Redistributive Taxation and Long-Run Income Inequality

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Abstract

Impacts of redistributive taxes on inter-cohort and intra-cohort income inequality are generated by long-run responses in precautionary savings and bequests. In a life-cycle overlapping-generations model with earnings risk, uncertain lifetime and nonaltruistic bequests, the long-run income inequality results from the dynastic accumulation of idiosyncratic shocks. This model is used to compare the short- and long-run effects on income distribution of alternative redistributive tax schemes. Economic process of earning, wealth, income, consumpation and savings are studied for a dynamic economy with heteregenous overlapping agents. Agents minimise income uncertainty and risk by engaging themselved in precautionary savings. Variances of consumtpion, saving and wealth are significantly lower than the variance of income and earning. The progressive taxation in presence of precautionary saving causes further increase in income inequality contrary to traditional beliefs on egalitarian nature of such taxes.

Key Words: Redistributive Taxes, Income Distribution.
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1 Introduction

This paper examines the impacts of redistributive taxes on inter-cohort and intra-cohort income inequality as brought about by long-run responses in precautionary savings that households make to ensure themselves against future income uncertainty, and unintentional bequests which result from imperfect annuitization in the presence of lifetime uncertainty.

In spite of a great deal of research on inequality, surprisingly little has been said in the literature on income inequality as a manifestation of life cycle response of individuals to taxes (von Weizsäcker, 1996). Most of the earlier studies on the distributional impacts of taxes have focused on inter-cohort welfare redistribution (Auerbach and Kotlikoff, 1987; Imrohoroglu and Jones, 1998), leaving income distribution aside. Although it is now well understood that income is a very imperfect indicator of distributional impacts, and is therefore not a good basis for normative prescriptions, the purely positive question of how taxes affect income distribution is of intrinsic interest.[1] This is the notion of inequality that this paper focuses on.

Several recent empirical studies have attempted to uncover the main factors accounting for rising inequality of income in the UK (Johnson and Webb, 1993; Goodman and Webb, 1994; and Jenkins, 1991, 1995, 1996). Overall, there seem to be three main empirical findings that all of these studies concur upon: (i) inequality in income distribution is growing. The income share of the bottom decile has declined with the share of the top decile showing a relatively steeper growth trend after 1980s; (ii) inequality of earning is the major source of growing inequality in income distribution. Wage inequality has contributed most to income inequality. The differences in earning of working and non-working households is another reason of inequality. Then comes the disparity of income in self-employment sector among households; (iii) changes in the demographic structure (the larger proportion of aged individuals in the population), changes in the structure of employment (e.g. the greater proportion of low-paying self-employment or part-time jobs), and alterations in productions technology (i.e. a shift from manufacturing to services) have also noticeably influenced income distribution in the UK in recent years.

Thus, changes in the tax and benefit system in 1980s are found by all studies to be a major factor contributing to the rising inequality in income. But all of the above studies focus only on the linkage between income distribution and contemporary tax changes. The main argument advanced in this paper is that empirical studies that do not properly account for long-run savings responses to taxes, and in particular the responses in precautionary savings and bequests, might produce misleading results. Precautionary savings that vary according to intertemporal preferences and attitude towards risk of individuals are important

[1] Current income remains the key dimension upon which real-world redistributive policies are based, possibly because it is a good proxy of political interest for the various generations currently alive.

sources of wealth accumulation. Much of the inequality seen at old age can be related to the saving behaviour in response to earnings uncertainty and taxes (Caballero, 1991). Furthermore, it has been argued that a large fraction of observed savings are associated with unintentional bequests stemming from the absence of perfect annuity markets (Kotlikoff, 1988). Different realizations of lifetime duration for different individuals would then generate dynastic effects, which would also be affected by tax responses in old-age savings behaviour.

