The Earned Income Tax Credit: Targeting the Poor but Crowding Out Wealth

Maren Froemel
Bank of England

Charles Gottlieb
University of St. Gallen

Abstract. This paper quantifies the individual, aggregate and welfare effects of the Earned Income Tax Credit (EITC). In particular, we analyze the labor supply and saving responses to changes in tax credit generosity and their implications for prices and welfare. Our results show that the EITC is a subsidy on labor income and a tax on savings. An increase in EITC generosity raises labor force participation, reduces savings for many and provides insurance to working poor households. The EITC reduces earnings inequality but increases the skill premium and wealth inequality. A 10% increase in tax credit generosity increases welfare by 0.31% and benefits the majority of the population.

Résumé. If you do not provide a French abstract, the English abstract will be translated into French and inserted here.

JEL classification: E60, E62, H23, H24, I38

The Earned Income Tax Credit (EITC) is the largest and fastest growing anti-poverty program in the United States. The EITC targets low income *working* households and tops up their labor earnings such that their effective tax rate can be negative. It thereby incentivizes work, provides insurance and increases tax progressivity. More than one in every five households receive

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Corresponding author:

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the EITC[1] and the EITC is credited for having lifted 9.1 million people out of poverty (Nichols and Rothstein 2015). Relative to other income support programs, the EITC is large and its budget comes close to the budget allocated to unemployment insurance.[2] While the effects of unemployment insurance policies have received a lot of attention in the literature, evidence on the EITC's aggregate and distributional effects is scarce despite its policy relevance. The size of the program and the strength of the estimated labor supply effects suggest significant price and welfare effects, and thereby call for a macroeconomic analysis of the EITC, which we are the first to provide.

We build a dynamic general equilibrium model with heterogeneous households (Aiyagari 1994, Huggett 1993) which we calibrate to the US economy. We use this framework to conduct policy counterfactuals and analyze the effects of the EITC on individual behavior, the distribution of wealth, economic aggregates and welfare. Our policy experiment increases tax credit generosity using a proportional top-up to the tax credit. This experiment mimics the across state variation of state-level EITC supplements to the federal rate that is used in the empirical literature to identify behavioral responses to the EITC. This allows us to link our results to existing empirical evidence.

Our results show that the EITC is a well targeted program: it improves households' insurance and welfare without reducing households' incentive to work. However, it reduces their incentive to save. We find that the labor supply margin matters most for the poorest households, while the intertemporal savings margin is most relevant for households in the middle of the income distribution. Furthermore, we show that more tax credit generosity increases the skill premium through a crowding in effect of low skilled labor supply. While an increase in EITC generosity increases wealth inequality, it is a welfare improving policy for the majority of the population. It benefits poor households through a smoother consumption profile, but also richer households through a general equilibrium effect on their earnings.

We contribute to the literature on fiscal policy and provide a macroeconomic analysis of tax credits, in particular of the EITC. Our findings complement the findings of the empirical literature on the EITC and document the EITC's effects on households' savings behavior, the skill premium and earnings inequalities. Our structural approach also allows us to make welfare statements about the EITC. Furthermore, we contribute to the literature on fiscal policy reforms. We are the first to look at tax credit as a fiscal policy instrument. For a given income tax code that is calibrated to the US, we show that an increase in EITC generosity improves welfare by introducing more tax progressivity at the bottom of the income distribution. Our results are in

1 In 2010, about 26 million tax filers received EITC (`https://www.eitc.irs.gov`).

2 See appendix A1 and figure A1.

line with Conesa and Krueger (2006) who show that tax deductions play an important role towards an optimal progressive labor income tax schedule.

The literature on the effects of the EITC focuses on labor supply responses to increases in EITC generosity in partial equilibrium settings.[3] A large empirical literature focuses on the measurement of these labor supply responses (Meyer and Rosenbaum 2001, Rothstein 2010, Eissa et al. 2008, Eissa and Liebman 1996). The consensus is that labor force participation is more elastic than hours worked to tax credit reforms in the United States (Blundell and Hoynes 2004) and that the labor supply response works at large via the extensive margin (Meyer 2002; 2010, Eissa and Hoynes 2006, Hotz and Scholz 2003). Motivated by this empirical evidence for the United States our model focuses on the extensive margin of households' labor supply.

