NIT picking: The macroeconomic effects of a Negative Income Tax

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A R T I C L E   I N F O

A B S T R A C T

I study a revenue-neutral reform of the U.S. income tax and welfare 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. The optimal NIT consists of a 22% rate and a transfer equivalent to 11% of per-capita GDP. The ex-ante average welfare gain is a 2.1% annual increase of individual consumption. I show that a NIT outperforms a flat tax reform (income tax plus deduction) by a considerable margin. The key consequence of the reform is that high-productivity agents increase their relative importance in the labor supply at the expense of low-productivity agents.

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1. Introduction

The discussion on the merits of adopting unconditional basic income programs is a long-dated debate that is gaining momentum at present. Several countries in Europe are exploring the possibility and some have already passed basic income proposals; in the United States, there are calls to reform the entire welfare system (Steuerle, 2012; Murray, 2006; Alexander, 2013; among others) and there is an ongoing debate on whether to expand the Earned Income Tax Credit (EITC) to a broader audience.[1] Under an unconditional basic income program, all citizens are assured a minimum income and there are no means tests or work requirements on behalf of the recipients, making it an effective tool to fight poverty without the administration costs of the current web of welfare programs. Naturally, a universal basic income can be instrumented in several ways and, following Friedman (1962), a Negative Income Tax (NIT) stands out because of its simplicity and progressive structure, thus becoming a valid candidate to replace the actual income tax and welfare system. A NIT does not distort the price system, as other income policies do, like the minimum wages policies or price controls, and it is able to

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[1] The EITC is a refundable tax credit for low- and middle-income families who satisfy certain requirements. It was enacted in 1975, and since then it has been expanded and modified in several occasions. The most recent of these modifications was in 2009 with the American Recovery and Reinvestment Act.

eradicate the so-called welfare cliffs.[2] It is no coincidence that a NIT is considered "one of the fundamental ideas of modern analysis of welfare programs" (Moffit, 2003). However, the effects that a NIT has on the labor supply or the increase on tax rates necessary to fund this minimum income is not clear yet. These are not minor questions and they need to be analyzed in the light of a general equilibrium model.

In this paper, I will make a case for a NIT and carry out the first, to the best of my knowledge, quantitative analysis of the tax in a general equilibrium setting. Specifically, I will answer the following questions: What are the macroeconomic effects of replacing the actual U.S. income tax and the welfare system with a NIT on income and earnings, labor supply, tax rates, savings, and welfare? Should we pick a NIT?

The present state of affairs makes the NIT a relevant and timely tax reform. On the one hand, the federal income tax has become increasingly complex and distortionary. Its considerable number of tax credits, deductions and overlapping provisions creates differences in the amounts paid by households earning the same level of income which lessens its progressivity and creates a fair share of distortions at all income levels. On the other hand, the welfare system makes it harder for low- and middle-income households who see their marginal tax rates surge at particular income thresholds, as many of the welfare programs in place vanish as their income increase. According to the Congressional Budget Office (Congressional Budget Office, 2012), 51% of taxpayers below 450% of the Federal Poverty Line face marginal rates higher than 30%, and 8% of them are taxed with marginal rates higher than 50%.[3] In contrast, only 5% of the high-income households are taxed at such high rates.[4]

In its simplest version, a NIT combines a constant marginal tax rate and fixed lump-sum transfer to all households. It works as follows. At the beginning of the fiscal year, all households receive a transfer from the government, say $2000, and all income made is taxed at a constant rate, say 20%. If a household has a yearly income of $50,000, then its total tax payments for the period will be $8000 ($50,000 × 20% – $2000). This means that households earning less than $10,000 ($2000÷0.2) pay no taxes and receive a positive net transfer (negative tax). All households have a guaranteed minimum income, and as income increases, the effect of the transfer declines.

To demonstrate a NIT's suitability, 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 productivity shocks. At any point in time, the resulting heterogeneity is characterized by the agents' shock history, their level of asset accumulation, and their age. Welfare payments are modeled as a non-linear function of income to capture the progressive structure of the U.S. welfare system. In addition, there is a social security system; once retired, agents receive benefits in the form of lump-sum payments.[5]

I calibrate this model to match several features of the U.S. economy, reproducing the actual distributions of labor earnings, wealth, federal income tax liabilities, and transfers. I focus on an equilibrium with transitional dynamics for an open economy 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) for an agent born at the time of the reform, taking into account the transitional path to the new steady state. My findings can be summarized as follows.

First and foremost, the NIT produces important welfare gains. A NIT with a marginal tax rate of 22% and a transfer of 11% of per-capita GDP – roughly, $5800 – implies a welfare gain equivalent to 2.1% annual increase in consumption. Low-ability agents in the bottom quintile of the productivity distribution benefit the most, with welfare gains that range up to 25%, but there are losers under the NIT: those in the upper level of the productivity distribution. Under an optimal NIT, the degree of redistribution is not trivial.

Second, the size of the transfers plays an important role in the results. Indeed, a proportional tax – that is, a NIT with no transfers (a "non-negative income tax") – has a welfare loss of 4.1% relative to the current tax system. This result is unsurprising; redistribution is an important feature of the U.S. income tax and welfare system. The elimination of transfers benefits only the most productive agents who, as a result, face a lower marginal tax rate. The way transfers are designed is also important. A competing scenario where the welfare system is kept unchanged and a flat tax is enacted (a "non-negative income tax" with a fixed deduction instead of a transfer) likewise underperforms the NIT. In particular, the optimal flat tax (characterized by a marginal tax rate of 15% and a fixed deduction of 29% of per-capita GDP, roughly $15,400) produces a 0.4% welfare gain.

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[2] Welfare cliffs are the income levels in which there are no incentives to provide an extra hour of labor to the market because of the loss of the welfare programs. In the case of the United States, they are not trivial at all. For example, a single mother on welfare with a gross income of $29,000 in the State of Pennsylvania has an after-tax income of $57,327 – the exact same after-tax income she would have received if she had earned a gross income of $69,000 (Alexander, 2013). Therefore, it would be an entirely rational choice for this single mother to reject a job offer, even for an extra $40,000.

[3] In 2012, the federal poverty guideline for a household of two and four were $15,130 and $23,050, respectively (Register, 2013).

[4] In order to compute the marginal rates, the CBO takes into account the combined effects of the Supplemental Nutrition Assistance Program (SNAP) and federal taxes. If they have included all other welfare programs, the rates would have been even higher.

[5] This model is a benchmark in the macroeconomic and public finance literature, and several papers have followed this quantitative approach to optimal taxation, in which artificial economies with heterogeneous agents and incomplete markets (e.g. Huggett, 1993; Aiyagari, 1994) are simulated while the individual and aggregate effects of tax reforms are studied (e.g. Ventura, 1999; Altig et al., 2001; Domeij and Heathcote, 2004; Diaz-Gimenez and Pijoan-Mas, 2006; Nishiyama and Smetters, 2005 among others). Domeij and Heathcote (2004) study the distributional effects of reducing capital taxes; Conesa et al. (2009) study the optimal capital and labor income tax and show that the labor income tax rate should be 23% with a deduction of $42,000, while capital should be taxed at a high 36% rate due to the life-cycle structure of the model, in accordance with the results found by Erosa and Gervais (2002). For a complete review, see Heathcote et al. (2009).

Third, there is a negative relationship between the magnitude of the NIT's transfer and per-capita GDP, which decreases by 9% under the optimal NIT. As leisure is a normal good, this drop in per-capita GDP does not automatically translate into a fall in welfare. Quite on the contrary, as the transfer insures agents against periods of low productivity, they are now able to work more hours when they are more productive, increasing their consumption of leisure and reducing their need to save in order to buffer the impact of negative income shocks. The savings rate drops 13% – implying a 22% reduction in the capital stock – and the composition of the labor force changes, where agents with high-productivity shocks are now working more hours than low-productivity agents. The immediate consequence is that the Gini coefficient for labor earnings increases to 0.57 from 0.55, but not consumption inequality, which is reduced due to the effect of the lump-sum transfer from the NIT.

