The Wealth Distribution and the Demand for Status*

Yulei Luo† Eric R. Young‡

Princeton University University of Virginia

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Abstract

Standard economic theories of asset markets assume that assets are valued entirely for the consumption streams they can finance. This paper examines the introduction of the demand for status (as a function of wealth) into a model of uninsurable idiosyncratic risk. We find that spirit of capitalism preferences lead to less inequality in wealth and more in consumption. They also imply very different responses to a move from a progressive to a flat income tax; with spirit of capitalism preferences, wealth inequality goes down when the economy moves to a flat tax regime.

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†Corresponding author. Department of Economics, Princeton University, Princeton, NJ 08544, (609) 986-8607 (phone), (609) 986-8607 (fax), `yluo@princeton.edu`

‡Department of Economics, University of Virginia, Charlottesville, VA 22904, (434) 924-3811 (phone), (434) 924-2904 (fax), `ey2d@virginia.edu.`

1. Introduction

Our interest in this paper is to evaluate the implications of a particular preference structure for the wealth distribution: we assume agents value wealth directly. We consider a simple specification in which agents value wealth because it gives them status. As in Bakshi and Chen (1996), we let status be a function of individual wealth; agents thus have an additional motivation to accumulate assets. The standard specification – Aiyagari (1994) – generates saving only for precautionary purposes, since the interest rate is strictly below the rate of time preference. As a result, agents stop accumulating wealth as soon as they become sufficiently well-insured. Our model adds another effect – higher wealth confers utility directly as well as indirectly through consumption purchases. This preference structure can also be motivated by appeals to home production technologies, in which certain components of wealth are used to produce home consumption goods, but the interactions in those models are considerably more complicated due to the fixed nature of home capital and the issue of time use.

These preferences have been shown to improve asset-pricing models by Bakshi and Chen (1996), Smith (2001), and Kenc and Dibooğlu (2003), to affect long-run growth by Zou (1994), and to change the implications of taxation for growth by Gong and Zou (2002).[1] In addition, Carroll (2002) examines the implications of valuing wealth directly – albeit only after one dies, leaving a bequest – for the portfolio decisions of households, finding that this specification is better able to match the portfolios of the rich. However, it remains an open question how preference for wealth changes the implications of general equilibrium models like the ones considered here. We find that increasing the weight placed on status decreases the concentration of wealth in our economy and raises the effective lower bound on wealth, holding constant discount factors and leisure weights. When we recalibrate the economy to the same equilibrium prices, we find that increasing the weight on status leads to a collapsing wealth distribution as the lower discount factor reduces the upper bound on wealth. At the same time, the distribution of consumption is spreading out. If we allow for the possibility that status is a luxury good, then we can counterbalance the tendency for the wealth distribution to collapse, but we cannot produce an increase in the Gini coefficient from the standard preference case. This result differs from Reiter (2004), who finds that nonhomethetic preferences of wealth can improve the fit of the model for the very wealthy, but it is difficult to

[1] However, this improvement in asset pricing may be illusory due to the failure of the papers to impose all the restrictions implied by the model; see Lettau (1997) for a discussion. A related paper (Chue 2004) considers the effects of spirit of capitalism on international risk sharing.

assess the differences because the models considered are very different.

The concern for status also impacts the distribution of hours worked. When the parameter governing the spirit of capitalism is increased, holding constant the capital/output ratio and the aggregate hours worked, the distribution shifts hours in a rather complicated way. For low values of the parameter, increases lead to increases in the correlation between hours and productivity, meaning that aggregate productivity rises. However, when this value gets bigger, the effects undergo two turns, at first falling and then rising again. The Gini coefficients for hours are negative at the calibrated equilibrium and increase to positive as the preference for status gets stronger. When the economy is recalibrated, the Gini coefficients converge to zero from below, implying that the Lorenz curve for hours will approach the 45° line from above. Having nonhomothetic preferences for status has no impact on the hours distribution, as those households most affected by nonhomotheticity are the wealthy, and they are not supplying very much labor.

In the final section of the paper, we explore the implications of our alternative preferences for taxation. Given that the preferences we consider are capable of producing the same Gini coefficients on wealth as standard ones, it is important to assess whether the predictions for the effects of policies are also similar. We calibrate the model to the US progressive tax system and then compute two reforms, replacing the progressive tax with a flat income tax and with a flat consumption tax. As is common in the literature, we find that standard preferences imply that the consumption tax reform results in higher average utility. However, with spirit of capitalism preferences, this ranking is reversed; agents would prefer the income tax. With the income tax, there is a higher probability of being very wealthy, an outcome which is somewhat surprising, and this higher tail mass generates a large welfare gain for a household who values wealth directly.

Our paper is organized as follows. First, we detail our model economy. Then we present our results regarding the relationship between the strength of the demand for wealth and the distributions of wealth, consumption, and hours for three cases – separable and homothetic, separable and nonhomothetic, and nonseparable and homothetic. The third conducts experiments which change the tax system from progressive to flat. The conclusion wraps up the paper and points to directions along which we feel research can fruitfully proceed.

2. The Model Economy

Our model economy will feature partially uninsurable labor income risk and markets will be exogenously incomplete; we will allow households to hold only aggregate capital for savings, and holdings of this asset are restricted by an exogenous borrowing limit. However, the household can supply labor endogenously to smooth consumption.

2.1. The Environment

We consider a model economy with a large (measure 1) population of infinitely-lived consumers as in Aiyagari (1994). There is only one consumption good per period and we assume that all agents have the same preferences over streams of consumption and social status,

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, s_t, l_t), \tag{2.1}$$

where $u_s(c_t, s_t) > 0$ (higher status is strictly preferred), $u_{ss}(c_t, s_t) < 0$ as discussed in Robson (1992), and the cross-derivative is unrestricted. We will confine ourselves to the class of utility functions which satisfy constant relative risk aversion over static gambles for consumption and status:

$$u(c, s) = \frac{\left[c\,(s+\gamma)^{\theta}\, l_t^{\mu}\right]^{1-\sigma}}{1-\sigma}; \tag{2.2}$$

our choice is dictated by the observation that the return to capital has been stationary over the postwar period. The status function $s\left(W, \overline{W}\right)$ will be assumed to possess the following properties: (1) it is strictly increasing in the investor's absolute wealth at time t, so that higher wealth means higher status regardless of the wealth distribution for the group of people with whom the investor has social or professional contacts; (2) it is a function of the social group to which this individual belongs. That is, we have $s_W > 0$ and $s_{\overline{W}} < 0$. In our economy, we will assume that W_t is the individual capital stock k_t. In the above utility function, $\sigma > 0$ is the coefficient of relative risk aversion, $\theta > 0$ controls the demand for the status good, and $\gamma > 0$ determines the degree to which status is a luxury.

Each agent is endowed with one unit of time with a stochastic productivity y. The budget constraint for the household is

$$c + k' \leq (r + 1 - \delta)\, k + ywh \tag{2.3}$$

where r is the rental rate on capital, $\delta \in [0, 1]$ is the depreciation rate, w is the wage rate, h is labor supply, and y is the idiosyncratic productivity factor. Endogenous labor supply is an important feature in our economy. As θ rises, the level of capital in our economy will rise significantly due to a strong demand for status. This increase will push the capital/labor ratio much too high if labor input is fixed, even if β is allowed to adjust.

We assume that y is generated by a Markov process with stationary transitions described by a vector of realizations $\{y\}$ and transition probabilities $[\pi_{ij}]$. The time allocation constraint is

$$1 = h + l.$$

Capital is restricted to be nonnegative:

$$k' \geq 0.$$

The technology produces output Y as a Cobb-Douglas function of capital input K and labor input N

$$Y = K^{\alpha} N^{1-\alpha}.$$

Output can be transformed into future capital K' and current consumption C according to

$$C + K' - (1 - \delta)K = Y. \tag{2.4}$$

2.2. The Market Arrangement

Consumers collect income from working and from the services of their capital. If the total amount of capital in the economy is denoted K and the total amount of labor supply is denoted H, the CRTS production function implies that the relevant first order conditions are

$$w(K, N) = (1 - \alpha)(K/N)^{\alpha} \tag{2.5}$$

and

$$r(K, N) = \alpha(K/N)^{-\alpha}. \tag{2.6}$$

We consider a recursive equilibrium definition, which includes a law of motion for the aggregate state of the economy as a key element. The aggregate state of the economy is the current measure (distribution) of consumers over holdings of capital and productivity, which we denote by Γ. For the individual agent, the optimization problem can therefore be expressed as follows:

$$v(k, y) = \max_{1 \geq h \geq 0, c \geq 0, k' \geq k_b} \{u(c, s, 1 - h) + \beta E[v(k', y')|y]\} \tag{2.7}$$

subject to

$$c + k' = r(K,N)k + w(K,N)hy + (1-\delta)k \tag{2.8}$$

$$s = F(k) \tag{2.9}$$

and the stochastic law of motion for y. The decision rule for the updating of capital coming out of the problem is denoted by the function $\pi_k(k,y)$ and the one for labor is denoted $\pi_h(k,y)$.

Definition 1. *A* ***recursive competitive equilibrium*** *is a value function $v(k,y)$, decision rules $\pi_k(k,y)$ and $\pi_h(k,y)$, pricing functions $r(K,N)$ and $w(K,N)$, and a law of motion $G(\Gamma)$ such that*

(i) (v, π_k, π_h) *solves the consumers' problems given prices and the law of motion;*

(ii) r *and* w *are consistent with the firm's first-order conditions;*

(iii) G *is generated by* f*, i.e., the appropriate summing up of agents' optimal choices of capital given their current state.*

(iv) The goods market clears: $C + K' = K^{\alpha}N^{1-\alpha} + (1-\delta)K$.

(v) Factor markets clear: $N = \int y\pi_h(k,y)\,\Gamma(k,y)$ *and* $K = \int k\Gamma(k,y)$

Our goal is to find stationary equilibria, so we seek only the fixed point of the law of motion

$$\Gamma^* = G(\Gamma^*)$$

and need not compute the law of motion explicitly.[2]

3. Results

We now present our results. Since the model will not produce a distribution with a known form (see Aiyagari 1994 or Young 2003 for discussions of the shape of the distributions produced) we use numerical methods to derive results. Our algorithm for solving the model follows Young (2004) – see the technical appendix of that paper for explicit details. Briefly, we do the following: (1)

[2]In a previous version of the paper we explored the business cycle dynamics of this model using tools developed in Young (2002). The impact of wealth in the utility function was trivial.

