Optimal Fiscal Policy under Preference Heterogeneity

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VERY PRELIMINARY AND INCOMPLETE ![*]

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Abstract

This paper studies optimal fiscal policy in a Mirrlees economy where agents are heterogeneous in their incomes, in preferences toward risk, and in the intertemporal elasticity of substitution. If low income people have both lower intertemporal elasticity of substitution and higher risk aversion, the optimal fiscal policy exhibits lower marginal tax rates and more redistribution in a recession. Marginal tax rates also decrease when government spending decreases. In the examples studied the results are purely due to the heterogeneity in preferences, that leads to differential fluctuations in the implicit Pareto weights of the agents across time and states, and in turn to fluctuations in marginal taxes and transfers.

1 Introduction

How should marginal and average taxes change over the business cycle? How should they vary with changes in government consumption over time and states? The answers to those long-standing questions are typically given in a representative agent Ramsey framework with no scope for redistribution or insurance across different types. That not only reduces the scope of the policy prescriptions - one cannot talk about redistribution

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across people for example - but can potentially give misleading answers about other dimensions of the policy design. In this paper I reconsider the optimal policies in the context of a dynamic Mirrlees economy with aggregate shocks, where agents are heterogeneous not only in their productivity, but also in their preferences, namely elasticity of intertemporal substitution and risk aversion.

I show, through stylized examples, that heterogeneity in preferences substantially alters the optimal policy prescriptions relative to an economy where all agents are identical, or differ only in their productivity. If low productivity agents are those that have lower intertemporal elasticity of substitution and higher risk aversion, it is optimal to decrease marginal taxes in a recession, and increase them in an expansion. I connect variations in the marginal taxes with the variations in the implicit Pareto weight of low productivity agents, and show that they are inversely related. Periods of low aggregate productivity are periods when their Pareto weights are high, and marginal taxes are low. The reason is that, due to the difference in preferences, low income people receive more insurance in a recession. That reduces their labor supply relative to the labor supply of high income people, which in turn relaxes the incentive compatibility constraint, and the need for distortive taxation. At the same time, transfers to low productivity people are higher in a recession. Those results stand in contrast to an otherwise identical economy where both types have identical preferences, and both receive the same amount of insurance against aggregate shocks.

I isolate the roles of infinite risk aversion and zero intertemporal elasticity of substitution and show that while both tend to decrease marginal taxes following an adverse productivity shock, they have markedly different implications for the future dynamics of the marginal taxes. Infinite risk aversion produces positive persistency in the marginal tax rates, because the implicit Pareto weights of the type A agent follow a random walk. Decreases in marginal tax rates are thus followed by low marginal tax rates in the future. Zero intertemporal elasticity of substitution, on the other hand, prescribes the opposite pattern: low marginal tax rates are followed by higher marginal tax rates in the future, because lower implicit Pareto weights today must be off-set by higher Pareto weights in the future. When both infinite risk aversion and zero intertemporal elasticity of substitution are present, both effects cancel each other out, and the optimal pattern is remarkably simple, in that it is a function of only the current state.

I also show that periods of higher government consumption should be accompanied by lower marginal tax rates. This result contrasts with a well-known tax-smoothing prescription in a complete markets dynamic Ramsey economy, where taxes are spread approximately equally across all states to equalize marginal distortions. The logic behind the novel result again follows from the fact that low income people receive relatively more insurance, their Pareto weights increase, and relatively lower labor supply under higher government consumption relaxes the incentive constraints. Transfers to the low income people are, on the other hand, negatively correlated with government consumption as government consumption crowds out transfers. The decrease in the transfers is, however, smaller relatively to an economy with standard preferences.

There is substantial empirical evidence that documents heterogeneity in the intertemporal elasticity of substitution across people (Vissing-Jørgensen (2002), Guvenen (2006)), typically between stockholders and non-stockholders, but also across people of different income levels (Blundell et al. (1994)), with higher income people exhibiting higher intertemporal elasticity of substitution. There is also an empirical evidence that wealthier people exhibit lower risk aversion (Mankiw and Zeldes (1991)). Both types of findings are consistent with the assumptions in this paper, and, by itself, motivate the microeconomic assumptions made in this paper.

There is, however, another reason to consider optimal fiscal policy under the type of preference heterogeneity studied in this paper. Models with this type of heterogeneity have had success in explaining key macroeconomic asset pricing moments, including equity premium, volatility of returns, or volatility of the risk free rate (Guvenen (2009), Gomes and Michaelides (2007), Gârleanu and Panageas (2015)). Matching those moments is important for a quantitative evaluation of the optimal fiscal policy, since they (especially the risk-free rate) have direct implications for the cost of the government debt across states.

