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Wealth Effects, Heterogeneity and Dynamic Fiscal Policy

by

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This paper studies the dynamic effects of fiscal policies in a simple perfect foresight model with heterogeneous agents. To obtain an analytical solution, Long and Plosser's (1983) functional form assumptions are combined with heterogeneous wealth levels and consumption/leisure tastes. As a result, the aggregate consumption-leisure ratio depends on the covariance of wealth shares and taste parameters. Policy effects decompose into a "representative agent effect" as in Hall (1971) and Judd (1987) and a "distributional effect" through changes of this covariance. Depending on how the covariance changes, the two effects may have opposite signs. The distributional effect can dominate the representative agent effect even if wealth inequality changes little.

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Introduction

Much recent analysis of the effects of fiscal policies relies on models that ignore heterogeneity, thus overlooking the redistributive effects of policies in the aggregate economy and possibly leading to distorted inferences.[1] For instance, because analysis based on an intertemporal general equilibrium model typically assumes the existence of a representative agent, the analysis will fail to detect the effects of a lump-sum transfer from one agent to another or, for that matter, any other shock that alters the wealth distribution. As the overlapping generations model shows, if fiscal policies alter higher moments of the wealth distribution, a non-zero distributional effect will occur since heterogeneous marginal responses to changes in the wealth distribution do not cancel in the aggregate. This is a critical insight behind non-neutrality results such as the failure of Ricardian equivalence.[2] Yet even overlapping generations models typically assume a representative agent for each age cohort. The unspoken reason for ignoring heterogeneity in macroeconomic models is that the repesentative agent assumption provides tractable microfoundations (see Kirman (1992)). However, the potential cost of this tractability is aggregation bias and faulty conclusions about the dynamic effects of fiscal policies.

To better understand this potential aggregation bias, I study the comparative dynamic effects of fiscal policies when heterogeneous households are introduced into an otherwise standard infinite horizon macroeconomic model. The model can easily be embedded into an overlapping generations framework à la Blanchard (1985). Starting with a simple perfect foresight model, diversity in initial full wealth levels and heterogeneity in preferences for consumption and leisure are introduced in a tractable way.

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1 Examples using a representative agent framework are Hall (1971) and Judd (1985, 1987). Auerbach and Kotlikoff (1987) and Laitner (1990) are recent examples of fiscal policy analysis using an overlapping generations model.

2 See for instance Aiyagari (1985) and Gilles and Lawrence (1986).

Tractability is guaranteed by adopting Long and Plosser's (1983) functional form assumptions that are a popular benchmark for simulations.[3] The functional form restrictions also yield an ana-lytical solution for the comparative dynamics. Consistent with the literature on exact aggregation, the assumed heterogeneity implies that the evolution of aggregate variables depends on higher moments of the joint wealth and taste distribution. In particular, the aggregate consumption-leisure ratio is found to depend on the covariance of initial wealth shares and taste parameters. Fiscal policy shocks to the wealth distribution feed back into the aggregate dynamics via heterogeneous wealth effects on the consumption-leisure ratio. This leads to dynamics that appear to be anomalous when viewed within the context of a representative agent model. For example, I find that temporary shocks have long-run effects. This suggests that the aggregation biases of ignoring heterogeneity may easily lead to distorted inferences about policy effects.

There are four disturbances considered in the present work: shocks to government spending and shocks to taxes on labor, capital and consumption. The paper shows that the total effect of any policy change decomposes into a "representative agent effect" and a "distributional effect". The representative agent effect mirrors the effects found by Hall (1971), Judd (1985, 1987) and others. Beyond this effect most fiscal policies have a distributional effect by altering the covariance of wealth shares and taste parameters. Intuitively, with heterogeneous propensities for consumption and work, wealth effects do not necessarily cancel in the aggregate. Since the distribution of wealth is endogenous, I show how fiscal policies alter initial wealth levels, wealth inequality, and the above-mentioned covariance. The paper focusses on how the efficiency (or representative agent) effect and distributional effect of policies interact in determining steady-states and the

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[3] See for instance King et al. (1988a). Becsi (1991) shows that the main results of this paper carry over to more general functional form specifications.

transition to steady-state. It is shown that the distributional and the representative agent effects may have opposite signs, depending on how the covariance changes. Moreover, analysis of the calibrated model shows that the distributional effect may dominate the representative agent effect. This occurs even if wealth inequality as measured by the variance of wealth shares changes little.[4]

The present paper may be viewed as a contribution to the growing literature that seeks to widen the scope of infinite horizon models. Lately, heterogeneity such as borrowing constraints (Scheinkman and Weiss (1986)), ex post heterogeneity (Atkinson and Lucas (1991)), ability-based models (Tamura (1991)), and heterogeneous recursive utilities (Benhabib et al. (1986)) or discount rates (Becker (1981)) have been incorporated into infinite horizon models. However, the dynamic effects of fiscal policies have not received much attention in these models.[5] This paper takes a framework similar to that of Judd (1985, 1987) and looks more closely into dynamic distributional issues. Moreover, it generalizes Blinder (1974) who analyzes the behavior of long-run income inequality within a parameterized "overlapping life-cycles" model in which factor prices are exogenous and only a limited number of fiscal policies are considered.

The remainder of the paper is organized as follows. The first section introduces the model and describes the equilibrium solution. The second section computes the model's comparative dynamics. After discussing the representative agent effects of policies, this section calculates and discusses the effects on wealth and wealth inequality and also compares the distribution and representative agent effects of policies. A third

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4 This makes estimation of distributional effects difficult (see Blinder (1975)).

5 Although the public finance literature has traditionally concerned itself with distributional issues, the literature on the dynamic effects of fiscal policies (with infinitely-lived agents) has held to the representative agent assumption. Possibly this reflects the view -- in Lucas (1986) and King et al. (1988b) -- that looking at distributional issues adds little for the purpose of understanding aggregate dynamics. One of few exceptions, Judd (1985b) looks at the dynamic incidence of capital taxes in a production economy with two classes of infinitely-lived individuals.

section calibrates the model and simulates the economic effects of fiscal policy shocks. Specifically, the size of the distributional effect and the size of the representative agent effect are compared and how wealth inequality responds for anticipated permanent policy shocks is examined. Finally, a conclusion briefly summarizes the findings of the paper.

I. The Model

The model consists of three sectors. In the production sector a representative perfectly competitive firm hires labor and capital services to produce a single consumption good using a constant-returns-to-scale technology. The household sector has a constant population (normalized to one) of infinitely-lived heterogeneous agents. Each individual chooses feasible time paths for consumption, leisure and savings (in productive capital and government bonds) to maximize intertemporally separable preferences. Type i individuals differ in their leisure-consumption preferences and in their initial full wealths; and n^i is class i's share of the population. The government finances its expenditures and lump-sum transfers by levying proportional taxes on consumption, wage and interest income, or by issuing bonds. The tax instruments financing the time path of expenditures satisfy an intertemporal revenue constraint.

The *production sector is standard.* In periods s ($\geq$1), a representative firm combines current labor, h_s, and the predetermined stock of physical capital, k_{s-1}, to produce a final good, y_s. The firm uses a Cobb-Douglas production function where $y_s = k_{s-1}^{\theta} h_s^{1-\theta}$ and θ is the capital share parameter. Given its wage rate, w_s, and interest rate, r_s, the firm's profits are maximized by choosing inputs to equate the marginal products of both inputs with their factor costs. These first order conditions are: $w_s = (1-\theta)(y_s/h_s)$ and $r_{s+1} = \theta(y_{s+1}/k_s)$. Capital is assumed to depreciate completely within each period

The household sector is also standard except for heterogeneous tastes and endowments. Each agent values consumption and leisure obtained in each period of an infinitely-long life that starts in period one. Individuals' lifetime utility is defined as:

$$\sum_{s\geq 1} \rho^{s-1}\Big[\alpha^i \ln(c_s^i) + (1-\alpha^i)\ln(l_s^i)\Big] \tag{1}$$

where $l_s^i \in (0,1)$ and c_s^i denote, respectively, leisure (or non-market hours) and consumption and $h_s^i = 1 - l_s^i$ is the fraction of time used for market labor. The rate of time preference, $\rho \in (0,1)$, discounts utility derived in future periods and reflects the agent's impatience. A high value of the parameter α^i means that the agent derives greater utility from consumption relative to leisure than someone with a low value. In other words, a high α^i agent is a consumption-lover, while a low α^i agent is a leisure-lover.

The representative individual chooses feasible time streams of consumption and leisure that maximize lifetime utility subject to an intertemporal budget constraint. This budget constraint requires that the discounted stream of purchases of consumption goods and expenditures on leisure do not exceed initial full wealth:

$$\sum_{s\geq 1}\left[\prod_{u=1}^{s} \frac{1}{(1-t_{ru})r_u}\right]\Big[(1+t_{cs})c_s^i + (1-t_{ws})w_s l_s^i\Big] = z_1^i \tag{2}$$

Full wealth is defined as the initial endowment of capital and government bonds plus the after-tax present value of the lifetime stream of full labor income and government transfers:

$$z_1^i \equiv \left(k_0^i + b_0^i\right) + \sum_{s\geq 1}\left[\prod_{u=1}^{s} \frac{1}{(1-t_{ru})r_u}\right]\Big[(1-t_{ws})w_s + t_s^i y_s\Big] \tag{3}$$

These equations are derived by time-aggregating agents' intratemporal revenue constraints and then ensuring that agents' transversality conditions are satisfied.[6]

Individuals start their economic lives in period one with an endowment of k_0^i shares of productive capital and b_0^i units of government bonds. Over their lifetime, both assets are perfect substitutes in the individual's savings portfolio and earn an after-tax real rate of return in period s of $(1-t_{rs})r_s$, where the returns to savings are taxed at the rate t_{rs} in period s. The product term in the definition of full wealth (or the present value factor discounting from period s to period 1) is the period 1 price of period s consumption. The period s pre-tax wage rate is given by w_s and t_{ws} is the period s tax rate on wage income. The tax on consumption is given by t_{cs}, and for simplicity, the lump-sum transfer (or tax) is defined as a fraction t_s^i of total output y_s.[7]

Households choose streams of consumption and leisure that maximize (1) subject to (2) given (3). This leads to the familiar (intratemporal and intertemporal) conditions for constrained utility maximization:

$$\frac{1-\alpha^i}{\alpha^i}\left(\frac{c_s^i}{l_s^i}\right) = \frac{(1-t_{ws})w_s}{(1+t_{cs})} \tag{4}$$

$$\frac{1}{\rho}\left(\frac{c_{s+1}^i}{c_s^i}\right) = (1-t_{rs+1})r_{s+1}\left(\frac{1+t_{cs}}{1+t_{cs+1}}\right) \tag{5}$$

In equation (4) the marginal rate of substitution between consumption and leisure is equated to the relative price of leisure. The Euler equation (5) sets the marginal rate of

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6 In other words,

$(1+t_{cs})c_s^i + (k_s^i + b_s^i) = (1-t_{ws})w_s h_s^i + (1-t_{rs})r_s(k_{s-1}^i + b_{s-1}^i) + t_s^i y_s$ and $\lim_{s\to\infty} \prod_{u-1}^{s} ((1-t_{ru})r_u)^{-1} x_s^i = 0$,

for x = k, b were used to derive equations (2) and (3).

7 The virtue of the functional form assumptions is that the analytical solution to the model can be described by writing endogenous variables as fractions of output. Since the corresponding aggregates are easily recovered, exogenous variables are described as fractions of output as an expositional shortcut.

substitution between consumption in period s and s+1 equal to the period s+1 return from reducing period s consumption by one unit.

