NIT Picking: The Macroeconomic Effects of a Negative Income Tax*

Martin Lopez-Daneri†

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Abstract

I study a revenue-neutral reform of the U.S. income tax system that involves the adoption of a Negative Income Tax (NIT). The reform is undertaken in a life-cycle economy with individual heterogeneity and uninsurable idiosyncratic labor risk. I find that the optimal NIT is characterized by an initial uniform transfer to each agent of 10% of GDP per capita, roughly $4600, followed by a tax rate of 28%. The ex-ante average welfare gain over the current system is equivalent to a 6.33% annual increase of individual consumption in every state of the world. The key consequence of the reform is that low productivity agents reduce their workforce participation in favor of high productivity agents. In addition, computational experiments indicate that the NIT clearly outperforms a flat tax.

Key words: Negative Income Tax, Income Tax, Efficiency, Distribution

JEL Classifications: E13, H21 and H24.

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†Lopez-Daneri, Martin: University of Iowa, Economics Department, 108 John Pappajohn Business Building, Office S361, Iowa City, IA 52242-1994, USA. Email: martin-lopezdaneri@uiowa.edu.

1 Introduction.

The U.S. Federal income tax is one of the most important sources of revenue for the Federal Government. It is a complex tax, with a considerable number of tax credits, deductions, overlapping provisions, and increasing marginal rates. The cost of compliance is not trivial and the distortions generated are significant. As a result, there has been a continuous demand for reform and numerous reform proposals have been floated. Some, like the flat tax (Hall and Rabushka, 1985), sank, while others did not—e.g., the significant reduction of marginal tax rates that took place in the 1980*s*. This study focuses on a particular reform proposal, the Negative Income Tax[1] (NIT; M. Friedman (1962)), and for the first time carries out the quantitative analysis of the tax in a general equilibrium setting.

A NIT works as follows. At the beginning of the fiscal year, all households receive a transfer from the government , say $2000. During the period, all income made is taxed at a constant rate, say 20%. Then, households with yearly income of less than $10000 ($2000/0.2) pay no taxes and receive a positive net transfer (negative tax). As income increases, the effect of the transfer declines. Under the NIT, all households have a guaranteed minimum income.

In this paper, I ask the following questions: What are the general equilibrium effects of replacing the actual income tax with a NIT? Specifically, what are the macroeconomic effects on income and earnings, labor supply, savings and welfare? Should we pick a NIT?

To tackle these questions, I study a life-cycle economy, in which agents are ex-ante homogeneous but grow different over time as a result of life uncertainty together with age-independent and idiosyncratic persistent productivity shocks. At any point in time, the resulting heterogeneity is characterized by the agents' shock history, their level of asset ac-

[1] There was a failed attempt to introduce it as a legislation during Richard Nixon's Presidency, but after all the modifications introduced in the Parliamentary debate, Milton Friedman who was a candid advocate, withdrew his support.

cumulation, and their age. There is a social security system and agents receive benefits, once they are retired, in the form of lump-sum transfers. In addition, accidental bequests may occur, and are distributed evenly among all living agents[2].

I calibrate this model to match features of the U.S. economy, reproducing the inequality of labor earnings across individuals. My model of the U.S. income tax recognizes the important role of transfers like the Earned Income Tax Credit (EITC). In addition, my tax function mimics the effective average tax rates paid by the American households. I focus on a stationary equilibrium and find the level of transfers and marginal tax rate such that the NIT reform is revenue neutral and maximizes ex-ante welfare (i.e. expected utility prior to birth and revelation of agents' types). My findings can be summarized as follows.

First and foremost, the NIT produces important welfare gains. A NIT with a marginal tax rate of 28% and a transfer of 10% of per capita GDP, roughly $4600, implies a welfare gain equivalent to 6.33% increase in annual consumption in every state of the world. Low-ability agents in the bottom quintile of the productivity distribution benefit the most, with welfare gains that range from 12% to 64%. However, there are losers under the NIT: those in the upper level of the productivity distribution –the "upper class". Therefore, the NIT is a "Robin Hood tax", taking from the rich and giving to the poor.

The level of transfers plays an important role in the results. Indeed, a proportional tax, i.e. a NIT with no transfers (a "non-negative income tax"), has a welfare loss of 4.3% relative to the current tax system. This result is unsurprising as redistribution by transfers is an important feature of the actual U.S. income tax. The elimination of transfers benefits only the highest productivity agents, who as a result face a lower marginal tax rate. Moreover,

[2] It is worth to notice that this benchmark economy has a level of transfers higher than what is actually seen in the data, especially for low-income households, where accidental bequests and social security benefits are not as important in relative terms as they are in the model. This matter is not irrelevant as the transfer in the NIT will be relatively more important for low-income than high-income households.

transfers are not only important, they are essential - a flat tax (a "non-negative income tax" with a fixed deduction) does not outperform the NIT. In particular, the optimal flat tax (characterized by a marginal tax rate of 19% and a fixed deduction of 33% of per capita GDP, roughly $15000[3]) produces a welfare loss of 0.12%[4]. Therefore, the replacement of lump-sum transfer by a fixed deduction is not welfare enhancing.

Second, there is a negative relationship between the size of the transfers and per capita GDP, which decreases by 13% under the optimal NIT. The reason is simple: leisure is a normal good and the presence of the transfer insures agents against periods of low productivity, enabling them to work only when they are productive. Therefore, the composition of the labor force changes: high-productivity agents increase participation at the expense of low productivity types. This is reflected by the fact that although labor supply measured in hours worked drops by 18%, labor supply measured in efficiency units falls by only 7%. Consequently, the Gini coefficient for labor earnings declines from 0.46 to 0.53.

Third, the transfer reduces the individual incentives to save, and the saving rate drops 11%, implying a reduction in the capital stock of 23% and the capital output ratio of 11%. The resulting decrease in the wage rate and increase in the interest rate produces an extra source of welfare gain for capital income earners (retirees and high-productivity agents) and a welfare loss for wage earners (the youngsters and low-ability agents). In order to isolate the role of price changes in producing the welfare gain, I employ a small open economy assumption (fixed interest rate and wages) and find that welfare increases by only 3% relative to the current system. Moreover, the decreases in the capital output ratio and per capita GDP are even larger (23% and 16%) than in the move to the optimal NIT.

Fourth, the way accidental bequests are modeled plays an important role in the results. If

[3] Hall and Rabushka (1985) propose a Flat Tax with a deduction of $22500 and marginal tax rate of 19%.

[4] In order to put into perspective this welfare loss, it is necessary to note that I am not taking into account the transition dynamics, and the comparison made is between steady states.

instead of the generous scheme in which all accidental bequests are returned as a lump-sum transfer to all agents, I assume a scenario in which all bequests are taxed away by the government, the resulting optimal NIT implies a 40% larger increase in welfare with respect to the benchmark case. As usual, the true state of the world lies somewhere in between the scheme considered and the extreme case of no accidental bequests.

Finally, there is a negative relationship between the persistence of the shocks and the size of the transfers in the optimal NIT. I have considered two cases, one in which the half life of the shocks is doubled relative to the benchmark case and another in which the half life is halved. In the more persistent case, the welfare gain is 8.7%, and the transfer level is 11% of per capita GDP, which are both higher than in the baseline scenario. In the less persistent case, the welfare gain is reduced to 2.6% and the transfer level is 9%. Clearly, the riskier the economy, the higher the gains from providing public insurance.

1.1 Related Literature.

This quantitative approach to optimal taxation has been followed in several papers, with models similar to mine, in which artificial economies with heterogeneous agents and incomplete markets (e.g. M. Huggett (1993) and S.R Aiyagari (1994)) are simulated and the individual and aggregate effects of tax reforms are studied (e.g. G. Ventura (1999), D. Altig et al (2001), D. Domeij and J. Heathcote (2004), J. Diaz-Gimenez and J. Pijon-Mas(2005), S. Nishiyama and K. Smetters (2005), among others). For instance, G. Ventura (1999) studies the effects of a flat tax reform of the U.S. income tax and finds that a flat tax has positive impacts on capital accumulation, labor supply measured in efficiency units, earnings, and income. D. Domeij and J. Heathcote (2004) study the distributional effects of reducing capital taxes and I. Correia (2010) shows the distributional and welfare effects of replacing the U.S.

income tax with a flat tax on consumption plus lump-sum transfers. Her approach is different than mine as she studies an economy populated with infinitely lived agents differentiated by the initial level of wealth and life-long labor productivity, whereas in my model, agents are born with no assets and there are no fixed inborn differences in labor productivity.