Finally, the optimal NIT has a strong support in the population. However, whether the tax may be transformed into a law is an open question. For the sake of understanding how sensitive to particular voting rules the NIT design is, I search for a NIT with a level of transfers and a tax rate that has the minimum required support in the population to be enacted (i.e. only 50% of the households favor the new tax), and I call it a "Popular NIT." Even though I am not considering a political economy model, this "Popular NIT" shows that in order to gain support from wealthy capitalists and high-income earners, its rate and transfer have to be lower than the optimal NIT (19% tax rate and a 9% transfer). Interestingly, this NIT produces a considerable welfare gain of 1.7% and still outperforms a flat tax reform. The "Popular NIT" has a stronger role in the economy's efficiency, giving the most productive agents a reduction in tax rates. All productivity types but the second most productive are better off, and there are still considerable welfare gains for less productive agents. Capital and GDP fall by less than in the optimal NIT – 6% and 2% respectively – and the labor supply, measured in efficiency units, has no changes despite the 3% plunge in hours worked.

1.1. Related literature

This paper is related to two strands of the literature on the effects of redistributive taxation: one involving the effects of earnings shocks and insurance (e.g. Eaton and Rosen, 1980; Flodén, 2001; Flodén and Lindé, 2001; Krueger and Perri, 2010; among others), and another involving the distortions affecting labor supply decisions (e.g. Ohanian et al., 2008; Rogerson, 2007; Prescott, 2004; Feldstein, 1973 among others).

Flodén and Lindé (2001) study the provision of insurance through government transfers in the U.S. and Sweden, and find 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%, respectively. Flodén (2001) studies the effects on risk sharing of different combinations of government debt and lump-sum transfers and also their effects in isolation. My work differs from these previous two papers in one important aspect: their aims are to find an optimal level of transfers or a combination of government debt and transfers without replacing neither of the present taxes nor the welfare system. In contrast, I focus on a particular revenue-neutral tax reform that has a lump-sum transfer as an important component but also has two other sources of welfare gains: the increase in efficiency produced by replacing increasing marginal tax rates with a constant tax rate, and the elimination of the "welfare cliffs." Moreover, Flodén and Lindé (2001) and Flodén (2001) do not model the U.S. welfare programs; as I will show later in this paper, this omission might bias their results.

Along the same line, Alonso-Ortiz and Rogerson (2010) compare the effects of taxes and transfers on welfare and labor supply in an incomplete market model, with indivisible labor and heterogeneous agents, against a neoclassical growth model with a representative agent. They find that even though the differences in both models on hours are modest, the differences on welfare are substantial. One of their findings is that the degree of redistribution implied for their U.S. calibrated economy is close to optimal. However, their calibration of the income tax and welfare system only takes into account the average rates in the economy, and ignores the marginal rates. On the contrary, in my study, I explicitly consider the shape of the tax and transfer functions, which are extremely important in order to assess the optimal degree of redistribution.

Closer to my standpoint, Correia (2010) studies the interplay of lump-sum transfers and consumption taxes as a potential reform of the U.S. tax code in a complete market setting. She finds that her proposed reform is desirable, reduces inequality and helps the poor. Even though both her paper and mine consider lump-sum transfers as a device to increase progressivity and reduce inequality, the aim of my study is to explore the general equilibrium effects of a particular reform of the U.S. income tax and welfare system, in a model that explicitly addresses the current level of distortions. Her paper is silent on this issue and on whether the non-discriminatory transfers and proportional taxation can overcome these distortions.[6]

Finally, Heathcote et al. (2014) study the optimal degree of progressivity of the tax and transfer system in a tractable framework that allows them to derive analytical expressions to better understand the actual trade-off between transfers and taxes. They find that when the redistribution motive is absent from the social welfare objective function, the optimal level of

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[6] This creates differences in the methodological approaches considered. For instance, Correia (2010) uses a particular class of utility functions that allow for Gorman aggregation and the use of a representative agent in order to solve her model. Therefore, she does not need to keep track of individual allocations and cannot completely characterize the cross-sectional distributions of wealth and earnings, limiting the scope of her study to the distributional changes in the economy due to a tax reform. An incomplete market setting, as my model considers, is better suited to analyze these changes. Moreover, there is no life-cycle structure in her economy, her infinitely-lived agents are differentiated only by their initial level of wealth and labor efficiency, and marginal taxes are the same for all agents (a requirement for Gorman aggregation). On the contrary, in my model, agents are born with no assets but they are different in their innate abilities and are subject to idiosyncratic shocks, the resulting wealth distribution is endogenous, taxes and transfers are not the same for all agents, and I do take into account the life-cycle structure of the economy, which is a relevant feature to be considered for the welfare analysis.

progressivity is given by a flat tax with a 19% rate. Under certain conditions, they find that the actual U.S. tax and transfer system would need to be less progressive than they actually are, but progressivity could be higher if other features are considered, such as the relative importance of the agent's initial conditions to his lifetime earnings. My results do not contradict their conclusions.

The remainder of this paper is organized as follows. Section 2 introduces the model and the definition of equilibrium. Section 3 presents the calibration strategy and the benchmark economy. Section 4 reports the quantitative results. Section 5 analyzes the political feasibility of the tax, and Section 6 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. 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 $R+1$, 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.[7]

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

$$\sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} s_j \right) u(c_{j,t}, l_{j,t}), \tag{2.1}$$

where $c_{j,t}$ and $l_{j,t}$ denotes consumption (c) and labor (l), respectively, at age j and period t. The momentary utility function is:

$$u(c_{j,t}, l_{j,t}) = \log(c_{j,t}) - \psi \frac{l_{j,t}^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}, \tag{2.2}$$

where $\gamma > 0$ is the Frisch elasticity, and $\psi > 0$ is the disutility of working.

2.2. Agents' endowments and labor productivities

Agents are born with no assets, and during their working lives they are endowed with one unit of time. They receive a competitive wage rate w_t, and their labor productivity is a first-order Markov process given by $e(\omega, j)$, which is a function of the shock $\omega \in \Omega = \Theta \times \Pi \times \Phi \subseteq \Re^3$ and their age $j \in J$ such that

$$\ln e(\omega, j) = \gamma_j + \theta^i + \pi_j^i + \varphi_j^i, \tag{2.3}$$

where

$$\pi_j^i = \rho \pi_{j-1}^i + \varepsilon_j^i, \quad \text{with} \quad \varepsilon_j^i \sim N(0, \sigma_\varepsilon^2) \quad \text{and} \quad \pi_0^i \equiv 0 \quad \forall i,$$

together with $\varphi_j^i \sim N(0, \sigma_\varphi^2)$ and $\theta^i \sim N(0, \sigma_\theta^2)$.

The structure of the idiosyncratic shocks consists of a permanent component θ, a persistent component π, and a temporary component φ. As a result, the labor income of an agent of age j and shock ω is equal to $w_t l_t e(\omega, j)$, where l_t is the amount of time that the agent decides to work. Agent's shock histories and ages are the drivers of the differences in the efficiency units supplied to the market.

The possibilities for insurance in this economy are limited. There are 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. In the benchmark case, agents are not allowed to borrow.

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

2.3. Firms and technology

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

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha}. \tag{2.4}$$

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

$$C_t + K_{t+1} - K_t(1-\delta) + G_t \leq K_t^{\alpha}(A_t L_t)^{1-\alpha}. \tag{2.5}$$

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

2.4. Taxes, transfers and government consumption

At any given time t, the government receives payments from the social security system, local and federal income taxes, corporate income tax, and accidental bequests. The proceeds serve to finance government consumption G_t, pay social security benefits SS_t, and welfare 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 throughout the retirement period.[8] Accidental bequests, occasioned by the deaths of the agents, are expropriated. Agents do not derive any utility from government consumption G_t.[9]

The government welfare transfers $TR_t(I)$ are a non-linear function of an agent's income I. They are progressive and capture the distortions that arise in the U.S. welfare system. I will assume that they are funded with part of the proceeds of the federal income tax.