Guess an rental rate r; (2) Solve the consumer problem using value iteration with cubic spline interpolation and Howard's improvement algorithm; (3) Compute an invariant distribution using iterative redistribution of mass at each point; and (4) Update r using Brent's method until the capital market clears. When calibrating the model, we add an outer loop which guesses values for (β, μ) and updates them according to a multivariate secant method with one-sided numerical derivatives until they converge. One thing we point out here is that the usual upper bound derived for the interest rate in an incomplete market model will hold here in a stronger form. With complete markets, the steady-state is defined by

$$u_c(c,s,l) = \beta \left[u_c(c,s,l)(r+1-\delta) + u_s(c,s,l) \right]$$

or

$$1 = \beta(r+1-\delta) + \beta \frac{u_s}{u_c}.$$

Rearranging we obtain

$$r - \delta = \frac{1 - \beta \frac{u_s}{u_c}}{\beta} - 1;$$

the additional term $-\frac{u_s}{u_c}$ is the steady-state marginal rate of substitution between status and consumption. With the utility function we will choose below, the expression becomes

$$r - \delta = \frac{1 - \beta\theta \frac{c}{k+\gamma}}{\beta} - 1.$$

Since this term is positive, the steady-state interest rate is strictly lower than without status in the utility function. In our economy without complete markets, there is an upper bound on r implied by this equation, as in Aiyagari (1994). Since $\frac{u_s}{u_c}$ is not equal for all households, we instead obtain the bound

$$r - \delta \leq \frac{1 - \beta\theta \min_{(k,y)} \left\{ \frac{c}{k+\gamma} \right\}}{\beta} - 1;$$

this bound was verified numerically across a wide variety of parameterizations – see Figure 1. Of course, since the right-hand-side contains variables which are themselves functions of r, we cannot actually compute the upper bound for r as a function of parameters. But results from the consumption literature can be used to show that as k goes to infinity, $\frac{c}{k+\gamma}$ converges from above to some value $\chi < 1$, which implies that our bound is

$$r - \delta \leq \frac{1 - \beta\theta\chi}{\beta} - 1 \leq \frac{1}{\beta} - 1.$$

χ must be less than one since $r - \delta$ is less than one and labor supply is zero for sufficiently high wealth.

3.1. Baseline Model

In this section we discuss our baseline model. In this model, we specify status as in Bakshi and Chen (1996),

$$s = k, \tag{3.1}$$

and set $\gamma = 0$; status has no luxury "feel" to it. We let risk aversion be set to 1; the resulting preferences are represented by

$$u(c, s, l) = \log(c) + \theta \log(s) + \mu \log(1 - h).$$

For calibration, we choose β to match a capital/output ratio of 11.5, δ to match an investment/output ratio of 0.25, and μ to generate average hours of 0.3271 percent of the time endowment. There is little consensus on the value of θ; we therefore consider many different values in an attempt to uncover the model's relationship between status and wealth concentration. To ensure that we can fairly assess this feature, we recalibrate (β, δ, μ) for each value of θ considered in the range $[0, 5.0]$. As evidence that the interval of values we consider encompasses a reasonable range, we note that Luo (2002) estimates a value of θ around 0.54, with a standard error of 0.0119, for an otherwise standard growth model using Generalized Method of Moments.

Storesletten, Telmer, and Yaron (2001) argue that the specification of labor income for an individual household must allow for persistent and transitory components. Based on their empirical work from PSID data, we specify $\log(y_i)$ to be

$$\log(y_i) = \omega_i + \epsilon_i \tag{3.2}$$

$$\omega_i' = \rho\omega_i + v_i' \tag{3.3}$$

where $\epsilon_i \sim N(0, \sigma_\epsilon^2)$ is the transitory component and ω_i is the persistent component. The innovation term associated with ω_i is assumed to be distributed $N(0, \sigma_v^2)$. Storesletten, Telmer, and Yaron (2001) estimate $\rho = 0.935$, $\sigma_\nu^2 = 0.01$, and $\sigma_\epsilon^2 = 0.061$. The unconditional variance of $\log(y_i)$ is then

$$\text{var}[\log(y_i)] = \frac{\sigma_\epsilon^2}{1-\rho^2} + \sigma_\nu^2 = 0.14051.$$

This process attributes about half the unconditional variance to the persistent component and half to the transitory component. We then approximate this process with a seven-state Markov chain using the Tauchen (1986) procedure. This process will not generate sufficient income inequality to replicate the observed Gini coefficient of wealth; however, it is sufficient to demonstrate how the parameter θ affects inequality, and our results will not be completely unreasonable given that we have abstracted from other factors that presumably generate wealth inequality (like differential returns on assets and bequests).[3]

Our concern here is the relationship between concern for status and the wealth distribution. Figure 2 presents the wealth distributions from several of the cases covered in Table 1.[4] We can see from both the table and the figure that increasing θ has the following effects (keeping in mind that the wealth/income ratio and aggregate hours are kept constant):

1. The standard deviation of the wealth distribution shrinks;

2. The skewness of the wealth distribution converges to zero;

3. The kurtosis of the wealth distribution shrinks;

4. The Gini coefficient goes to zero.

Thus, we see that adding concern for wealth into the utility function of the household leads the wealth distribution to collapse. Figure 3 graphs the Lorenz curves for the data and the baseline model with and without concern for status. It is obvious that when we increase the concern for the status the wealth distribution becomes more equal and converges to the 45° line. The contraction of the wealth distribution has several components. One, agents are risk averse toward gambles over status; that is, they prefer to smooth status, and by extension, wealth. Since the economy possesses

[3]For a reference point, the data for the U.S. examined in Budría *et.al.* (2002) imply a Gini coefficient of wealth of 0.78 whereas our benchmark case generates a value of 0.55. We could easily add permanent skill differences, as in Storesletten, Telmer, and Yaron (2001) and bring the model exactly into line with the data, but it would not change any of the results on which we focus.

[4]The small irregular spikes occur at points where households in productivity state y hit the zero constraint on hours. We did not include the distributions for the higher values of θ because they are simply more pronounced versions of the $\theta = 0.5$ case and scaling starts to become an issue.

an ergodic distribution and satisfies the mixing conditions discussed in Aiyagari and Alvarez (1996), each household understands that they will visit each point in the state space infinitely often over their infinite life; that is, the ergodic distribution is simultaneously the cross-sectional distribution at a point in time and the distribution of an individual over time. Risk aversion over wealth compels them to make this ergodic set smaller, which is exactly what they do. To get a handle on the size of this effect, we include in Table 1a the highest and lowest levels of wealth observed in our distribution (we carry the computation out to 10 decimal places, all of which we require to be zero) for each value of θ.[5] The maximum value of k decreases rapidly as θ increases, lending support to the idea that households are reducing the size of their ergodic set. In addition, as θ increases the minimum value of k observed increases, as agents become less willing to hold low amounts of wealth. If we allow θ to go to infinity, the ergodic distribution converges to a single point.[6]

The mean levels of wealth are not the same across the economies, despite the fact that the capital/output ratio and the total hours worked are forced to be equal. The reason this result holds is that there is a change in the distribution of hours across each economy. As noted in Pijoan-Mas (2004), shifts in the distribution of hours between low to high-productivity workers can alter the amount of precautionary savings. Table 1 presents the correlation between productivity and hours across values of θ. Starting from $\theta = 0$, the correlation initially rises with θ; this continues until θ reaches a critical value somewhere between 0.0 and 0.5, where it begins to decline. When demand for status is initially low, increasing it results in a shift of aggregate hours toward the productive, leading to higher aggregate productivity. As θ continues to rise, however, this relationship reverses itself, producing low productivity workers who supply a lot of labor to get their wealth and status to increase. However, when θ begins to get very large, the correlation again begins to rise; this occurs above $\theta = 5.0$.[7]

The decreases in wealth concentration are quite large in the economy – an increase in θ to 0.1 causes a 43 percent decline in the Gini coefficient. However, since we recalibrate the economy, it is difficult to distinguish the direct effect of increasing θ from the required decline in β needed to match the average amount of wealth. As β declines, households have shorter horizons and thus

[5]It is important to note here that our invariant distribution is not constructed using a finite simulation, meaning that sample size concerns are not an issue. See the technical appendix to Young (2004) for further explanation.

[6]We confirmed this fact by computing a version of the model with $\theta = 10000$, which resulted in all the mass of the invariant distribution being located over two points in the grid, those which bracket the desired aggregate stock of capital.

[7]When $\theta = 10000.0$, the case that leads to a near-complete collapse of the wealth distribution, the correlation between h and y is 0.8758.

tend to accumulate less wealth in general. With a lower upper bound and a fixed lower bound on wealth, the Gini coefficient will naturally decline as more agents have sufficiently good luck to reach their endogenous upper bound. To examine this possibility, we hold β fixed at the calibrated value for the benchmark and examine how the wealth distribution changes when θ changes. The results are presented in Table 2a; with fixed β, the level of wealth increases dramatically but the concentration of wealth still shrinks. However, the ergodic set does not shrink; rather, it increases in size and dispersion in wealth actually increases. It is curious to note that the net return on capital $r - \delta$ becomes negative when θ rises sufficiently high; for example, when $\theta = 5.0$ the net return to capital with a fixed (β, μ, δ) vector is -0.0012. Since wealth is still producing status, it is demanded despite its negative value as a savings vehicle; if households could store goods this return could never go below 0.

In Figure 4, we present the equilibrium in the asset market. Since $r - \delta < \frac{1}{\beta} - 1$ for the case when $\theta = 0.0$, households are only saving for precautionary purposes. When θ increases and we hold (β, μ, δ) fixed, asset supply shifts to the right. At every $r - \delta$ households supply more assets to the capital market. Since households now demand assets directly for status purposes, they hold more assets which they rent to the market. In addition, there is an increase in aggregate labor input, shifting asset demand to the right. The computation shows that the shift in supply exceeds the shift in demand, leading to a drop in $r - \delta$ from 0.0096 to 0.0046 and a rise in $\frac{K}{N}$ from 45.429 to 59.724. When the economy is recalibrated, it ends up back at the same equilibrium, but the process is more complicated. To increase the interest rate and reduce the capital-labor ratio, we need something to shift the asset supply curve backward; this shift is accomplished by reducing β. In addition we need to shift capital demand back as well; by increasing μ we reduce aggregate labor input and reduce the marginal product of capital, shifting capital demand to the left. Properly calibrated, these shifts counteract the direct effects of the preference change on $\left(r, \frac{K}{N}\right)$.

The flipside to smoothing wealth is that consumption may now be less insulated against fluctuations. To examine this possibility, we compute the cross-sectional distribution of consumption in the steady state. As θ increases, we observe the following facts from Table 1b:

1. Mean consumption falls – the substitution effect caused by increases in the demand for status is larger than the wealth effect generated by additional capital and the direct increase caused by falling β;

2. The standard deviation of consumption rises – consumption becomes more exposed to income

risk as the demand to smooth status induces smoother asset positions;

3. Skewness in consumption rises;

4. Kurtosis in consumption rises and then falls;

5. The Gini coefficient for consumption rises.

Thus, we see some evidence that consumption is being exposed to more risk. As before, we cannot easily make statements about the effect of θ on consumption, since it is contaminated by the required changes in β. Table 2b presents the distribution of consumption statistics when β is held fixed; it is clear that the increase in the Gini coefficient is the result of recalibration. However, there is a nonmonotonic effect on the standard deviation of consumption; it initially rises and then falls. The eventual decline in the standard deviation is the result of the massive increases in wealth evident in Table 2a; with more wealth, agents are more able to self-insure against movements in their income. At low levels for θ, however, increases in θ have the effect of raising the standard deviation of consumption. Furthermore, the nonmonotonic behavior of the correlation between hours and productivity disappears; as θ rises, there is an increase in this correlation; the most productive agents begin to work more to accumulate additional wealth and status, and this shift produces an increase in aggregate productivity.