J.C. Conesa and D. Krueger (2006) focus on the optimal level of progressivity in the U.S. income tax and find that a flat tax with a tax rate of 17% and a deduction of $9400 is optimal, with an ex-ante welfare gain of 1.7%. Their approach differs from mine because they restrict themselves to a particular set of tax functions which do not allow for transfers. Along the same line, J.C. Conesa, D. Krueger and Kitao (2009) extend the work of J.C. Conesa and D. Krueger (2006) and allow for differences in the tax rates on capital income and labor earnings and show that capital should be taxed at a positive rate - in accordance with the results of A. Erosa and M. Gervais (2002).

My paper is also related to the literature on the effects of redistributive taxation, in particular, two strands, one involving the effects of earnings shocks and insurance (e.g. J. Eaton and S. Rosen (1980), M. Flodén and J. Lindé (2001) and D. Krueger and F. Perri (2009)) and another involving the distortions to labor supply decisions (e.g. R. Rogerson (2008), E. Prescott (2002) and M. Feldstein (1973), among others). M. Flodén and J. Lindé (2001) study the provision of insurance through government transfers in the U.S. and Sweden, finding that a transfer of 15% of per capita GDP in the U.S. and 1.6% of per capita GDP in Sweden are optimal with welfare gains of 8.5% and 1.6%. My work differs from them in one important aspect: their aim is to find an optimal level of transfer without replacing any of the present taxes. On the contrary, I focus on a particular revenue neutral tax reform that has a lump-sum transfer as an important component but has another source of welfare gain: the increase efficiency produced by the replacement of increasing marginal tax rates with a constant tax rate.

This paper is organized as follows. Section II introduces the model and the definition of equilibrium. Section III presents the calibration strategy and the quantitative results. Section IV shows a sensitivity analysis and Section V concludes.

2 Model.

The modeling framework is a general equilibrium life-cycle economy, populated by J heterogeneous overlapping generations. Agents face idiosyncratic risk and life uncertainty. Time is discrete and there is no aggregate risk[5]. There are no explicit insurance arrangements.

2.1 Environment.

At each date t, a continuum of ex-ante homogeneous agents is born. An agent of age j faces a conditional survival probability s_{j+1} of being alive in the next period but no one survives after age J. There is an exogenous retirement age R, adding the first dimension of heterogeneity in the model: agents can be classified as workers or retirees depending on whether their ages are higher or lower than $R + 1$.

There is a fixed positive population growth rate n and the total measure of the population at time t is N_t. Despite the fact that the population size evolves through time, each age $j-$generation represents a constant fraction μ_j of the total population size, making the demographic structure stationary[6].

[5] Krusell and Smith (1998) show that the inclusion of aggregate uncertainty, besides of introducing an extra layer of difficulty in the model, does not significantly change the results of a model with no aggregate uncertainty.

[6] The weights μ_j are obtained by the recursive formula $\mu_{j+1} = \mu_j.s_{j+1}/(1+n)$

All agents share a time separable utility function and value the expected discounted stream of leisure and consumption:

$$\sum_{j=1}^{J} \widetilde{\beta}^{j-1} \left(\prod_{i=1}^{j} s_j \right) u\left(c_{j,t}, l_{j,t}\right)$$

where $c_{j,t}$ and $l_{j.t}$ denotes consumption and leisure at age j and period t respectively. The momentary utility function is Cobb-Douglas:

$$u\left(c_{j,t}, l_{j,t}\right) = \frac{\left[c_{j,t}^{\nu}\left(1-l_{j,t}\right)^{1-\nu}\right]^{1-\sigma}}{1-\sigma}.$$

Consumption and leisure are not separable and the intratemporal elasticity of substitution is equal to 1. The parameter $\nu \in (0,1)$ influences the time spent working, and together with $\sigma > 0$ influences the degree of risk of aversion and the Frisch elasticity of labor supply[7] (Rios-Rull, 1995)

2.2 Agents' endowments, labor productivities and insurance possibilities.

Agents are born with no assets and during their working life they are endowed with one unit of time. They receive a competitive wage rate w_t and their labor productivity is a first-order

[7] The Frisch elasticity, which gives the elasticity of hours worked to changes in wages, keeping the marginal utility of consumption constant, is given by:

$$\eta\left(\nu, \sigma, l\right) = \frac{(1-l)}{l} \frac{\left[1-\nu\left(1-\sigma\right)\right]}{\sigma}$$

The Arrow-Pratt measure of Relative Risk Aversion $\rho = -\frac{c u_{cc}''(c)}{u_c'(c)}$ is $1-\nu(1-\sigma)$.

Markov process given by $e(z', j)$, which is a function of the shock $z' \in Z$, and their age $j \in J$:

$$\begin{aligned} \ln e(z', j) &= \gamma_j + z' \quad \text{and} \\ z' &= \rho z + \varepsilon, \quad \text{where } \varepsilon \sim N\left(0, \sigma_\varepsilon^2\right). \end{aligned}$$

Thus, agents differ in the efficiency units of labor they supply to the market depending on their age and their shock history. Therefore, the labor income of an agent of age j and shock z is equal to $w_t l_t e(z, j)$, where l_t is the amount of time that the agent decides to work. At age 1, the measure of agents with shock z is $q(z)$.

The possibilities for insurance in this economy are limited. There no annuity markets and agents cannot trade contingent claims. Nevertheless, agents trade a one-period risk-free asset $a_{j,t} \in A \subseteq \mathbb{R}_+$ that will help them partially insure against their idiosyncratic productivity shocks. Agents are not allowed to borrow.

2.3 Firms and Technology.

There is a representative firm that produces total output Y_t with a Cobb-Douglas production function:

$$Y_t = K_t^\alpha \left(A_t L_t\right)^{1-\alpha}.$$

where K_t and L_t are the aggregate capital and labor (measured in efficiency units) at time t, and $A_t = A_0 \left(1 + g\right)^t$. The resource constraint is:

$$C_t + K_{t+1} - K_t \left(1 - \delta\right) + G_t \leq K_t^\alpha \left(A_t L_t\right)^{1-\alpha}.$$

Following conventional notation, δ is the depreciation rate, G_t is public consumption and C_t is total private consumption.

2.4 Government and tax structure.

At time t, the government receives payments from the social security system and the income tax. The proceeds serve to finance government consumption G_t , pay social security benefits SS_t and transfers TR_t. The social security system is fully funded by social security taxes paid by the working agents at a constant marginal tax rate τ_{ss} on labor earnings. Benefits are distributed evenly among all retirees of a particular cohort and are kept constant through out the retirement period[8]. Accidental bequests occasioned by deaths of agents are returned as a lump-sum transfers to all living agents. Agents do not derive any utility from government consumption G_t[9].

The actual U.S. income tax system is the benchmark case and I will aim to replicate two of its main features: the double taxation of dividends and the effective tax rates paid by households. For the case of the double taxation of dividends, I introduce a constant corporate income tax τ_k that is levied on capital income.

In the personal U.S. income tax, an agent pays taxes on his total income, defined as the sum of labor and capital income, according to an income scale given by six brackets. Each bracket has a different statutory marginal tax rate τ_i that increases with the bracket, making the tax progressive. Mimicking the income tax requires recognition that there exists a considerable

[8]This setting will not let me capture the actual degree of risk sharing present in the actual social security system. Although, this assumption will underestimate the potential benefits of the reform, it eliminates the need to include agents' past contributions as a state variable.

[9]This assumption is consistent with either two views: 1) all government consumption is wasteful; 2) the consumption of public goods enters linearly in the agent's utility function. In any case, the results would be the same.

number of tax credits, deductions and overlapping provisions, which together implies that the statutory tax rates faced by an agent are not necessarily the ones effectively paid. Moreover, the presence of the Earned Income Tax Credit (EITC) needs to be taken into account[10]. Therefore, I follow N.Guner et al (2008) and replicate the average tax rate paid with the following function[11]:

$$Average\ Tax\ Rate\,(Normalized\ Income) = \eta_1 + \eta_2 \log\,(Normalized\ Income)\,. \tag{1}$$

where $Normalized\ Income$ is $Income$ divided by the $Mean\ Household\ Income$. Then, the total taxes paid by an Agent are:

$$T_{j,t}^{Benchkamrk}\,(Income) = Average\ Tax\ Rate\,(Normalized\ Income) \times Income.$$

In the reform scenario, the NIT replaces the U.S. personal income tax, leaving the rest of the taxes and the social security system unchanged. Now, all agents receive a fixed lump-sum transfer TR_t^{NIT} at the beginning of the period and pay a constant marginal tax rate τ for every unit of income earned. Then, the total tax liability for an agent of age j and shock z with income $I_{j,t} \equiv w_t e\,(z,j)\, l_{j,t}\, + a_{j,t} r$ is:

$$T_{j,t}^{NIT} = I_{j,t} \times \tau - \mathrm{TR}_t^{NIT}.$$

[10] The Earned Income Tax Credit is a refundable tax credit for low and middle income families, who satisfy certain requirements and is calculated based upon the number of children in the household, among other things. It was enacted in 1975 and has been expanded ever since. (Moffit, 2003)

[11] Several papers use the Gouveia and Strauss tax function (Gouveia and Strauss, 1994) to approximate the average tax rates paid instead of the function depicted above. Even though, it approximates the average tax rate well, it implies a lower marginal tax rate for higher incomes than the ones seen in the U.S. income tax. Moreover, it behaves as a flat tax for incomes higher than twice the household mean income. On the other hand, the tax function that I am considering not only does approximate well the average tax rate but it also does a good job for the marginal tax rates.

