is geometrically distributed with an expected duration of 25 years as a young worker and 15 years as an old worker. The probability that a retired agent remains in that state is $\chi(r,r) = 0.9875$, making the expected duration of retirement 20 years. Hence, on average, agents spend 2/3 of their adult life in the labor force and 1/3 in retirement.

The constant-returns-to-scale Cobb-Douglas technology has capital share parameter $\theta = 0.333$. The quarterly depreciation rate is $\delta = .02$. The curvature of the search technology and the disutility of searching are taken from Alvarez and Veracierto (2001), who specify $\xi = 0.98$ and $\gamma = 0.98$, respectively, making these close to linear. We set $D = B$, i.e., the scale parameter in the disutility of search is equal to the disutility of working which together with our previous parameter choices ensures that an unemployed agent who incurs a disutility from searching similar to an employed agent's disutility from working would almost certainly find a job after one period (one quarter) of search.

The high skill level is twice the low skill level, $H = 2$. All newborn agents start with the low skill level that we normalize to 1. Agents gains skills by working. After each period of employment, workers at the low skill level move to the high skill level with probability $p^n(1,H) = 0.0125$, making the expected time to become a high-skilled worker 20 years.[10] Employed workers who have reached the high skill level retain those skills until they become nonemployed. In the benchmark parameterization, all workers who choose nonemployment revert to the low skill level, $p^u(H,1) = 1$. (Under the alternative assumption of no skill loss, we show, surprisingly enough, that the nonemployment effects of taxation are almost unchanged. See figure 11.)

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[10]We thank Daniel Hamermesh for conversations about his data explorations of wage-experience profiles. Our assumption that work experience alone can double a worker's earnings seems to line up well with data for full-time male workers in the U.S. manufacturing industry.
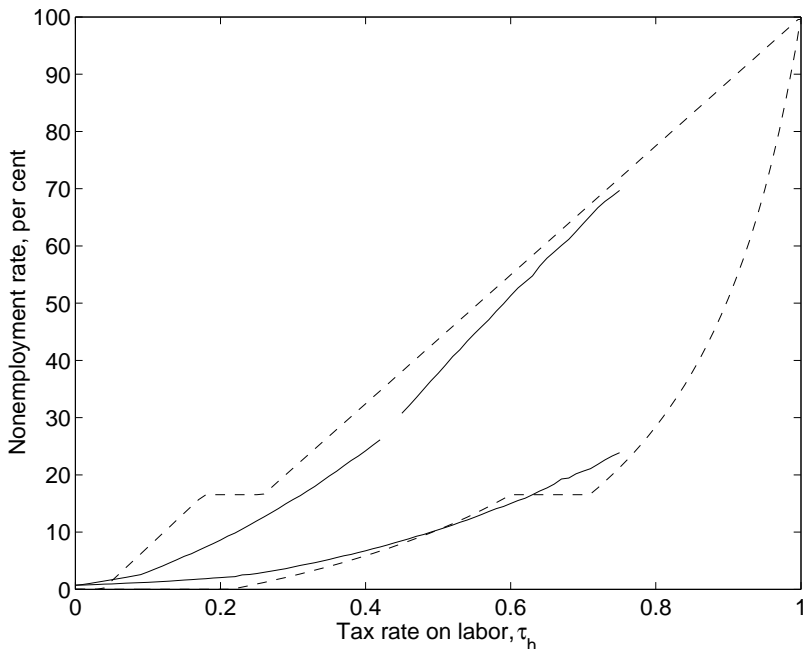
Figure 1: Nonemployment effects of taxation with and without lump-sum transfers. The solid (dashed) lines refer to the incomplete-market (complete-market) economy. For each economy, the upper line depicts equilibrium outcomes when tax revenues are returned as lump-sum transfers to the households ($\zeta = 0$), while the lower line depicts equilibrium outcomes when tax revenues finance government expenditures that are not substitutes for private consumption ($\zeta = 1$).

In the benchmark parameterization, the government hands back all tax revenues as equal per-capita lump-sum transfers to the agents, $\epsilon = \epsilon_r$, and hence, no tax revenues are wasted, $\zeta = G = 0$. In the incomplete-market economy, the lump-sum transfers also include accidental bequests from retired agents who have died with positive amounts of assets.

We set the disutility of working $B = 1$. This value implies that at tax rates below 3.8 percent all agents are employed throughout their working age in the complete-market economy.

3 Despite differences at the individual levels, similar aggregate outcomes

For both the complete-market and incomplete-market economies, figure 1 depicts nonemployment outcomes for different labor tax rates. Remarkably, the nonemployment effects of taxation are quite similar across the two economies (the dashed and solid lines are close for each setting of the fraction of wasted government expenditures ζ). The aggregate outcomes

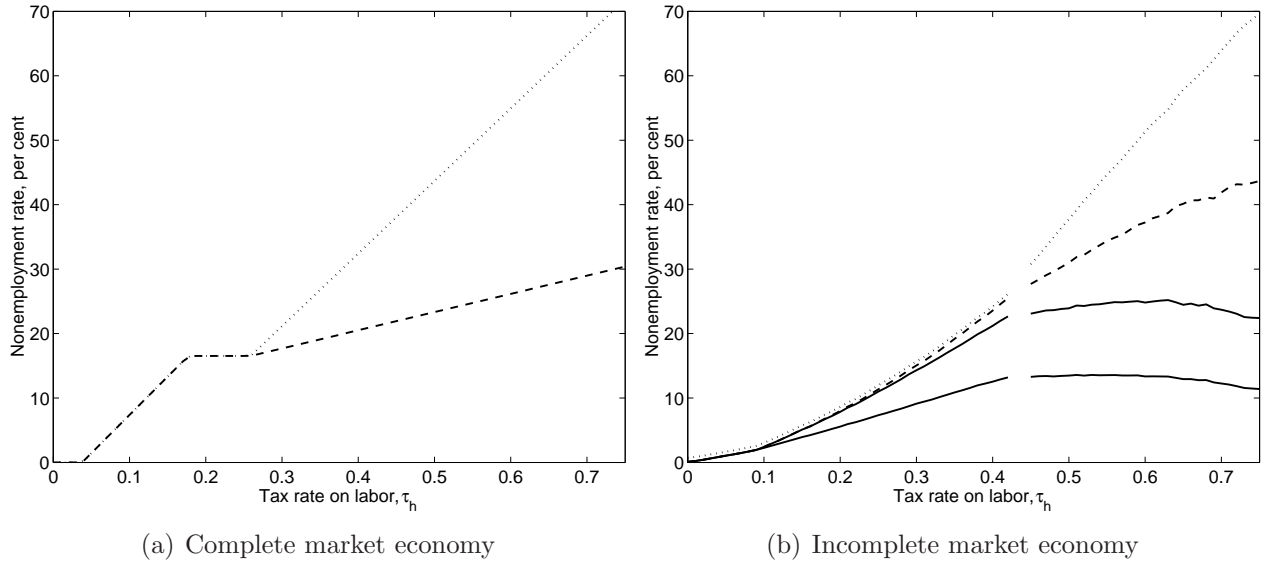(a) Complete market economy   (b) Incomplete market economy

Figure 2: Decomposition of aggregate nonemployment rates. The lower solid line shows nonemployment among high-skilled old workers while the gap between the two solid lines refers to high-skilled young workers. The next gap to the dashed line shows nonemployment among low-skilled old workers and the last gap to the dotted line refers to low-skilled young workers. (All tax revenues are handed back as lump-sum transfers to the households, $\zeta = 0$.)

conceal substantial differences across the economies in the incidences of nonemployment across different age and skill groups. Figure 2 shows the contribution of different age and skill groups to the aggregate nonemployment rate in the complete-market and incomplete-market economy, respectively.

3.1 Complete-market economy

The stand-in household efficiently assigns work and leisure. Low amounts of leisure in a steady state are best generated by allocating old workers with low skills to nonemployment. Even though young and old workers with low skills have the same ability to become high-skilled workers, old workers have a shorter expected time horizon to retirement. That makes the payoffs to skill accumulation higher for the young. If the stand-in household wants to consume still more leisure after all old workers with low skills have been assigned to nonemployment, it does so by furloughing some young agents with low skills into nonemployment.

We begin by assuming along with Prescott (2002) that the government rebates all of its tax collections. The optimal division between work and leisure is illustrated in table 1, where the stand-in household's total nonemployment is increasing in the labor tax rate. The upper dashed line in figure 1 depicts the aggregate nonemployment rate in the complete-market economy as a function of the labor tax rate. The first upward-sloping segment describes how the stand-in household furloughs old agents with low skills into nonemployment, while the

	Labor tax rate, τ_h				
	0	0.10	0.20	0.30	0.40
Young, $h = 1$	0.6 (0.0)	0.6 (0.0)	0.6 (0.0)	0.6 (3.5)	0.6 (11.9)
Young, $h = H$	0.0 (0.0)	0.2 (0.0)	2.3 (0.0)	5.2 (0.0)	8.7 (0.0)
Old, $h = 1$	0.0 (0.0)	0.0 (7.4)	0.1 (16.5)	0.7 (17.7)	2.4 (20.5)
Old, $h = H$	0.1 (0.0)	2.3 (0.0)	5.6 (0.0)	9.1 (0.0)	12.5 (0.0)
Total	0.7 (0.0)	3.1 (7.4)	8.6 (16.5)	15.6 (21.2)	24.2 (32.4)

Table 1: Nonemployment rates in percent of the total labor force, decomposed into different age groups and conditional on whether the agents have ever experienced the high skill level ($h = H$) or only the low skill level ($h = 1$). The numbers without (within) parentheses refer to the incomplete-market (complete-market) economy.