In order to explore the implications of precautionary savings and bequests responses for the long-run impact of taxes on income distribution, we develop a life-cycle overlapping-generations model of redistributive taxation in a small open economy with idiosyncratic earnings risk and lifetime uncertainty, where income inequality at any point in time stems both from age-related differences in accumulated wealth and from differences in the realizations of life-cycle earnings profiles across individuals belonging to the same cohort, as well from accumulated dynastic effects linked with unintentional bequests. Savings in this model are due to consumption-smoothing reasons as well as precautionary reasons, to insure against earnings shocks and lifetime uncertainty.

This framework is related to recent work on the impacts of stochastic life-cycle earnings processes on intra-cohort wealth distribution (Deaton and Paxson, 1994; Pemberton, 1977; Davies, 1997); but, in contrast with these earlier studies, it is extended here to account for dynastic linkages through bequests, and is used to examine the short- and long-run impacts of redistributive taxation on income distribution. We focus on a pure redistributive tax, whose proceedings are used to finance a uniform lump-sum transfer to all individuals alive in each given period, and decompose distributional impacts by deriving variance and concentration based measures of inter- and intra-cohort, real, after-tax income inequality. We compare effects of redistributive taxes levied respectively on labour income, comprehensive income, and consumption. For each type of tax base, we examine how short- and long-run effects on inequality diverge in dependence of time preference, attitudes towards risk and on the stochastic structure of life-cycle earnings.

We find that, while behavioural responses to a redistributive earnings tax make its long-run impacts on income inequality more pronounced than its corresponding short run impacts, the effect of long-run responses to a redistributive income tax are ambiguous, and effects on inter- and intra-cohort inequality are possibly of different sign. Overall variance of income, within and across generations can increase in response to income taxes, which is contrary to the conventional belief that income taxes are progressive. Likewise, for most configuration of time preference and intertemporal substitution parameters with low or high risk aversion, individual responses to taxes on earnings results in smaller variance of income, implying less inequality in income distribution, again contrary to conventional wisdom that earning taxes are regressive.

Because of this divergence between short and long-run impacts, findings of earlier empirical studies on tax impacts on income distribution which have not duly taken into account responses in precautionary savings behaviour might be misleading. To explore the potential importance of these responses, we use a larger-scale version of our model, calibrated to capture stylized facts concerning the structure of the UK economy, deriving estimates of effects of tax reform in the 1980s on long-run income inequality. Our simulation results suggest that, when reactions in precautionary saving behaviour are accounted for, long-run effects might considerably larger than short run effects, perhaps on average by a factor 3.5

The plan of the paper is as follows. Section 2 describes the model. Section 3 derives implications for income distribution of alternative forms of redistributive taxation. Section 4 describes the calibrated version of the model, and presents simulation results. Section 5 concludes.

2 An Overlapping-Generations Life Cycle Model with Earnings and Lifetime Uncertainty, and Nonaltruistic Bequests

In this section we shall describe the basic structure of an overlapping-generations open economy with earnings and lifetime uncertainty, and redistributive taxation. In the subsequent sections, this model will be used to explore the effects of alternative redistributive tax schemes on long-run income inequality.

2.1 The Lifecycle Problem

Each cohort born at time j is composed of $n_j = (1+\gamma)^j$ individuals, where $\gamma > 0$ is the population growth rate.

Lifetime is uncertain; the survival probability at age t (the probability of being alive at age $t+1$ conditional on being alive at age t) is ξ_t, with $\xi_T = 0$, i.e. individuals never live longer than T periods. Let λ_t^j be the life "status" at age t of an individual of cohort j, with $\lambda_t^j = 1$ signifying that the individual is alive at age t and $\lambda_t^j = 0$ signifying that death has occurred before age t. Then, lifetime uncertainty can be represented by the following process

$$\lambda_{t+1} = \lambda_t^j \delta_t, \tag{1}$$

where δ_t is a random variable which takes a value of 1 with probability ξ_t and a value of 0 with probability $1-\xi_t$. We shall denote with λ^j a certain sequence of realizations of λ_t^j, $t = 1, \ldots, T$, for a certain individual in cohort j.

