Gradual Tax Reforms: If You Like It, You Can Keep It *

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Abstract

A key challenge faced by tax reforms is their short-run welfare consequences. In this paper, I focus on a consumption-based tax reform that, despite the long-run welfare gains it generates, causes the welfare for some groups such as retirees or the working poor to fall during transition between steady states. Using a life-cycle model with heterogeneous households, I show how to devise a transition path from the current U.S. federal tax system to a consumption-based tax system that improves the welfare of current generations as well as those who are born in the long-run steady state. In a nutshell, all households alive at the time of the policy change can choose when they want to switch to the new tax system, or whether they want to switch at all. I find that implementing a tax reform with this feature improves the welfare of 95% of the population in the short run, compared to less than 25% of population in the simple case with no choice. It takes about 20 years for half of the population to pay their taxes under the new tax code.

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1 Introduction

Multiple features of the current U.S. federal tax system make the study of tax reforms an important object of research. Many proposals for reformulating the tax code suggest eliminating individual and corporate income taxes and implementing a new tax system based on consumption (Zodrow and Mieszkowski (2008)). Several authors show that replacing the current federal tax system with a system that levies taxes on all income with complete deductibility of savings would increase the economy's long-run output and improve the welfare of people born in the new steady state. This result mainly comes from the fact that taxing consumption does not distort saving desicions at the margin. Ventura (1997) and Altig et al. (2001), among others, show that a newborn agent would prefer to be born into the steady state of the economy with a consumption tax system rather than the one with the progressive income tax and capital income tax system.

However, Except for few papers like (Altig et al., 2001), the short-run welfare consequences of such a reform have not been addressed in existing literature. The central problem is that although consumption-based tax reform leads to welfare gains in the long run, achieving these gains typically involves welfare losses for generations who are alive at the time of the tax reform. Therefore, these individuals would favor the status quo over the reformed tax regime. Hence, it is challenging to implement a consumption tax reform that is simultaneously welfare improving for both current generations and those born in the long run.

In this paper I address this issue. I build an equilibrium life-cycle model with heterogeneous households and endogenous labor supply. Using this model, I show that a move from the current U.S. federal income tax system to a flat consumption tax system can be feasible as well as welfare improving for households alive at the time of the policy change. The key to this result is that I allow for a voluntary rather than compulsory switch to the new tax regime for generations alive at the time of the policy change. In a nutshell, all households who are alive during the first period of the transition can choose their preferred tax system: the benchmark tax system or the consumption tax system. In my analysis, I explicitly endogenize households' move to the new tax system, and quantify the aggregate as well as the welfare implications of this reform.

My paper builds on the tradition of analyzing the transition dynamics in overlapping generation economies, in the spirit of Auerbach and Kotlikoff (1987). I compute the

perfect-foresight transition path, with the initial state parametrized to the current U.S. federal tax system (hereafter the benchmark tax system). I keep the government revenue constant along the transition and in the new steady state. Thus, the result I obtain do not depend on an issuance of government debt to finance the new regime. The model features within-cohort heterogeneity, with differences arising from agents' permanent productivity types, which also evolve as they age. I study the effects of the new tax system on different birth cohorts and different income groups.

I first consider a *simple* form of revenue-neutral transition from the steady state of the benchmark economy toward the steady state of the economy with a flat consumption tax. In this version, after the date of the policy change, all households who are alive at the time of the tax reform, along with those who are born in the new tax system, are taxed using the reformed tax code (a flat consumption tax). Doing a conventional reform in my calibrated model illustrates the tension; future generations born in the long run benefit from the reform while more than 75% of generations who are alive at the time of the reform experience welfare losses.

Then I introduce a flexible form of revenue-neutral transition, which I refer to as the **gradual tax reform**. In the gradual tax reform, all households who are alive at the time of the policy change have the option of choosing between the benchmark tax system and the consumption tax system, with one condition: having chosen the new tax system, they cannot go back to the old one. For all households who are born after the reform, the new tax code (the flat consumption tax) applies.

In principle, welfare effects for all generations depend on their ages, productivity abilities, and asset holdings. Changing the tax base from income to consumption, changes the distribution of tax burden across generations. In the simple tax reform, during the first transition period, the young, more productive agents are largely unaffected, or they experience welfare gains. However, the elderly agents face welfare losses independent of their productivity types. Older generations, who possess a large share of capital stock, and do not have a labor income, face a higher tax burden in the consumption tax system. This group are mainly consuming out of their wealth which they saved from their after-tax income. Therefore, consumption taxes are levied on their wealth, hence placing a higher burden on older agents. Likewise, the low-productivity agents lose given the non-linear features of current tax system. Altogether, in the first period of transition, 75.6% of agents

experience welfare losses and only 24.6% of the population enjoy welfare gains and hence, would favor the tax reform.

By presenting all agents alive at the time of policy change with the choice of their preferred tax system, the gradual tax reform improves the welfare effects compared to the simple tax reform. In the first period of transition, welfare losses are negligible and about 95% of the population experience welfare gains and favor the tax reform. However, these gains are not for free, and the important differences lie in the speed of the transition to the new steady state. With the gradual tax reform, it takes 1.7 times longer for the economy to reach the new steady state, implying that the beneficial effects of the new tax system materialize more slowly in the gradual tax reform. Another consequence of introducing the tax reform gradually is that adopting the new tax system is a protracted process. Because of the revenue-neutral nature of the reform, the consumption tax rates are higher in the initial periods of the transition. The higher consumption tax rate translates into a higher tax burden on those who are born in the new tax system and affects their welfare.

The paper is organized as follows: Section 2 provides a review of the related literature. Section 3 presents the life-cycle model. Section 4 discusses its parametrization. Sections 5 and 6 contain the main results. Critical discussions of the results including additional exercises and sensitivity analysis are presented in Section 7, and Section 8 concludes.

2 Related Literature

The long-run welfare implications of various tax reforms are the focus of many studies (see, e.g., Hall et al. (1995), Ventura (1999), Altig et al. (2001), Díaz Giménez and Pijoan-Mas (2006), Domeij and Heathcote (2004), Nishiyama and Smetters (2007a), Lopez-Daneri (2016)). Except for Altig et al. (2001), these studies mainly focus on the long-run effects of modifying the tax code and do not explore the effects of tax structure on generations living through the initial transition periods to the new steady state.

One of the pioneering papers that considers the transitional effects of tax changes is Summers (1981). In this paper, Summers compares steady state utility for a model with fixed labor supply; his study also attempts to measure the efficiency consequences of an explicit transition from one tax system to another. Summers' transition analysis, however, is based on the assumption of myopic rather than rational expectation and he assumes a

completely inelastic supply of labor.

Altig et al. (2001) and Auerbach and Kotlikoff (1983) are two papers that analyze the consequences of tax reforms along the transition path. Altig et al. (2001) use a general equilibrium simulation model with intragenerational heterogeneity to examine the consequences of a revenue-neutral move from an income tax system to some alternative consumption-based tax system, such as a flat income tax and a flat-rate consumption tax system. They compute the entire transition path and conclude that the poor members of generations alive at the time of the policy change lose under the flat-rate consumption tax system.

The point of departure of this paper is to examine short-run as well as long-run consequences of the reforms while highlighting the difficulties and to suggest a practical solution grounded in economic theory. The method of gradual tax reform is a practical way to implement any structural tax reform. Notice that although the method is discussed in the context of a consumption tax reform, it is a broadly applicable framework for implementing any policy reform that provides higher welfare in the long run. One potential context is reforming the social security system, see Huggett and Ventura (1999), Conesa and Krueger (1999) among others, for discussions. In fact, several papers study the transitional dynamics of moving to a privatized social security and find sizable welfare gains in the long run , along with considerable short-run welfare losses that cannot be compensated with the long-run gains, see Huang et al. (1997), Kotlikoff et al. (2002), Feldstein and Samwick (1998) and Nishiyama and Smetters (2007b) as examples.

My paper is related to the literature that focuses on studying taxation in the dynamic general equilibrium model, such as those proposed by Conesa and Krueger (2006), Guner et al. (2012), Badel and Huggett (2014), and Guner et al. (2016).

3 Model

I study a discrete time general equilibrium life-cycle economy with individual heterogeneity and endogenous labor supply.

3.1 Demographics

The economy is populated by J heterogeneous overlapping generations. Each period, a continuum of agents are born and live for J periods. Population at time t is denoted by N_t and grows at a constant rate n , that is $N_{t+1} = (1+n)N_t$. The demographic structure is stationary such that age j agents constitute a fraction μ_j of the population at each point in time.

3.2 Preferences

All agents value the path of consumption and leisure according to the following utility function:

$$\sum_{j=1}^{J} \beta^{j-1} u(c_j, l_j),$$

where c_j and l_j denote consumption and labor at age j. The period utility function is

$$u(c_j, l_j) = \log(c_j) - \frac{l_j^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}},$$

where γ is the Frisch elasticity .

3.3 Technology

The production technology is represented by a Cobb-Douglas production function that transforms capital K and labor L into output Y according to

$$Y = K^{\alpha} L^{1-\alpha},$$

where α is the capital share parameter. The resource constraint is

$$C_t + K_{t+1} - K_t(1-\delta) + G_t \leqslant K_t^{\alpha} L_t^{1-\alpha},$$

where Υ is the depreciation rate of the capital stock, G_t is public consumption, and C_t is aggregate private consumption.

3.4 Individual Constraints

All agents are born with no assets and face mandatory retirement at age $T+1$; that is they work for T periods and then live as a retiree for T^R periods.

The market return per hour of labor supplied by an age j agent at time t is given by $w_t e(z,j)$, where w_t is the wage rate that is common to all agents and $e(z,j)$ is a function that represents the efficiency units that combines the effects of age j and a permanent productivity shock z with $z \in \mathcal{Z}$, $\mathcal{Z} \subset \mathscr{R}^+$. Each newborn agent draws a productivity shock z from the probability distribution $F(z)$, which remains constant during the working life cycle. In what follows, I call the agent with the productivity shock z, the type z agent.

A agent of age j and type z with $e(z,j)$ efficiency units chooses consumption $c_{j,t}$, labor hours $l_{j,t}$, and level of asset holdings for next period $a_{j+1,t+1}$. The budget constraint is:

$$c_{j,t} + a_{j+1,t+1} \leqslant a_{j,t}(1+r_t) + (1-\tau^{ss}) w_t e(z,j) l_t + b_{j,t} - Tj, t,$$

$$c_{j,t} \geqslant 0\,, \quad \text{and} \quad a_{j+1,t+1} \geqslant \underline{a}\ \forall j,$$

where $a_{j,t}$ is the asset holding at age j and time t; r_t is the risk-free net return on asset holding; τ^{ss} is the constant flat social security tax rate on labor earning; $b_{j,t}$ is the social security benefit, which equals 0 at working ages and a fixed benefit during the retirement periods; and $T_{j,t}$ are taxes paid. The constraint $a_{j+1,t+1} \geqslant \underline{a}$ implies that agents are not allowed to borrow beyond a borrowing constraint.

3.5 Government, Taxes, and Transfers

In this model economy, at each period the government engages in three activities: it spends resources (consumes G), it levies taxes (to finance government consumption G), and it runs a balanced budget social security system.

The social security system is fully funded by social security taxes paid by working agents at a constant marginal tax rate τ^{SS} on their labor income. Social security benefits are distributed evenly among all retirees of different types and different ages i.e. the benefit for each retired agent does not depend on her earning history.