The government finances its purchases of goods and its lump-sum transfers from its tax revenues.[8] The government's intertemporal revenue constraint is described by:

$$b_0^g = \sum_{s\geq 1}\left[\prod_{u=1}^{s}\frac{1}{(1-t_{ru})r_u}\right]\left[\gamma_s + \Sigma_i n^i t_s^i - \tau_s\right]y_s \tag{6}$$

where b_s^g is the amount of government bonds outstanding in period s and γ_s is the fraction of total output, y_s, devoted to government expenditures. Tax revenues from taxes on individuals' wage and interest income and consumption can be described as a fraction, τ_s, of output, y_s:

$$\tau_s = t_{ws}\frac{w_s\,\Sigma_i n^i h_s^i}{y_s} + t_{rs}\frac{r_s\,\Sigma_i n^i k_{s-1}^i}{y_s} + t_{rs}\frac{r_s\,(\Sigma_i n^i b_{s-1}^i + b_{s-1}^g)}{y_s} + t_{cs}\frac{\Sigma_i n^i c_s^i}{y_s} \tag{7}$$

Finally, the goods, factor and asset markets are assumed to clear in all periods. In particular, equilibrium in the goods and bond markets is given by:

$$\Sigma_i n^i c_s^i + k_s + \gamma_s y_s = y_s \tag{8}$$

$$\Sigma_i n^i b_s^i + b_s^g = 0 \tag{9}$$

where aggregate consumption will be defined by $c_s \equiv \Sigma_i n^i c_s^i$. Factor market equilibri-

[8] I assume government spending does not enter utility or production functions. But the solution methods below apply also to preferences where government spending complements or substitutes for consumption

$$\sum_{s\geq 1}\rho^{s-1}\left[\alpha^i\ln(c_s^i + \beta_\gamma\,\gamma_s y_s) + (1-\alpha^i)\ln(l_s^i)\right],\ \text{for}\ \beta\in(-1,\,1),$$

as well as production functions where government spending complements (or substitutes) for private inputs

$$y_s = k_{s-1}^{\theta_k}h_s^{\theta_h}(\gamma_s y_s)^{\theta_\gamma},\quad \theta_k+\theta_h+\theta_\gamma = 1.$$

um implies $k_s = \Sigma_i n^i k_s{}^i$ and $h_s = \Sigma_i n^i h_s{}^i$. In this model, a perfect foresight equilibrium is defined as sequences of optimal household consumption, labor, and savings plans and sequences of optimal firm output and input plans that perfectly forecast the time path of all prices and government variables and clear goods, factor and asset markets.

The Model's Solution

The solution of this model can now be briefly described. Because preferences are logarithmic, household optimization implies the individual household demands for consumption and leisure are linear in initial wealth. Substituting equations (4) and (5) into (2) yields:

$$(1+t_{cs})c_s^{\,i} = \alpha^i(1-\rho)\,\rho^{s-1}\left(\prod_{u=1}^{s}(1-t_{ru})r_u\right)z_1^{\,i},$$

$$(1-t_{ws})w_s l_s^{\,i} = (1-\alpha^i)(1-\rho)\,\rho^{s-1}\left(\prod_{u=1}^{s}(1-t_{ru})r_u\right)z_1^{\,i}$$

These individual demands can be combined to form aggregate consumption and leisure. Let $E_{xy} \equiv \Sigma_i n^i x^i y^i$ be the aggregation (or averaging) operator and let $S_{xy} \equiv \Sigma_i n^i(x^i - E_x)(y^i - E_y)$ be the covariance operator, where n^i represents the type i population share. The terms "aggregate" and "average" are interchangeable, since the population size is constant and normalized to unity. If agent i's wealth share is defined by $\sigma^i \equiv z_1{}^i/E_z$, individual demands are a time-invariant fraction of aggregate demands: $c_s{}^i = (\alpha^i\sigma^i/E_{\alpha\sigma})c_s$ and $l_s{}^i = ((1-\alpha^i)\sigma^i/E_{(1-\alpha)\sigma})l_s$, where aggregate leisure is defined by $l_s \equiv \Sigma_i n^i l_s{}^i$ and $l_s = 1 - h_s$ in equilibrium.

Substituting these relations into (4) and (5) yields aggregate household optimality conditions. Combining these conditions with the firms' optimality conditions yields

$$\frac{1}{\varepsilon}\left(\frac{c_s}{1-h_s}\right) = \frac{1-t_{ws}}{1+t_{cs}}\left((1-\theta)\frac{y_s}{h_s}\right) \tag{11}$$

$$\frac{1}{\rho}\left(\frac{c_s}{c_{s+1}}\right) = (1-t_{rs+1})\left(\theta\frac{y_{s+1}}{k_s}\right)\frac{1+t_{cs+1}}{1+t_{cs}} \tag{12}$$

where the "distributional" term $\varepsilon \equiv E_{\alpha\sigma}/ E_{(1-\alpha)\sigma} = (E_\alpha + S_{\alpha\sigma})/\{1 - (E_\alpha + S_{\alpha\sigma})\}$ summarizes the inclusion of heterogeneous tastes and wealth shares. The distributional term ε is the ratio of average after-tax (marginal wealth) propensities to consume goods and leisure. Since an interior solution implies $\varepsilon > 0$, the covariance of taste parameters and wealth shares satisfies $S_{\alpha\sigma} \epsilon$ ($-E_\alpha$, $1-E_\alpha$). In particular, when either tastes or wealth shares are equal across agents, $S_{\alpha\sigma}$ is zero. Identical tastes yield Long and Plosser's representative agent model. While the unlikely case of identical wealth shares also implies $S_{\alpha\sigma} = 0$, the endogeneity of wealth means that government policy shocks will affect the covariance.

Heterogeneity in tastes and wealth implies that any policy shock will affect aggregate demands through two wealth channels. The first channel through aggregate wealth cancels for the representative agent and heterogeneous agent case, since the model's time path depends on the ratio of aggregate consumption and leisure. When tastes are not identical, the distributional term provides a second wealth channel by which the government can influence the evolution of the economy. This channel arises because changing the wealth share distribution alters $S_{\alpha\sigma}$. Wealth share inequality tends to increase when there is a mean-preserving spread of wealth or when all agents are hurt equally and average wealth falls. If $S_{\alpha\sigma}$ is positive initially, then on average consumption-lovers are relatively wealthier than leisure-lovers. Thus, when wealth share inequality increases, consumption-lovers are made even more wealthy relative to leisure-lovers.

Since heterogeneous wealth effects do not cancel in the aggregate, aggregate consumption and labor rise in all periods. This is summarized by a rise of the distributional term ε. Alternatively, if the covariance is negative and inequality rises, rich leisure-lovers become richer and aggregate leisure rises while ε, consumption and labor fall.

Together with equation (8), equations (11) and (12) constitute a dynamic system describing the evolution of aggregate consumption, capital and labor. One simple way of finding a solution to this system is by positing a candidate division of output into consumption, investment and government spending that also fulfills the aggregate optimality conditions. Let χ_s denote the fraction of output less government spending that is devoted to capital, or $k_s = \chi_s(1-\gamma_s)y_s$. Then, from equation (8) $c_s = (1-\chi_s)(1-\gamma_s)y_s$. Substituting these divisions of output into equations (11) and (12) the perfect foresight equilibrium satisfies

$$1-\chi_{s+1} = (\theta\rho)\left(\frac{(1+t_{cs})(1-t_{rs+1})}{(1+t_{cs+1})(1-\gamma_{s+1})}\right)\frac{1-\chi_s}{\chi_s} \tag{13}$$

$$h_s = \frac{1}{1+\lambda_s}, \quad \lambda_s \equiv \frac{(1+t_{cs})(1-\chi_s)(1-\gamma_s)}{(1-t_{ws})(1-\theta)\varepsilon} \tag{14}$$

where λ_s is the leisure to labor ratio. These relations can be used to recursively compute the equilibrium paths for output, prices, individual plans, private wealth and so on.

In particular, if one defines an "augmented" present value factor as the discounted value of period s output, one can easily show that

$$\left[\prod_{u=1}^{s}\frac{1}{(1-t_{ru})r_u}\right]y_s = \frac{k_0}{\chi_s(1-\gamma_s)}\prod_{u=1}^{s}\frac{\chi_u(1-\gamma_u)}{\theta(1-t_{ru})} \equiv \pi_s$$

Substituting this definition into equation (2), individual wealth can be described by

$$z_1^i = \left(k_0^i + b_0^i\right) + \sum_{s\geq 1} \pi_s\left[(1-t_{ws})(1-\theta)(1+\lambda_s) + t_s^i\right] \tag{15}$$

Also, equation (6), the government's revenue constraint, can be rewritten as

$$b_0^g = \sum_{s\geq 1} \pi_s\left[\gamma_s + \Sigma_i n^i t_s^i - \tau_s\right] \tag{16}$$

where $\tau_s = t_{ws}(1-\theta) + t_{rs}\theta + t_{cs}(1-\chi_s)(1-\gamma_s)$ from equation (7).

A non-stationary closed-form solution is not easily characterized. It is assumed that a χ_s solving the non-linear and non-stationary difference equation (13) exists. However, a time-stationary solution to (13) is easily found: If $(1+t_{cs})(1-t_{rs+1})/(1+t_{cs+1})(1-\gamma_s) = x$, then $\chi_s = (\theta\rho)x$. To complicate the search for an explicit solution, the leisure-labor ratio, λ_s, depends on χ_s and the distributional term ε; and ε in turn depends on individual wealth which is a function of the time path of λ_s and π_s. Rather than characterize the dynamic system directly, I take an indirect approach below and look at the comparative dynamics of this system around a steady-state that is unique given the wealth distribution. A closed-form solution exists for the local dynamics.

II. Comparative Dynamics

I am now prepared to isolate the dynamic response of the system to each of the fiscal instruments introduced above. Determining the comparative dynamics is a straightforward if laborious exercise in totally differentiating and solving the equations that describe the dynamic equilibrium. This section will first compute the response of aggregate variables holding the distributional term constant. After discussing the representative agent effect, I compute and discuss the distributional effect through changes in the distributional term ε. The distributional effect represents the aggregation bias that results when a representative agent and Long and Plosser's functional forms are adopted.

(The appendix provides explicit solutions for the equations and defined variables below.)

Representative Agent Effects

To simplify the exposition, only policy shocks over a connected time interval are considered. Since all tax and spending shocks are analyzed separately, all shocks are assumed to occur over the same time interval. And since the model is Ricardian (ie. the timing of lump-sum transfers is irrelevent for aggregate activity if all agents are treated equally), I assume without loss of generality that budget-balancing lump-sum taxes and transfers occur over the same interval. Define an indicator function I_s that is unity over the time interval [S, T-1] and zero otherwise, where $1 \leq S \leq T-1$ and $T \leq \infty$. Then letting $dx_s \equiv I_s dx$ for all policy variables x, one can show that the capital to consumption ratio and the leisure to labor ratio evolve according to

$$\hat{\chi}_s = -\mathrm{X}_s \frac{dt_r}{1-t_r} + (1-\chi)(I_s - \mathrm{X}_s)\frac{dt_c}{1+t_c} + \mathrm{X}_s \frac{d\gamma}{1-\gamma} \tag{17}$$

$$\hat{h}_s = -(1-h)\hat{\lambda}_s, \quad \hat{\lambda}_s = -\hat{\varepsilon} + I_s \frac{dt_w}{1-t_w} + \left(\frac{\chi \mathrm{X}_s}{1-\chi}\right)\frac{dt_r}{1-t_r} + \left((1-\chi)I_s + \chi \mathrm{X}_s\right)\frac{dt_c}{1+t_c} - \left(I_s + \frac{\chi \mathrm{X}_s}{1-\chi}\right)\frac{d\gamma}{1-\gamma} \tag{18}$$

where $\mathrm{X}_s \equiv (1-\chi)\sum_{v\geq 1} \chi^{v-1} I_{s+v} \geq 0$.

According to equation (17), capital's share of output is independent of concurrent (and past) fiscal policies. However, future increases of the share of government spending or future reductions in capital or consumption taxes tend to tilt the composition of current output from consumption towards investment. Wage taxes do not alter the composition of output which only responds to anticipated policies via the intertemporal Euler equation. From equation (19), labor rises at the same time the composition of output shifts towards higher investment or when there is a rise of wage taxes or the share of government spending.

