General Equilibrium Effects of Targeted Transfers: The case of the Earned Income Tax Credit (EITC) *

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Abstract

Transfers have recently become the most important fiscal policy tool of the U.S. Government. Moreover, within the transfer category, refundable tax credits have reached the same magnitude as unemployment insurance, yet little research documents the macroeconomic implications of tax credits. The existing literature on the effect of tax credits, abstract from behavioral responses to policy changes and are silent on potential general equilibrium effects. This paper fills this gap by addressing these two shortcomings of the existing literature, by modeling the Earned Income Tax Credits (EITC) in an infinite horizon economy with exogenously incomplete asset markets and heterogeneous agents. In particular, we assess the welfare effects of the EITC and analyze how effective targeted transfers are in alleviating distortions arising from incomplete financial markets, and contribute to the debate on labor supply responses to EITC. We also conduct two policy exercises. First, we evaluate the impact of a more generous targeted transfer program on welfare and aggregate outcomes, and thereby uncover the distributional properties of this fiscal policy tool. Secondly, we assess whether targeted transfers are a better policy tool than lump sum transfers and show that targeted transfers are indeed welfare enhancing as they achieve more redistribution at lower tax rates, but that they lead to a less efficient production at the aggregate level.

1 Introduction

The Earned Income Tax Credits (EITC) is the largest anti-poverty program for the non-aged population in the United States, and as of 2007 it paid out transfers amounting to about 1% of US GDP to 25 million families. The EITC has over the past decade evolved towards a fiscal policy instrument of the same magnitude as unemployment benefits. The existing literature on the EITC argues that it is a fiscal instrument with good features in terms of income distribution because it lifted over 1.1 million of families out of poverty and reduced poverty rates by around 10% (Meyer 2010). It is with those numbers in mind that the EITC has been expanded under the American Recovery and Reinvestment Act (ARRA) of 2009. Moreover, the EITC's effects relative to Minimum Wage policies

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have been praised by policy-makers because the EITC is targeted towards the working population and has therefore less adverse effects on the decision to work.

The above mentioned evidence is merely the outcome of accounting exercises. This approach neglects two important dimensions that can potentially challenge the policy discourse on the EITC. First, as emphasized by Meyer (2010) the changes in taxes and transfers alter pre-tax and transfer incomes and will affect households' behavior in many dimensions. However, these behavioral responses have to our knowledge not been addressed from a macroeconomic perspective. Second, the implementation of transfer policies of the magnitude of the EITC have economy wide effects, meaning that changes in households' behaviour will affect market clearing prices. Taking into account these effects could either mitigate or strengthen the aforementioned effects of the EITC. In order to revisit the effect of EITC in light of the above two shortcomings, we assess the effect of the EITC in a general equilibrium model with exogenously incomplete markets that gives rise to an endogenous distribution of wealth. By doing so we will not only assess the effects of EITC on economic aggregates and welfare, but also whether the widely accepted success of the EITC in policy circles withholds potential general equilibrium effects, as well as behavioural changes due to the implementation of policies such as the EITC.

The existing literature estimated the effect of the EITC on household labor supply, on household formation, on consumption behaviour and on individuals knowledge about transfer programmes (Chetty and Saez 2013).[1] It has been shown that the EITC has been successful at encouraging labor market participation, and has only marginally distorted the supply of hours worked by tax filers (Eissa and Hoynes 2011). Eissa, Kleven, and Kreiner (2008) focus on the response of single mothers to 4 tax acts that reform the EITC and compute using a welfare theoretic model the welfare implications of these tax reforms. They emphasize the need to distinguish between labor supply responses on the intensive and on the extensive margin, and find that large efficiency gains are achieved by these tax reforms since participation rates of single mothers increased significantly as a response to the tax reforms. Their results are in line with previous research by Eissa and Liebman (1996) and Meyer and Rosenbaum (2001). The additional tax from the phase-out rate reduces the incentive to work amongst the working population.[2] The overall prediction widely advocated in the literature is an increase in the extensive margin (participation) and a reduction in the intensive margin (hours worked) of labor supply, for given prices. The above mentioned evidence on the EITC's effects on labor supply are partial equilibrium analysis, and ignores the effects on equilibrium prices. In this paper, we disentangle how the EITC has affected hours worked directly on the intensive margin, and also via feedback effects due to general equilibrium effects on wages. Furthermore, as argued by Feldstein (1995) most of the literature focuses on labor supply responses to changes in marginal tax rates. However, changes in marginal tax rates also induce households to alter their taxable income by jointly adjusting their labor supply, their portfolio and expenditure decisions. The framework developed below will allow us to disentangle households responses to the EITC both on their labor supply decision and on their asset holding decision.

Liebman (1998) discusses the effect of EITC on income inequality, and stresses that the EITC has expanded over a period in which income inequality has risen. His calculations suggest that the EITC has offset 12.5 percent of the decline in earnings for males in the bottom quintile. Our calibration will allow us to disentangle in which direction the general

[1] Readers interested in a comprehensive review should consult Meyer (2010).

[2] see Section 2.2 for a detailed explanation of the phase-out regime.

equilibrium effects on both wages and interest rates go, and whether the EITC has fuelled or mitigated the increase in income inequality.

Most of the literature on fiscal policy has studied the impact of tax reforms and lump sum transfers on the allocative efficiency of production factors, but overlooked targeted transfers in spite of their quantitative importance as we argue in section 2. This paper sheds light on the welfare implications of EITC and on the effectiveness of this policy instrument in improving the risk sharing properties of an economy. In particular, we evaluate to what extent these targeted transfers affects behavior, general equilibrium prices and inequalities, and consequently to what extent EITC undoes inefficiencies and welfare losses caused by financial market frictions. By doing so, this paper bridges two strands of literature: the literature on fiscal policy in models with heterogeneous agents, and the aforementioned micro-econometrics literature that evaluates the effect of tax credit on household behavior. As suggested by Hotz and Scholz (2003), "research on the labor market effects of tax credits have pushed quasi-experimental and IV repeated cross-sectional analyses using the Current Population Survey (CPS) to their logical limits, but there have not been utility-based structural analyses of the EITC". This is particularly puzzling as the EITC is widely considered as one of the most successful welfare reform in the U.S. lifting at least 4.0 million individuals above the poverty line (Meyer 2010). This paper fills this gap and strives to enrich the understanding of the impact of EITC by disentangling the effect of this transfer policy on economic aggregates, and the distribution of wealth in a general equilibrium environment with heterogeneous agents.

We address this question using an exogenously incomplete markets economy as developed by Pijoan-Mas (2006) where households are ex-ante identical, but differ ex-post with respect to their wealth due to uninsurable idiosyncratic labor productivity risk. We choose this economic environment for two reasons. First, Domeij and Heathcote (2004) emphasize that incorporating heterogeneity dramatically changes the welfare implications of tax reforms. Second, our choice to model endogenous labor supply rests on the importance to relax the assumption of exogeneous labor supply, as in such environments, changes in labor taxes are equivalent to changes in uniform taxation/transfers. This modelling framework allows us to evaluate labor supply responses to targeted transfers such as the EITC, and thereby to contribute to the debate on the effect of targeted transfer on the incentives to supply labor. In fact, most of the debate in the literature on the EITC focuses on it's effect on the incentive to work, in particular on the extensive and the intensive margin (Hotz and Scholz 2003, Eissa and Hoynes 2011, Hoynes and Luttmer 2011, Saez 2002). To our knowledge this paper is the first attempt to shed light on the macroeconomic implications of targeted transfers such as the EITC. We find that the responses of prices are sizeable, in particular with respect to lump sum transfers. The response of prices thus dampens the effect on aggregate quantities to some extent. In this sense, we can confirm the argument of Meyer (2010), who pointed out that one general equilibrium effect of EITC will be a downward pressure on wages.

In this class of economy, households cannot insure themselves perfectly against idiosyncratic income risk. Given the market structure, they use both trade in financial assets and labor supply to smooth consumption. Households with low productivity work more and households with high productivity less than in an economy with complete insurance markets. Also, households tend to overaccumulate assets due to the precautionary motive, such that the allocation is suboptimal from a planner's perspective. Throughout our positive analysis of the EITC, our focus will be the EITC effects on the allocative efficiency of labor supply as highlighted in Pijoan-Mas (2006) and of private insurance as in Aiyagari (1994), and we will discuss the ability of targeted transfers to address the inefficient supply of labor by households, and the over-accumulation of capital. Subsequently, we conduct a policy experiment where we evaluate how changes in the transfer targeting rule affect the allocation and risk-sharing.

We show numerically that redistribution increases welfare and leads to a drop in output, consumption, aggregate labor supply, and capital, for both transfer systems considered. First we show that the effects on welfare are stronger for targeted transfers, which is reflected in lower post-tax Gini coefficients for earnings, and a lower cross-sectional variation of consumption than in the case of uniform transfers. Secondly, the welfare gains for the targeted transfers economy are maximized for a relatively low size of the transfer system, whereas they are still increasing for uniform transfers in that range. In other words, our results suggest that the redistributive capacity of targeted transfers is higher, but that the maximum potential redistribution is limited due to the single dimension of targeting and the non-linear schedule of EITC.

The efficiency gains in term of output per hours worked are only present for uniform transfers. Although targeted transfers induce the right qualitative effect on hours worked by productivity (and uniform transfers do not), the negative quantitative effect on low income workers is not strong enough and output per hour falls. This effect is due to the contingency of transfers on labor income: households internalize the change in transfers in their intratemporal decision. Since the transfer schedule is increasing for low income households, and income and productivity are positively correlated, households experience a negative wealth effect from cutting down hours worked because the forgone income is larger than the utility loss incurred. Uniform transfers do not depend on household characteristics and show different dynamics in this respect.[3]

Also this paper contributes to the literature on endogenous labor supply decisions in models of limited insurance. Alonso-Ortiz and Rogerson (2010) extend a standard Aiyagari model to evaluate the aggregate effects of tax and transfer programs. In particular, they focus on the effect of assistance programs on labor supply decisions. Their analysis of a simple labor tax that finances uniform transfers highlights two key findings that are closely related to this paper. First, they show that moving from a low tax environment to a high tax environment when markets are incomplete and households heterogeneous, the implied welfare losses are reduced by a factor of 3 compared to the standard complete markets scenario. Second, tax and transfer programs have a substantial positive impact on output per hours worked, leading the authors to argue that the productivity catch up of European countries relative to the US could be a mere reflection of the differences in tax systems. Our paper differs from theirs due to our focus on borrowing and, and the contingency of the uniform transfers on households' labor earnings and capital income. Furthermore, Alonso-Ortiz and Rogerson (2010) consider a model with indivisible labor supply only, whereas we adapt the intensive margin framework from Pijoan-Mas (2006). We will show in our comparative policy experiment that our framework replicates their results, and extend their analysis along the distributional dimension.

The rest of this paper is organized as follows. In the next section, we document the quantitative importance of uniform transfers as a component of government budgets, and

[3]This welfare exercise compares steady states and does not yet take transitions dynamics and thus initial wealth heterogeneity of agents into account. We are aware that conclusions could well be reversed when we take into account transition dynamics, as in Domeij and Heathcote (2004).

deliver insights into the Earned Income Tax Credit program. In section 3, we describe the model economy. Section 4 presents the parameter choice, the solution method and discusses the results. Section 6 conducts two policy experiments and section 7 concludes.