The government finances its consumption G merely through taxation. The current U.S. federal tax system is taken as the benchmark case. To mimic its main features, taxes

paid by each agent consist of two components: a flat-rate capital income tax and a non-linear income tax, for which, the tax is levied on labor and capital income as well as social security transfer during the retirement periods:

$$I \equiv \omega e(z,j)l + ra + b_{j,t} \ , \ \ for\ all\ \ z\ \ and\ \ j.$$

This means that in the benchmark case, the total income tax liability for an agent with income I is

$$T = T_f(I) + \tau^k ar,$$

where T_f is a strictly increasing and convex function that represents the nonlinear income tax scheme, and τ^k is the flat capital income tax rate, which replicates the corporate tax in the federal tax system. In the benchmark tax system, for an agent with income I, the marginal tax rate on capital income equals $T_f'(I) + \tau^k$, and the marginal tax rate on labor income equals $T_f'(I) + \tau^{SS}$.

In the reform scenario, a flat rate consumption tax replaces the U.S. federal income tax, leaving the social security system unchanged. That is, the progressive income tax and the capital income tax are eliminated, and all agents pay a constant tax rate on each unit of consumption and receive a lump-sum transfer. Thus, in the reformed case, the total tax liability for the agent is

$$T = \tau^c\, c + TR,$$

where TR is the fixed lump-sum transfer that agents receive at each period.

3.6 Recursive Formulation

In this section I state the decision problem of an agent in my economy in a recursive form. First, I describe the decision problem for the agent when the economy is at the steady state. Then, I demonstrate how the problem changes when the economy is out of the steady state, that is, in the transition from the old steady state to the new steady state.

3.6.1 Steady State

The state of each agent is fully described by the agent's asset holdings a, her type z, and her age j. Time subscripts are dropped as I describe the stationary equilibrium. Let the nonage-dependent part of the state vector be described by $x = (a, z),\ x \in \mathscr{X}$, where a

is the current asset holding and z is the permanent productivity shock for the agent that determines her type. The set $\mathscr{X}$ is $\mathscr{X} = [0, \infty) \times \mathscr{Z}$. Therefore, the state vector for any agent is (x, j).

Given the prices (w, r) and the tax regimes ($\Upsilon \in \{B$ *(the benchmark tax system)* , R *(the reformed tax system)*$\}$), an agent with state (x, j) needs to optimally choose the amount of labor $l(x, j)$ to supply to the market, the amount of consumption $c(x, j)$, and the amount of saving or assets to carry over to the next period $a(x, j)$, in such a way that these choices solve the following dynamic programming problem:

- Working agents ($j \leqslant T$):

$$v(x, j) = \max_{c,l,a'} \Big\{ u(c, l) + \beta v(x', j + 1) \Big\} \tag{1}$$

subject to

$$c + a' \leqslant a(1 + r) + we(z, j)l(1 - \tau^{ss}) - \Gamma^{\Upsilon}(c, l, a')$$
$$c \geqslant 0\,, \quad \text{and} \quad a' \geqslant \underline{a}$$

- Retirees ($T < j \leqslant T + T^R$):

$$v(x, j) = \max_{c,a'} \Big\{ u(c, 0) + \beta v(x', j + 1) \Big\} \tag{2}$$

subject to

$$c + a' \leqslant a(1 + r) + b_j - \Gamma^{\Upsilon}(c, l, a')$$
$$c \geqslant 0\,, \quad \text{and} \quad a' \geqslant \underline{a}$$

and

$$v(x, T + T^R + 1) = 0 \quad \forall x,$$

Where $\Gamma^{\Upsilon}(c, l, a')$ is the total tax the agent pays, depending on the tax code of the economy and her optimal choices. The definition of a stationary recursive competitive equilibrium for this class of models is by now standard.[1]

[1]Equilibrium definition is provided in appendix A.

3.6.2 Tax Reform

As the benchmark economy, I take the model with the benchmark tax system, which mimics the features of the current U.S. federal tax system: the flat-rate capital income tax and a the non-linear income tax. In period 0, the economy is in a steady state with this tax system.

I assume that the change in the tax system takes place at the beginning of period 1, before any economic choices have been made. I consider the consumption tax reform being implemented in two potential ways: simple tax reform and gradual tax reform.

Simple Tax Reform: At the beginning of period 1, before any economic choices have been made, the government announces it has abolished the benchmark tax system and replaced it with the consumption tax system. From period 1 onward, all agents have to pay their taxes under the new tax code (the one that uses consumption as the tax base).

Gradual Tax Reform: Let period 1 be the period in which the tax reform occurs. At the beginning of period 1, before any economic choices have been made, the government announces it is replacing the benchmark tax system with the consumption tax system, with a specific condition: all agents who are alive at period 1 have the option of choosing between the benchmark and the consumption tax system. In particular, all those who are alive at the time of the policy change can choose when they want to switch to the new tax system, or if they want to switch at all. The switch is irreversible. All those born after period 1 have to pay their taxes under the new tax code (the consumption tax code). With this implementation method, it takes time for the economy to reach the point at which the entire population is paying its taxes under the new tax code, in other word, adoption of the new system is a gradual process.

In both methods of implementing the consumption tax reform, the initial point is the steady state of the economy with the benchmark tax system and the final point is the steady state of the economy with the consumption tax system. However, the transition path and the decision problems of the agents depend on the type of the tax reform being implemented.

In what follows, I state the decision problem for the agents in the **gradual tax reform**. However, the decision problem of the agents in the simple tax reform is nested

as a special case of the gradual tax reform.

3.6.3 Out of Steady State

In the gradual tax reform, agents fall into two categories: those who have the option of choosing their preferred tax system, and those who have to pay their taxes under the new tax code. The first group comprises all agents who are alive at the time of the policy change and have not yet switched to the new tax system. The second group comprises all agents who are born in the new tax system as well as those who were alive at the time of the policy change and have already switched to the new tax system.

To describe the agent's decision problem, I need to distinguish between the two categories. To do this, I add an indicator variable q to the state vector of the agent. The indicator is a binary variable that signals whether the agent can choose between the two tax systems. Therefore, $q = 0$ indicates the agent belongs to the first group and she can choose her preferred tax code, and $q = 1$ indicates there is no option available for the agent and she must pay her taxes under the new tax code. Now I can define the decision problem for the agents when the economy is out of steady state for each value of q.

At any period t, given the prices (w_t, r_t), an agent of age j with states x and q must choose the amount of labor supply $l_t(x, j, q)$, the amount of consumption $c_t(x, j, q)$, and the amount of saving or assets to carry over to next period $a_{t+1}(x, j, q)$. Furthermore, if $q = 0$, that is the agent has the option of choosing between two tax systems, she must also choose her preferred tax code. Therefore, optimal decision rules solve the following dynamic programming problem:

- $q = 1$:

$$v_t(x_t, j, q_t = 1) = \max_{c_t, l_t, a_{t+1}} \Big[u(c_t, l_t) + \beta v_{t+1}(x_{t+1}, j+1, q_{t+1} = 1) \Big]$$
$$s.t. \quad c_t + a_{t+1} = w_t e(z_i, j) l_t (1 - \tau^{ss}) + (1 + r_t) a_t + b_{t,j} - \Gamma_t^R.$$

Notice that this case also describes the decision problem of agents in the simple tax reform. Recall that in the simple tax reform, after the government has announced the change in tax policy, all agents must pay their taxes under the new tax code.

- $q = 0$:

$$v_t(x_t, j, q_t = 0) = \max \left\{ v_t(x_t, j, q_t = 1), \max_{c_t, l_t, a'_t} \left[u(c_t, l_t) + \beta v_{t+1}(x_{t+1}, j+1, q_{t+1} = 0) \right] \right\}$$

$$s.t. \quad c_t + a'_t = w_t e(z_i, j) l_t (1 - \tau^{ss}) + (1 + r_t) a_t + b_{j,t} - \Gamma^B.$$

For the case of $q = 0$, the first part in the maximization problem is the value of choosing the new tax system and the second term is the value of staying in the old tax system.

In equilibrium, goods, capital, and labor markets clear in each period. This determines the corresponding factor prices of the period. The definition of a recursive equilibrium for this economy is provided in Appendix A.

4 Parametrization

The parameters of the model have been calibrated so that the initial steady state for the economy replicates selected features of the current U.S. economy. The model period is 5 years. Table 1 summarizes the parameter choices.

4.1 Demographics

In my model, agents are born at age 25, retire from working at age 65 ($T = 8$), and die at age 85 ($J = 12$), so their life length is 12 model periods and they face mandatory retirement after 8 periods of working. I consider an annual population growth of 1.09%, which corresponds to the average population growth rate for the United States form 1960 to 2009, see the Economic Report of the President 2012, Table B.34.

4.2 Technology and Preferences

To set the values for parameters α, the capital share and Υ, the depreciation rate, I follow the standard method of Cooley and Prescott (1995). To align my model economy with the data, I define the notion of capital to include the stock of fixed private capital, the

stock of consumer durables, the stock of inventories, and the stock of land.[2] The capital-to-output ratio averages 2.89 over $1965 - 2007$, at the annual level. The parameter α is set to 0.34, which is the average of the capital share. The depreciation rate is determined endogenously to be 0.074 at the annual level such that the model generates the average investment-to-capital ratio found in the data over the same period.

The intertemporal elasticity of labor supply γ is set to 1. Notice that the macro estimates of the elasticity of labor supply tend o be higher than those from the micro literature. As shown by Keane and Rogerson (2015) the value for γ at the macro level is larger than 1. I have an exercise with a higher value for γ (2.5 instead of 1) in the Discussion section.

The value of parameter β, which is the discount factor is determined endogenously to 0.9675, in such a way that the model generates the same capital to output ratio as I calculate from the data.

4.3 Labor Endowments

The labor labor efficiency profile $e(z, j)$ for each agent, consists of two components: a common age-dependent component, and a fixed productivity type with which each agent is born with. We can think of this as a permanent productivity shock that agents draw from a distribution when they are born. To estimate the effiecency profile, I use the available observations on wage (hourly earning). For the age productivity profile I regress the log hourly wage of households on a polynomial of age together with a time fixed effect. For this regression, I use the data from the Current Population Survey (CPS) for $1980 - 2005$. The sample consists of households whose heads are between 25 and 64 years old. All individuals in the sample earn hourly wages above half of the federal minimum wage, and they work at least 260 hours per year, as in Heathcote et al. (2010).

For the permanent productivity shock, I assume that z is drawn from a log-normal distribution function. To estimate the distribution, I use the same sample of data from the CPS, and select the households whose heads are between 25 and 29 years old, and calculate the yearly standard deviation of the log hourly wages for these households. I

[2]The stock of durables is from Current-Cost Net Stock of Fixed Assets and Consumer Durable Goods, BEA, Table 1.1. August 2015, the stock of inventories is from Economic Reports of the President 2012, Table B.1., and the stock of land is from Flow of Funds accounts, balance sheet tables

normalize the distribution by its mean and set the standard deviation σ_z to 0.51, which is the average of the yearly standard deviation of the log hourly wages calculated from the data. The permanent productivity shock is approximated with seven states.

4.4 Taxation

Following Benabou (2002) , Heathcote et al. (2014) and others, I approximate the federal income tax with a two parameter function:

$$t(\tilde{I}) = 1 - \lambda(\tilde{I})^{-\tau},$$

where $t(\tilde{I})$ is an average tax function and $\tilde{I}$ is income normalized by household income, that is income I divided by the mean household income in the economy. The parameter λ defines the level of the tax rate and the parameter τ governs the curvature or progressivity of the system. A larger τ creates a more progressive system. To set values for these parameters, I use the Guner et al. (2014) estimates for all households: $\lambda = 0.902$ and $\tau = 0.036$.

The tax rate τ^k levied on capital income is used to proxy the U.S. corporate income tax. It is estimated as the rate that reproduces the level of tax collections from corporate income taxes after the major reforms of 1986. The average corporate tax revenue as a percentage of GDP is 1.9% for $1987 - 2007$.[3] Using the technology parameter and specifications of output in my model, I obtain $\tau^k = 10.54\%$. Finally, the parameter τ^{SS} the payroll tax rate levied on labor income to finance social security benefits, is set to 10.25%, which is the average of the ratio of the contribution to social security to labor income for $1990 - 2014$.[4]

[3]Office of Management and Budget, "Fiscal 2017 Budget of the United States, Historical Tables: Table 2.3–Receipts by Source as Percentages of GDP: 1934–2016 "

[4]The contributions considered are those from the Old Age and Survivors Insurance. The data comes from the Social Security Bulletin, Annual Statistical Supplement, 2015, Table 4.A1.