Letting $K_s^I \equiv \sum_{\nu=0}^{s-1} \theta^{\nu-1} I_{s-\nu} \geq 0$ and $K_s^X \equiv \sum_{\nu=0}^{s-1} \theta^{\nu-1} X_{s-\nu} \geq 0$, one finds

$$\hat{k}_s = (1-h)(1-\theta^s)\hat{\varepsilon} - \left((1-\phi)K_s^I\right)\frac{dt_w}{1-t_w} - \left(\frac{1-\phi\chi}{1-\chi}K_s^X\right)\frac{dt_r}{1-t_r}$$

$$+\left(\frac{1-\phi\chi}{1-\chi}K_s^X - \phi K_s^I\right)\left(-(1-\chi)\frac{dt_c}{1+t_c} + \frac{d\gamma}{1-\gamma}\right) \tag{19}$$

Equations (17) and (19) can be used to derive expressions for changes in aggregate output and consumption. Recall that $\hat{y}_s = \hat{k}_s - \hat{\chi}_s + (1-\gamma)^{-1} d\gamma_s$ and $\hat{c}_s = \hat{k}_s - (1-\chi)^{-1}\hat{\chi}_s$. Thus,

$$\hat{y}_s = (1-h)(1-\theta^s)\hat{\varepsilon} - \left((1-\phi)K_s^I\right)\frac{dt_w}{1-t_w} - \left(\frac{1-\phi\chi}{1-\chi}K_s^X - X_s\right)\frac{dt_r}{1-t_r}$$

$$+\left(\frac{1-\phi\chi}{1-\chi}K_s^X - \phi K_s^I + I_s - X_s\right)\left(-(1-\chi)\frac{dt_c}{1+t_c} + \frac{d\gamma}{1-\gamma}\right) \tag{20}$$

and

$$\hat{c}_s = (1-h)(1-\theta^s)\hat{\varepsilon} - \left((1-\phi)K_s^I\right)\frac{dt_w}{1-t_w} - \frac{1}{1-\chi}\left((1-\phi\chi)K_s^X - X_s\right)\frac{dt_r}{1-t_r}$$

$$+\left(\phi(1-\chi)K_s^I - (1-\phi\chi)K_s^X - (I_s - X_s)\right)\frac{dt_c}{1+t_c} + \frac{1}{1-\chi}\left((1-\phi\chi)K_s^X - \phi(1-\chi)K_s^I - X_s\right)\frac{d\gamma}{1-\gamma} \tag{21}$$

Finally, perturbations to the capital-labor ratio (and factor prices) are derived by subtracting equation (18) from (20), since $(-\frac{1-\theta}{\theta}\hat{r}_s = \hat{w}_s =) \hat{y}_s - \hat{h}_s = \theta(\hat{k}_{s-1} - \hat{h}_s)$.[9]

Before computing the distributional effect, I discuss the representative agent effect of the individual fiscal policies. Using the coefficients in equations (17) through (21), I distinguish between two cases - a temporary one-period policy shock (or, S=T-1≥1) and a permanent shock (1≤S<<T→∞) announced in period 1. Evaluating the coefficients from equations (17) through (21) one sees that labor taxes have the following effects. Taxes on wage income lower the cost of leisure over the interval [S, T-1] relative to labor and consumption in all periods. As households substitute away from consumption and labor towards leisure, output falls for periods s≥S. Falling labor tends to raise the net-of-tax wage rate and lower the equilibrium return to capital, thus, reducing capital over the interval [S, T-1]. In the long-run, the capital-labor ratio returns to its original steady-state level, because the after-tax interest rate is pegged by the fixed subjective discount rate. Also, wage taxes have no anticipation effects for periods s≤S-1, because capital depends on past expectations of future policy movements through $\hat{\chi}_s$. This term is independent of wage taxes which do not enter the Euler equation.

Taxes on capital income reduce the return to capital and raise the price of consumption and leisure in the interval [S, T-1] relative to other periods. Thus, from equations (18) and (21), consumption and leisure rise in periods s≤S-1 and labor falls in anticipation of this tax. Also, consumption rises relative to savings as demonstrated by the fall of χ_s and capital in periods preceeding the shock. Over the interval [S, T-1], investment and capital fall in equation (19) to reduce households' tax burdens. The

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9 When solving the local dynamics, King et al. (1988a) hold consumption and investment shares constant and so find $\hat{k}_s = \hat{c}_s = \hat{y}_s$ when $d\gamma_s = 0$. Under constant-returns-to-scale technologies, this treatment in effect fixes the capital-labor ratio along the transition path.

decline in capital tends to raise the after-tax return to capital, lower the equilibrium return to labor and cause labor to fall. Whether consumption rises or falls in the interval [S, T-1] depends on whether T is finite or not. For periods in the interval [S, T-1] there are two opposing effects on consumption that depend on the length of the interval T-S. Intertemporal substitution means that consumption over the policy interval falls relative to other periods. On the other hand, increasing consumption at the expense of capital will lower the tax burden. If T-S is small consumption tends to rise, but as T-S grows the intertemporal substitution effect tends to dominate and households will tend to reduce consumption. Finally, whether T is finite or not determines whether the capital-labor ratio falls in the long-run, since the long-run after-tax interest rate is pegged to the constant subjective discount rate.

A higher tax on consumption raises the price of consumption in the interval [S, T-1] relative to consumption in other periods and relative to leisure in all periods. According to equations (18) and (21), the anticipatory effect of a future increase in consumption taxes is that consumption and leisure rise and labor falls in periods $s \leq S-1$. Since a higher cost of consumption is equivalent to a lower return to savings, households increase consumption relative to savings in periods before the policy shock. Thus, according to equations (17) and (19) χ_s and capital fall in periods prior to S; output in equation (20) falls because labor and capital fall. In the policy interval, households substitute away from consumption towards leisure causing labor to fall. Capital may rise or fall in the policy interval: there are two conflicting effects on capital that depend on the duration of the policy T-S. When T-S is small, households substitute away from consumption towards savings for future periods when consumption is relatively cheap. But as these periods grow further away, or T-S grows, households smooth consumption by dissaving capital and raising early consumption more. In either case, reduced labor ensures a lower path of output.

Finally, increasing the government's share of output takes away resources from the private sector, unless output can be increased by increasing private inputs. In anticipation of the scarcity of resources, households shift away from consumption and leisure towards savings and work effort in equations (17) through (21). This serves a dual purpose: it smooths the path of consumption and leisure and it increases production capacity when the policy takes effect. In the interval [S, T-1], households continue to reduce consumption and increase labor, and shift the private share of output from consumption to investment. However, if the duration of the policy is short (specifically, T-S=1) capital and output will fall, while if the policy duration is long (or, $T \rightarrow \infty$) capital and output rise. This is because as the policy interval lengthens households are more inclined to smooth consumption by raising output than through disinvestment.

Equations (18) through (21) show that aggregate quantities are permanently affected by shocks to the distributional term ε, while the distributional effect on factor prices is transient. Thus, preference heterogeneity produces persistent policy effects in the aggregate quantity measures; and distributional effects alter the correlations between factor prices and aggregate quantities that are commonly predicted by representative agent models. This is clearly seen, for instance, by looking at the long-run effects of temporary policies (with finite T). From the above equations one can easily show that $\hat{k}_\infty = \hat{c}_\infty = \hat{h}_\infty = \hat{y}_\infty = (1-h)\hat{\varepsilon}$ and that the change of the capital-labor ratio is zero in the limit. Thus, in contrast to Judd's (1987a) discussion, temporary fiscal policies have long-run consequences (as long as the distributional effect is not zero). In other words, preference heterogeneity introduces persistent effects for otherwise temporary policies.

Wealth and Distributional Effects

To derive the distributional effect $\hat{\varepsilon}$ requires several steps. First, uncompensated perturbations of individual wealth are derived. Then the distributional effect through compensated wealth changes is computed. Finally, the government's intertemporal revenue constraint is used to determine budget balancing lump-sum compensations. These lump-sum disbursements are then used to find the compensated changes of wealth. How wealth inequality is affected is also derived.

To find the net effect of the disparate general equilibrium effects on wealth, define the transform functions $\mathrm{P} \equiv \sum_{s\geq 1} \rho^s$, $\mathrm{P}^I \equiv \sum_{s\geq 1} \rho^s I_s$, $\mathrm{P}^X \equiv \sum_{s\geq 1} \rho^s X_s$. Then normalizing the initial steady-state level of output to $y_0 = 1$, the uncompensated effects on individual and aggregate wealth are described by

$$dz_1^i = -(E_z E_{(1-\alpha)\sigma})\hat{\varepsilon} + Z_w \frac{dt_w}{1-t_w} + Z_r^i \frac{dt_r}{1-t_r} + Z_c^i \frac{dt_c}{1+t_c} + Z_\gamma^i \frac{d\gamma}{1-\gamma} + \mathrm{P}^I dt^i \tag{22}$$

$$dE_z = -(E_z E_{(1-\alpha)\sigma})\hat{\varepsilon} + Z_w \frac{dt_w}{1-t_w} + Z_r \frac{dt_r}{1-t_r} + Z_c \frac{dt_c}{1+t_c} + Z_\gamma \frac{d\gamma}{1-\gamma} + \sum_i n^i \mathrm{P}^I dt^i \tag{23}$$

where $Z_x \equiv \sum_i n^i Z_x^i$, and $Z_w = -(1-\theta)(1-t_w)\mathrm{P}^I$ as well as

$$(1-\chi)Z_r^i \equiv \left[(1-\theta)(1-t_w) + t^i\right]\left(X_0\mathrm{P} - \chi\mathrm{P}^X\right) + \left[(1-\theta)(1-t_w)\lambda\right]X_0\mathrm{P}$$

$$Z_c^i \equiv (1-\chi)\left(Z_r^i - \left[(1-\theta)(1-t_w) + t^i\right]\mathrm{P}^I\right) = -(1-\chi)Z_\gamma^i$$

Thus, consumption taxes and government spending have opposite effects on wealth. Subtracting equation (22) from (23) yields differential wealth effects

$$dz_1^i - dE_z = (t^i - E_t)\mathrm{P}^I\left(D_r \frac{dt_r}{1-t_r} + D_c \frac{dt_c}{1+t_c} + D_\gamma \frac{d\gamma}{1-\gamma}\right) + \mathrm{P}^I\left(dt^i - \sum_i n^i dt^i\right) \tag{25}$$

where $(1-\chi)\mathrm{P}D_r \equiv X_0\mathrm{P} - \chi\mathrm{P}^X$, $\mathrm{P}D_c \equiv (1-\chi)\left(\mathrm{P}D_r - \mathrm{P}^I\right) = -(1-\chi)\mathrm{P}D_\gamma$.

Labor taxes only have a (negative) direct effect on full wealth, while consumption taxes and government expenditures only have indirect effects through changes in the augmented present value factors and via changes of the wage-output ratio. Capital taxes have a both a direct and a negative indirect effect on wealth. From the appendix where the Z_x^i are calculated for equations (22) and (23), one can show that increasing capital or consumption taxes or decreasing government spending will increase wealth when S=1. But as S grows, it is more and more likely that the effect on full wealth is negative. In other words, only if S is small do policy effects on wealth through changes of λ_s dominate effects through changes in π_s. The policy duration, T-S, determines when the policy effects switch signs: the policy effects on wealth tend to switch signs earlier when T-S rises.[10] The differential effects in equation (24) reflect changes in the augmented present value factors that alter present value of heterogeneous endowment streams. (Although not modeled explicitly, the endowment streams can be interpreted to include heterogeneous wage profiles.) Higher capital or consumption tax rates or lower government spending tends to lower present value factors (since even D_r tends to be negative).

Assuming that lump-sum compensations balance the government's intertemporal revenue constraint, the distributional effect (for equations (18) through (21)) is

$$(1-h)\hat{\varepsilon} = \frac{1-h}{E_\alpha E_{(1-\alpha)\sigma} E_z}\left(\sum_i n^i(\alpha^i - E_\alpha)\mathrm{P}^I dt^i + S_{\alpha t}\mathrm{P}\left(D_r\frac{dt_r}{1-t_r} + D_c\frac{dt_c}{1+t_c} + D_\gamma\frac{d\gamma}{1-\gamma}\right)\right)$$

$$-\frac{1-h}{E_\alpha E_{(1-\alpha)\sigma}}\left(\frac{S_{\alpha\sigma}\mathrm{P}}{E_z}\right)\left(C_r\frac{dt_r}{1-t_r} + C_c\frac{dt_c}{1+t_c} + C_\gamma\frac{d\gamma}{1-\gamma}\right) \tag{25}$$

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10 Using the parameter assumptions of the next section in the expressions for Z_r, Z_c, and Z_γ(also see the appendix), one can easily calculate the critical S when these terms change signs. For a one period shock, $Z_r > 0$ as long as $S \leq 5$, while $Z_c > 0$ and $Z_\gamma < 0$ as long as $S \leq 4$. For a permanent policy shock the critical S falls: $Z_r > 0$ as long as $S \leq 2$, while $Z_c > 0$ and $Z_\gamma < 0$ only if $S=1$.

and the compensated change of average wealth

$$dE_z = -\frac{1}{E_\alpha}\left(\sum_i n^i(\alpha^i - E_\alpha)P^I dt^i + S_{\alpha t}P\left(D_r\frac{dt_r}{1-t_r} + D_c\frac{dt_c}{1+t_c} + D_\gamma\frac{d\gamma}{1-\gamma}\right)\right)$$

$$+\frac{E_{\alpha\sigma}P}{E_\alpha}\left(C_r\frac{dt_r}{1-t_r} + C_c\frac{dt_c}{1+t_c} + C_\gamma\frac{d\gamma}{1-\gamma}\right) \tag{26}$$

Finally, a natural measure of wealth share inequality for this model is the variance of wealth shares, $S_{\sigma\sigma}$, which is the coefficient of variation squared.[11] Since

$dS_{\sigma\sigma} = 2\sum_i n^i(\sigma^i - 1)d\sigma^i$ and $E_z d\sigma^i = \left(dz_1^i - dE_z\right) - (\sigma^i - 1)dE_z$, it follows that

$$\left(\frac{E_z}{2}\right)\frac{dS_{\sigma\sigma}}{S_{\sigma\sigma}} = \sum_i n^i\sigma^i P^I dt^i + S_{\sigma t}P\left(D_r\frac{dt_r}{1-t_r} + D_c\frac{dt_c}{1+t_c} + D_\gamma\frac{d\gamma}{1-\gamma}\right) - dE_z \tag{27}$$

Thus, equations (25) through (27) decompose into two parts. The first part is the effect of differential changes in wealth levels. The second part involves equal absolute changes in wealth levels that lead to non-proportional changes in wealth shares.