The actual U.S. income tax system is the benchmark case and I will aim to replicate three of its main features: the presence of local and state income taxes, the double taxation of dividends, and the effective tax rates paid by households in the federal income tax. For the case of the double taxation of dividends, I introduce a constant corporate income tax τ_k that is levied on capital income. A proportional income tax with marginal tax rate τ_L mirrors the local and state income taxes.

Mimicking U.S. the federal income tax requires recognition that there exists a considerable number of tax credits, deductions and overlapping provisions which together imply that the statutory tax rates faced by an agent are not necessarily the ones effectively paid. I approximate the federal income tax rates with this two-parameter function[10]:

$$\text{Average Tax Rate}\left(\hat{I}\right) = \eta_1 + \eta_2 \log\left(\hat{I}\right), \tag{2.6}$$

where $\hat{I}$ is income normalized by household income, i.e. income I divided by the mean household income in the economy. Then, the federal income tax paid by an agent is:

$$T_{Federal,t}^{Benchmark}(I) = \text{Average Tax Rate}\left(\hat{I}\right) \times I. \tag{2.7}$$

This means that the total income tax liability for an agent of age j and shock ω with income $I_{j,t}(a,\omega) \equiv w_t e(\omega,j)l_{j,t} + a_{j,t}r_t$ is

$$T_t^{Benchmark}\left(I_{j,t}\right) = T_{Federal,t}^{Benchmark}(I_{j,t}(a,\omega)) + \tau_L \times I_{j,t}(a,\omega) + \tau_k \times a_{j,t} \times r_t. \tag{2.8}$$

In the reform scenario, the NIT replaces the U.S. federal income tax and eliminates all transfers from federal welfare programs (i.e. $TR_t(I) \equiv 0$), leaving the rest of the taxes and the social security system unchanged. All agents now receive a fixed lump-sum transfer $\tilde{TR}_t^{NIT}$ at the beginning of the period and pay a constant marginal tax rate τ for every unit of income earned.

Under a NIT, the total federal income tax liability for an agent of age j with income $I_{j,t}(a,\omega)$ is:

$$T_{Federal,t}^{NIT}\left(I_{j,t}(a,\omega)\right) = I_{j,t}(a,\omega) \times \tau - \tilde{TR}_t^{NIT}. \tag{2.9}$$

This results in a total income tax bill of:

$$T_t^{NIT}\left(I_{j,t}\right) = T_{Federal,t}^{NIT}\left(I_{j,t}(a,\omega)\right) + \tau_L \times I_{j,t}(a,\omega) + \tau_k \times a_{j,t} \times r_t. \tag{2.10}$$

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[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 of two views: (1) all government consumption is wasteful or, (2) the consumption of public goods enters linearly in the agent's utility function. In either case, the results would be the same.

[10] 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, the Gouveia and Strauss function 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. The tax function I am considering approximates both the average and marginal tax rates well.

2.5. Agent's problem: recursive formulation

In order to express the model in terms of a recursive formulation, it is necessary to apply stationary inducing transformations to the variables, which I will denote with an upper-hat symbol. Then, the state of any agent is fully described by the agent's assets holdings $\hat{a}$, productivity shock ω, and age j. In order to simplify notation, let $x = (\hat{a}, \omega)$ be the non-age-dependent variables of the state vector.

The decision problem for an agent of age j with state x is such that, given prices $(\hat{w}_t, \hat{r}_t)$ and a tax regime $k \in \{\text{NIT, Benchmark, Flat Tax}\}$, he needs to choose the amount of labor $l_{j,t}(x)$ to supply to the market, how much to consume $\hat{c}_{j,t}(x)$, and the volume of assets $\hat{a}_{j+1,t}(x)$ to carry over to the next period. Optimal decision rules solve the following dynamic programming problems:

1. Working agents:

$$\nu_t(x, j) = \sup_{(\hat{c}_{j,t}, l_{j,t}, \hat{a}_{j+1,t})} \left\{ u(\hat{c}_{j,t}, l_{j,t}) + \beta E[v_{t+1}(x', j+1)] \right\}$$

subject to

$$\hat{c}_{j,t} + \hat{a}_{j+1,t}(1+g) \leq \hat{a}_{j,t}(1+\hat{r}_t) + \hat{w}_t(1-\tau_{ss})e(\omega, j)l_{j,t} - \hat{T}_t^k(x, j) + \hat{TR}_t^k(x, j)$$

$$\hat{c}_{j,t} \geq 0, \quad \hat{a}_{j,t} \geq 0, \quad \hat{a}_{j+1,t+1} \geq 0, \quad \text{and} \quad l_{j,t} \in [0, 1]. \tag{2.11}$$

2. Retirees:

$$\nu_t(x, j) = \sup_{(\hat{c}_{j,t}, \hat{a}_{j+1,t})} \left\{ u(\hat{c}_{j,t}, 0) + \beta E[v_{t+1}(x', j+1)] \right\}$$

subject to

$$\hat{c}_{j,t} + \hat{a}_{j+1,t}(1+g) \leq \hat{a}_{j,t}(1+\hat{r}_t) + \hat{SS}_{j,t} - \hat{T}_t^k(x, j) + \hat{TR}_t^k(x, j)$$
$$\hat{c}_{j,t} \geq 0, \quad \hat{a}_{j,t} \geq 0, \quad \hat{a}_{j+1,t+1} \geq 0$$

with

$$v(x, J+1) \equiv 0. \tag{2.12}$$

2.6. Equilibrium

The notion of recursive competitive equilibrium with transitional dynamics for an open economy is by now standard in the literature. Still, for the sake of completeness, I provide a formal definition in the Online Appendix.

Heuristically, an equilibrium for this economy that moves from the benchmark federal income tax and welfare system to a new tax system consists of a sequence of prices, decision rules, value functions and taxes, as well as economic aggregates and probability distributions. In equilibrium, decision rules are optimal, market clearing conditions are satisfied, and the government budget as well as the social security system are balanced. Also, the tax reform is not only revenue neutral in the new steady state but also along the transition path, where lump-sum taxes are used to assure the revenue neutrality. In the original steady state, factor prices are equal to marginal products but the interest rate is kept fixed – and therefore all other prices, – once the tax reform is enacted.

3. Calibration

In this section, 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 and values used in the calibration.

3.1. Demographics

In my model, agents are born at age 25 (model period 1), work until age 64 (model period 40, i.e. R=40) and die for certain at age 100 (model period 75, i.e. J=75). Survival probabilities s_{j+1} are taken from the National Vital Statistics System.[11]

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

Table 1
Calibrated parameters.

Parameters	Values	Description
β	0.9825	Discount Factor calibrated to target K/Y=2.93
γ	1.0	Frisch Elasticity
ψ	7.1	Disutility of Labor. Target: average working time
J	75	Maximum model age (99 years in real life)
R	40	Oldest working age in the model (64 years in real life)
n	1.09%	Average population growth from 1990 to 2009
α	0.35	Capital share (1960–2007)
g	2.22%	Average Per-Capita Real GDP growth (1960–2007)
δ	4%	Depreciation rate. Target: I/Y=21.38% (1960–2007)
$\{\gamma_j\}_{j=1}^R$	$\{\hat{\gamma}_j\}_{j=1}^R$	Age-specific component. Estimated from the CPS 1980–2005
$\{\rho, \sigma_\epsilon^2\}$	$\{0.958, 0.017\}$	AR(1) process (Kaplan, 2012)
σ_φ^2	0.081	Variance Temporary Shocks (Kaplan, 2012)
σ_θ^2	0.35	Variance Permanent Shocks. Target: Earnings' Gini.
$\{\eta_1, \eta_2\}$	$\{0.09, 0.053\}$	Federal Income Tax Parameters (Guner et al., 2014)
$\hat{TR}^{Benchmark}$	$\hat{TR}^{Benchmark}$	Calibrated Transfers from Government Programs (Congressional Budget Office, 2013)
τ_k	7.4%	Calibrated Capital Income Tax Rate
τ_L	5.0%	Local Income Tax Rate (Guner et al., 2014)
τ_{SS}	12.2%	Calibrated Payroll Tax Rate

Note: Entries show the values used in the model calibration and an explanation on how they were selected. See the text for more details.