Table 1: Parameter Values

Parameter	Values	
β	0.967	Discount Factor, target K/Y
τ^k	0.1054	Calibrated Capital Income Tax Rate
τ^{SS}	0.1025	Calibrated Payroll Tax Rate
n	1.09%	Average Population Growth Rate (1990-2009)
γ	1	Frisch Elasticity
α	0.34	Capital Share (1965-2007)
δ	0.067	Depreciation Rate, target I/Y (1965-2007)
σ_z	0.51	Std. Deviation of Permanent Shock
λ	0.902	Federal Income Tax Level Parameter (Guner et al. (2014))
τ	0.036	Federal Income Tax Curvature Parameter (Guner et al. (2014))

Note: this table summarizes parameters values with brief descriptions. The upper panel shows the parameters that are calibrated endogenously using the model and the lower panel shows the parameters chosen exogenous to the model. For detailed explanations see the text.

5 Findings: Steady States

Both simple and gradual reforms start from the same initial steady state and end in the final steady state of the consumption tax system. I first discuss the quantitative properties of these steady states and then turn to the transition dynamics and the welfare analysis for simple and gradual tax reforms.

Table 2 shows how the main aggregate variables compare across the two steady states. The first column describes the initial steady state of the economy where the benchmark tax system (with the non-linear income tax and flat capital income tax) is the formal tax code. The second column characterizes the steady state of the economy under the consumption tax system. Note that the generated tax revenue is the same across both steady states. The condition of generating a constant level of tax revenues is imposed to help pin down the consumption tax rate in the new steady state.

Table 2: Comparing Aggregate Variables the Steady States with Different Tax Regimes

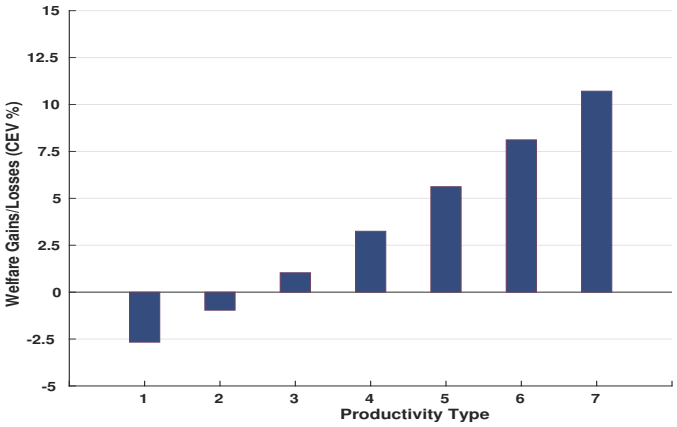
Variables	Benchmark Tax System	Consumption Tax System
τ_c	0%	14.06%
τ_k	10.54%	0%
τ	0.053	0
λ	0.911	1
Ouput	100	111.3
Capital Stock	100	127.6
Labor Supply	100	103.7
K/Y	2.89	3.31
Household Income (Avg.)	100	108.2
CEV	.	3.4%

Note: This table summarizes the aggregate variables of the economy under a revenue−neutral consumption tax reform in the long run (steady state comparison). The first part describes the tax structure and the second part describes effects of the tax reform on aggregate variables. I normalize the aggregate variables in the steady state of the benchmark economy to 100.

Table 2 shows that replacing the benchmark tax system with a consumption tax system leads to 27.6% higher capital accumulation in the steady state. The capital-output ratio increased by 14.5%. Removing the increasing marginal tax rate on capital income motivates agents to accumulate more assets. As a result of an increase in the asset accumulation, and only a modest increase in labor supply, the interest rate decreases by 25% and the wage increases; this is translated into an 11.3% rise in the retirement benefits which come from the increase in the average income. Output increases by 11.1% because of higher levels of capital stock and labor supply. These are the standard effects of replacing a non-linear tax system with a proportional one.

This increase in the size of the economy has implications for the welfare effects of the consumption tax reform. An agent born in the steady state of the economy with the consumption tax system would benefit from an ex-ante 3.4% higher level of consumption in each period of her life, as opposed to an agent born into the steady state of the economy under the benchmark tax system. Figure 1 decomposes the aggregate welfare gain into

Figure 1: Distribution of Long-run Welfare Effect of the Consumption Tax Reform



Note: This figure shows the long-run welfare gains/losses distribution of having a consumption tax reform, measured in consumption equivalent variation, for agents with different permanent productivity shock, which is approximated with seven states, each state is called a productivity type and represented with a number on the horizontal axis, with type 1 being the least productive agents. Each bar represents the amount of consumption growth that a newborn in the steady state of the reformed economy would have over the newborn in the steady state of the benchmark economy.

the welfare gains for various productivity types. As mentioned earlier, the permanent productivity shock is approximated with seven states, which I call types, where Type 1 has the lowest productivity shock, which is about 1/3 of the median productivity shock, and Type 7 has the highest productivity shock which is about 3 times of median productivity shock.

Figure 1 reveals that the largest welfare gain from switching to the consumption tax system accrues to agents with higher productivity. Higher productivity type agents are naturally those with higher income. The progressive nature of the nonlinear income tax under the benchmark tax system has relatively unfavorable effects on agents with higher levels of income, so the most productive agents clearly benefit the most from replacing a progressive income tax with a flat tax. The lowest-productivity group has a welfare loss of 2.6%, and the welfare gains increase with the increase in productivity.[5]

[5]In the Discussion section, I show that by providing a lump-sum transfer for all agents in the new tax system, even the lowest productivity type enjoys the tax reform.

6 Findings: Transitional Dynamics

In this section I turn to the discussion of transitional dynamics and short-run welfare effects of both simple and gradual tax reforms. The simple tax reform represents a case in which all agents, even those who have planned their lives under the benchmark tax system, would have to switch to the new tax system immediately after it is implemented. I consider this reform to be a baseline for comparison with the gradual tax reform which phases in the new tax system and phases out the benchmark tax system more gradually. Notice that the reforms are revenue neutral; that is, the economy generates the same level of tax revenue along the transition and in the new steady state as under the initial steady state.

6.1 Simple Tax Reform

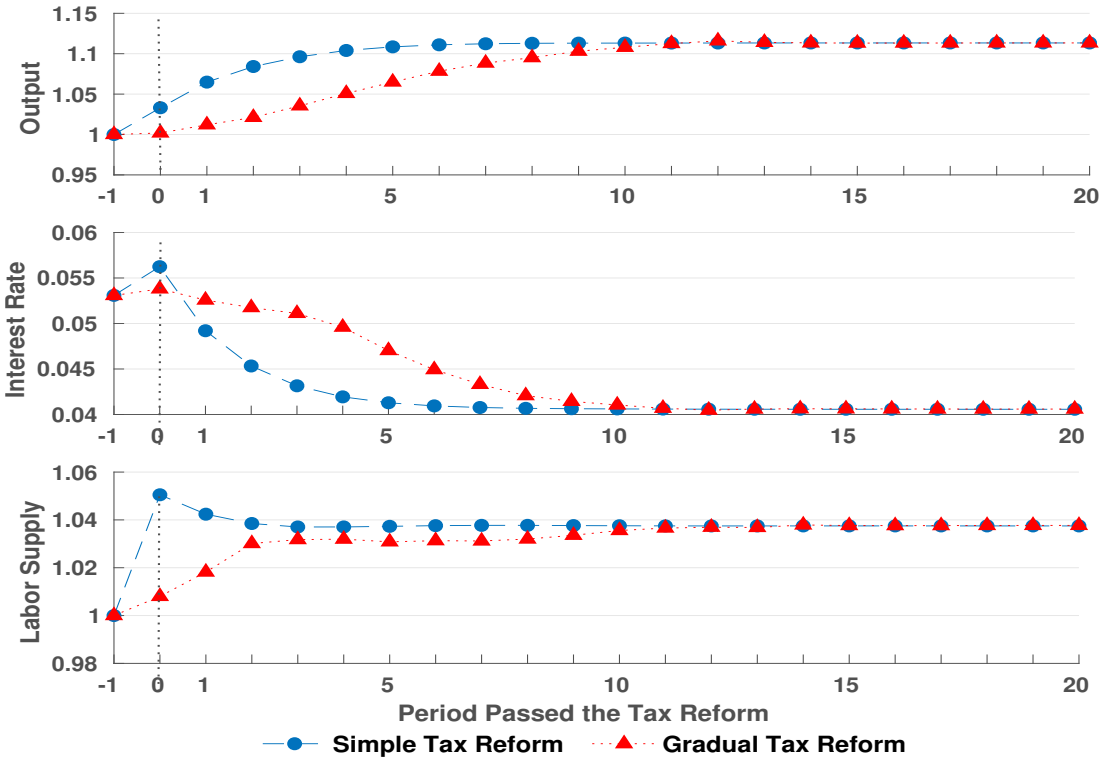
Figure 2 shows the evolution of macroeconomic aggregates along the transition in the simple tax reform. The upper graph shows the evolution path for output, the middle graph shows the transition path for the interest rate, and the lower graph shows the evolution of aggregate labor supply.

It can be seen from Figure 2 that under the simple tax reform, the economy reaches its new steady state after about 35 years. With the consumption tax system, the accumulated capital is untaxed, which makes saving more attractive. Therefore, directly after initiating the reform there is a sharp increase in aggregate labor supply, which is essentially the result of a substitution effect that induces delays in consumption as well as leisure, and creates a jump in the labor supply. However, as the aggregate capital stock is predetermined from the period before the policy change, the capital−labor ratio plunges sharply, resulting in an initial spike in the interest rate and a decrease in wage rate and capital−output ratio.

In subsequent periods, higher capital accumulation kicks in, which results in further increases in output. This happens despite the fact that wealth effects mitigate some of the increase in the aggregate labor supply, which gradually decreases to its new steady−state value. Also, after its initial surge, the interest rate falls and the wage rate rises, to their new steady−state values.

All these trends are documented quantitatively in Table 3. Notice that the labor

Figure 2: Transition Path for Aggregate Macroeconomic Variables in the Simple Tax Reform, and the Gradual Tax Reform



Note: This figure shows the evolution of the macroeconomic aggregates under both the simple and the gradual tax reforms.

supply rises by 5% immediately after the policy change. Because of this, output increases by 3.3% in the first period. This means that about 30% of the total increase in output is realized in the initial period of the tax reform.

Five periods into the reform, the capital stock is 24.6% larger than its initial steady state and output is 10.8% larger. Further along the transition, after 10 periods, output exceeds its initial steady state level by 11.3%, and the capital stock is 27.5% larger. Over the long−run the capital stock is 27.6% higher than its initial steady state and the output is 11.4% larger. As the economy expands, the required consumption tax rate declines. Along the transition, the consumption tax rate falls from 16.1% initially to its long-run value of 14.1%.