In this specification, there is a strong disincentive to be very poor; the marginal utility of status goes to infinity as wealth goes to zero. Unlike the standard model, all of our households will hold positive stocks of assets even when there is no possibility of drawing zero income in a given period (as in our model). We can easily see this from Table 1a, where the minimum wealth in the distribution rises significantly as θ increases from zero.[8] Thus, counterfactually the model with $\gamma = 0$ predicts zero consumers who have zero wealth, and preferences are not even defined for negative levels of wealth. Unfortunately for this preference specification, Budría *et.al.* (2001) report 9.9 percent of all households have zero or negative wealth. Clearly, this model is incapable of reproducing this observation; we will therefore examine how nonhomotheticity in the preference for status affects the wealth distribution.[9]

[8] Again, we wish to point out that this increase in the observed lower bound for wealth is not the result of simulation error, as our method for constructing the invariant distribution does not use finite simulations.

[9] There are other models in which the assumption that preferences have spirit of capitalism would be problematic. For example, in the debt-constrained environment considered in Krueger (1999), banishment to autarky would involve utility equal to $-\infty$, meaning that perfect risk sharing could be sustained.

3.2. Nonhomothetic Preferences

We now consider Stone-Geary preferences over status; these preferences can allow households to consider negative wealth positions. Although we now define utility over negative wealth positions, we do not allow households to borrow; we make this assumption to maintain comparability across model specifications. In the appendix we show that if $\gamma > 0$ and $\theta < 1.0$ status will be a luxury good. This assumption would seem plausible given that membership in country clubs, philanthropic contributions, and other status-enhancing activities are strongly correlated with wealth.[10] Carroll (2002) suggests that nonhomothetic preferences over wealth (in his formulation, bequests) can account for the portfolios chosen by the very wealthy, while Reiter (2004) argues that it can help account for the savings behavior of the very wealthy.

γ is difficult to calibrate given no obvious target. In fact, it is not even clear what factors of the wealth distribution γ most directly influences. Therefore, as we did in the previous section, we explore various settings of θ for $\gamma = 15.6$, which is the average level of wealth in the $\gamma = 0.0$ and $\gamma = 15.6$ economies (since we recalibrate (β, μ, δ) in each case). To get a sense of how γ impacts choices, we consider a static problem in which a household must allocate consumption between two consumption goods and has logarithmic preferences:

$$\max_{s,c} \left\{ \log(c) + \theta \log(s + \gamma) \right\}.$$

Denote income by m and the relative price of status by p. In this case, the demand functions would be given by

$$\begin{aligned} c &= \frac{m + \gamma p}{1 + \theta} \\ s &= \frac{\theta m - \gamma p}{p(1 + \theta)}; \end{aligned}$$

that is, as γ increases, consumption of status decreases and consumption of other goods increases. For example, when $\theta = 1.0$ and $\gamma = 5.0$ (setting $m = 10$ and $p = 1$) we have that status is $s = 2.5$, 25 percent of income, but increasing γ to 7.5 yields status being 1.25, which is now only 12.5 percent of income. That is, in our model γ mutes the demand for wealth by reducing the impact of k on the marginal utility of status; because savings functions will not be exactly linear in our

[10] This would follow directly from Veblen's notion of conspicuous consumption; large philanthropic gifts confer status both because they are large (which requires high wealth) and because they are very public.

environment, the elasticity will not be 1 as it is in the example. Furthermore, it implies that some households will choose not to pursue status, since the marginal utility will be finite at $s = 0$; that is, for the relatively poor status will not be purchased. Furthermore, increasing wealth will not alter the demand for status for constrained agents:

$$
\begin{aligned}
\left.\frac{\partial s}{\partial m}\right|_{m \leq \frac{\gamma}{\theta} p} &= 0 \\
\left.\frac{\partial s}{\partial m}\right|_{m > \frac{\gamma}{\theta} p} &= \frac{\theta}{p(1+\theta)} > 0.
\end{aligned}
$$

In our formulation, this implies there is no wealth demand increase for the very poor when θ increases.

When we compute our model with $\gamma = 15.6$, we see that the Gini coefficient on wealth is higher for every value of θ considered (we did not compute the $\theta = 5.0$ economy because, as shown in the appendix, that economy does not imply status is a luxury, but rather is a necessity). Additionally, the ergodic set of capital stocks shrinks much more slowly than when $\gamma = 0$, and the lower bound remains at the borrowing limit instead of rising. Standard deviations are also smaller in this case. In effect, making status a luxury good has the perverse effect of reducing inequality rather than increasing it, which is what our intuition suggested would happen. What γ is doing is muting the increased demand for capital by reducing the marginal utility of status for every agent. Further increases in γ (for example, to twice the average amount of capital) increase the Gini coefficient on wealth. Reiter (2004) uses a value which is equal to 30,000 times the capital/output ratio in his economy. When we solve this economy, we find that the Gini coefficient is nearly the same when $\theta = 0.1$ as when $\theta = 0.0$. Nonhomothetic preferences over status cannot increase the Gini coefficient, however, as further increases in γ have little to no effect on inequality.[11] This result obtains in our economy because, with separable preferences, as $\gamma \to \infty$ the households behave identically to ones with $\theta = 0$; with an arbitarily large constant in the utility function, status is unaffected by wealth. $\gamma > 0$ has little effect on the distribution of hours, which is to be expected since it primarily affects the wealthy and these households supply little labor.

[11] The cutoff value of γ (that is, where further increases have no effect on the wealth distribution) depends on the endogenous choice of the observed upper bound for k (which of course is determined by γ). As θ rises, this cutoff value for γ falls.

3.3. Non-Separable Preferences – The Effect of Risk Aversion

We now generalize our preference structure to arbitrary values of σ:

$$u(c,s,l) = \frac{\left[cs^{\theta}l^{\mu}\right]^{1-\sigma} - 1}{1-\sigma}$$

where $\sigma \geq 0$. There are two effects typically associated with rising values for σ. First, it increases the amount of precautionary savings in its role as the Arrow-Pratt coefficient of relative risk aversion; when σ increases, households become more averse to fluctuations in the components of period utility and they therefore react by increasing savings in such a way as to reduce those fluctuations. Here, this precautionary savings effect is strengthened because wealth is a component of the period utility function itself; it is therefore directly subject to risk aversion as noted above. The second effect of increasing σ is to reduce the general desire for savings in its role in determining the elasticity of intertemporal substitution; when $\theta = 0$, the EIS in consumption is given by σ^{-1}. As we show in the appendix, the EIS here is still negatively related to σ, but has a wedge term that depends on the demand for status in a manner similar to the habit formation preferences considered in Díaz, Pijoan-Mas, and Ríos-Rull (2003). With lower savings desires, consumption fluctuations are exacerbated by the presence of more households in the region of wealth near the borrowing limit.[12]

Because computing the model with $\sigma > 1$ is considerably more difficult than with $\sigma = 1$, we only report the model with $\theta = (0.0, 0.1)$ at $\sigma = 4.0$. The problem with solving this model is the curvature in the utility function near the borrowing constraint. As $k \to 0$ the utility function (when $\gamma = 0$) converges to $-\infty$; near this point, the extremely high values for the derivative make it hard to accurately solve for the policy function. Other values for θ appear to lead to the same qualitative conclusions, but we did not compute them to very high accuracy. The first thing to note is that mean capital goes down slightly when σ goes from 1.0 to 4.0, despite the fact that the economies have the same wealth/GDP ratio and the same aggregate hours; this is another manifestation of the effects of reallocating labor across productivity groups. With higher risk aversion, the less productive workers supply a higher proportion of total hours, leading to declines in aggregate productivity. As seen above when $\sigma = 1.0$, the result of increasing θ is to reduce the

[12] Technically speaking, we cannot differentiate the effects of risk aversion and the elasticity of intertemporal substitution, since both depend on σ. While we derive an expression for the EIS in the appendix, and therefore could recalibrate it to produce the same EIS by adjusting the strength of the status parameter θ, we do not do so both because the effects would not appear to be strong and because our interest lies in the effects of θ.

Gini coefficient on wealth, producing less inequality.[13] Adding nonhomotheticity to the high risk aversion economies had the same effect as above.

4. Tax Policy

In this final substantive section of the paper, we consider some experiments designed to explore whether spirit of capitalism preferences have any substantive impact on the evaluation of certain types of taxes. Specifically, we consider the replacement of a progressive income tax with two different flat tax systems – an income tax system and a consumption tax system. Our flat income tax experiments are similar in spirit to those conducted by Castañeda, Díaz-Giménez, and Ríos-Rull (2002) and Conesa and Krueger (2004), who compute the welfare and distributional consequences of replacing a calibrated progressive tax system with a revenue-neutral flat tax. Our interest is not in a careful measurement of the relative gain from reforming the tax system, but rather to assess whether spirit of capitalism preferences have consequences for these types of policy experiments. We find that they do.

Following Gouveia and Strauss (1994), we choose to approximate the existing income tax code using the function

$$\tau\left(i\right) = a_0 \left(i - \left(i^{a_1} + a_2\right)^{-\frac{1}{a_1}} \right) \tag{4.1}$$

with parameters (a_0, a_1, a_2). As noted in those papers mentioned above, the tax rate is not invariant to a rescaling of income, so we take the same approach as in Conesa and Krueger (2004): we set $a_0 = 0.258$, $a_1 = 0.768$, and calibrate a_2 to balance the government budget when wasteful spending is 19 percent of GDP. The budget constraint of the household is now given by

$$\left(1 + \tau_c\right) c + k' = \left(1 + r - \delta\right) k + wyh - \tau\left(i\right) \tag{4.2}$$

where

$$i = \left(r - \delta\right) k + wyh \tag{4.3}$$

is personal income and τ_c is a consumption tax. The government budget constraint is given by

$$\int \left(\tau_c c + \tau\left(i\right)\right) \Gamma\left(k, y\right) = G. \tag{4.4}$$

[13] Increasing σ has the effect of reducing inequality as well, since fewer households are willing to hold very small amounts of capital.

The goods market becomes

$$C + K' + G = Y + (1 - \delta) K. \tag{4.5}$$

The definition of equilibrium needs only to be modified to account for these two changes.