2 Empirics

This section delivers descriptive statistics that documents the recent increase of government transfers as well as the importance of the EITC, amongst the transfer category. Subsequently, we provide descriptive evidence on the EITC and its technicalities, as well as a brief summary of the effects of EITC documented by the empirical literature.

2.1 Trends in U.S. Government Spending

This section highlights several facts on U.S. government spending, in particular on the relevant importance of various fiscal policy instruments. Figure 2.1 plots government consumption, transfers, and government investment as shares of total U.S. Government Expenditures, and the shaded areas plot the recessions as defined by the NBER. In general, over the past 20 years, one can observe a compositional shift towards transfers[4] and away from investment in US government expenditure, whereas government consumption as a fraction of government expenditure remained roughly constant. Interestingly as a response to the last recession, transfer policies have become the most prominent fiscal policy tool. As of 2011, transfers amount to 43% of total government spending, although up until 2008, the share was still around 40% and back in 1990, it was just above 30%.

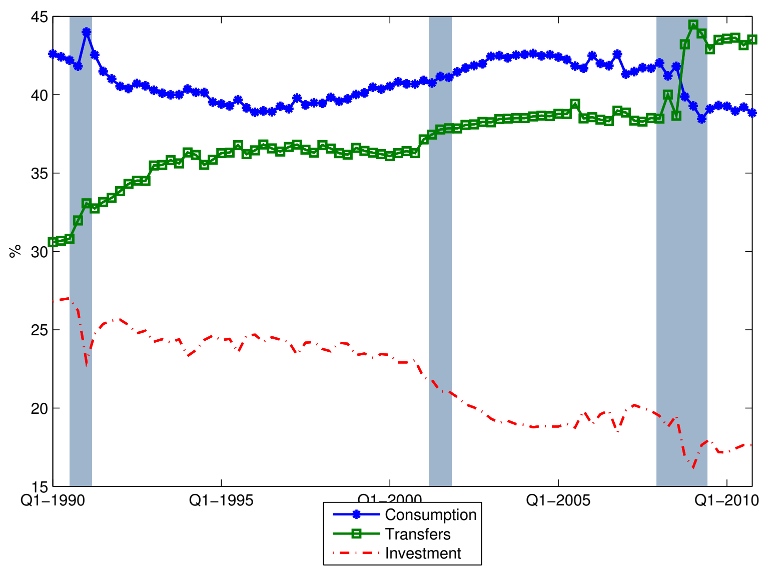

Figure 1: Decomposition of U.S. Government Expenditure (1990-2010)

Contrasting the increased importance of transfers with the occurrence of recessions, one can observe that recessions accelerated the compositional shift of government spending towards transfers. This policy activism seems intuitive as transfers are mostly thought of

[4]Transfers are defined as the sum of social benefits, subsidies and capital transfers.

as short-term alleviations of welfare losses incurred in recessions. Further, the fact that these transfers programs have not been scaled back when recessions resumed is robust. To complete this descriptive analysis on the importance of fiscal transfers as a policy instrument, we plot in Figure 13 the fiscal policy instruments as ratios of GDP, in order to highlight their magnitude and dynamics in relation to the economy.

We observe that transfers have been increased at a faster pace than GDP over the past two decades, in contrast to government consumption which mostly grew as fast as GDP, and government investment, which has been reduced relative to GDP. Government transfers and consumption now amount to 17 and 15 % of GDP respectively. Over the past 20 years, transfers have grown by 7 % point more than GDP, further reinforcing the importance gained by this fiscal tool.

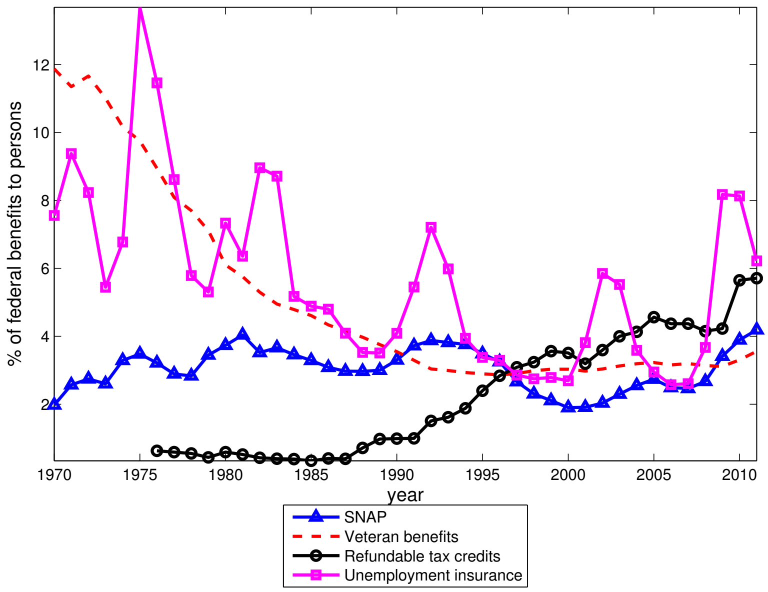

Figure 2: Shares of selected transfer categories in total federal social benefits, 1970-2012. Source: BEA NIPA table 3.12.

The increase in transfers as a share of government spending has been fuelled by two factors. First, social security and Medicare/Medicaid constitute the lion's share of total transfers (see Figure 14). Second, the share of spending on unemployment insurance has increased substantially due to the spike in unemployment in 2008-2010. In contrast to EITC, these two policy instruments have radically different effects on household behavior but also they target different socio-economic population groups. In fact, both unemployment insurance and social security / Medicare are not a policy tool that redistribute resources within the current *working* population, whereas the Earned Income Tax Credit (EITC) is such a means-tested transfer programme.

2.2 Means-tested Transfers: The EITC

The EITC has become the main redistribution policy at the Federal level in the United States. In the past, fiscal policies aimed at securing a minimum income, and thereby targeted the poorest of the whole population. Recently, these policies have been slowly substituted by policies that subsidize work rather than secure a minimum income, thereby

Table 1: Eligibility criterion for the Earned Income Tax Credit program

- Earned and adjusted gross income below a threshold that varies by year and family size (Figure 3).
- A qualifying child must be younger than 19 (24 if student or disabled).
- Claimant must be parent / grandparent / foster child.
- Child must live at least 6 months with the tax payer.
- Sum of interest, dividends, net capital gains, rents and royalties must be less than $ 2,350.

targeting the poor working population. The main political rationale behind this compositional shift is to offset potential adverse effects of minimum income on the incentives to work (Hotz and Scholz 2003). Because the EITC is in contrast to traditional income support programs (Food Stamp, Temporary Assistance for Needy Families) aimed at households whose members are part of the labor force, this shift in the policy has lead to an expansion of the EITC. Since its introduction in 1975, it steadily expanded and the number of eligible participants has increased rapidly to reach in 2008, about 25 million, at a total cost to the federal government of $51 billion (Eissa and Hoynes 2011, Hotz and Scholz 2003).

For a household to be eligible to EITC, the conditions listed in Table 2.2 must be fulfilled. The amount of tax credit perceived is a function of the households earned income, the filing status, and number of children as depicted in Figure 3. The total amount of tax credit perceived is a (positive) function of both the filing status of the household, and the number of children living within the household. With regard to total annual earned income, the total tax credit shows three distinct regimes. In the first regime, referred to as the phase-in regime, the tax credit acts as a subsidy on earnings. In the second regime, tax credit are invariant with earnings, and finally in the third regime, the phase-out regime, tax credit are a negative function of earnings.

Dowd and Horowitz (2011) look at the profiles of EITC recipients over the period 1989-2006 and find that a sizeable fraction of recipients during this time used EITC as a "temporary safety net". To shed light on this aspect of the EITC, Table 8 relates the range and size of EITC transfer to the poverty threshold, by family.[5] For instance, a household composed of a working single-parent and one child receives positive payments throughout the EITC programme if her earnings are up to 233% of the official U.S. poverty threshold. The maximum sum is received for earnings within 59-108% of the poverty threshold, and can be up to 34% of labor income. Thus, while EITC provides a substantial subsidy for families below the poverty threshold (but not too low), the programme also extends beyond this line. An additional feature of the EITC is it's relative generosity to married couples that file tax returns jointly (see Table 8). Also Meyer (2010) reports that in 2007 17% of the people who filed tax returns received a positive transfer from the program. Since the poverty rate of the U.S. working age population in that year was 10.9%, this suggests that EITC reaches out to households beyond the poverty threshold. Finally,

[5] The data are based on EITC 2011 (IRS 2011) and poverty data from the U.S. Census Bureau due to unvailability of complete information for 2012.

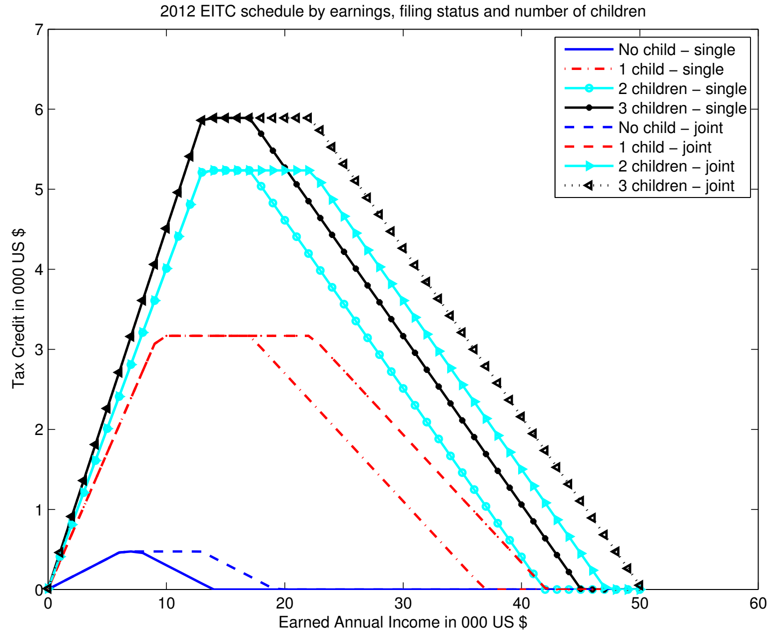

Figure 3: EITC schedule. Source: Department of Treasury - Internal Revenue Service - Publication 596

these numbers need to be handled with care, as the literature argues that the unawareness among the low income families of the benefits to file a tax return is still quite high (Hotz and Scholz 2003, Chetty and Saez 2013) - they are under-represented in total tax filers.

Table 9 further documents the importance of potential core EITC recipients in total U.S. population, and sketches their socio-economic characteristics. A large fraction of participants and of total benefits in EITC is claimed by single mothers, who constitute only about 5% of U.S. working age population, but 48.3% of EITC claimant. Within that group, poverty is a widespread phenomenon: more than one third of these families have an income below the poverty threshold. EITC benefits are also important for the group of married couples with children. For this group, the poverty rate is quite low, compared to all other subgroups.[6]

This section highlighted the empirical relevance of fiscal transfers as a policy tool, and therefore suggests the need to better understand its impact on allocation and welfare as well as how to design such transfers programs. In the following sections, we assess the welfare properties of a transfer program that replicates features of the EITC in a model economy.