The identification of these large changes in labor participation raises the question whether and how equilibrium wages adjust in response to changes in EITC generosity. As argued by Stiglitz (1982) this general equilibrium channel has strong implications for the welfare properties of tax structure and its optimal design. Leigh (2010) and Rothstein (2010) address this question empirically and show that wage effects are relatively large and statistically significant, in particular for unskilled labor. Rothstein (2010), for example, shows that single mothers and childless women lose 55% of the marginal EITC dollar due to reduced wages. Leigh (2010) estimates that an increase of 10% in EITC generosity leads to a 5% drop of wages for high school drop-outs, a 2% fall in wages those with high school diploma and has no effects on the wages of individuals with tertiary education. This evidence motivates our analysis and our decision to analyze this policy through the lens of a general equilibrium model with permanent skill heterogeneity and endogenous wages.

Beyond its intra-temporal effect on labor market participation and wages, tax credit policies affect households' saving behavior for two reasons. First, by changing the effective marginal tax rates schedule the EITC alters household disposable income and should trigger changes in both labor supply and savings. Second, welfare programs in general affect the risk sharing properties of the economy and thereby households' precautionary savings motive (Hubbard et al. 1995, Feldstein 1995). For example, Engen and Gruber (2001) show the importance of savings responses to changes in unemployment insurance policies. Given this evidence, it is pertinent to jointly allow tax credit reforms to affect savings behavior and labor supply. Recently, Blundell et al. (2016) account for the role of the intertemporal margin in a structural model of human capital accumulation and female labor supply and the role of the United Kingdom tax credit program. They emphasize both the insurance value of the tax credit for poor working women, as well as

3 A comprehensive review of the literature on the EITC is provided by Nichols and Rothstein (2015).

the negative effect on self-insurance. For the United States and the EITC, Weber (2014) finds that around 40 percent of the decline in the fraction of EITC recipients with savings in income bearing accounts can be explained by changes in EITC incentives, suggesting adverse effects on individuals' incentive to save.

The empirical evidence suggests that an assessment of tax credit reforms should jointly allow for changes in the labor force composition, savings behavior and wage adjustments. We let this evidence guide our modelling choices. We therefore use a framework that features labor supply, savings choice and general equilibrium effects to the EITC to conduct policy experiments and a welfare analysis.

This paper is also related to the literature on the evaluation of policy reforms in inter-temporal choice models with heterogeneity.[4] The literature on the tax reforms (Domeij and Heathcote 2004, Heathcote 2005), insurance effects of tax progressivity reforms (Conesa and Krueger 2006, Conesa et al. 2009, Heathcote et al. 2014, Guner et al. 2011) and unemployment insurance (Engen and Gruber 2001, Crossley and Low 2011) is dense, but few papers look at transfer policy reforms with the exception of Athreya et al. (2014) and Oh and Reis (2012). Oh and Reis (2012) model targeted transfers that are conditioned on household health and on their productivity. In their framework, targeted transfers are expansionary because they redistribute funds from healthy, high productivity workers towards low productivity workers. This redistribution has an expansionary effect since to finance those transfers, high productivity workers face a negative wealth effect which induces them to work more, while sick workers will reduce their labor supply. In contrast, our transfer is conditioned on persistent shocks to household productivity, giving a stronger role to private savings and hence crowding out effects. Athreya et al. (2014) highlight the insurance effect of the EITC for young unskilled women in a partial equilibrium environment. In particular, they show that the EITC reduces consumption volatility over the life cycle by 12 percentage points relative to an economy without transfer program. In contrast to Athreya et al. (2014) wages are not policy invariant in our framework.

The remainder of the paper is organised as follows. In section 1, we present our theoretical model and then proceed to our calibration strategy in section 2. We discuss our results in section 3 and conclude in section 4.

1. The Model

The economy is populated by four types of agents: a continuum of households, a government, a firm and an external sector. Households are infinitely lived, supply labor to firms, consume a homogeneous good, and save in a non-state

4 An extensive review of this literature is provided in Heathcote et al. (2009).

contingent real asset. Also they differ in terms of skills and are subject to idiosyncratic shocks on their labor productivity. Firms use labor and capital supplied by households and the rest of the world to produce a final good. The government taxes households' gross income, pays out tax credits to working households that qualify and gives welfare payments to households that do not work.