When switching to a flat income tax, we set the tax rate τ to keep the ratio $\frac{G}{Y}$ constant at 19 percent when the consumption tax is set to zero. For the consumption tax experiments, we set the tax rate τ_c to again imply a $\frac{G}{Y}$ ratio of 19 percent when the income tax function is set identically to zero. We chose to keep the $\frac{G}{Y}$ ratio constant to isolate the disincentive effects of the various taxes, rather than emphasizing the wealth effects. We evaluate the welfare change according to the criterion

$$W = \int v(k, y) \Gamma^* (k, y) \tag{4.6}$$

in which each agent evaluates the reform "before they are born." That is, this is a comparison done by an agent who is being asked to insert themselves into one of the two economies; being measure zero they have no impact on the equilibrium in the economy and can therefore fairly assess the consequences of living in each world. We then convert this utility measure into consumption units and calculate the welfare change as

$$\phi = \exp((1 - \beta)(W_1 - W_0)) - 1, \tag{4.7}$$

where W_0 is welfare before the reform and W_1 is after. We compare our results for the two experiments using $\theta = 0.0$ and $(\theta, \gamma) = \{0.5, 32\}$, since they imply approximately the same Gini coefficients for wealth; in each case, we recalibrate (β, δ, μ) to reproduce the same facts as above and we keep $\sigma = 1$ fixed across each of these tax experiments.[14] Since we are comparing two economies which are identical in wage distributions and very similar in terms of wealth distributions, we hope to attribute any differences across policy experiments to be the result of (θ, γ).[15]

In the model economy with spirit of capitalism, the income tax is not "pure." Since households derive direct utility from wealth, the income tax, which changes the relative price of assets, is inducing a shift away from status and toward consumption. To see this more clearly, consider a

[14]We do not attempt to search for the optimal tax code, as is done in Conesa and Krueger (2004). Our paper is not the only one in which nonstandard preferences have been used to explore the progressive income tax; see Boskin and Sheshiski (1978) and Corneo (2000).

[15]Without computing transitional dynamics, we cannot initialize the experiments with the same distribution, because one of them would have additional dynamics.

two period model with inelastic labor supply

$$\max_{c_1,c_2,k_2 \geq 0} u\left(c_1, c_2, s_1, s_2\right) = \left[\log\left(c_1\right) + \theta \log\left(k_1 + \gamma\right)\right] + \beta\left[\log\left(c_2\right) + \theta \log\left(k_2 + \gamma\right)\right] \tag{4.8}$$

subject to the budget constraints

$$\begin{aligned} \left(1+\tau_c\right) c_1 + k_2 &\leq \left(1 + r_1 - \delta\right) k_1 + w_1 - \tau\left[\left(r_1 - \delta\right) k_1 + w_1\right] \\ \left(1+\tau_c\right) c_2 &\leq \left(1 + r_2 - \delta\right) k_2 + w_2 - \tau\left[\left(r_2 - \delta\right) k_2 + w_2\right]. \end{aligned} \tag{4.9}$$

The first-order condition is

$$\frac{1+\tau_c}{c_1} - \frac{\beta\left(1+\tau_c\right)}{c_2}\left[1 + (1-\tau)\left(r_2 - \delta\right)\right] = \frac{\beta\theta}{k_2 + \gamma} + \Lambda.$$

where Λ is the multiplier on the nonnegativity constraint for k_2. To obtain one unit of status tomorrow, the household must sacrifice $\frac{1}{(1+\tau_c)}$ units of consumption today (this comes from the first budget constraint). However, the household also gets additional consumption tomorrow because wealth confers status, so that the effective price of status is reduced by the second term on the left-hand-side of the Euler equation. Thus, income taxes, by reducing the wedge term, raise the effective price of status and induce shifts in the consumption bundle, similar to a nonuniform consumption tax. The condition also clearly shows that even constant consumption taxes have an intertemporal effect by decreasing the relative price of status, an effect which is not present with standard preferences.

Table 5 presents our results from considering the two types of tax reforms. With standard preferences, we obtain the usual result that consumption taxation dominates income taxation. However, with spirit of capitalism preferences we find the opposite – the social welfare function is higher under the income tax regime. Welfare gains are large for either type of change; the extremely large increases observed for the spirit of capitalism households are partially attributable to the large increase in wealth. While all households benefit from the additional consumption financed out of permanently-higher wages, the soc households get an additional direct bonus. It turns out that this direct effect is the crucial component to the welfare reversal. Although we do not show them for the sake of brevity, plots of the cumulative distributions of consumption and leisure for the two types of preferences change in essentially identical ways for each type of tax reform. Both income and consumption tax reform produce FSD shifts in the distributions, with the consumption shift being larger for the income tax reform and the leisure shift being larger for the consumption tax reform.[16] The net result would be that the consumption tax reform gets preferred because the shift in leisure is quantitatively more important for welfare (note the relatively large weight on leisure relative to consumption – $\mu > 1$ in both calibrated equilibria).

With spirit of capitalism preferences, we must also consider the effects on the distribution of wealth when exploring changes in welfare. Figure 5 presents the cumulative distributions of wealth in the soc case for three different tax systems – the benchmark progressive tax system, the flat income tax, and the flat consumption tax. The cumulative distributions for the two tax reforms cross exactly once, but the area between them is not larger to the left of the intersection than to the right, meaning there is no ranking according to stochastic dominance of the second degree.[17] We have been unable to rank the two distributions according to any known stochastic ordering rule, meaning that our model's conclusions may not be robust to alternative parameterizations, but the finding is still unique in the literature.

5. Conclusion

This paper has explored the effect of 'spirit of capitalism' preferences for the wealth distribution in a model with incomplete asset markets. Our first result is that increasing the demand for status has a strong negative effect on wealth inequality, whether measured by the standard deviation or the Gini coefficient on wealth, but a positive effect on consumption inequality. As the demand for status increases, the wealth distribution actually converges to a single point due to a combination of risk aversion and a shrinking discount factor; when the discount factor is held constant, the distribution shrinks and shifts to the right. When we consider the likely possibility that status is

[16] 'FSD' means stochastic dominance in the first-order sense:

$$E_F\left[u\left(X\right)\right] \geq E_G\left[u\left(X\right)\right]$$

for all increasing functions u, which has the equivalent representation

$$F\left(x\right) \leq G\left(x\right) \quad \forall x.$$

The definition is from Hadar and Russell (1969).

[17] 'SSD' means that

$$E_F\left[u\left(X\right)\right] \geq E_G\left[u\left(X\right)\right]$$

for every concave function u, and has the integral representation

$$\int_{-\infty}^{\alpha} F\left(x\right) dx \leq \int_{-\infty}^{\alpha} G\left(x\right) dx \quad \forall \alpha.$$

This comes from Hadar and Russell (1969) and Rothschild and Stiglitz (1971).

instead a luxury good, we find that making the utility function more nonhomothetic increases in Gini coefficient on wealth; these effects can be strong if the constant in the utility function (which has an interpretation in terms of the amount of capital needed before an agent buys status) is larger than the average stock of wealth in the economy. However, it cannot produce a higher Gini coefficient than the case of no demand for status. Increasing the risk aversion of households does not qualitatively affect our results.

Our tax experiments suggest that spirit of capitalism preferences have important policy implications. In particular, we find that the presence of wealth in the utility function can reverse the welfare rankings of consumption versus income taxes; spirit of capitalism households would prefer an income tax. In addition, removing the progressive tax in our economy actually leads to less, not more, income inequality, and the change is much larger for the soc case. While we recognize that critical features of the tax-transfer system in the US are missing from our model, and thus it does not provide an accurate measure of the consequences of flat-tax reform, it does call into question the robustness of experiments such as those carried out in Castañeda, Díaz-Giménez, and Ríos-Rull (2002) and Conesa and Krueger (2004). More investigation along the lines of Carroll (2002), in which the behavior of the wealthy is qualitatively different from the poor, would seem to be called for in order to provide clear tests of the strength of the spirit of capitalism motive. Our results, in parallel to those in Reiter (2004), suggest that this distinction may be hard to obtain.

In previous versions of this paper, we considered the impact of spirit of capitalism preferences on business cycles. Using the algorithm from Young (2003), we introduced aggregate productivity shocks into the model. While this initial exploration was somewhat disappointing in that it failed to produce any significant changes in the behavior of the model, we think it is advisable to revisit this issue for the following reasons. First, our results here suggest that the behavior of the aggregate labor input is impacted by the spirit of capitalism in complicated ways. Furthermore, the nature of the effects of progressive income taxation are also dependent on the presence of status terms in the utility function, even when economies are calibrated to produce the same wealth/GDP ratio and aggregate hours worked. The effects of progressive income taxation over the business cycle have not really been studied within a fully-heterogeneous dynamic general equilibrium model, but it appears that the efficacy of such taxes in performing their role as an automatic stabilizer may be affected by the spirit of capitalism, as well as the desireability of such policies. Since our initial investigation featured inelastic labor supply, we feel that reopening this inquiry is appropriate. Furthermore, initial investigations imply that the welfare costs of business cycles are not invariant to the presence of spirit of capitalism, so we intend to extend the work of Krusell and Smith (2002) as well.

In addition, we think it advisable to consider the asset pricing implications of our model. In Krusell and Smith (1997), the asset pricing behavior of their benchmark model with exogenous labor supply and aggregate shocks was shown to be quite poor. The essence of the problem is that only a small fraction of agents price bonds in their economy, and these agents are quite well-insured. As a result, their marginal rates of substitution do not vary much in equilibrium, creating very little improvement in the failures of the complete markets model; this anomaly was not resolved by the introduction of stochastic discount factors. Introducing spirit of capitalism preferences could potentially alter the nature of asset pricing within their model, since it implies that the elasticity of intertemporal substitution is likely to be countercyclical (see our appendix). This change might be particularly pronounced if status is a luxury good, as it would imply sharp behavioral differences for wealthy versus poor households. Indeed, we hope that such departures do occur, as they would provide the profession with a tool for determining whether spirit of capitalism can be distinguished from standard preferences.

6. Appendix

In this appendix we show that for the class of utility used in this paper, $u(c,s,l) = \frac{\left[c(s+\gamma)^{\theta} l^{\mu}\right]^{1-\sigma}}{1-\sigma}$, status is a luxury good if $\theta < 1.0$ and $\gamma > 0$. Define

$$\begin{aligned} \eta_c &= \frac{\frac{du_c(c,s,l)}{dc}}{\frac{u_c(c,s,l)}{c}} = -\theta - (1-\theta)\sigma \\ \eta_s &= \frac{\frac{du_s(c,s,l)}{ds}}{\frac{u_s(c,s,l)}{s}} = (-\theta\sigma + \theta - 1)\frac{s}{s+\gamma}. \end{aligned} \tag{A1}$$

With $\gamma > 0$ and $\theta < 1.0$ (with $\sigma \geq 1$) we have $\eta_s > \eta_c$; that is, the marginal utility of status declines less with wealth than the marginal utility of consumption does. In other words, as wealth rises so does the fraction of current utility derived from status.