3 The Model

The economy is populated by three types of agents: households, a government and firms. Households supply labor elastically to firms, consume a homogeneous good, and hold risk-free assets of firms' capital stock. They face idiosyncratic shocks to their labor productivity against which they attempt to insure by both borrowing and lending risk-free assets and supplying labor. Firms use labor supplied by households and capital whose assets are

[6]There is no differentiation with respect to number of children in the overview tables.

held by households, to produce the final good. They operate with a constant returns to scale production function and there is free entry in the market. The government pays out transfers to households according to a fixed transfer policy rule which it finances by levying a proportional tax on labor income.

3.1 Households

The economy is inhabited by a continuum of ex-ante identical households. In every period, a household receives a shock to labor productivity, ϵ_t. Ex post, households are heterogeneous because they are unable to insure against their idiosyncratic productivity risk. Households are dynastic and the population is constant. Households derive utility from consumption (c_t^i) and disutility from supplying labor (n_t^i). We assume that instantaneous utility is additively separable in consumption and leisure (l_t^i). Households maximize expected life time utility subject to the infinite sequence of budget constraints:

$$\mathbb{E}\sum_{t=0}^{\infty}\beta^t[u(c_t^i)+g(l_t^i)] \tag{1}$$

$$\begin{aligned} c_t^i + a_{t+1}^i &= w_t\epsilon_t n_t^i + (1+r_t)a_t^i - T(w_t\epsilon_t n_t^i, r_t a_t) && (2)\\ a_{t+1}^i &\geq \underline{a}, && (3)\\ n_t^i &= 1 - l_t^i && (4)\\ 0 \leq\; l_t^i &\leq 1 && (5) \end{aligned}$$

where β is the subjective discount factor, and $\mathbb{E}$ is the mathematical expectations operator. In each period, households choose their consumption (c_t^i), labor supply (n_t^i) and asset holdings for the next period (a_{t+1}^i) such that their budget constraint is satisfied. Their wealth is composed of current labor income which amounts to the product of their productivity (ϵ_t), hours worked (n_t^i) and the aggregate wage rate (w_t). Also they derive income from their capital holdings (a_t^i) which is remunerated at the market interest rate (r_t), and finally they receive transfers from the government ($T(W,D)$). The amount of transfer a household perceives from the government depends on its characteristics as will be made explicit in Section 4.1. Households can borrow up to an exogenous borrowing limit $\underline{a}$, which is identical for all agents.[7]

3.2 Government

The government taxes labor income at the rate τ and redistributes these revenues as targeted transfers to households such that its budget constraint is balanced in every period. We assume that the government conditions the targeting rules of transfers ($T(W,D)$) as a function of both the households' earnings *before* taxes (W), and gross capital holdings (D), as it is the case for the EITC. Note that $T(W,D)$ is defined as a net-tax function at the household level (i.e. it embeds the tax on labor income and the transfer targeting rule).

$$W \equiv w\epsilon(1-l), \qquad D \equiv (1+r)a \tag{6}$$

[7]In the analysis, we will focus throughout on stationary equilibria, that is $r_t = r$, $\forall t$.

Denote by $T_W \equiv T_k(W, D)$, and $T_D \equiv T_D(W, D)$ the partial derivatives of the transfer schedule.

The government budget constraint is the following:

$$0 = \int \int T(W(a, \epsilon), D(a, \epsilon))\lambda(a, \epsilon)\, da\ d\epsilon. \tag{7}$$

3.3 Firms

Firms operate a constant returns to scale technology and are perfectly competitive. They use capital K_t and labor L_t to produce the final good, Y_t. δ denotes the depreciation rate of capital. Returns on capital (r_t) are defined as net of depreciation, $r_t = R_t - \delta$, where R_t is the marginal productivity of capital. The problem of the representative firm is standard and reads as follows:

$$\Pi_t \equiv \max_{K_t, L_t} AK_t^{\alpha} L_t^{1-\alpha} - (r_t + \delta)K_t - w_t L_t. \tag{8}$$

Demand for (effective) labor and capital satisfy the following static optimality conditions:

$$r_t = \alpha A \left(\frac{K_t}{L_t}\right)^{\alpha - 1} - \delta, \qquad w_t = (1 - \alpha)A \left(\frac{K_t}{L_t}\right)^{\alpha}. \tag{9}$$

3.4 Recursive Formulation of the household problem

The household's maximization problem can be written recursively as a function of her state variables a, ϵ. Let $V(a, \epsilon)$ denote the discounted expected life-time utility of a household with asset holdings a and productivity ϵ, and a' be the households' capital holdings choice. The maximization problem in recursive form reads as follows:

$$\begin{aligned}
V(a, \epsilon) &= \max_{a', l, c} u(c) + g(l) + \beta \int_{\epsilon' \in \Omega} V(a', \epsilon') f(\epsilon, \epsilon') d\epsilon' && (10)\\
\text{s.t.} \quad c + a' &= w\epsilon(1 - l) + (1 + r)a - T(W, D) && (11)\\
0 \leq \ l &\leq \ 1 && (12)\\
a' &\geq \underline{a} && (13)
\end{aligned}$$

Let μ denote the Lagrange multiplier on the borrowing constraint, and ν be the Lagrange multiplier on the upper bound for leisure l. Given the targeting rule for transfer (see equation [cite]), the amount of transfers distributed by the government depend on the households' choice variables n_t, a_t, or possibly both. The household internalizes the transfer rule in her decision-making, which is reflected in the following intertemporal optimality condition of the household problem.

$$u'(c) = \beta(1 + r - T_D)\mathbb{E}u'(c') + \mu, \quad \mu \geq 0. \tag{14}$$

The households' intertemporal optimal condition dictates that whenever the borrowing constraint is binding, *ceteris paribus* current marginal utility from consumption increases and consumption is lower than when the constraint does not bind. In this environment

with endogeneous labor supply, the value of the multiplier will crucially depend on how much the household uses labor supply to smooth consumption, that is the relative curvature of the utility from consumption and leisure.
As the transfer system is contingent on households' capital income, the transfer system directly impacts the return on capital which becomes household specific. If $T_D < 0$, that is, if the transfer system benefits low asset holders, the household faces a *tax* on asset holdings and internalizes this into the optimal investment choice. A steep transfer function *ceteris paribus* translates into lower savings and higher current consumption. On the other hand, in the presence of such a transfer system, a credit constrained household benefits from receiving a higher transfer, which reduces his consumption volatility.

The intratemporal optimality condition determines time allocated to work.[8]

$$g'(l) - \nu = u'(c)(1 - T_W)w\epsilon, \qquad \nu \geq 0, \ l \leq 1 \tag{15}$$

The upper bound on hours worked may be binding: Suppose the household is very wealthy and her marginal utility of consumption is very low. Given a transfer system, a wage rate and productivity, there is a level of consumption $\tilde{c} = D + T(0, D)$ such that $g'(1) \leq u'(\tilde{c})(1 - T_W|_{W=0})w\epsilon$. [9]

3.5 Stationary Competitive Equilibrium

Definition Given a borrowing limit $\underline{a}$, a labor income tax τ and a transfer allocation rule $T(D, W)$, a stationary competitive equilibrium is a set of positive prices w, r, a positive quantity of aggregate labour supply L, and capital K, time invariant decision rules $n(a, \epsilon), a'(a, \epsilon)$ and a probability distribution $\lambda(a, \epsilon)$ such that:

1. The price w, r satisfy the static optimization problem of the representative firm formulated in section 3.3

2. The policy functions $c(a, \epsilon), n(a, \epsilon), a'(a, \epsilon)$ solve the household maximization problem formulated in section 3.4

3. The government balances its budget constraint such that equation 7 holds.

4. The probability distribution $\lambda(a, \epsilon)$ is a stationary distribution s.t.

$$\lambda(a', \epsilon') = \int_{\epsilon} \int_{a:a'(a,\epsilon)} \lambda(a, \epsilon) df(\epsilon'|\epsilon) \tag{16}$$

5. The labor market clears, such that aggregate effective labor equals the sum of all individual hours supplied multiplied by their respective productivity:

$$L = \int_{\underline{a}}^{\bar{a}} \int_{\epsilon} \epsilon n(\tilde{a}, \tilde{\epsilon}) \lambda(a, \epsilon) d\tilde{a} d\tilde{\epsilon}, \tag{17}$$

[8] We use a utility specification that has $\lim_{l \to 0} g'(l) = \infty$ and impose conditions on assets such that it will never be optimal to spend all time working.

[9] Obviously, $\tilde{c}$ is decreasing in ϵ and $T(0, D)$.

6. The capital market clears, such that the aggregate capital stock is the sum of all individual asset holdings:

$$K = \int_{\underline{a}}^{\bar{a}} \int_{\epsilon} a(\tilde{a}, \tilde{\epsilon}) \lambda(a, \epsilon) d\tilde{a} d\tilde{\epsilon}. \tag{18}$$

7. By Walras Law, the goods market clears.

3.6 Complete Markets

The natural benchmark for our analysis is the above economy without financial frictions: households have access to a complete set of state contingent arrow securities. In such an economy, individual allocations depend only the current realization of productivity and not on the history of shocks (see Appendix B for derivations). Due to the assumption of additive separable preferences, consumption will be identical across agents and over time. Also, the correlation between productivity and hours worked is perfect. There are two possible sets of benchmark allocations to compare the incomplete markets economy with transfers to. The first is the *undistorted economy*, without taxes and transfers. Comparing this economy to the economy with transfers assesses the total net effect of redistribution: The negative welfare and allocative effect from distortionary taxation, and the positive effect from providing ex post insurance to low income households. Relative labor supply only depends on the utility for leisure. For two values of labor productivity $\epsilon^i > \epsilon^j$, we have:

$$n^i = \max \left[1 - v^{-1\prime} \left(\frac{\epsilon^i}{\epsilon^j} \right) (1 - n^j) \, , 0 \right], \tag{19}$$

which, if $v(l^i)$ is increasing in n^i, is increasing in ϵ^i.

The second benchmark is the economy with complete markets, but with distortions due to the tax and transfer system. In this case, relative labor supply depends also on the aggregate wage rate and the shape of the transfer system because the marginal tax rate depends on individual income:

$$n^i = \max \left[1 - v^{-1\prime} \left(\frac{(1 - T_{W(\epsilon^i)}(W, b))\epsilon^i}{(1 - T_{W(\epsilon^j)}(W, b))\epsilon^j} \right) (1 - n^j) \, , 0 \right]. \tag{20}$$

For a broad range of ϵ^i, we will still see a monotone relationship between n^i and ϵ^i. However, there are differences with respect to Equation (19): if the equilibrium marginal tax is relatively lower for low productivity agents than for high productivity agents, they will work relatively *more* than without transfers, because the income gain is larger than the utility loss from having less free time.

4 Parametrization

In this section, we discuss the parameter choice, the tax systems and the solution method for the benchmark economy.