	Labor tax rate, τ_h				
	0	0.10	0.20	0.30	0.40
Interest rate	2.8 (4.1)	3.4 (4.1)	3.6 (4.1)	3.7 (4.1)	3.9 (4.1)
Wage rate	9.4 (8.9)	9.1 (8.9)	9.1 (8.9)	9.0 (8.9)	9.0 (8.9)
Output	15.1 (14.4)	14.3 (13.5)	13.1 (12.3)	11.8 (11.6)	10.2 (10.0)
Capital stock	47.0 (39.8)	42.2 (37.2)	37.9 (34.0)	33.9 (32.1)	29.0 (27.5)
Transfer	0.0 (0.0)	11.6 (11.3)	24.2 (23.2)	37.4 (37.5)	50.9 (50.0)

Table 2: Annualized values of the interest rate, wage rate per unit of skill, and output per capita; capital stock per capita; and government lump-sum transfer, excluding the accidental bequest part, per capita as a per cent of after-tax low-skilled earnings. The numbers without (within) parentheses refer to the incomplete-market (complete-market) economy.

second upward-sloping segment entails assigning young agents with low skills to nonemployment because all old agents with low skills are already nonemployed.

The plateau between the two upward-sloping segments of the upper dashed line in figure 1 reflects a corner solution in the stand-in household's optimization problem. At the labor tax rate $\tau_h = 0.17$, the marginal condition (35) for assigning an old agent ($x = o$) with low skills to specialize in leisure holds with equality when the household assigns everyone in that category to enjoy leisure. Since that marginal condition holds with equality, it follows that the household's first-order condition (35) for letting a young agent ($x = y$) with low skills enjoy leisure is a strict inequality (> 0). Thus, at the labor tax rate $\tau_h = 0.17$, the household strictly prefers to send all young agents with low skills to the labor market. The stand-in household does not want to exchange the future earnings potential of a young worker for the additional leisure that person can generate. However, as the labor tax is raised further, it will eventually reach a point where the stand-in household's first-order condition with respect to the career choice of a young agent with low skills holds with equality. That occurs at the tax rate $\tau = 0.26$ in figure 1. Further tax increases prompt the stand-in household to furlough more and more young agents with low skills into nonemployment.

Depending on their luck in the employment lottery, agents with the same *ex ante* expected life-time utility find themselves assigned to different career paths. Given the additively separable disutility of working, all agents consume the same amount regardless of their age, skill, and employment status. As in Ljungqvist and Sargent (2006b), workers who have attained the high skill level are destined to work until retirement.

3.2   Incomplete-market economy

To indicate the allocation of leisure in the incomplete-market economy, we examine the optimal decision rules as functions of age, skill level and asset holdings. Figure 3 shows decision rules of young agents in panels (a) and (b), and of old agents in panels (c) and (d). For a given age and skill level, each panel depicts decision rules as functions of the agent's asset holdings. The figure refers to an equilibrium with zero labor taxation. (For data on aggregate equilibrium outcomes in the incomplete-market economy with zero labor taxation, see the leftmost column in tables 1 and 2.)

In figure 3, the employment decision of an already employed worker is represented by the thick horizontal line that takes on a horizontal value of 1 if employment is preferred to nonemployment, and a value of 0 otherwise. The thin horizontal line is another dummy variable pertaining to an employed agent, which takes on a horizontal value of 0.95 if the employed agent wants to increase his assets to next period, and a value of 0 otherwise. Finally, the thin curve describes a nonemployed agent's search effort, $s \in [0, 1)$. The search effort is at the upper bound for low asset levels and equals zero for high assets. In the range between those low and high asset levels, the optimal search intensity takes on intermediate values, as shown by the thin curve in the form of a drawn-out inverted-S shape that is almost a straight vertical line.

(a) Young with low skills

(b) Young with high skills

(c) Old with low skills
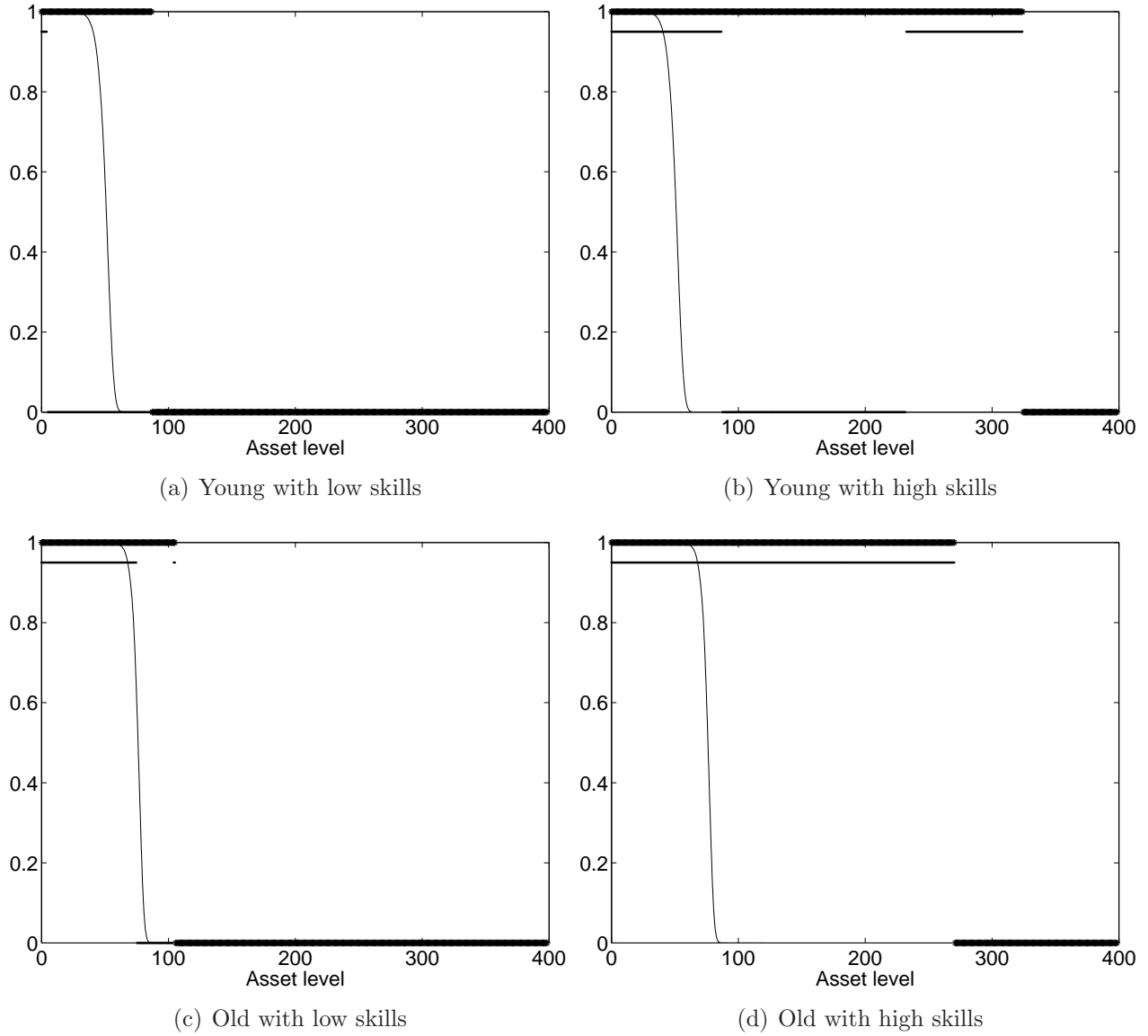

(d) Old with high skills

Figure 3: An agent's decision rule as a function of his age, skill level and asset holdings (in the incomplete-market economy with zero labor taxation). The thick horizontal line is the employment decision of an employed worker, which assumes the value 1 if employment is preferred to nonemployment, and 0 otherwise. The thin horizontal line describes an employed worker's asset decision, which takes value 0.95 if the agent increases his assets next period and a value of 0 otherwise. The thin curve, in the form of an inverted-S shape, is a nonemployed worker's search intensity, $s \in [0, 1)$.

17

3.2.1 *Employed young workers*

In figure 3, panel (a), a young employed agent with low skill prefers to remain employed for asset holdings below approximately 90, as marked by the thick horizontal line at the top of the graph. However, this employed agent does not want to accumulate assets unless he is at the very low end of the asset range, as marked by the short thin horizontal line (which is really just a tick below the very beginning of the thick line). Since newborn agents start with zero assets, it follows that young agents with low skills will have only those very low asset holdings, as marked by the thin horizontal line. Moreover, newborn agents choose to expend full search effort at zero assets, so the equilibrium outcome is that all newborn workers search intensively for employment and then prefer to stay employed as long as they are young with low skills. If young agents become high-skilled, their decision rules in figure 3, panel (b) show that they start accumulating savings with target asset holdings of around 90. Since they strictly prefer to remain employed at that target asset level, it follows that all young workers of both skill levels are working in an equilibrium (except during their initial search for employment as newborn agents).

3.2.2 *Employed old workers*

Figure 3 panel (c) shows that an employed old worker with low skills behaves much like an employed young worker with high skills. An employed old agent has a target asset level that is in the interior relative to his choice of employment over nonemployment. Hence, all old agents with low skills who have never attained the high skill level will work in an equilibrium. In the case of an old agent with high skills, figure 3, panel (d), shows how the dummy variables for employment and asset accumulation coincide, i.e., an employed worker will accumulate assets until he attains a target level of around 275, at which point he prefers to quit and enjoy leisure. The agent finances "early retirement" out of his assets and continues to enjoy leisure in working age until he either retires or his assets fall all the way down to a critical point of around 80 in figure 3, panel (c), at which point an old worker with low skills prefers to expend positive search effort to find employment. (Recall that the initially high-skilled worker becomes low-skilled upon entering nonemployment.)