Earnings θ_t^j for an individual in cohort j at age t are subject to idiosyncratic shocks that can be summarized by an ARMA(1,1) process:[2]

$$\theta_{t+1}^j = \theta_t^j + \epsilon_{t+1} - \rho\epsilon_t, \tag{2}$$

where ϵ_t is an independently distributed shock with zero mean and constant variance. The parameter ρ captures the degree of persistency in earnings shocks:

[2]In our analysis, we shall abstract from economywide earnings shocks, which may imply an understatement of the importance of precautionary motives in lifecycle choices.

if $\rho = 1$, earnings innovations are fully permanent and the earnings process is a "random walk" (as in Banks and Blundell (1995)); if $\rho = 0$ income innovations are fully temporary (white noise). We shall use the symbol θ^j to denote a given realization of earnings θ_t^j, $t = 1, \ldots, T$, for a certain individual in cohort j.

Next, consider a specific individual in cohort j, who is dynastically linked with a specific individual in cohort $j - d + 1$, with d being the age at which individuals produce children. For simplicity we shall assume that no individual dies before producing an offspring, i.e. $\xi_t = 0$, $t < d$. If the parent in cohort $j - d + 1$ at the end of the period when the child is of age t, the child receives a bequest, V_{t+1}^j, at age $t + 1$. From the point of view of the child, bequests are also a random variable entering their budget constraint (how bequests are determined will be discussed below). Income received by an individual in cohort j at age t is

$$m_t^j = \lambda_t^j (W_t^j r + \theta_t^j), \tag{3}$$

where W_t^j is wealth at age t and r is the rate of interest, which is assumed to be exogenously determined and constant (consistently with our small open economy assumption).[3] Thus, we can write the wealth accumulation equation for an individual in cohort j as

$$W_{t+1}^j = \lambda_{t+1}^j (W_t^j + m_t^j - c_t^j + V_t^j) = \lambda_{t+1}^j (W_t^j (1 + r) + \theta_t^j - c_t^j + V_t^j). \tag{4}$$

If the individual dies at age t, all of her residual wealth is bequeathed to her offspring and becomes zero in subsequent periods. In addition a no-bankruptcy condition of some sort is required here; perhaps it could simply be that individuals' wealth at death must be non-negative. The bequest left in each period is thus

$$B_{t+1}^j = (\lambda_t^j - \lambda_{t+1}^j)(W_t^j (1 + r) + \theta_t^j - c_t^j + V_t^j), \tag{5}$$

which will only be positive in the period $t + 1$ in which the individual dies (i.e., when $\lambda_t^j - \lambda_{t+1}^j > 0$).

Individuals only derive utility form consumption c_t^j. Preferences are assumed to be intertemporally separable, and expected utility at age t can be recursively defined as

$$U_t^j = F(c_t^j) + \frac{1}{1 + \beta} E(U_{t+1}^j \lambda_{t+1}^j \mid \lambda_t^j, \theta_t^j, W_{t+1}^j, \lambda_t^{P(j)}, \theta_t^{P(j)}, W_{t+1}^{P(j)}). \tag{6}$$

where F is a concave instantaneous utility function, β is the pure rate of time preference, and E denotes an expectation, and where $\lambda_t^{P(j)}$, $\theta_t^{P(j)}$ and $W_t^{P(j)}$ are respectively the life status, and the level of earnings and wealth of the parent when the child is of age t, i.e. $\lambda_t^{P(j)} \equiv \lambda_{d+t}^{j-d+1}$, $\theta_t^{P(j)} \equiv \theta_{d+t}^{j-d+1}$ and $W_t^{P(j)} \equiv W_{d+t}^{j-d+1}$. Note that in an intergenerational equilibrium, the bequests left by the parents will equal the bequests received by their children, i.e., for individuals which are dynastically linked, we will have

$$V_t^j = B_{d+t}^{j-d+1} \equiv B_t^{P(j)}. \tag{7}$$

[3] We thus also abstract from worldwide economic fluctuations.