To illustrate the interplay of the last three equations, consider the case of a lump-sum transfer from a rich consumption-lover (leisure-lover) to a poor leisure-lover (consumption-lover). Thus, $S_{\alpha\sigma} > (<)\ 0$ initially. If the n^i are equal, the transfer causes a negative (positive) distribution effect, a rise (fall) of average wealth, and a negative (ambiguous) effect on wealth inequality. Intuitively speaking, when $S_{\alpha\sigma} < 0$ initially, redistribution from individuals with a low propensity to consume and a high propensity

[11] The Herfindahl index, $E_{\sigma\sigma}$, is cardinally equivalent to the variance of wealth shares, since $E_{\sigma\sigma} = S_{\sigma\sigma} + 1$. The variance of wealth shares and the Herfindahl index satisfy the Pigou-Dalton strong principle of transfers (Cowell (1977)). Like the coefficient of variation, the Gini coefficient, $\sum_i n^i \sum_{j>i} n^j |\sigma^j - \sigma^i|$, where $\sigma^i < \sigma^j$ whenever $i < j$, only satisfies the weak principle of transfers. While the Gini coefficient is very popular, I prefer computing changes of the variance of wealth shares for its simplicity.

for leisure to agents with the opposite propensities causes aggregate consumption and labor to rise for all periods - a positive distribution effect. As the supply of labor rises, wages are driven down which causes individual wealth levels to fall. Thus, transfers from rich to poor cause a fall in average wealth. When individual wealth levels fall equally, the wealth shares of the poor fall. Thus, wealth share inequality rises. The net effect on inequality of a lump-sum redistribution is ambiguous, because the indirect effects of a fall of average wealth works against the direct effect of the transfer. If wealth is very unequal initially, wealth inequality may rise further.

What happens if capital or consumption taxes rise permanently or government spending falls? As discussed above, this implies a contractionary representative agent effect. Consider first the case where $S_{\alpha t}$ and $S_{\sigma t}$ are zero. The first assumption means that the covariation of tastes for consumption and wealth shares is solely due to the initial endowments of capital and government bonds. The second assumption means that all of the variation in wealth shares is due to the initial endowment.[12] These assumptions mean that differential effects are irrelevant. Since the compensated wealth effects (the C_x defined in the appendix) of these policies are positive, individual wealth levels rise equally but not equiproportionately. The wealth shares of those agents poorer than average rise. Thus, the variance of wealth shares and wealth share inequality fall as average wealth rises. If the initial covariance of consumption tastes and wealth shares is positive, then the wealth shares of poorer leisure-lovers rises and aggregate labor and consumption fall. In other words, a negative distribution effect occurs that reinforces the representative agent effect of these policies. Similarly, if this covariance is negative a

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[12] If x is defined as either α or σ, then $E_z S_{x\sigma} = S_{x(k+b)} + \mathrm{P} S_{xt}$, since steady-state wealth is $z_1^i = (k_0^i + b_0^i) + \mathrm{P}(1-t_w)(1-\theta)(1+\lambda) + \mathrm{P}t^i$.

positive distribution effect occurs as the wealth share of poor consumption-lovers rises.

If $S_{\alpha t}$ is still zero but $S_{\sigma t}$ is positive, then differential wealth effects enter into the calculation of wealth share inequality. Since the differential effects of the above polices are to lower the present value of the endowment streams, agents with lower than average endowment streams to begin with, or $t^i < E_t$, experience a fall of their wealth share. Thus, the differential effects increase wealth share inequality and offset the fall in inequality due to compensated wealth effects. If the endowment streams explain a large part of wealth share inequality, overall inequality may rise.

Finally, when $S_{\alpha t}$ is not zero, differential wealth effects enter the calculation of the distributional effect and the effect on average wealth. Permanently raising capital or consumption taxes or lowering government spending has the differential effect of raising wealth share inequality. Thus, if, for instance, $S_{\alpha t}$ is positive, consumption-lovers with high lump-sum transfer endowment streams gain. This in turn causes aggregate consumption and labor to rise and a positive distribution effect that must be added to the above distribution effects. Alternatively, if the covariance of consumption propensities and endowment streams is negative, consumption-lovers lose and a negative distribution effect ensues and aggregate labor and consumption fall. When $S_{\alpha t}$ and $S_{\alpha\sigma}$ have the same sign, differential and compensated wealth effects work in opposite directions in the distributional effect; and when these covariances have opposite signs they work in the same direction. At the same time, when the supply of labor rises (falls), wages and average wealth fall (rise) in steady state. This change in average wealth tends to raise (lower) wealth share inequality, thus, offsetting (reinforcing) the direct effect on inequality from the differential effects.[13]

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[13] Embedding the model in Blanchard's (1985) overlapping generations framework weakens the wealth and distributional effects, since the wealth effects depend positively on individuals' life expectancy. To see (continued...)

III. Numerical Exercises

In this section the model is calibrated and some numerical examples are then computed. The simulations quantify how wealth inequality is affected by the various fiscal policies and how large the distributional effect of a policy can be relative to the representative agent effect. Using a priori information, parameters for the model are chosen so that the calibrated initial steady state of the model is close to the long-term averages for the U.S. economy.[14] Special attention is paid to how sensitive the initial steady-state, wealth inequality effects and the distributional effects are with respect to the initial distribution of tastes and wealth shares. For simplicity, I only look at anticipated *permanent* shocks, specifically $S = 4$ and $T \rightarrow \infty$ are assumed. Policy effects are calculated by parameterizing equations (18) through (21) and (25) through (27).

Since most variables in the model are described as shares of output, the initial steady-state output is normalized to unity. The utility discount factor, $\rho = .993$, defines the length of a period as a quarter of a year. This implies an average annual after-tax and risk-free real rate of return of 2.8 percent. This is in line with estimates by McGrattan (1991) and is slightly higher than the commonly used value of 0.99. Capital's share in production, θ, is assumed to be 0.3. In simulations that use a Cobb-Douglas production function θ ranges from 0.25 in Judd (all) and Auerbach and Kotlikoff (1987) to 0.43

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[13](...continued)
this, let q be the time-invariant probability of surviving every period. Then, ρq rather than ρ is used to calculate the wealth effects of individuals. Thus, P is replaced by $P[\rho q]$, P^{χ} by $P^{\chi}[\rho q]$, D_x by $D_x[\rho q]$ and so on. However, the government budget effects are evaluated at $q=1$, if the government lives forever. Also, the timing of budget-balancing taxes is very important in this non-Ricardian set-up. Further, it can be shown that q does not enter the calculation of the representative agent effects in equations (17) through (21).

[14] For reference, the following long-run averages over 1960 to 1989 were computed from the 1991 Economic Report of the President. Consumption expenditures (as a share of GNP) were 0.635, investment was 0.159, total government purchases were 0.202, transfers were 0.92, total tax receipts 0.302, net interest paid was 0.029 and the total government deficit was 0.012. Also, the annual real return on Treasury Bills averaged 1.39 percent, while Aaa Corporate Bonds were 3.19 percent.

in King et al. (1988). McGrattan (1991) estimates a value of 0.434.

In the numerical examples below, I simulate the model's response to a ten percent (balanced-budget) increase of all fiscal policy instruments from their initial steady-state levels. The government sector is identified by $t_c = 0.05$, $t_w = 0.22$, $t_r = 0.46$, $\gamma = 0.203$. Estimates of marginal tax rates range from 0.2 to 0.4 for labor taxes and from 0.3 to 0.5 for capital taxes (see Hansson (1985) and Judd (1987a) for references). I assume that the consumption tax rate is close to the sales tax rates reported in Ring (1989). Since τ denotes total tax receipts less net interest payments, net interest payments are added to transfers and $E_t = \Sigma_i n^i t^i = 0.133$ is assumed. With the assumptions below, this implies that the deficit including net interest payments is 1.3 percent of GNP. The above parameter assumptions imply that investment's share of output less government spending, χ, is 0. 202. Also, the share of output that is invested, $\chi(1-\gamma)$, is 0.161 and the share that is consumed, $(1-\chi)(1-\gamma)$, is 0.636.

There is little evidence on tastes for consumption relative to leisure. Auerbach and Kotlikoff (1987) assume for average tastes for consumption that $E_\alpha = 0.4$ to tie down aggregate labor, h, while Blinder (1974) assumes $E_\alpha = 0.33$. However, E_α does not tie down h when the covariance of tastes and wealth shares$S_{\alpha\sigma}$ can vary. The term h ranges from 0.4 in Auerbach and Kotlikoff (1987) to 0.44 in Kydland and Prescott (1989) for employed workers. For comparison, employed households are assumed to spend between 40.1 and 45.0 percent of their substitutable time working in the original steady state. Assuming that h=0.401 (h=0.45) implies that $E_\alpha + S_{\alpha\sigma} = 0.45$ (0.5) and that the distributional term $\varepsilon = 0.82$ (1.0). This also means that the representative agent case occurs when $E_\alpha = 0.45$ (0.5) and that for all E_α larger than this critical value $S_{\alpha\sigma}$ is negative. There is not much evidence on the size or sign of $S_{\alpha\sigma}$. Blinder (1974) provides anecdotal evidence that the covariance is positive in the U.S., while Menchik and

David (1983) and Diamond and Hausman (1984) provide support for a negative covariance. I focus on two cases: $E_\alpha = 0.2$ and $S_{\alpha\sigma} > 0$ and $E_\alpha = 0.8$ and $S_{\alpha\sigma} < 0$. To my knowledge, there is no evidence on the size or sign of $S_{\alpha t}$, the covariance of consumption tastes and the endowment stream of lump-sum transfers. (Heterogeneity of this stream of endowments can be interpreted as including heterogeneity of wage profiles.) Thus, I assume that $PS_{\alpha t}/E_z = (0.75)S_{\alpha\sigma}$ or else that $PS_{\alpha t}/E_z = -(0.5)S_{\alpha\sigma}$. In the first case, the endowment stream provides most of the variation in wealth shares. In the second case, the covariation of the endowment stream is opposite to that of the initial endowment of capital and bonds.

The above parameter assumptions imply that aggregate full wealth is 189.5 (210.6) times the size of output for $h=0.45$ (for $h=0.401$). Only a small fraction of this number is due to the initial capital and bond endowment: the rest is due to the endowment stream. Since the steady-state wage stream and full wealth are inversely related to labor supplied, choosing h lower than 0.4 would have implied even higher wealth. Also, the variance of wealth shares, $S_{\sigma\sigma}$, is assumed to be 6.5 which corresponds to a Gini coefficient of about 0.56. Winnick (1989) reports population shares and mean net worths (in 1985 dollars) for six income groups in the U.S.[15] Based on this data, $S_{\sigma\sigma}$ was 6.83 and the Gini coefficient was 0.565 in 1983. In 1986, $S_{\sigma\sigma}$ was 6.34 and the Gini coefficient was 0.554. For comparison, Wolff and Marley (1989) report that the Gini coefficient for their broadest measure of wealth was 0.59 in 1962 and 0.57 in 1983. Finally, Kessler and Masson (1988) report that the size of $S_{\sigma t}$, the covariance of wealth shares and endowment streams in wealth, is unresolved. This question is related to the debate of what percentage of wealth is from bequests or life-cycle savings. For simplicity, I assume the

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[15] In 1983 the (n^i, σ^i)-pairs were (0.226, 0.22), (0.261, 0.402), (0.183, 0.595), (0.211, 0.892), (0.088, 2.383), (0.022, 15.132). In 1986 the pairs were (0.24, 0.218), (0.256, 0.427), (0.186, 0.571), (0.21, 1.016), (0.088, 2.553), (0.019, 15.28).

endowment stream constitutes fifty percent of the variation of wealth shares or that $PS_{\sigma t}/E_Z = (0.5)S_{\sigma\sigma} = 3.25$.