3.2.3 *Distributions of assets*

The aggregate outcome from the interactions among agents' decision rules are summarized in the stationary asset distribution depicted in figure 4, panel (a). The solid line is distribution of assets held by the total population of workers and retirees. The dashed line separates young agents. Our description of optimal decision rules tells us that the peak in the distribution at an asset level at 90 reflects the target asset holdings of young agents with high skills. There is no discernible peak in the target asset level of old agents with low skills because of their slow rate of savings accumulation as they approach the end of the thin horizontal line in figure 3, panel (c). Similarly, old workers with high skills exhibit tepid saving rates when they approach the top asset levels in figure 3, panel (d), when they still prefer employment

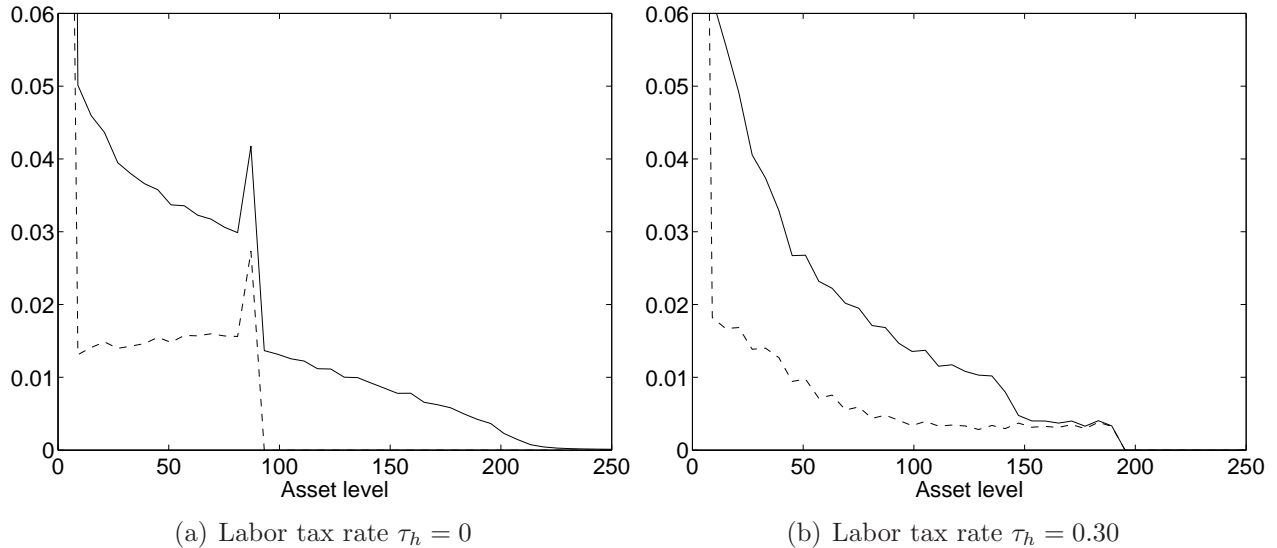(a) Labor tax rate $\tau_h = 0$ (b) Labor tax rate $\tau_h = 0.30$

Figure 4: Asset distribution in the incomplete-market economy for different labor tax rates. The solid line is the asset distribution for the entire population of workers and retirees. The dashed line shows assets for young agents only. The distributions have peaks at a zero asset level, which have been cropped in the figure.

and asset accumulation over nonemployment and savings decumulation. As a result, very few old workers with high skills reach the upper bound on their desired assets and choose "early retirement" in working age. (According to table 1, only 0.1 percent of the labor force are nonemployed old agents who have been high-skilled.)

3.2.4 *Effects of taxation on the asset distribution*

Dramatic changes in the distribution of assets across individuals accompany the nonemployment effects of taxation in the incomplete-market economy, as depicted by the smooth upper solid line in figure 1. For example, compare the asset distribution when the labor tax rate is $\tau_h = .30$ in figure 4, panel (b), to that when there is no labor taxation in panel (a). First, the intermediate peak in the asset distribution has vanished because the desired asset level of young agents with high skills has substantially increased. The decision rules of young agents with high skills still look like those in figure 3, panel (b), except that the disjoint segments of the thin horizontal line are now connected. Hence, young agents with high skills accumulate sizeable assets, and if the target level is reached, they choose to enjoy leisure as "early retirees." Second, the upper end of the asset distribution for tax rate $\tau_h = .30$ consists mostly of young agents. This can also be understood in terms of the decision rules in figure 3, panels (b) and (d). Note that even when there is no labor taxation, employed young agents with high skills prefer employment over nonemployment at asset levels that are higher than those of old agents with high skills. But while young agents with high skills in the economy with zero labor taxation are unwilling to accumulate savings and reach those
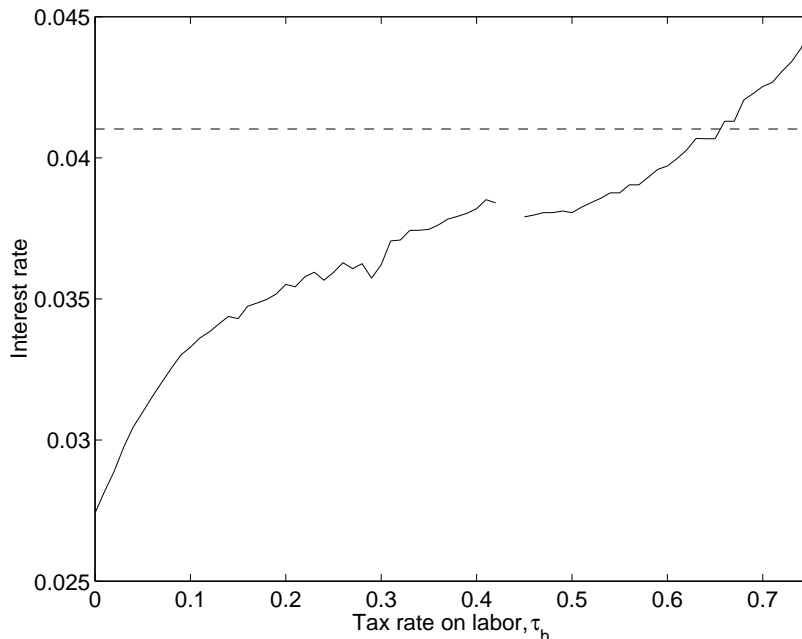
19

Figure 5: Interest rate as a function of the tax rate. The solid (dashed) lines refer to the incomplete-market (complete-market) economy.

high asset levels, their aspirations change when $\tau_h = 0.30$, as just delineated. Why would a higher distortionary labor tax motivate young agents with high skills to postpone consumption in order to accumulate assets? The answer is once again the prospect of early retirement either as a young worker or after becoming an old worker.

How these shifts in the asset distribution impinge on the capital-labor ratio is shown in figure 5, which depicts the equilibrium interest rate as a function of the tax rate. First, at a zero tax rate, our incomplete-market economy with idiosyncratic risk delivers the standard precautionary savings force that makes the aggregate capital stock larger than that of a complete-market economy. In particular, at $\tau_h = 0$, the much lower interest rate in the incomplete-market economy in figure 5 corresponds to a significantly higher capital stock in table 2.[11] Next, our account of how higher taxes impel workers to accumulate assets early in life in order to finance an early withdrawal from the labor force might lead us to expect that capital per remaining employed worker should become even larger and thereby further decrease the interest rate. But the opposite happens in figure 5, where the interest rate increases with the tax rate. The reason is that higher taxes are accompanied by higher lump-sum transfers so that agents do not have to save as much to finance their early retirement plans. We will discuss this outcome more below.

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[11]Recall that, for $\tau_h = 0$, full employment prevails approximately in the incomplete-market economy and exactly in the complete-market economy. Thus, differences in aggregate capital stocks map into differences in capital-labor ratios.
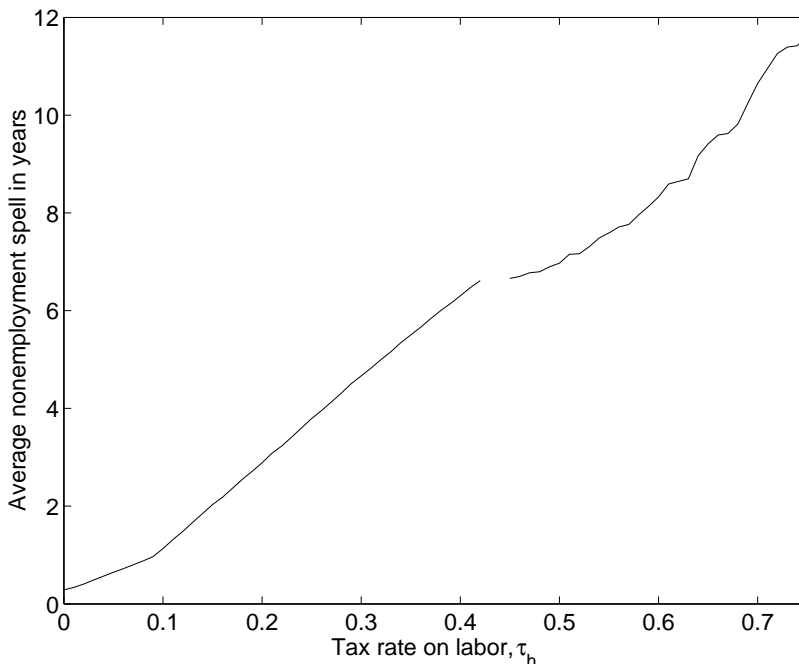
Figure 6: Average duration of nonemployment spells as a function of the tax rate in the incomplete-market economy.

3.2.5 *Early retirement: effects of taxation on career lengths*

We have described how higher taxes cause workers to accumulate assets and plan for early retirement. As an illustration of these outcomes, figure 6 depicts a statistical construct of the average length of nonemployment spells constructed by dividing the aggregate nonemployment rate by the aggregate inflow rate into nonemployment. Evidently, higher taxes are associated with ever longer lasting nonemployment spells.