Table 3: Comparison of Aggregate Variables Along Transition Path

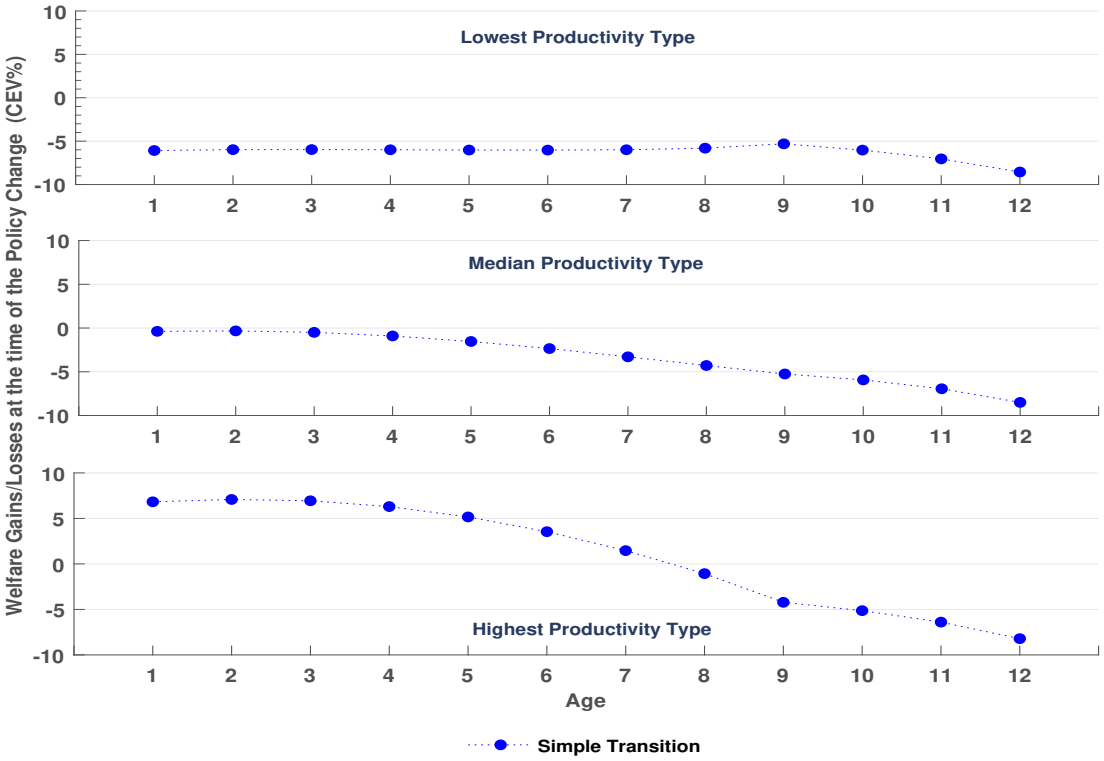
	Periods in the new system	Output	Capital Stock	Labor Supply	Interest Rate	Consumption Tax Rate
	1	103.30	100.00	105.10	0.056	16.09%
Simple	5	110.84	124.63	103.71	0.042	14.34%
Tax Reform	10	111.30	127.55	103.76	0.041	14.07%
	36	111.32	127.67	103.77	0.041	14.06%
	1	100.19	100.00	100.81	0.053	23.35%[b]
Gradual	5	105.07	108.84	103.18	0.049	19.22%
Tax Reform	10	110.31	125.17	103.35	0.041	15.17%
	36	111.30	127.60	103.70	0.041	14.06%

Note: This table provides snapshots of the economy right after the policy change, 5 years into the transition, 10 years into the transition and at the new steady state for both simple tax reform and gradual tax reform. Interest rates are the calculated annual interest rate that are implied by the interest rate for the 5−year−period in the model. Note that in the gradual tax reform no one chooses to switch to the new tax system, the consumption tax rate in the first period is irrelevant. I reported the consumption tax rate at the second period in the table.

Welfare: Figure 3 shows the welfare effects, measured by the consumption equivalent variation, during the first transition period for the three groups of agents: the most productive agents, the least productive agents, and the agents with median productivity. This graph confirms that the welfare consequences for agents vary significantly with ages and productivity types.

Notice that all agents who are in their retirement periods, independent of their productivity type, face welfare losses. In fact, older agents are the biggest losers of the reform, with agents age 65 or higher losing about $4 - 8\%$. The rationale for this is the considerably different tax burden these agents face under the consumption tax system. Changing the timing of tax payments over the life cycle significantly alters the burden of taxation across generations. Under the benchmark tax system, the tax burden for retirees is negligible compared to the tax burden of agents who are in their prime working ages. However, under the consumption−smoothing

Figure 3: Welfare Gains/Losses at the First Period of Transition in the Simple Tax Reform



Note: This figure shows the welfare gains/losses, measured in consumption equivalent variation, in the first period of implementing the simple tax reform, for the highest, the lowest and the median productivity type agents.

behavior of agents, and the fact that each agent has to pay a flat tax rate on each units of consumption, the tax burden of retirees is comparable to that of working agents. Therefore, agents who are in retirement when the tax reform takes place have already played their role as major contributors to the tax revenue during their working years. With the change in the tax system, they are now expected to provide a considerable part of tax revenue, in their retirement years as well.

Among young agents, the welfare changes are increasing in productivity type. Whereas agents with higher productivity types experience welfare gains, less productive agents are negatively affected by the tax reform. The miscellaneous welfare effects stem from the progressivity of the income tax under the benchmark tax system. The nonlinear income tax scheme has an increasing marginal tax rate that adversely affects agents with higher earnings. Hence, more productive agents who in the this setup have higher income,

benefit more from replacing the progressive income tax with a flat−rate consumption tax. This explains why young agents who are more productive experience welfare gains. Less productive agents, no matter their ages, lose, even though they would have higher wages and higher social security benefits in their retirement years.

Overall, my quantitative experiment shows that under the simple tax reform, only 24.6% of the population who are alive at the time of the policy change, experience welfare gains, and the tax reform is detrimental for the rest. Also, the weighted sum of the welfare gains of the winners is just 14% of the weighted sum of the welfare losses borne by the losers. These results show that long−run welfare gains mask the asymmetry in the distribution of short−run welfare effects.

6.2 Gradual Tax Reform

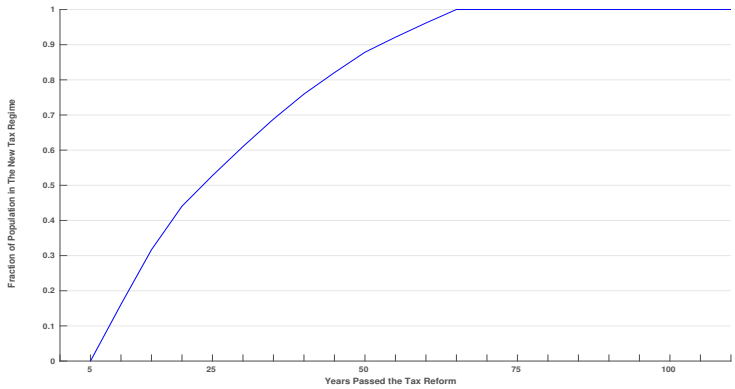
The gradual tax reform phases out the benchmark tax system by letting agents, who are alive when the change of policy takes place, choose their preferred tax code. Figure 2 shows the evolution of macroeconomic aggregates in the gradual tax reform (the dotted line with triangular points). As shown in this figure, the transition to the new steady state is much slower. Convergence to the new steady state now takes about 60 years, and it takes 18 years for the economy to materialize half of the increase in the output. In the simple tax reform, they take place in the first period of transition.

Figure 4 shows the fraction of population who pay their taxes according to the new tax code in each transition. In the first period, during which the change in policy occurs, no one chooses to pay taxes under the new tax code, and it takes about 18 years for half of the population to pay their taxes under the consumption tax system.

Younger, more productive agents are among the first to adopt the new tax system. These are the cohorts who experience higher incomes in their life cycles and are therefore affected more severely by a nonlinear income tax. The consumption tax system is thus more appealing to these groups, and they choose to switch to the new tax system in the initial periods of the tax reform.

The retired agents, no matter their productivity type, choose to stay in the benchmark tax system over the rest of their life. As mentioned before, these agents have already made their economic choices and paid income taxes under the benchmark tax scheme, assuming the tax burden is negligible in their retirement years. Switching to

Figure 4: Rate of Adopting the New Tax Regime



Note: This figure shows the fraction of the population who are paying their taxes according to the new tax system at each period of transition. Notice that it takes nearly 3.5 model periods(18 years) to have half of the population in the new tax system

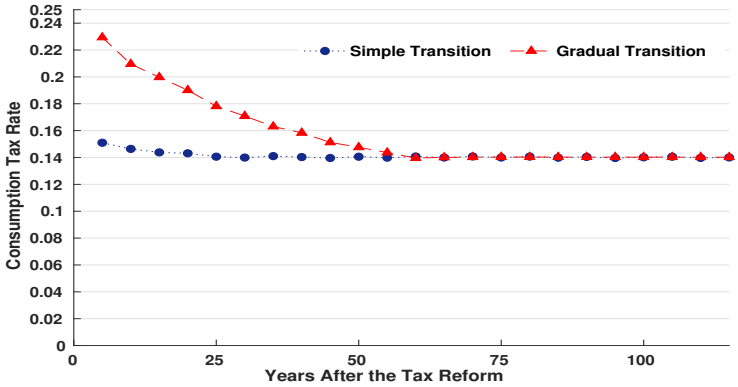
the new tax system increases their tax burdens and is not beneficial for this group.

Having just a fraction of population in the new tax system during the initial periods of the tax reform induces higher consumption tax rates during these periods compared to the simple tax reform as shown in Figure 5. Further along the transition, more agents will be willing to pay consumption taxes. As a result, the endogenous consumption tax rate eventually declines to its steady−state value.

The gradual tax reform slows down the emergence of beneficial features of the consumption tax code in the economy, a fact that is quantified in the second panel of Table 3. For example, immediately after the tax reform, there are few noticeable differences in the economy. It takes two model periods for the economy to realize a 30% increase in output, the amount realized during the same period when the policy change goes into effect under the simple tax reform. Five periods into the transition, output increases by 6.4% from its initial steady state compared to 10.3% in the simple tax reform, and the capital stock increases by 13.9% compared to 24.6%.

Hence, with the gradual tax reform, it takes longer for the economy to benefit from the desirable effects of the consumption tax system. Moreover, with the gradual tax reform, the endogenous consumption tax rate required to keep the tax revenue constant is much higher in the early years of the transition than the simple reform.

Figure 5: Comparison of the Consumption Tax Rate at Each Period of Transition to the New Steady state, in the Simple Tax Reform and Gradual Tax Reform



Note: This figure compares the consumption tax rate at each period of transition, needed to generate a constant tax revenue, in the simple tax reform and the gradual tax reform.