This paper studies uses the Mirrlees approach to the optimal fiscal policy, but focuses on issues traditionally studied in the dynamic Ramsey tradition, following the seminal approach of Lucas and Stokey (1983). Karantounias (2018) considers a dynamic Ramsey economy with recursive preferences that are considered in this paper as well. To keep things simple, the agents face no idiosyncratic shocks as in (Farhi and Werning (2012), Kapička (2013) Golosov et al. (2016)); all their characteristics are permanent. Werning (2007) studies similar issues, but in the absence of preference heterogeneity, thus shutting down the key mechanisms in this paper.

2 The Model

Time is discrete, infinite and starts at zero. There is uncertainty regarding aggregate productivity and government spending. The aggregate shock in period t is denoted by $s_t \in S$, where S is a finite set. The initial shock s_0 is known. The probability of a history of shocks $s^t = (s_0, s_1, \ldots, s_t)$ is $\pi(s^t)$. A probability distribution of s_{t+1} conditional on s^t is denoted by $\pi_t(s_{t+1}|s^t)$. Then aggregate productivity in period t is $Z_t(s^t)$, and government consumption is $G_t(s^t)$.

There are two types of agents, A and B, with population fractions λ and $1-\lambda$. The agents differ in their preferences and in their productivity. Both types have Epstein-Zin preferences, defined recursively over stochastic processes for consumption and hours worked by

$$V_t^i(s^t) = \left[(1-\beta)U\left(c_t^i(s^t), n_t^i(s^t)\right)^{1-\rho^i} + \beta\mu_t^i\left(V_{t+1}^i(s^{t+1})\right)^{1-\rho^i}\right]^{\frac{1}{1-\rho^i}} \tag{1}$$

for $i \in \{A, B\}$, where $c_t^i(s^t) \geq 0$ is consumption, $n_t^i(s^t) \geq 0$ are hours worked, and U is a period utility function, increasing and concave in the first argument, decreasing and concave in the second argument, and twice differentiable. The function μ^i is the certainty equivalent of a risky continuation utility,

$$\mu_t^i(V(s^{t+1}) = \left[\sum\nolimits_{s_{t+1}} \pi(s_{t+1}|s^t)(V(s^{t+1})^{1-\gamma^i})\right]^{\frac{1}{1-\gamma^i}}.$$

The parameter γ^i measures the relative risk aversion of type i, while $1/\rho^i$ is the intertemporal elasticity of substitution between current period utility and the certainty equivalent μ^i.[1] Expected utility is recovered if $\gamma^i = \rho^i$.

Both types of agents also differ in their relative productivity. The productivity of type A agent is normalized to equal the aggregate productivity $Z(s^t)$. The productivity o type B agent is $Z(s^t)\theta$, where $\theta > 1$ is the their productivity relative to type A agents. Type B agents are thus always of higher productivity than typer A agents. The value of θ is constant across time and states, which rules out changes in relative productivity

[1] One needs to distinguish between an intertemporal elasticity of substitution in utilities and intertemporal elasticity of substitution in consumption, which depends on the function U, and will in general be different.

over time and over business cycle.[2]

The aggregate resource constraint requires that for all histories, aggregate consumption cannot exceed aggregate production.

$$\lambda c_t^A(s^t) + (1-\lambda)c_t^B(s^t) + G_t(s^t) \leq Z_t(s^t)\left[\lambda n_t^A(s^t) + (1-\lambda)\theta n_t^B(s^t)\right] \quad \forall s^t \in S^{t+1}. \quad (2)$$

The agent's type is defined by their productivity, their relative risk aversion, and their intertemporal elasticity of substitution. I follow a standard Mirrlees information structure where the agent's type and hours worked are a private information of the agents, while consumption and incomes are publicly observable. The incentive compatibility constraint requires that both types prefer their own allocation to the allocation of the other type. Given that type B agents have higher relative productivity, I will restrict attention to situations where only the incentive constraint on type B agents binds. To that end, define the utility of a type B agent from an allocation of a type A agent as

$$\hat{V}_t^B(s^t) = \left[(1-\beta)U\left(c_t^A(s^t), \frac{n_t^A(s^t)}{\theta}\right)^{1-\rho^B} + \beta\mu_t^B\left(\hat{V}_{t+1}^B(s^{t+1})\right)^{1-\rho^B}\right]^{\frac{1}{1-\rho^B}},$$

where the expression for the period utility reflects the fact, that type B agents must only work n_t^A/θ hours to produce what type A agent produces. The incentive compatibility constraint then requires

$$V_0^B(s_0) \geq \hat{V}_0^B(s_0). \quad (3)$$

The social planner assigns a relative Pareto weight $\alpha \geq 0$ to the type A agent. The Pareto weight is assumed to be sufficiently large that the planner wants to redistribute from type B agents toward type A agents. The planning problem then solves

$$\max \ \alpha V_0^A(s_0) + V_0^B(s_0) \quad \text{s.t.} \quad (2) \text{ and } (3).$$

[2] I do so in order to isolate the role of preference heterogeneity. It is easy to relax this assumption.