2.5 Agent's problem: recursive formulation.

The sate of any agent is fully described by his/her assets holdings a, productivity shocks z and age j. Let $x = (a, z)$ be the non-age dependant variables of the state vector. The mathematical formulation of the state space is formalized as follows.

Let $(A, \mathcal{A})$, $(Z, \mathcal{Z})$ and $(J, \mathcal{J})$ be measurable spaces, where $\mathcal{A}$ is the Borel $\sigma-$algebra defined on A; $\mathcal{Z}$ is the Borel $\sigma-$algebra defined on Z, and $\mathcal{J}$ is the Power set of J. Let $(X, \mathcal{X}) = (A \times Z, \mathcal{A} \times \mathcal{Z})$ be a product space and $(x, j) \in X \times J$ be the state vector. Let $\left(X, \mathcal{X}, \psi_j\right)$ be the probability space, where $\psi_j : \chi \to [0, 1]$ is a probability measure. The measure of agents with state $x = (a, z)$ within the cohort of age j is $\psi_j(x)$.

I need to do stationary inducing transformations of the variables in order to express the model in terms of a dynamic programming formulation. Let $a_j(x) \equiv \frac{a_{j,t}}{A_t}$, $l_j(x) \equiv l_{j,t}$, $c_j(x) \equiv \frac{c_{j,t}}{A_t}$ be the asset, labor supply and consumption decision rules; let $w \equiv \frac{w_t}{A_t}$ and $r \equiv r_t$ be the wage rate and interest rate and let $\beta \equiv \widetilde{\beta}(1+g)^{\nu(1-\sigma)}$; let $G \equiv \frac{G_t}{A_t}$, $K \equiv \frac{K_t}{A_t}$ and $L \equiv L_t$ be the aggregate government consumption, capital and labor supply and let $\mathrm{TR} \equiv \frac{\mathrm{TR}_t}{A_t}$ and $T_j(x) \equiv \frac{T_{j,t}}{A_t}$ be the transfers and tax collection, and $SS_j \equiv \frac{SS}{(1+g)^{j-(R+1)}}$, where $SS = \frac{SS_t}{A_t}$, be the social security benefits[12]. Finally, let $T : X \times J \to X \times J$ be an operator and let ν denote the expected discounted stream of consumption and leisure for an agent with state (x, j) behaving optimally from now onwards.

Then, given prices $\{w, r\}$ and a tax regime T_j^k with $k \in \{NIT,\ Benchmark\}$, an agent of age j with state x needs to choose the amount of labor $l_j(x)$ to supply to the market, how much to consume $c_j(x)$ and the amount of assets $a_{j+1}(x)$ to carry over the next period. Optimal decisions rules solve the following dynamic programming problem:

[12] Time subscripts have been dropped because I am interested in a stationary equilibrium.

1. Working agents:

$$\nu(x,j) = (Tv)(x,j) \equiv \sup_{(c_j, l_j, a_{j+1})} \{u(c_j, l_j) + \beta E[v(x',\ j+1)]\}.$$

subject to

$$c_j + a_{j+1}(1+g) \leq a_j(1+r) + w(1-\tau_{ss})\, e(i,j)\, l_j - T_j^k(x) + \mathrm{TR} \qquad if\ j \leq R$$

$$c_j \geq 0, \quad a_j \geq 0, \quad a_{j+1} \geq 0\, and\ l_j \in [0,1] \qquad .$$

2. Retirees:

$$\nu(x,j) = (Tv)(x,j) \equiv \sup_{(c_j, a_{j+1})} \{u(c_j, 0) + \beta E[v(x',\ j+1)]\}.$$

$$c_j + a_{j+1}(1+g) \leq a_j(1+r) - T_j^k(x) + \mathrm{TR} + SS_j \qquad if\ j > R$$

$$c_j \geq 0, \quad a_j \geq 0, \quad a_{j+1} \geq 0 \ .$$

with

$$v(x, J+1) \equiv 0$$

2.6 Stationary Equilibrium.

Definition 1 *A stationary equilibrium is a collection of value functions* $v(x,j)$, *decision rules* $\{c_j(x),\ l_j(x)\ ,\ a_{j+1}(x)\}_{j=0}^{J}$, *factor prices* $\{w, r\}$, *a tax regime* T_j^k, *taxes paid* $T_j(x)$

and transfers TR, aggregate capital K and labor L, government consumption G and social security benefits SS_j, with a collection of invariant distributions $(\psi_1, \ldots, \psi_J)$ such that:

1. *Decision rules $c_j(x)$, $l_j(x)$ and $a_{j+1}(x)$ together with a value function $v(x, j)$ solve the decision problem for an agent of age j and state x.*

2. *Factor prices are competitive:*

$$w = F_2(K, L).$$

$$r = F_1(K, L) - \delta.$$

3. *Market clearing conditions are satisfied:*

   (a) $\sum_j \mu_j \left[\int_X (c_j(x) + a_{j+1}(x)(1+g))\, d\psi_j(x)\right] + G = F(K, L) + (1-\delta) K$

   (b) $\sum_j \mu_j \int_X a_{j+1}(x)\, d\psi_j(x) = (1+n) K$

   (c) $\sum_j \mu_j \int_X l_j(x)\, e(z, j)\, d\psi_j(x) = L$

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

$$\psi_{j+1}(B) = \int_X P(x, j, B)\, d\psi_j(x).$$

   where $P(x, j, B) = 1$ if $a_{j+1}(x) \in B$, and $P(x, j, B) = 0$ otherwise, $\forall B \in \mathrm{X}$, $j = 1, \ldots, J$. $\psi_1(x)$ is unequivocally determined by $q(z)$ as agents are born with no assets.

5. *Government budget is balanced:*

$$G = \sum_j \mu_j \int_X T_j(x)\, d\psi_j(x).$$

6. The social security system is fully funded:

$$\tau_{ss} w L = \sum_{j=R+1}^{J} \mu_j SS_j.$$

7. Transfers are equal to accidental bequests:

$$(1+n)\, TR = \sum_j \mu_j \left(1 - s_{j+1}\right) \int_X a_{j+1}(x)\,(1+r)\, d\psi_j(x).$$

3 Results.

3.1 Calibration.

In this subsection, I discuss the calibration strategy and the assumptions made for the benchmark economy. I set the model period equal to 1 year. Table 1 summarizes the parameters values used in the calibration. Table 2 presents the results for the calibrated economy.

3.1.1 Demographics.

In my model, agents are born at age 21 (model period 1), work until age 65 (model period 45, i.e. $R = 45$) and die for certain at age 100 (model period 81, i.e. $J = 81$). Survival probabilities s_{j+1} are taken from the National Vital Statistics System[13]. Population growth n is set equal to 1.09% which is the average population growth for the U.S. during 1990−2009[14].

[13] National Vital Statistics Report, volume 58, number 10, March 2010.

[14] Economic Report of the President 2010, Table $B34$.

3.1.2 Preferences.

I set σ equal to 4 and calibrate ν endogenously in order to achieve an average time spent working equal to a 1/3. The resulting value for ν is 0.383 which together with σ give an intertemporal elasticity of substitution approximately equal to 1/2.

The discount factor β is calibrated endogenously to 0.979 in order to target a capital-output ratio equal to 2.89. This last figure is the average capital-output ratio for the period $1960-2007$. I calculate it following the Cooley and Prescott Methodology[15].

3.1.3 Technology.

I set α equal to 0.35, which is the average of capital income over total income for the period $1960-2007$ (Cooley and Prescott, 1995). The parameters for the labor augmenting technology are calibrated as follows. The growth rate g is equal to 2.22% and is taken from the average growth rate of real per capita GDP during $1960-2007$[16]. The parameter A_0 is a free parameter and I set it equal to 1. Also, I set the depreciation rate δ equal to 4% to assure an investment-output ratio equal to 21.38%[17], which was the average for the $1960-2007$ period.

[15] Data for Residential and non-residential structures (equipment and software, structures) and consumer durable goods comes from Table 1.1. Current-Cost Net Stock of Fixed Assets and Consumer Durable Goods BEA April 2010 (http://www.bea.gov/national/FA2004/SelectTable.asp). Data for the stock of Land comes from Flow Funds Accounts, Table B.100, Table B.102 and Table B.103. Inventories are taken from the Economic Report of the President 2010, Table B1.