We next compute the EIS for our preference specification. Let status be simply given by current capital. The Euler equation can be written

$$u_c(c_t, s_t, l_t) = \beta E_t \left[u_c(c_{t+1}, s_{t+1}, l_{t+1})(1 + r_{t+1}) + u_s(c_{t+1}, s_{t+1}, l_{t+1})\right]. \tag{A2}$$

Using our functional forms this becomes

$$c_t^{-\sigma}(s_t+\gamma)^{\theta(1-\sigma)} l_t^{\mu(1-\sigma)} = \beta E_t \left[\begin{array}{c} c_{t+1}^{-\sigma}(s_{t+1}+\gamma)^{\theta(1-\sigma)} l_{t+1}^{\mu(1-\sigma)}(1+r_{t+1}) + \\ \theta c_{t+1}^{1-\sigma}(s_{t+1}+\gamma)^{\theta(1-\sigma)-1} l_{t+1}^{\mu(1-\sigma)} \end{array}\right]. \tag{A3}$$

Along some steady state path we have no uncertainty, so this becomes

$$1 = \beta \left[\begin{array}{c} \left(\frac{c_{t+1}}{c_t}\right)^{-\sigma}\left(\frac{s_{t+1}+\gamma}{s_t+\gamma}\right)^{\theta(1-\sigma)}(1+r_{t+1}) + \\ \theta\left(\frac{c_{t+1}}{c_t}\right)^{-\sigma}\left(\frac{s_{t+1}+\gamma}{s_t+\gamma}\right)^{\theta(1-\sigma)}\frac{c_{t+1}}{s_{t+1}+\gamma} \end{array}\right], \tag{A4}$$

since l_t is constant in the steady state path. Following Kongsamut, Rebelo, and Xie (2001), we define a Generalized Balanced-Growth path as one which implies a constant real interest rate r. This requires that

$$g = \frac{c_{t+1}}{c_t} = \frac{s_{t+1}+\gamma}{s_t+\gamma}. \tag{A5}$$

Note that, if $\gamma > 0$ we have that

$$g_s = \frac{s_{t+1}}{s_t} > \frac{c_{t+1}}{c_t},$$

because

$$\frac{d}{d\gamma}\left[\frac{s_{t+1}+\gamma}{s_t+\gamma}\right]_{\gamma=0} = \frac{s_t - s_{t+1}}{(s_t+\gamma)^2} < 0. \tag{A6}$$

Using this result we have

$$1 = \beta\left[g^{-\sigma}(1+r) + \theta g^{-\sigma}\frac{c_{t+1}}{s_{t+1}+\gamma}\right]. \tag{A7}$$

The appearance of the additional term is what differentiates this model from the standard one. Rearranging we obtain

$$g^{\sigma} = \beta\left[1+r+\theta\frac{c}{s+\gamma}\right]. \tag{A8}$$

Taking logs we obtain

$$\sigma\log(g) = \log(\beta) + \log(1+r) + \log\left(1+\theta\frac{c}{s+\gamma}\frac{1}{1+r}\right).$$

Thus, there is a wedge between the EIS and $\frac{1}{\sigma}$; the size of the wedge is directly related to θ. For small enough values of θ and r we obtain

$$\sigma(g-1) \approx \log(\beta) + r + \theta\frac{c}{s+\gamma}\frac{1}{1+r}$$

or

$$\frac{dg}{dr} \approx \frac{1}{\sigma} - \frac{1}{\sigma}\theta\frac{c}{s+\gamma}\left(\frac{1}{1+r}\right)^2 < \frac{1}{\sigma}. \tag{A9}$$

That is, the EIS is smaller than the standard model with $\theta = 0$. In addition, increases in γ increase the EIS by decreasing the size of the wedge term, and as $\gamma \to \infty$ the EIS approaches the standard value $\frac{1}{\sigma}$. Essentially, the second term is only relevant for agents who are not constrained in status; with $\gamma > 0$ this constraint binds at positive income levels.

References

[1] Aiyagari, S.R. (1994), "Uninsured Idiosyncratic Risk and Aggregate Saving," *Quarterly Journal of Economics* **109**, pp. 659-84.

[2] Aiyagari, S.R. and F. Alvarez (2001), "Efficient Dynamic Monitoring of Unemployment Insurance Claims," manuscript, University of Chicago.

[3] Bakshi, G.S. and Z. Chen (1996), "The Spirit of Capitalism and Stock-Market Prices," *American Economic Review* **86(1)**, pp. 133-57.

[4] Boskin, M.J. and E. Sheshiski (1978), "Optimal Redistributive Taxation When Individual Welfare Depends on Relative Income," *Quarterly Journal of Economics* **92(4)**, pp 589-601.

[5] Budría, S., J. Díaz-Giménez, V. Quadrini, and J.-V. Ríos-Rull (2001), "Updated Facts on the U.S. Distributions of Earnings, Income, and Wealth," Federal Reserve Bank of Minneapolis *Quarterly Review* **26(3)**, pp. 2-35.

[6] Carroll, C.D. (2002), "Portfolios of the Rich," in *Household Portfolios: Theory and Evidence*, MIT Press.

[7] Castañeda, A., J. Díaz-Giménez, and J.-V. Ríos-Rull (2003), "Accounting for Wealth and Income Inequality," *Journal of Political Economy* **111(4)**, pp. 818-57.

[8] Chue, T.K. (2004), "The Spirit of Capitalism and International Risk Sharing," Econometric Society 2004 Far Eastern Meetings Working Paper **589**.

[9] Conesa, J.C. and D. Krueger (2004), "On the Optimal Progressivity of the Income Tax Code," manuscript, University of Pennsylvania.

[10] Corneo, G. (2000), "The Efficient Side of Progressive Income Taxation," CESifo Working Paper No. **364**.

[11] Díaz, A., J. Pijoan-Mas, and J.-V. Ríos-Rull (2003), "Precautionary Savings and Wealth Distribution Under Habit Formation Preferences," *Journal of Monetary Economics* **50(6)**, pp. 1257-91.

[12] Duesenberry, J.S. (1949), *Income, Saving, and the Theory of Consumer Behavior*, Harvard University Press.

[13] Dupuy, B. and W.F. Liu (2003), “Jealousy and Equilibrium Overconsumption,” *American Economic Review* **93(1)**, pp. 423-8.

[14] Gong, L. and H. Zou (2002), “Direct Preferences for Wealth, the Risk Premium Puzzle, Growth, and Policy Effectiveness,” *Journal of Economic Dynamics and Control* **26**, pp. 247-70.

[15] Gouveia, M. and R.P. Strauss (1994), ”Effective Federal Individual Tax Functions: An Exploratory Empirical Analysis,” *National Tax Journal* **47**, pp. 317-39.

[16] Hadar, J. and W.R. Russell (1969), ”Rules for Ordering Uncertain Prospects,” *American Economic Review* **49(1)**, pp. 25-34.

[17] Kenc, T. and S. Dibooğlu (2003), ”How Does the Spirit of Capitalism Affect Stock Market Prices in a Small-Open Economy,” Society for Computational Economics Working Paper **196**.

[18] Kongsamut, P., S. Rebelo, and D. Xie (2001), “Beyond Balanced Growth,” *Review of Economic Studies* **68**, pp. 869-82.

[19] Krueger, D. (1999), ”Risk Sharing with Incomplete Markets: Macroeconomic and Fiscal Policy Implications,” Doctoral Dissertation, University of Minnesota.

[20] Krusell, P. and A.A. Smith, Jr. (1997), ”Income and Wealth Heterogeneity, Portfolio Choice, and Equilibrium Asset Returns,” *Macroeconomic Dynamics* **1(2)**, pp. 387-422.

[21] Krusell, P. and A.A. Smith, Jr. (2002), ”Revisiting the Welfare Effects of Eliminating Business Cycles,” manuscript, University of Rochester and Carnegie Mellon University.

[22] Lettau, M. (1997), “Comment on 'The Spirit of Capitalism and Stock Market Prices' by G.S. Bakshi and Z. Chen (AER, 1996),” Tilburg University, Center for Economic Research Discussion Paper **49**.

[23] Luo, Y. (2002), “Notes on Stochastic Growth Models with Spirit of Capitalism,” manuscript, Princeton University.

[24] Miao, J. (2003), “Competitive Equilibria of Economies with a Continuum of Consumers and Aggregate Shocks,” manuscript, University of Rochester.

[25] Pjioan-Mas, J. (2004), ”Precautionary Savings or Working Longer Hours?” manuscript, CEMFI.

[26] Reiter, M. (2004), "Do the Rich Save Too Much? How to Explain the Top Tail of the Wealth Distribution," manuscript, Universitat Pompeu Fabra.

[27] Robson, A. (1992), "Status, the Distribution of Wealth, Private and Social Attitude to Risk," *Econometrica* **60(4)**, pp. 837-857.

[28] Rothschild, M. and J.E. Stiglitz (1970), "Increasing Risk I: A Definition," *Journal of Economic Theory* **2(3)**, pp. 225-43.

[29] Smith, W.T. (2001), "How Does the Spirit of Capitalism Affect Stock Market Prices?" *Review of Financial Studies* **14**, pp.1215-32.

[30] Storesletten, K., C.I. Telmer, and A. Yaron (2001), "Cyclical Dynamics in Idiosyncratic Labor Market Risk," *Journal of Political Economy* **112(3)**, pp. 695-717.

[31] Young, E.R. (2003), "Solving the Krusell-Smith Model with Finite Forecasting Functions," manuscript, University of Virginia.

[32] Young, E.R. (2004), "Unemployment Insurance and Capital Accumulation," forthcoming, *Journal of Monetary Economics.*

[33] Zou, H. (1994), "The Spirit of Capitalism and Long-Run Growth," *European Journal of Political Economy* **10(2)**, pp. 279-93.