3 Three Examples

I start by considering three examples, where type A agents have an extreme version of the preferences specified in (1). In all three examples, the preferences of type B agents are standard. They have zero aversion toward utility risk ($\gamma^B = 0$) and infinite elasticity of intertemporal substitution in utilities ($\rho^B = 0$),[3] and his lifetime utility is then

$$V^B = (1-\beta)\mathbb{E}\sum_{t=0}^{\infty}\beta^t U\left(c_t^B(s^t), n_t^B(s^t)\right).$$

Preferences of type A agents will differ in each example. In the first one, they will have an infinite risk aversion; in the second one, they will have zero intertemporal elasticity of substitution; in the third one, their preferences will combine both infinite risk aversion and zero intertemporal elasticity of substitution. In each of the three cases, the implication for the optimal marginal tax rates and allocations are worked out.[4]

To further simplify the problem, I assume that the period utility exhibits a constant Frisch elasticity of labor,

$$U(c,n) = \ln c - \frac{n^{1+\eta}}{1+\eta}.$$

Marginal tax rates. We characterize the solution in terms of the marginal tax rates faced by agents A in each period and state,

$$\tau_t^A(s^t) = 1 + \frac{U_{nt}^A(s^t)}{U_{ct}^A(s^t)}\frac{1}{Z(s^t)},$$

which measure the degree of distortions in the economy.[5]

If type A agents have also had standard preferences with zero utility risk aversion, this period utility function delivers constant marginal tax rates across all aggregate shocks, given by

$$\tau_t^A(s^t) = \frac{\kappa(1-\phi)}{\alpha-\kappa\phi}, \tag{4}$$

[3] Intertemporal elasticity of substitution in consumption depends on the function U, and will in general be finite.

[4] It should be noted that if type B agents would have extreme preferences instead of type A agents, the solution to the problem would be very different. It is because the incentive constraint is not symmetric: it always binds type B agents from taking the allocation of type A agents.

[5] The optimum always features zero distortions of the type B agents for well known reasons.

where $\psi = \theta^{-1-\eta}$ is a constant, and $\kappa > 0$ is the Lagrange multiplier on the incentive constraint (3). Since $0 < \phi < 1$, the marginal tax rates are positive. Any variations in the marginal tax rates in the three extreme examples below can then be attributed to the heterogeneity of preferences.

3.1 Example 1: Differences in Risk Aversion

Low productivity type A agents have infinite intertemporal elasticity of substitution in utilities ($\rho^A = 0$), but at the same time infinite aversion toward utility risk ($\gamma^A = \infty$). Their preferences are

$$V_t^A(s^t) = (1-\beta)U\left(c_t^A(s^t), n_t^A(s^t)\right) + \beta \min\left\{V_{t+1}^A(s^{t+1})\right\}.$$

The optimum requires that $V_{t+1}^A(s^t, s_{t+1})$ is independent of the current shock s_{t+1}, and so the lifetime utility must satisfy

$$V_t^A(s^{t-1}) = (1-\beta)U\left(c_t^A(s^t), n_t^A(s^t)\right) + \beta V_{t+1}^A(s^t) \quad \forall s^t. \tag{5}$$

The promise keeping constraint (5) has an obvious implication that changes in the current and continuation utility are inversely related to each other, since they must sum to a value independent of the current shock. A reasonable conjecture is that an adverse aggregate shock (either low productivity or high government spending) will decrease the current utility of the A agent, but his continuation utility is going to increase. At the same time, the fluctuations in the current and continuation utilities are going to be relatively small, given that their lifetime utility is independent of the current shock.