4.1 Tax and Transfer System

In this subsection, we contrast two tax and transfer system. Both have a proportional tax on labor earnings, however one features a uniform transfer (as in Alonso-Ortiz and Rogerson (2010), Floden and Lindé (2001), Golosov and Sargent (2012) and Krusell, Mukoyama, Rogerson, and Sahin (2008)) whereas the other one features a targeted transfer system which replicates the EITC.[10]

4.1.1 Uniform Transfers

When transfers are uniform, the government simply redistributes revenues from labor income taxation in a lump-sum fashion across all households (Υ). As a bi-product, the marginal tax rate is constant as shown in equation (22).

$$T(W, D) = \tau w \epsilon (1 - l) - \Upsilon, \tag{21}$$

$$T_W(W, D) = \tau, \quad T_D = 0. \tag{22}$$

The government budget constraint simplifies to:

$$\tau w N = \Upsilon. \tag{23}$$

In this case, the economy is analogous to the one in Alonso-Ortiz and Rogerson (2010). Their economy is our natural benchmark for our policy experiment in Section 6, where we will contrast the welfare properties of a lump-sum transfer economy with an economy, where transfer are targeted towards income, such as the EITC as exposed in the following subsection.

4.1.2 Targeted Transfers

This second tax system features a targeted, non-linear transfer policy that conditions the transfers on households' labor income only.

$$T(W, D) = \tau w \epsilon (1 - l) - \Upsilon(W), \tag{24}$$

$$T_W(W, D) = \tau - \Upsilon_W(W), \quad T_D = 0. \tag{25}$$

In this case, government revenues still depend on aggregate effective labor supply, but expenditures now depend on the distribution of income:

$$\tau N_t = \int_{\underline{D}}^{\bar{D}} \int_{\underline{W}}^{\bar{W}} \Upsilon(\tilde{W}_t, \tilde{D}_t) \lambda(\tilde{W}_t, \tilde{D}_t) \, d\tilde{W}_t \; d\tilde{D}_t. \tag{26}$$

The EITC is the empirical counterpart of our transfer function. We approximate the EITC by using a Ricker function, which takes the following form:

$$\Upsilon(W) = \eta_1 W \exp^{-\frac{W}{\eta_2}}, \tag{27}$$

[10]Golosov and Sargent (2012) consider an economy without individual income risk, but instead with permanent earnings and wealth inequality.

where η_2 sets the unique maximum of the function, and η_1 determines the function value at zero. The derivative of the transfer function with respect to W is

$$\Upsilon_W = \eta_1 exp^{-\frac{W}{\eta_2}} \left(1 - \frac{W}{\eta_2}\right). \tag{28}$$

Since $exp^{-\frac{W}{\eta_2}}$ is a strictly decreasing continuous function in W, $\Upsilon(W)$ has a unique maximum at

$$W^0 = \eta_2. \tag{29}$$

The limit as W grows larger is zero for both the value of the function as for the derivative (which is negative beyond W^0). Finally, the transfer function in the range considered here has one point of inflection, after which it becomes convex.

$$\Upsilon_{WW} = \Upsilon(W) \left(1 - \frac{W}{\eta_2}\right)^2 - \Upsilon(W) \frac{1}{\eta_2}. \tag{30}$$

Given $\eta_2 < 1$, for $W \in [0, W^0]$, the square in brackets is smaller than or equal to one and decreasing in W, and $\Upsilon_{WW} < 0$. The turning point is[11]

$$W^{TP} = \eta_2 \left(1 + \sqrt{\frac{1}{\eta_2}}\right) > \eta_2. \tag{31}$$

The marginal tax schedule in this case is

$$T_W(W, D) = \begin{cases} \text{increasing} & 0 < W < W^0 \\ \text{increasing} & W^0 \leq W \leq W^{TP} \\ \text{decreasing} & W > W^{TP} \\ \lim_{W \to \infty} T_W(W, D) & = \tau \end{cases} \tag{32}$$

Figure 15 shows the U.S. marginal tax rate quoted from Eissa and Hoynes (2011) for the year of 2004. It appears that ours is missing an increase after the peak rate for intermediate incomes, but the general shape is consistent.

In the benchmark transfers economy, we fix η_2 such that the maximum transfer is received by the average earnings of the first quintile. We calibrate η_1 to determine the transfer to income ratio $\eta_0 = 40\%$ for the lowest 1% earnings in the stationary distribution.[12]

$$\eta_1 = \eta_0 \exp^{\frac{W_{min}}{\eta_2}}. \tag{33}$$

Given that $\exp^{-\frac{W_{min}}{\eta_2}}$ is strictly decreasing in W, the transfer rule implies that the transfer to income ratio is decreasing from W_{min} onwards, and for $W > W^0$ also total transfers will decrease. This is contrary to the EITC schedule, where the transfer rate first remains constant (phase-in range), then decreases such that the transfer remains constant, and lowered thereafter (phase-out range). We make the choice of this approximation mainly for computational reasons. Introducing discontinuous transfer rules has inconvenient effects on the numerical solution due to strongly discontinuous policy functions and

[11] The other turning point is $\tilde{W}^{TP} = \eta_2(1 - \frac{1}{\eta_2})$, which is at negative income values as long as $\eta_2 < 1$. If $\eta_2 > 1$, $W^{TP} < W^0$, which is not desirable. This never happens in the calibration.

[12] For $W_{min} = 0$, transfer payments are zero.

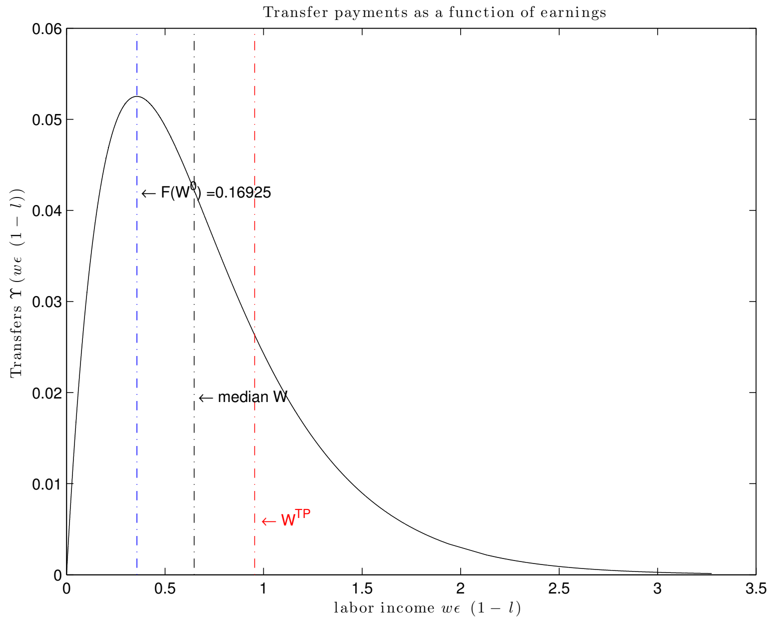

Figure 4: Transfers as a function of labor earnings. $W^0 = q_2$, $\eta_0 = 0.4$.

close to degenerate distribution functions. This itself may be an interesting alternative avenue to explore as there is empirical evidence of bunching to some extent (Saez 2010).

Figure 4 plots transfers as a function of labor earnings in this case. Figure 5 plots the marginal tax rate, net tax payments ($T(W)$), and the ratio of transfers to labor earnings. Median income is plotted as the dashed line.

Υ_n in the households' optimization problem becomes

$$\Upsilon_n = \Upsilon(W)\left(1 - \frac{W}{\eta_2}\right) w\epsilon. \tag{34}$$

Rewriting the intra temporal optimality condition:

$$\frac{-g'(l^i)}{u'(c^i)} = (1 - \tau + \Upsilon_W) w\epsilon, \quad \forall i. \tag{35}$$

The current transfer rule affects a household differently depending on which part of the income distribution she currently resides. For $W \leq W^0$, the transfer schedule acts as a subsidy to labor supply; for incomes above as an additional tax. The sum of tax and marginal transfer is the marginal tax rate in this model. Beyond the turning point of the transfer function, the additional tax decreases again because the transfer function flattens out quicker than before. The marginal tax rate decreases beyond W^{TP} and tends towards τ as marginal transfers goes to zero.

4.2 Parameter Choice

For the purpose of the calibration of our benchmark economy, we follow Pijoan-Mas (2006) to calibrate the economy *without transfers*. We calibrate our model to annual data because the EITC is received annually in a single check.[13]

[13] The average amount of the check is \$1,500 (Meyer 2010).

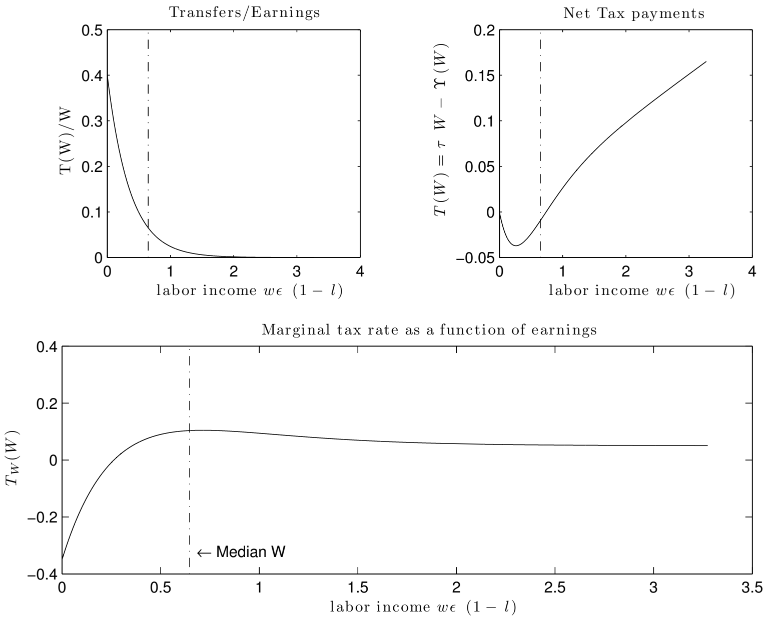

Figure 5: Transfers as a function of labor earnings. $W^0 = q_2$, $\eta_0 = 0.4$.

Two comments are in order. First, there are no transfers in Pijoan-Mas (2006), whereas the data on labor supply implicitly include taxes and transfers. Second, given that the model has been calibrated to the economy without transfers, by construction we will not be able to match the moments better in the model with transfers. The current quantitative analysis is thus a first step building on the literature; a further step will then account for transfers in the baseline calibration.

The instantaneous utility function takes the form:

$$u(c) + g(l) = \frac{c^{1-\gamma}}{1-\gamma} + \chi \frac{l^{1-\psi}}{1-\psi}, \quad \gamma > 0, \quad \chi > 0, \quad \psi > 0, \quad \gamma > 0, \tag{36}$$

where γ is the coefficient of relative risk aversion, χ the parameter scales the utility from an additional unit of leisure and ν pins down the Frisch elasticity of labor supply.

The stochastic process for labor productivity is assumed to be log-normally distributed and follows a stable autoregressive process of order one.

$$\log \epsilon_t = \rho \log \epsilon_{t-1} + \zeta_t, \qquad \zeta_t \overset{i.i.d.}{\sim} \mathcal{N}(0, \sigma_\zeta^2) \tag{37}$$

The calibration for the parameters of the transfer function is explained in section 4.1. We fix η_0 so that the maximum transfer to earnings ratio amounts to 40%, η_1, such that this is given to the 1% poorest earner, and η_2 such that the maximum total transfer expenditures goes to the upper first quintile of the earnings distribution. Furthermore, we fix the borrowing limit to a 100% GDP as in Pijoan-Mas (2006). We assume that in addition to government transfers, there is also a constant fraction of output consumed by the government in form of wasteful spending: $\frac{G}{Y} = 0.13$. In the economy without transfers, the government needs to impose a flat tax on labor of 20.31% to balance its budget.