Due to this linkage, the probability distribution of the bequests the child expects from the parent will be dependent on the parent's wealth and earnings level at any point in time before the parent's death occurs; this is why the expectation in (6) is also conditioned on the parent's earnings and wealth.

In this model, bequests are unintentional and arise because of incomplete annuitization of death risk ... [there seems to be more empirical support for this type of bequests than for Barro type altruistic bequests (Kotlikoff(1988))].

The optimal consumption pattern c_t^j, $t = 1, \ldots, T$, for an individual in cohort j is then found by maximization of her first period expected utility U_1^j as defined by (6) subject to (1), (2), (4), (5), for a given distribution of her possible earnings histories, θ^j, of her parent's lifetime outcomes and earnings histories $\lambda^{P(j)}$, $\theta^{P(j)}$, and of the parent's initial wealth when the child is borne, $W_1^{P(j)}$ (information on initial wealth is sufficient for the child to reconstruct the probability distribution of bequests on the basis of the parent's optimization problem).

2.2 Long-Run Equilibrium and Income Distribution

A long-run equilibrium path for this economy can be characterized as follows. Let G denote a given distribution of individuals' wealth when they produce offspring, $W_1^{P(j)}$. For a given G, each individual solves the problem described in the previous section, which, via the probability distributions of λ^j and θ^j, induces a probability distribution over wealth held by individuals at age $1+d$. Let this mapping from G to a wealth distribution for new parents with the symbol g. Then, in a long-run equilibrium, the following fixed point condition must be satisfied:

$$G = g(G). \tag{8}$$

Such an equilibrium gives rise to a distribution of income for cohorts on the long-run equilibrium path; if the number of individuals in each cohort is sufficiently large, the distribution of income realizations can be approximated by the probability distribution. Thus, the average income of individuals of age t can be expressed as

$$E(m_t) = \sum_{\theta^j, \lambda^j, W_1^{P(j)}, \theta^{P(j)}, \lambda^{P(j)}} G(W_1^{P(j)}) Pr(\theta^j) Pr(\lambda^j) Pr(\theta^{P(j)}) Pr(\lambda^{P(j)})$$

$$\lambda_t^j m_t^j(\theta^j, \lambda^j, W_1^{P(j)}, \theta^{P(j)}, \lambda^{P(j)}), \tag{9}$$

where Pr denoted probability, and income m_t^j is written as a function of the realizations of the random variables involved. Overall average income in the economy is

$$E(m) = \frac{\sum_t (1+\gamma)^{T-t} E(m_t)}{\sum_t (1+\gamma)^{T-t}}. \tag{10}$$

A summary measure of intra-cohort income inequality can be obtained by computing age-conditional variances:

$$\sigma^2(m_t) = \sum_{\theta^j, \lambda^j, W_1^{P(j)}, \theta^{P(j)}, \lambda^{P(j)}} G(W_1^{P(j)}) Pr(\theta^j) Pr(\lambda^j) Pr(\theta^{P(j)}) Pr(\lambda^{P(j)})$$

$$[\lambda_t^j m_t^j(\theta^j, \lambda^j, W_1^{P(j)}, \theta^{P(j)}, \lambda^{P(j)}) - E(m_t)]^2; \qquad (11)$$

whereas inter-cohort income inequality can be measured by

$$\sigma^2(E(m_t)) = \frac{\sum_t (1+\gamma)^{T-t} [E(m_t) - E(m)]^2}{\sum_t (1+\gamma)^{T-t}}. \qquad (12)$$

Finally, overall income inequality can be measured by

$$\sigma^2(m) = \left(\sum_t (1+\gamma)^{T-t} \sum_{\theta^j, \lambda^j, W_1^{P(j)}, \theta^{P(j)}, \lambda^{P(j)}} G(W_1^{P(j)}) Pr(\theta^j) Pr(\lambda^j) Pr(\theta^{P(j)}) Pr(\lambda^{P(j)}) \right.$$

$$\left. \left[\lambda_t^j m_t^j(\theta^j, \lambda^j, W_1^{P(j)}, \theta^{P(j)}, \lambda^{P(j)}) - E(m) \right]^2 \right)$$

$$/ \left(\sum_t (1+\gamma)^{T-t} \right). \qquad (13)$$

Higher-order moments can also be obtained using the same approach, but for the purposes of our analysis the first and second order moments will suffice.