The early retirement dynamics mean that behind the smooth nonemployment curve for the incomplete-market economy (upper solid line in figure 1) lie dramatic changes in individual agents' decision rules and in the resulting asset distributions. In our simulations, high-skilled old workers are the first ones to consider early retirement, followed next by high-skilled young and low-skilled old agents. The last workers contemplating such a career decision are the low-skilled young agents. The critical tax rate at which these agents are willing to forego the prospect of accumulating human capital and instead plan for early retirement, becomes a tipping point in our incomplete-market economy and occurs inside the tax range $\tau_h \in (0.42, 0.45)$. Equilibrium decision rules of low-skilled young agents on either side of that tax range are depicted in figure 7. Unwilling to accumulate assets when $\tau_h = 0.42$ these agents are bent on a target asset level of around 18 when $\tau_h = 0.45$ with the goal of retiring early. To convey a time dimension to their work–leisure plans when $\tau_h = 0.45$, figure 8 depicts a simulated time series for a newborn worker who remains young with low
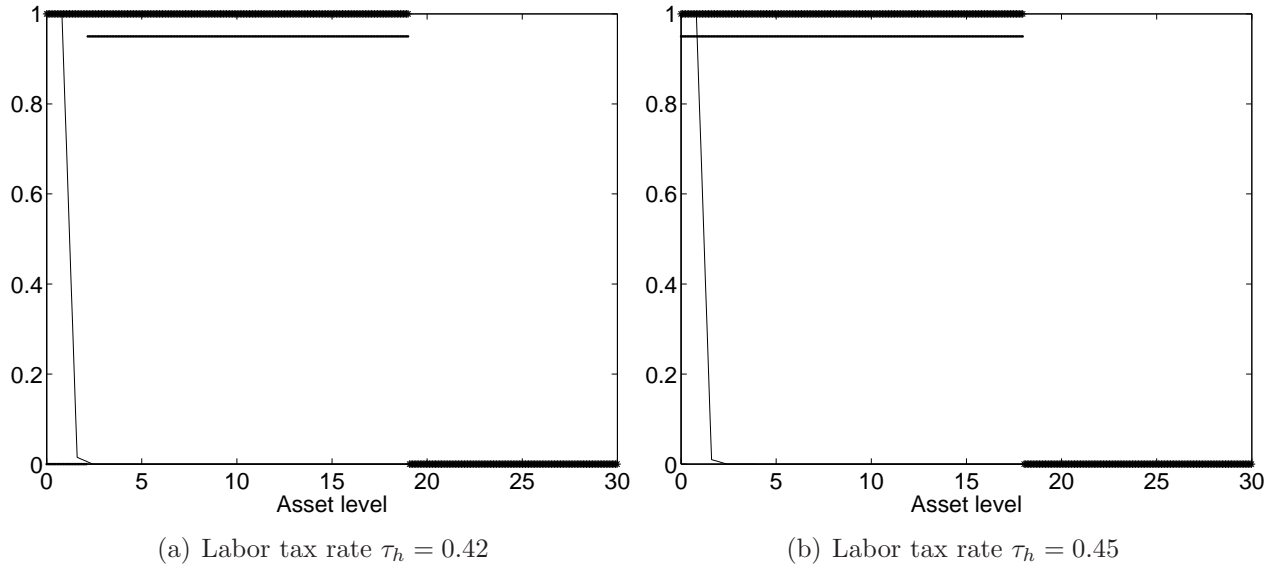
21

(a) Labor tax rate $\tau_h = 0.42$ (b) Labor tax rate $\tau_h = 0.45$

Figure 7: A low-skilled young agent's decision rules as functions of his asset holdings (in the incomplete-market economy). The thick horizontal line is the employment decision of an employed worker, which assume the value 1 if employment is preferred to nonemployment, and 0 otherwise. The thin horizontal line describes an employed worker's asset decision, which takes on value 0.95 if the agent increases his assets next period and a value of 0 otherwise. The thin vertical curve is a nonemployed worker's search intensity, $s \in [0, 1)$.

skills throughout the simulation period. The agent spends the first 21 years of his career working and accumulating assets, followed by a 6-year spell of leisure and then another spell of work and asset accumulation.

Our notion of a tipping point refers especially to equilibrium outcomes in the tax range $\tau_h \in (0.42, 0.45)$ when the 'invisible hand' must devise equilibria in which identical newborn workers choose to follow different decision rules while young with low skills. The challenge for the 'invisible hand' is as follows. If low-skilled young agents were all to switch from decision rules of the type in panel (a) to those of the type in panel (b) in figure 7, an equilibrium would fail to exist. In particular, consider a tax rate that is slightly lower than the critical tax rate at which such a switch was supposed to occur. At the slightly lower tax rate, all low-skilled young agents are working as prescribed by the decision rules in panel (a) in figure 7 and, hence, their tax payments enable the government to finance a sizeable lump-sum transfer to all agents. The generous transfer in turn makes a low-skilled young agent almost indifferent between the alternatives of working continuously while young with low skills and adopting the strategy of embarking on work–leisure cycles even as a newborn worker. So when the tax rate is increased further, it might seem that all low-skilled young agents prefer to embark on work–leisure cycles. But if they did, both the government tax revenues and the capital-labor ratio would change discretely in a stationary allocation. Such discrete changes in the implied transfer level, wage rate and interest rate in response to an
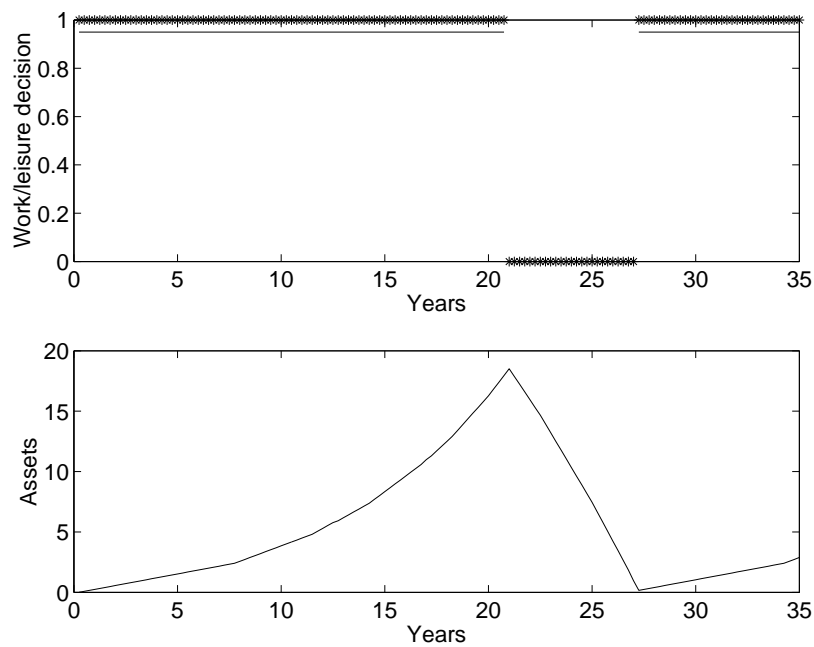
Figure 8: Time series of a newborn worker who remains young with low skills throughout the simulation period (in the incomplete-market economy with labor tax rate $\tau_h = 0.45$ when the agent's decision rules are those of panel (b) in figure 7). The upper panel depicts the agent's decisions on work and asset accumulation. The thick horizontal line describes the agent's employment status, 1 if employed and 0 otherwise, and the thin horizontal line describes the agent's asset decision, taking the value 0.95 if asset holdings are increasing and 0 otherwise. The lower panel shows the agent's asset holdings over the simulated period.
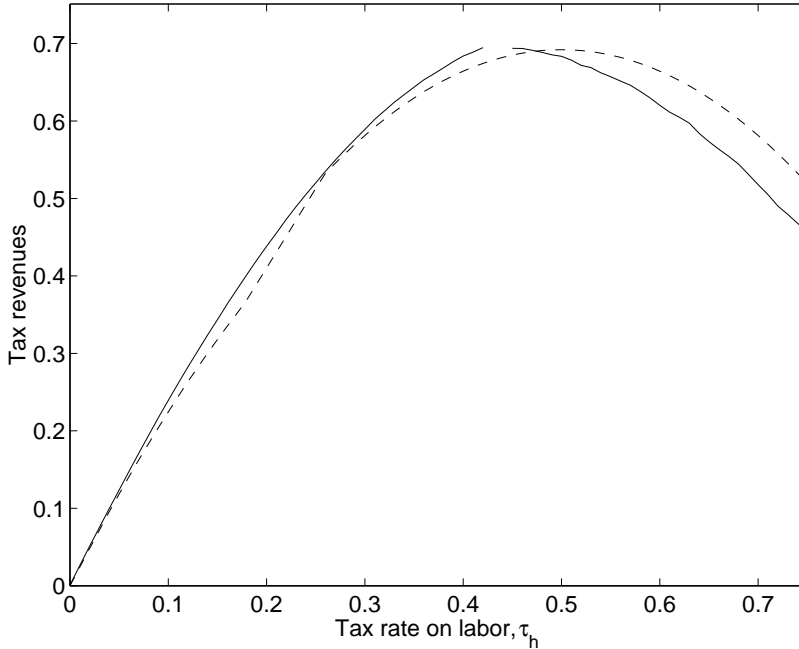
Figure 9: Tax revenues per capita which are equal to the lump-sum transfer (excluding the accidental bequest component in the incomplete-market economy). The solid (dashed) lines refer to the incomplete-market (complete-market) economy.

incrementally higher tax rate have proven incompatible with the existence of an equilibrium. Thus, there exists no equilibrium with all low-skilled young agents following the same set of decision rules. Instead, the 'invisible hand' must divide newborn workers into those who are 'work prone' (working continuously while young with low skills) and those who are 'leisure prone' (cycling between work and leisure). Both groups attain the same expected lifetime utility but the former group consumes more on average while the latter group enjoys more leisure on average. As the tax rate is increased further, a higher fraction of newborn workers is assigned to the 'leisure prone' and ultimately, at tax rates above $\tau_h = 0.45$, all low-skilled young agents are following decision rules of the type in panel (b) in figure 7.