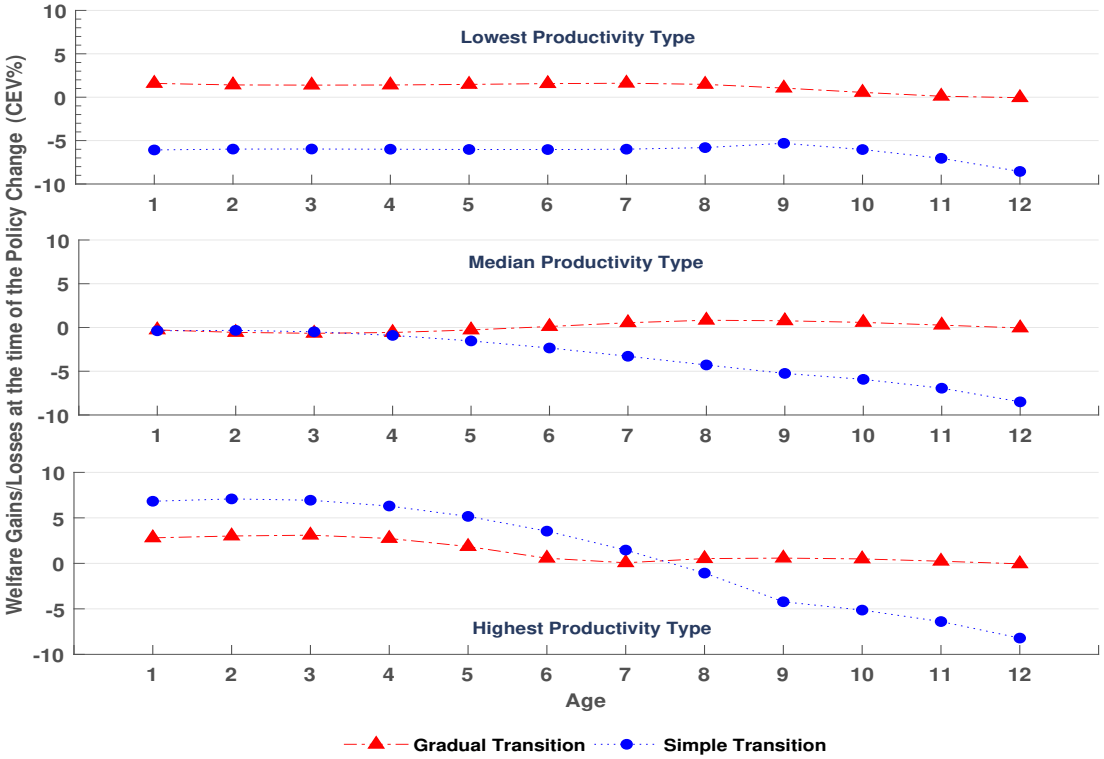
Welfare: Figure 6 shows the welfare gains/losses, measured in consumption−equivalent variation, during the first transition period for all agents who are alive when the tax reform takes place. Comparing the welfare effects of the gradual tax reform with their counterparts in the simple tax reform confirms that allowing agents to choose their preferred tax regime enables them to avoid the unfavorable welfare effects of the tax reform. The gradual tax reform eliminates the adverse effects of changing the tax policy and reduces it to the general equilibrium effects, which happen to be small in this case.

My quantitative results show that under the gradual tax reform, 95% of the population who are alive at the time of the policy change, experience welfare gains, as opposed to 24.6% under the simple tax reform. Younger agents from the median productivity group are those who are experiencing a tiny welfare losses, that are coming from the general equilibrium effects.

7 Discussion

In this section, I run five exercises. First, I rerun the experiment using a consumption tax system that features a lump-sum transfer for everyone, and thus retains some flavor of progressivity. The goal is to investigate whether the negative welfare consequences in

Figure 6: Welfare Gains/Losses at the First Period of Transition, in the Gradual Tax Reform and the Simple Tax Reform



Note: This figure compares the welfare gains/losses for three types of agent at the first period of transition, measured in consumption equivalent variation, in the simple tax reform (circle dots) and the gradual tax reform (triangle dots).

the first period are driven by the lack of progressivity of the new tax system. Second, I simulate the model in a partial equilibrium to understand the roles of endogenous factor prices on the results. Third, I investigate the sensitivity of my results to labor supply elasticity by conducting the experiment with a higher value for γ. Forth, I explore whether announcing the change of policy in advance would help ameliorate the negative short-run welfare consequences of the tax reform. Fifth and finally, I compare my method with the one in which the old tax system is phasing out while the new tax system is phasing in over a certain number of periods.

7.1 A Linear Progressive Consumption Tax

Although proportional consumption taxes have received a great deal of attention in the literature, it is important to note that consumption-based taxes can also be progressive. In particular, giving a lump-sum transfer to all households is one way of converting a flat consumption tax system into a progressive one. In this section, I rerun the experiment, replacing the benchmark tax system with a consumption tax system that features lump-sum transfers to all agents. The goal of the exercise is to examine whether having the transfer alleviates the negative short-run welfare consequences of the tax reform, and how the gradual tax reform performs in this context.

I consider three levels of transfers: 1%, 2.5%, and 5% of the gross domestic product (GDP) per capita of the steady state of the benchmark economy. Transfers, such as government consumption, are financed by taxes. Thus, providing higher levels of transfers, induces higher tax rates to keep the government budget balanced.

Table 4 reports the value of the aggregate variables with induced changes in the consumption tax rate for the three levels of transfer as well as the one without transfers. As we expected, the need to finance the higher level of transfers increases the consumption tax rate well above the case without any transfers. As a result, the output effects when there are transfers are substantially reduced relative to when there are no transfers. The long-run increase in the capital stock and level of output are lower in tax systems with a higher level of transfers. The labor supply decreases as well.

The aggregate welfare gain increases with the level of transfers. This reflects the fact that providing a fixed level of transfer changes the effective marginal tax rate of agents, which then alters their tax burdens. This is illustrated in Figure 7, which decomposes the aggregate welfare gains across agents with different levels of productivity. Looking at the distribution of the welfare gains, we see that the welfare gains for less productive agents who are relatively poor are increasing in the amount of transfers, whereas the gains for agents with higher levels of productivity, decline with the rise of the transfer. Results occurs because the effect of transfers declines as income increases. Poor agents benefit most from transfers, and richer agents bear the burden of financing the transfers.

Table 4: Comparison of Aggregate Variables for The consumption Tax Reform with Transfers

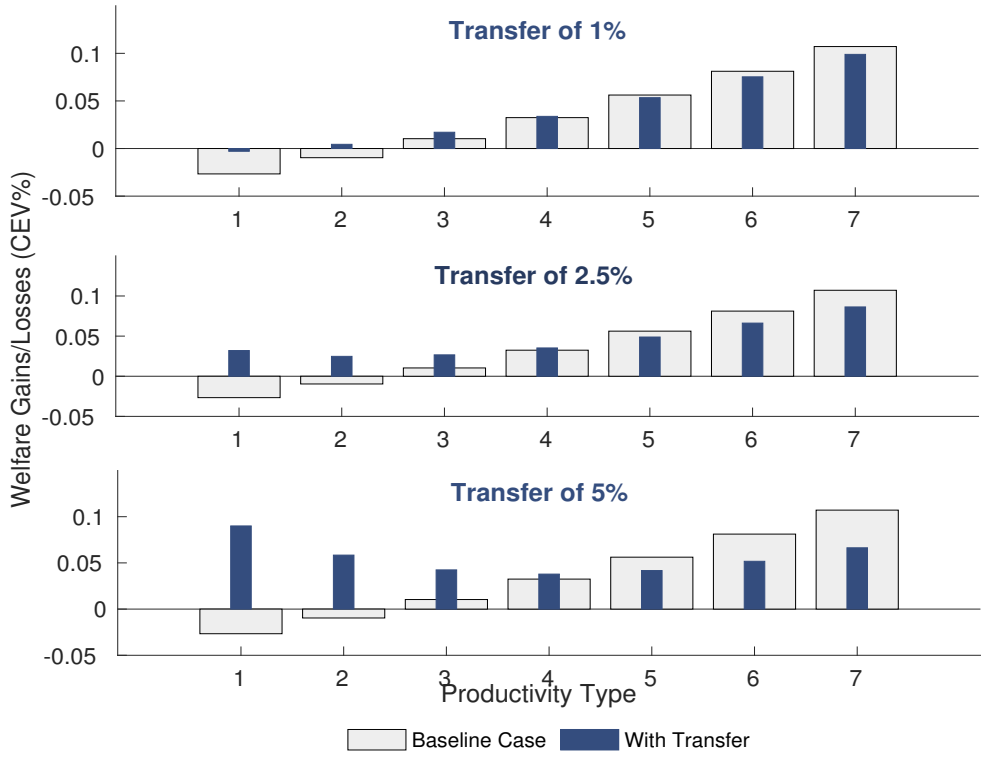
	Benchmark Tax System	Consumption Tax System (Without Transfer)	Consumption Tax System (1% Transfer)	Consumption Tax System (2.5% Transfer)	Consumption Tax System (5% Transfer)
Consumption Tax Rate (τ^c)	.	14.06%	15.49%	17.71%	21.42%
Output	100	111.3	110.7	109.8	108.3
Capital Stock	100	127.6	127.0	126.1	124.6
Labor (efficiency units)	100	103.7	103.1	102.2	100.7
K/Y	2.89	3.313	3.316	3.318	3.325
Household Income (Avg)	100	108.8	108.2	107.2	105.7
Aggregate Welfare Gain (CEV%)	.	3.4%	3.7%	4.1%	4.7%

Note: This table provides a comparison of changes in the aggregate variables in the steady state of the reformed economy, for the consumption tax systems with 0%, 1%, 2.5%, and 5% transfer.

Figure 7 plots the short-run welfare consequences of the consumption tax reform with different levels of transfers. The upper graph shows the welfare effects for agents at the lowest productivity level, and the middle and lower graph show the welfare effects for agents at the median and the highest productivity levels. The figure confirms that the welfare of the least productive agents, who are the poorest in the economy, increase with the rise in transfers. This suggests that the transfer has a considerable effect on their income that outweighs the cost of financing it out of their taxes. For agents at the median productivity level, who are in the middle income group, the cost and benefit of the transfer have no noticeable effect on their welfare gains. Finally, the welfare gains for the most productive agents, who have the highest income in the economy, decline with the rise in transfers. These groups bear the burden of financing transfers, although the amount they receive in transfers is negligible compared to their income; thus, a consumption tax system with no transfers would be most preferable to them.

Although including transfers mitigates the short−run welfare losses for poor agents, it does not significantly decreases the welfare losses observed under the simple tax reform. As Figure 8 shows, the welfare losses could be as large as 12% in consumption equivalent variation (CEV) measure, for the higher productivity types who are retired. Even among

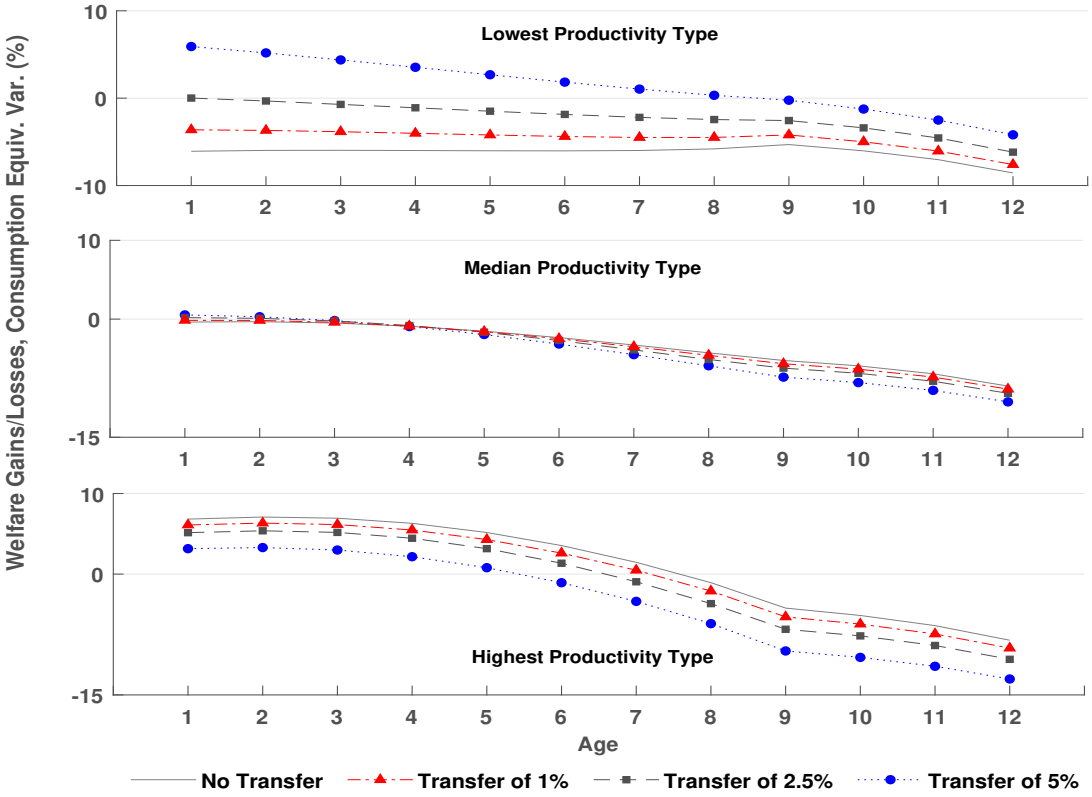
Figure 7: Comparison of Aggregate Welfare Effects across Steady States: Consumption Tax System with Transfer



Note: This figure shows the distribution of the welfare gains/losses of switching to a consumption tax system at the steady state of the reformed economy. Each graph compares the distribution of the welfare effects for two cases: the consumption tax system without any transfer (the baseline case) and the consumption tax system with a lump-sum transfer equivalent to of 1%, 2.5% and 5% of GDP per capita for all households.

members of the lowest productivity group, who are the main beneficiary of the transfers, those who are retired face welfare losses as large as 6%. In fact, even with a 5% transfer, agents with higher productivity, as well as agents in their retirement years, still face welfare losses. This suggests that a gradual method could be relevant for implementing a progressive consumption tax reform. Figure 9 shows how the gradual tax reform alters the welfare consequences of implementing the consumption tax reform with a transfer equivalent to 5% of output per capita . This graph confirms that implementing the reform gradually improves the welfare of agents who are alive at the time of the policy change.