Note that, provided the number of individuals is sufficiently large, there is no aggregate uncertainty in this setup. Thus, it would in principle be possible to provide everyone with full insurance against both earnings and lifetime uncertainty. [?? more]

3 Redistributive Taxation and Income Inequality

In this section we extend the model described above in order to incorporate the effects of redistributive taxation on income inequality. Our analysis will focus on non-discriminatory redistributive schemes, where individuals pay taxes on a certain tax base at a given rate, irrespectively of age, and tax revenues are used to finance an identical lump-sum transfer to all individuals, again irrespectively of age or any other characteristics. Formally, equation (4) becomes

$$W_{t+1}^j = \lambda_{t+1}^j \{ W_t^j [1 + r(1 - t^K)] + \theta_t^j (1 - t^L) - c_t^j (1 + t^C) + V_t^j + Z \}. \qquad (14)$$

where t^L, t^K, and t^C are rates of proportional taxation respectively on labour income, capital income (residence based), and consumption, and Z is a uniform lump-sum transfer. A lung-run equilibrium for this economy is identified by the first-order conditions for the modified optimization problem and the fixed point condition (8) together with the budget balance condition

$$\sum_{t=1}^{T}(1+\gamma)^{T-t}Z = \sum_{t=1}^{T}(1+\gamma)^{T-t}$$

$$\sum_{\theta^j,\lambda^j,W_1^{P(j)},\theta^{P(j)},\lambda^{P(j)}} G(W_1^{P(j)})Pr(\theta^j)Pr(\lambda^j)Pr(\theta^{P(j)})Pr(\lambda^{P(j)})$$

$$\lambda_t^j[W_t^j(\theta^j,\lambda^j,W_1^{P(j)},\theta^{P(j)},\lambda^{P(j)})rt^K + \theta_t^j t^L$$

$$+c_t^j(\theta^j,\lambda^j,W_1^{P(j)},\theta^{P(j)},\lambda^{P(j)})t^C]. \qquad (15)$$

The remainder of this section will be devoted to a discussion of the mechanisms which determine the effects in long-run inequality of redistributive schemes based on alternative tax bases. Results of a quantitative investigation of these effects via a calibrated model will be presented in the next section.

Long-run impacts of taxes on income inequality diverge from the corresponding short-run impacts because of the induced long-run effects on lifecycle wealth accumulation and bequests; and, depending on the tax base used, the sign of this divergence can be positive or negative.

In the presence of earnings uncertainty, a transfer financed by wage taxation is unambiguously progressive (with respect to the distribution of after-tax income) in the long run than it is in the short run, both in terms of inter-cohort and intra-cohort inequality. This is because an earnings tax provides insurance against earnings uncertainty, which depresses precautionary savings and results in smaller non-labour income tax differentials across individuals within and across cohorts.This may to some extend depend on the elasticity of intertemporal substitution.

A transfer of the same amount funded by comprehensive income taxation generates a larger short-run impact on inter-cohort and intra-cohort income distribution but if life-cycle consumption profiles are sufficiently steep, it can be more regressive in the long-run. Precautionary savings, bequests and consumption taxes have fair roles in such redistribution.

4 A Calibrated Model of the Long-Run Distribution of Income for the UK

This section describes simulation experiments of the effects on long-run income distribution of alternative redistributive tax schemes, performed using a calibrated version of the model described in the previous two section. We shall begin by describes the methodology we employed for obtaining an approximated equilibrium.