3.3 Laffer curves and the size of lump-sum transfers

As in any model with an endogenous labor supply, we expect to see a Laffer curve in total tax revenues as a function of the tax rate. Figure 9 shows how the Laffer curve in the incomplete-market economy initially lies above and later below that of the complete-market economy. Two opposing effects are at work. On the one hand, for most tax rates, the incomplete-market economy has fewer agents nonemployed so, everything else equal, tax revenues should be higher. On the other hand, the labor allocation in the incomplete-market economy has employed workers possessing less human capital and hence, relatively
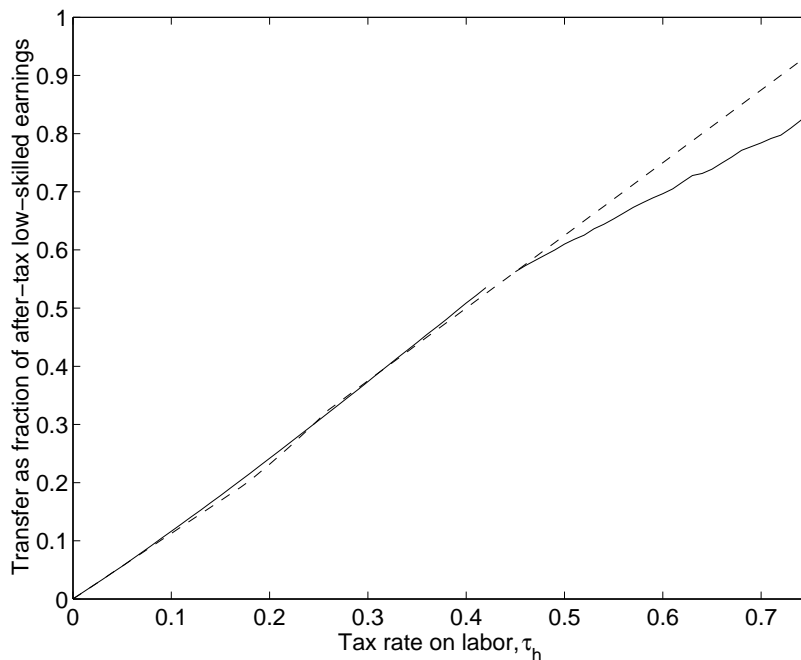
Figure 10: Lump-sum transfer as a fraction of after-tax low-skilled earnings. The solid (dashed) lines refer to the incomplete-market (complete-market) economy.

more low-skilled tax payers who pay lower taxes. Recall that the employed agents in the complete-market economy are those who have the best labor market prospects and that high-skilled workers are never furloughed into leisure before reaching the age class of retirees.

The per capita tax revenue in figure 9 equals the government's lump-sum transfer to each agent (excluding the accidental bequest component in the incomplete-market economy). Figure 10 measures the lump-sum transfer as a fraction of after-tax low-skilled earnings. Not surprisingly, the transfer constitutes a significant part of an agent's disposable income at high tax rates because the after-tax market earnings are diminished and substantial amounts of tax revenues are returned to the agents as transfers.

Prescott (2006a) expresses concern about the implied large lump-sum transfer in his earlier analysis (Prescott 2002, 2004) and labels the transfer level as "ridiculously high" when computed at his estimates of an European tax wedge of 60% and a U.S. tax wedge of 40%. Though, it is appropriate to emphasize that Prescott's earlier conclusion that a higher tax wedge can explain the lower labor supply in Europe relative to the U.S. hinges primarily on the difference in tax wedges of 20 percentage points that he posits and not on the underlying absolute levels of tax wedges. Note the almost linear relationship between the nonemployment rate and the tax rate along the two upper curves in figure 1.[12] Hence, an

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[12]Here we ignore the kink in the curve for the incomplete-market economy in figure 1 which is an artefact of our two-skill two-age parameterization.

alternative set of lower tax estimates for Europe and the U.S. but with a similar difference in percentage points would produce a similar difference in nonemployment outcomes. Moreover, Prescott's estimated tax wedges refer to marginal tax rates while a proper computation of lump-sum transfers would involve the lower average tax rates.[13]

4   Nonemployment effects of taxation

We see similar nonemployment outcomes for different labor tax rates in both the complete-market and incomplete-market economy, as shown by the upper dashed and upper solid line, respectively, in figure 1. Despite these similar aggregate outcomes, in sections 5 and 6 we warn against concluding that the choice between the complete and incomplete market settings is inconsequential for understanding observed employment outcomes and for policy analysis. But before we do that, we study the robustness of our findings to perturbations in how government revenues are handed back and a couple of other features.

4.1   How taxes are spent is crucial

Figure 1 demonstrates that equilibrium outcomes depend on how the government uses its tax revenues: either returning the revenues to households as lump-sum transfers or financing government expenditures that are not substitutes for private consumption. The solid (dashed) lines refer to the incomplete-market (complete-market) economy, where the upper line represents the outcomes with lump-sum transfers and the lower line describes the outcomes without transfers. In both economies, the nonemployment effects of taxation are rather small without transfers because of the negative income effect of taxation, while nonemployment increases sharply when tax revenues are handed back lump sum to the households. According to table 2 and figure 10, these transfers soon become large compared with the after-tax earnings of a worker with low skills.

Figure 1 confirms Prescott's (2002, p. 7) observation about the importance of the assumption that tax revenues are handed back to households as transfers or as goods and services because "[i]f these revenues are used for some public good or are squandered, private consumption will fall, and the tax wedge will have little consequence for labor supply."

4.2   Potential skill loss suppresses nonemployment initially

Figure 11 examines the sensitivity of the effects of taxation to our stark assumption that an employed agent with high skills loses his skills and becomes low-skilled when entering

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[13]Mulligan (2001) argues that *average* rather than *marginal* tax rates determine labor supply in a model with indivisible labor when the indivisibility is at least as long as the tax accounting period. This is certainly true in our model, in which agents contemplate early retirement in response to high taxation. An additional year in employment is then evaluated based on the take-home pay for that year, i.e., the average rather than the marginal tax rate matters. The marginal tax rate will matter only in the last year of employment when the agent decides exactly when to retire during the final year.

nonemployment. As an alternative, we adopt the opposite assumption that there is no skill loss, i.e., once a high-skilled worker, always a high-skilled worker. Not surprisingly, the upper and lower dashed lines that represent the assumption of no skill loss in the incomplete-market economy with or without lump-sum transfers, respectively, lie above the corresponding solid lines under the benchmark assumption of skill loss. (The solid lines are the same as in figure 1.) At zero labor taxation, the figure shows that the nonemployment rate in the economy without skill loss is a couple of percentage points higher than in the economy with skill loss. Since agents are not threatened by skill loss when entering nonemployment in the former economy, their decision rules yield a higher incidence of early retirement.

We need not recompute equilibrium outcomes for the complete-market economy under the alternative assumption of no skill loss. Here is the reason. Recall that the stand-in household's optimal labor allocation declares that all agents with high skills work. In the complete-market economy, there is no furloughing of highly productive workers into nonemployment, since leisure is most efficiently generated by low-skilled agents, preferably *old* low-skilled agents.

4.3   Timing of transfers over the life cycle tilts the response

We are interested in how the nonemployment effects of taxation depend on the timing of government transfers over an agent's life cycle. Once again, this is not an issue in the complete-market economy where the stand-in household's allocation of labor and consumption is unaffected by any such reshuffling of transfers. But in the incomplete-market economy, it matters.[14] We consider two alternatives to the benchmark assumption that agents receive the same lump-sum transfer regardless of their age: retired agents receive per-capita transfers half and twice those of working age agents, respectively.

The dashed line in figure 12 describes equilibrium outcomes when retired agents are entitled to half of the transfer that working age agents receive. At low tax rates, we see that the nonemployment rate falls below that of the economy with equal transfers to all agents, as represented by the solid line (which is the same as the upper solid line in figures 1 and 11). Agents of working age who now receive the larger transfer choose to save more for their retirement state, when they know that the size of the government transfer will be cut in half. The higher savings manifest themselves in a larger capital stock. That increases the real wage, and as a result, agents work more and the nonemployment rate falls at those low tax rates. But evidently, this effect is overturned at higher tax rates, when transfers grow in size and become larger than half of the after-tax wage rate of a low-skilled worker. The nonemployment rate will then exceed that of the benchmark economy with equal transfers to all agents.

The dotted line in figure 12 describes equilibrium outcomes when retired agents are entitled to twice the transfer that working age agents receive. The equilibrium outcomes are now almost the mirror image of the previous experiment. At low tax rates, working age agents who know that they will be provided for in old age, choose to save and work a little

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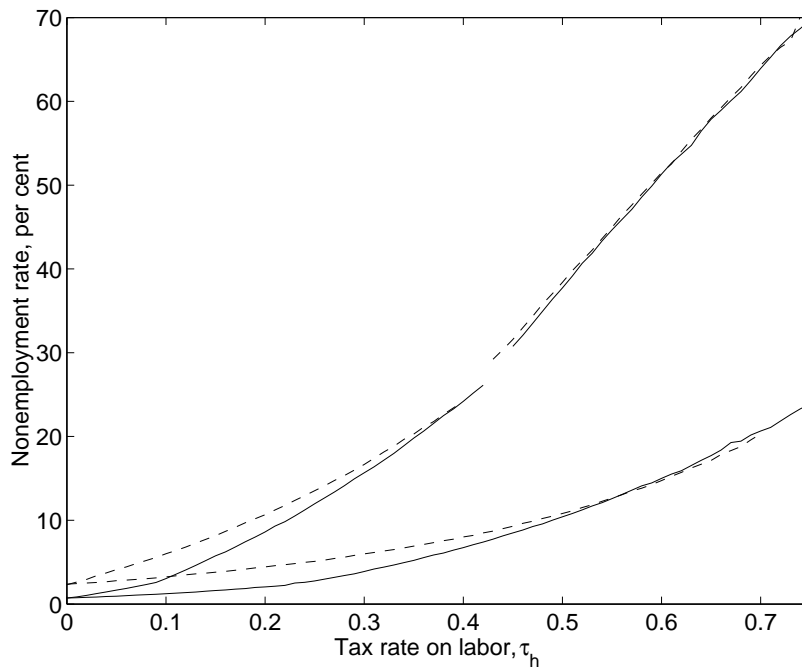[14]This is a theme of Barsky et al. (1986).

