Redistribution Policy in a Model with Heterogeneous Time-Preference*

David Andolfatto†
Simon Fraser University

James Redekop
University of Waterloo

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Abstract

We examine how redistribution policy affects the distribution of earnings when human capital accumulation is endogenous and the fundamental source of heterogeneity in the economy stems from differences in the pure rate of time-preference. The model produces a steady-state equilibrium in which more more patient individuals become higher skilled, earn higher wages, and work longer hours; a feature that is consistent with observation.

Using this as our theory of the earnings distribution, we find that a more generous redistribution policy exacerbates earnings inequality, especially in the long-run. After-tax income inequality is reduced substantially, but only in the short-run. In comparing steady-states, a majority of individuals prefer the absence of government intervention. Nevertheless, when one takes into account transition dynamics, a majority of individuals may vote in favor of implementing a redistribution policy. The distribution of time-preference plays a critical role in generating this last result.

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†Corresponding author: Department of Economics, Simon Fraser University, Burnaby, British Columbia, Canada, V5A 1S6. Email: dandolfa@sfu.ca. Phone (604) 291–3508. Fax (604) 291–5944.

1 Introduction

The purpose of this paper is to explore some of the economic and political aspects of redistribution policy within the context of a simple dynamic general equilibrium model. The model we study emphasizes the role of a particular form of parameter heterogeneity; namely, in the rate of pure time preference. We illustrate how heterogeneous time-preference can lead to a distribution of wage rates (human capital) and earnings (labor supply). Using this as our theory of the earnings distribution, we evaluate the economic implications of a government policy designed to redistribute income with a negative income tax instrument; i.e., a universal lump-sum transfer financed with a flat tax on earnings.

While there are a number of different ways in which to model heterogeneity, we find the hypothesis of heterogeneous time-preference to be compelling for a number of reasons. To begin, there is a long tradition in economics, beginning at least with Rae (1834) that stresses the role of heterogeneous discounting in determining differences in personal consumption and investment behavior.[1] To the extent that personal investments include additions to human capital, the hypothesis potentially provides a parsimonious explanation of the joint behavior of earnings and wealth, as well as other economic variables.[2] In particular, more patient individuals are likely to invest more heavily in human capital, so that their wages are higher. These higher wages may induce them to work harder as well, so that highly skilled individuals are associated with higher earnings, labor supply, and living standards, in accordance with the data; see Attanasio (1994) and Card (1998). One goal of our paper is to determine to what extent the model is consistent with these basic facts.

Secondly, there is a considerable amount of empirical support for the notion

[1] Rae refers to time-preference as 'the effective desire of accumulation.' He describes this parameter as a trait that individuals develop early on in life, primarily as a habit formed from the example set forth by other members in their society. His theory of economic development is based on cultural differences in the propensity to discount.

[2] Standard neoclassical growth models have a difficult time in replicating the joint distribution of income and wealth; see Quadrini and Rios-Rull (1997).

of heterogeneous discounting. Psychologists have long pointed out that 'the willingness to defer gratification' appears to differ both across members of a given population as well as over time for any given person (in particular, from infancy to adolescence). A number of psychological studies purport to show that the willingness to defer gratification correlates positively with various measures of success; see Maital and Maital (1977) and Wärneryd (1999). Economic studies also lend support to the presence of heterogeneous discounting. For example, using household data on the purchase and use of air conditioners, Hausman (1979) estimates that discount rates range between 8.9 and 39 percent per annum and that they vary inversely with income. Lawrance (1991) uses the Panel Study of Income Dynamics to estimate pure rates of time preference that range from 12 percent for high-income college educated individuals, to 19 percent for low-income individuals without a college education. Dreyfus and Viscusi (1995) estimate annual rates of time preference ranging between 11 and 17 percent, using a hedonic pricing model for automobiles. Samwick (1998) uses an overlapping generations structure and wealth data from the Survey of Consumer Finances to estimate discount rates ranging between -15 and 20 percent. Consistent with other empirical work, he finds a negative relation between the rate of time preference and income. More recently, Warner and Pleeter (2001) use evidence from military downsizing programs to estimate personal discount rates ranging betwen 0 and 30 percent.[3]

If heterogeneous time-preference is a fact of life, then what are the likely consequences for economic inequality? Rader (1981, pg. 232) demonstrates that in an intertemporal endowment economy (with additive discounted utility functions over an infinite horizon), efficiency implies that the most patient individuals asymptotically consume the economy's entire output. In a decentralized version of his model, this rather extreme result would depend crucially on the tenuous assumption that individuals have the ability to commit to debt con-

[3]On the other hand, Ogaki and Atkeson (1997) use a panel of household level data from India to reject the hypothesis of heterogeneous rates of pure time preference in favour of heterogeneous intertemporal elasticities of substitution.

tracts that would leave them impoverished at some future date.[4] Becker (1980) extends Rader's analysis by allowing for capital accumulation; he also imposes a non-negative net worth restriction. Becker demonstrates that the most patient household ends up owning the entire capital stock with the remainder of the population resorted to consuming their wage earnings.[5]

While the extremity of these outcomes may call into question the relevance of the theory for explaining inequality, we take a more generous view of this economic framework. To begin, think of the population as being segmented into different groups, with discount factors differing across groups but not within groups. Then Becker's analysis points to the emergence of a dominant class of 'capitalists'. In fact, even today the vast bulk of the capital stock in industrialized nations is generated by a relatively small group of individuals; in this sense, the theory is consistent with observation.[6] However, while it is true that the distribution of wealth in reality is highly skewed, it is also true that most households hold positive net worth (albeit at relatively low levels). While this latter fact may be viewed as a strike against the theory, it should be realized that some relatively simple modifications to the environment will allow the model to accommodate this fact.[7]

Because we are interested primarily in explaining the distribution of wage earnings, we choose to abstract from physical capital entirely; we do not believe that the qualitative results presented below will be terribly sensitive to the inclusion of capital. Following Becker (1980), we impose a non-negative net worth restriction. As a result, individuals are restricted to consume no more than their current earnings. However, we endogenize the human capital accu-

[4] In reality, borrowing constraints would prevent such an extreme result. That is, consumption can asymptote to zero only if all entitlements to earnings (human capital) have been disposed of; this is legally prohibited in most economies.

[5] Becker essentially proves a result that was anticipated by Ramsey (1928).

[6] See, for example, Gimenez, Quadrini, and Rios-Rull (1997) for data on the United States.

[7] For example, Carroll (1997) introduces uninsurable idiosyncratic risk to the earnings process so that people wish to hold on to a small 'buffer stock' of wealth. Alternatively, one might introduce a simple life-cycle element, as in Andolfatto, Gomme and Ferrall (2000). As well, one might suppose that households occasionally experiences mean-reverting shocks to their patience parameter; see Krussel and Smith (1997). Finally, Sarte (1997) has used the progressivity of the tax system to generate a unique non-degenerate distribution of wealth.

mulation process, so that earnings capacity (wages) will differ in a systematic way across the population in accordance to individual discount rates (less patient individuals will devote less time to education and training investments). We find that the resulting distribution of human capital induces consumption and labor supply distributions that are qualitatively consistent with available evidence.

Our model of earnings inequality is applied to the question of redistribution policy implemented via a negative income tax. While the model structure is simple (it is deterministic and abstracts from physical capital), it nevertheless features heterogeneity and general equilibrium feedback effects through the government budget constraint. Consequently, we adopt a 'quantitative-theoretic' approach and explore the model's properties with the use of numerical techniques. To impose some discipline on parameter choices, the model is calibrated to match some features of the Canadian economy. However, we stress that the exercise is merely intended to be exploratory in nature with the view of illustrating some interesting qualitative features; the model is too simple for one to take the quantitative predictions very seriously.