In the benchmark calibration, 10% of households are borrowing constrained (versus 12.6% in the economy with transfers), 99.8% of which have a productivity below the

Parameter	Target	Calibrated value
β	$(K/Y=3)$	Set to 0.948
$1-\alpha$	$\frac{wL}{Y}$	Set to 0.64
γ	$corr(n,\epsilon)$=0.02	1.5733
ψ	$cv(n)$=0.02	3.6039
χ	N=0.33	0.6807
δ	$\frac{I}{Y}$=0.25	0.0822
$\underline{a}$	24.5% in debt	-0.4709
ρ	persistence of $\log\epsilon$	0.92
σ_ζ	std of $\log\epsilon$	0.21
η_0	Max $\frac{\Upsilon}{W}$	0.4
η_1	poorest 1%	0.5057
η_2	Max Υ at first 20%	0.3478

Table 2: Source: Folloing Pijoan-Mas (2006), Productivity process: Floden and Lindé (2001)

unconditional mean. Overall, the size of the transfer system is 4.8% of GDP, which implies a tax rate of 27.84%. The transfer system is bigger than EITC, and the tax rate is lower than the overall tax rate faced by U.S. households (see Figure 15). The match with current U.S. data could be improved by including ex-ante heterogeneity in productivity to achieve a better fit with the actual size of the EITC program. Furthermore, the labor tax schedule is not progressive in the current calibration, which exaggerates the burden on poor households and understates it for rich ones.

The borrowing limit is set such that 24.5% of households are indebted, following Ábrahám and Cárceles-Poveda (2010).

5 Results

We begin by briefly reviewing the policy functions of the economy. Subsequently, we report the equilibrium allocation of the model without transfers and show that we replicate the results of Pijoan-Mas (2006). Building on this, we then move to disentangling the effects of the calibrated transfer system on the economy.

5.1 Policy Functions

Figure 6 plots the policy functions for the baseline model without transfers. The borrowing constraint leads to a very steep labor supply policy function and consumption policy function for households with low labor productivity and a high marginal utility of consumption. This translates into very low levels of expected lifetime utility for low asset holders.

Figure 7 plots the differences in consumption, labor and asset choice policies for targeted transfers with respect to the economy without transfers. In the economy with transfers, low productivity households consume more and save more (for low and intermediate asset levels) than without transfers, as a direct consequence of the transfer. Furthermore, low productivity households also work more when they are not indebted. When they are,

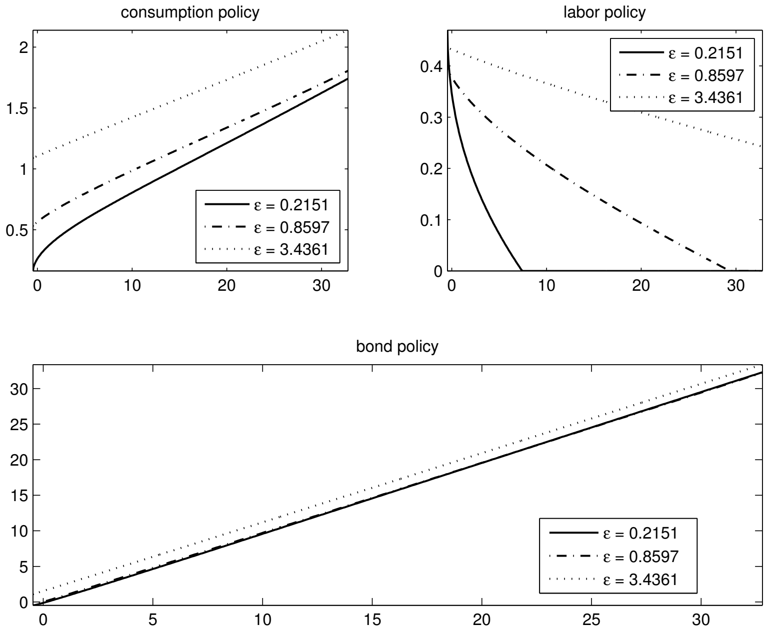

Figure 6: From top left to bottom left, clockwise: Consumption policy, labor policy, and bond policy in the baseline model with transfers

they work slightly less because of a positive wealth effect.[14] Very high productivity households work slightly more than without transfers unless they are very asset rich, because they suffer the highest loss in income with the introduction of the transfer.

5.2 Distributional Statistics

Table 3 shows the distributional statistics for both the economy without transfers, as in Pijoan-Mas (2006), the economy with calibrated targeted transfer functions and those observed in the data (Current Population Survey, CPS).[15] Our model matches relatively well the U.S. earnings distribution as well as the distribution of hours worked, but as expected, our model performs worse than Pijoan-Mas (2006) as we use an income process that has been calibrated to an economy without transfers.

The introduction of targeted transfers has a small effect on the cross-sectional distribution of hours worked and earnings: hours worked decrease slightly across all quintiles. This results is very much in line with the micro-econometric papers that analyze the effects of EITC on the intensive margin of labor supply (Eissa and Hoynes 2004, Eissa, Kleven, and Kreiner 2008). The introduction of targeted transfers shifts the distribution of pre-tax earnings to the right. The households in both the first and the fifth quantile of the wealth distribution receive a higher fraction of total pre-tax earnings, whereas the share of earnings perceived by the middle class is reduced. As a bi-product, the introduction of transfers leads to higher earnings inequality.

[14] Most low productivity households will be indebted in this model or hold very low assets, so the overall response of low productivity households' labor supply will be negative.

[15] As a reference, we report the values from Pijoan-Mas, Table 2.

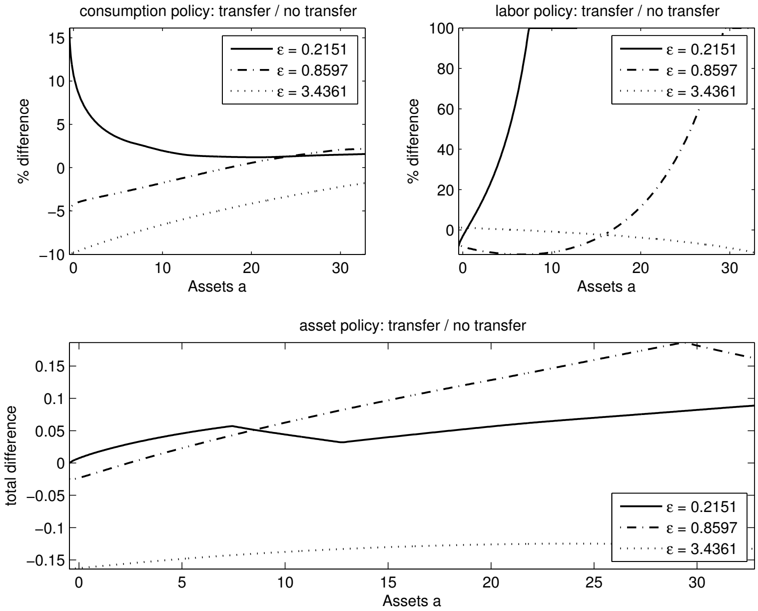

Figure 7: From top left to bottom left, clockwise: Consumption policy, labor policy, and bond policy in the baseline model with transfers, percentage difference of uniform to targeted, absolute differences for bond policies.

	cv	q_1	q_2	q_3	q_4	q_5
Hours						
Model w/o transfers	0.220	0.215	0.306	0.346	0.375	0.408
Pijoan-Mas (2006)	0.22	0.21	0.31	0.35	0.37	0.40
Model w/ transfers	0.214	0.205	0.286	0.328	0.358	0.386
Data (CPS) (%)	0.22	0.24	0.31	0.33	0.35	0.42
Pre-tax Earnings						
Model w/o transfers (%)	0.638	7.241	12.413	17.596	22.941	39.809
Pijoan-Mas (2006) (%)	0.65	7.3	12.4	17.2	23.0	40.1
Model w/ transfers (%)	0.674	7.313	12.010	16.751	22.706	41.219
Data (CPS) (%)	0.56	7.9	13.7	18.0	23.3	37.1

Table 3: Distributional Statistics: Model with and without transfers. *Data are quoted from Pijoan-Mas (2006). Results from Table 2.*

5.3 Aggregate Statistics

In this subsection, we contrast the aggregate outcomes of the economy without transfers, with those from the benchmark economy with transfers and those from the economy with full insurance (complete financial markets) - this allows us to evaluate how the presence of targeted transfers interacts with financial imperfections.

Table 4 shows that in the economy with transfers capital is lower, and that aggregate allocations are brought closer to those prevailing in an environment with perfect risk-sharing. The introduction of a redistribution system crowds out capital, as households have less incentive to save against low productivity shocks with the transfer system in place. Furthermore, low income households with low assets will not cut down borrowing as much as before, because the fall in consumption given transfers will be smaller for very low income agents at the borrowing constraint. This is to some extent reflected in the correlation between assets holdings and earnings ($corr(a, W)$), which falls. Aggregate consumption falls as well, but the effect of redistribution is clearly visible in the distribution of consumption: cross-sectional variation is slightly lower.

The ratio of effective labor supply to hours worked is higher in the economy with transfers. The presence of transfers leads to a stronger downward adjustment of hours worked by low productivity households, which makes labor on average more productive. In fact, $corr(n, \epsilon)$ is higher in the economy with transfers than in the economy without transfers. However, overall the ratio of effective labor supply to hours worked remains substantially lower than in the economy with complete markets.

	IM w/o transfers	CM w/o transfers	IM w/ transfers
Y	1.16	0.99	1.09
L	0.33	0.30	0.32
N	0.33	0.24	0.31
L/N	1.00	1.24	1.01
C	0.72	0.80	0.69
K	3.47	2.59	3.17
w	2.24	2.08	2.20
corr(a,W)	0.24	-1.00	0.21
cv(c)	0.41	0.00	0.39
corr(n,ϵ)	0.02	1.00	0.10

Table 4: Aggregate Outcomes

Table 5 documents the labor supply response of households to the introduction of targeted transfers by productivity levels. On average, low productivity households reduce hours worked, and they fall most for households with the lowest productivity. However, high productivity households on average increase hours worked. These qualitative changes are consistent with an increase in efficiency (and welfare) as the values for the full insurance economy shows. They also reinforce the increase in the correlation between hours worked and productivity.

As documented above, the pre tax earnings distribution becomes more right skewed and consequently the Gini coefficient increases slightly as shown in Table 5. This shows that targeted transfers pushed the allocation in the direction of the complete markets allocation, which exhibits a rather high degree of earnings inequality relative to the incomplete markets economy. This happens of course because the correlation between productivity and earnings is equal to one, itself due to the assumption of additive separable utility function.