Figure 11: Nonemployment effects of taxation with or without skill loss during nonemployment in the incomplete-market economy. The solid (dashed) lines refer to equilibrium outcomes in an economy with (without) skill loss during nonemployment, specifically, $p^u(h, 1) = 1$ $(p^u(h, h) = 1)$ for all h. For each economy, the upper line depicts equilibrium outcomes when tax revenues are returned as lump-sum transfers to the households, while the lower line depicts equilibrium outcomes when tax revenues finance government expenditures that are not substitutes for private consumption. (The solid lines are the same as in figure 1.)
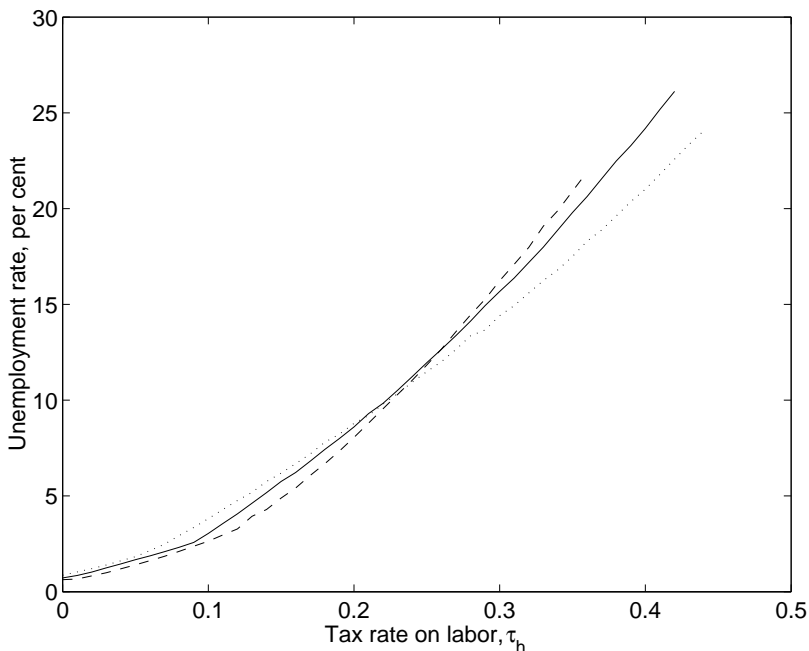
Figure 12: Nonemployment effects of taxation with different timing of government transfers over the life cycle in the incomplete-market economy. All tax revenues are returned as lump-sum transfers to the households but with different distributions across age groups. The solid, dashed and dotted line refer to equilibrium outcomes in an economy where retired households receive per-capita transfers equal to, half of and twice that of working age households, respectively. (The solid line is the same as the upper solid line in figures 1 and 11.)

less as compared to the benchmark economy with equal transfers to all agents. However, at higher tax rates, people find themselves working more than in the benchmark economy because they are faced with an ever larger tax bill that funds transfers to retired agents.

While the latter experiment with higher per-capita transfers to retirees moderates the nonemployment effects of taxation, it does not overturn the robust finding that labor taxes have a large positive effect on nonemployment when tax revenues are handed back as lump-sum transfers to the households.

4.4   Subjective discount factor plays no major role

As a last sensitivity test, we examine the effects of varying the subjective discount factor. Specifically, we assume that the agents are more patient with $\beta = 0.995$, cutting the annual interest rate in the complete-market economy in half to 2.0 percent. To facilitate a comparison with the benchmark economy, we also adjust disutility parameters of working and searching to $B = D = 1.1$, which implies similar equilibrium outcomes across the two parameterizations for the complete-market economy with transfers, as can be verified by
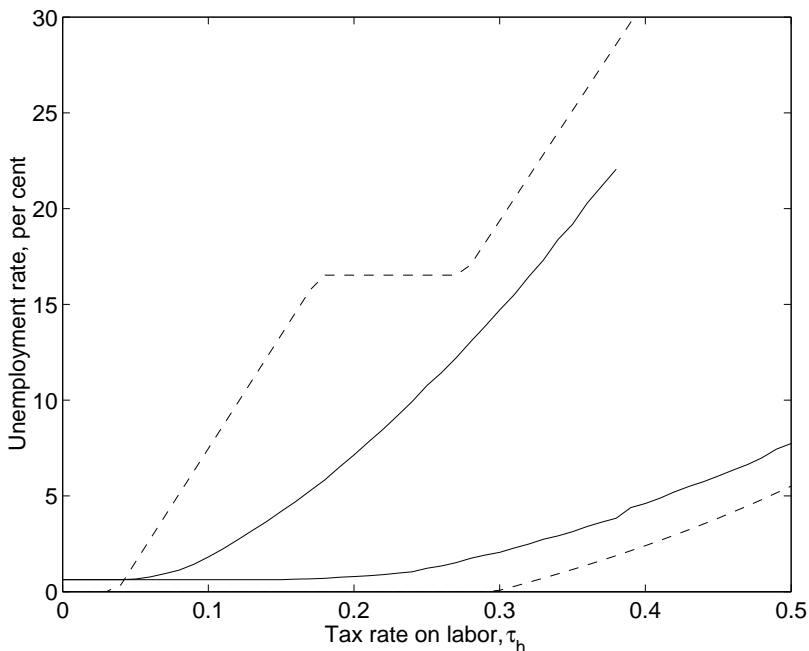
Figure 13: Nonemployment effects of taxation with a higher discount factor ($\beta = .995$). The solid (dashed) lines refer to the incomplete-market (complete-market) economy. For each economy, the upper line depicts equilibrium outcomes when tax revenues are returned as lump-sum transfers to the households, while the lower line depicts equilibrium outcomes when tax revenues finance government expenditures that are not substitutes for private consumption.

comparing the upper dashed line in figures 1 and 13.

The impression to be gleaned from figures 1 and 13 is that our earlier findings about the similarities of the incomplete-market and complete-market economy and about the nonemployment effects of taxation are not sensitive to variations within a commonly used range of subjective discount factors.[15]

5   Nonemployment benefits versus labor taxes

Prescott (2006a) argues that no analytical distinction should be made between labor taxes and nonemployment benefits "because from the perspective of the budget constraint, there is no distinction. Being paid not to work is a negative tax on nonmarket time." Hence, distinguishing between the aggregate effects of labor taxes and nonemployment benefits is

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[15]We have not explored parameterizations with $\beta > 1$ that are sometimes assumed in calibrations of overlapping-generations models, see e.g. Ríos-Rull (1996). Such parameterizations would of course not be permissible in our complete-market economy with an infinitely-lived stand-in household.

a 'red herring' in the words of Prescott. To understand how this argument holds up in our models, we study the effects of two alternative benefit policies:

1. benefits are paid to all nonemployed agents of working age;

2. benefits are paid only to nonemployed agents of working age who have never been high-skilled.

In both policies, all recipients receive the same level of benefits expressed as a fraction η of low-skilled earnings. Benefits are taxed, and, hence, every eligible nonemployed agent receives an after-tax benefit equal to $\eta(1 - \tau_h)w$ in each period he is not working.

5.1 Complete-market economy

In the complete market economy, the differences in the alternative benefit policies have no effects on the stand-in household's choice of an optimal labor allocation in a steady state: without nonemployment benefits, the stand-in household chooses never to furlough high-skilled workers into leisure, so when benefits are restricted to the nonemployed who have always been low-skilled, the stand-in household has even less reason to furlough high-skilled workers into leisure.

In a steady state with benefits η, the earlier characterization of the stand-in household's labor allocation without benefits in (35) is modified as follows. In terms of the steady-state wage rate w and consumption c, the employment of low-skilled agents N_1^x of age $x \in \{y, o\}$, is characterized by

$$-B + \frac{(1 - \tau_h)(1 - \eta)w}{c} \left[1 + \frac{H - 1}{1 - \eta} \beta \pi \Omega^x \right] \begin{cases} > 0, & N_1^x = M_1^x; \\ = 0, & N_1^x \in (0, M_1^x); \\ < 0, & N_1^x = 0. \end{cases} \tag{38}$$

As before, the second term in square brackets captures the effect of human capital and the age-specific factor Ω^x is given by (36) and (37). Once again, in the presence of human capital accumulation, the stand-in household will assign leisure first to low-skilled old agents and, only after all of them are nonemployed, to low-skilled young agents.