Table 1a

Moments of Wealth Distribution

$\gamma = 0$ (Wealth not a Luxury Good)

Models	Gini	mean (k)	std. (k)	skew (k)	kurt. (k)	max (k)	min (k)
$\theta = 0$	0.5518	15.6099	16.7764	1.6154	6.0583	156.0399	0.0000
$\theta = 0.1$	0.3154	15.4645	9.1320	1.2950	5.1835	87.6268	0.9702
$\theta = 0.5$	0.1927	15.2839	5.3948	0.9777	4.3469	48.9794	3.6107
$\theta = 1.0$	0.1635	15.2318	4.5292	0.8619	4.0519	39.6176	5.0510
$\theta = 5.0$	0.1392	15.1973	3.8235	0.7452	3.7469	32.1762	6.4912

Table 1b

Moments of Consumption Distribution

$\gamma = 0$ (Wealth not a Luxury Good)

Models	Gini	mean (c)	std. (c)	skew (c)	kurt. (c)
$\theta = 0$	0.1042	1.0195	0.2069	-0.0764	3.1841
$\theta = 0.1$	0.1083	1.0092	0.2133	0.3362	3.0304
$\theta = 0.5$	0.1176	0.9974	0.2274	0.5859	3.3628
$\theta = 1.0$	0.1224	0.9940	0.2328	0.6524	3.5038
$\theta = 5.0$	0.1316	0.9917	0.2409	0.7156	3.6598

Table 1c

Moments of Hours Distribution

$\gamma = 0$ (Wealth not a Luxury Good)

Models	Gini	mean (h)	std. (h)	skew (h)	kurt. (h)	corr (h, y)
$\theta = 0$	-0.0761	0.3271	0.1220	-0.8120	3.5079	0.6386
$\theta = 0.1$	-0.0379	0.3271	0.1020	-0.7449	3.7351	0.6547
$\theta = 0.5$	-0.0168	0.3271	0.0851	-0.7112	3.9259	0.6223
$\theta = 1.0$	-0.0117	0.3271	0.0817	-0.6900	3.9333	0.5997
$\theta = 5.0$	-0.0078	0.3271	0.0853	-0.6480	3.8482	0.5437

Table 2a

Moments of Wealth Distribution, Fixed (β, μ, δ)

$\gamma = 0$ (Wealth not a Luxury Good)

Models	Gini	mean (k)	std. (k)	skew (k)	kurt. (k)	max (k)	min (k)
$\theta = 0.1$	0.3087	21.3803	12.2622	1.2045	4.8681	116.1923	1.2102
$\theta = 0.5$	0.1846	44.1167	14.7631	0.8292	3.9025	139.4767	8.8917
$\theta = 1.0$	0.1484	70.9451	18.9538	0.6981	3.6215	185.5656	20.1739
$\theta = 5.0$	0.0970	199.3871	34.5612	0.5134	3.2994	392.7253	91.4675

Table 2b

Moments of Consumption Distribution, Fixed (β, μ, δ)

$\gamma = 0$ (Wealth not a Luxury Good)

Models	Gini	mean (c)	std. (c)	skew (c)	kurt. (c)
$\theta = 0.1$	0.0984	1.0966	0.2094	0.2224	2.9428
$\theta = 0.5$	0.0901	1.2466	0.2167	0.3637	3.0390
$\theta = 1.0$	0.0835	1.2861	0.2056	0.3845	3.0677
$\theta = 5.0$	0.0667	0.9357	0.1174	0.3780	3.0819

Table 2c

Moments of Hours Distribution, Fixed (β, μ, δ)

$\gamma = 0$ (Wealth not a Luxury Good)

Models	Gini	mean (h)	std. (h)	skew (h)	kurt. (h)	corr (h, y)
$\theta = 0.1$	-0.0266	0.3415	0.1087	-0.6872	3.6196	0.7237
$\theta = 0.5$	0.0002	0.3919	0.1048	-0.7079	3.8594	0.7849
$\theta = 1.0$	0.0060	0.4451	0.1028	-0.7631	4.0966	0.8111
$\theta = 5.0$	0.0055	0.6761	0.0703	-0.8253	4.2666	0.8561

Table 3a

Moments of Wealth Distribution

$\gamma = 15.6$ (Wealth a Luxury Good)

Models	Gini	mean (k)	std. (k)	skew (k)	kurt. (k)	max (k)	min (k)
$\theta = 0.1$	0.4856	15.6152	14.2362	1.3120	4.9313	124.5939	0.0000
$\theta = 0.5$	0.3689	15.5625	10.4351	0.9284	3.9717	84.7462	0.0000
$\theta = 1.0$	0.2666	15.4426	7.4519	0.7893	3.8303	59.7815	0.0000

Table 3b

Moments of Consumption Distribution

$\gamma = 15.6$ (Wealth a Luxury Good)

Models	Gini	mean (c)	std. (c)	skew (c)	kurt. (c)
$\theta = 0.1$	0.1037	1.0196	0.2053	0.0912	3.2430
$\theta = 0.5$	0.1072	1.0157	0.2100	0.4054	3.2914
$\theta = 1.0$	0.1140	1.0077	0.2196	0.5703	3.3592

Table 3c

Moments of Hours Distribution

$\gamma = 15.6$ (Wealth a Luxury Good)

Models	Gini	mean (h)	std. (h)	skew (h)	kurt. (h)	corr (h, y)
$\theta = 0.1$	-0.0643	0.3271	0.1192	-0.7455	3.4243	0.6571
$\theta = 0.5$	-0.0433	0.3271	0.1119	-0.6744	3.3950	0.6641
$\theta = 1.0$	-0.0265	0.3271	0.1014	-0.6633	3.5422	0.6421

Table 4a

Moments of Wealth Distribution

$\gamma = 0$ (Wealth not a Luxury Good), High Risk Aversion $\sigma = 4.0$

Models	Gini	mean (k)	std. (k)	skew (k)	kurt. (k)	max (k)	min (k)
$\theta = 0.0$	0.4117	15.2498	11.5249	1.0734	4.1837	98.1800	0.0000
$\theta = 0.1$	0.2969	15.2122	8.1976	0.9052	3.9013	72.9747	0.2401

Table 4b

Moments of Consumption Distribution

$\gamma = 0$ (Wealth not a Luxury Good), High Risk Aversion $\sigma = 4.0$

Models	Gini	mean (c)	std. (c)	skew (c)	kurt. (c)
$\theta = 0.0$	0.0744	0.9951	0.2206	0.5167	3.4784
$\theta = 0.1$	0.0767	0.9918	0.2244	0.6047	3.5264

Table 5

Income Tax Experiments

(θ, γ)	Δmean (k)	ΔGini (k)	Δmean (c)	ΔGini (c)	Δmean(h)	Δcorr(h, y)	ϕ
$(0.0, 0.0)$	54.098%	−0.721%	0.289%	19.769%	25.226%	−17.374%	16.6%
$(0.5, 32)$	57.174%	−4.881%	29.088%	18.852%	26.006%	−14.673%	28.4%

Consumption Tax Experiments

(θ, γ)	Δmean (k)	ΔGini (k)	Δmean (c)	ΔGini (c)	Δmean(h)	Δcorr(h, y)	ϕ
$(0.0, 0.0)$	31.815%	3.410%	9.742%	6. 602%	5.321%	−0.556%	18.1%
$(0.5, 32)$	48.241%	−8.270%	12.727%	2.711%	6.138%	5.198%	6.6%

Figure 1

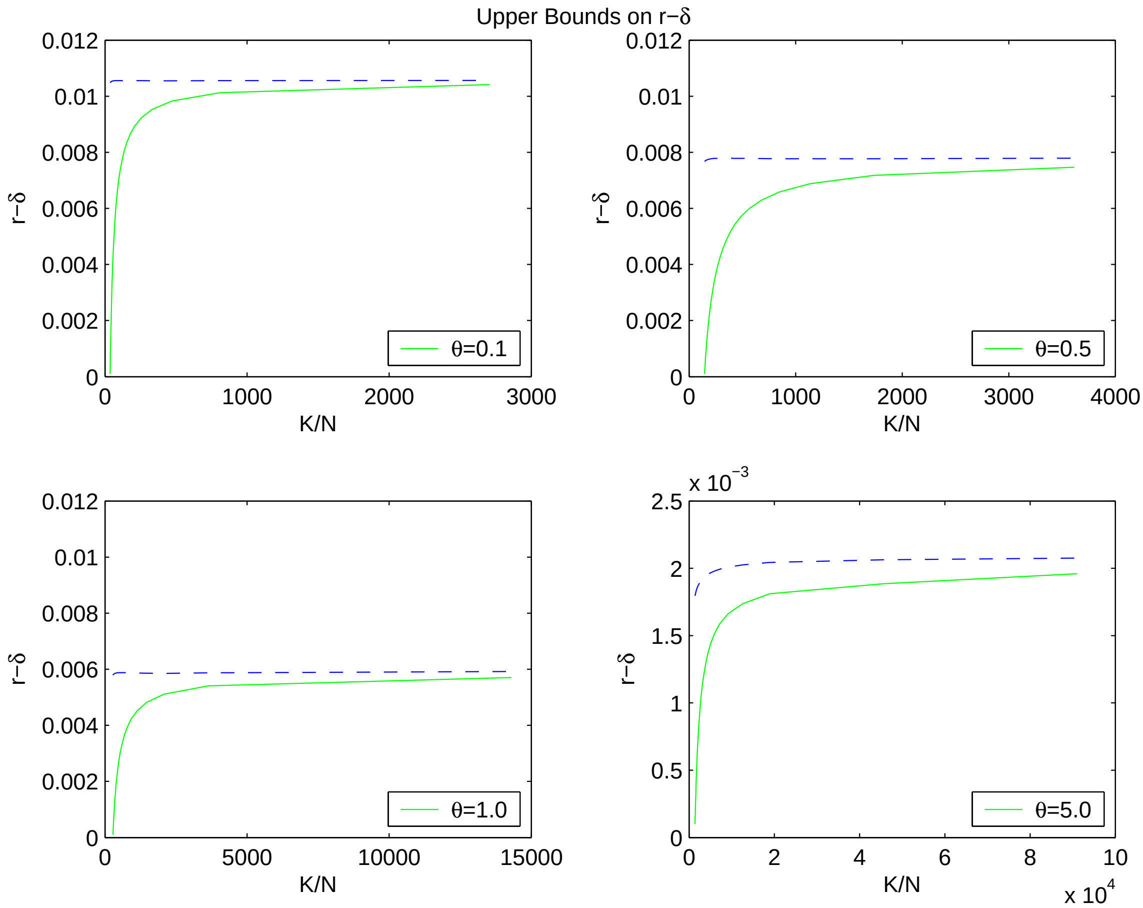
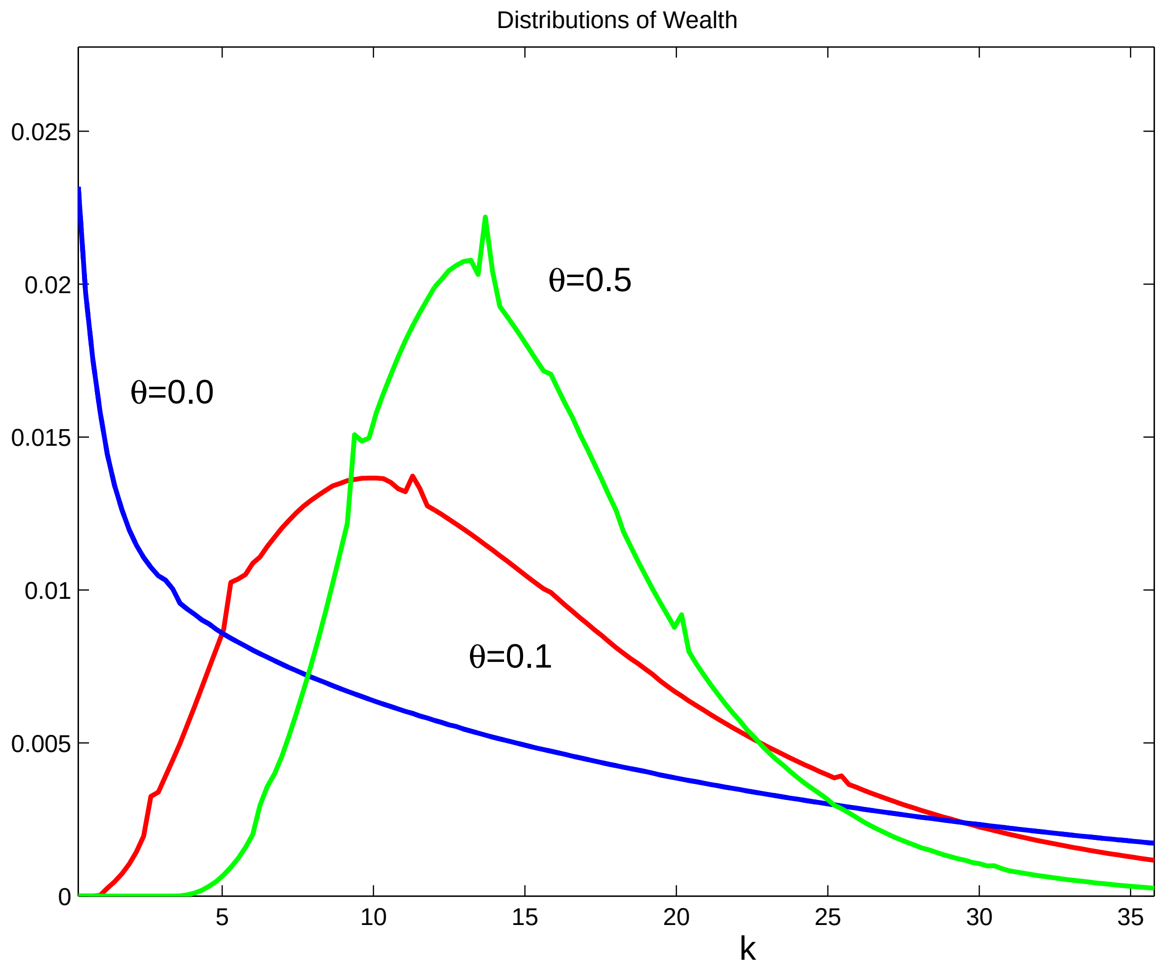