[16] Economics Report of the President 2010, Table B.26.

[17] Investment comes from Economic report of the President 2010, Table B1. Consumption of durables is taken from Economic report of the President 2010 Table B16.

3.1.4 Taxes.

I need to calibrate three taxes: the social security tax τ_{ss} and the U.S. personal and corporate income taxes. For the first case, I calculate the average social security contribution as a fraction of total labor income for the $1990-2000$ period and set τ_{ss} equal to 8.6%.[18].

In the case of the U.S. personal income tax, I need to specify a parametric function to reproduce the effective average tax rate paid by an American household. For that purpose, I use the N. Guner et al's (2008) estimates for married households. They use data from the U.S. Internal Revenue Service for the year 2000 and calculate the average tax rate for every income bracket normalized by the mean household income for the period as:

$$average\ tax\ rate = \frac{\frac{total\ amount\ of\ income\ tax\ paid}{number\ of\ taxable\ returns}}{\frac{total\ adjusted\ gross\ income}{number\ of\ returns}}.$$

They fit the function (1) and obtain $\widehat{\eta}_1 = 10.23\%$ and $\widehat{\eta}_2 = 7.33\%$ with an $R^2 = 99\%$. As noted by N.Guner, this tax function fits the data a little better than the functional form employed by M. Gouveia and R. Strauss (1994). Further, Figure 1 shows that the two formulations lead to very similar average effective tax rates, while Figure 2 indicates that the Gouveia Strauss tax function displays a constant marginal tax rate for incomes higher than twice the mean household income. This situation does not correspond to what is seen in the data.

For the corporate income tax, I set τ_k equal to 7.48% in order to reproduce the 1.74% average ratio of capital net of depreciation to total income for the $1987-2007$ period (Cooley and Prescott, 1995).

[18]I consider those contributions from Old Age, Survivors and DI programs. Social Security Bulletin, Annual Statistical Supplement, 2005, Tables 4.A.3.

3.1.5 Idiosyncratic Shocks.

The efficiency profile $e(z', j)$ has an age-component γ_j, which is taken from G. Hansen (1993), and an idiosyncratic shock-component z', which follows an $AR(1)$ process whose values are taken from the J. Heathcote et al (2010) estimates using the PSID data from the period $1967 - 2000$[19]. They find a correlation coefficient ρ of 0.973 and a variance for the innovations σ_ε^2 equal to 0.02.

I use a Gaussian-Hermite quadrature procedure (Tauchen and Hussey, 1991) to approximate this $AR(1)$ with a 21 state Markov process. The transition-probability matrix is Q $-Q_{zz'} = P\left(Z = z'/Z = z\right) -$, where Q is aperiodic and irreducible, what insures an invariant distribution (Hopenhayn and Prescott, 1992). I follow M. Flondé's (2008) approach that consists of taking a weighted average of the conditional and unconditional variances of the AR(1) as variance of the process, and gives a good approximation for highly persistent processes.

The initial distribution of shocks $q(z)$ follows a Gaussian Distribution with mean zero and a variance σ_z^2 that is endogenously calibrated to match the 0.46 Gini coefficient for labor earnings in the U.S. for the year 2000[20]. Table 3 shows the 21 values of the shocks in log-scale with their initial and invariant distribution.

[19]The interesting feature of this paper -and the difference with K. Storeletten et al.(2004)- is that they allow in their model for an endogenous supply of labor, which enables me to take directly their estimates for the AR(1) process.

[20]US Census Bureau 2000.

3.2 Tax Reform's results.

In order to understand the effects of a transfer in the tax scheme, I eliminate the implicit/explicit transfers in the actual U.S. income tax through the introduction of a proportional tax, i.e. a NIT with no transfers (a "non-negative income tax"), and then I increase the transfer level in the NIT to 2.5% and 5% of per capita GDP in the benchmark economy. These quantitative exercises will let me evaluate the changes in the aggregate variables and understand how the transfer works. Table 4 summarizes the results.

In a world with a proportional tax, the marginal tax rate drops to 12%, and the resulting dramatic decrease in the marginal tax rate faced by high-income households means that they benefit more than other households. The absence of the transfer eliminates any redistribution from high to low-productivity agents, making it possible to have a low tax rate. Additionally, the 10% increase in per capita GDP augments the size of the tax base, allowing for a further reduction of the tax rate. The tax bill is reduced for high and medium-productivity agents, while the opposite is true for low productivity types. As a result, labor supply measured in efficiency units increases 7%, while the number of hours worked increases less (6%).

A lower marginal tax rate induces medium and high-productivity agents to supply more hours to the market via a substitution effect, even though there is an income effect that works in the opposite direction. In contrast, low-productivity agents deprived of transfers face a negative income effect making them work more, while a substitution effect caused by a higher tax rate makes them want to work less. The effect is not symmetric and there is a change in the composition of the labor supply: high-productivity agents gain participation at the expense of low-productivity agents. Therefore, average labor productivity increases.

Without transfers agents wish to save more for precautionary reasons: the saving rate, defined as the interperiod change in household's assets holdings divided by GDP, increases

6% leaving this economy with a higher capital stock. Consequently, with more capital and more productive labor available, GDP is higher.

It is worth point out that that the total transfers received by the households can be divided into three different sources: the social security system, the income tax and the accidental bequests. The social security payments are a function of the total earnings in the economy, the income tax transfers depend explicitly on the tax scheme considered while the accidental bequests are proportional to the level of capital in the economy. Therefore, changes in earnings and the capital stock change the composition and size of the total transfers received by the households. The increase in the capital stock (17%), labor supply (7%) and the wage rate (3%) imply that the social security payments and accidental bequests has increased (10% and 12%).

Naturally, there has been a change in the composition of the total transfers received and it can be argued that there has been an improvement in the income of wage earners, particularly low-income households. However, the removal of the income tax transfers has shut down an important redistributive channel that previously benefited low-income households.

Does the increase in social security and accidental bequest transfers offset the loss of the income tax transfers? No, because welfare is lower under the proportional tax. Indeed, to make agents indifferent between a proportional tax and the US income tax regime, consumption under the proportional tax regime would need to increase by 4.26% in every state of the world (i.e. the Consumption Equivalent Variation -CEV- is -4.26%).

An analysis of the CEV by productivity types shows that losses are concentrated on the low types, with welfare losses as high as 8%, while more productive types are better off. Not surprisingly, the most productive agents in this economy have a striking welfare gain of 15.13%. It is clear that the trade-off between tax rates and transfers depends crucially on the productivity type: low-productivity types prefer hight transfers and high tax rates while the opposite is true for high-productivity types.

To illustrate this last point, I increase the transfer from 0 to 2.5% ($1150) and 5% ($2250). By doing so, welfare increases by 3.71 and 6.86 percentage points respectively. Naturally, the increase in the size of the transfer must be accompanied by an increase in tax rates in order to make the tax reform revenue neutral: the marginal tax rates for a NIT with 2.5% and 5% transfers are 16% and 19% respectively.

In the absence of complete markets, the transfer can be thought as a source of insurance: in any state of the world, the transfer is present reducing the need to save and work. Consequently, there is a negative correlation between the size of the transfer, and the saving rate and hours worked. The saving rate moves from 10.25% in a proportional tax regime or "non-negative income tax" to 9.5% in a NIT with 5% transfers (NIT 5%), while the original 6% increase of hours worked in the proportional tax subsides to a 1% increase in a NIT with 2.5% transfers (NIT 2.5%), to finally end in a decrease of 4% in the NIT 5%.

Labor supply measured in efficiency units moves from a 7% increase in the proportional tax case to a 4% and 1% increases in the NIT 2.5% and NIT 5% respectively, remaining in the last case practically at the same level as in the benchmark case, even though there is a drop in the hours worked. As the decrease in hours worked is higher than the decrease in labor supply, it is evident that there is a change in the composition of the labor supply and average labor productivity increases.

The reasoning behind this result is that the presence of the transfer enables agents to cope better with bad productivity shocks. Agents hit with a bad shock increase their consumption of leisure, which is a normal good; i.e. they work fewer hours. When positive shocks hit, they work more. This means that the transfer enables them to work when they are more productive.

As a result, there is an increase in the dispersion and concentration of labor earnings. The Gini coefficient on labor earnings deteriorates from 0.46 to 0.47 in the proportional tax setting, 0.48 in the NIT 2.5% and 0.49 in the NIT 5% (see Table 5).

In this economy, prices are a function of the capital labor ratio, being the wage rate an increasing function of the capital labor ratio and the interest rate a decreasing function. The capital labor ratio moves from 5.6 in the proportional tax regime to 5.3 in the NIT 2.5%, and 5 in the NIT 5%. This translates into a 4% decrease in the wage rate and a 12% increase in the interest rate from the proportional tax to a NIT 5%.