The dashed line in figure 14 shows the nonemployment rate as a function of benefits in the complete market economy, where the labor tax rate $\tau_h = 0.30$ is kept constant and any tax revenues in excess of benefit payments are used to finance government expenditures that are not substitutes for private consumption, $\zeta = 1$. That is, at a zero benefit level in figure 14, the nonemployment rate on the dashed line is the same as the one on the lower dashed line in figure 1 at tax rate $\tau_h = 0.30$. Qualitatively, the entire dashed equilibrium relationship in figure 14 resembles that of the upper dashed line in figure 1, and both are driven by related decisions by the stand-in household. Recall that increasing the labor tax rate in figure 1 causes the stand-in household first to furlough low-skilled old workers into leisure. After all such workers are nonemployed, the stand-in household responds to further tax increases by assigning low-skilled young agents into leisure. Similarly, at first low-skilled old workers and
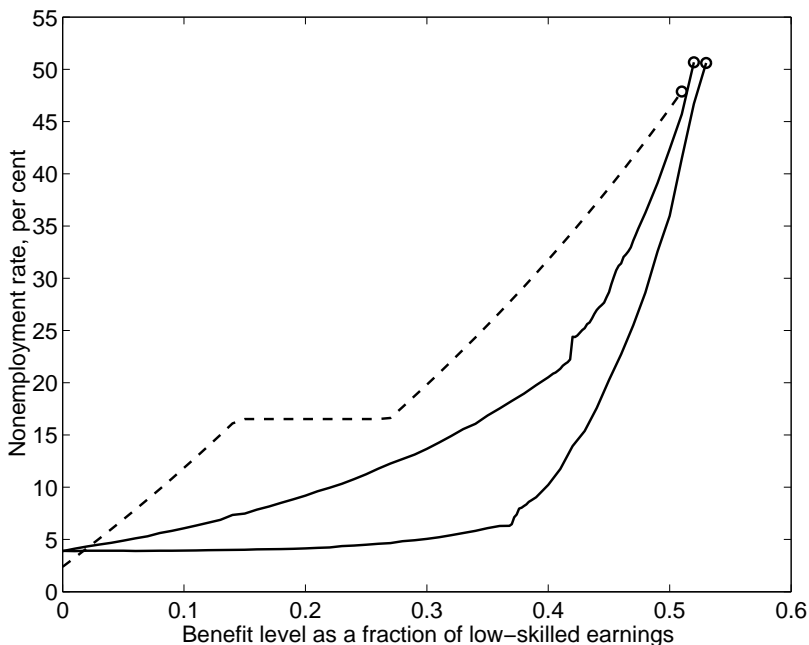
Figure 14: Nonemployment effects of benefits (with labor tax rate $\tau_h = 0.30$ and no lump-sum transfers, $\zeta = 1$). The solid (dashed) lines refer to the incomplete-market (complete-market) economy. For each economy, the upper line depicts equilibrium outcomes when all nonemployed are entitled to benefits, while the lower line depicts equilibrium outcomes when benefits are only paid to nonemployed who have never been high-skilled. (The two curves coincide for the complete-market economy.) Equilibrium outcomes marked with circles indicate that benefit payments exhaust total tax revenues.

then low-skilled young workers are furloughed into leisure in response to higher benefits in figure 14. When the benefit level is 51% of low-skilled earnings and the nonemployment rate reaches 48%, benefit payments exhaust total tax revenues. (This equilibrium is marked by a circle on the dashed line in figure 14.) Once again, in the complete market economy, both benefit policies yield the same dashed equilibrium relationship in figure 14.

5.2 Incomplete-market economy

Unlike the employment lotteries model, the outcomes associated with the two benefit policies differ substantially in the incomplete markets economy. In an economy without employment lotteries and complete consumption insurance, individuals care about whether they are entitled to benefits and adjust their life cycle savings behavior accordingly. For an economy with the more generous policy in which all working-age agents are entitled to benefits, the upper solid line in figure 14 depicts an equilibrium relationship that resembles the upper solid line in figure 1, i.e., here the incomplete market economy seems to respond to nonemployment
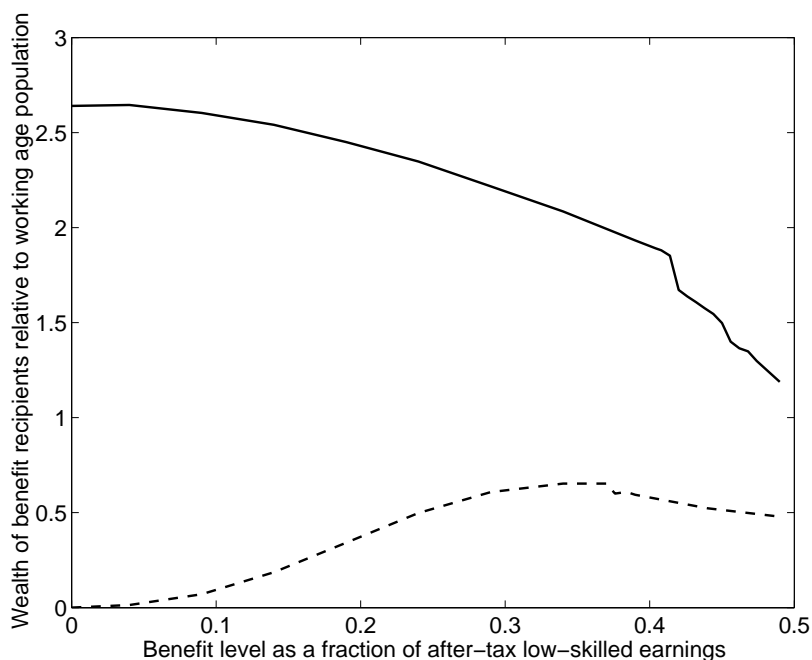
Figure 15: Average wealth of benefit recipients relative to the working age population as a function of the benefit level (in the incomplete-market economy with labor tax rate $\tau_h = 0.30$ and no lump-sum transfers, $\zeta = 1$). The solid line refers to the policy when all nonemployed are entitled to benefits. The dashed line refers to the policy when benefits are only paid to the nonemployed who have never been high-skilled.

benefits just as it responds to labor taxes, validating Prescott's 'red herring' assertion. In both cases, it is first high-skilled old workers and then high-skilled young workers who are prone to retire early. In the economy with nonemployment benefits, well-off agents use the benefits to "top off" their retirement savings. This behavior is shown in figure 15, where the solid line describes the evolution of these workers' wealth. At very low benefit levels, the average wealth of a benefit recipient is more than 2.5 times the average wealth level in the working-age population. At successively higher benefit levels, the average wealth of benefit recipients falls relative to that of the working-age population because early retirees can then to a larger extent rely on generous nonemployment benefits and less on having had to accumulate very large retirement savings.

In the incomplete markets economy, the arrangement in which agents are entitled to benefits only if they have always been low-skilled generates a very different equilibrium relationship. The nonemployment response to benefits are initially tepid along the lower solid line in figure 14. The reasons are that low-skilled agents cannot afford to retire early at low benefits and affluent high-skilled workers are not permitted to use benefits to "top off" their savings. As a result, the aggregate nonemployment rate remains almost flat for a wide range of benefits. The changing average wealth of benefit recipients, shown by the dashed

line in figure 15, tells what is going on. At very low benefits, the only benefit recipients are newborn workers looking for a job. Since these workers are born without assets, the average wealth of benefit recipients is zero. At successively higher benefit levels, more and more low-skilled old workers accumulate savings to finance early retirement and hence, average wealth of benefit recipients increase to reach a maximum of 65% of average asset holdings in the working-age population. Beyond this benefit level, the relative wealth of benefit recipients falls with higher benefits for the same reason as for the first benefit policy. Benefits have now become attractive enough to make low-skilled young agents plan for early retirement, and the aggregate nonemployment rate in figure 14 increases at an ever faster rate until benefit payments exhaust total tax revenues, which happens at a nonemployment rate of 51% when the benefit level is set at 53% of low-skilled earnings. (This equilibrium is marked by a circle on the lower solid line in figure 14.)

5.3 Revisiting Prescott's 'red herring' argument

The second benefit policy offers a qualification to Prescott's 'red herring' argument that there is no reason for distinguishing between labor taxes and nonemployment benefits when analyzing the effects on aggregate nonemployment. Prescott's argument is correct in the complete markets economy where society's labor-leisure choice is made collectively through employment lotteries and consumption insurance. The complete markets effectively produce a common net wedge between consumption and leisure which is shared by all workers, in spite of any institutional features that restrict individual workers' eligibility to nonemployment benefits.

Prescott's 'red herring' argument breaks down in the incomplete markets economy since there is no longer any common net wedge between consumption and leisure. Differences in eligibility to nonemployment benefits across successful and less successful workers cannot be arbitraged between workers when there is neither employment lotteries nor consumption insurance. Individual workers are left to bear the consequences of their own luck in the labor market and of their own decisions on whether or not to bail out into social safety nets.

6 Concluding Discussion

Our thinking about taxation and equilibrium career choices is partly inspired by Prescott's (2002, 2004) tight theoretical framework and provocative attribution of high nonemployment in Europe to distortionary labor taxation. Prescott's assumption of complete markets that accompany employment lotteries is controversial. And, as with any explicit quantitative analysis, questions arise about whether important things have been tossed out along with the realistic features that Prescott intentionally omitted from his model, foremost among these being his decision to ignore the pervasive phenomenon of generous social insurance in Europe.[16] We conclude by giving our opinion about two dimensions of modeling choice

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[16]Prescott (2002, p. 9) recognized this omission: "I find it remarkable that virtually all of the large difference in labor supply between France and the United States is due to differences in tax systems. I

faced by researchers today, complete markets versus incomplete market, and a representative agent versus heterogeneous agents.

6.1 Complete markets versus incomplete markets

Voicing a common criticism of complete-market employment-lottery models, Browning et al. (1999) argue that "the employment allocation mechanism strains credibility and is at odds with the micro evidence on individual employment histories." Our analysis both confirms and responds to this criticism. We concede that our complete-market employment-lottery model with human capital yields incredible equilibrium outcomes that realize Shiller's (2003) utopian vision for a new financial order in the 21st century with privately provided livelihood and inequality insurance. Nevertheless, we demonstrate that the incomplete and complete markets economies sometimes yield similar aggregate employment outcomes. Thus, complete markets and employment lotteries are not needed for arriving at Prescott's high aggregate labor supply elasticity.[17]

Even when aggregates agree, the identities of the nonemployed differ. In the complete market economy, leisure is efficiently allocated to those with ex post poor labor market prospects while those with successful careers continue to work and to make contractually stipulated allowances to their 'labor-market challenged' neighbors. The incomplete market economy allocates leisure to a very different set of people, namely, workers with successful careers, because they are the ones who can afford to retire early.[18]

6.2 Representative agent versus heterogeneous agents

Ljungqvist and Sargent (2006a) challenged Prescott (2002) for ignoring the all-pervasive welfare systems in Europe. They showed how adding generous government supplied benefits to Prescott's model causes employment to implode and therefore prevents the model from matching outcomes observed in Europe. Prescott (2006a) responded to our criticism by including benefits in his analysis and drastically cutting his calibration for the European tax wedge. Specifically, he slashed the marginal labor tax in Europe from his earlier estimate of 50% (Prescott 2004) to only 30% (Prescott 2006a). That puts his estimate of the European labor tax wedge below his estimate of a U.S. labor tax rate of 33%, which Prescott held

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expected institutional constraints on the operation of labor markets and the nature of the nonemployment benefit system to be more important."