1.1. Households

The economy is populated by a continuum of infinitely-lived households that differ permanently in their skill level: a share of households is low-skilled (π^u) and the complementary share is high-skilled (π^s). All households are subject to idiosyncratic labor productivity shocks (ϵ) and self-insure by borrowing or saving and supplying labor. The labor supply decision is binary: households either work full time or do not participate in the labor market ($\mathbf{1}_t = \{1, 0\}$). If households work, they receive an efficiency wage ($W_t \equiv w_{i,t}\epsilon$). If they do not work, they obtain a welfare payment (Ω). Saving and borrowing is subject to an interest rate r_t and households can borrow up to an exogenous borrowing limit ($\underline{a}$). Households' net tax payments ($T(W_t, D_t)$) are the sum of taxes on gross income and tax credits. Both depend on labor income (W_t) and (gross) capital income ($D_t \equiv r_t a_t$).

Households discount time at the rate β_i, derive utility from consumption (c_t), incur a skill-specific utility cost q_i when working and maximize their expected life time utility subject to the infinite sequence of budget constraints:

$$\mathbb{E} \sum_{t=0}^{\infty} \beta_i^t \left(u(c_t) - q_i \mathbf{1}_t \right) \tag{1}$$

where $\mathbb{E}$ is the mathematical expectations operator and $u(c_t) = \frac{c_t^{1-\gamma}}{1-\gamma}$ is a CRRA utility function with risk aversion parameter γ. If a household chooses to supply labor $\mathbf{1}_t = 1$, her budget constraint is

$$c_t + a_{t+1} = w_{i,t}\epsilon_t + (1 + r_t)a_t - T(W_t, D_t) \tag{2}$$

$$a_{t+1} \geq \underline{a} \tag{3}$$

If the household decides not to work ($\mathbf{1}_t = 0$), she receives welfare payments (Ω) and her budget constraint is

$$c_t + a_{t+1} = \Omega + (1 + r_t)a_t \tag{4}$$

$$a_{t+1} \geq \underline{a}. \tag{5}$$

In each period, households choose their consumption (c_t), whether to work ($\mathbf{1}_t$) and save/borrow (a_{t+1}) such that their budget constraint is satisfied.[5]

1.2. Firms

Firms demand capital (K) and labor (L) and produce the final good (Y) with a constant return to scale production technology.

$$Y = K^{\alpha} L^{1-\alpha} \tag{6}$$

Capital depreciates at the rate δ and its return R is equal to the marginal product of capital. In equilibrium, it is equal to the interest rate gross of depreciation: $R = r + \delta$. We assume that the representative firm uses both high and low skilled labor which are imperfectly substitutable. Aggregate labor input is a composite of low skilled and high skilled labor:[6]

$$L \equiv [\lambda L_s^{\rho} + (1-\lambda) L_u^{\rho}]^{1/\rho}\ ,\ \rho \leq 1 \tag{7}$$

where $\epsilon = \frac{1}{1-\rho}$ is the elasticity of substitution between skilled labor L_s and unskilled labor L_u and λ is a demand shifter.

The representative firm maximizes profit and sets wages equal the marginal productitvity from employing an additional unit of each type. Wages will be equal to:

$$w^s = (1-\alpha) k^{\alpha} \lambda \left(\frac{L}{L_s}\right)^{1-\rho}, \quad w^u = (1-\alpha) k^{\alpha} (1-\lambda) \left(\frac{L}{L_u}\right)^{1-\rho}. \tag{8}$$

where $k \equiv \frac{K}{L}$ is the capital to labor ratio.

The ratio of labor earnings across skill groups determines the skill premium, which is unambiguously decreasing in the ratio of skilled to unskilled labor supply:

$$\frac{w_s L_s}{w_u L_u} = \frac{\lambda}{1-\lambda} \left(\frac{L_s}{L_u}\right)^{\rho}. \tag{9}$$

1.3. Government

The government taxes Adjusted Gross Income (AGI), distributes tax credits to working households and welfare payments to non-working households. The net-tax function ($T(W, D)$) is the difference between income taxes ($\tau(AGI)$) and tax credits ($\Upsilon(W, D)$):

$$T(W, D) = \tau(AGI) AGI - \Upsilon(W, D) \tag{10}$$

5 We focus on stationary equilibria, that is $r_t = r$ and drop time indices from now onwards.

6 This production function is widely used in the literature. Recent papers have used it to understand the effects of the increase in wage inequality (Heathcote et al. 2010), the rise in the skill premium (Krusell et al. 2000) and to analyze optimal tax progressivity (Krueger and Ludwig 2016).

where $W \equiv w\epsilon$ denotes labor income, $D \equiv ra$ dividends and $AGI = w\epsilon + ra$ Adjusted Gross Income (AGI).