Define the consumption function by $C(u, n) = U^{-1}(u, n)$. The function C is strictly increasing and convex in both c and n, and has derivatives $C_u = 1/U_c$ and $C_n = -U_n/U_c$. We rewrite the problem in terms of a choice of period utilities u_t^A and u_t^B, and determine consumption from the consumption function C. The social planner maximizes

$$\alpha V_0^A + (1-\beta)\sum_{t=0}^{\infty}\sum_{s^t} \beta^t \pi_t(s^t) u_t^B(s^t)$$

subject to the promise keeping constraint for type A agent,

$$V_t^A(s^{t-1}) = (1-\beta)u_t^A(s^t) + \beta V_{t+1}^A(s^t) \quad \forall s^t,$$

the resource constraint,

$$\lambda C(u_t^A(s^t), n_t^A(s^t)) + (1-\lambda) C\left(u_t^B(s^t), n_t^B(s^t)\right) + G_t(s^t) \leq Z_t(s^t)\left[\lambda n_t^A(s^t) + (1-\lambda)\theta n_t^B(s^t)\right],$$

and the incentive compatibility constraint

$$(1-\beta)\sum_{t=0}^{\infty}\sum_{s^t}\beta^t \pi_t(s^t) u_t^B(s^t) \geq (1-\beta)\sum_{s^t}\beta^t \pi_t(s^t) U\left(C\left(u_t^A(s^t), n_t^A(s^t)\right), \frac{n_t^A(s^t)}{\theta}\right).$$

Denote the Lagrange multiplier on the incentive compatibility constraint by κ, and the Lagrange multiplier on the promise keeping constraint of type A agent, following a history s^t, by $\beta^t \pi(s^t) \alpha_t(s^t)$. The first-order conditions show that α_t satisfies

$$\alpha_t(s^t) = (1+\kappa)\frac{\lambda}{1-\lambda}\frac{U_{ct}^B(s^t)}{U_{ct}^A(s^t)} + \kappa. \tag{6}$$

I will interpret $\alpha_t(s^t)$ as relative Pareto weights of type A agents in a given state of the world and time period: a higher value of α_t is associated with a consumption of agent A relative to agent B. The stochastic process for α_t has three important properties. First, its initial value equals to the Pareto weight of the type A agents α. Second, its unconditional expected discounted value equals α:

$$\alpha = (1-\beta)\sum_{t=0}^{\infty}\sum_{s^t}\beta^t \alpha_t(s^t)\pi(s^t)$$

Third, and most cristically for the dynamics of the optimal taxes, $\alpha_t(s^t)$ follows a random walk:

$$\alpha_t(s^t) = \sum_{s_{t+1}} \pi(s_{t+1}|s^t)\alpha_{t+1}(s^{t+1}).$$

The social planner keeps the expected value of α_t constant over time, in expectation, because both types of agents have identical intertemporal elasticity of substitution. However, it does not keep the value of α constant across states. This is so, because type A agents are infinitely risk averse, and the social planner maintains an identical lifetime utility across states. The random walk property implies that any changes in the Pareto weights are permanent. This, as we shall see, is the opposite pattern of what's optimal if type A agents have zero IES instead of infinite risk aversion.

One can expect that α will be relatively higher in states with low productivity or high government consumption, where keeping a constant lifetime utility of a type A agent requires an increase in their consumption relative to the consumption of type B agents.

The value of the implicit Pareto weight α_t is important for the marginal tax rates. In the optimum, they are equal to

$$\tau_t^A(s^t) = \frac{\kappa(1-\phi)}{\alpha_t(s^t) - \kappa\phi}, \tag{7}$$

generalizing the expression (4), where the implicit Pareto weights constant across time and space. The optimal marginal tax rates thus vary across states only because of the variations in the state-dependent Pareto weights $\alpha_t(s^t)$.

It is clear from the optimal tax formula (7) that the movement of the marginal tax rates is inversely related to the movement of the Pareto weights. The intuition is the following. A higher value of α_t is associated with relatively higher period utility, and relatively higher consumption, of type A agent. This by itself decreases the hours worked of agent A due to a positive income effect. But lower hours worked of the type A agent help to relax the incentive constraint, because they help in separating both types of agents. As a result, the need to introduce distortions in that state of the world is reduced, and the marginal tax rates decrease.

Given that the Pareto weights follow a random walk, it follows immediately from Jensen's inequality that taxes on type A agents have a upward drift:

Lemma 1. *Marginal tax rates are on average increasing over time:*

$$\tau_t(s^t) < \textstyle\sum_{s_{t+1}} \pi(s_{t+1}|s^t)\tau_{t+1}(s^{t+1}) \quad \forall s^t.$$

While marginal taxes themselves have an upward drift, it is easy to see that the inverse of marginal taxes follows a random walk. The random walk component has an interesting analogue in the dynamic Ramsey literature under incomplete markets. In that case, random walk comes from the inability of the Ramsey planner to issue state-contingent claims and equalize the marginal cost of collecting taxes across states. In contrast, the model in this section features complete markets, but type A agents are unwilling to transfer utility across states.