Figures 1a through 3d show how the size of the long-run distributional effect, $(1-h)\hat{\varepsilon}$, of permanent increases in capital and consumption taxes and government spending depends on different combinations of E_α and $S_{\alpha\sigma}$. Also, the corresponding percentage changes of the variance of wealth shares from its initial value of 6.5 are shown. As the average taste for consumption E_α rises along the x-axis, $S_{\alpha\sigma}$ falls in order to keep h fixed at 0.401 or 0.45. Figures 1a, 2a, and 3a graph the distributional effects when $PS_{\alpha t}/E_Z = (0.75)S_{\alpha\sigma}$ and Figures 1c, 2c, and 3c graph the corresponding inequality effects. By contrast, Figures 1b, 2b, and 3b assume $PS_{\alpha t}/E_Z = -(0.5)S_{\alpha\sigma}$. Table 1 summarizes the effects for four cases assuming either h=0.401 or h=0.45. In case A, $E_\alpha = 0.2$ and $S_{\alpha\sigma} = 0.275$, while for case B, $E_\alpha = 0.8$ and $S_{\alpha\sigma} = -0.325$, where for both cases $PS_{\alpha t}/E_Z = (0.75)S_{\alpha\sigma}$. Alternatively, assuming $PS_{\alpha t}/E_Z = -(0.5)S_{\alpha\sigma}$, $E_\alpha = 0.2$ in case C and $E_\alpha = 0.8$ in case D.

Government spending shocks are shown to have the largest distributional effects followed by capital taxes and then consumption taxes. For the parameter assumptions of Table 1, the distributional effect of a capital tax ranges from -2.67 percent to +1.03 percent. The distributional effect of a consumption tax is much smaller ranging from -0.58 percent to +0.38 percent, while the distributional effect of a spending shock ranges from -2.52 percent to +3.89 percent.[16] The direction of the distributional effect is governed by differential wealth effects that overwhelm the small compensated wealth effects. Also, whether $S_{\alpha\sigma}$ is positive or negative affects the absolute size of the distributional effect and the effect on wealth inequality discussed below. This asymmetry occurs be-

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[16] For comparison, if real GNP is $5 trillion, a one percent distributional effect corresponds to a $50 billion annual change of real GNP.

cause as $S_{\alpha\sigma}$, or the covariance of wealth shares and consumption propensities, rises, ε and h rise which implies lower wages, lower wealth and a greater proportional change for a given absolute change in wealth. When aggregate labor, h, is fixed, increasing $S_{\alpha\sigma}$ requires a reduction of E_{α}, the average taste for consumption, and this in turn increases the multiplier in equation (25) and (26) and magnifies the wealth effect. Thus, fiscal policies have a proportionately stronger effect on aggregate wealth and larger distributional and inequality effects when $S_{\alpha\sigma} > 0$ or the larger h is.

To determine plausible ranges of changes to the variance of wealth share, consider the case $E_{\alpha} = 0.2$ and compare this to where the percentage changes converge to as E_{α} grows large in Figures 1 through 3. Thus, permanent capital taxes cause the variance of wealth shares to change from -9.0 percent to -16.8 percent. For consumption taxes wealth share inequality changes from -2.0 percent to -3.75 percent, while for a permanent spending shock the range is +13.3 percent to +25.0 percent by this measure. If fiscal policies are ranked according to how much wealth inequality changes, the rankings are the same as for distributional effects. This ranking is partly explained by the nature of the policy experiment. An across the board ten percent increase naturally means larger effects the larger the initial level of the individual policy parameters. Another reason is that capital taxes and government expenditures have larger present value effects on wealth than consumption (and wage) taxes. Also, both rankings depend on aggregate wealth effects. The effects through average wealth dominate the differential wealth effects if $S_{\alpha t}$ is positive. The opposite is true when this covariance is negative. Finally, unless $S_{\alpha\sigma}$ is very large (or E_{α} very small), permanent polices have moderate effects on wealth inequality.[17] Fiscal policies have larger effects on inequality the larger

[17] As a reference, the variance of wealth shares fell by approximately 7.2 percent from 1983 to 1986 using Winnick's (1989) data. This corresponds to a small fall of the Gini coefficient: from 0.565 to 0.554.

$S_{\alpha\sigma}$ or the smaller E_{α}, since initial wealth and the wealth multiplier tend to be larger.

Assuming h = 0.425, I simulate the aggregate effects of anticipated permanent fiscal policy shocks. The graphs of the simulation (Figures 4a through 6d) contrast the representative agent effect of policies with the total policy effect. The total effect adds the distributional effect to the representative agent effect. The distributional effect is computed for the parameter assumptions underlying cases A through D in Table 1 (evaluated at h=0.425). These cases yield bands around the representative agent effects that can be thought of as a measure of possible aggregation bias. Choosing an E_{α} less than 0.2 or greater than 0.8 would have widened the region of potential bias.

Figure 4 shows the effects of an anticipated permanent future capital tax increase. This has the representative agent effect of increasing consumption prior to the start of the shock and then lowering it. Capital, labor and output fall in all periods. The simulated long-run representative agent elasticity with respect to a permanent capital tax is around -0.27 for consumption, -1.34 for capital, -0.12 for labor, and -0.49 for output. The simulated long-run elasticity for the distributional effect ranges from -0.24 to +0.14. This range is tighter the larger the average propensity to consume, E_{α}. As can be seen from the graphs, the distributional effect can dominate the representative agent effect for labor in all periods. The representative agent effect for consumption and output is likely to be dominated only in the anticipation phase. The representative agent effect on capital is much too large to be offset. Of all the policies considered, the representative agent effect of a capital tax shock is least likely to be overwhelmed by the distributional effect.

An expected permanent consumption tax -- shown in Figure 5 -- has the representative agent effect of raising consumption and leisure prior to the shock and then lowering consumption and labor. Capital and output fall in all periods. The simulated long-run representative agent elasticities of the four graphed variables are small - approximately -0.027 for capital, consumption, labor and output. This is mainly because the initial tax rate is small. The simulated elasticity of a permanent consumption taxes' distributional effect on all aggregate variables ranges from -0.053 to +0.034. The representative agent effect is most likely to be offset if $S_{\alpha t}$ is negative. In other words, the offsetting influence is strongest if wealth from heterogeneous endowment streams (eg. lump-sum transfer and/or wage profiles) is negatively correlated with consumption propensities. This effect is magnified if E_α is small and $S_{\alpha\sigma}$ positive.

Lastly (in Figure 6), an anticipated permanent increase of government spending has the representative agent effect of reducing the consumption of goods and leisure and raising investment and output in all periods. The baseline simulation finds that the long-run representative agent elasticities are approximately +0.18 for labor, capital, and output and -0.14 for consumption. The simulated long-run elasticity from the distributional effect of a permanent government expenditure shock ranges from -0.23 to +0.35 for capital, consumption, labor, and output. The distributional effect offsets the representative agent effect on consumption when, the covariance of consumption tastes and endowment streams, $S_{\alpha t}$, is negative. When $S_{\alpha t}$ is positive, the distributional effect tends to offset the representative agent effect on capital, labor, and output. As can be seen in the graphs, the distributional effect is largest when E_α is small. Had I chosen an E_α less than 0.2, the distributional effect would have easily dominated the representative agent effect.

To sum up, the distributional effect is most likely to overturn the representative agent effect for a government spending shock. This is not surprising since these shocks tend to have the largest wealth effects. More surprising is that the distribution effects of consumption taxes are likelier than capital taxes to dominate the representative agent effect. A consumption tax tends to have weaker wealth effects than capital taxes because of smaller initial tax rates, but the wealth effects are not weak relative to the representative agent effects. Also, a capital tax has a very large direct representative agent effect on capital that is hard to offset while consumption is not as sensitive to the direct effects of consumption taxes. Finally, the case for distributional effect overwhelming the representative agent effect is probably stronger for temporary policy shocks, since the representative agent effect gradually weakens returning the economy to the original steady-state. The distributional effect is weaker for a temporary shock, but it does not dissipate.

IV. Conclusion

In this paper the traditional public finance concern with distributional issues is combined with the dynamic analysis of fiscal policies. I argue that distributional considerations should not be dismissed out of hand when analyzing macroeconomic policies. Not only are they important for the study of equity effects, ignoring them by assuming a representative agent leads to aggregation biases when computing the dynamic effects of policies. That the aggregation biases are potentially significant points to the fragility of insights derived from representative agent models. To show this a simple perfect foresight model was developed where agents have heterogeneous preferences for consumption and leisure and heterogeneous full wealth levels (due to differences in both the initial endowments and the profile of future endowments). I find that the aggregate consumption-leisure ratio depends on the endogenous covariance of full wealth shares and propensities for consumption (or work). Thus, fiscal policies have distributional effects through changes of this covariance that are not found in representative agent models.

Although the model's functional form assumptions are restrictive, they allow an exact solution of the dynamic effects of fiscal policies when agents are heterogeneous. To compute the distributional effect of policies, I first calculate how fiscal policies affect full wealth levels and full wealth inequality and find that the size and sign of uncompensated wealth effects -- without budget balancing lump-sum compensations -- depends critically on when and how long a policy is enacted. An increase in capital or consumption tax rates or a decrease in government spending tends to increase wealth levels if there is very little anticipation time or the policy duration is short. But wealth levels will fall the longer the anticipation time or policy duration. On the other hand, the compensated (or, balanced budget) effect of such policies is to increase individual wealth levels. This paper shows that such policies affect wealth levels equally but not equiproportionately. The differential wealth effects of these policies occurs through negative present value effects on the endowment streams that lower the wealth share of individuals with below average endowment streams. If the endowment stream is positively correlated with total wealth, overall inequality will rise (or fall for a negative correlation).

I also show analytically that the sign of the distributional effect on aggregate activity depends on how tastes for consumption and labor and the components of wealth are distributed initially. For example, if the covariance of wealth shares and tastes for consumption is positive, compensated wealth effects have a positive effect on activity. But if the covariance of tastes and endowment streams is positive, differential wealth effects cause a negative distributional effect. Simulations of the model show that the latter effects dominate. Thus, the distributional effect of higher capital or consumption tax rates or lower government spending counteracts (reinforces) the contractionary representative agent effect for a negative (positive) covariance of tastes and endowment streams. Numerical computations suggest that the distributional effects of spending shocks and consumption taxes probably overwhelm the representative agent effects. The distributional effects of capital taxes are less likely to dominate, since they have large direct effects on investment. The simulations of the model are, also, consistent with the stylized fact that wealth inequality moves little over time, even with large distributional effects.

Appendix

Representative Agent Effects

Totally differentiating equations (13) and (14) and solving the resulting difference equations forward yields

$$\hat{x}_s = (1-\chi)\sum_{v\geq 1}\chi^{v-1}\left[-\frac{dt_{rs+v}}{1-t_r}+\frac{dt_{cs+v-1}-dt_{cs+v}}{1+t_c}+\frac{d\gamma_{s+v}}{1-\gamma}\right]\quad \forall s\geq 0 \tag{A1}$$

$$\hat{h}_s = -(1-h)\hat{\lambda}_s,\quad \hat{\lambda}_s = -\hat{\varepsilon}+\frac{dt_{ws}}{1-t_w}+\frac{dt_{cs}}{1+t_c}-\frac{d\gamma_s}{1-\gamma}-\frac{\chi}{1-\chi}\hat{x}_s\quad \forall s\geq 1 \tag{A2}$$

where $\hat{x}_s$ denotes dx_s/x evaluated at the initial steady-state value. The above equations describe dynamic effects for any time path of fiscal policy shocks. Solving these equations out and inserting I_s as well as

$$X_s \equiv (1-\chi)\textstyle\sum_{v\geq 1}\chi^{v-1}I_{s-v} = \begin{cases}\chi^{S-1-s}(1-\chi^{T-S}) & s\leq S-1\\ 1-\chi^{T-1-s} & S\leq s\leq T-1\\ 0 & s\geq T\end{cases} \tag{A3}$$

yields equations (17) and 18).