These changes on prices have a natural impact on the distribution on income. If we abstract from any other transfer present in this economy, it will be possible to argue that young and low-productivity agents, who receive most of their income from labor earnings, are worse off while capital income earners are better off. The final verdict depends on the size of the different transfers.

A conflicting picture emerges for retirees, who have their social security benefits practically unchanged in the NIT 5% after an initial increase of 10% in the proportional tax setting. As the income tax transfer and the interest rate increase, the social security benefits and the accidental bequests are reduced, attenuating the potential gains from the income tax transfer.

It is interesting to notice the relationship between the welfare profile and the introduction of transfers. In a "non-negative income tax" scenario, the welfare profile is monotone increasing in productivity types. Once the transfer is introduced, a U-shaped figure emerges with low productivity types benefitting directly from the transfer, while high-productivity type agents enjoy lower marginal tax rates. The "middle class" is caught in the middle: the transfer is not high enough for them and the tax rates are not as low as they want to (see Figure 3).

3.3 The Optimal NIT versus the Flat Tax.

A NIT with a marginal tax rate of 28% and a transfer of 10% of the benchmark's economy per capita GDP, approximately $4600, is optimal in the sense that it maximizes the expected lifetime utility calculated before the agent is born and knows his true type. The expected welfare gain is an impressive 6.33% increase in individual consumption in every state of the world. The picture that emerges for this economy is similar to those associated with the sub-optimal NIT's of the previous subsection. Table 6 summarizes the results.

A striking result is that the optimal NIT causes per capita GDP to decline 13%. This is due to a 23% decrease in the capital stock and a 7% decrease in the labor supply measured in efficiency units. In the previous exercises, per capita GDP declines as the transfer increases. The transfer in the optimal NIT is even larger and per capita GDP declines further.

Next, I examine the determinants of the drop in the capital stock and labor supply. The transfer from the optimal NIT enables agents to save less in order to cope with the uncertainty they face, implying a lower level of capital. Indeed, the need to save for precautionary motives has subsided: the saving rate drops 11%; total savings falls more than the GDP.

The transfer enables agents to substitute leisure for work when they are hit by a bad shock, moving the threshold that splits the active population into working and non-working agents. The NIT provides agents with fewer incentives to adjust their labor supply decisions as means of insurance (see J. Pijoan-Mas (2006)): hours worked decrease 18%, a decrease 2.5 times greater than the reduction of labor supply. Further, the presence of the transfer means that the productivity of the least productive working agent under the NIT is higher than that under the US tax system.

Because less productive agents work less and more productive ones work more, income inequality goes up. The Gini coefficient for labor earnings jumps to 0.53 from 0.46, a deterioration of 15%.

The move to the optimal NIT also changes prices in this economy as a consequence of the 11% and 17% reduction in the capital output ratio and capital labor ratio. The wage rate falls 6% and the interest rate rises 19%, from 8% to 9.5%. For capital income earners, who are concentrated among high-income households, this increase in interest rates partially offset the increase in the tax rates.

As a result of the fall in savings, wage rates, and labor supply, social security benefits and accidental bequests fall 13% and 29% respectively. It is clear that the composition of the total transfers, given by the sum of income tax transfers, social security benefits and accidental bequests, has changed because of the increase in the income tax transfers and the decrease of the social security benefits and accidental bequests. However, it is not necessarily true that its size has diminished.

The welfare profile under the optimal NIT is different from the cases studied above. The clear U-shape relationship has disappeared and there is a single cut-off that separates winners from losers: the winners are agents from the productivity level 1 through 9 with welfare gains from 26% to 64%, while high-productivity agents lose (see Figure 4).

Even though, the optimal NIT has a lower marginal tax rate than the actual US income tax for the highest income households, their tax bill has increased as the result of replacing a structure of increasing marginal tax rates under the US income tax with a single tax rate under the optimal NIT. In relative terms, they are better off with respect to medium-income households but for both groups financing a sizeable transfer has increased their tax burden.

The large size of the income tax transfer is due to the persistence of the idiosyncratic shocks. The calibrated value for the parameter ρ implies that a shock has a half life of 25 periods. Thus, agents born with a low productivity shock are plagued by it for a long time, so they prefer a high transfer in order to smooth consumption. The opposite is true for agents born with a good shock. They prefer a low marginal tax rate instead of a high transfer. The natural trade-off between low marginal tax rates and high transfers is a question of efficiency versus insurance. A high transfer means that the insurance and redistributive aspects of the NIT erode the efficiency effects of the tax, i.e. the welfare gains come from the fact that low-ability agents are able to insure themselves against bad shocks.

To further understand the NIT, I compare it with the popular flat tax and evaluate the desirability of the reform. I search for the optimal flat tax that maximizes ex-ante welfare and find, in accordance with the literature, that a 33% deduction ($15000) computed from the benchmark GDP and a marginal tax rate of 19% is optimal.

The optimal NIT outperforms the optimal flat tax, which has a welfare loss of 0.12%. It may seem surprising that an optimal flat tax implies a welfare loss but as I noted above, I am not taking into account the transition dynamics which may convert this welfare loss into a welfare gain. Even if this were to be the case, the steady state welfare gain under the NIT outweighs any potential transitional gains under the flat tax.

In a world with a flat tax, all the implicit/explicit transfers from the income tax are replaced with a fixed deduction. With no transfer to fund, the marginal tax rates are lower than the ones in the optimal NIT.

The most interesting result is related to the shape of the welfare profile. It is clear that high-productivity agents benefit but the picture is mixed for low-productivity agents: the lowest types are actually worse off. This result is at odds with previous studies (e.g. G. Ventura (1999) and Diaz-Gimenez and J. Pijoan-Mas (2005)) but it is explained by the way I modeled the U.S. income tax to capture the actual level of transfers present in the system (e.g. EITC, among others). Such transfers represent an important source of income for low-income households. Naturally, these agents prefer a transfer to a deduction. As productivity increases, because of the U-shaped welfare gain profile, a fraction of the low-income households are better off. This exercise highlights the importance of modeling the income tax transfers carefully.

Under the flat tax, per capita GDP increases 4% as a result of an increase in capital (5%) and labor supply (3%). The latter increases more than hours (2%), a natural consequence of the lower marginal tax rate that gives high-productivity agents more incentives to work and the increase in the lowest ability type's tax bill, due to the replacement of the transfer by a deduction. Agents in the low part of the productivity distribution, between the lowest and the median, see a reduction in their tax bill, while the middle types see the opposite. This explains the different effects on hours and labor supply; in some groups an income effect prevails over a substitution effect, and vice versa.

The saving rate remains practically at the same level with a modest increase of 1%. Nevertheless, total savings increases as a result of the elimination of the transfers. This loss of transfers is partially offset by a 4% increase of social security benefits and the 6% increase of accidental bequests.

The wage rate increases 0.5% and the interest rate drops 1%. The increase in the wage rate partly offset the loss of the transfer for the low productivity types, whose main source of income comes from labor earnings.

In summary, a flat tax implies higher GDP, capital accumulation and labor supply than the optimal NIT, but considerably lower welfare.

4 Sensitivity Analysis.

In the previous section, I have established that the optimal NIT requires a high level of transfers and produces important changes to prices, social security benefits and accidental bequests that could dampen the potential welfare gains from the reform. Therefore, in this section, I undertake a sensitivity analysis, disentangling the role of prices, accidental bequests and the nature of the shocks in the welfare gains reported. [21]

4.1 The role of prices: An Open Economy.

In this exercise, I make an open economy assumption, with free movements of labor and capital, and therefore, the wage rate and the interest rate are kept fixed. Doing so will let us understand the direction and the role of prices in the tax reform. In this scenario, the optimal NIT has a welfare gain of 6.5% and a slightly lower transfer of 10% of the benchmark economy's per capita GDP. Remarkably, even though the transfer level slightly decreases, the marginal tax rate shows a moderate increase: the new marginal tax rate is 29% (see Table 7).

This increase can be explained by the shrinkage of the tax base: GDP decreases 16% versus the 13% shrinkage under the optimal NIT with flexible prices. This reduction is a direct consequence of the drop in the capital stock level. As the interest rate remains constant,

[21] Otherwise stated, all comparisons made are against the optimal NIT found in the previous section.

the fall in savings is larger, and there is no increase in the interest rate that could partially offset the decrease in individual savings. The saving rate falls a dramatic 23%, doubling the 11% fall previously seen.

Even though GDP decreases more, labor supply decreases less: -4% versus -7%. As there is no change in the wage rate, leisure does not get cheaper as it did before, so labor supply does not decrease as much. The same effect can be seen in the total hours worked (-12% versus -17%). Naturally, leaving the wage rate in the same level gives high-productivity agents more incentive to supply more work, gaining participation in the labor supply and changing the composition of the labor input.