Population growth n is set equal to 1.09%, which is the average population growth for the U.S. during the period 1990–2009.[12]

3.2. Preferences

I set γ equal to 1 and calibrate ψ endogenously in order to achieve an average time spent working equal to 1/3, resulting in a value for ψ of 7.1. The parameter γ gives an intertemporal elasticity of labor supply and a Frisch elasticity equal to 1, consistent with previous macro estimates (see Domeij and Flodén, 2006; Pistaferri, 2003).[13]

The discount factor β is calibrated endogenously to 0.9825 in order to target a capital-output ratio equal to 2.93. This last figure is the average capital-output ratio for the period 1960–2007, which is calculated using the Cooley and Prescott Methodology.[14]

3.3. Technology

I set α equal to 0.35, which is the average of capital income over total income for the period 1960–2007 (Cooley et al., 1995). The parameters for the labor augmenting technology are calibrated as follows. The growth rate g is equal to 2.22%, which is the average growth rate of real per-capita GDP during the period 1960–2007, and the free parameter A_0 is set equal to 1.[15] The depreciation rate δ is equal to 4% in order to ensure an investment-output ratio equal to 21.38% (the 1960–2007 average).[16]

3.4. Taxes and transfers

I calibrate the social security tax (τ_{SS}), and the U.S. federal, corporate and local income taxes, and transfers. In the case of the welfare transfers, the CBO has estimated them by income quintiles, including both the cash payments and the value of in-kind benefits, such as health insurance to name an example (Congressional Budget Office, 2013).

I took their estimates for the year 2000 and exclude Medicare and Social Security. Specifically, my definition of welfare transfers include the following benefits: unemployment insurance, Supplemental Security Income (SSI), Temporary Assistance for Needy Families (TANF), veterans' programs, workers' compensation, state and local government assistance programs, Supplemental Nutrition Assistance Program vouchers (SNAP, a.k.a. "food stamps"), school lunches and breakfasts,

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[12] *Economic Report of the President 2010, Table B34.*

[13] The macro estimates of the Frisch elasticity tend to be higher than those from the labor literature for prime-age male workers. This apparent discrepancy is because macro-elasticities are unrelated to micro elasticities, as was documented by Rogerson and Wallenius (2009).

[14] 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/iTable/iTable.cfm?ReqID=10&step=1#reqid=10&step=1&isuri=1). 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*.

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

[16] Investment and consumption of durable goods come, respectively, from the *Economic Report of the President 2010, Table B1, and Table B16*.

Table 2
Earnings and wealth distributions.

Income quintiles	Earnings		Wealth	
	Data[a]	Model	Data[b]	Model
Share by 1st quintile (poorest 20%)	2.1%	2.5%	4.6%	0.4%
Share by 2nd quintile (20–40%)	6.7%	6.4%	6.6%	3.2%
Share by 3rd quintile (40–60%)	12.3%	11.7%	8.3%	8.1%
Share by 4th quintile (60–80%)	21.3%	20.5%	13.9%	19.5%
Share by 5th quintile (richest 20%)	57.6%	58.9%	66.6%	68.9%
Overall inequality: Gini coefficient	0.55	0.55	0.8	0.7

Note: The entries show the shares of earnings and wealth held by income quintiles.
   [a] *Sources*: U.S. Individual Income Tax Public Use File (2000).
   [b] Díaz-Giménez et al. (2002).

housing and energy assistance, Medicaid, and the Children's Health Insurance Program. I fit a cubic spline and reproduce, by income quintiles, the average percentage of the household income received as a welfare transfer.

For the social security taxes, I calibrate τ_{ss} in such way that the replacement ratio in my model is equal to the median replacement ratio of the retired beneficiaries aged 64–66 in 2005.[17]

In the case of the federal income tax, I use Guner et al. (2014) estimates of Eq. (2.6) for all households (single and married), which takes into account the EITC: $\hat{\eta}_1 = 9.0\%$ and $\hat{\eta}_2 = 5.3\%$.[18]

For the corporate income tax, I endogenously calibrate τ_k to reproduce the 1.74% average ratio of capital net of depreciation to total income for the 1987–2007 period, resulting in a value of τ_k of 7.4% (Cooley et al., 1995).

I represent the state and local income taxes as a proportional income tax with a tax rate τ_L equal to 5%. The reason is that once the effective tax to be paid is computed, the data show that the local and state income taxes range from 4.0% to 5.3%, and they are proportional to income for the last three income quintiles (Guner et al., 2014).

3.5. Idiosyncratic shocks

The earnings profile $e(\omega, j)$ has an age component, γ_j, and an idiosyncratic age-independent shock component that consists of the sum of a permanent, a persistent, and a temporary shock. I estimate the age productivity profile γ_j from the Current Population Survey (CPS) for the years 1980–2005 by running a regression of the mean of log hourly wages against time effects and a polynomial of age. My sample consists of males aged between 25 and 64, whose wages are higher than half the federal minimum wage, and work for more than 260 h in a year. I follow Lemieux (2006) to correct for top-coding observations.

Meanwhile, for the persistent and temporary shocks, I follow Kaplan (2012) and set the autocorrelation coefficient ρ equal to 0.958, with σ_ε^2 equal to 0.017 and the variance for the temporary shocks σ_φ^2 equal to 0.081. The variance for the permanent shocks σ_θ^2 is endogenously calibrated to reproduce the overall household earnings inequality. Using micro-data from the Internal Revenue Service's Public Use Tax File for the year 2000, I find a Gini coefficient of 0.55. This level of inequality is reproduced in the model, with σ_θ^2 equal to 0.35.

Finally, I follow Tauchen (1986) to approximate the persistent shocks – an $AR(1)$ process – with an 11-state Markov process. The transition-probability matrix is $Q_{zz'} = P(Z = z'/Z = z)$, where Q is aperiodic and irreducible, thus insuring an invariant distribution (Hopenhayn and Prescott, 1992). The permanent and temporary shocks are approximated with five and three states, respectively.

3.6. Benchmark economy

Before we proceed with the main results of the paper, it is worth pointing out the quantitative properties of the calibrated model economy. The nature of the questions that I am asking makes it imperative to reproduce four dimensions of the U.S. economy successfully: the distributions of labor income and wealth and the payment distributions of the federal income tax and welfare transfers.

Let us start with the distribution of labor income. Table 2 presents the shares of earnings by income quintiles and earnings inequality. The model perfectly matches the level of inequality, as it should – it was one of the calibration targets. The distribution of earnings was not a target, however. Despite this fact, there is a perfect resemblance between the data and the model distributions. In the data, the bottom 20% earns 2.1% of total earnings, and the subsequent quintiles earn 6.7%,

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   [17] The replacement ratio is the percentage of the real average pre-retirement earnings that equals the social security benefits received. A list with the different replacement ratios for different cohorts can be found at: http://www.socialsecurity.gov/policy/docs/ssb/v68n2/v68n2p1.html.
   [18] The good thing about their estimates is that they used micro-data from the Internal Revenue Service's Public Use Tax File for the year 2000, which is representative of the actual universe of taxpayers and has no censored observations.

Table 3
Federal income tax payments and government transfers distributions.