Equations (17) and (18) are are useful in deriving equations (19) through (21). After totally differentiating the equilibrium production relationship, $y_s = [(1-\chi_{s-1})(1-\gamma_{s-1})y_{s-1}]^{\theta}h_s^{1-\theta}$, iterate backwards and substitute for $\hat{h}_s$. Collecting $\hat{x}_s$ terms and letting $1-\phi\equiv(1-h)(1-\theta)$, one can show that

$$\hat{k}_s = \sum_{v=0}^{s-1}\theta^v\left[(1-\phi)\left(\hat{\varepsilon}-I_{s-v}\frac{dt_w}{1-t_w}-I_{s-v}\frac{dt_c}{1+t_c}\right)-I_{s-v}\phi\frac{d\gamma}{1-\gamma}+\frac{1-\phi\chi}{1-\chi}\hat{x}_{s-v}\right]\quad \forall s\geq 1 \tag{A4}$$

Using the following expressions then yields equations (19) through (21):

$$K_s^I \equiv \sum_{v=0}^{s-1}\theta^v I_{s-v} = \begin{cases}0 & s\leq S-1\\ \dfrac{1-\theta^{s+1-S}}{1-\theta} & S\leq s\leq T-1\\ \theta^{s+1-T}K_{T-1}^I & s\geq T\end{cases} \tag{A5}$$

$$K_s^\chi \equiv \sum_{v=0}^{s-1} \theta^v X_{s-v} = \begin{cases} \dfrac{1-(\theta\chi)^s}{1-\theta\chi} X_s & s \le S-1 \\[2ex] \dfrac{1-(\theta\chi)^s}{1-\theta\chi}(X_s - 1) + K_s^I + \left(1-(1-\theta)K_s^I\right)\dfrac{1-(\theta\chi)^{S-1}}{1-\theta\chi} & S \le s \le T-1 \\[2ex] \theta^{s+1-T} K_{T-1}^\chi & s \ge T \end{cases} \tag{A6}$$

Wealth and Distributional Effects

Totally differentiating full wealth yields

$$\frac{dz_1^i}{y_0} = \sum_{s\ge 1} \rho^s \left((1-t_w)(1-\theta)(1+\lambda)[\frac{\lambda}{1+\lambda}\hat{\lambda}_s - I_s \frac{dt_w}{1-t_w} + \hat{\pi}_s] + dt_s^i + t^i \hat{\pi}_s \right) \tag{A7}$$

This expression can be solved with the help of

$$\begin{aligned} \hat{\pi}_s &= \frac{\chi \hat{X}_s - \hat{X}_0}{1-\chi} + \frac{d\gamma_s}{1-\gamma} - \frac{dt_{cs}}{1-t_c} \\ &= -\left(\frac{\chi X_s - X_0}{1-\chi} \right) \frac{dt_r}{1-t_r} + (X_0 - \chi X_s - (1-\chi)I_s)\frac{dt_c}{1+t_c} + \left[\frac{\chi X_s - X_0}{1-\chi} + I_s \right] \frac{d\gamma}{1-\gamma} \end{aligned} \tag{A8}$$

and equation (18) which capture the policies' indirect effects on wealth. Note that raising capital or consumption taxes or reducing government's share of output increases λ_s in periods $s \le T-1$ and thus raises wealth. After T, these policies have no effect on wealth through this channel. By contrast, these policies lower π_s for periods $s \le S-1$. During the policy interval [S, T-1], a one-period positive shock to capital taxes will raise π_s, but a permanent shock will lower π_s. This is because the shorter the policy duration is, the more likely it is that the direct effect of capital taxes on after-tax interest rates will outweigh the indirect effect through changes in net of tax interest rates. By contrast, an increase in consumption taxes or a decrease in government expenditures will lower π_s in periods $s \in$ [S, T-1]. This occurs because there are no direct effects on after-tax interest rates.

To derive the distributional effect, $\hat{\varepsilon} = (E_{\alpha\sigma} E_{(1-\alpha)\sigma})^{-1} dS_{\alpha\sigma}$, use the fact that $dS_{\alpha\sigma} = (E_z)^{-1}(dS_{\alpha z} - S_{\alpha\sigma} dE_z)$ and $dS_{\alpha z} = \sum_i n^i(\alpha^i - E_\alpha)(dz_1^i - dE_z)$ to yield

$$\begin{aligned} (E_{(1-\alpha)\sigma} E_z)\hat{\varepsilon} = {} & \frac{1}{E_\alpha} \sum_i n^i (\alpha^i - E_\alpha) P^I dt^i + \frac{S_{\alpha t} P}{E_\alpha} \left(D_r \frac{dt_r}{1-t_r} + D_c \frac{dt_c}{1+t_c} + D_\gamma \frac{d\gamma}{1-\gamma} \right) \\ & - \frac{1}{E_\alpha} \left(Z_w \frac{dt_w}{1-t_w} + Z_r \frac{dt_r}{1-t_r} + Z_c \frac{dt_c}{1+t_c} + Z_\gamma \frac{d\gamma}{1-\gamma} + \sum_i n^i P^I dt^i \right) \end{aligned} \tag{A10}$$

Substituting this expression into equation (23) yields

$$dE_z = -\frac{1}{E_\alpha}\sum_i n^i(\alpha^i - E_\alpha)\mathrm{P}^I dt^i - \frac{S_{\alpha t}\mathrm{P}}{E_\alpha}\left(D_r\frac{dt_r}{1-t_r} + D_c\frac{dt_c}{1+t_c} + D_\gamma\frac{d\gamma}{1-\gamma}\right)$$

$$-\frac{E_{\alpha\sigma}}{E_\alpha}\left(Z_w\frac{dt_w}{1-t_w} + Z_r\frac{dt_r}{1-t_r} + Z_c\frac{dt_c}{1+t_c} + Z_\gamma\frac{d\gamma}{1-\gamma} + \sum_i n^i\mathrm{P}^I dt^i\right) \tag{A11}$$

If all fiscal policy changes are required to balance the government's intertemporal revenue constraint, then applying the method for deriving equation (23) to equation (16) yields

$$0 = db_0^g = Z_w\frac{dt_w}{1-t_w} + (Z_r - \mathrm{P}C_r)\frac{dt_r}{1-t_r} + (Z_c - \mathrm{P}C_c)\frac{dt_c}{1+t_c} + (Z_\gamma - \mathrm{P}C_\gamma)\frac{d\gamma}{1-\gamma} + \Sigma_i n^i\mathrm{P}^I dt^i \tag{A12}$$

where $(1-\chi)\mathrm{P}C_r = \mathrm{P}C_c = -(1-\chi)\mathrm{P}C_\gamma = \mathrm{P}(1+t_c)(1-\chi)(1-\gamma)\frac{1+\varepsilon}{\varepsilon}\mathrm{X}_0 > 0$. *Note that to derive this equation.* it

is helpful to rewrite the steady-state deficit as $\gamma + E_t - \tau = ((1-t_w)(1-\theta) + E_t) + \theta(1-t_r) - (1-\gamma)(1+t_c(1-\chi))$.

To compute uncompensated, differential and compensated wealth effects, some building blocks are developed. The transform functions P, P^I, and P^χ defined in the text have the solutions $\mathrm{P} = \rho/(1-\rho)$ and

$\mathrm{P}^I = \rho^{S-1}(1-\rho^{T-S})\mathrm{P}$. Substituting (A3) into $\mathrm{P}^\chi \equiv \sum_{s\geq 1}\rho^s\mathrm{X}_s$ implies

$$\mathrm{P}^\chi = (1-\chi^{T-S})\rho^{S-1}\sum_{s=1}^{S-1}\left(\frac{\chi}{\rho}\right)^{S-1-s} + \sum_{s=S}^{T-1}\rho^s - \rho^{T-1}\sum_{s=S}^{T-1}\left(\frac{\chi}{\rho}\right)^{T-1-s}$$

which after some algebra yields

$$\left(1-\frac{\chi}{\rho}\right)\mathrm{P}^\chi = \rho^{S-1}\left[(1-\rho^{T-S})\left(\left(1-\frac{\chi}{\rho}\right)\mathrm{P}+1\right) - (1-\chi^{T-S})\left(\frac{\chi}{\rho}\right)^{S-1}\right] \tag{A13}$$

Since

$$\mathrm{P}\mathrm{X}_0 = \rho^{S-1}(1-\chi^{T-S})\mathrm{P}\left(\frac{\chi}{\rho}\right)^{S-1} \tag{A14}$$

it follows that

$$\left(1-\frac{\chi}{\rho}\right)(\mathrm{P}\mathrm{X}_0 - \chi\mathrm{P}^\chi) = \rho^{S-1}(1-\chi)\mathrm{P}\left[(1-\chi^{T-S})\left(\frac{\chi}{\rho}\right)^{S-1} - (1-\rho^{T-S})\left(\frac{\chi}{\rho}\right)\right] \tag{A15}$$

$$\left(1-\frac{\chi}{\rho}\right)\left(\frac{\mathrm{P}\mathrm{X}_0 - \chi\mathrm{P}^\chi}{1-\chi} - \mathrm{P}^I\right) = \rho^{S-1}\mathrm{P}\left[(1-\chi^{T-S})\left(\frac{\chi}{\rho}\right)^{S-1} - (1-\rho^{T-S})\right] \tag{A16}$$

Note that the last two equations correspond to the differential effects defined in equation (24).

Using these building blocks to find the uncompensated wealth effects in equations (22) and (23), first, reproduce the coefficients from equation (23):

$$(1-\chi)Z_r \equiv M\left(X_0 P - \chi P^{\chi}\right) + N X_0 P,\; Z_c \equiv (1-\chi)\left(Z_r - M P^{I}\right) = -(1-\chi)Z_{\gamma} \tag{A17}$$

where, to save space, $M \equiv (1-\theta)(1-t_w) + E_\rho$ $N \equiv (1-\theta)(1-t_w)\lambda = (1+t_c)(1-\chi)(1-\gamma)\frac{1}{\varepsilon}$.

Solving these terms out yields:

$$\left(1-\frac{\chi}{\rho}\right)P^{-1}(1-\chi)Z_r = \left[M(1-\chi) + N\left(1-\frac{\chi}{\rho}\right)\right]\left(1-\chi^{T-S}\right)\chi^{S-1} - \left(\frac{\chi}{\rho}\right)M(1-\chi)\left(1-\rho^{T-S}\right)\rho^{S-1} \tag{A18}$$

$$\left(1-\frac{\chi}{\rho}\right)P^{-1}Z_c = \left[M(1-\chi) + N\left(1-\frac{\chi}{\rho}\right)\right]\left(1-\chi^{T-S}\right)\chi^{S-1} - M(1-\chi)\left(1-\rho^{T-S}\right)\rho^{S-1} \tag{A19}$$

To find the compensated wealth effects in equation (A12) note that, for instance, originally

$$PC_r \equiv (1-\gamma)\left[\left(1-\frac{\chi}{\rho}\right)\left(X_0 P - \chi P^{\chi}\right) + (1-\chi)\left(\frac{1+\varepsilon}{\varepsilon}(1+t_c) - 1\right)X_0 P + (1-\chi)\frac{\chi}{\rho}P^{I}\right] \tag{A20}$$

from which (with the building blocks defined above) it is straightforward to derive the terms in equation (A12).

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TABLE 1: Total Wealth Effects of Permanent Policy Shocks

	h = 0.401				h = 0.45			
$PS_{\alpha t}/E_z$ =	$(0.75)S_{\alpha\sigma}$		$-(0.5)S_{\alpha\sigma}$		$(0.75)S_{\alpha\sigma}$		$-(0.5)S_{\alpha\sigma}$	
E_α =	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8
$S_{\alpha\sigma}$ =	0.275	-0.325	0.275	-0.325	0.275	-0.325	0.275	-0.325
CASE	A	B	C	D	A	B	C	D
Distributional Effect of Capital Tax	-2.2%	0.77%	1.27%	-0.44%	-2.67%	0.67%	1.54%	-0.39%
Distributional Effect of Consumption Tax	-0.48%	0.17%	0.31%	-0.11%	-0.58%	0.15%	0.38%	-0.09%
Distributional Effect of Spending Shock	3.21%	-1.12%	-2.08%	0.73%	3.89%	-0.97%	-2.52%	0.63%
Effect on $S_{\sigma\sigma}$ of Capital Tax	-9.83%	-14.70%	-16.21%	-12.47%	-9.11%	-14.52%	-16.76%	-12.61%
Effect on $S_{\sigma\sigma}$ of Consumption Tax	-2.16%	-3.32%	-3.61%	-2.81%	-1.99%	-3.28%	-3.73%	-2.84%
Effect on $S_{\sigma\sigma}$ of Spending Shock	14.47%	22.24%	24.17%	18.85%	13.32%	21.95%	24.96%	19.04%