An important result is that earnings inequality before taxes and transfers behaves differently depending on financial market structure. When financial markets are complete, low productivity households work relatively more in the economy with transfer, whereas high productivity households work relatively less. This directly implies that earnings dispersion will be slightly lower in the transfer economy. However, when financial markets are incomplete, the slight increase in the share of earnings for the lowest quintile does not offset the decrease for the intermediate three, and the increase in the fifth quintile, thereby leading to a higher earnings inequality.

	ϵ =0.215	ϵ =0.542	ϵ =1.364	ϵ =3.436	Gini W	Gini W net
w/o transfers	0.373	0.328	0.329	0.357	0.326	0.326
CM w/o transfers	0.000	0.149	0.342	0.490	0.474	0.474
w/ transfers	0.355	0.308	0.313	0.360	0.338	0.287
CM w/ transfers	0.039	0.178	0.314	0.483	0.452	0.452

Table 5: Labor Supply Misallocation: Average hours worked by productivity, and the effect of redistribution

The earnings inequality after taxes and transfers is significantly lower in the transfer economy both for incomplete and complete markets. It shows, in connection with the fall in cross-sectional consumption volatility, how transfers targeted on labor income can to some extent substitute state contingent assets. Transfers provide insurance to low income households, reduces both their inefficient labor supply and their precautionary motive for holding assets. The correlation between hours worked and productivity is almost zero. However, because productivity enters multiplicatively the household's overall wage income, the correlation between earnings and productivity will be high - in fact, in the benchmark targeted transfer economy, it amounts to 0.95. Hence, a transfer policy that is targeted towards low income household is, to a large extent, targeted towards low productivity households. On the other hand, the non-linear incentive effects of the transfer weaken the pure insurance effect of the transfer by inducing some households to work more than what would be efficient. Finally, the correlation between assets and earnings is low, which means that low earnings households are not necessarily asset-poor.

Overall, our results show that the introduction of transfers jointly reduces the inefficient supply of labor and the over-accumulation of assets of household. Our results need to be qualified to the extent that, the current transfer system that mimics EITC, does not restrict the eligibility of a household to receive transfers to a certain asset range, although it is the case for EITC. Therefore low income, asset rich households will be EITC recipients in our model economy, although they should not. We will address this issue in the next version of the model.

6 Policy Experiment

In this section, we evaluate quantitatively the aggregate, individual and distributional effects of a higher degree of redistribution towards low earnings households. In particular, we contrast and analyze the outcomes to those that would occur with lump sum transfers, and evaluate welfare. Our policy variable η_0 is the "redistribution" variable. We let η_0 vary from 0 (no transfers) to 0.9 (transfers to a minimum earner is 90% of her income). The minimum earner is the marginal earner of the poorest 1% earners in the economy. For each scenario, our strategy consists in calibrating η_2 such that the maximum transfer is given to the upper bound earner of the first quintile. The tax rate is set such that the government budget constraint is satisfied. In order to establish the right comparison, we then use the size of the tax and transfer system and solve for the resulting equilibria that would occur under uniform transfers. For each tax rate, we choose the lump-sum transfer that satisfies the government budget constraint.

η_0	η_2	Υ	τ	$\frac{\Upsilon}{Y}$
0.00	0.3806	0.0000	0.2031	0.0000
0.20	0.3638	0.0260	0.2394	0.0235
0.40	0.3476	0.0533	0.2784	0.0484
0.70	0.3241	0.0944	0.3408	0.0883
0.90	0.3066	0.1216	0.3851	0.1167

Table 6: Resulting policy variables in policy experiment 1: increasing η_0.

Table 6 lists the equilibrium values for η_2, the uniform transfer (Υ), the labor tax (τ), and the ratio of transfer expenditures to GDP ($\frac{\Upsilon}{Y}$). Recall that the benchmark value for η_0, is 0.4, financed by a tax rate of 27.84%, and a ratio of transfers to GDP $\frac{\Upsilon}{Y} = 0.04$. The maximum size of transfers in our experiment is 11.67 % of GDP, which corresponds to a tax rate τ of 38.51%. In this respect, we remain far below the values considered by Alonso-Ortiz and Rogerson (2010) and Floden and Lindé (2001), but the focus of our exercise is not to solve numerically for the *optimal* level of transfers.

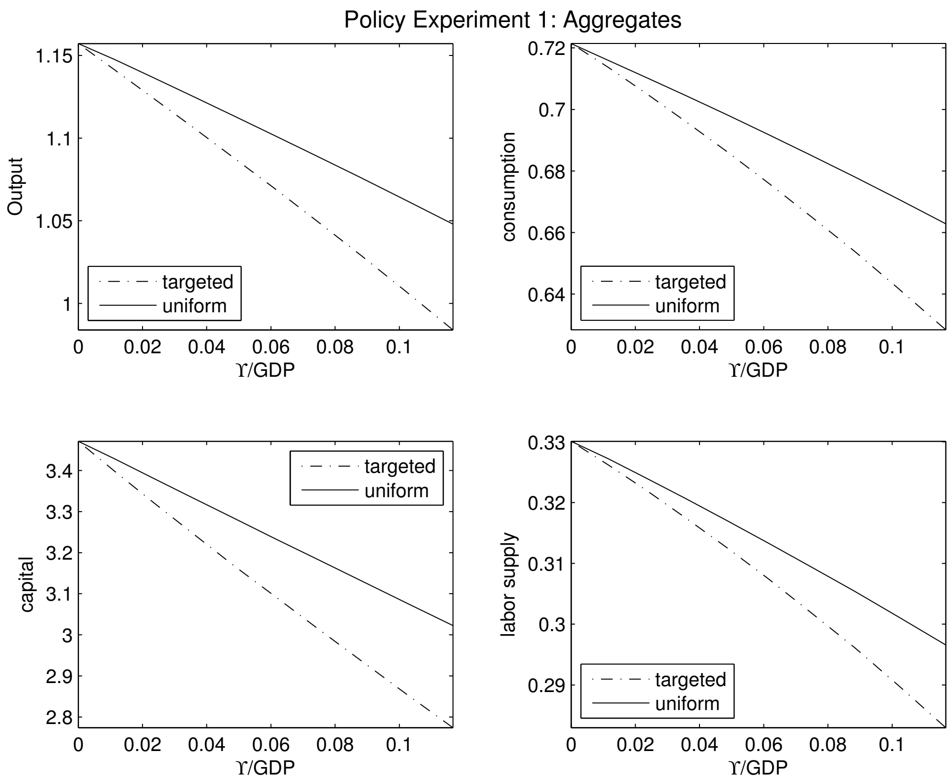

Figure 8: Allocation for several sizes of transfer system: uniform and targeted.

Figure 8 plots aggregate variables for uniform and targeted transfers. Increasing the generosity parametrized by η_0 (Υ in the case of uniform transfers) leads to a decrease in aggregate variables. The fall in output, consumption, and effective labor supply is much more pronounced with targeted transfers than with uniform transfers. In fact, targeted transfers jointly crowd out the precautionary motive for holding capital and the misallocation of labor, which are strongest at the bottom of the earnings distribution. This is also the fraction of the population that will benefit most from targeted transfers. Interestingly, equilibrium prices react also more strongly to enhanced redistribution in the economy with targeted transfers, as shown in Figure 9. This highlights two important results. First, as argued by Meyer (2010), a thorough analysis of EITC needs to take into account prices responses (via general equilibrium) as the effects are sizeable. Second, although both equilibrium levels of labor supply and capital holdings are reduced by enhanced redistribution, wages fall whereas the equilibrium interest rises. This would suggest that the response to increased redistribution is stronger on financial markets than on the labor market, in the sense that the effect of the equilibrium interest rate dominates the effect on wages.

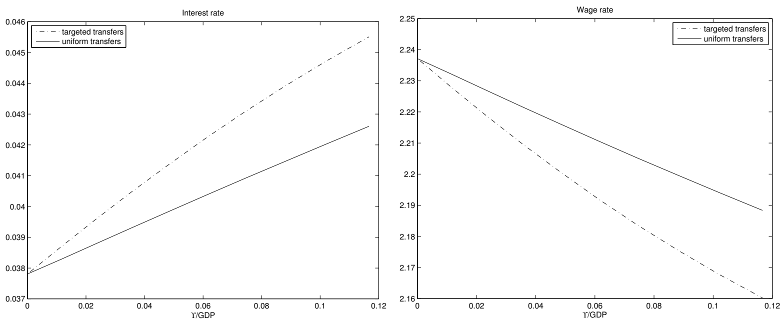

Figure 9: Response of prices to an increase in the transfer system, targeted versus uniform transfers. **Left**: Interest rate. **Right**: Wage rate.

So far our analysis does not suggest major difference on aggregate behaviour between an economy with uniform transfer and an economy with targeted transfer. Figure 10 however shows the key difference between both transfer policies. In an economy with uniform transfers, increased transfers lead to an increase in the ratio of effective labor supply to hours worked, as well as an increase in output per hour. The reverse happens in the case of targeted transfers, where output per hour actually falls. Using output per hour as a measure of efficiency would suggest that targeted transfers is not only worse than the economy with uniform transfers, but also worse than the economy without transfers ($\nu_0 = 0$). However, the ratio of effective labor supply to hours worked increases also for the targeted transfers economy, but less than for uniform transfers. The differential effect is due to the non linear effects of the transfer schedule on labor supply.

Figure 11 plots labor supply by productivity for targeted and uniform transfers. With uniform transfers hours worked decline uniformly across quintiles, and across productivity states. This is due to the wealth effect of transfers, which enter directly in the budget constraint. The effect is reinforced by the fall in the wage rate and the increase in the interest rate. With targeted transfers, hours worked fall for lower values of productivity, but less so than with uniform transfers. For highly productive workers, hours worked actually *increase*. In this case, the non linear tax and transfer schedule shifts average hours worked by productivity slightly towards the full insurance allocation.

While the sign of changes in hours worked across productivity is largely correct (in the sense of bringing the allocation closer to First Best), because of the incentives to work more hours, hours worked are less elastic for high productivity workers than in the case of uniform transfers. They fall by less (and productive workers increase hours by too little)

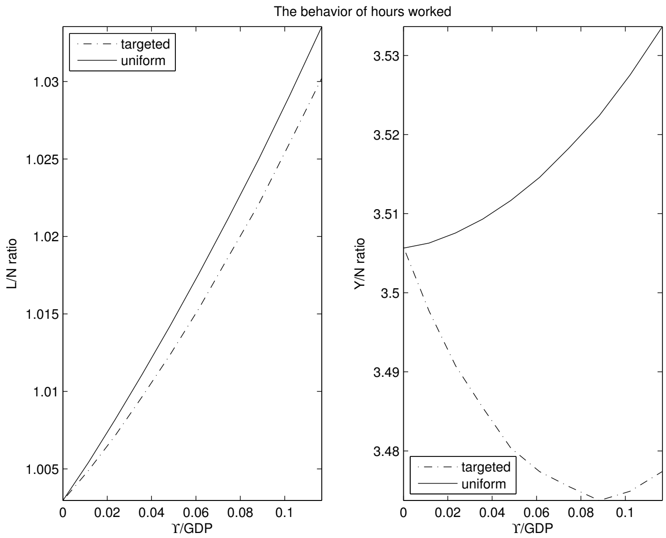

Figure 10: Ratio of effective labor supply to hours worked and output per hours worked, targeted vs. uniform transfers .