Solution to the lifecycle problem described in Section 2.1 yields the following condition:

$$F'(c_t^j) = \frac{1+r}{1+\beta} E[F'(c_{t+1}^j)\lambda_{t+1}^j \,|\, \lambda_t^j, \theta_t^j, W_{t+1}^j, \lambda_t^{P(j)}, \theta_t^{P(j)}, W_{t+1}^{P(j)}]. \tag{16}$$

This is the Euler equation of the problem, which summarizes the law of motion of consumption. In order to use the above for characterizing consumption behaviour, it is necessary to know the form of the expectation on the right-hand side of (16). Because of the high dimensionality involved, characterizing an exact solution for this problem is not feasible.

To obtain an approximation to a true solution, we adapt the parameterized expectations technique that was first described by de Haan and Marcet (1990) with application to a stochastic growth model. The general idea behind the approach is to approximate the expectations on the right-hand side of (16) by a parameterized function of the state variables $\lambda_t^j, \theta_t^j, W_{t+1}^j, \lambda_t^{P(j)}, \theta_t^{P(j)}, W_{t+1}^{P(j)}$. Starting form an initial guess of the parameters, the expectation so obtained are used to derive optimal lifecycle choices, and then these are in turn used to update the parameters of the approximating function by running a regression of it on the actual choices obtained. This sequence of steps is repeated until convergence is reached, i.e. until the approximated expectation is consistent with the actual realizations.

Because the lifecycle optimization problem individuals face in our model has a finite horizon and because of the presence of bequests, however, the sampling technique and computational strategy we use is rather different from that described by de Haan and Marcet. First, the expectation on the right hand-side of (16) is approximated by means of an age-dependent function

$$\psi_t(\lambda_t^j, \theta_t^j, W_{t+1}^j, \lambda_t^{P(j)}, \theta_t^{P(j)}, W_{t+1}^{P(j)}) \tag{17}$$

The functional form we use is logs of expected income and we also introduce lagged θ as it improves performance considerably

To parameterize the above, we begin by postulating a distribution of W_t^j, and then generate a large number of samples for λ^j, θ^j, W_t^j, and $\lambda^{P(j)}$, $\theta^{P(j)}$, $W_t^{P(j)}$. Beginning at age $T-1$, for each sampled point, we generate a certain (large) number of realizations of the random variables involved at $T+1$. Then, starting from an initial guess of the parameters of ψ_{T-1} we use the approximated Euler equation together with (1), (2) and (4) to compute c_T^j for all realizations. Next, we run a non-linear regression of ψ_{T-1} on c_T^j, and repeat this procedure until an good approximation to ψ_{T-1} is achieved;[4] after which the parameters of ψ_{T-1} are held constant and the same procedure is applied to determine the parameters of ψ_{T-2}, and so on moving backwards to ψ_1. Once this sequence of calculation is completed, we can compute the implied distribution for W_t^j. This is typically not be consistent with the sample assumed at the outset; this sample

[4] We stop this iteration process when the change in the squared residuals from successive iterations falls below a certain tolerance level.

is thus updated on the bases of this new information and then the process is repeated. We have found that a few iterations of this algorithm are sufficient to provide a good approximation. [5]

5 Solutions of the model

Above model is solved with a set of parameter values listed in Table 1 for a sample of 500 imaginary random individuals in each cohort that are subject to stochastic shocks to their income and are alive conditionally as explained by survival probabilities.λ_t^j. Corresponding age dependent profiles of earning, wealth, icome, consumtion and saving are given in Table 2 to 6 respectively. These economic agents experience a humped shaped earning and income profiles as shown in Table 2 and 4 consistent to the life cycle theory of income. Consumption is smoother income but rises as individuals become older. Agents borrow in early period of their life and disave in the retirement period. These are reflected in the wealth and saving profiles of these households.

Uncertainty in income, wealth, consumption and saving is measured by their variances reported in Tables 7 to 11. Precautionary motives and attitude towards risk aversion cause the variance of saving and wealth to be significantly lower than the variance of consumption or income. Short and long run inequaltiy measured by the ratio of variance of cohort 5 to cohort 1 is around 3.5. Older cohort expereince more inequality than younger generation as preferences of individauls vary regarding current versus future consumption the income inequality rises as individuals become loder. Opportunity for bequests are other factors for variances.