In our experiments, we find that progressively higher levels of redistribution lead to greater levels of earnings inequality. Although increasing program generosity is found to reduce income (earnings plus transfers) inequality, this effect comes about only because income in the higher quintiles falls by proportionately more than it falls in the lower quintiles. Our steady state welfare analysis reveals that only a small minority of individuals benefit (in utility terms) from the redistribution policy under consideration, which leads one to wonder how the political support for such a program might be mustered within the context of the environment under study. We demonstrate how a majority of individuals may nevertheless vote for redistribution when one considers the transition dynamics from one steady state to another.

The paper is organized as follows. Section 2 develops the theoretical setup. In Section 3, the model is parameterized and calibrated using measurements on the distribution of after-tax income across quintiles for the 1994 Canadian economy. Section 4 examines the steady state properties of the model for a number of redistribution policies that differ in their level of generosity. Economy-wide transition dynamics are examined in Section 5; here we examine the implementation and removal of a Canadian style welfare state, respectively. Section 6 concludes.

2 The Model

We include only those elements that are necessary to generate an endogenous (nondegenerate) distribution of long-run earnings capabilities and employment levels from an assumed distribution of time preference parameters. To this end, we include human capital and a labor/leisure choice, but abstract from physical capital and uncertainty. The redistribution policies we consider are negative income tax schemes; i.e., universal lump-sum transfers financed by a flat income tax. Individuals are faced with non-negative net worth constraint and the government is constrained to balance its budget on a period by period basis.

The model considers a fixed population (with unit mass) of infinitely-lived individuals. Time is discrete and denoted by $t = 0, 1, ..., \infty$. There is no uncertainty. Individuals have preferences defined over sequences of consumption and leisure (c_t, l_t) that are represented by the function:

$$\sum_{t=0}^{\infty} \beta^t U(c_t, l_t), \tag{1}$$

where U is strictly increasing and concave, and β represents a time-preference parameter (discount factor). Our analysis allows for the possibility that the discount factor varies across members of the population. Assume that β lies in a discrete set B contained in the open unit interval, and let $\mu(\beta)$ represent the measure of individuals with discount factor β. The model reduces to a standard representative-agent economy when $\mu(\beta) = 1$ for some β in B.

Production of the composite commodity y_t takes place with a technology that is linear in efficiency-units of labor E_t; i.e.,

$$y_t = \omega E_t, \tag{2}$$

where $\omega > 0$ is exogenous and common across individuals. Assume, without loss, that individuals own and operate the production technology. Alternatively, we could assume that the technology is owned by firms and that efficiency-units of labor are traded in a competitive market, in which case ω would represent the equilibrium price of E measured in units of y.

At any point in time, individuals differ in terms of their education and training, or the degree to which their current skills are matched with current wants or technology in the economy; such factors together determine the value of an individual's human capital, $h_t > 0$. Individuals can combine their human capital together with time n_t in order to produce efficiency-units of labor according to:

$$E_t = E(h_t, n_t), \tag{3}$$

where E is strictly increasing, concave, and linearly homogeneous in its arguments. Time not spent working can be applied toward leisure $l_t = T - n_t$, where T denotes the period time endowment.

In reality, there are a number of economic forces that subject individuals to some amount of uncertainty regarding the value of their human capital. For example, the arrival of a new technology or a change in the pattern of tastes for different products may render current skills or accumulated knowledge less valuable if they are not well-matched to the new structure of technology/tastes. Ideally, such an event might be modelled as a stochastic depreciation in the value of human capital, but as we wish to abstract from uncertainty, we shall instead assume that everyone's human capital is subject to a deterministic geometric rate of depreciation $0 \leq \delta \leq 1$.

Human capital can be augmented by diverting goods and services toward general learning activities. For simplicity, assume that new human capital is produced with exactly the same technology that is used to produce the composite commodity, so that x_t units of output devoted to skill acquisition augments human capital according to the accumulation equation:

$$h_{t+1} = (1 - \delta)h_t + x_t, \tag{4}$$

where $h_0 > 0$ is given.[8] With some loss of generality, assume that each initial human capital endowment is associated with a particular discount factor; i.e., $h_0(\beta)$. In this way μ can also be used to describe the distribution of human capital in this economy.

2.1 Government

The government of this economy exists to redistribute output. For simplicity, assume that the government supplies a lump-sum universal transfer payment S that is financed by a distortionary income-tax τ. It is perhaps easiest to think of S as transfer income like subsidies, welfare, unemployment insurance and so on. However, to the extent that government-provided output and private output are close substitutes, one could also interpret S as consisting of government purchases that are supplied to citizens free of charge.

Government policy is implemented as follows. At date $t = 0$ the government announces a time-invariant lump-sum subsidy level S and a corresponding income-tax policy $\overline{\tau} \equiv \{\tau_t \mid t \geq 0\}$. Individuals are assumed not to expect any future changes in this government policy.

[8] Alternatively, we could have followed Heckman (1976) here and specified the learning technology as $x_t = G(h_t, e_t)$, where e_t represents time spent training. We have experimented with both specifications and found little to choose between the two in terms of qualitative features of the equilibrium. Presumably, the distinction may become important in more serious quantitative applications.

2.2 Equilibrium

The choice problem for each individual can be stated as follows. Given β (and $h_0(\beta)$), and $(\overline{\tau}, S)$, choose $\{c_t, n_t, l_t, h_{t+1}, x_t \mid t \geq 0\}$ in order to solve:

$$\max \sum_{t=0}^{\infty} \beta^t U(c_t, l_t)$$

subject to:

$$\begin{aligned}(1-\tau_t)\omega E(h_t, n_t) + S - x_t - c_t &\geq 0; \quad (5)\\ h_{t+1} - (1-\delta)h_t - x_t &\geq 0;\\ T - n_t - l_t &\geq 0;\\ c_t, n_t, l_t, h_{t+1}, x_t &\geq 0.\end{aligned}$$

We will restrict our attention to interior solutions.[9] Hence, an optimal program will satisfy the following restrictions:

$$\begin{aligned}(1-\tau_t)\omega E_n(h_t, n_t) U_c(c_t, T-n_t) - U_l(c_t, T-n_t) &= 0; \quad (6)\\ -U_c(c_t, T-n_t) + \beta[(1-\tau_{t+1})\omega E_h(h_{t+1}, n_{t+1}) + 1 - \delta] U_c(c_{t+1}, T-n_{t+1}) &= 0;\end{aligned}$$

where $c_t = (1-\tau_t)\omega E(h_t, n_t) + S - x_t$ and $x_t = h_{t+1} - (1-\delta)h_t$.

The choice-problem essentially boils down to the choice of the two sequences $\{n_t, h_{t+1}\}$; abusing notation somewhat, let $\{n_t(\beta, S, \overline{\tau}), h_{t+1}(\beta, S, \overline{\tau}) \mid t \geq 0\}$ denote the solution for a type-β individual faced with government policy $(S, \overline{\tau})$.

Given a transfer amount S, the government must choose a tax policy $\overline{\tau}$ in order to balance its budget at every date; i.e., τ_t must satisfy:

$$\tau_t \omega \sum_{\beta \in B} E(h_t(\beta, S, \overline{\tau}), n_t(\beta, S, \overline{\tau}))\mu(\beta) = S, \quad (7)$$

[9] For individuals with sufficiently low discount factors, corner solutions may be optimal. In particular, for extremely impatient individuals (anticipating that government charity S will always remain in place), it may be optimal to undertake zero investment in human capital and to devote all available time to leisure activities.

for all $t \geq 0$ (where $h_0(\beta, S, \overline{\tau}) = h_0(\beta)$). In equilibrium, the tax-rate that satisfies this budget constraint at each date is required to be consistent with the tax policy hypothesized by individuals when formulating their labor supply and human capital investment decisions. Note that an equilibrium may not exist for a sufficiently generous transfer S.