Figure 8: Comparison of the Welfare Effects of the Simple tax Reform at the First Period of Transition: for Consumption Tax Systems with Transfers

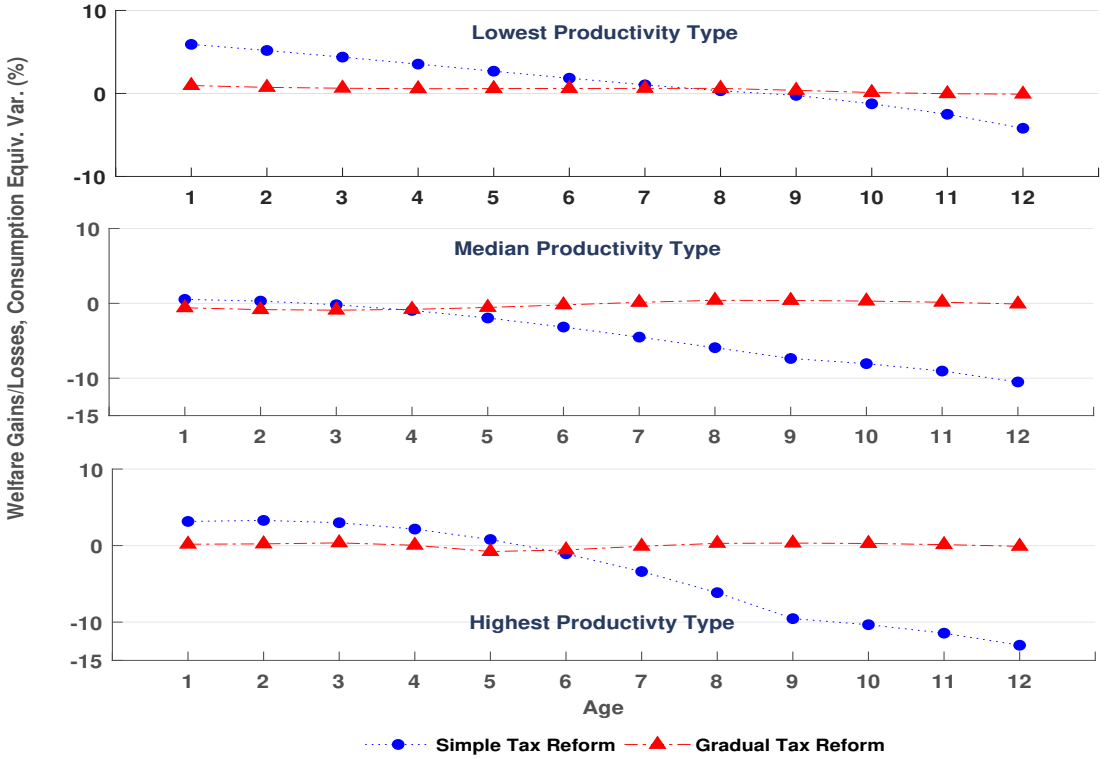


Note: This figure compares the welfare consequences of implementing a consumption tax reform with various levels of transfer, at the first period of transition for three types agent.

7.2 Small Open Economy

To understand the roles of endogenous factor prices, I rerun my experiment in partial equilibrium. I fix the interest rate and wage at their levels in the benchmark economy with the benchmark tax system, and compute the transition path without requiring market−clearing conditions for labor and capital markets. Table 5 shows how the aggregate variables compare across steady states assuming a small open economy. The second column reports variables for the closed economy where prices can adjust, and the third column reports variables for the steady state of the open economy where prices stay unchanged at their initial values.

Figure 9: Comparison of the Welfare Consequences of a Consumption Tax Reform with 5% Transfer, at the First Period of Transition, In the Simple Tax Reform and the Gradual Tax Reform



Note: This figure shows the welfare gains/losses for agents at the first period of implementing a consumption tax system with a lump-sum transfer equivalent to 5% of GDP per capita in the simple tax reform (circle dots) and the gradual tax reform (triangle dots).

Table 5: Comparison of Aggregate Variables under the Open Economy Assumption

	Benchmark Tax System	Consumption Tax System (Baseline Case)	Consumption Tax System (Small Open Economy)
Consumption Tax Rate (τ^c)	.	14.06%	12.35%
Output	100	111.3	129.9
Capital Stock	100	127.6	215.5
Labor (efficiency units)	100	103.7	100.0
K/Y	2.89	3.313	4.79
Household Income (Avg)	100	108.8	121.9
Aggregate Welfare Gain(CEV%)	.	3.37%	3.43%

Note: This table provides a comparison of changes in the aggregate variables in the steady state of the reformed economy, between the baseline case and the case of a small open economy.

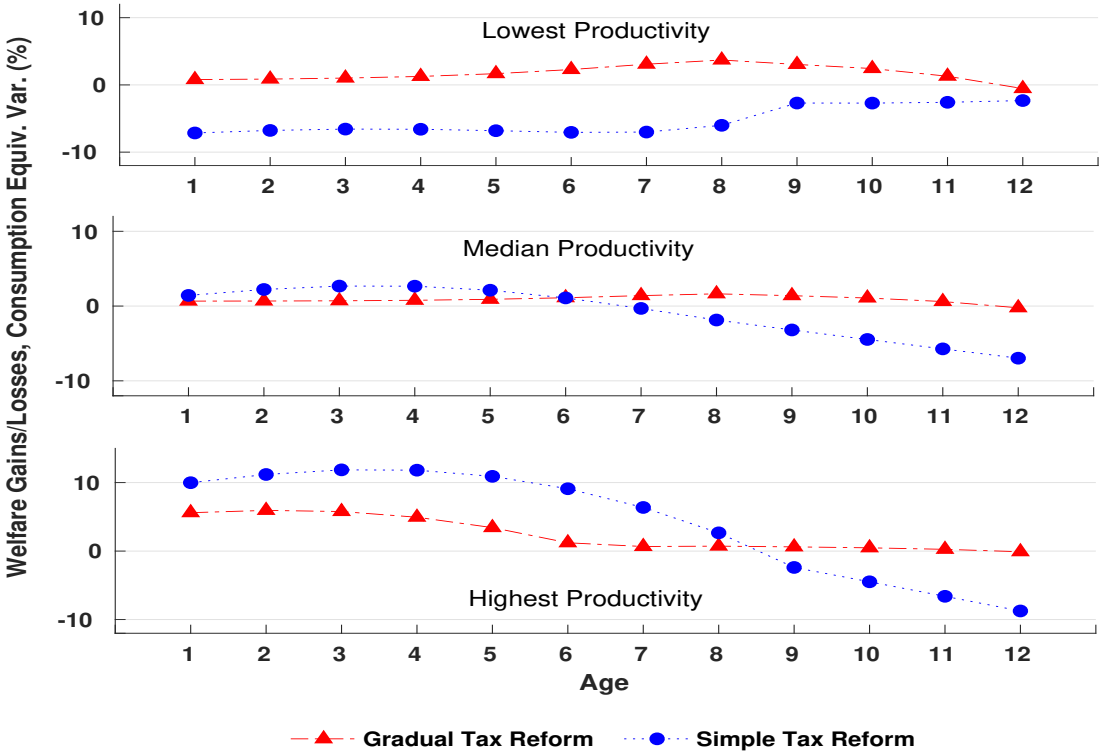
With fixed factor prices, capital stock is twice as large as its initial steady state value. As discussed earlier, taxing consumption encourages savings. When prices are fixed and cannot react to a higher level of capital accumulation, the high rate of return to capital reinforces this incentive, which in turn induces a huge expansion of the capital stock.

Wage is fixed at a lower level compared to that of the closed economy, and we see that labor supply stays almost unchanged at its initial level. In the consumption tax system, the capital accumulation margin is not taxed; this creates a substitution effect that induces delaying consumption, as well as leisure, which increases the labor supply. In the closed economy, as more capital is accumulated, the prices adjust such that higher wage exerts a downward pressure on labor supply through the wealth effect. In the long−run, these two effects work together so that labor supply increases. In the open economy, wage is constant , but the considerable amount of capital stock creates a wealth effect that seems to offset the substitution effect in such a way that the labor supply does not move in the long−run. Compared to the general equilibrium benchmark, average household income is higher in the open economy.

The long-run aggregate welfare gain is almost the same across both open and closed economies. However, the distribution of welfare gains across productivity types is more concentrated in the open economy. In this case, the rate of return to capital stays unchanged instead of declining, so more productive agents for whom the return to capital is a major source of income, enjoy greater welfare gains. Conversely, less productive agents who live mainly on their labor income and social security transfers, are deprived of higher wages and higher retirement benefits under the open economy. Thus, they must endure larger welfare losses.

Figure 10 plots the short-run welfare effects for living generations of the highest, median, and lowest productivity types at the first transition period, for both simple tax reform and gradual tax reform. This figure confirms that keeping prices unchanged does not eliminate the negative effects of the tax reform on agents who are alive at the time of the policy change. In other words, the short-run welfare consequences of the tax reform

Figure 10: Welfare Effect of a Consumption Tax System: Small Open Economy



Note: This figure shows the welfare gains/losses for agents at the first period of implementing a consumption tax system, with the small open economy assumption, in the simple tax reform (circle dots) and the gradual tax reform (triangle dots).

do not appear to be driven primarily by a change in factor prices.

However, endogenous factor prices slightly affect the distribution of welfare effects for generations alive at the first transition period. Comparing Figure 10 with its analog in the closed economy, Figure 6, we see that older generations of the lowest productivity type experience smaller welfare losses in the open economy compared to the closed economy. Fixed prices, and in particular, fixed wage, can explain this observation. In the closed economy, at the first transition period, labor supply jumps; this pushes down the capital−labor ratio and therefore decreases the wage rate and affects aggregate labor income. Retired generations receive social security benefits that are proportional to their average labor income. This creates another channel through which these groups are affected by the change in the tax regime. In the small open economy prices are fixed and cannot react to the change in the capital−labor ratio; as a result, average labor income

in the first transition period is about 10% higher in the small open economy compared to the closed economy. This translates into higher social security benefits for retirees in the open economy and justifies the observed trend in welfare cost. Overall, Figure 10 confirms that the gradual implementation of the reform can address short-run welfare consequences even with fixed factor prices.

7.3 The Role of the Labor Supply Elasticity

We know that the macro estimates of the elasticity of labor supply are higher than micro estimates (Domeij and Floden (2006), Pistaferri (2003)). In my experiments I set the intertemporal elasticity of labor supply γ equal to 1. However, Keane and Rogerson (2015) argues that different mechanisms at play in aggregate settings suggest values of labor supply elasticity higher than 1. In this section, I examine the sensitivity of my results to the value of γ. More precisely, I set the value of γ equal to 2.5, recalibrate the model and rerun the experiment.