As there is no decrease in the wage rate, all the change in the social security benefits comes from the drop in the labor supply. However, the transfers are affected by the drop of capital: accidental bequests are reduced by half (-48% versus -29%).

As can be seen, despite the fact that income tax transfers remains at practically the same level, there is a higher welfare gain characterized by a smaller reduction in hours and social security benefits, but a much larger reduction in accidental bequests. The direct consequence of shutting down the role of prices in the tax reform is that capital income earners and retirees do not benefit from a higher interest rate, while the wage earners are unaffected. This means that the welfare gains are concentrated at the beginning of the working life, particularly for those suffering low productivity shocks. These agents, despite suffering a dramatic decrease in accidental bequests, are better off if the wage rate does not change. In contrast, retirees receive higher social security benefits and this offsets the interest rate effect.

Moreover, a constant interest rate, lower than the one with flexible prices, gives agents less incentives to postpone consumption, explaining the increase in welfare.

4.2 The role of accidental bequests.

In the benchmark economy, I treated accidental bequests in the usual fashion by returning them via equal lump-sum transfers to all living agents. Although the assumption is common in this type of model, it implies that bequests are higher on average than what is actually seen in the data. This is especially true for low-income households. Moreover, as most of the welfare gains in this income group come from the NIT explicit transfer, it is important to be careful in modeling the accidental bequests because their treatment could affect the potential gains from the reform. Therefore, in this exercise, I move to an opposite scenario and make the extreme assumption that all accidental bequests are taxed away by the government, and used to finance public consumption.

For this exercise, the definition of revenue neutrality that I am employing is different. Here, prior to the reform, there are two sources of income: the current tax system and the total of accidental bequests. The tax reform will be revenue neutral if it raises the same total revenue, accounting for any change in the equilibrium level of accidental bequests. Table 8 summarizes the results.

The optimal NIT now has a transfer level of 10% of the benchmark economy's per capita GDP and a marginal tax rate of 31%. The increase in the tax rate arises from the drop in the level of accidental bequests. As can be seen, the drop in individual savings implies a fall in the capital stock (-28% versus -23%) that leads to lower bequests and the need to raise the marginal tax rate to compensate the shrinkage of the tax base. In a world with no accidental bequests as lump-sum transfers, savings are higher from the very beginning and the introduction of the NIT transfer causes the saving rate to fall more (-14% versus -11%).

The welfare gains are impressive: the CEV is 8.8%, a 40% increment from the original experiment. Naturally, the accidental bequests are not as important as a source of income for the high-productivity agents, while the opposite is true for the low-productivity agents. Therefore, the introduction of an optimal NIT implies welfare gains for the latter group as high as 92%, while the changes in welfare for the former group are not as spectacular.

Labor supply deteriorates 20%, moving to -8.5% from -7%. This is a natural consequence of the higher marginal tax rate, which gives high productivity agents smaller incentives to supply work. Hours deteriorate 10% (-19% versus -18%) and a familiar message emerges again: high productivity types crowd out low productivity ones, increasing the average labor productivity by hour worked.

The greater fall in labor supply and capital implies a greater drop in GDP (-16% versus -14%). Naturally, there is a change in prices: the wage rate is lower (-8% versus -6%) and the interest rate higher (25% versus 19%). A lower wage rate negatively affects low productivity agents but their supply of labor is reduced by the transfer, mitigating the impact of the lower wage rate. However, the transfer is not large enough to compensate for the low wage rate to the medium-productivity types. On the other hand, high productivity types enjoy a higher interest rate which offsets the wage effect.

In a world with no accidental bequests returned evenly as lump-sum transfers to all living agents, there is an increase in the welfare gains due to the NIT as a provider of public insurance.

4.3 The role of idiosyncratic shocks.

In the final exercise, I analyze the effect of the persistence of the idiosyncratic shocks on the optimal NIT. I analyze two cases. In the first, I pick a new ρ (equal to 0.946) to reduce the half life of a shock by half. In the other, I do the opposite: I choose a new ρ (equal to 0.986) to double the half life of a shock (see Figure 5). In all cases, the variance of the error term is changed in order to keep the same mean of the shock process, and by log normality, the variance of the log of the shock. Table 9 summarizes the results.

The welfare gains from the move to the NIT is higher the more persistent the shocks are. For the high persistence shock, the welfare gain is 8.7%, an increment of 38% with respect to the benchmark case. In contrast, for the less persistent shock, the welfare gain is 2.6% or a 59% reduction in welfare from the original exercise. It is clear that the decrease of the persistence of the shock has a large effect on the optimal NIT and the welfare gains.

The results for transfers and tax rates are as expected. Naturally, the less persistent the shock, the lower the level of the transfer; for a ρ equal to 0.946, the transfer is just 9% while in the other case, it is 11% of the benchmark economy's per capita GDP. The positive association between marginal tax rates and transfers re-emerges. In the less persistent case (low transfer), the marginal tax rate is 26% against a marginal tax rate of 30% in the high persistence case (high transfer).

The relation between the size of the transfer and the aggregate variables is also similar to previous cases. With a lower transfer, GDP drops 11% while with a higher transfer, the reduction is 15%, confirming the negative relationship between the size of the transfer and GDP. A similar story appears in labor supply (-5% versus -9%) and hours (-13% versus -22%): the adjustments are larger the more persistent are the productivity shocks.

The less persistent the shocks, the less the need for higher individual savings. In the less persistent case, capital drops 19% against the 27% reduction when shocks are more persistent. Also, the wage rate falls less the lower the persistence (-6% versus -7%) and the interest rate rises less (17% versus 23%). Consequently, social security benefits (-11% versus -16%) and accidental bequests (-26% versus -31%) fall less the less persistent are the shocks.

The conclusion is clear: with more persistent shocks, the gains from providing public insurance are higher.

5 Conclusions.

In this paper, I provide a new, general equilibrium, analysis of a Negative Income Tax (NIT) in a model with ex-ante homogeneous agents beset by idiosyncratic shocks. The model reproduces key features of the U.S. economic data, and in a setting that explicitly takes into account the tax credits, overlapping provisions, and transfers from the actual U.S. income tax. The NIT is simple, consisting of a transfer and a constant marginal tax rate, and produces an outstanding welfare gain, equivalent to a 6.33% increase of individual consumption in every state of the world. The NIT outperforms the popular flat tax (a zero transfer NIT with deductions) by a huge margin.

The optimal NIT has an important insurance component and benefits most those agents who suffer low productivity shocks at the beginning of their working lives. Different and smaller levels of transfers in the NIT have non trivial welfare gains. The NIT has an effect on insurance and efficiency: regarding insurance, individual savings drops as the transfer replaces the need to save, while for efficiency, high-productivity agents face lower marginal tax rates, giving them incentives to work more hours, and the NIT transfer enables all agents to work when they are more productive. Therefore, the composition of labor supply changes and the average labor productivity by hours worked increases. In all cases, the medium-productivity agents are worse off. A similar result emerges from a flat tax.

I conduct sensitivity analyses and show that the persistence of the shocks and the way accidental bequests are modeled have non trivial effects on the welfare gains reported. Further, the more persistent the shocks, the more desirable the reform. Moreover, modeling the level of accidental bequests in two ways brackets the welfare gain that could be obtained from this tax reform: in the both cases considered, one with a generous scheme of bequests and the other one with none, the differences in welfare are not trivial, and in all cases the low-income households are better off.

My comparisons are of steady states and it could be argued that the transitions dynamics of the NIT could be important. However, the welfare gains are of such magnitude that the computation of transitions will not change the direction of the results. Moreover, the important drop in the capital stock in the optimal NIT implies that moving from one steady state to the other one will increase welfare, as agents will consume the capital they have already accumulated.

For future research, it will be interesting to model a NIT in a political economy model, in order to understand the reasons why a tax with such welfare gains had so many difficulties and obstacles at the time it was discussed in the U.S. Congress.

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Table 1: Calibrated Parameters.