3.2 Example 2: Differences in IES

Low productivity type A agents have zero intertemporal elasticity of substitution in utilities ($\rho^A = \infty$), and zero aversion toward utility risk ($\gamma^A = 0$). Their preferences are

$$V_t^A(s^t) = \min \left\{ U\left(c_t^A(s^t), n_t^A(s^t)\right), \sum_{s_{t+1}} \pi(s_{t+1}|s^t) V_{t+1}^A(s^{t+1}) \right\}.$$

The optimum requires that the two terms on the right-hand side are equalized. This yields $V_t^A(s^t) = U\left(c_t^A(s^t), n_t^A(s^t)\right)$, and in turn,

$$U\left(c_t^A(s^t), n_t^A(s^t)\right) = \sum_{s_{t+1}} \pi(s_{t+1}|s^t) U\left(c_{t+1}^A(s^{t+1}), n_{t+1}^A(s^{t+1})\right) \quad \forall s^t.$$

In other words, it is now the period utility of the type A agent that follows a random walk. Unlike in the previous example with the infinite risk aversion, a decrease in the current utility will not be compensated by an increase in the continuation utility; quite to the contrary, the expected continuation utility decreases just as much.

We again define the implicit Pareto weights of type A by (6). They no longer start at α or follow a random walk. Unlike in the previous example, the implicit Pareto weights now exhibit history dependence in the following sense. For any infinite history s^∞, the implicit Pareto weights must sum to the unconditional Pareto weight α:

$$(1-\beta) \textstyle\sum_{t=0}^{\infty} \beta^t \alpha_t(s^t) = \alpha \quad \forall s^\infty \in S^\infty.$$

That is, any change in the implicit Pareto weight today must be met with a future change(s) in the opposite direction. Moreover, given that the future values are discounted, the off-setting change, or the sum of off-setting changes, must be larger in absolute value. In addition, one would expect that an unexpected adverse shock today will increase the Pareto weight of agent A, because agent B's decrease in utility can be compensated in the future, but agent A's cannot: the utility follows a random walk. But, to compensate, the Pareto weight of agent A must go up in the future.

The optimal marginal tax rates continue being determined by (7), and so inherit the off-setting property of the implicit Pareto weights. That is, an adverse shock is expected to decrease the marginal taxes on type A today, but increase them in the future.

3.3 Example 3: Differences in IES and Risk Aversion

I now modify the preferences of type A agents have so that, in addition to infinite aversion toward utility risk ($\gamma^A = \infty$), they have zero intertemporal elasticity of substitution in utilities ($\rho^A = \infty$). Their preferences are then

$$V_t^A(s^t) = \min\left\{U\left(c_t^A(s^t), n_t^A(s^t)\right), \min\left\{V_{t+1}^A(s^{t+1})\right\}\right\},$$

which is equivalent to requiring that type A agents have a constant period utility not only across states, but also across time:

$$U\left(c_t^A(s^t), n_t^A(s^t)\right) \quad \forall t, s^t \in S^{t+1} = V^A.$$

for some value V^A.

The fact that the period utility of type A is constant across time and states simplifies the planning problem considerably. The planner maximizes

$$\alpha V^A + (1-\beta)\mathbb{E}\sum_{t=0}^{\infty}\beta^t u_t^B(s^t)$$

subject to the resource constraints

$$\lambda C(V^A, n_t^A(s^t)) + (1-\lambda)C\left(u_t^B(s^t), n_t^B(s^t)\right) + G_t(s^t) \leq Z_t(s^t)\left[\lambda n_t^A(s^t) + (1-\lambda)\theta n_t^B(s^t)\right]$$

and the incentive compatibility constraint

$$(1-\beta)\mathbb{E}\sum_{t=0}^{\infty}\beta^t u_t^B(s^t) \geq (1-\beta)\mathbb{E}\sum_{t=0}^{\infty}\beta^t U\left(C\left(V^A, n_t^A(s^t)\right), \frac{n_t^A(s^t)}{\theta}\right).$$

In one important aspect, the solution is similar to the solution to a Ramsey problem under complete markets (Lucas and Stokey (1983)): conditional on the Lagrange multiplier on the incentive constraint and the utility of type A agent, the optimal allocations and taxes are only a function of the current aggregate shocks G and Z, and thus inherit their stochastic properties.