Averages and variance of of earning, wealth , income, consumption and saving for each cohort for sample over 500 individuals as reported above clearly demonstrate the degree of income uncerstainty as given in equations (1) to (7). Process of intertemporal borrowing and lending reduced individual risks but variation in preferences as well as differences in response income, labour and consumption taxes only contributes towards greater inequality.

Table 1: Parameters of the Model

β	γ	g	r	ρ	θ	ξ	ι	cohorts	Sample	minor	major
0.995	0.15	0.015	0.05	-1.0	0.15	0-1	0.5	$t1$ to $t5$	500	2	25

[5] The degree of approximation can be measured by computing the Euler residuals, i.e. the difference between actual and rexpected series. Our approximation is such that this residual is statistically insignificant using a standard Normal distribution

$$\mu - z\sigma < \frac{\mu - x}{\sigma} < \mu + z\sigma = 1 - \alpha, \tag{18}$$

where α is the probability of an error (which we select to be equal to 0.0001), μ, σ, z are respectively the mean, variance and the standard normal variate of a random variable, in this case income. See Christiano and Fisher (1994) for a discussion of methods for assessing the performance of parameterized expectations procedure.

Table 2: average earning by cohort

Cohorts	1	2	3	4	5	6	7
t1	1.0078	1.0078	1.0078	1.0078	1.0078	1.0078	1.0078
t2	1.7578	1.7578	1.7578	1.7578	1.7578	1.7578	1.7578
t3	2.0037	2.0037	2.0037	2.0037	2.0037	2.0037	2.0037
t4	1.7437	1.7437	1.7437	1.7437	1.7437	1.7437	1.7437
t5	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894

Table 3: Average Wealth by Cohort

Cohorts	1	2	3	4	5	6	7
t1	-0.0114	-0.0114	-0.0114	-0.0114	-0.0114	-0.0114	-0.0114
t2	-0.0581	-0.0581	-0.0576	-0.0581	-0.0576	-0.0581	-0.0596
t3	0.2936	0.2936	0.2677	0.2936	0.2617	0.2936	0.2889
t4	0.7814	0.7814	0.7729	0.7814	0.77	0.7814	0.7804
t5	0.9976	0.9976	1.0037	0.9976	0.9875	0.9976	0.9896

Table 4: average income by cohort

Cohorts	1	2	3	4	5	6	7
t1	1.0006	1.011	1.011	1.0039	1.0039	1.0047	1.0047
t2	1.7213	1.7331	1.7227	1.7195	1.7199	1.7211	1.7202
t3	2.1883	2.1891	2.1734	2.1849	2.1837	2.1854	2.1825
t4	2.2351	2.2206	2.2147	2.2335	2.2263	2.2319	2.2251
t5	1.6168	1.5954	1.5981	1.6202	1.6138	1.6173	1.6122

6 Concluding Remarks

Impacts of redistributive taxes on inter-cohort and intra-cohort income inequality are generated by long-run responses in precautionary savings and bequests. In a life-cycle overlapping-generations model with earnings risk, uncertain lifetime and nonaltruistic bequests, the long-run income inequality results from the dynastic accumulation of idiosyncratic shocks. This model is used to compare the short- and long-run effects on income distribution of alternative

Table 5: Average consumption by cohort

Cohorts	1	2	3	4	5	6	7
t1	1.0473	1.0577	1.0752	1.0506	1.0500	1.0514	1.0529
t2	1.3696	1.3815	1.3694	1.3679	1.3706	1.3695	1.3716
t3	1.7006	1.7013	1.6682	1.6972	1.7054	1.6977	1.7010
t4	2.0189	2.0043	2.9839	2.0172	2.0089	2.0157	2.0059
t5	2.6144	2.5931	2.6017	2.6178	2.6013	2.6149	2.6018