Parameters	**Value**	**Target.**
β	0.979	$K/Y = 2.89$
σ	4	$IES = 0.5.$
ν	0.383	Average time spent working= 1/3
J	81	Maximum Age 100
R	45	Retirement age 65
n	1.1%	Data
ρ *and* σ_ε^2	0.973 *and* 0.02	J. Heathcote et al (2010)
α	0.35	Capital share.
δ	4%	$I/Y = 21.38\%.$
g	2.22%	Data
η_1 and η_2	10.23% & 7.33%	N. Guner et al (2008)
τ_{ss} and τ_k	8.6% & 7.48%	Data

Table 2: Benchmark Economy

Variables	**Values**
GDP per capita	0.682
Capital Stock per capita	1.976
Labor Supply per working agent	0.385
Hours per working agent	0.33
Measure working age population	0.80
Saving Rate	9.66%
Capital Output Ratio	2.89
Capital per Labor	5.141
Wage	1.153
Interest Rate	0.080
Social Security benefits per capita	0.235
Bequests per capita	0.022
Mean Household Income	0.662

Table 3: Markov process

Types	**States**	**Initial Distribution**	**Invariant Distribution**
1	-2.06	1.94%	0.27%
2	-1.77	1.81%	0.59%
3	-1.53	2.53%	1.17%
4	-1.31	3.35%	2.05%
5	-1.11	4.22%	3.23%
6	-0.91	5.09%	4.66%
7	-0.72	5.91%	6.23%
8	-0.54	6.63%	7.75%
9	-0.36	7.18%	9.04%
10	-0.18	7.52%	9.90%
11	0	7.64%	10.21%
12	0.18	7.52%	9.90%
13	0.36	7.18%	9.04%
14	0.54	6.63%	7.75%
15	0.72	5.91%	6.23%
16	0.91	5.09%	4.66%
17	1.11	4.22%	3.23%
18	1.31	3.35%	2.05%
19	1.53	2.53%	1.17%
20	1.77	1.81%	0.59%
21	2.06	1.94%	0.27%

Table 4: Aggregate variables for different levels of Transfers.

Variables	**Baseline**	**Proportional Tax**	2.5% TR	5% TR
GDP per capita	100	110.13	105.36	100.12
Capital Stock	100	116.90	108.08	98.77
K/Y	100	106.16	102.58	98.65
K/L	100	109.57	103.90	97.86
Saving rate	100	106.12	102.52	98.61
Labor supply	100	106.64	103.92	100.86
Hours	100	105.79	101.06	95.73
Wage	100	103.25	101.35	99.25
Interest Rate	100	91.31	96.30	102.13
Bequests	100	111.95	102.55	92.73
Social Security Benefits	100	110.23	105.42	100.23
Marginal tax rate	–	12.28%	15.49%	19.03%
CEV	–	**−4.26%**	**−0.55%**	**2.63%**

Table 5: Gini coefficients for Pre-Tax Earnings

	$Gini\ Pre - Tax\ Earnings$
Benchmark	0.46
Proportional	0.47
NIT 2.5%	0.48
NIT 5%	0.49
Optimal NIT	0.53

Table 6: Optimal NIT versus Optimal Flat Tax

Measures	$Optimal\ NIT$ (10% TR)	$FlatTax$ (33% *deduction*)
GDP per capita	87.18	103.81
Capital Stock	77.37	104.85
K/Y	88.74	101.00
K/L	83.22	101.37
Saving rate	88.74	100.89
Labor supply	92.97	103.26
Hours	82.41	101.96
Wage	93.77	100.48
Interest Rate	119.12	98.67
Bequests	70.76	105.91
Social Security Benefits	87.33	103.82
Marginal tax rate	27.95	18.47
CEV	**6.33**%	−0.12%

Table 7: Optimal NIT in an Open Economy

Measures	*Optimal NIT* (10% TR)
GDP per capita	83.64
Capital Stock	64.38
K/Y	76.98
K/L	66.69
Saving rate	76.85
Labor supply	96.30
Hours	86.86
Wage	100.00
Interest Rate	100.00
Bequests	52.21
Social Security Benefits	96.40
Marginal tax rate	28.74
CEV	6.48%

Table 8: The role of accidental bequests

Measures	*Optimal NIT* (10% TR)
GDP per capita	84.20
Capital Stock	72.11
K/Y	85.65
K/L	78.71
Saving rate	85.59
Labor supply	91.52
Hours	80.68
Wage	91.96
Interest Rate	125.34
Bequests	0.00
Social Security Benefits	84.21
Marginal tax rate	30.52
CEV	8.81%

Table 9: Idiosyncratic Shocks

Measures	*Optimal NIT* (9% TR) ; $\rho = 0.946$	*Optimal NIT* (11% TR) ; $\rho = 0.986$
GDP per capita	89.48	84.49
Capital Stock	80.68	73.44
K/Y	90.16	86.92
K/L	85.08	80.40
Saving rate	90.03	86.78
Labor supply	94.62	91.12
Hours	86.87	77.64
Wage	94.50	92.65
Interest Rate	116.69	122.93
Bequests	73.82	67.59
Social Security Benefits	89.49	84.37
Marginal tax rate	25.71	30.31
CEV	2.60%	8.70%

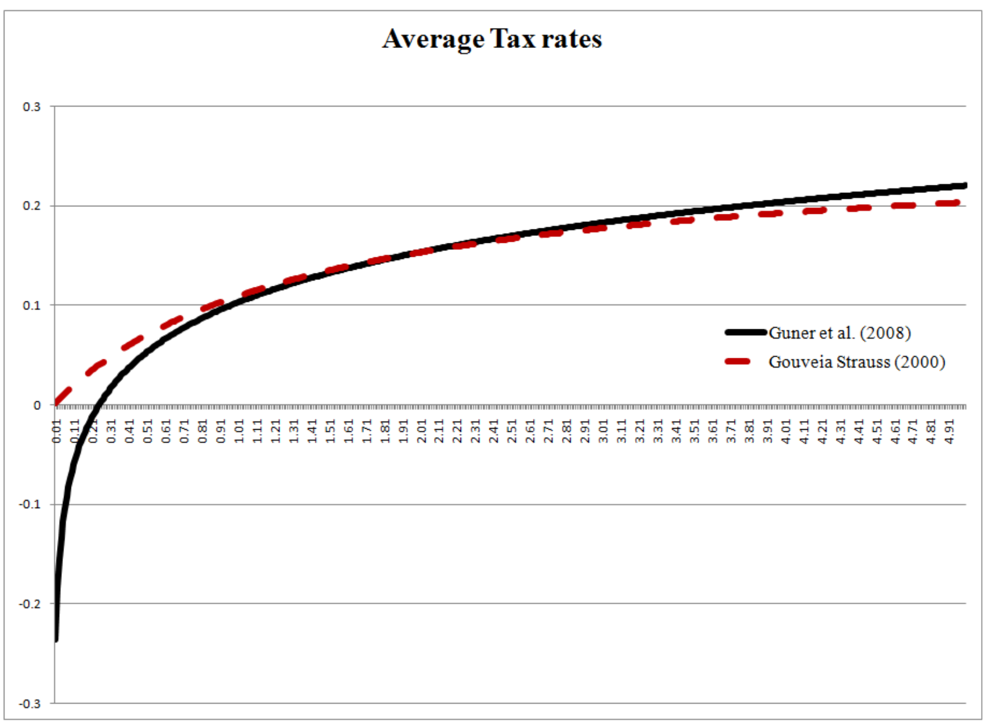

Figure 1: Average Tax Rates.

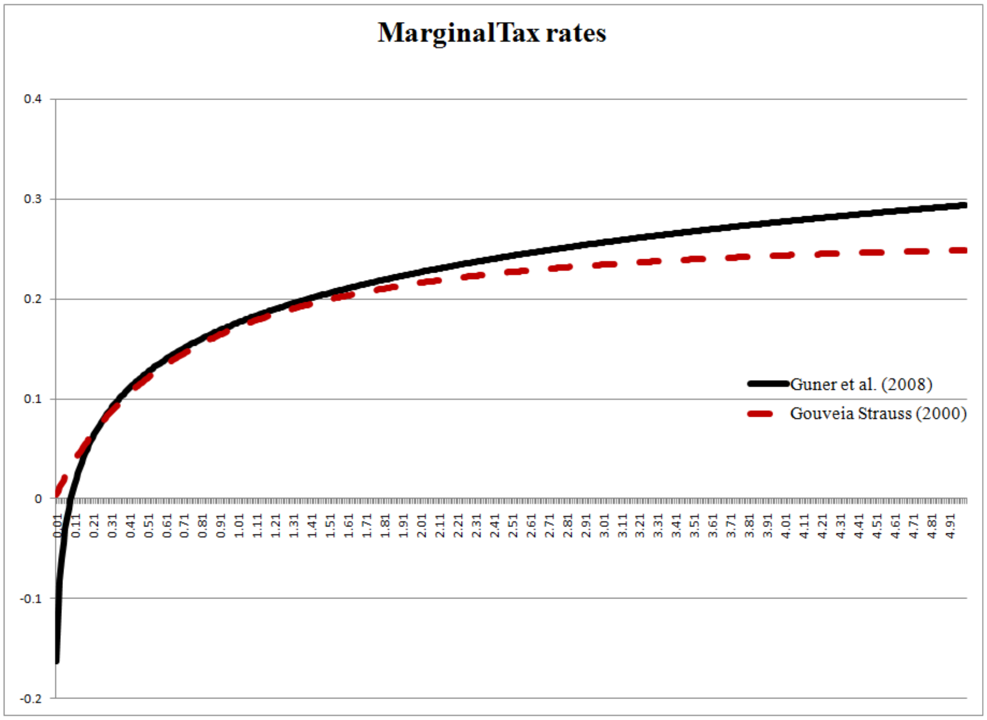

Figure 2: Marginal Tax Rates.