2.3 Steady-State

Under suitable restrictions (i.e., the parameterizations considered below), the economy converges to a steady-state featuring a constant tax-rate τ, constant labor supply $n(\beta)$ and human capital stock $h(\beta)$ for each β; these steady-state values satisfy (for an interior solution):

$$\begin{gathered}(1-\tau)\omega E_n(h(\beta),n(\beta))U_c((1-\tau)\omega E(h(\beta),n(\beta))-\delta h(\beta)+S,T-n(\beta))-\\ U_l((1-\tau)\omega E(h(\beta),n(\beta))-\delta h+S,T-n(\beta))=0;\\ -1+\beta[(1-\tau)\omega E_h(h(\beta),n(\beta))-1+\delta]=0;\\ \tau\omega \textstyle\sum_{\beta\in B} E(h(\beta),n(\beta))\mu(\beta)=S.\end{gathered} \tag{8}$$

2.4 Object of Analysis

We are primarily interested in examining how the model economy responds as we increase the generosity of the transfer payment S. In particular, we are interested in determining how different segments of society respond in terms of their human capital and labor supply choices. Does redistribution reduce inequality or exacerbate it and why? Which segments of society are made better off and which are harmed? How does the economy respond during the transition phase following the unexpected implementation of a 'welfare state'?

Because we are unable make much progress answering these questions through the use of analytical methods, we choose to parameterize the model and study its properties using numerical methods. In order to help us along with assigning parameter values, wherever possible we will calibrate the model (using the steady-state restrictions above) to fit various measurements on the Canadian economy for the year 1994. In particular, the exogenous distribution of discount factors μ will be chosen on the basis of replicating the after-tax income distribution. An alternative approach would have been to use some empirical study on the distribution of discount rates (such as Warner and Pleeter, 2001) to guide the specification of μ. As it turns out, either of these two approaches yield essentially the same results. In particular, our calibrated distribution of discount rates range from roughly $2-35\%$, which compares favourably to the range of $0-30\%$ reported in Warner and Pleeter (2001).

3 Calibration

The model is calibrated to fit various measurements on Canadian income distribution for the year 1994; the data source is Statistics Canada (1996). Income is measured in 1994 dollars and is reported as a ratio of the adult population.[10]

One striking feature of the data in Table 1 is that the dispersion in transfer income across quintiles is considerably less than the dispersion in earned income; the average transfer was \$3126, with a high of \$4354 (accruing to the second quintile) and a low of \$2044 (accruing to the fifth quintile). The lowest quintile received a transfer of \$3328, which is only slightly higher than the economy-wide average transfer.[11] Notice that the dispersion in after-tax incomes is about 40% (46 percentage points) smaller than the dispersion in earned income. Finally, the last column reveals that only the top two quintiles pay more in taxes than they receive in transfers.

According to this data, the average income-tax paid per adult (net of transfers) is \$1190. Presumably, this revenue is used to finance government purchases

[10] Statistics Canada does not report income per individual adult, focussing instead on 'families' and 'unattached individuals' as well as a composite 'unit' composed of family units and unattached individual units. In deriving income per adult, we make the assumption that the average unit contains two adults (individuals aged 15 and over). Average unit size for 1994 was 2.42 individuals.

[11] Hence, our assumption of a uniform lump-sum transfer does not appear terribly inconsistent with the data.

of goods and services (in addition to interest payments on government debt). In a sense, such expenditures represent a transfer payment to Canadians, but in the form of output instead of cash. If we make the assumption that the government utilizes the same production technology as firms in the private sector (or that the government purchases its output from the private sector) and that individuals view government-provided output as a perfect substitute for market-provided output, then we may proceed by including the \$1190 as a part of transfer income without changing any of the theoretical analysis.

The model requires functional forms for U, E, and μ. We specify preferences and technology as follows:

$$
\begin{aligned}
U(c,l) &= \ln(c) + \lambda \ln(l), \quad \lambda > 0; \\
E(h,n) &= h^{\theta} n^{\alpha}, \quad \theta, \alpha > 0.
\end{aligned}
$$

Our calibration strategy will involve matching the steady-state after-tax income of population quintiles in the model with those in the data. To this end, we specify $B = \{\beta_1, ..., \beta_5\}$ and $\mu(\beta) = 1/5$ for each β. Altogether then, the model has twelve parameters: $\beta_1, ..., \beta_5, \lambda, \theta, \alpha, \delta, \omega, T$ and S, for which values must be assigned.

Most empirical studies in the human capital literature simply impose an efficiency units function $E = hn$; i.e., $\theta = \alpha = 1.0$ (see, for example, Heckman, 1976). In the present context, such a specification would imply that a steady-state (in levels) will fail to exist.[12] Consequently, we will proceed by imposing linear homogeneity on the function E and make the plausible assumption that human capital and raw labor time are equally important in the production of quality-adjusted labor services; i.e., $\theta = \alpha = 0.5$.

A model time-period corresponds to one year. We assume that human capital depreciates at an annual rate of 5%; thus $\delta = 0.05$. With positive depreciation, individuals will in general devote some resources to replenishing their human

[12] Heckman (1976) and others avoid this problem by specifying some curvature on the production of new human capital; i.e., see footnote 9.

capital even in a steady-state. For our model economy, a five percent rate of depreciation implies that on average, around 20% of output consists of investments devoted to augmenting human capital. This figure sounds too large if one considers only the output that is devoted to formal education, but it is probably not too bad of an approximation if one also considers the learning investments made through on-the-job training activities.

In their survey of time-use studies, Juster and Stafford (1991) found that individuals report around 100 hours of discretionary time per week (i.e., hours not spent on sleep and personal care); this amounts to approximately $T = 5000$ hours per year. The parameter λ governs the relative importance of leisure in the utility function. The same time-use studies reveal that individuals aged between 25–64 devote, on average, around 2000 hours of their time toward work in the market sector. Because younger adults (those aged 15-24) typically work much less than this, we choose λ to generate an equilibrium labor input of around 1500 hours per adult per year (so that, on average, people allocate about 30% of their discretionary time to the labor market).

The productivity parameter ω was chosen in order to generate a level of per capita income consistent with the data. The five discount parameters were then allowed to vary in a manner that generated steady-state incomes across quintiles that matched the data. Finally, the subsidy level S was chosen to equal the value of per capita transfer payments to individuals in the economy; i.e., $S = \$4316$. The equilibrium tax-rate required to finance this subsidy is 22.7%.

The model was calibrated to the after-tax distribution of income; Table 2 reports the calibration results and the model's implications for the distribution of earned-income and the fraction of after-tax income accounted for by transfer income for each quintile in both the model and the data. The dispersion in earned-income is considerably greater than in after-tax income; the calibrated model replicates this feature of the data, although it appears to overestimate earned-income for the lower quintiles and underestimate earned-income for the upper quintiles. The final two columns report the ratio of transfer income to after-tax income for the data and model. Presumably, allowing the subsidy level and tax rate to vary across quintiles could improve the model's fit along these dimensions.