Table 6: Comparison of Aggregate Variables for Higher Elasticity of Labor

	Benchmark Tax System	Consumption Tax System (with $\gamma = 1$)	Consumption Tax System (with $\gamma = 2.5$)
Consumption Tax Rate (τ^c)	.	14.06%	13.82%
Output	100	111.3	113.2
Capital Stock	100	127.6	129.9
Labor (efficiency units)	100	103.7	105.4
K/Y	2.89	3.313	3.316
Household Income (Avg)	100	108.8	110.0
Aggregate Welfare Gain(CEV%)	.	3.4%	3.8%

Note: This table provides a comparison of changes in the aggregate variables in the steady state of the reformed economy, for two levels of the labor supply elasticity: $\gamma = 1$ (the baseline case) and $\gamma = 2.5$.

As shown in Table 6 the higher value of labor supply elasticity slightly magnifies the change in the macroeconomic aggregate variables in the long run. In fact comparing $\gamma = 1$ with $\gamma = 2.5$, the output, capital stock, and labor supply are all higher by about 2 percentage points for the higher value of γ. In particular, having higher labor supply elasticity enables agents to amplify their reaction to the change in the tax code, so the output of the new steady state is higher and the consumption tax rate required to keep the government budget balanced is lower. Also, the aggregate welfare gain is slightly higher for $\gamma = 2.5$.

Figure 11 compares the welfare consequences of the consumption tax reform in the first transition period, under the simple tax reform and the gradual tax reform. Comparing this figure with Figure 6, it can be seen that the pattern of welfare effects is similar in the high− and low−elasticity cases, and that the gradual tax reform can address the short-run welfare effects of the tax reform here as well.

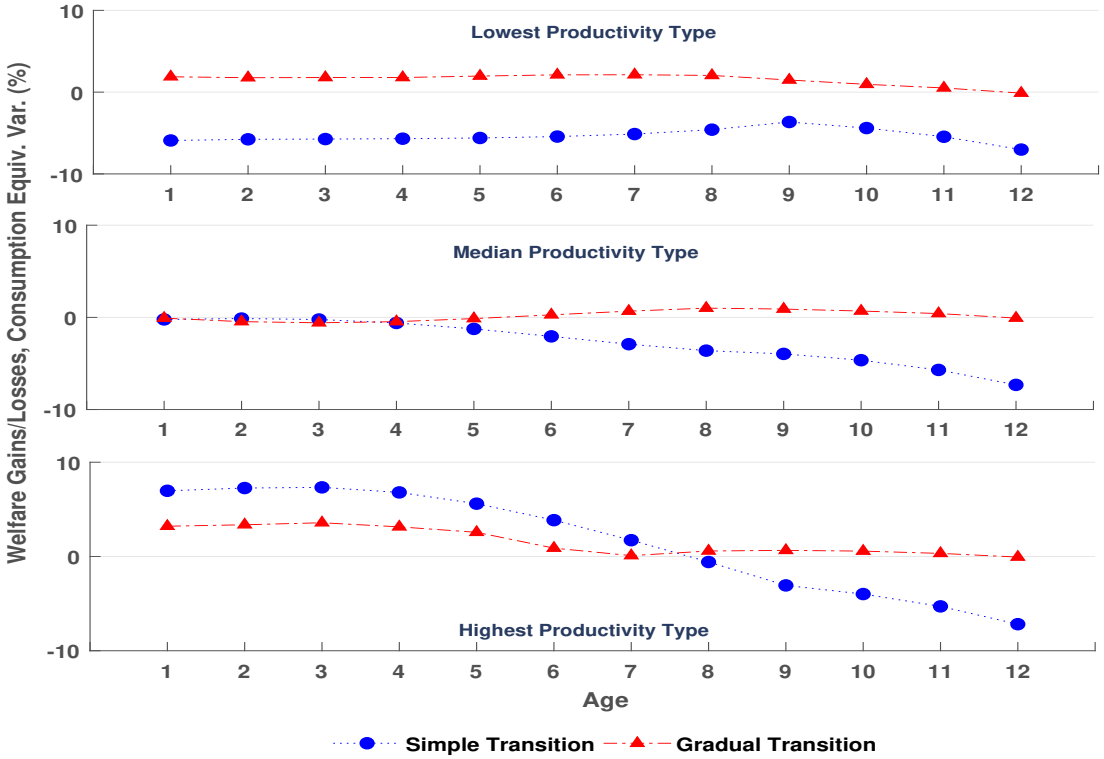
7.4 Anticipated Tax Reform

Major policy changes such as tax reforms, which have profound impacts on the economic behavior of the population, are usually announced in advance. The idea is that by knowing that a specific reform will take place in the near future, agents can adjust their economic decisions to alleviate the brunt of the change.

In my major computation, I treat the tax reform as being an unanticipated policy change. To explore the extent to which announcing the policy change beforehand would change short−run welfare consequences of the reform, I conduct the following exercise. Assume that in period 0, before any economic decisions are made, the government announces a change in the tax regime: starting from the next period, the benchmark tax system will be replaced with a flat− rate consumption tax, and everyone has to pay their taxes according to the new tax code.

Figure 12 compares the short−run welfare effects of the simple tax reform in the first transition period for both anticipated and unanticipated reforms. It can be seen that announcing the tax reform one period ahead, does not appear to mitigate the welfare

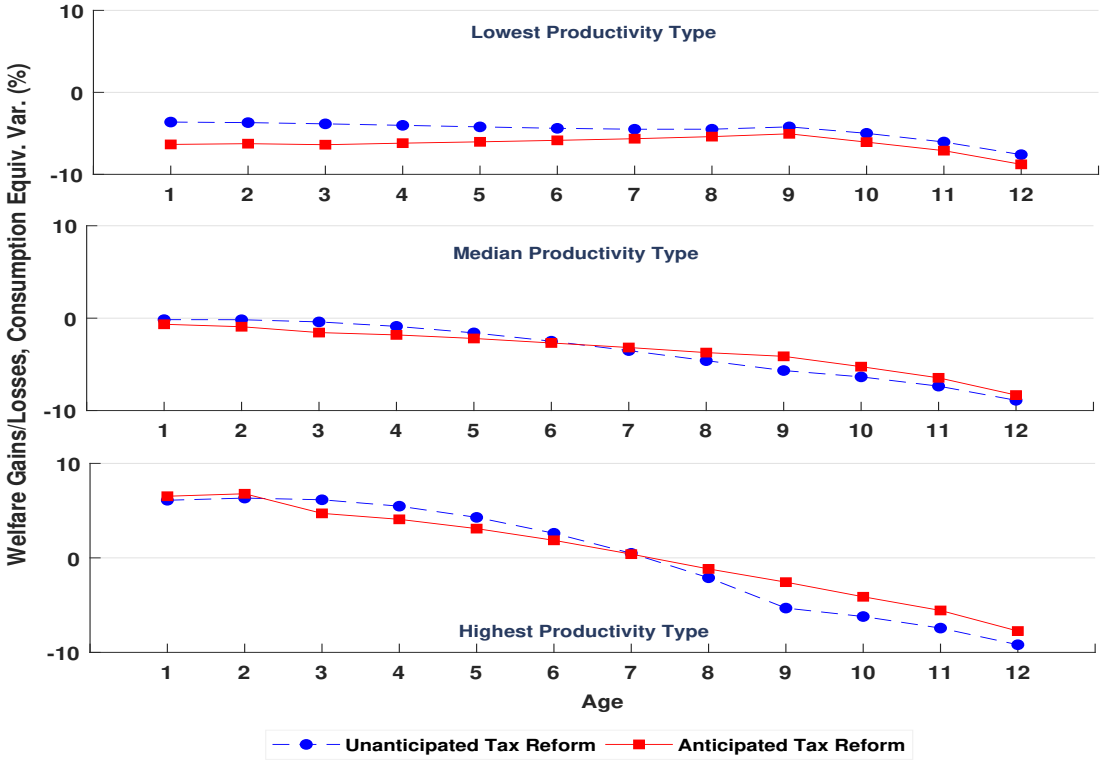
Figure 11: Welfare Gains/Losses of a Consumption Tax Reform at the First Period of Transition with $\gamma = 2.5$



Note: This figure shows the welfare gains/losses for agents at the first period of implementing a consumption tax system under the simple tax reform (circle dots) and the gradual tax reform (diamond dots), with a higher labor supply elasticity ($\gamma = 2.5$).

consequences at the first implementation period. Even with an anticipated reform, 62% of the population endure welfare losses. By announcing the policy one period ahead, agents know that in the next period, they must pay a flat tax on each unit of their consumption, and that their savings will be tax exempt. As a result, they increase consumption and decrease savings in period 0. Thus, in the first transition period, the welfare costs are slightly lower for those who own the lion's share of capital (the older, more productive group), as they now hold lower levels of capital compared to the unanticipated case. However, as the capital stock is lower in the first transition period, the jump in the labor supply places greater downward pressure on wage compared to the unanticipated case. This means for those living mainly on labor income, the welfare costs are greater. Figure 12 reflects these results.

Figure 12: Welfare Gains/Losses of a Consumption Tax Reform at the First Period of Transition: Anticipated Policy Change



Note: This figure compares the welfare gains/losses for agents at the first period of a consumption tax reform between an unanticipated tax reform (circle dots) and an anticipated tax reform (square dots) in which the tax reform is announced one period ahead. The welfare effects are reported for a simple tax reform.

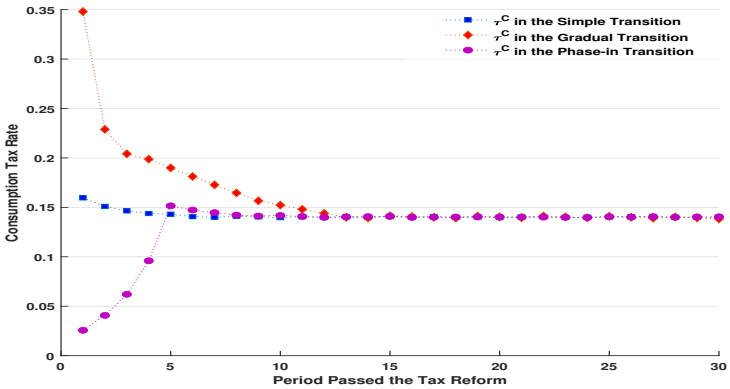
Overall, it can be seen that even the anticipated tax reform creates undesirable short-run welfare consequences for the living generations, and these welfare consequences could be alleviated by implementing the tax reform gradually.

7.5 Phasing Out the Current Tax System

One of the procedures discussed in the literature for replacing a major policy system is to gradually phase-out the old system and introduce the new system over a certain period of time[6]. In this section, I compare the performances of a phase-in/phase-out method of

[6]See For examples see (Conesa and Krueger, 1999).

Figure 13: Consumption Tax Rate Along the Transition



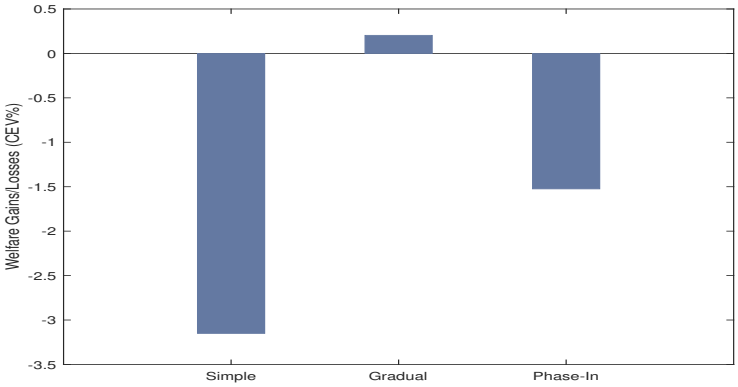
Note: This figure compares the consumption tax rate at each period of transition, needed to generate a constant tax revenue, in the simple tax reform, the gradual tax reform and the phase-in/phase-out tax reform .

implementing a tax reform with the gradual tax reform I propose in this paper.