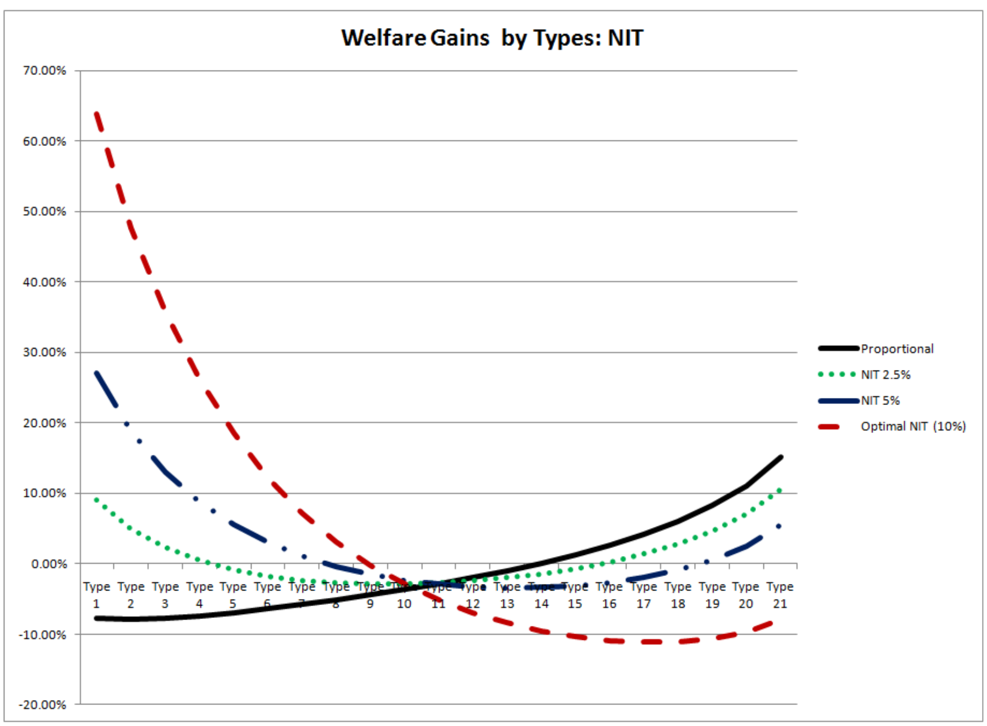

Figure 3: Welfare gains by types: Proportional Tax, NIT 2.5% and NIT 5%.

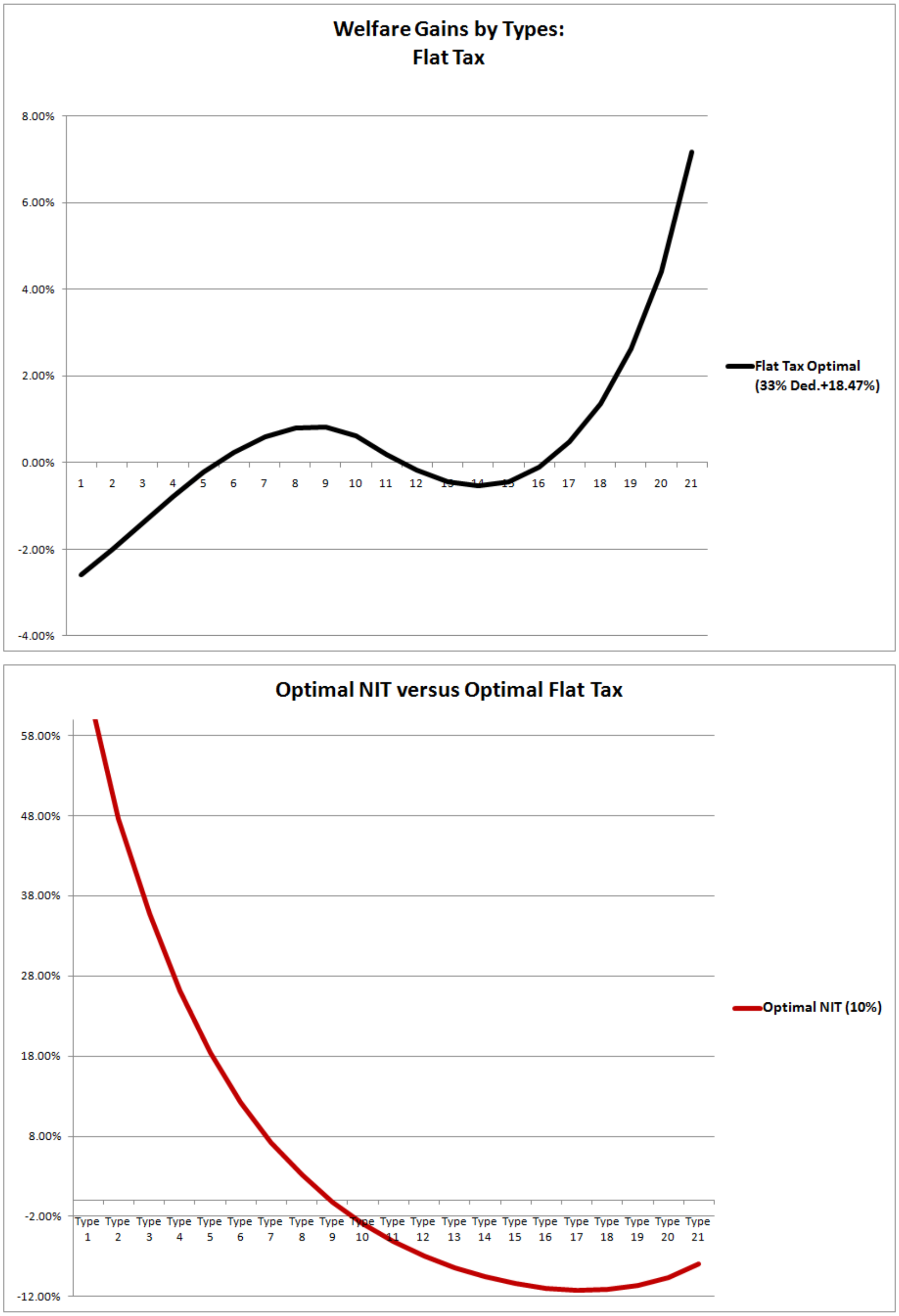

Figure 4: Welfare gains by types: Optimal NIT versus Optimal Flat Tax.

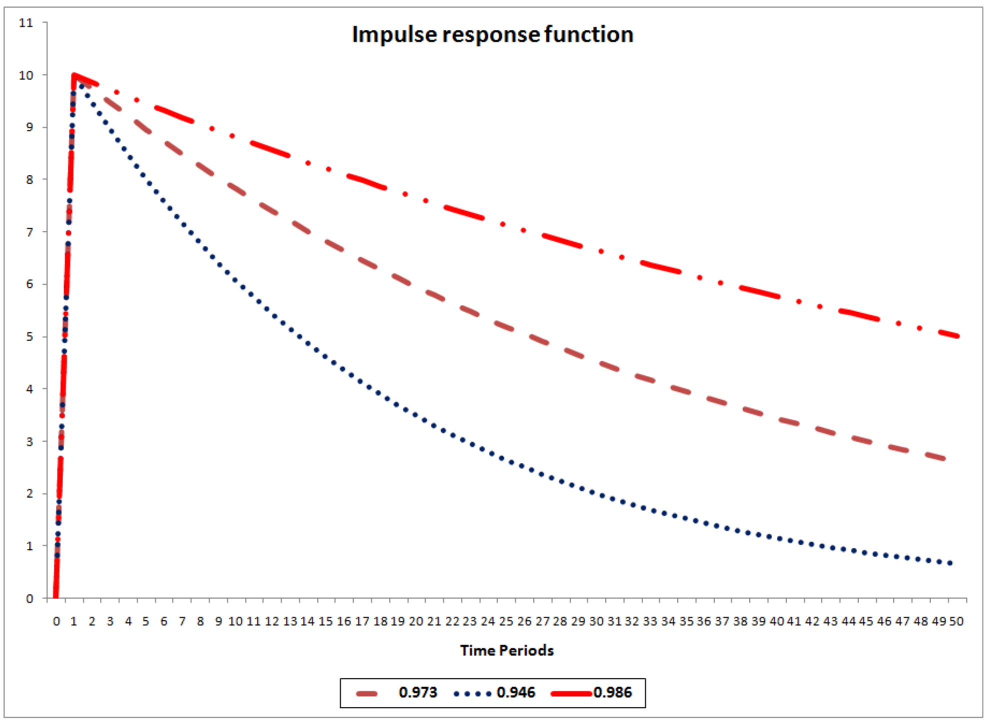

Figure 5: Impulse Response Function