[17]Emboldened by the robustness of a high labor supply elasticity, as a discussant of our earlier work, Prescott (2006a) instigated research on lifetime labor supply without employment lotteries. And while his original Nobel lecture (Prescott 2005) was devoted to the complete-market representative-agent framework, the later version (Prescott 2006b) contains an added section on "The Life Cycle and Labor Indivisibility." As we emphasize, this alternative analytical perspective raises new issues to be addressed and suggests new empirical facts to be explained.

[18]Marcet et al. (2003) offer another study of ex post wealth effects in a model with incomplete markets, idiosyncratic shocks and endogenous labor supply (at the intensive margin). They focus on how the capital stock and aggregate labor supply are affected by the fact that those agents who experience high productivity are ex post richer and work fewer hours.

unchanged from his earlier analysis. His European tax cut allows Prescott to introduce a nonemployment benefit in Europe that amounts to a replacement rate of 29% on after-tax earnings.[19]

We have two objections to Prescott's (2006a) revised quantitative analysis. First, we question the empirical support for his new estimates of European labor tax rates and replacement rates in social insurance. Earlier researchers like Prescott (2002, 2004) and Rogerson (2005) have convincingly documented that labor tax wedges are much higher in Europe than in the U.S. Martin (1996) reports estimates of replacement rates in European social insurance systems that are 50% and above. Second, we question the appropriateness of using a representative agent model to capture the 'dual economies' of Europe. The statistical evidence indicates that the working age population in Europe segments itself into one group that is highly attached to the labor market and another group that is not. As reported by the OECD (2003), benefit dependency rates in the working age population have increased dramatically in Europe between 1980 and 1999 while it has fallen in the U.S.[20] The largest benefit programs in 1999 were for disability, unemployment, and early retirement. The OECD (2005, figure SS3.1) reports that in 2000 the number of persons living in households with a working-age head in which no one works accounted for 11.1% and 16.1% of the total population in France and Germany, respectively, versus only 4.9% in the U.S.

To us, it seems that the representative agent model is ill equipped to address the reality of European welfare programs.[21] We advocate models with heterogeneous agents *and* incomplete markets. In our benefit experiments, complete markets inevitably lead to an unbridled abuse of government supplied benefits that contradicts observations, while incomplete markets hold out the promise to explain times and economies in which generous benefits were offered without disastrous nonemployment outcomes.[22] The critical difference between the two types of models is that incomplete markets compartmentalize households who must individually bear the consequences of bailing out into social safety nets rather than reaping the market returns on their human capital. That compartmentalization made all the difference

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[19]As suggested by our marginal condition (38), Prescott is swapping a high labor tax rate of 50% for a combination of a low labor tax rate of 30% and a meager replacement rate of 29% in the social insurance system, which implies an unchanged net wedge since $(1 - .50) \approx (1 - .30) \times (1 - .29)$.

[20]For example, the OECD (2003, table 4.1) reports that the benefit dependency rate in France (Germany) increased from 13.9% (15.2%) in 1980 to 24.2% (22.4%) in 1999, while it fell from 16.8% to 13.7% in the U.S. over the same period.

[21]For other analyses that model taxes and welfare benefits as a net wedge between leisure and work against which all workers choose their labor supply in each period, see Olovsson (2004), Ragan (2005) and Rogerson (2006a). While Olovsson and Ragan focus on government provided day care services conditional on employment in their quantitative studies of Swedish labor supply, Rogerson discusses a wider array of welfare benefits including disability insurance. Though, acknowledging the limitations of his representative-agent framework, Rogerson concludes by calling for "richer models on the consumer side, since many programs have important interactions with heterogeneity across consumers, along dimensions of income, age, marital status, and health status."

[22]As an example, OECD (1994, chap. 8) documents generous unemployment insurance in Europe well before the outbreak of high unemployment and, as a result, there was a negative correlation between benefit levels and unemployment in the 1960s and early 1970s.

in our second benefit experiment in which benefits are paid only to nonemployed who have not been high-skilled. This restriction is our stylized way of capturing real-world institutional features that limit well-off agents' access to social insurance. We conjecture that the heterogenous-agent incomplete-market framework would have even greater promise for explaining the dual labor markets of Europe if we were to drop a maintained assumption in the current paper – Prescott's assertion of a high disutility of working. With a lower disutility of working, the model might suggest that European workers who have succeeded in labor markets become disinterested in joining the ranks of individuals who draw on disability, long-term unemployment or early retirement benefits.[23]

6.3   An overarching challenge: the labor supply elasticity

We conclude by citing an elegant call for a two-way street between macro and micro:

> "While dynamic general equilibrium models may suggest new directions for empirical macroeconomic research, it is essential to build the dynamic economic models so that the formal incorporation of microeconomic evidence is more than an afterthought. Macroeconomic theory will be enriched by learning from many of the lessons from modern empirical research in microeconomics. At the same time, microeconomics will be enriched by conducting research within the paradigm of modern dynamic general equilibrium theory, which provides a framework for interpretation and synthesis of the micro evidence across studies." Browning et al. (1999, p. 625)

The two-way street holds especial promise for learning how to estimate and interpret that key macro parameter, the labor supply elasticity. Our analysis has focused on the common assumption in macroeconomics of exogenous labor supply indivisibilites and studied how it gives rise, in the presence of human capital accumulation, to endogenous indivisibilities in form of labor market careers. This analytical focus is of interest both because of its empirical relevance and as a promising meeting place along the two-way street between macro and micro.

Rogerson (2006b, figure 37) reports that employment-population ratios are remarkably similar between Europe and the U.S. for ages 30–50 years. The deficiency in European employment rates can be attributed to those over 50 years of age and to those under 30. It is these differences at the extensive margin in labor supply that are of concern to governments and policymakers rather than the facts that European workers have more vacation time and shorter work hours than their American counterparts. For example, President Barroso of

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[23]Ljungqvist and Sargent (1998, 2007) show that a model with high benefits (and employment protection) can explain the European experience of low nonemployment in the 1950s until the early 1970s, and high nonemployment since the 1980s. We attribute the dramatic change in outcomes to a more turbulent microeconomic environment, modeled as an increased risk of human capital depreciation on occasions of job displacements. While our framework has been criticized for ignoring the disutility of work, we emphasize that the parameter choice is a continuous one and our analysis would continue to hold as long as the disutility of working is not set too high.

the EC (Commission of the European Communities (2005, p. 26)) deplores the fact that European workers "start exiting the labor market on a very large scale by the time they reach 55 years of age." These shortened career lengths emerge in our analysis because of indivisibilities in labor supply.

The assumption of indivisibilities in macroeconomic models creates both common and disputed ground with microeconomic studies on labor supply elasticities. On the one hand, if workers are not at an interior solution with respect to the length of their labor market career – models of indivisibilities predict an inelastic labor supply as suggested by many empirical microeconomic studies. On the other hand, if workers are at an interior solution, labor supply responds sensitively to taxation and the Laffer curve rears its ugly head. These different possibilities seem to lie at the heart of some of the disagreements on the labor supply elasticity.

Two different views on the labor supply elasticity are offered by Prescott (2002, 2004), who credits high European nonemployment rates to high labor taxes, and Carneiro and Heckman (2003), who say that "a proportional tax on human capital is like a nondistorting Henry George tax." Their prescription comes out of a model where the length of labor market careers is at a corner solution and the issue is efficiency in human capital accumulation. It is beautiful to follow their reasoning on the importance of education expenditures being tax deductible (either by the private individual or by the firm in which training takes place) and of the fact that the main opportunity cost in education is time lost working which is automatically tax deductible (since no income is earned and therefore, no tax paid). Hence, if the income tax is proportional, it would not distort human capital accumulation and we end up with 'a nondistorting Henry George tax.'

Prescott's view of the world is quite different and comes from the real business cycle tradition in which the labor force is always poised at the margin between choosing employment and nonemployment. In this paper, we have shown that even in the absence of employment lotteries, 'time averaging' delivers the same high labor supply elasticity in response to labor taxation because enough agents in our incomplete markets model are poised on the verge of bailing out into early retirement. But we have also shown that aggregate nonemployment in the incomplete markets model can respond very differently to nonemployment benefits as compared to labor taxes, and our analysis puts the spotlight on the distribution of heterogeneous agents.[24] Incomplete markets models give voice to individual workers who make hard choices about whether or not to terminate labor market careers, replacing that anonymous fraction of nonemployed in representative-agent models.

Following the two-way street advice of Browning et al. (1999), we see interesting challenges for macroeconomists to make contact with micro observations on the characteristics of the nonemployed in Europe, and challenges for microeconomists to confront determinants

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[24]The current state of affairs in macroeconomics between the representative-agent framework and heterogeneous-agent models is best described as an 'harmonious' one. For example, Prescott (2006b) cites that the importance of total factor productivity shocks for business cycle fluctuations, as estimated in his representative agent model, is robust in the alternative heterogenous-agent models of Ríos-Rull (1994) and Krusell and Smith (1998).

of career lengths.[25] Advances on both fronts will serve a common goal of understanding labor supply elasticities and their uses.

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[25]For a quantitative study of human capital accumulation and career lengths, see Imai and Keane (2004).

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