More specifically, using the model, I simulate a revenue-neutral transition from the old tax system to the new system where the old tax regime is being phased out exponentially over five model periods (20 years), whereas the consumption tax system is introduced and the consumption tax rate is adjusted to keep the tax revenue constant. Figure 13 compares the consumption tax rates along the transition for the simple tax reform, the gradual tax reform, and the phase-in/phase-out tax reform. In the phase-in/phase-out reform, during the first five periods where everyone pays taxes in both tax systems, the induced consumption tax rate is lower compared to the simple and the gradual reforms. Starting in the sixth period, the consumption tax system is the only tax regime and everyone pays taxes under this tax code. Hence, the dynamics of the consumption tax rate in this setting closely resemble those of the rate under the simple tax reform.

The aggregate short−run welfare consequences of the three tax reforms are compared in Figure 14. The figure shows that although the phase-in/phase-out tax reform improves the welfare effects upon the simple tax reform, it still under-performs the gradual tax reform in that dimension. Comparing the short-run welfare consequences across agents with different productivity type at different ages, we see that the welfare effects on younger agents are mostly similar under the simple tax reform and the phase-in/phase-out tax

Figure 14: Comparison of Aggregate Welfare Effects at the First Period of Transition



Note: This figure compares the aggregate welfare effects at the first period of transition across three tax reforms; the simple tax reform, the gradual tax reform and the phase-in/phase-out tax reform.

reform, which suggests the additional burden of paying a consumption tax is being offset by the reduction in income taxes. Relatively older agents are better off with the phase-in/phase-out tax reform than they are with the simple tax reform. But they are worse off with the phase-in/phase-out tax reform than with the gradual tax reform. The tax burden for these agents under the old tax system is much lower compared to the tax burden for the younger agents, whereas it is almost the same for both groups under the new tax system (recall these are the agents who choose to stay in the old tax system under the gradual tax reform). Hence, the welfare costs would be lower in the phase-in/phase-out reform as agents face a much lower consumption tax rate.

To sum up, although phasing out the old tax system while phasing in the new tax system gradually improves the short-run welfare effects of the consumption tax reform for some groups, it still induces considerable aggregate welfare losses at the first transition period with more than 62% of population experiencing welfare losses. Hence, the gradual tax reform I propose here outperforms this method in addressing the short-run welfare consequences of the reform.

8 Conclusion

A central concern in all discussions of tax reform is the dynamics of the transition path of the economy following the implementation of the reform. A major challenge that policy

makers face when considering a consumption-based tax reform is how to solve initial resistance to the reform. This inertia is created by undesirable welfare consequences of the reform on generations alive at the time of the policy change, which may make the reform too costly to be politically acceptable. I propose a practical method for implementing tax reforms, which addresses this issue by delaying the adoption of the new tax code. More precisely, in the gradual tax reform, generations alive at the time of the policy change have the option of choosing between the benchmark tax system and the consumption tax system. Almost all current retirees, who would face a much heavier tax burden under the consumption tax system, decide to stay in the old tax regime. Workers, especially more productive ones, who can take advantage of the flat rate consumption tax and exemption of their savings from taxation, opt into the new tax system faster.

Comparing the predicted short-run welfare effects of the gradual tax reform with those of the simple tax reform on generations alive at the first period of the reform, confirms that letting agents choose if and when they want to switch improves their welfare experiences significantly.

My experiment suggests that the gradual tax reform can address most of the unfavorable short-run welfare effects of the tax reform. Although I describe this method in the context of a consumption−based tax reform, it can be broadly used as a practical way of implementing any type of policy reform that provides higher welfare in the long run.

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9 Appendix: Equilibrium Definition

In this appendix I define the equilibrium for the steady states as well as for the economy during the transition when the equilibrium is not stationary.

9.1 Steady State

n the model economy, agents are heterogeneous with respect to their productivity types (permanent productivity shocks), their asset holdings and their ages. For aggregating, I need to define a probability measure ψ_j on subsets of the agent state space. The probability measure ψ_j describes the heterogeneity in assets and permanent productivity shocks within an specific cohort. Let $(\mathscr{X}, B(\mathscr{X}), \psi_j)$ be the probability space where $B(\mathscr{X})$ is the Borel $\sigma-$algebra on $\mathscr{X}$ and $\psi_j : [0,1] \to \mathscr{X}$ is a probability measure. The measure of agent with state $x = (a, z_i)$ within the cohort of age j is $\psi_j(x)$.

Definition of Equilibrium. A steady state equilibrium is a collection of decision rules $c(x,j), l(x,j), a(x,j)$, factor prices w and r, taxes paid $T^{\Upsilon}(x,j)$, $\Upsilon \in \{$*The benchmark tax system,The reformed tax system*$\}$, social security transfers b_j, aggregate capital K, aggregate labor L, government consumption G, a payroll tax τ^{ss} , a tax regime $\in \{$*benchmark tax system* , *reformed tax system*$\}$ and distributions $\{\psi_1, \cdots, \psi_J\}$ such that

1. $c(x,j), l(x,j)$ and $a(x,j)$ are optimal decision rules.
2. Factor prices are determined competitively:
   (a) $r = F_1(K,L) - \Upsilon$
   (b) $w = F_2(K,L)$
3. Markets clear :
   (a) $\sum_j \mu_j \int_x \big(c(x,j) + a(x,j)\big) d\psi_j + G = F(K,L) + (1-\Upsilon)K$
   (b) $\sum_j \mu_j \int_x a(x,j) d\psi_j = (1+n)K$
   (c) $\sum_j \mu_j l(x,j) e(z,j) = L$

4. Law of motion of distributions is consistent with individual decision rules:

$$\psi_{j+1}(\mathbf{B}) = \int_x P(x, j, \mathbf{B}) d\psi_j \quad , \quad \forall\, \mathbf{B} \in \mathscr{X} \text{ and } j = 1, 2, \cdots, J$$

where

$$P(x, j, \mathbf{B}) = \begin{cases} 1 & \text{if } (a(x, j), z) \in \mathbf{B} \\ 0 & \text{otherwise} \end{cases}$$

5. Government budget constraint is satisfied

$$G = \sum_j \mu_j \int_x T(x, j) d\psi_j$$

6. Social security benefits is fully funded by payroll taxes :

$$wL\tau^{ss} = \sum_{z=1}^{Z} \sum_{j=T+1}^{T+T^R} \mu_j b_j$$

9.2 Out of the Steady State

Let $\psi_t(A, Z; j, q)$ be the mass of individuals with asset holding $a \in A$, type $z \in Z$, age j who are paying their taxes in the system indexed by q [7].The probability measure ψ_t is defined for all A in $\mathcal{A}$, the class of Borel subsets of $\mathcal{R}$, all $Z \subset \mathcal{Z}$, all $j \subset \mathcal{J}$ and all $q \in \{0, 1\}$. The dynamic evolution of ψ_t is as follows.
For newborns, if $t = 0$ [8]

$$\psi_1(A, Z; 1, q) = \begin{cases} \mu_1 & \text{if } 0 \in A \text{ and } q = 0 \\ 0 & \text{otherwise} \end{cases}$$

if $t \geq 1$

$$\psi_1(A, Z; 1, q) = \begin{cases} \mu_1 & \text{if } 0 \in A \text{ and } q = 1 \\ 0 & \text{otherwise} \end{cases}$$

Everyone dies at age J so

$$\psi_{t+1}(A, Z; J + 1, q) = 0$$

[7]Remember $q = 0$ means the individual paid her taxes under the benchmark tax system in previous period and she has the option of choosing between alternative tax system for this period, and $q = 1$ means she has already switched to the new tax system and there is no option available fr her in this period

[8]μ_1 is the normalized portion of the newborns of all types in the total population alive at each period

For $1 < j \leq J$, ψ_t evolves according to the following recursion. for the case $q'_t = 0$

$$\psi_{t+1}(A, Z; j, q = 0) =$$
$$\int_{\mathcal{R}^+ \times \mathcal{Z}} (1 - q'_t(a, z, j-1, q = 0)) I(a'_t(a, z, j-1, q = 0) \in A) d\psi_t(a, z; j-1, q = 0)$$

This means the mass of individuals in the next period who have not yet switched to the new tax system, are those who had the option in the previous period and chose to stay in the old system.

Similarly, the mass of individuals in the next period who are paying their taxes under the new tax system i.e. who do not have the option of choosing between alternative tax systems, comprise (ι) those who are born after the policy change so they have to pay their taxes under the new tax system; ($\iota\iota$) those who have already switched to the new tax system in previous periods. Therefore

$$\psi_{t+1}(A, Z; j, q = 1) =$$
$$\int_{\mathcal{R}^+ \times \mathcal{Z}} I(a'_t(a, z, j-1, q = 1) \in A) d\psi_t(a, z; j-1, q = 1) +$$
$$\int_{\mathcal{R}^+ \times \mathcal{Z}} q'_t(a, z, j-1, q = 0) I(a'_t(a, z, j-1, q = 0) \in A) d\psi_t(x; j-1, q = 0)$$

Equilibrium. For the model economy that moves from the benchmark tax system (the one with a progressive income tax and a flat capital income tax) to the new tax system (the flat consumption tax), an equilibrium with perfect foresight transition dynamics is a collection of decision rules $\{(c_t(x, j, q)\ , l_t(x, j, q)\ , a_t(x, j, q), q_t(x, j, q))^J_{j=1, x \in \mathcal{X}}\}^\infty_{t=1}$ [9] , factor prices $\{w_t, r_t\}^\infty_{t=1}$, tax systems $\{T^\kappa_t(x, j)\}^\infty_{t=0, \kappa \in \{benchmark, consumption\}}$, aggregate capital $\{K_t\}^\infty_{t=1}$ and aggregate labor $\{L_t\}^\infty_{t=1}$ and government consumption $\{G_t\}^\infty_{t=1}$ and social security benefit $\{b_{j,t}\}^{T+T^R, \infty}_{j=T+1, t=0}$, with a collection of distributions $\{(\psi_1, \cdots, \psi_{T+T^R})\}^\infty_{t=0}$ such that, for all t :

1. Decision rules solve the decision problem for the agent.

2. Factor prices are determined competitively

[9] $q_t(x, j, q)$ is a decision rule only for those agents who are allowed to choose between the alternative tax systems at period t, i.e. agents who are alive at the time of the policy change and have not yet switched to the new tax system in periods before t. So $q_t(x, j, q = 1) = 1$

- $r_t = F_1(K_t, L_t) - \Upsilon$
- $w_t = F_2(K_t, L_t)$

3. Markets clear :
   (a) $\sum_{q\in\{0,1\}} \sum_j \left[\int_x (c_t(x,j,q) + a_t(x,j,q)) d\psi_t \right] + G_t = F(K_t, L_t) + (1-\Upsilon)K_t$
   (b) $\sum_{q\in\{0,1\}} \sum_j \int_x a_t(x,j,q) d\psi_t = K_{t+1}$
   (c) $\sum_{q\in\{0,1\}} \sum_j \int_x l_t(x,j,q) e(z,j) d\psi_t = L_t$

4. Law of motion of distributions is consistent agent decision rules, as described.

5. Government budget constraint is satisfied

$$G_t = \sum_q \sum_j \int_x (q_{t+1}(x,j,q) T_t^{consumption}(x,j,q) + (1 - q_{t+1}(x,j,q)) T_t^{benchmark}(x,j,q)) d\psi_t$$

6. Social security benefits equal taxes :

$$w_t L_t \tau^{ss} = \sum_{q\in\{0,1\}} \sum_{j=T+1}^{T+T^R} \int_x b_{j,t} d\psi_t(x,j,q)$$