Denoting the Lagrange multiplier on the incentive compatibility constraint by κ, we write a generic subproblem conditional on κ, V^A and the current shocks as

$$\max_{n^A, n^B, u^B} (1+\kappa)u^B - \kappa U\left(C\left(V^A, n^A\right), \frac{n^A}{\theta}\right)$$

subject to

$$\lambda C(V^A, n^A) + (1-\lambda)C\left(u^B, n^B\right) + G \leq Z\left[\lambda n^A + (1-\lambda)\theta n^B\right].$$

Denote the solution to the subproblem by $n^i = \tilde{n}^i(Z, G)$ and $u^B = \tilde{u}^B(Z, G)$, with the dependence on κ and V^A being implicit. The optimal allocation can then by obtained by solving $n^i_t(s^t) = \tilde{n}^i(Z_t(s^t), G_t(s^t))$, and similarly for other variables. The solution to the problem is completed by finding κ such that the incentive constraint holds, and V^A that maximizes the objective function of the planner.

Importantly, the stochastic nature of the optimal allocation is inherited by the implicit Pareto weights of type A, which can be written as $\alpha_t(s^t) = \tilde{\alpha}(Z_t(s^t), G_t(s^t))$, and by the optimal marginal tax rates

$$\tau^A_t(s^t) = \tilde{\tau}^A\left(Z_t(s^t), G_t(s^t)\right) = \frac{\kappa(1-\phi)}{\tilde{\alpha}(Z_t(s^t), G_t(s^t)) - \kappa\phi}.$$

3.4 Aggregate Productivity Shock

I compute the optimum in a simple T period economy with aggregate productivity risk only. I set $T = 5$. The aggregate productivity is $Z(s_0) = 1$ in the first period, while $Z_t(s^t)$ is an iid random variable taking three possible values 0.9 (recession), 1.0, and 1.1 (expansion) with equal probability. Both agents have equal share in the population ($\lambda = 0.5$), type B agents are 40 percent more productive ($\theta = 1.4$), and the Frisch elasticity of labor is 0.5 ($\eta = 2$). The Pareto weight α is set so that the initial period marginal tax rate is 40 percent.

Figure 1 compares the optimal marginal tax rates over time in an economy with standard preferences, and in the three extreme economies above. In all scenarios, the optimal marginal tax rates under standard preferences are constant across time and states.

The top left panel shows the reaction to a temporary low productivity shock in period 1, followed by a return to the average productivity from period 2 on. In all three