Federal tax payments by income quintiles	Data[a]	Model	Government transfers by income quintiles	Data[b]	Model
Share by 1st quintile	0.3%	0.2%	As % of mean 1st quintile income	58.5%	55.0%
Share by 2nd quintile	2.2%	3.0%	As % of mean 2nd quintile income	6.4%	17.9%
Share by 3rd quintile	6.9%	6.5%	As % of mean 3rd quintile income	2.1%	2.5%
Share by 4th quintile	15.9%	16.2%	As % of mean 4th quintile income	0.9%	0.8%
Share by 5th quintile	74.6%	74.2%	As % of mean 5th quintile income	0.3%	0.3%
Revenue as % GDP	10.1%	11.2%	As % of economy's mean income	2.5%	2.4%

Note: In the left, there is a comparison of the shares of federal income tax payments by income quintiles as they are reflected in the model and the data. In the right, government transfers are expressed in terms of the average income in each quintile. See the text for details.

  [a] *Sources*: U.S. Individual Income Tax Public Use File (2000).

  [b] Own calculations based on CBO, Supplemental Material (2013) (Congressional Budget Office, 2013).

12.3%, 21.3% and 57.6%, respectively; the model closely follows the data, with the bottom 20% earning 2.5% of total earnings, and the following corresponding quintiles having shares of 6.4%, 11.7%, 20.5% and 58.9%. The benchmark economy rather successfully accounts for the main features of the whole distribution, and especially of the concentration of earnings at the top quintile.

Regarding the distribution of wealth, it is well known that a model like mine that has no entrepreneurship and includes agents born with no assets has difficulties in reproducing the actual U.S. wealth distribution. However, Table 2 shows that the benchmark economy does a satisfactory job: the overall model wealth inequality is not far apart from reality (0.7 versus 0.8).

The model captures well the wealth concentration at the top 20%, where 68.9% of the wealth is held by the model richest 20%; 66.6% is the actual number in the U.S. data. It perfectly accounts for the wealth owned by the third quintile (8.1% versus 8.3%). The coarse misrepresentations of the wealth distribution are restricted to the poorest 20%, where capital income is not an important source of total income. Despite these shortcomings, the model distribution is as concentrated as in the data and has practically the same level of inequality.

Table 3 presents the main results of the distributions of federal income tax payments and transfers.The benchmark economy successfully reproduces both distributions. In the case of the federal income tax, there are no major divergences along the shares of payments by income quintiles. The model reflects well how progressive the actual federal income tax is: the top 20% accounts for more than 74% of total payments while the poorest 20% represents less than 0.3%.

Federal income tax revenue is similarly modeled well: the actual revenue from the federal income tax is 10.1% of U.S. GDP; it represents 11.2% in the benchmark economy.

These features also confirm that the earnings and wealth distributions are well depicted in the model. It would not have been possible to have an accurate federal income tax payments distribution if the model had failed in these two dimensions.

Finally, the benchmark economy has the same level of welfare transfers, measured as a percentage of mean household income, as in the U.S. economy. The model reflects the progressive nature of the welfare system, where the transfers received represent more than 55% of the average income of the poorest 20% and, as income increases, the transfers' importance subsides. Indeed, in all but the second quintile, the model distribution fits the data well. In the model second quintile households received more transfers than they actually would. In any case, this situation dampens the effect of the welfare cliffs present in the data, meaning that in this dimension the benchmark economy is less distorted than the actual economy.

In sum, the benchmark economy closely matches all of the distributions considered, reflecting the level of concentration and inequality in both earnings and wealth and the progressivity of the federal income tax and welfare systems.

4. Results

The purpose of this section is to analyze the effects of replacing the actual federal income tax and all welfare programs with a NIT. It also shows how a NIT stands with respect to a flat tax that replaces the federal income tax but keeps the welfare system unchanged. Additional calculations are left to the Online Appendix where several sensitivity analyses are performed.[19]

All reforms are revenue-neutral: the proceeds, from either the flat tax or the NIT, are equal to the sum of the revenue from the benchmark federal income tax, less transfers from the welfare programs and plus revenue needed to pay the new transfers that arise from the NIT or the welfare system present in the flat tax scenario.

To demonstrate the effects of the transfer in the NIT scheme, I start with the analysis of a proportional tax, – that is, a NIT with no transfers (a "non-negative income tax") – and then I increase the transfer level to 2.5% and 5% of per-capita GDP in

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  [19] Specifically, I analyze the effects of the labor supply elasticities, the existence of private credit markets, the nature of the idiosyncratic shocks and the welfare system have on the welfare gains reported and the macroeconomic performance of the NIT against a flat tax.

Table 4
Comparison of different NIT's.

Variables	Baseline	NIT 0%	NIT 2.5%	NIT 5%	Optimal NIT
GDP	100.0	124.7	118.1	110.9	90.6
Capital stock	100.0	163.3	144.6	125.5	78.5
Labor supply	100.0	107.8	105.9	103.8	97.8
Hours	100.0	110.8	107.0	103.2	93.2
Savings rate	100.0	131.0	122.5	113.1	86.7
Social security benefits	100.0	107.8	105.9	103.8	97.8
K/Y	100.0	131.0	122.5	113.1	86.7
K/L	100.0	151.5	136.6	120.9	80.3
Marginal tax rate	–	8%	10%	13%	22%
Welfare transfers	100.0	0.0	113.1	226.3	497.8
CEV	0.0%	−4.1%	−2.0%	−0.2%	2.1%

Note: A comparison of the macroeconomic performance of different NIT's is shown in a setting where the actual federal welfare system is abolished. Aggregate variables are normalized with respect to the benchmark economy (Baseline=100.0). The welfare gain/loss for different taxes – Consumption Equivalent Variation (CEV) – takes into account the transitional dynamics.

the benchmark economy. These quantitative exercises let me evaluate the changes in the aggregate variables. Table 4 summarizes the results.

In an economy with a proportional tax, the marginal tax rate drops to 8%, 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 a welfare system eliminates an important source of redistribution from high- to low-productivity agents, making it possible to have a low tax rate. Additionally, the 25% increase in per-capita GDP augments the size of the tax base, allowing for a further tax rate reduction. The tax bill is reduced for high- and medium-productivity agents, while the opposite is true for low-productivity agents. As a result, labor supply measured in efficiency units increases 8%, and the number of hours worked increases even more (11%).

A lower marginal tax rate induces medium- and high-productivity agents to supply more hours to the market via a substitution effect, but there is an income effect that works in the opposite direction. For low-productivity agents, the absence of transfers pushes them to supply more labor to the market, due to an income effect; meanwhile, their new higher tax rate makes leisure cheaper, counteracting their willingness to increase the supply of labor – a substitution effect. The effect is asymmetrical, and there is a change in the composition of the labor supply: low-productivity agents increase their relative importance in the labor supply at the expense of high-productivity agents. The result is that the average labor productivity decreases, even though the total labor supply, measured in efficiency units, increases.

As might be expected, without transfers agents wish to save more, for precautionary reasons. Consequently, the savings rate, defined as the interperiod change in household's assets divided by GDP, increases 31%, resulting in an economy with a higher capital stock. More capital and labor imply a higher GDP, but the increase in labor supply is less than the increase in capital. This means that the over-accumulation of capital translates into a 52% increase in the capital available per unit of labor and a 31% higher capital-output ratio.

Even though there are no welfare programs and the proportional tax eliminates the income tax's transfers (EITC), there is still another source of lump-sum payments received by the households: the social security system. As these payments are proportional to the economy's labor earnings and the open economy assumption precludes changes in prices, their 8% increase follows from the same increase in the labor supply.

This represents a change in the composition of the total transfers. The removal of the welfare system has shut down an important redistributive channel that previously benefited low-income households and increased redistribution from the social security system.

Does the increase in social security payments offset the loss of the income tax's transfers and welfare payments? No, because welfare is lower under the proportional tax. Indeed, to make agents indifferent between a proportional tax and the U.S. income tax and welfare regimes, consumption under the proportional tax regime would need to increase annually by 4.1% (i.e. the Consumption Equivalent Variation [CEV] is −4.1%).