Figure 1a Long-Run Distributional Effect

Permanent Capital Tax, P*Sat/Ez=.75*Sas

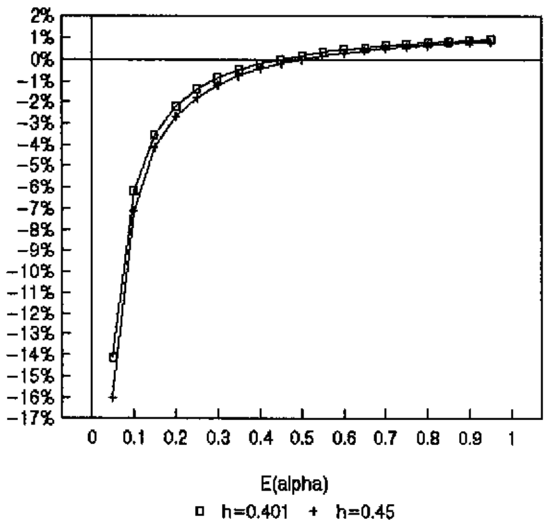


Figure 1b Long-Run Distributional Effect

Permanent Capital Tax, P*Sat/Ez=-.5*Sas

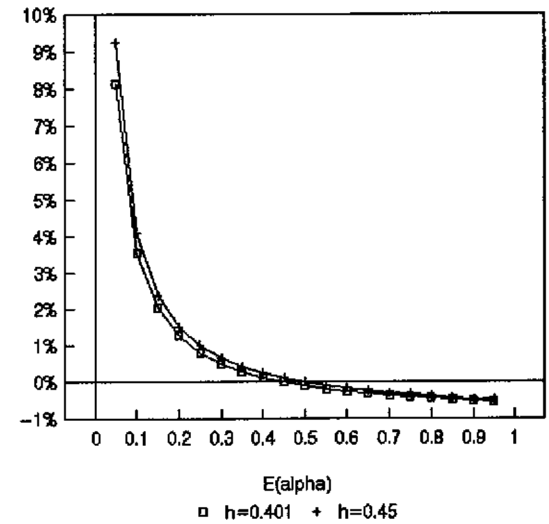


Figure 1c Effect on Variance of Wealth Shares

Permanent Capital Tax, P*Sat/Ez=.75*Sas

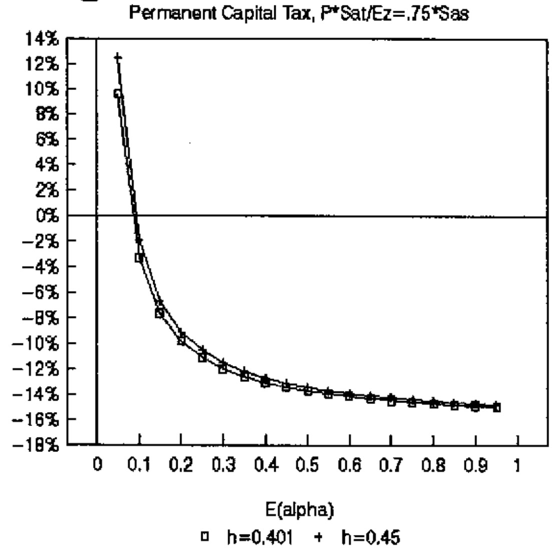


Figure 1d Effect on Variance of Wealth Shares

Permanent Capital Tax, P*Sat/Ez=-.5*Sas

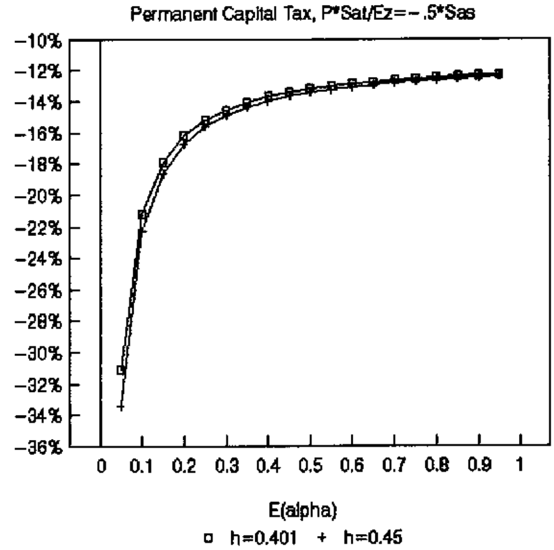


Figure 2a Long–Run Distributional Effect

Perm. Consumption Tax, P*Sat/Ez=.75Sas

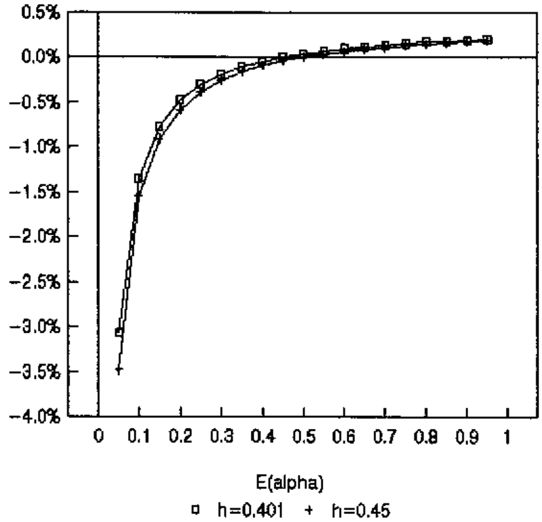


Figure 2b Long–Run Distributional Effect

Perm. Consumption Tax, P*Sat/Ez=–.5*Sas

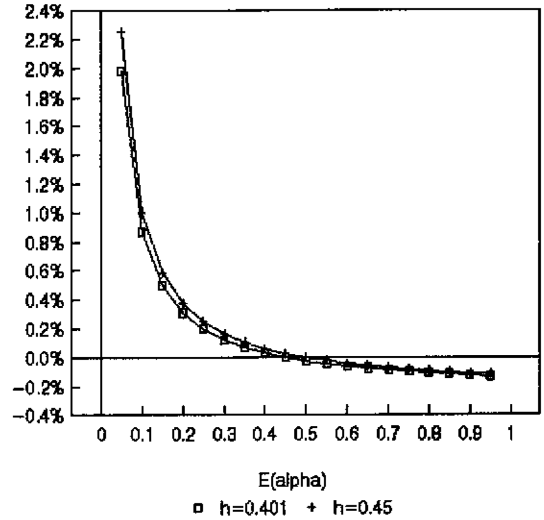


Figure 2c Effect on Variance of Wealth Shares

Perm. Consumption Tax, P*Sat/Ez=.75*Sas

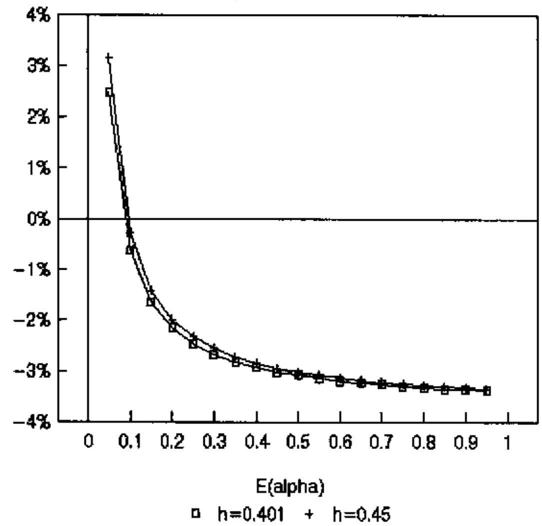


Figure 2d Effect on Variance of Wealth Shares

Perm. Consumption Tax, P*Sat/Ez=–.5*Sas

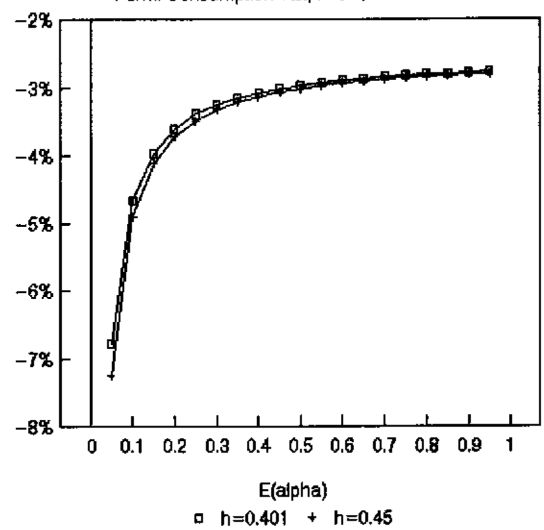


Figure 3a Long-Run Distributional Effect

Perm. Spending Shock, P*Sat/Ez=.75*Sas

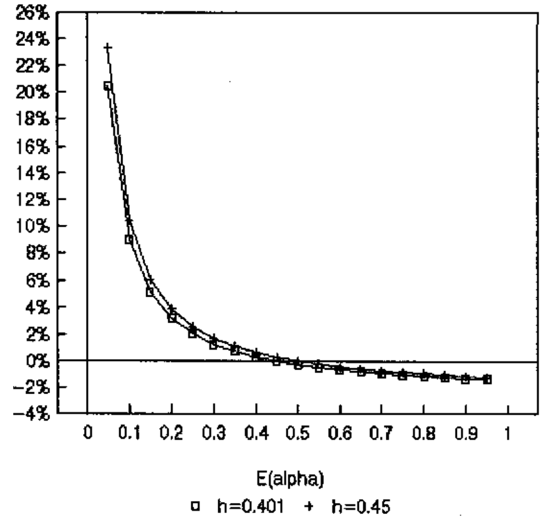


Figure 3b Long-Run Distributional Effect

Perm. Spending Shock, P*Sat/Ez=-.5*Sas

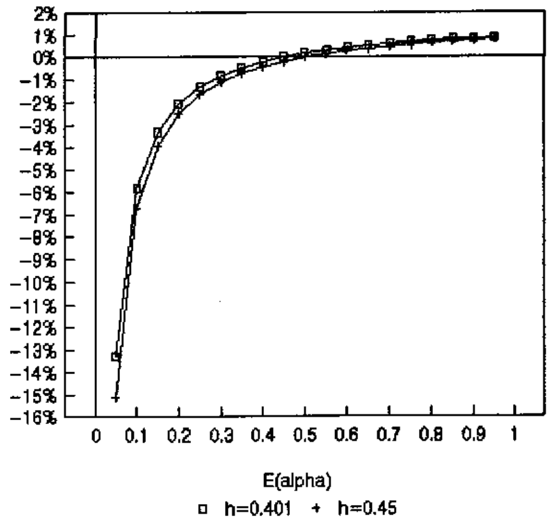


Figure 3c Effect on Variance of Wealth Shares