The parameter values used in calibration are given in Table 3. The model requires that significant differences in the rate of time-preference exist among individuals occupying different income quintiles. The estimated annual discount rates for quintiles one through five are: 34.6%, 14.9%, 8.7%, 4.9%, and 1.7%, respectively. Note that these calibrated discount rates are not far off the range reported in many of the empirical studies cited earlier.

In addition to income distributions, for which relatively good measurements are available, the model also makes predictions concerning labor supplies, wage rates, consumption levels and the value of human capital wealth across income quintiles. This information is presented in Table 4.

The model generates a considerable amount of heterogeneity in hours worked, ranging from 722 hours per year (14 hours per week) to 2047 hours per year (40 hours per week). High-income earners generate high levels of income in part because they work relatively long hours. These individuals devote such a high fraction of their time to work activities partly because the return to work is so high: the average hourly wage for upper quintile individuals is \$20.85 compared to just \$3.54 for lower quintile individuals. The return to work for upper quintile individuals is so high because they are so skilled: the 'value' of their human capital is estimated to be one hundred times greater than that of the lowest-skilled individuals. Upper quintile groups are more skilled because they devote a higher fraction of their resources toward building and maintaining human capital (this behaviour is a direct manifestation of their lower discount rates). The highest quintile devotes about 33% of their work-time and human capital resources simply toward building new human capital, while the lowest quintile devotes only 2% of their resources for this purpose. Finally, note that the dispersion in material well-being, as measured by consumption levels, is considerably less than the dispersion in even after-tax incomes. In addition, since higher income individuals sacrifice a significantly higher fraction of their leisure time in the form of work, measures of income dispersion to a large extent likely overstate the actual disparity of living standards in the economy.

Despite the model's simplicity, it replicates important features of the data (without having been designed for this purpose). For example, it is well-known that better-educated individuals tend to devote more time to the labor market than less-educated individuals; if one equates education with human capital, then our model reproduces this result.

One can also estimate the 'human capital earnings function' so commonly employed in the empirical labor literature (Mincer, 1974):

$$\ln y = a + bh + \varepsilon,$$

where y is taken to be either earnings, wages, or labor supply, and h is some measure of schooling.[13] The parameter b is referred to as the 'return to education'. Card (1998) estimates b separately using wages and labor supply (the two coefficients sum to the coefficient that one would estimate by using earnings). He finds that for the U.S. labor market in the mid-1990s, about two-thirds of the measured return to education in annual earnings data is attributable to the effect of education on the wage rate, with the remainder attributable to the effect on annual hours worked. When we run the same regression on our model data (replacing education with our measure of human capital), we obtain almost precisely the same results.[14]

4 Steady-State Analysis

In this section, we examine how the steady-state of our model economy responds as the government transfer is increased in one-thousand dollar increments:

$$S \in \{0, 1000, 2000, 3000, 4000, 4850\};$$

[13] Typically, the regression equation estimated in the literature also includes other variables (e.g., demographic characteristics, work experience, etc.).

[14] See Appendix I for details.

(Note: \$4850 appears to be the maximum feasible level of per capita government spending for the parameterization considered here). We report results for the following six variables: after-tax income (earnings minus net taxes paid), earned income, consumption, labor supply, human capital, and welfare across income quintiles.

Tables 5–7 are constructed as follows. The first column reports the level for the relevant variable for each quintile under the 'laissez-faire' regime ($S = 0$). The columns corresponding to positive subsidy levels record the ratio of the variable relative to its laissez-faire level.

4.1 After-Tax Income and Earned Income

Table 5 reports the results for after-tax income and earned income. Annual per capita income for Canada in 1994 was $\$19,033$, which is about 63% the level predicted by our model under a laissez-faire regime ($\$30,089$); our model suggests that the Canadian welfare state has had a huge negative impact on total earnings. On the other hand, increasing the generosity of the welfare state does appear to reduce after-tax income inequality. For example, a subsidy level of $\$4,000$ is predicted to reduce the standard deviation of after-tax income by 6.8%. However, notice that the after-tax income of all quintiles is predicted to fall as generosity is increased; the after-tax income distribution is compressed because the after-tax incomes of the rich fall proportionately more than the poor.

Under laissez-faire, earned income corresponds to after-tax income, which is why the first column of the table above corresponds to the first column of the previous table. As the generosity of the welfare state is increased, earned incomes for all quintiles is reduced. Notice that earned incomes fall (relative to after-tax incomes) at a greater rate for the poor but at a slower rate for the rich; at the highest subsidy level, earned income for the bottom quintile is 6.1% of what they would be earning under laissez-faire (after-tax income is at 62.9%), while earned income for the top quintile is 56.2% of what they would be earning under laissez-faire (after-tax income is at 45.3%). Consequently, the dispersion in the distribution of earned incomes is predicted to rise along with the generosity of the welfare state.

This last result provides an important caveat for policymakers and analysts who assert that the increased generosity of the welfare state has stabilized after-tax income inequality in the face of an exogenous increase in earned income inequality (e.g., see Little, 1995). Here we have developed a model in which the direction of causality runs in reverse: it is the increased generosity of the welfare state itself that leads to an increase in earned income inequality.

4.2 Consumption and Labor Supply

Table 6 reports the results for consumption and labor supply. Consumption levels across quintiles behave in a manner that is very similar to after-tax income levels as the generosity of the welfare state is increased. Notice that the standard deviation in consumption across quintiles is about fifteen percentage points less than the standard deviation in after-tax income for each subsidy level. Thus, measures of dispersion in after-tax income likely overestimate actual inequality in material well-being (as measured by consumption).

The labor supply response to increased tax/subsidy levels is not quite as severe as the response observed in earned incomes. Nevertheless, the labor input declines significantly for all quintiles as the generosity of the welfare state is increased, with the lower quintiles being particularly affected. This result is consistent with the empirical evidence reported in Cardia, Kozhaya, Ruge–Muria (1999), who find that persistent labor tax increases in Canada over the period 1966–93 appear to have played an important role in generating the observed downward trend in hours worked. Notice that while a more generous welfare state reduces consumption inequality, it leads to an increase in the inequality of leisure (consumption of home produced goods and services); for the highest subsidy level considered here, the inequality in labor supply increases sixfold.

4.3 Human Capital and Welfare

Table 7 reports the results for human capital and welfare. The value of an individual's human capital stock affects his earnings capabilities (real wages). Observe that the human capital response to increased tax/subsidy levels is more severe than the response observed in earned incomes. Under the most generous welfare state, the value a person's human capital skills in the lowest quintile is depleted to 4% of the value that would have prevailed under laissez-faire. Under even more generous welfare provision, the lowest quintile would reach a corner in their labor supply decision and allow their human capital to depreciate fully, at least, to the extent that they expect that the transfer payment will remain available for the indefinite future. Note that in this case, an unexpected removal of the welfare state could leave such individuals in extremely dire straits, as they would have virtually no means by which to generate any decent earnings. Such a scenario appears to be playing out in various regions of Canada today.

The level of welfare is measured by the steady-state maximum value function $W_i = (1-\beta_i)^{-1}U(c_i^*, \ell_i^*)$ for each quintile i. In comparing steady-states, quintiles II–V strictly prefer the laissez-faire regime to any welfare state, with economic welfare declining monotonically as generosity increases. The bottom quintile, on the other hand, actually appears to prefer redistribution policy, as long as it is not too generous; for this quintile, steady-state welfare is maximized at a subsidy level of around \$3000.

In evaluating the pattern of economic welfare across quintiles for different redistribution policies, it seems apparent that a clear majority of individuals prefer (and presumably would vote for) the laissez-faire regime. How then is one to rationalize the existence of the welfare state in such an environment? In the sequel, we consider one possible answer to this puzzle, which is based on the way transition dynamics following implementation of a redistribution policy might influence the distribution of welfare benefits accruing to different quintiles in a way that makes implementation politically viable.