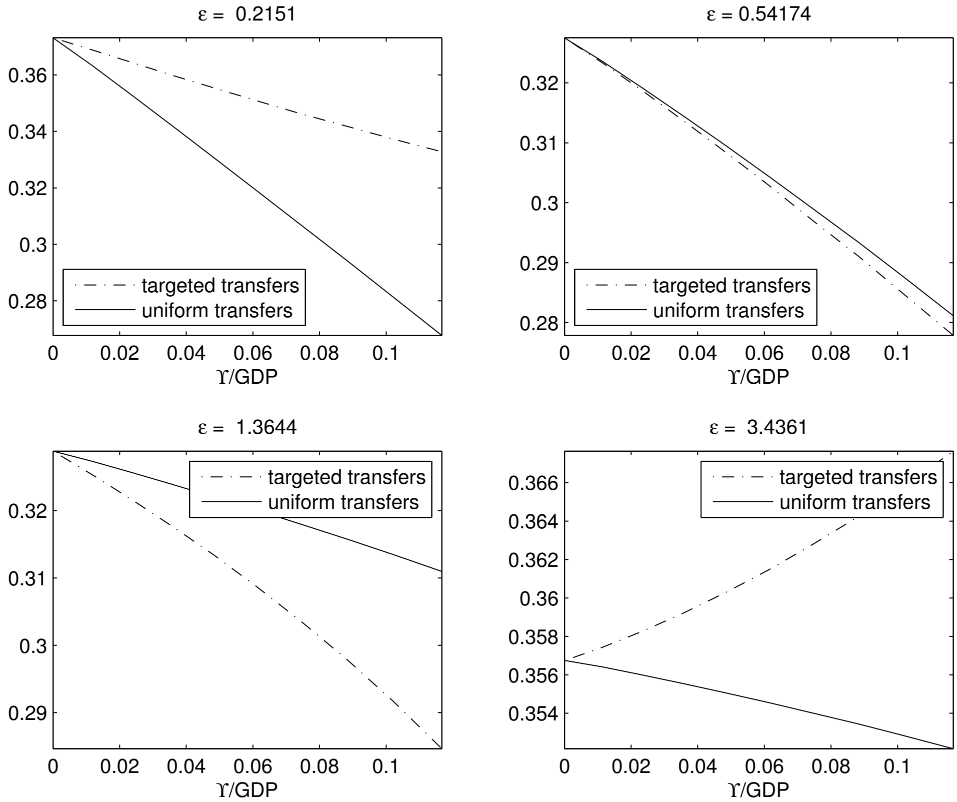

Figure 11: Hours worked by productivity level, uniform transfers versus targeted transfers

in order to offset the fall in output, and as a result, effective labor supply increases by less than with uniform transfers, and the ratio of output to hours worked falls.

We now evaluate the welfare effects of enhanced redistribution in both economies. In both economies, more redistribution initially increases welfare as can be seen in the upper left panel in Figure 12.[16] Aggregate welfare for the targeted transfer economy initially increases more than with uniform transfers, for a given size of the transfer system. At a value for η_0 of around 0.7, the welfare gains from increasing targeted transfers peak and decrease from there onwards. However, for the economy with uniform transfers, welfare continues to increase for the range of transfers (Υ) considered. This is an important result: in this economy, a large targeted transfer system is not necessarily welfare improving, whereas a large uniform transfer system is. For intermediate tax rate, the welfare gains for a given mechanism can be fully reaped. Our results show that, for low levels of government spending, targeted transfer is the more efficient policy at enhancing welfare, however, for higher level of redistribution (and government spending) higher aggregate welfare can be achieved by using uniform transfers, albeit at a higher tax rate inducing a higher degree of distortion in the economy. Finally, the size of the U.S. EITC scheme in term of the maximum transfer to earnings ratio η_0 viewed from this perspective is not far away from the optimal size.

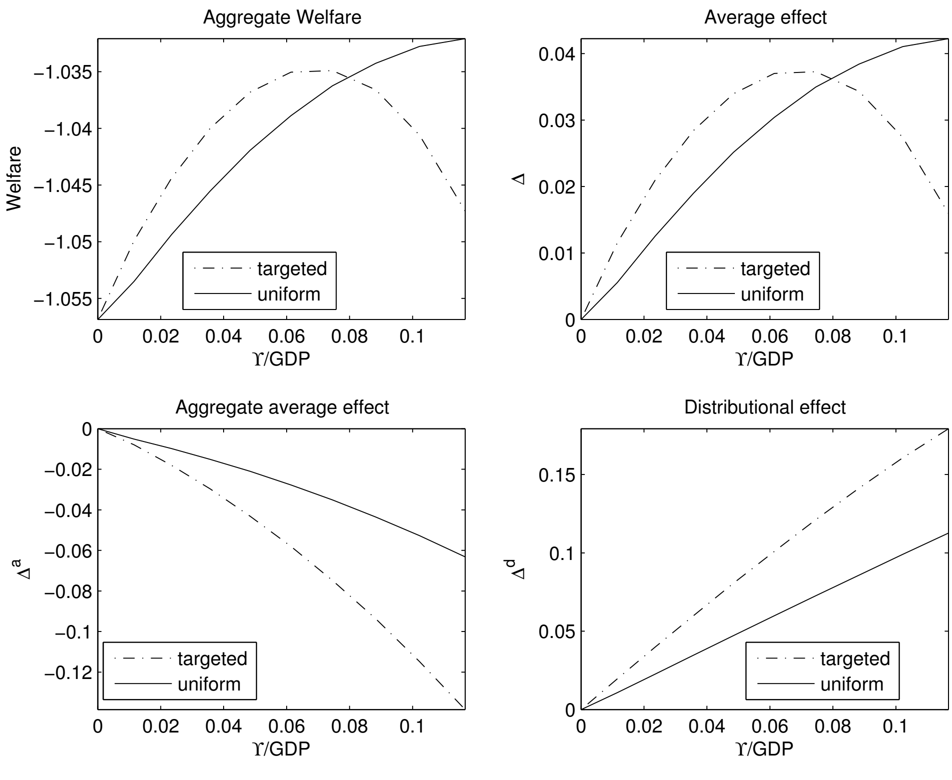

Figure 12: Aggregate welfare and decomposition of welfare change into average, aggregate and distributional.

In spite of its dampening effects on aggregate welfare, targeted transfer replace missing insurance markets more accurately than uniform transfers, as we show below. We proceed as in Alonso-Ortiz and Rogerson (2010) and compute the steady state welfare changes relative to some initial uniform (lump-sum) transfer policy, denoted by T_0. In addition to

[16]The x-axis for uniform transfers is the corresponding value for Υ.

the average welfare gain, Δ, we decompose the welfare change into an average aggregate component, Δ^a, and a distributional component, Δ^d, which we adapt to our analysis from Domeij and Heathcote (2004). An important difference is that Domeij and Heathcote (2004) use transitions to compute their welfare measures, which we don't do yet. In their case the welfare effects from a policy change are qualitatively different from an ex post perspective. In our case, we believe that while there will be quantitative effects due to the non-degenerate wealth and income distribution, the qualitative predictions will not be reversed as our policy measure is not mainly targeted towards the intertemporal choice variable.

Define as $\lambda(\epsilon, a, T_0)$ the measure of agents with productivity ϵ and capital holdings a in the economy with tax and transfer system T_0. The policy functions can be defined accordingly. We consider a change from T_0 and T_1. The *average welfare gain* Δ is defined as the percent consumption increase that has to be given to all households in system T_0 such that aggregate welfare is the same as in the system T_1. If Δ is positive, welfare is higher in T_1.

$$\frac{1}{1-\beta}\int_\epsilon\int_a u((1+\Delta)c(\epsilon,a,T_0)) \quad + \quad g(l(\epsilon,a,T_0)\lambda(\epsilon,a,T_0)d\epsilon da \tag{38}$$

$$= \frac{1}{1-\beta}\int_\epsilon\int_a u(c(\epsilon,a,T_1)) \quad + \quad g(l(\epsilon,a,T_1))\lambda(\epsilon,a,T_1)d\epsilon da \tag{39}$$

The average aggregate effect is defined as the percentage increase in consumption that needs to be given to al agents to equate aggregate welfare assuming that the distribution of consumption remains unchanged. Define

$$\hat{c}(\epsilon,k,T_1) = \frac{c(\epsilon,k,T_0)}{C(T_0)}C(T_1). \tag{40}$$

Then

$$\frac{1}{1-\beta}\int_\epsilon\int_k u((1+\Delta^a)c(\epsilon,k,T_0)) \quad + \quad g(l(\epsilon,k,T_0))\lambda(\epsilon,k,T_0)d\epsilon dk \tag{41}$$

$$= \frac{1}{1-\beta}\int_\epsilon\int_k u(\hat{c}(\epsilon,k,T_1)) \quad + \quad g(l(\epsilon,k,T_1))\lambda(\epsilon,k,T_1)d\epsilon dk \tag{42}$$

The distributional component of welfare can be computed from

$$(1+\Delta) = (1+\Delta^a)(1+\Delta^d) \tag{43}$$

The results are shown in the remaining three panels of figure 12. The welfare gains are exclusively due to a change in the cross-sectional distribution of consumption: the standard deviation of consumption decreases. The effect here is stronger for targeted transfers because redistribution is more effective, as we will show using pre and post tax earnings inequality. The welfare gains from redistribution also offset the average aggregate effect, which is negative, because consumption falls, and more so with uniform transfers.

Table 7 shows pre and post earnings inequality, the cross-sectional variation in consumption, and the correlation between hours worked and productivity for targeted ($\Upsilon(W)$) and uniform (Υ) transfers.[17] Both systems show an increase in pre-tax earnings inequality

[17] What is actually the data in countries with more generous transfer payments? Can you observe a higher correlation between hours and productivity?

(which of course translates into higher idiosyncratic earnings variability), but the increase is more pronounced with uniform transfers. On the other hand, redistribution is more effective with targeted transfers. The fall in post tax earnings inequality is substantial and the gap between uniform and targeted grows wider as the size of transfers increases.

η_0	Gini W		Gini W net		$std(C)$		$corr(n, \epsilon)$	
	$\Upsilon(W)$	Υ	$\Upsilon(W)$	Υ	$\Upsilon(W)$	Υ	$\Upsilon(W)$	Υ
0.00	0.326	0.326	0.3265	0.326	0.294	0.294	0.019	0.019
0.20	0.331	0.332	0.3086	0.317	0.279	0.284	0.055	0.057
0.40	0.338	0.338	0.2918	0.309	0.264	0.273	0.097	0.102
0.70	0.350	0.348	0.2690	0.297	0.241	0.256	0.175	0.169
0.90	0.361	0.356	0.2559	0.290	0.225	0.244	0.227	0.220

Table 7: Distributional effects in the model with targeted transfers and with uniform transfers.

As a result, cross-sectional consumption volatility falls by more in the economy with targeted transfers. Finally, the effect of uniform transfers on the correlation between hours worked and productivity is actually *larger* than for targeted transfers within the range of η_0 that leads to higher welfare in the targeted transfer regime. This is at first surprising given that the evidence in Figure 11. However, the decline in labor supply is not uniform, and the labor supply of high productivity households reacts substantially less.