Perm. Spending Shock, P*Sat/Ez=.75*Sas

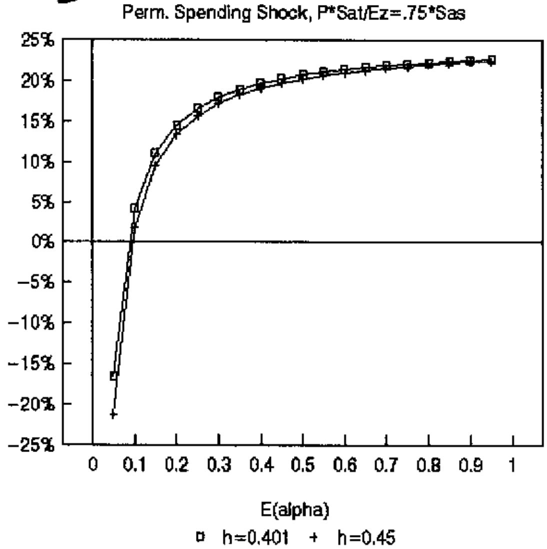


Figure 3d Effect on Variance of Wealth Shares

Perm. Spending Shock, P*Sat/Ez=-.5*Sas

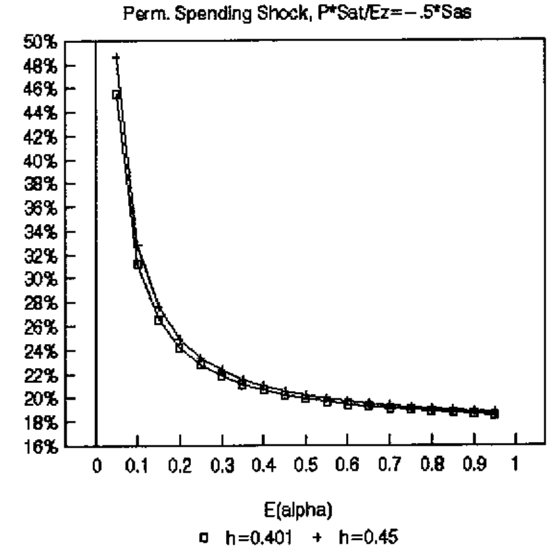


Figure 4a Effect on Labor: h=0.425

Permanent Capital Tax

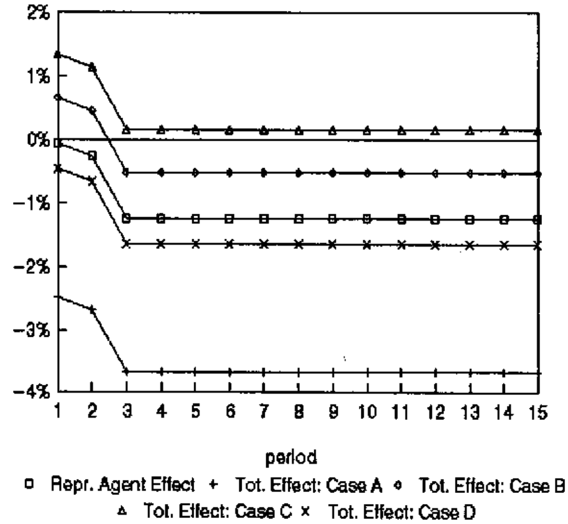


Figure 4b Effect on Capital: h=0.425

Permanent Capital Tax

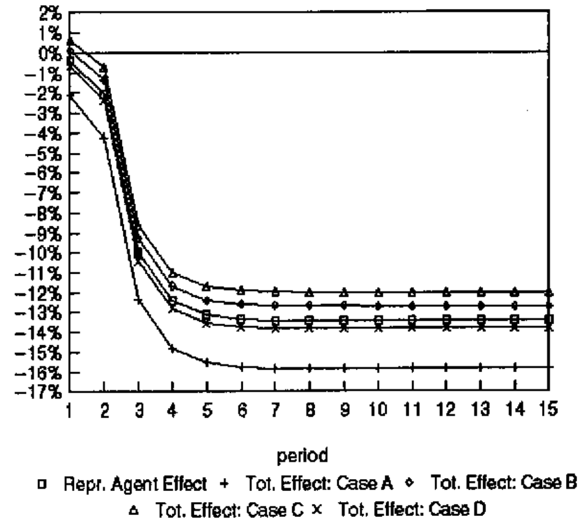


Figure 4c Effect on Output: h=0.425

Permanent Capital Tax

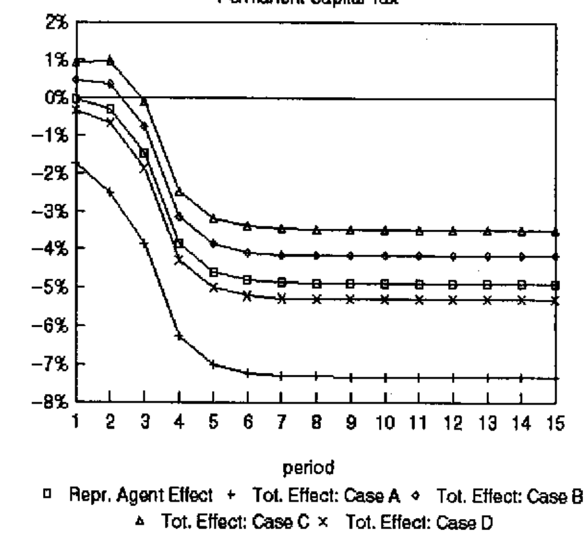


Figure 4d Effect on Consumption: h=0.425

Permanent Capital Tax

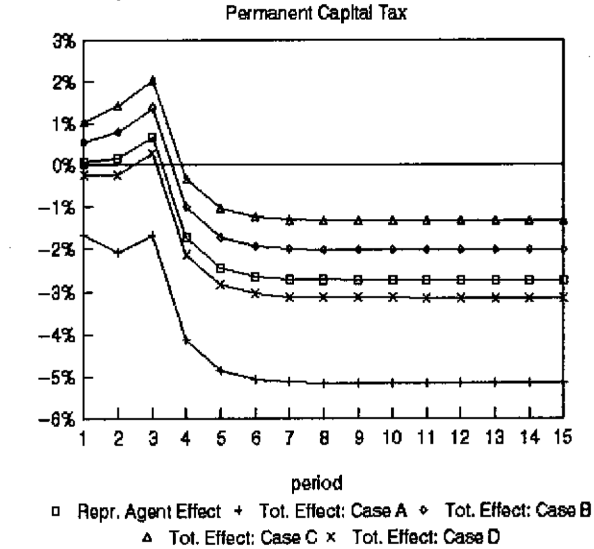


Figure 5a Effect on Labor: h=0.425

Permanent Consumption Tax

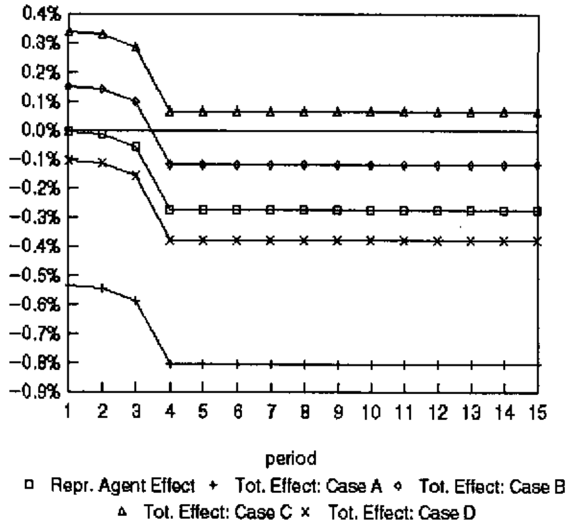


Figure 5b Effect on Capital: h=0.425

Permanent Consumption Tax

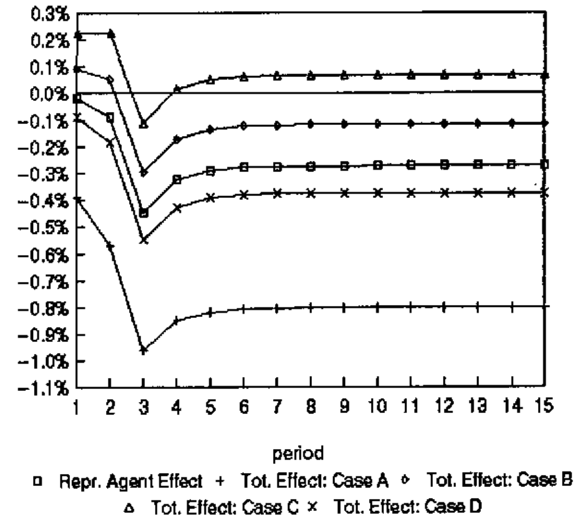


Figure 5c Effect on Output: h=0.425

Permanent Consumption Tax

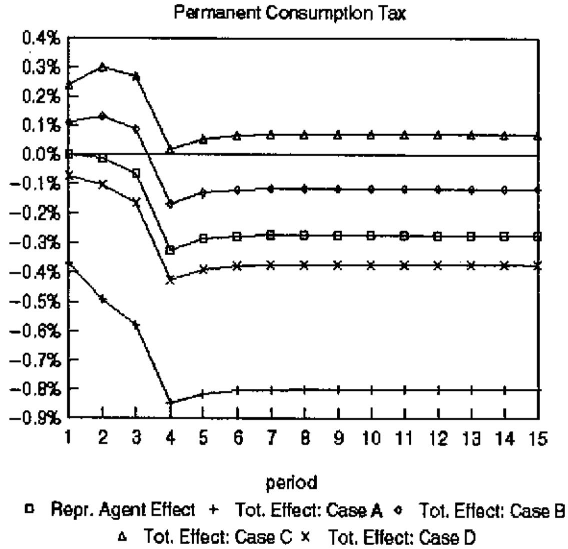


Figure 5d Effect on Consumption: h=0.425

Permanent Consumption Tax

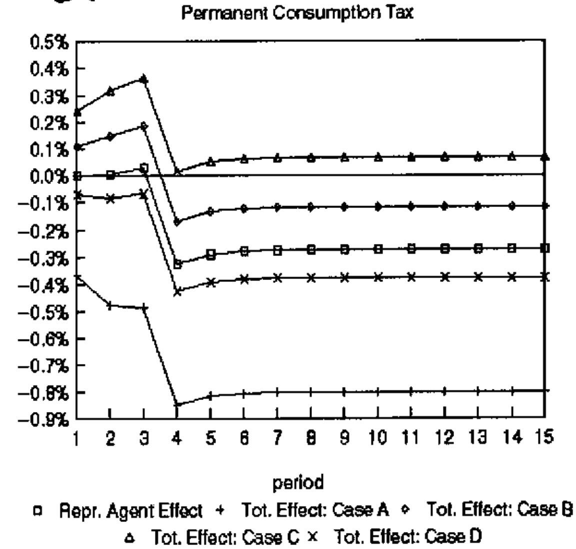


Figure 6a

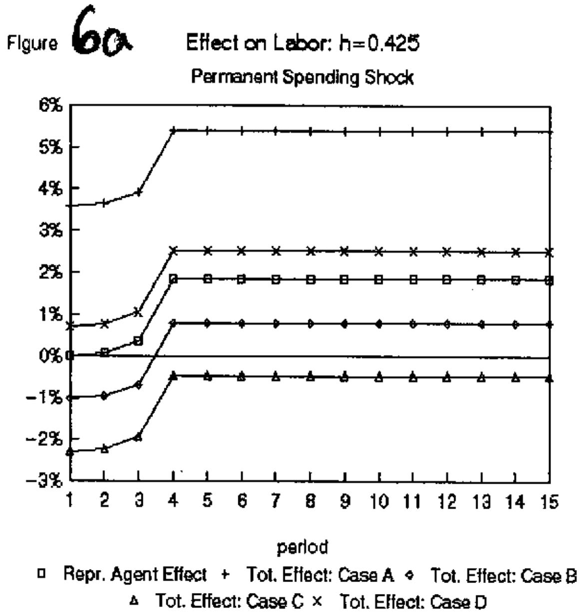


Figure 6b

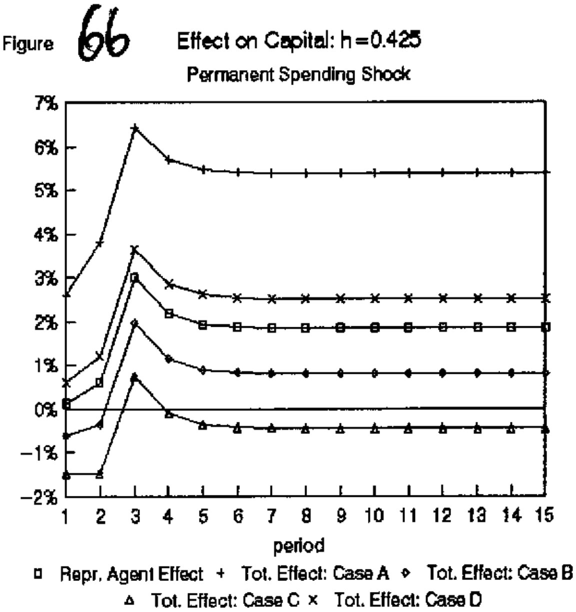


Figure 6c

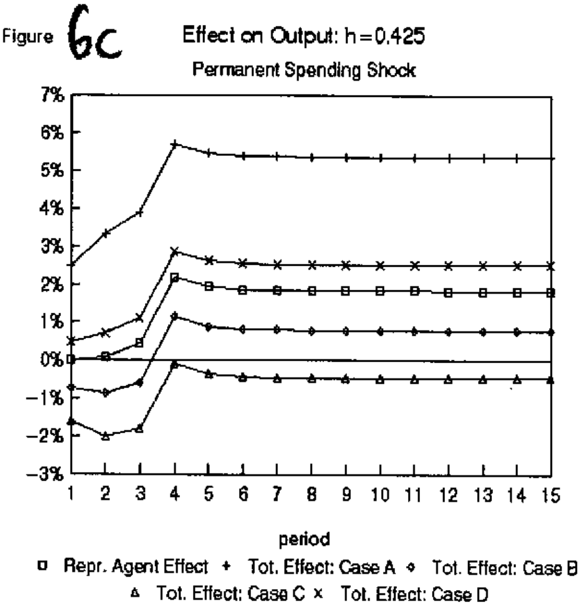
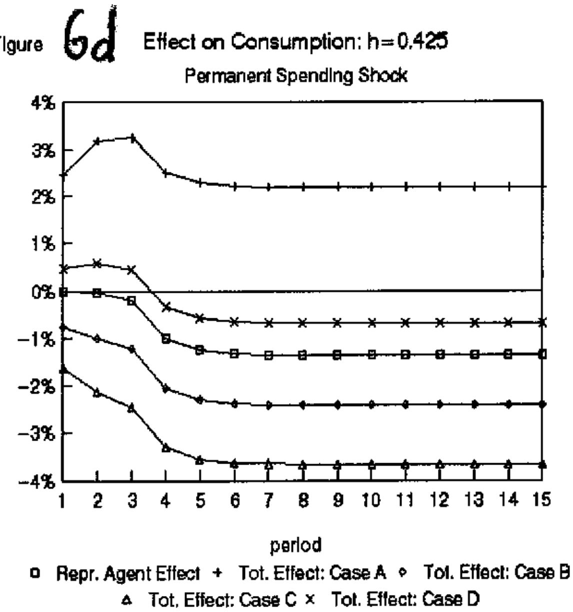


Figure 6d



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