An analysis of the CEV by productivity types shows that losses are felt most by the low-productivity agents, who experience welfare losses as high as 33%. More productive types are better off. Indeed, the most productive agents in this economy have a striking welfare gain of 18%. It is clear that the trade-off between tax rates and transfers depends upon productivity: low-productivity types prefer high transfers – and, consequently, high tax rates – while the opposite is true for high-productivity agents. As can be seen in Fig. 1, the welfare profile is monotone increasing in productivity types.

To illustrate this last point, I turn my analysis from a proportional tax toward a NIT with a transfer of 2.5% ($1330) and 5% ($2660). By doing so, welfare increases by 2.1 and 3.9 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 10% and 13%, respectively.

In the absence of complete markets, the transfer can be thought as a source of insurance: when the transfer is present, the need to save and work is reduced. Consequently, there is a negative correlation between the size of the transfer and the
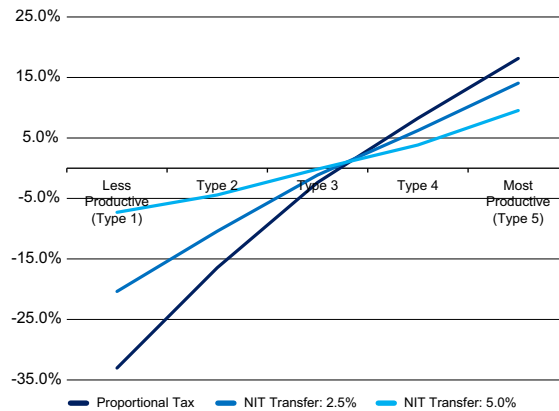
Fig. 1. Welfare profiles by productivity types: proportional tax, NIT 2.5% and NIT 5%. *Note*: Ex-ante welfare gains for agents born at the time of the reform, taking into account the transitional dynamics, and conditional on each of the permanent productivity categories.

savings rate and hours worked. For instance, the savings rate moves from 31% under a proportional tax regime to 13% under a NIT with 5% transfers (NIT 5%). The original 11% increase of hours worked under the proportional tax drops to a 7% increase under a NIT with 2.5% transfers (NIT 2.5%) and a 3% increase under the NIT 5%.

Labor supply measured in efficiency units moves from an 8% increase under the proportional tax to 6% and 4% increases under the NIT 2.5% and NIT 5%, respectively. As the decrease in the hours worked is higher than the decrease in the labor supply, there is a change in the composition of the labor supply, and the average labor productivity per hour worked increases.

The transfer is the reason for this surge in productivity. It enables agents to cope better with bad productivity shocks. Agents hit with a bad shock increase their consumption of leisure -i.e., they work fewer hours, – a normal good. When a positive shock arrives, they work more. The NIT's transfer enables all agents to work when they are more productive.

As a result, there is an increase in the dispersion and concentration of labor earnings and a deterioration of the capital-output ratio and the capital per unit of labor. The Gini coefficient on labor earnings deteriorates from 0.55 in the proportional tax setting to 0.56 in the NIT 5%, while the capital-output ratio moves from a 31% increase in the proportional tax to a 13% increase in the NIT 5%. The capital per labor ratio is reduced from a 52% increase under the proportional tax to a 21% increase under the NIT 5%.

Meanwhile, although retirees enjoy higher benefits with the increase of the NIT's transfer, the negative relationship between labor supply and the transfer implies a reduction in social security payments. Indeed, while these payments are 8% higher under the proportional tax, this increase is halved under the NIT 5%. As the NIT's transfer increases, the social security benefits are reduced, attenuating the NIT's potential gains for this particular group.

As we move from a NIT 2.5% to a NIT 5%, low-productivity agents improve their situation at the expense of the high-productivity agents. The slope of the welfare profile depicted in Fig. 1 rotates on the median-productivity agent, who is caught in the middle: the transfer is not high enough for them, and the tax rates are not as low as they want them to be.

4.1. The optimal NIT

A NIT with a 22% marginal tax rate and a transfer of 11% of the benchmark economy's per-capita GDP, or approximately $5800, is optimal in the sense that it maximizes the expected lifetime utility for a newborn at the time of the reform, i.e. before he knows his true type, and taking into account the transitional costs of changing the actual tax and welfare systems. The expected welfare gain is a 2.1% annual increase of individual consumption. The picture that emerges for this economy is consistent with the tendencies observed with the previous suboptimal NIT's.

A striking outcome is that the optimal NIT causes a 9% decline in per-capita GDP, a 22% decrease in the capital stock, and a 2% reduction in the labor supply (see Table 4). As impressive as this may seem, these decreases are explained by the size of the transfer. A larger transfer causes a larger drop in per-capita GDP precisely because of the effect that the transfer has on precautionary savings and labor supply decisions. Agents are able to work more hours when they are more productive and their consumption of leisure increase. Putting it differently, per-capita GDP was higher because of an over-accumulation of capital, with agents working more hours than they want to in order to save.

Next, I examine the determinants of the drops in the capital stock and labor supply. As I said before, the optimal NIT's transfer 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 savings rate drops 13%, and total savings falls more than the GDP.

The NIT gives agents fewer incentives to adjust their labor supply decisions as means of insurance (see Pijoan-Mas, 2006): hours worked decrease 7% – a 3.1 times-higher-reduction than the drop in the labor supply. Because less productive agents work less and more productive agents work more hours, labor income inequality goes up, and the capital-output and capital-labor ratios deteriorate to 13% and 20%, respectively. The Gini coefficient for labor earnings increases to 0.57 from 0.55 but, due to the transfer, the Gini on consumption inequality declines to 0.35 from 0.36.
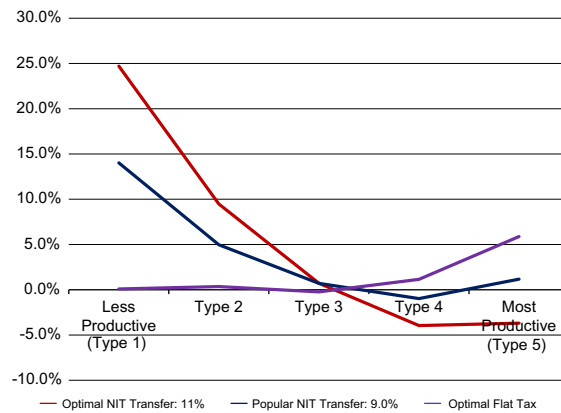
Fig. 2. Welfare profiles by productivity types: optimal NIT, popular NIT and optimal flat tax. *Note*: Ex-ante welfare gains for agents born at the time of the reform, taking into account the transitional dynamics, and conditional on each of the permanent productivity categories.

Table 5
Earnings, wealth and tax payments distributions.

Income quintiles	Baseline	Flat tax	Optimal NIT
	Earnings distribution		
Share by poorest 20%	2.5%	2.8%	2.4%
Share by 2nd quintile (20–40%)	6.4%	5.9%	6.0%
Share by 3rd quintile (40–60%)	11.7%	11.0%	10.8%
Share by 4th quintile (60–80%)	20.5%	19.9%	19.6%
Share by richest 20%	58.9%	60.6%	61.1%
	Wealth distribution		
Share by poorest 20%	0.4%	0.3%	0.1%
Share by 2nd quintile (20–40%)	3.2%	2.6%	1.1%
Share by 3rd quintile (40–60%)	8.1%	6.7%	5.0%
Share by 4th quintile (60–80%)	19.5%	17.0%	16.5%
Share by richest 20%	68.9%	73.4%	77.3%
	Fed. tax payments distribution		
Share by poorest 20%	0.2%	0.3%	−0.7%
Share by 2nd quintile (20–40%)	3.0%	2.6%	0.4%
Share by 3rd quintile (40–60%)	6.5%	7.5%	1.5%
Share by 4th quintile (60–80%)	16.2%	19.0%	14.7%
Share by richest 20%	74.2%	70.7%	84.1%

Note: The entries show the shares of federal income tax payments, earnings and wealth held by income quintiles under the benchmark economy, a flat tax and the optimal NIT scenarios. See the text for details.