5 Transition Dynamics

5.1 Implementation of the Welfare State

Imagine that the economy has over a period of time settled into the laissez-faire steady-state; i.e., individuals have based their economic decisions in the absence of government redistribution policy and under the expectation that zero taxes/transfers would be a part of the economic landscape for the indefinite future. We begin our observation of this economy at some arbitrary time period $t = 1$. Now, assume that at the end of time period $t = 10$, the government suddenly (and unexpectedly) announces that it will be distributing a transfer payment $S = \$4316$ (à la Canada 1994) to each member of the economy for all future time periods $t > 10$. Of course, at the same time the government announces (or, in the absence of an announcement, people can figure out) a corresponding budget-balancing income-tax $\{\tau_t \mid t > 10\}$. We ask two questions: What is the nature of the ensuing transition dynamics toward the new steady state; and what sort of political support might such a policy garner?

The resulting transition dynamics for earned and after-tax incomes are plotted in the top panel of Figure 1. Under the laissez-faire regime, earned and after-tax incomes coincide, while under the welfare state, earned and after-tax incomes diverge, with earned incomes being larger than after-tax incomes for only the top two quintiles. Immediately following the government's announcement, earned incomes fall dramatically for all quintiles. Earned incomes fall proportionately a little more for the lower quintiles, which is why earned income inequality rises moderately on impact (see bottom panel). After-tax incomes drop by even more than earned incomes for the top two quintiles, while for the bottom quintile, after-tax income actually rises on impact, all of which contributes to a reduction in after-tax income inequality. Along the transition path, earned and after-tax incomes converge monotonically to their lower steady state values with the net tax bill for each quintile remaining more or less stable. Observe that after-tax income inequality reaches a minimum in the period of implementation; subsequently, inequality rises but remains below its initial steady state level. On the other hand, inequality in earned incomes continues to rise throughout the transition period.

Figure 2 records the transition dynamics for consumption and labor supply (leisure) across income quintiles. The most striking feature of these transition dynamics is the general 'consumption boom' that immediately follows the implementation of the welfare state; consumption of both market output and leisure (home production) increase significantly, with the lower income quintiles displaying proportionately larger changes. Most of the adjustment in labor supply occurs in the impact period of the policy change, although the labor input of the bottom quintile appears to show some continued adjustment (downward) for close to twenty years. This adjustment in the labor supply accounts for the bulk of the short-run change in earned incomes described above. In contrast, the consumption boom in market-produced output is relatively short-lived, lasting for only a few years (the duration of the boom is longer for lower quintile groups). This consumption boom, together with the behaviour of after-tax incomes, implies that individuals are substituting away from human capital investment; this depletion of the human capital stock erodes productivity and is what causes the gradual decline of earned incomes (following the impact period) toward the new steady state. Notice that earned incomes fall in the short run because of the reduction in employment; however, the bulk of the long-term decline in earned incomes comes about because of reduced long-run productivity. As earning capabilities are gradually eroded, consumption possibilities across all quintiles fall below their initial steady state levels, with the upper quintiles experiencing proportionately greater losses.

What are the economic incentives at work that generate these transition dynamics? A number of different forces are at work. To begin, there is the lump-sum transfer payment. As this income is perceived to be permanent, one would expect it to result in an increase in consumer demand roughly equal to the amount of the transfer. In addition, the same wealth effect would induce an increase in the demand for leisure. On the other hand, individuals are also expecting a sequence of distortionary income taxes, as plotted in Figure 3. In the period of implementation, the government must levy a 16% income tax, which generates an income effect that works in a direction opposite to that of the subsidy. In their net effects, one might expect that these two income effects roughly cancel each other out; the negative income effect likely dominates in the upper quintiles (as they are net contributors of tax revenue), while the positive income effect likely dominates in the lower quintiles (as they are net recipients of transfer income). The distortionary tax also has the effect of making work less attractive relative to leisure. All of these forces taken together contribute to a decline in work effort across all quintiles, with a larger decline witnessed among the lower quintiles.

Along the transition path, the income tax rate rises monotonically to its new steady state of 22.7%. This gradual tax hike is required to finance the transfer program in the face of a shrinking tax base. The tax base shrinks along the transition path not because of lower employment, but because of lower productivity. Productivity falls because individuals are induced to substitute away from human capital investment (future consumption) and into current consumption. Individuals substitute away from human capital investment because its return (higher future wages) is taxed at a higher rate. As the human capital stock is depleted, reduced wealth levels translate into lower consumption. One might expect these reduced wealth levels to stimulate employment to some extent, but working against this force is the fact that the return to working falls along the transition path, both because income tax rates are rising and because real wages are falling (along with reduced human capital).

It is interesting to examine how different groups in society view the desirability of the welfare state, both from a 'long-run' perspective (i.e., simply comparing steady states), and taking into account the transition dynamics toward the new steady state. Figure 4 records how momentary utility, $u_t = \ln(c_t) + 0.95\ln(\ell_t)$, evolves for each quintile following the implementation of the welfare state. As the figure makes clear, and as is consistent with the steady state analysis explored earlier, the long-run utility levels are higher in the welfare state only for the bottom income quintile.

In order to get a feel for the quantitative magnitude of utility gain or loss, we can construct an 'equivalent variation' measure as follows. Let

$$v_i^{LF}(\zeta) = (1-\beta_i)^{-1}U((1-\zeta)c_i^{LF}, \ell_i^{LF})$$

denote the utility payoff from living in the steady state of the laissez-faire regime for an individual of type i when subject to a 'tax' on consumption equal to rate ζ. Let

$$v_i^{WS} = (1-\beta_i)^{-1}U(c_i^{WS}, \ell_i^{WS})$$

denote the utility payoff from living in the steady state of the welfare state regime for an individual of type i. For each individual, compute the ζ_i that satisfies:

$$v_i^{LF}(\zeta_i) = v_i^{WS}.$$

The value ζ_i has the interpretation of being the maximum rate of consumption that an individual of type i would be willing to sacrifice (in perpetuity) for the opportunity of remaining in the laissez-faire regime rather than being transported instantly to the steady state of the welfare state regime. Thus, ζ_i is a measure of the welfare loss that would be realized in moving to the welfare state. For our parameterization, these welfare losses are given by:

Steady-State Welfare Cost					
	I	II	III	IV	V
$\zeta_i \times 100$	-5.2	17.2	23.7	27.3	29.9

As the above table reveals, the welfare cost associated with the welfare state is very large for the upper four income quintiles; these individuals would willingly sacrifice up to 30% of their consumption for the opportunity of remaining in the laissez-faire regime. On the other hand, the bottom quintile would have to have its consumption augmented by 5.2% in order for these people to become indifferent between the steady state of the two regimes.