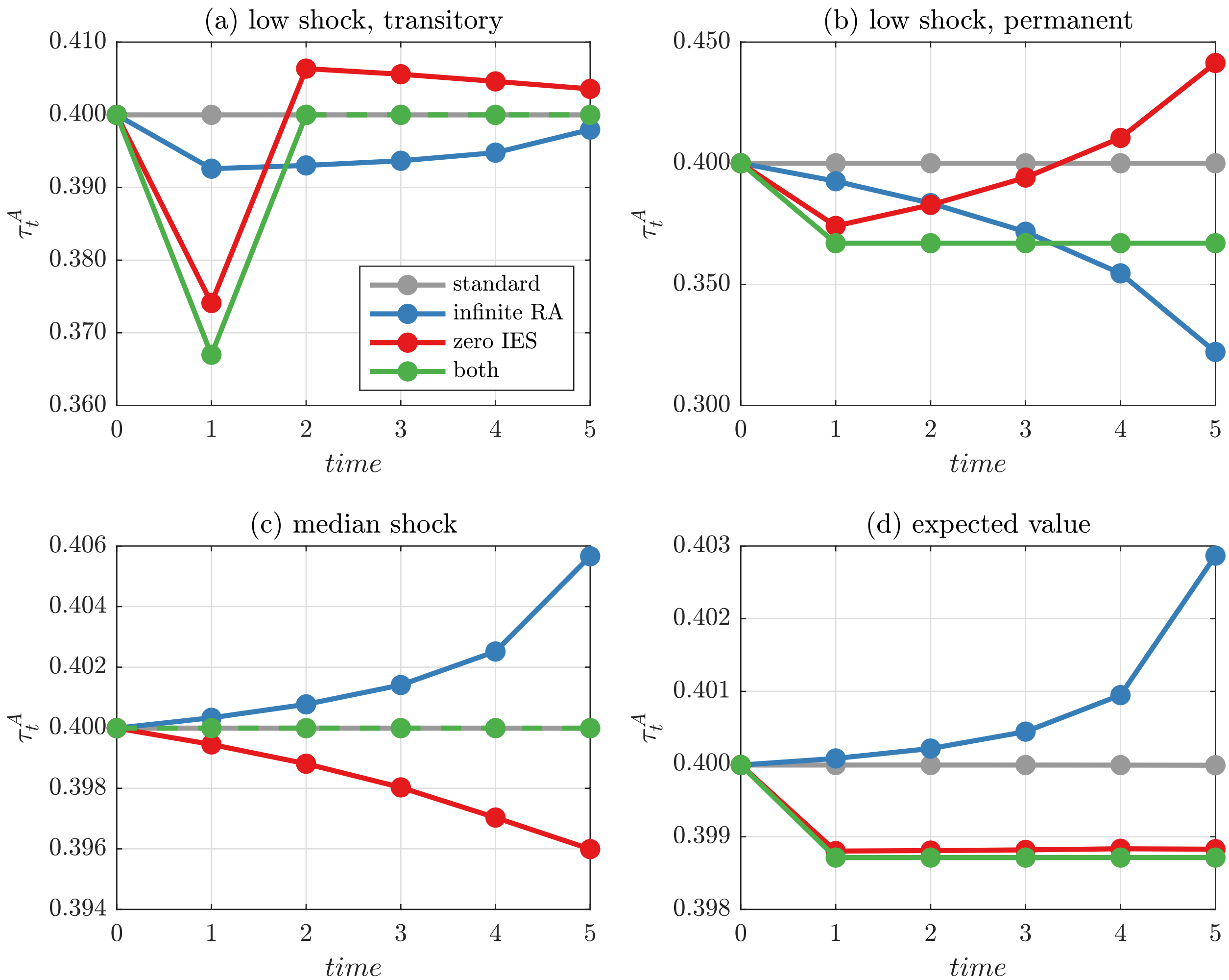

Figure 1: Marginal tax rates on type A agents. Infinite RA, zero IES, or a combination of both refers to preferences of type A agents.

examples, marginal tax rates on type A agents decrease, as the Pareto weight of type A agent increases, more under zero IES than under infinite risk aversion, and most under both zero IES and infinite risk aversion, where both forces are combined. But the three extreme economies differ in their future responses to the current shock. Persistency in the Pareto weights under infinite risk aversion lead to a persistent decline in the marginal tax rates that only slowly increase. With zero IES, future Pareto weights of type A must decrease, and that leads to lower marginal tax rates. With both infinite risk aversion and zero IES both forces off-set each other, marginal taxes are a function of only the current state, and they immediately revert to their initial period level.

The top right panel shows the effect of a permanent decrease of productivity from period one onwards, modeled as a sequence of unexpected low shock realizations. The responses under both extreme assumptions again differ markedly. Under extreme risk aversion the Pareto weight of type A keeps decreasing with each additional realization of the low shock, and leads to decreasing marginal tax rates. Under zero IES, there are two forces in play. On one hand, each low shock realization tends to increase the Pareto weight. On the other hand, those increases must be eventually compensated with offsetting decreases in the Pareto weight. Ultimately, the second force must win, which leads to an increasing sequence of marginal tax rates. Under both extremes, both trends again cancel each other out and marginal taxes stay lower as long as llow shocks last.

The bottom left left shows the marginal tax rates if the economy experiences no recession or expansion, and productivity stays at its median value. Infinite risk aversion and zero IES again have a diametrally opposite effect on the marginal tax rates. Under infinite risk aversion the Pareto weight follows a random walk, but the increases and decreases are not symmetric. Decreases in marginal tax rates following a low shock are larger in magnitude than increases in the opposite case, and median marginal taxes increase. The opposite is true under zero IES. If both extremes are present, both effects cancel each other out.

Finally, the bottom right panel shows the expected marginal tax rates over time. With infinite risk aversion, the expected marginal taxes are increasing, confirming the results of Lemma 1. If type A agents have zero IES, the expected marginal tax rates are decreasing. Under both extremes, they decrease from period one on, and then stay constant. This is due to the fact that period zero features no uncertainty; under uncertainty, marginal tax increases in bad times are more than offset by marginal tax decreases in good times, producing a decline of their average.

Figure 2 shows the transfers to type A agents, under the same scenarios. The transfers are are computed under the assumption that type A agents are *hand-to-mouth*, and are fully excluded from the asset markets, and are defined as a ratio of consumption to income minus one. The figure shows that average transfers follow the opposite pattern of the marginal tax rates. This is to be expected, since high relative Pareto weight of type A agent is an indicator of both low marginal tax rates, through the optimal tax formula, and, directly, of relatively high consumption and high transfers.