As a result of the fall in labor supply, social security benefits fall, too. The composition of the total transfers, given by the sum of the income tax's transfers and social security benefits, has changed because of the increase in the income tax's transfers and the decrease of the social security benefits. However, the total transfer size has not diminished: the NIT's transfers are 5 times larger than the benchmark's welfare transfers.

Who is benefiting from these changes? Fig. 2 shows that the optimal NIT's welfare profile has changed from the previous cases. The clear positive relationship between productivity types and welfare has changed its sign: there is a strong redistribution from high-productivity to low-productivity types. The cut-off separating winners from losers is the median-productivity agent. The least to the median productive agents have welfare gains from 25% to 1% respectively, while high-productivity levels 4 and 5 have, approximately, a 4% welfare loss. In terms of welfare gains, the most productive agents are worse off.

Under the optimal NIT, high-productivity agents are enjoying a lower marginal tax rate than the prevailing rate for the richest households in the U.S. federal income tax; however, their tax bill is also higher as a result of replacing a structure of increasing marginal tax rates with a single tax rate. This can be seen in Table 5, where the distribution of earnings has remained practically unchanged but the richest 20% has increased its share of tax payments. In relative terms, this top 20% is richer because they have increased their share of wealth with respect to the households in the fourth income quintile, but financing a sizable transfer has increased both group's tax burdens.

It is clear that the size of the transfer affects the degree of redistribution in the optimal NIT. A higher transfer implies a higher redistribution, with low-productivity agents experiencing welfare gains while the most productive are worse off. The

Table 6
Flat tax, optimal NIT and "Popular NIT".

Variables	Baseline	Flat tax	Optimal NIT	"Popular NIT"
GDP	100.0	105.2	90.6	98.0
Capital stock	100.0	111.0	78.5	94.2
Labor supply	100.0	102.2	97.8	100.1
Hours	100.0	100.1	93.2	96.7
Savings rate	100.0	105.5	86.7	96.2
Social security benefits	100.0	102.2	97.8	100.1
K/Y	100.0	105.5	86.7	96.2
K/L	100.0	108.5	80.3	94.2
Marginal tax rate	–	15%	22%	19%
Welfare transfers	100.0	105.0	497.8	407.3
CEV	0.0%	0.4%	2.1%	1.7%

Note: A comparison of the macroeconomic performance of an optimal NIT, a "Popular NIT" and a flat tax is shown. Under the flat tax scenario, the actual federal welfare system is still in place; under the NIT's, it is abolished. Aggregate variables are normalized with respect to the benchmark economy (Baseline = 100.0). The welfare gain/loss for different taxes – Consumption Equivalent Variation (CEV) – takes into account the transitional dynamics. See the text for details.

need for a generous transfer in the optimal NIT setting can be traced back to the permanent component of the idiosyncratic shocks. In this setting, agents born with a permanent low-productivity shock are plagued by it for the rest of their working life, 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 NIT's insurance and redistributive features erode the effects that a NIT has on efficiency. Welfare gains come from the fact that low-ability agents are able to insure themselves against their permanent bad shock and not because the most productive agents have more incentives to work.

4.2. The NIT versus the flat tax

I next compare the optimal NIT with a flat tax (income tax plus deduction) that keeps the welfare system unchanged 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 29% deduction ($15,400) computed from the benchmark GDP and a 15% marginal tax rate is optimal.[20] Table 6 outlines the results.

The optimal NIT outperforms the optimal flat tax, which has a 0.4% welfare gain. In this setting, all the implicit transfers from the U.S. income tax (e.g. EITC) are replaced with a fixed deduction and the welfare system is still active, with a big share of welfare transfers focused on the poorest income quintiles. These welfare payments are 5% higher than the benchmark scenario, but they are lower than in the optimal NIT, explaining the flat tax's low marginal tax rate.

The most interesting result is related to the shape of the welfare profile depicted in Fig. 2. With welfare gains of 1.2% and 5.9% for productivity levels 4 and 5, respectively, the most productive agents clearly benefit the most from a flat tax, but low-productivity agents still enjoy the reform due to the increase in welfare spending. They have modest gains in their CEV, in the range of 0.1–0.4%, while the median productivity type has a welfare loss of 0.2%.

This result is in line with previous studies (e.g. Ventura, 1999; Diaz-Gimenez and Pijoan-Mas, 2006) and shows that the presence of a deduction, instead of an income tax's transfer, implies higher tax rates and an increase in savings for middle-income households. Not surprisingly, the fourth quintile of income earners has increased its share of tax payments while the richest 20% is paying proportionally less than in the benchmark case. This increase in savings is concentrated among the income earners below the 60th percentile, who are proportionally wealthier in the flat tax scenario than in the NIT scenario (see Table 5). Arguably, the flat tax is not an easy ride for middle-income households.

This picture is different from what happens in the optimal NIT. The most productive agents are hurt by the reform at the expense of a greater welfare for less productive agents (including the median productivity agents).

Fig. 3 shows the welfare gains by age for all living agents at the time of the reform, considering the transitional dynamics to the new steady state. As it can be seen in Fig. 3(a), a flat tax deduction, instead of income tax's transfers and progressive rates, is preferred by working agents at the middle and tail ends of their working lives and older, or when income earners

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[20] My estimates for the flat tax's rate and deduction are not far away from what has been discussed in the literature. For instance, in their seminal work, Hall and Rabushka (1985) propose a flat tax with a deduction of $22,500 and a marginal tax rate of 19%. However, they do not consider any general equilibrium effects nor any welfare criteria to choose the best possible flat tax. On the other hand, Conesa and Krueger (2006), while studying the optimal level of progressivity in the U.S. income tax under a general equilibrium setting, 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%. Nevertheless, their approach differs from mine because their model does not allow for welfare programs, and income tax transfers such as the EITC.
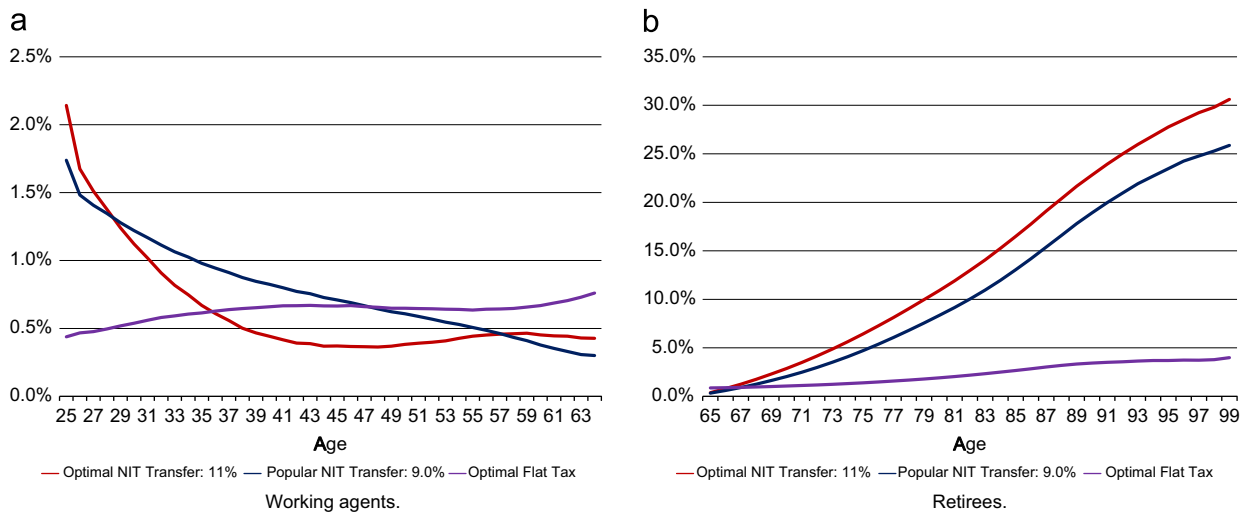
Fig. 3. Welfare gains for all living agents at the time of the reform. *Note*: Conditional on their ages, average welfare gains experienced by all living agents at the time of the reform. All welfare gains reported take into account the transitional dynamics.
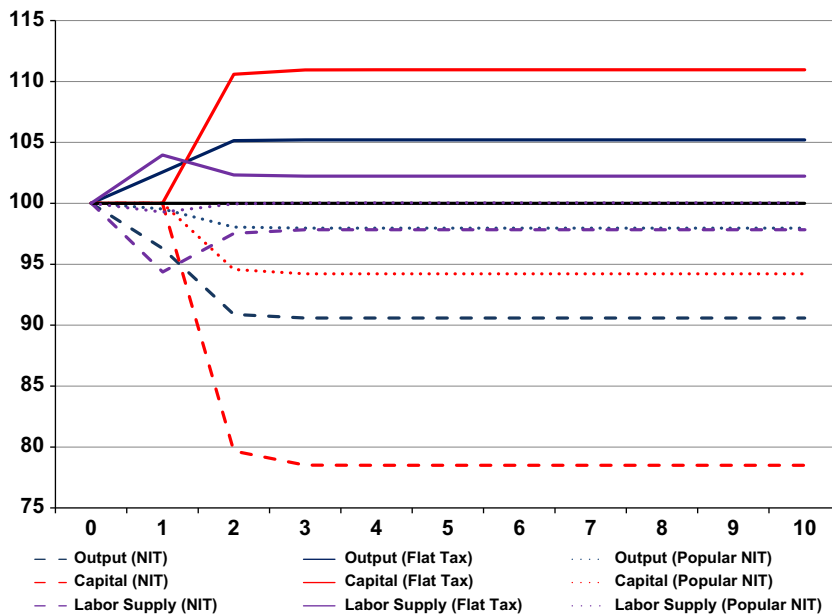