From Table 5, it is clear that the majority of individuals strongly prefer the laissez-faire regime to the welfare state regime. Is there any way to rationalize the existence of the welfare state in the context of this environment? Surprisingly (to us, at least), the answer is 'yes'. To see this, let us compute the utility payoff of implementing the welfare state, taking into account the transition dynamics toward the new steady state:

$$v_i^{IWS} = \sum_{t=0}^{\infty} \beta_i^t U(c_{it}^{IWS}, \ell_{it}^{IWS}),$$

where c_{it}^{IWS} and ℓ_{it}^{IWS} represent the equilibrium consumption and leisure dynamics following the change in policy. In order to quantify the welfare loss of implementing this policy, compute the ξ_i that satisfies:

$$v_i^{LF}(\xi_i) = v_i^{IWS},$$

for each income quintile i. The value ξ_i represents the maximum rate of consumption that an individual of type i would be willing to sacrifice (in perpetuity) for the opportunity of remaining in the laissez-faire regime rather than having to live through the transition dynamics associated with the implementation of the welfare state. From Figure 4, it is clear that $v_i^{WS} < v_i^{IWS}$ for each i, so that $\zeta_i > \xi_i$. In other words, living through the transition dynamics lowers the welfare cost of implementing the welfare state; the following table quantifies these costs:

Transition Dynamics Welfare Cost					
	I	II	III	IV	V
$\xi_i \times 100$	-46.6	-12.1	-0.3	8.4	21.1

Evidently, the short-run momentary-utility boom results in a significant reduction in the cost of implementing the welfare state, with the lower quintiles experiencing a proportionately greater benefit. This larger benefit accrues for two reasons. First, the short-run increase in momentary utility is proportionately larger for lower quintiles, because of their proportionately larger consumption and employment responses, as described earlier. Second, the lower quintiles attach a relatively greater weight to these short-run benefits as a result of their higher discount rates. As a result, the costs of implementation are now so much reduced that the second and third income quintiles actually prefer its implementation, relative to remaining in the laissez-faire state. Hence, quintiles I–III could presumably use their majority to vote in a government committed to implementing (and maintaining) the welfare state, even though quintiles II and III understand that they will come to 'regret' its implementation. For these two quintiles, the short-lived but proximate periods of 'mirth and laughter' more than make up for the 'sermons and soda-water' that occur only in the distant future. And for the bottom quintile, the mirth evidently never ends.[15]

5.2 Welfare Reform

This section briefly describes (in the absence of diagrams) the transition dynamics that take place when the welfare state is removed and the economy converges to the steady state associated with the laissez-faire regime. For the most part, the dynamics are the same as described earlier, only in reverse. However, this transition is not a simple mirror image of the earlier one, primarily because the income-tax dynamics now display a simple 'step' pattern (from the initial steady state to the new steady state), with no corresponding adjustment period.

As before, while the transition period appears to vary across quintiles, it appears that the bulk of the transition is completed after about twenty years. With the exception of the top quintile, all other groups in the economy experience an immediate, but temporary, decline in their material well-being as measured by consumption expenditure. The severity of the consumption decline is greater for poorer individuals. For example, the bottom quintile is compelled to reduce consumption spending in the first year by \$3000, which represents almost a 50% decline. It takes these individuals a full six years of hard work and investment before they recover their initial level of material well-being. Beyond

[15] "Let there be wine and women, mirth and laughter; Sermons and soda water, the day after." Lord Byron in *Don Juan*.

the sixth period of adjustment, consumption grows steadily beyond its initial level of \$6170, approaching \$7723 asymptotically. Consumption also declines for the middle quintile, who pay close to zero in net taxes. The consumption decline here largely represents the attempt by these individuals to divert income away from consumption toward human capital investment, which has now suddenly become more attractive.

All groups are encouraged to increase their work effort in response to the tax reform, with lower-income groups doing the bulk of the adjustment (higher income groups are already working many hours). However, the economic forces that motivate this increased work effort differ across quintiles. For poorer individuals, who are initially net recipients of transfer income, the removal of government-provided output/income makes longer hours of work (at still very low wages) necessary in order to maintain material living standards. For richer individuals, who are initially net contributors of tax revenue, leisure time is now made more feasible, but the removal of the distortionary income-tax increases the attractiveness of work and further investment in human capital.

With the exception of the poorest individuals, after-tax income rises in all periods following the reforms. For the top two quintiles, after-tax incomes rise because they pay less in taxes and also work harder. For the next two quintiles, after-tax incomes rise solely because of increased work effort. For the bottom quintile, the increase in earned income is not initially sufficient to make up for lost transfer income.

Removal of the welfare state is predicted to increase per capita income dramatically on impact; this larger income is the result of greater work effort. Subsequently, work effort declines to its new (and higher) steady-state level, but incomes continue to rise because workers are becoming more productive. labor productivity rises through the increased investment in human capital stimulated by the tax reform. However, while average income rises sharply on impact, so does the degree of after-tax income inequality. To a large extent, income inequality increases because the rich are gaining proportionately more than other classes, although the lowest quintile does experience an absolute decline in after-tax income. The model predicts that income disparity will be greatest within the first five years of the reform; after this period of time, inequality falls substantially, but remains higher than before (of course, the level of income for all quintiles is at this stage higher than their initial levels).

It is interesting to examine how economic welfare is affected with the removal of the welfare state. Of course, we already know that in comparing steady states, the majority of individuals prefer the laissez-faire regime. However, as the equilibrium transition dynamics to the laissez-faire steady state involve significant short-run costs (reduced consumption and increased work effort), welfare reform may not be attractive to the majority of individuals. Let

$$v_i^{ILF} = \sum_{t=0}^{\infty} \beta_i^t U(c_{it}^{ILF}, \ell_{it}^{ILF}),$$

where c_{it}^{ILF} and ℓ_{it}^{ILF} represent the equilibrium consumption and leisure dynamics following the change in policy. In order to quantify the welfare loss of implementing this policy, compute the ξ_i that satisfies:

$$v_i^{WS}(\xi_i) = v_i^{ILF},$$

for each income quintile i, where $v_i^{WS}(\xi_i) \equiv (1-\beta_i)^{-1} U((1-\xi_i)c_i^{WS}, \ell_i^{WS})$ is the utility payoff associated with the steady state of the welfare state, when subject to a consumption 'tax' ξ_i. The value ξ_i represents the maximum amount of consumption that an individual of type i would be willing to sacrifice (in perpetuity) for the opportunity of remaining in the welfare state regime rather than having to live through the transition dynamics associated with the implementation of the laissez-faire regime. Thus, ξ_i gives us a quantitative measure of the welfare cost of implementing the removal of the welfare state; for our parameterization, these numbers are:

Transition Dynamics Welfare Cost					
	I	II	III	IV	V
$\xi_i \times 100$	47.5	14.2	-0.3	-11.7	-23.9

From the above table, it appears that while the bottom two quintiles would find the dismantling of the welfare state extremely disagreeable, the majority of the population would actually vote in favour of the reform, with the middle quintile being close to indifferent. Thus, it appears possible that in some distant period following the implementation of a welfare state, individuals may (if given the opportunity) 'change their minds' and vote in a policy to dismantle the welfare state.

6 Summary and Conclusions

In this paper, we have developed a theory of the earnings distribution and applied it to various questions concerning the likely economic consequences of redistribution policy. A parameterized version of the model was calibrated to match key properties of the Canadian data on after-tax income distribution and government policy. The model was found to display a considerable amount of heterogeneity along several economic dimensions, even though individuals differed fundamentally only in their rate of time-preference.

The calibrated model was then used to illustrate how various hypothetical changes in government policy might influence the level and distribution of earned income, after-tax income, consumption, labor supply and welfare. In comparing steady states, more generous welfare states generally resulted in lower average levels for each of these variables across quintiles; this effect was primarily the consequence of depleted human capital stocks brought about by the disincentives put in place by distortionary income taxes which reduced the return to human capital investment. One exception to this finding was with respect to the welfare level of the bottom quintile, which was shown generally to increase with the level of redistribution. It was also shown that while redistribution policy reduced inequality in consumption and after-tax income, inequality in earned incomes, labor supply and human capital increased.