Upper Bounds on r−δ
0.012
0.01
0.008
0.006
0.004
0.002
0
r−δ
0
1000
2000
3000
K/N
θ=0.1
0.012
0.01
0.008
0.006
0.004
0.002
0
r−δ
0
1000
2000
3000
4000
K/N
θ=0.5
0.012
0.01
0.008
0.006
0.004
0.002
0
r−δ
0
5000
10000
15000
K/N
θ=1.0
x 10−3
2.5
2
1.5
1
0.5
0
r−δ
0
2
4
6
8
10
K/N
x 104
θ=5.0

Figure 2



Distributions of Wealth
0.025
0.02
0.015
0.01
0.005
0
5
10
15
20
25
30
35
k
θ=0.0
θ=0.1
θ=0.5

Figure 3

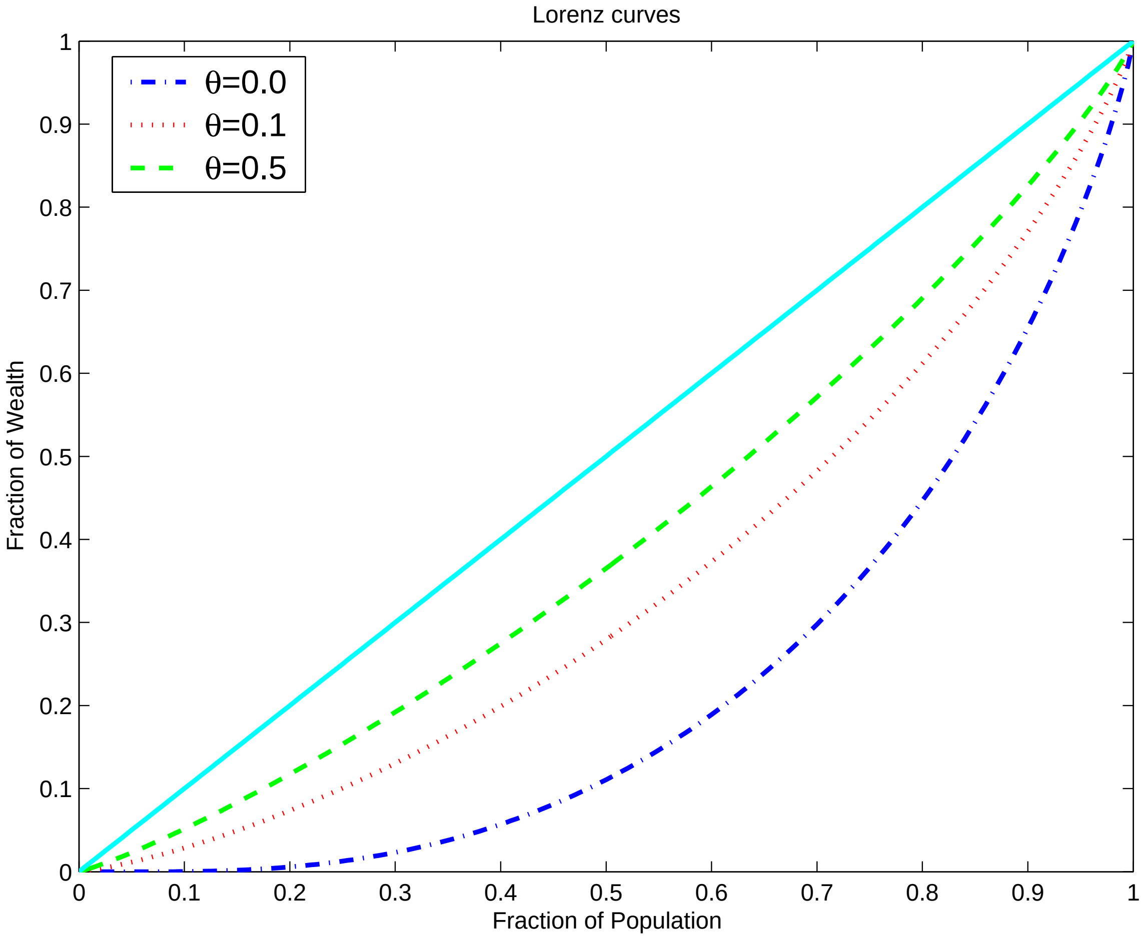

Lorenz curves
θ=0.0
θ=0.1
θ=0.5
Fraction of Wealth
Fraction of Population
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Figure 4

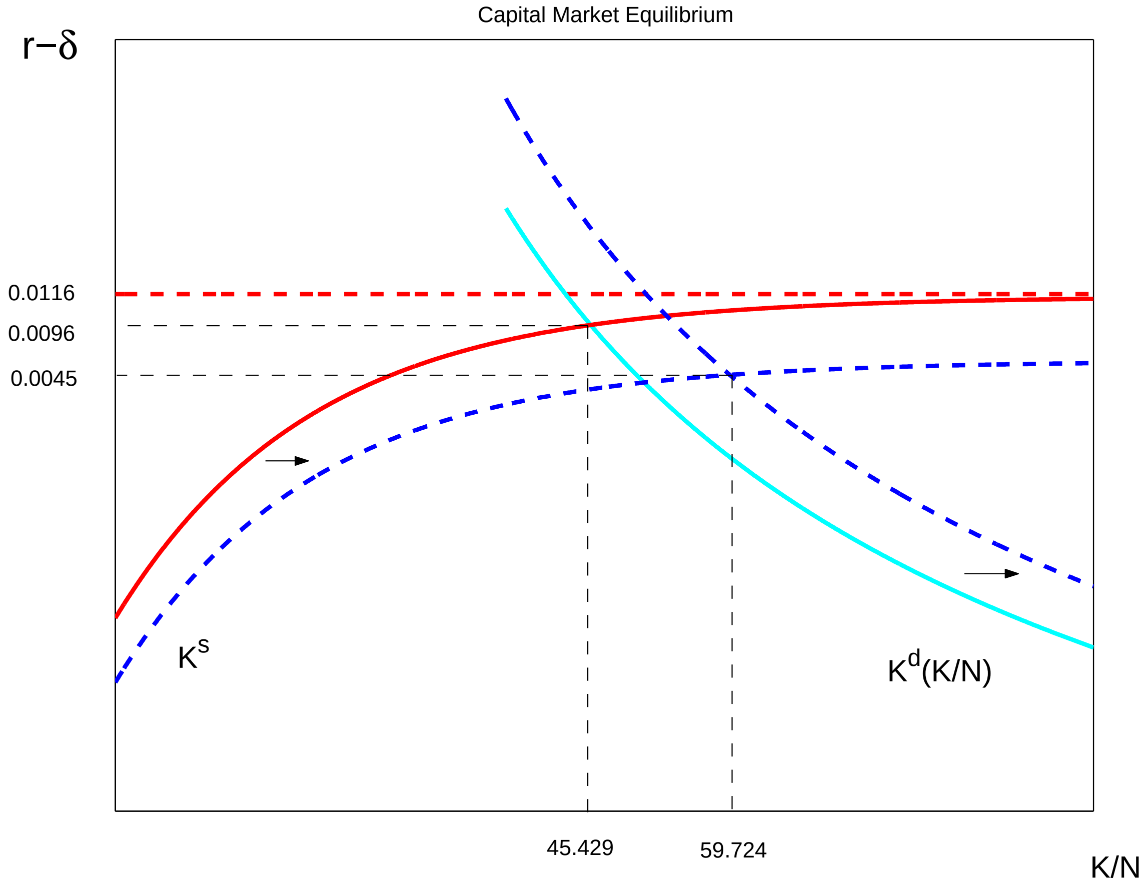
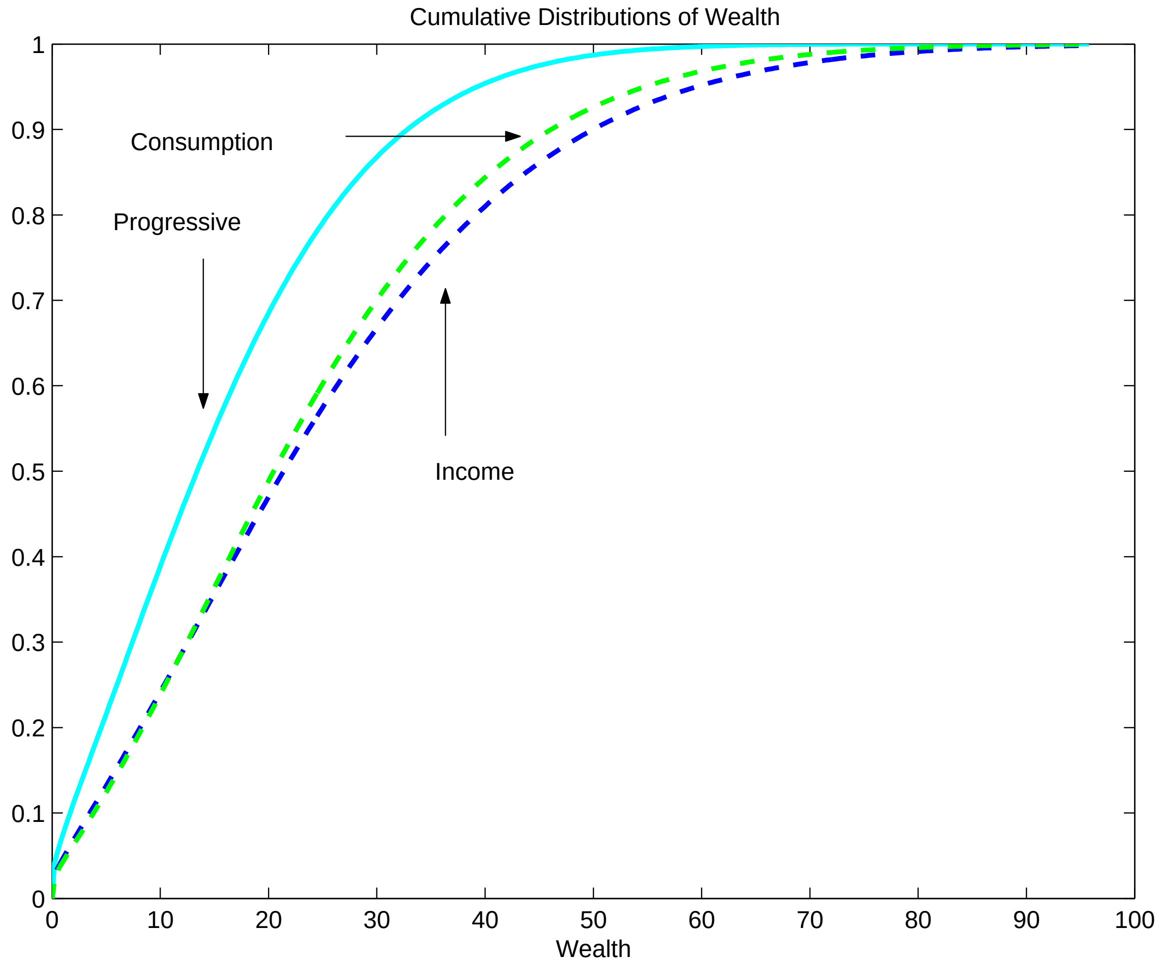