Fig. 4. Transitional dynamics: optimal NIT, popular NIT and flat tax. *Note*: Transitional Dynamics from an unannounced tax reform at time 0 under an open economy assumption.

are at their peak income. Under the NIT, retirees, who are depleting their assets, are able to improve their income and increase their consumption – thanks to the NIT's transfer – and prefer this tax over all other alternatives (see Fig. 3(b)).

There are differences in the macroeconomic performance between a NIT and a flat tax scenario. Under the flat tax, per-capita GDP increases 5% as a result of an increase in capital (11%) and in labor supply (2%). Social security payments increase 2%. Overall, hours have no changes but the youngest (25–29 years old) and oldest agents (60–64 years old) reduce their hours worked (−0.5% and −0.6%, respectively) at the expense of middle-aged agents who work more and compensate their fall in hours (0.6% increase). This is a consequence of the lower marginal tax rate that gives them incentives to work when they are more productive, and not to postpone their work for later in their life-cycle as they did under the NIT.

Meanwhile, in the lower two-fifths of the productivity distribution, there is a reduction in the taxes paid while the median agents see the opposite, explaining the different effects on hours and labor supply. In some groups, an income effect prevails over a substitution effect, and vice versa in others.

It is interesting to compare the transitional dynamics of the two taxes (see Fig. 4). Under the flat tax, immediately after the reform is in force, labor supply peaks and gradually declines. Capital increases period after period until it reaches the new steady state, and GDP goes up as soon as the flat tax becomes effective. On the contrary, under the NIT, labor supply

drops immediately after the reform is adopted, and recovers in a couple of periods without reaching the pre-reform level. There is an important and continuous drop in capital, and GDP gradually declines period after period.

Agents enjoy an increase in consumption due to this reduction in aggregate capital and work less hours while they approach the new steady state, explaining the welfare differences between both taxes. It is clear that in both cases, there is a change in the composition of the labor force: low-productivity agents reduce their supply of market hours while the opposite is true for high-productivity agents.

Summing up, a flat tax implies a higher GDP, capital accumulation, and labor supply than the optimal NIT, but it results in considerably lower welfare due in part to the distortions generated by the welfare system and the different transitional dynamics.

5. Political feasibility

A NIT has a strong support: 49% of the model's population favor the tax. However, whether a NIT can become a law remains an open question. In this section, I show how robust an optimal NIT is, if we pursue a combination of transfers and tax rate that will lead to a NIT with approval ratings higher than 50%. Naturally, given the initial popularity of the tax, the question is reduced to the changes needed in order to entice only 1% of the opposing votes.[21]

For that reason, I define as a "popular NIT," a NIT with a level of transfers and a tax rate that is supported by only 50% of all living households. I find that it consists of a 9% transfer and a 19% tax rate, and has a 1.7% welfare gain. It shares many similarities with the optimal NIT and the main difference between the two lies in the fact that the redistributive component of the tax does not compromise its effects on efficiency.

The first thing to notice is that many living agents at the time of the reform do not want a high transfer at the price of a high tax rate because they are either wealthy capitalists or high-earning workers and they are not interested in any sort of redistribution. This prevailing *status quo* imposes a lower marginal tax rate and transfer, which translates into fewer radical changes in the benchmark economy: there is a 2% drop in GDP and a 6% fall in capital accumulation, while the labor supply remains unchanged, with agents supplying few hours to the market (see Table 6).

Naturally, the transition is smoother and labor supply drops immediately after the new tax comes into force but recovers as time goes by, reflecting the change in the composition of the labor force. GDP and capital gradually decline in contrast to the transition seen under the optimal NIT (see Fig. 4).

In terms of welfare, agents at the center of the productivity distribution are actually better off and the most productive agents now experience welfare gains – although not of the magnitude experienced in the flat tax scenario. Only agents at productivity level 4 suffer a 1% welfare loss (see Fig. 2).

Agents in the middle of their working lives and at their peak of their productivity are the strongest supporters of the "Popular NIT" (See Fig. 3(a)). The fact that a significant share of their income comes from their capital holdings means that they cannot adjust their level of assets as easily as their supply of labor, opting for a tax that reduces their tax payments. This is not the case for agents in their first years of their working life, who practically have no assets and, as a result, favor the optimal NIT despite its higher tax rate. On the other side of the age spectrum, tax rates are less important than the lump-sum transfer and retirees prefer a generous transfer in order to cope with their dissaving. Naturally, the optimal NIT is the right choice for them (See Fig. 3(b)).

6. Conclusions

In this paper, I provide a novel analysis of a Negative Income Tax (NIT) in a general-equilibrium model with ex-ante homogeneous agents beset by idiosyncratic shocks. The model reproduces key features of the U.S. economic data in a setting that explicitly takes into account the tax credits, overlapping provisions, and transfers from the U.S. income tax and welfare system. The NIT, consisting of a transfer and a constant marginal tax rate, is simple and produces an important welfare gain equivalent to a 2.1% annual increase in individual consumption. The NIT outperforms the popular flat tax by a considerable margin.

The NIT has non-trivial effects on insurance and efficiency. With respect to insurance, individual savings drop as the transfer replaces the need to save for precautionary reasons and retirement; with respect to efficiency, high-productivity agents face lower marginal tax rates, giving them incentives to work more hours and low-productivity agents are not trapped by welfare-cliffs. The NIT's transfer enables all agents to work more when they are more productive, changing the composition of labor supply and increasing the average labor productivity by hours worked.

For future research, it will be interesting to further explore the political feasibility of the NIT in a political economy model in order to understand why a tax with such important benefits on insurance and efficiency is not as widespread as one might expect.

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[21] The logic of this exercise can be traced back to Meltzer and Richard (1981). In their political economy model with rational voters, who are not myopic and do not suffer from "fiscal illusion", they show that in single-issue elections under a simple majority rule, the optimal combination of tax rates and lump-sum transfers depends on the median voter's income. As long as his income is below (above) the mean, the outcome is an increase (decrease) of the redistribution via transfers and higher (lower) tax rates.

Acknowledgment

Appendix A. Supplementary data

Supplementary data associated with this paper can be found in the online version at http://dx.doi.org/10.1016/j.jedc.2016.04.008.

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