Table 6: Average savings by cohort

Cohorts	1	2	3	4	5	6	7
t1	-0.0467	-0.0467	-0.0643	-0.0467	-0.0462	-0.0467	-0.0482
t2	0.3517	0.3517	0.3433	0.3517	0.3493	0.3517	0.3485
t3	0.4878	0.4878	0.5052	0.4878	0.4873	0.4878	0.4815
t4	0.2162	0.2162	0.2308	0.2162	0.2175	0.2162	0.2192
t5	-0.9976	-0.9976	-1.0037	-0.9976	-0.9875	-0.9976	-0.9896

redistributive tax schemes. Economic process of earning, wealth, income, consumpation and savings are studied for a dynamic economy with heteregenous overlapping agents. Agents minimise income uncertainty and risk by engaging themselved in precautionary savings. Variances of consumtpion, saving and wealth are significantly lower than the variance of income and earning. The progressive taxation in presence of precautionary saving causes further increase in income inequality contrary to traditional beliefs on egalitarian nature of such taxes.

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Table 7: Variance of earning by cohort

Cohorts	1	2	3	4	5	6	7
t1	0.1375	0.1375	0.1375	0.1375	0.1375	0.1375	0.1375
t2	0.2532	0.2532	0.2532	0.2532	0.2532	0.2532	0.2532
t3	0.3941	0.3941	0.3941	0.3941	0.3941	0.3941	0.3941
t4	0.4857	0.4857	0.4857	0.4857	0.4857	0.4857	0.4857
t5	0.5436	0.5436	0.5436	0.5436	0.5436	0.5436	0.5436

Table 8: Variance of Wealth by Cohort

Cohorts	1	2	3	4	5	6	7
t1	0.1436	0.1436	0.1436	0.1436	0.1436	0.1436	0.1436
t2	0.1748	0.1748	0.1696	0.1748	0.1746	0.1748	0.1740
t3	0.1879	0.1879	0.1770	0.1879	0.1884	0.1879	0.1870
t4	0.1675	0.1675	0.1504	0.1675	0.1689	0.1675	0.1667
t5	0.0932	0.0932	0.0867	0.0932	0.0917	0.0932	0.0910

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Table 9: Variance of income by cohort

Cohorts	1	2	3	4	5	6	7
t1	0.1668	0.1643	0.1643	0.1661	0.1661	0.1659	0.1659
t2	0.2592	0.2578	0.2544	0.2577	0.2571	0.2577	0.2568
t3	0.3670	0.3675	0.3633	0.3645	0.3631	0.3649	0.3631
t4	0.4404	0.4422	0.4453	0.4372	0.4343	0.4378	0.4356
t5	0.5517	0.5511	0.5572	0.5481	0.5465	0.5484	0.5478

Table 10: Variance of consumption by cohort

Cohorts	1	2	3	4	5	6	7
t1	0.1706	0.1683	0.1751	0.1699	0.1710	0.1697	0.1715
t2	0.3111	0.3098	0.3105	0.3096	0.3108	0.3096	0.3108
t3	0.4036	0.4033	0.3881	0.4012	0.4030	0.4015	0.4012
t4	0.3697	0.3701	0.3642	0.3668	0.3630	0.3672	0.3630
t5	0.5767	0.5757	0.5896	0.5732	0.5688	0.5735	0.5712

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Table 11: Variance of savings by cohort

Cohorts	1	2	3	4	5	6	7
t1	0.0865	0.0865	0.0878	0.0865	0.0865	0.0865	0.0866
t2	0.0850	0.0850	0.0872	0.0850	0.0859	0.0850	0.0860
t3	0.1050	0.1050	0.1041	0.1050	0.1060	0.1050	0.1056
t4	0.1424	0.1424	0.1409	0.1424	0.1438	0.1424	0.1434
t5	0.0932	0.0932	0.0867	0.0932	0.0917	0.0932	0.0910

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