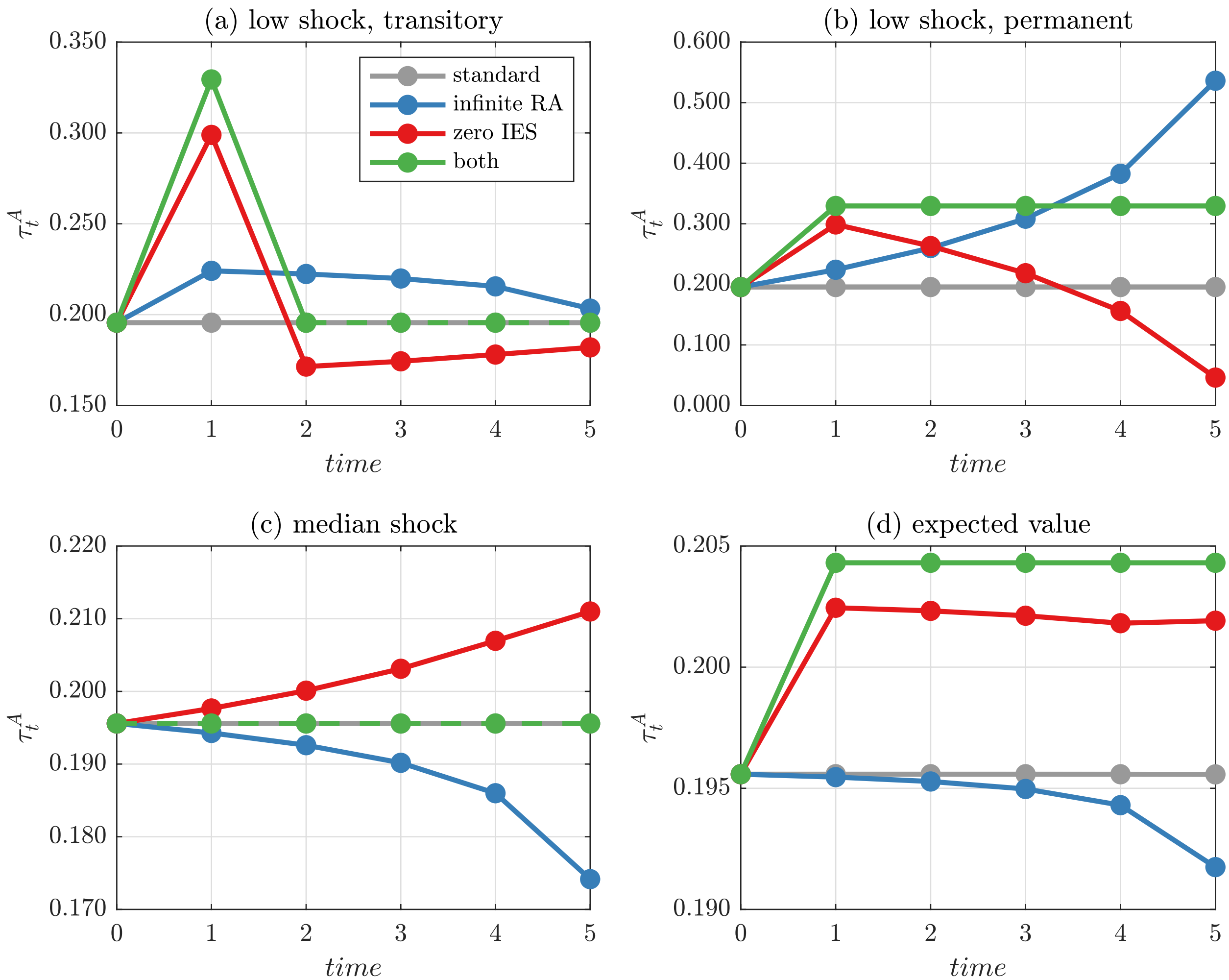

Figure 2: Transfers to type A agents as a fraction of income. Infinite RA, zero IES, or a combination of both refers to preferences of type A agents.

3.5 Government Spending Shock

A similar analysis can be made with respect to an increase in government spending, instead of aggregate productivity. In terms of the response of marginal tax rates, the results are qualitatively similar to the ones in Figure 1. A temporary increase in government spending increases the relative Pareto weight of type A agents and reduces their marginal taxes. The subsequent dynamics again has an opposite sign for infinite risk aversion and zero IES, and, when working together, they cancel each other. Other scenarios perform a similar dynamics. The dynamics of transfers differs, however. A temporary increase in government spending always reduces transfers to type A agents, although the reduction is relatively mild under zero IES, and under both zero IES and infinite risk aversion.

4 Conclusions

Preference heterogeneity matters for the design of optimal policies.

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