In studying the transition dynamics from laissez-faire toward the steady state associated with some given redistribution policy, we found that the equilibrium trajectories entailed a short-run 'utility boom' followed by steadily declining utility levels for all quintiles. For the redistribution policy considered (modelled after Canada), long-run utility levels were lower for everyone with the exception of the bottom quintile. However, the short-run utility boom together with positive discounting implies that the utility payoff associated with implementing the redistribution policy is considerably higher than the utility payoff associated with the steady state of the redistribution policy. Consequently, it may turn out (as it did with our parameterization) that a majority of individuals would favour implementation of the welfare state, even anticipating that they will in some sense be worse off in the long-run. Thus, not only does the model provide a possible explanation for the emergence of a welfare state, but it also hints at reasons for why dissatisfaction with the welfare state may grow over time. Indeed, when we considered the steady state associated with a Canadian-style welfare state, we found that a slim majority would actually be in favour of its removal. Consequently, our model may be able to provide the underpinnings for a political model that features alternating episodes of 'liberal' and 'conservative' governments.

If heterogeneous time preference is a primary source of economic inequality (there are those who argue that the direction of causality may actually run in reverse), then there are some potentially important implications concerning the design of redistributive policy. In particular, some policies that appear to alleviate income inequality may do so primarily in the short run, while actually exacerbating earnings inequality in the long run. Furthermore, such policies may be politically expedient precisely because of the support they might garner from those groups in society that discount the future at relatively high rates. If alleviating earnings inequality is a preferred social outcome, then the theory points to tax instruments that subsidize (or even force) human capital investments rather than policies that redistribute incomes via lump-sum transfers.

Appendix I

Card's (1988) estimates for the return to education based the 1994–96 CPS are reported in the following table.

	Dependent Variable		
	$\log w$	$\log n$	$\log y$
Men			
b	0.100	0.042	0.142
R^2	0.328	0.222	0.403
Women			
b	0.109	0.056	0.165
R^2	0.247	0.105	0.247

When we run the analogous regression using our data from our calibrated model (and replacing years of schooling with the level of human capital), we obtain the following results:

	Dependent Variable		
	$\log w$	$\log n$	$\log y$
b	5.92E–06	3.06E–06	8.98E–06
R^2	0.73	0.41	0.56

The t-statistics on b are: 2.88, 1.94 and 2.49, respectively.

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Table 1					
	Earned	Total	Transfer	After-Tax	Net Tax
Quintile	Income	Income	Income	Income	Paid
I	1 961	5 289	3 328	5 091	(3 130)
II	7 025	11 379	4 354	10 228	(3 203)
III	15 311	18 603	3 292	15 599	(288)
IV	24 911	27 522	2 611	22 063	2 848
V	46 123	48 167	2 044	36 399	9 724
Mean	19 066	22 192	3 126	18 114	1 190
Std Dev	122 %	84 %	29 %	76 %	

Table 2 Canada (1994) vs Calibrated Model						
	After-Tax Income		Earned-Income		Transfer Ratio	
Quintile	Data	Model	Data	Model	Data	Model
I	6 281	6 295	1 961	2 559	0.53	0.69
II	11 418	11 454	7 025	9 231	0.38	0.38
III	16 789	16 617	15 311	15 908	0.20	0.26
IV	23 253	23 482	24 911	24 787	0.11	0.18
V	37 589	37 316	46 123	42 678	0.06	0.12
Mean	19 066	19 033	19 066	19 033		
Std Dev	68 %	68 %	122 %	107 %		

Table 3

Parameter Values

β_1	β_2	β_3	β_4	β_5	$\delta = \alpha$	θ	ω	λ	T	S
0.743	0.870	0.920	0.953	0.983	0.05	0.50	1.905	0.95	5000	4316

Table 4					
Quintile	labor Supply	Wage Rate	Consumption Expenditure	Investment Rate	Human Capital
I	722	3.54	6 170	0.02	2 499
II	1 312	7.04	10 559	0.08	17 896
III	1 553	10.24	14 372	0.13	44 908
IV	1 755	14.13	18 658	0.20	96 490
V	2 047	20.85	25 057	0.33	245 194
Mean	1 478	11.16	14 963	0.15	81 398
Std Dev	40 %	68 %	54 %	12 %	175 %

Table 5

After-Tax Income						
Subsidy	0	1000	2000	3000	4000	4850
Quintile						
I	08243	0.969	0.930	0.878	0.800	0.629
II	17091	0.947	0.886	0.813	0.714	0.524
III	25946	0.940	0.873	0.792	0.686	0.490
IV	37720	0.936	0.864	0.780	0.670	0.470
V	61445	0.933	0.857	0.769	0.655	0.453
Average	30089	0.938	0.869	0.787	0.679	0.481
Std Dev	68.6%	0.988	0.974	0.956	0.932	0.885

Earned Income						
Subsidy	0	1000	2000	3000	4000	4850
Quintile						
I	08243	0.879	0.744	0.588	0.392	0.061
II	17091	0.921	0.833	0.730	0.596	0.361
III	25946	0.935	0.861	0.775	0.661	0.456
IV	37720	0.943	0.878	0.802	0.734	0.513
V	61445	0.950	0.893	0.825	0.734	0.562
Average	30089	0.938	0.869	0.787	0.679	0.481
Std Dev	68.6%	1.024	1.054	1.095	1.160	1.330

Table 6

Consumption						
Subsidy	0	1000	2000	3000	4000	4850
Quintile						
I	07723	0.977	0.946	0.902	0.833	0.668
II	14949	0.956	0.903	0.838	0.747	0.564
III	21210	0.949	0.890	0.818	0.721	0.532
IV	28225	0.945	0.882	0.806	0.705	0.513
V	38618	0.942	0.876	0.798	0.694	0.500
Average	22144	0.948	0.889	0.817	0.719	0.530
Std Dev	53.9%	0.984	0.966	0.945	0.917	0.863

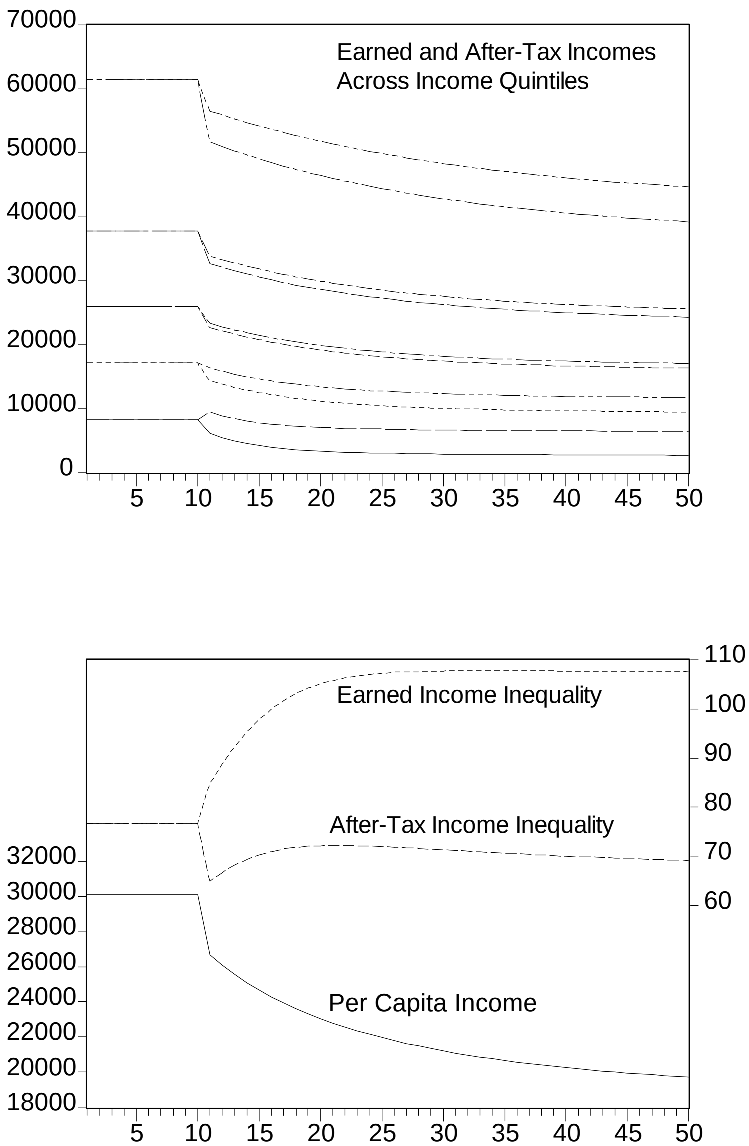
Labor Supply						
Subsidy	0	1000	2000	3000	4000	4850
Quintile						
I	1799	0.911	0.806	0.674	0.487	0.091
II	1878	0.955	0.902	0.836	0.742	0.542
III	1958	0.969	0.933	0.887	0.823	0.686
IV	2065	0.978	0.951	0.918	0.871	0.772
V	2279	0.985	0.967	0.945	0.913	0.845
Average	1996	0.961	0.916	0.859	0.778	0.606
Std Dev	9.3%	1.281	1.660	2.207	3.135	5.958