7 Conclusion and Future Work

We document the recent shift in U.S. government expenditure towards transfers, which have now become the most important fiscal policy tool. Within transfers, targeted transfers to the working population have become quantitatively as important as unemployment insurance. In this paper, we enrich the debate on the pertinence of targeted transfers, in particular EITC, by bringing insights from a structural model, in particular through a welfare analysis and by quantifying the general equilibrium effects of transfer policies that target labor income.

Theoretically, we contribute to the debate and show that targeted transfers reduce inefficiencies due to market incompleteness and qualitatively work in the *right* direction - towards the full insurance economy. We show that increased redistribution, leads to a drop in output per effective hour worked in the economy with targeted transfers, whereas it increases in the lump sum transfers economy. It suggests that targeted transfer policy are dominated by uniform transfers.

In spite of this bad productive efficiency property, we show that increased redistribution with targeted transfers is more effective and leads to a larger decline in the cross-sectional volatility of consumption. The distributional effect dominates the negative overall effect from lower consumption in the economies with transfers. This is however only true below a certain level of the transfer system: aggregate welfare is maximized for an intermediate size of the transfer system with targeted transfers, while it could be increased further with uniform transfers.

Finally, from a policy perspective, our exercise suggests that the current size of the EITC program in the Unites States is below but not far from its optimal size.

To conclude, we mention our plans for future work. We will embed an extensive margin into the model, in order to account for the effect of the EITC on the decision to work. Also we will take into account transition dynamics. It would also be interesting to see whether some of the dynamic implications can actually be identified in the data (increase in earnings variability, increase in correlation between wage and hours worked, increase in earnings inequality). Finally, we will recalibrate the economy, in particular the labor income process to account for transfers.

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A Figures and Tables

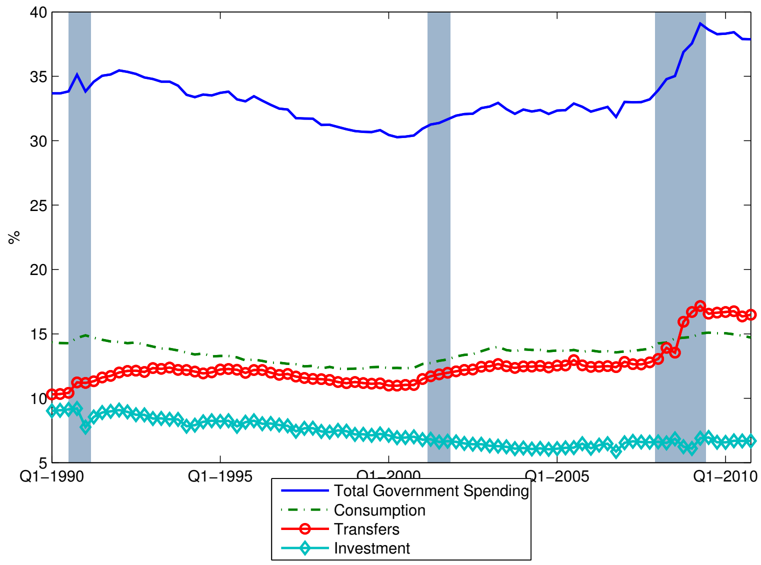

Figure 13: Fiscal instruments over GDP ratio (1990-2010)

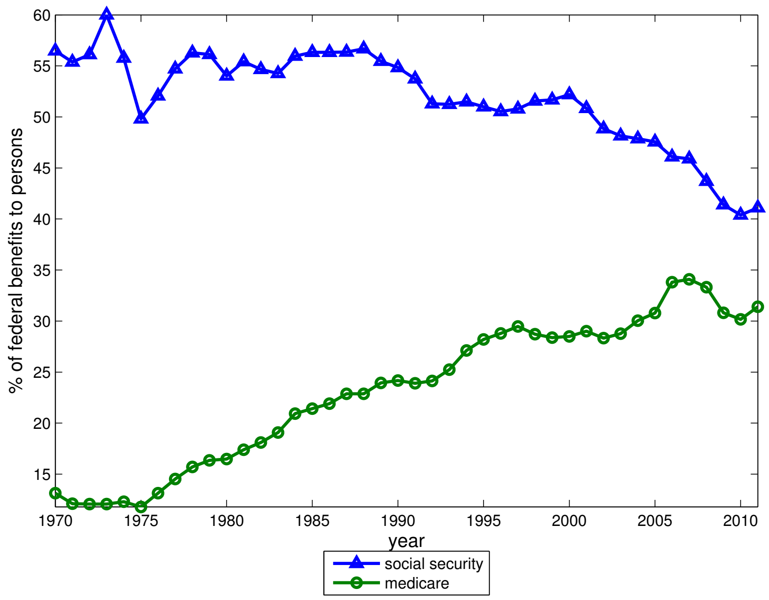

Figure 14: Shares of Social Security benefits and Medicaid in total federal social benefits to persons, 1970-2011. *Source: BEA, NIPA tables 3.12.*

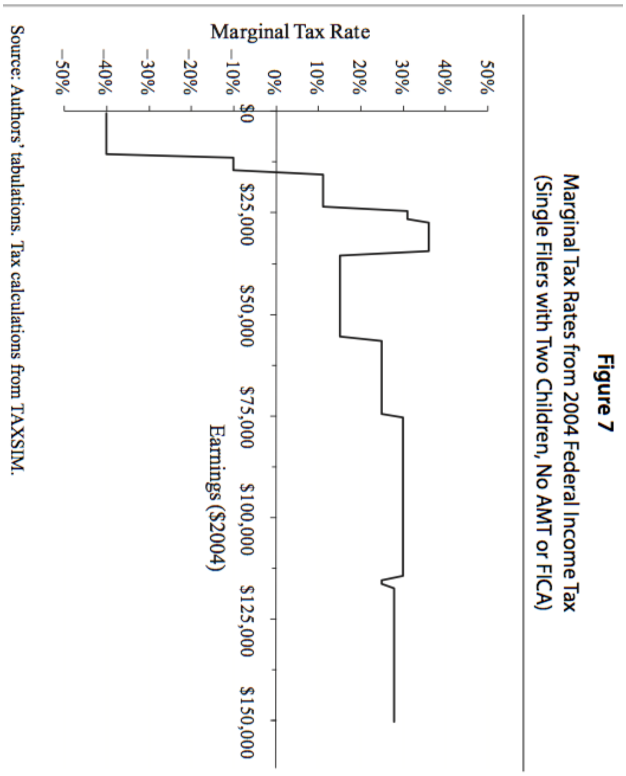

Figure 15: Marginal Tax Rate for the U.S., 2004, quoted from Eissa and Hoynes (2011), figure 7.

EITC vs poverty line

	Single filers			
	No Child	One Child	Two Children	Three Children
Household size	1	2	3	4
Ratio to poverty line	1.17	2.33	2.26	1.92
Ratio in	0.52	0.59	0.70	0.56
Ratio out	0.65	1.08	0.92	0.73
max trans as % of earnings	7.67	34.00	40.09	45.11
Household size	2	3	4	5
Ratio to poverty line	0.91	1.99	2.02	1.64
Ratio in	0.40	0.52	0.56	0.47
Ratio out	0.84	0.92	0.73	0.62
max trans as % of earnings	7.67	34.00	40.09	45.11

	Joint filers			
	No Child	One Child	Two Children	Three Children
Household size	2	3	4	5
Ratio to poverty line	0.91	2.27	2.02	1.83
Ratio in	0.40	0.50	0.56	0.47
Ratio out	0.84	1.20	0.96	0.81
max trans as % of earnings	7.67	34.00	40.09	45.11

Table 8: EITC 2011 in relation to weighted poverty threshold.

(Sub)group	% of total Pop.	% in poverty	% of total EITC particip.	% total EITC benefits
Pop 18-64 yrs	62.64	13.7		
Families	48.98	10.7	77.74	95.4
with children < 18	25.07	15.0		
Married couples	18.79	8.90	38.04	30.01
Single Mothers	4.90	37.30	36.13	48.30
Unrelated individuals	13.41	24.4	23.26	4.60

Table 9: Shares of Subgroups in U.S. Population and in EITC programme. Note: all categories refer to people between 18-64 years old. Source: U.S. Census Bureau and Meyer (2010)

B Complete Markets Solution

We consider an economy where households have access to a complete set of state-contingent assets. The maximization problem with complete markets reads:

$$\mathbb{E}_{-1} \sum_{t=0}^{\infty} \beta^t [u(c_t^i) + g(l_t^i)] \tag{44}$$

$$\begin{aligned} c_t^i + \sum_{\epsilon_{t+1}|\epsilon_t} p(\epsilon_{t+1}|\epsilon_t) b^{i\prime}(\epsilon_{t+1}) &= w_t \epsilon_t n_t^i + b^i(\epsilon_t) - T(w_t \epsilon_t n_t^i, b_t^i) && (45) \\ n_t^i &= 1 - l_t^i && (46) \\ 0 \leq \; l_t^i &\leq 1 && (47) \end{aligned}$$

$p(\epsilon_{t+1}|\epsilon_t)$ is the price for the asset paying out in productivity state ϵ_{t+1}, given that today productivity state is ϵ_t. The optimal decision is to choose $b'(\epsilon_{t+1}) = b(\epsilon_t)$ if $\epsilon_{t+1} = \epsilon_t$, from the Euler equation:

$$p(\epsilon_{t+1}|\epsilon_t) c_t^i = \beta \pi(\epsilon_{t+1}|\epsilon_t) c_{t+1}^i, \tag{48}$$

where $\pi(\epsilon_{t+1}|\epsilon_t)$ is the probability of productivity realization ϵ_{t+1} given ϵ_t. The asset price consistent with constant consumption, and thus with market clearing is $p(\epsilon_{t+1}|\epsilon_t) = \beta\pi(\epsilon_{t+1}|\epsilon_t)$, and as in Pijoan-Mas (2006), the stationary equilibrium is characterized by the following set of equations.

$$\begin{aligned} 1 &= \beta[\alpha \left(\frac{K}{L}\right)^{\alpha-1} + (1-\delta)] && (49) \\ K &= \sum_{\epsilon} \pi(\epsilon) b(\epsilon) && (50) \\ L &= \sum_{\epsilon} \pi(\epsilon) \epsilon n(\epsilon) && (51) \\ n(\epsilon) &= 1 - l(\epsilon) && (52) \\ v'(l(\epsilon)) &= u'(c)(1 - T_W(w\epsilon n(\epsilon)) && (53) \\ c + \beta \sum_{\epsilon_{t+1}|\epsilon_t} \pi(\epsilon_{t+1}|\epsilon_t) b(\epsilon_{t+1}) &= w\epsilon_t n(\epsilon_t) + b(\epsilon_t) - T(w\epsilon_t n(\epsilon_t), b(\epsilon_t)). && (54) \end{aligned}$$

where $\pi(\epsilon)$ is the stationary distribution of labor productivity. The first equation is the steady state condition that pins down the equilibrium real interest rate. The second and third condition impose market clearing on the capital and labor markets. The fourth equation is the time constraint of the economy followed by the intratemporal optimality conditions and the household budget constraints.

The relationship between leisure and productivity can be found by combining the intratemporal optimality condition, (53), for two values of productivity $\epsilon_i > \epsilon_j$.