Capital Market Equilibrium
r−δ
0.0116
0.0096
0.0045
K^s
K^d(K/N)
45.429
59.724
K/N

Figure 5



Cumulative Distributions of Wealth
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Consumption
Progressive
Income
0
10
20
30
40
50
60
70
80
90
100
Wealth

7. Computational Appendix (Not For Publication)

In this appendix we detail the solution method used in this paper. It is very similar to the appendix from Young (2004), so that the reader need not consult both. The accuracy of the solution method used here is discussed in Young (2003).

7.1. Solving the Consumer Problem

We wish to implement a solution that has a continuous state space. However, the all-too-common linear-quadratic methods will fail here; one, they fail because the uncertainty in income is large across idiosyncratic states, and two, the borrowing constraint does not bind in every state of the world. We therefore detail now a solution method that builds a nonlinear smooth approximation to the value function.

First, we select a grid in the k direction. For the k direction the value function will have a good deal of curvature, particularly near the borrowing constraint and for high values of σ. Therefore, we choose a large number of grid points, typically between 100-200, and space them such that the majority of points are near the borrowing constraint. Having chosen the grid we now wish to construct an approximate value function. From the previous iteration on the Bellman equation we have the value function exactly at the grid points. We then construct Schumaker splines through the grid points. Schumaker splines are piecewise quadratic polynomials with knots placed on the interior of each segment in such a way as to preserve monotonicity and concavity. With high degrees of risk aversion, standard cubic splines display internodal oscillations which violate the monotonicity and concavity properties of the value function; under such circumstances, it would be difficult to preserve the stability of the Bellman operator since obtaining the true optimum would require robust global optimization methods. With our approximation scheme, we preserve monotonicity and concavity, allowing us to employ gradient methods; it is also possible to show that the approximate Bellman operator is a contraction since our approximation is linear in the function values at the fixed grid points.

Having chosen an approximation for $v(k, y)$, we then solve the equation

$$u_1(c, s, 1-h)\left(-1 + wy\frac{\partial h}{\partial k'}\right) - u_3(c, s, 1-h)\frac{\partial h}{\partial k'} + \beta E\left[v_1(k', y')\,|y\right] = 0 \tag{7.1}$$

subject to the constraint

$$k' \geq 0. \tag{7.2}$$

The labor supply h is determined by the solution to the equation

$$\begin{aligned} u_1(c,s,1-h)\,wy - u_3(c,s,1-h) &\leq 0 \\ &= 0 \text{ if } h > 0, \end{aligned}$$

which is linear in (k, k') and thus can be solved analytically. We use bisection to solve for the optimal value k'. The Schumaker splines allow the calculation of v_1 exactly at any value k'. Denote the solutions by

$$k' = \pi_k(k,y) \tag{7.3}$$

$$h = \pi_h(k,y). \tag{7.4}$$

We update the value function by

$$v^{n+1}(k,y) = u\left((r+1-\delta)k + wy\pi_h - \pi_k, s, 1-\pi_h\right) + \beta E\left[v^n(\pi_k, y')\,|y\right]. \tag{7.5}$$

In the actual computation we use Howard's improvement routine to speed up convergence; this routine solves once for the decision rules and then updates the value function several hundred times without recalculation.[18] We stop whenever

$$\max_{(k,y)} \left| v^{n+1}(k,y) - v^n(k,y) \right| < \varepsilon.$$

7.2. Constructing the Ergodic Set

We now want to use the decision rules from the consumers to compute the implied stationary distribution. To do so, we solve the equation

$$\widehat{v}(k,y) = \max_{k' \geq 0, 0 \leq h \leq 1} \left\{ u\left((r+1-\delta)k + why - k', s, 1-h\right) + \beta E\left[v(k',y)\,|y\right] \right\} \tag{7.6}$$

over a very fine, evenly-spaced grid of 5000 points. Denote the decision rules (which will match the ones before) by π_k and π_h again. Starting from an initial distribution of wealth and employment status, we then use the decision rules to update this distribution.

[18] This procedure defines a contraction mapping as well. However, it can be numerically unstable, so it was only applied after the value function had converged to one decimal place.

Let the initial distribution be $\Gamma_0(k, y)$ and consider a point (k, y) in this distribution. Locate the decision rule $k' = \pi_k(k, y)$ in the grid and calculate the linear interpolation weight

$$\omega = 1 - \frac{\pi_k(k, y) - k_l}{k_h - k_l}. \tag{7.7}$$

Then the mass at (k, y) is "relocated" to the following points in the following portions:

$$\pi_{yy'}\omega\Gamma_0(k, y) \tag{7.8}$$

goes to new point (k_l, y') and

$$\pi_{yy'}(1 - \omega)\Gamma_0(k, y) \tag{7.9}$$

goes to new point (k_h, y'). Looping over all points constructs a new distribution $\Gamma_1(k, y)$. We then check whether the process has converged:

$$\sup_{(k,y)} |\Gamma_1(k, y) - \Gamma_0(k, y)| < \varepsilon?$$

If not, we continue iterating. Once this has converged, we compute

$$\begin{aligned} K &= \int k\Gamma^*(k, y) \\ N &= \int y\pi_h(k, y)\Gamma^*(k, y) \end{aligned}$$

and check whether the implied interest rate equals the one taken as given:

$$r(K, N) - r = 0?$$

If not, we update r using Brent's method until convergence. Brent's method takes upper and lower bounds on r and uses inverse quadratic interpolation to update the guess for the root; the bounds are set arbitrarily since, as shown in the paper, there is not an easy upper bound and the lower bound can actually be below δ when the demand for status is very strong. Whenever the updating would jump outside the bounds, a bisection step is taken instead. During the computations, we must check that the upper bound assumed for the grid of capital is not binding. However, we chose to set the upper bound so high (about 80 times average wealth) that it was never encountered in the computation of any equilibrium.

7.3. Policy Experiments

When solving the model with the progressive income tax, we cannot use the approach detailed above to solve for the policy functions since labor supply functions are no longer linear. Instead, we use a nested bisection procedure that chooses a value for h, obtains the value for k' by bisection, and then determines whether to adjust h up or down using a bisection rule and a numerical one-sided derivative. Because the upper bound on h will never bind, we use a forward derivative. That is, given an h first solve for k' using the inequality

$$-u_1(c,s,1-h)+\beta E\left[v_1(k',y')\,|y\right]\leq 0.$$

Denote the value of this action vector (k',h) by f_1. Then solve for k_2' in the equation

$$-u_1(c,s,1-h_2)+\beta E\left[v_1(k_2',y')\,|y\right]\leq 0,$$

where $h_2 = h + 1.0^{-6}\,|h|$. Denote the value of this action vector (k_2', h_2) by f_2. If f_2 exceeds f_1, then the bisection bounds are adjusted to raise h, otherwise to lower it. We never compute the actual value of the derivative with respect to h, which is approximated by

$$f' \approx \frac{f_2 - f_1}{1.0^{-6}\,|h|},$$

because the value is not needed for the adjustment of the bisection bounds and the calculation will be inaccurate since we must use forward derivatives. While this approach may be slower than alternatives, it is very robust.[19]

For the income tax experiments, we are careful to use the exact same convergence tolerance for both the initial and terminal steady states, so as not to contaminate the result with numerical error. We first calibrate the initial economy using the progressive tax system; we retain the parameters (β,μ) for future use. We then resolve the economy with a flat tax for the return r and the tax rate τ, using the (β,μ) obtained in the calibration step. The tax rate is forced to satisfy the government budget constraint

$$\tau\left((r-\delta)K + wN\right) = gY$$

[19]If speed were a real concern, we could implement Brent's method in the solution of the Kuhn-Tucker conditions; bisection has linear convergence while Brent's method can often obtain better rates than linear. Additional tricks could be applied as well, but the computational time of the model is not that significant.

so that government expenditures are the same fraction of GDP as before the reform. We use a secant method to solve for the tax rate that balances the budget. The same procedure is used to solve the consumption tax experiments, with the obvious change to the government budget constraint:

$$\tau_c C = gY.$$