Table 7

Human Capital						
Subsidy	0	1000	2000	3000	4000	4850
Quintile						
I	010411	0.848	0.687	0.514	0.315	0.040
II	042851	0.889	0.769	0.637	0.480	0.240
III	094723	0.902	0.795	0.677	0.532	0.303
IV	189897	0.910	0.811	0.700	0.563	0.342
V	456544	0.916	0.825	0.720	0.590	0.374
Average	158885	0.911	0.813	0.703	0.567	0.346
Std Dev	113%	1.009	1.020	1.034	1.057	1.113

Welfare						
Subsidy	0	1000	2000	3000	4000	4850
Quintile						
I	0064.66	1.001	1.003	1.003	1.003	0.999
II	0132.74	0.999	0.997	0.995	0.991	0.980
III	0219.77	0.998	0.996	0.992	0.987	0.974
IV	0379.43	0.998	0.995	0.991	0.985	0.971
V	1063.22	0.997	0.994	0.990	0.983	0.968
Average	371.97	0.998	0.995	0.991	0.985	0.971
Std Dev	109%	0.999	0.999	0.998	0.997	0.995

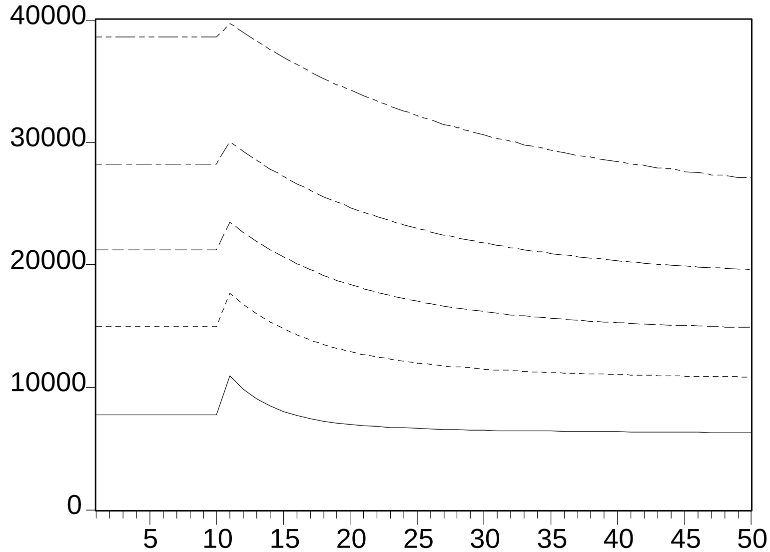
FIGURE 1
Transition Dynamics Following
Implementation of the Welfare State



Left-hand scale: $ per annum
Right-hand scale: % standard deviation

FIGURE 2
Transition Dynamics Following
Implementation of the Welfare State

Consumption Across Quintiles
($ per annum)



Labour Supply Across Income Quintiles
(Hours per Annum)

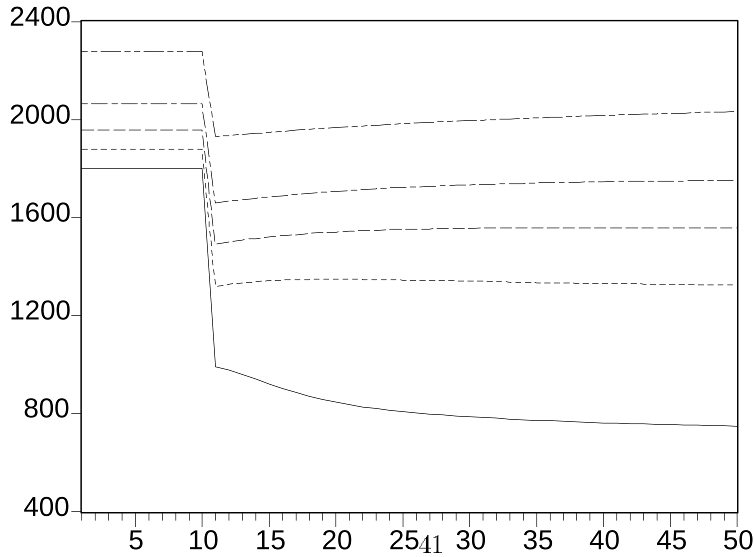


FIGURE 3
Income-Tax Rate Following Implementation
of the Welfare State

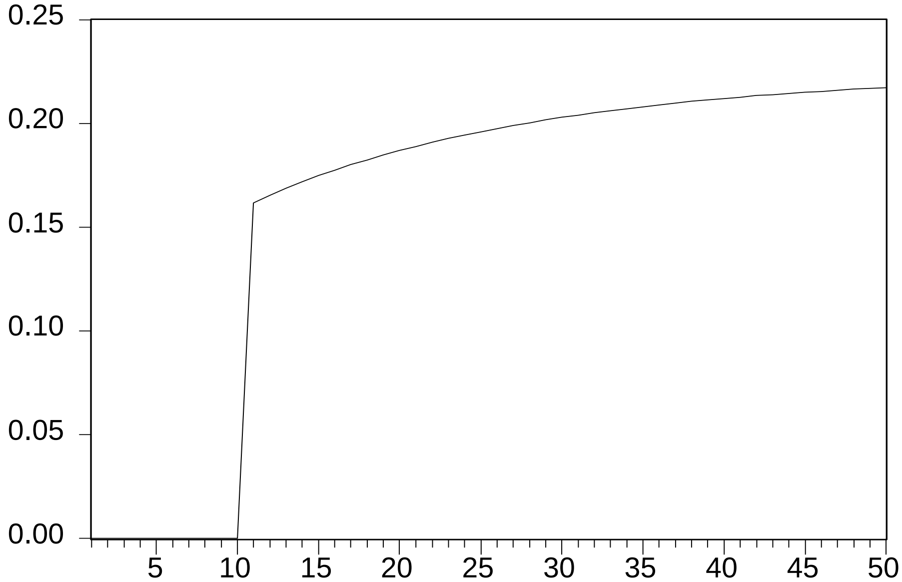


FIGURE 4
Momentary Utility Following Implementation
of the Welfare State