The tax function $\tau(AGI)$ is a parametric approximation of the average income tax schedule *net of tax credits*, and takes the following functional form:

$$\tau(AGI) = b(1 - (sAGI^p + 1)^{\frac{-1}{p}}) \tag{11}$$

where b, s and p are three parameters that determine the shape of the tax function.[7]

The tax credit schedule $\Upsilon(W, D)$ is characterized by three regions: the phase-in, the plateau and the phase-out region. In the range of the phase-in region, the tax credit increases with income while it is constant in the plateau region, and falls with income in the phase-out range. The tax credit schedule can be captured with 5 parameters $(\beta_{in}, \beta_{out}, \alpha_{out}, \overline{D}, \bar{\Upsilon})$. The parameter β_{in} is the slope of the phase-in region, $\bar{\Upsilon}$ is the tax credit payment in the plateau region and $\alpha_{out}, \beta_{out}$ are respectively the intercept and the slope of the function that approximates the phase-out region. Finally tax credit payments are asset-tested: to be eligible households must earn dividends below $\bar{D}$.

$$\Upsilon(W, D) = \begin{cases} \beta_{in} AGI & \text{if } \ 0 < AGI < \underline{T} \text{ and } ra \leq \overline{D} \\ \bar{\Upsilon} & \text{if } \ \underline{T} \leq AGI \leq \overline{T} \text{ and } ra \leq \overline{D} \\ \alpha_{out} + \beta_{out} AGI & \text{if } \ \overline{T} < AGI < \widehat{T} \text{ and } ra \leq \overline{D} \\ 0 & \text{if } \ \widehat{T} < AGI \text{ or } ra > \overline{D} \end{cases} \tag{12}$$

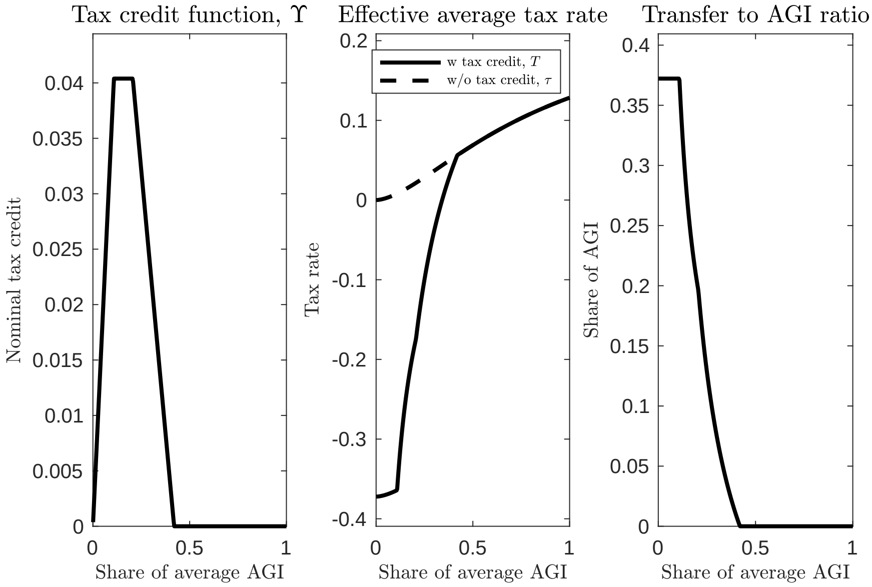
where $\beta_{in} > 0$, $\beta_{out} < 0$, $\underline{T} = \frac{\bar{\Upsilon}}{\beta_{in}}$, $\overline{T} = \frac{\bar{\Upsilon} - \alpha_{out}}{\beta_{out}}$, $\widehat{T} = \frac{-\alpha_{out}}{\beta_{out}}$.

Figure 1 offers a graphical representation of the tax credit schedule when parametrized to the EITC schedule in 2010 and shows (a) the tax credit schedule as a function of income, (b) the effect of the tax credit on the effective average tax rate, and (c) the transfer to income ratio implied by the tax credit function for the income levels below average AGI.

Finally, government consumption G is the sum of net tax payments $T(W, D)$ paid by working household and welfare payments Ω paid out to non-working households.

7 This tax function provides a better fit of the tax incidence for households with an average AGI relative to alternative specifications in the literature. However, this specification does not generate negative tax rates and does not provide a good fit of the tax incidence for low income households. Since we combine the tax function approximation with an explicit modelling of the EITC, our specification of the tax system provides a good fit for both low and middle income households. Our modelling choice for the tax function is discussed in further detail in section 2.1.2.

FIGURE 1: Tax credit function and its effect on the average tax rate.



1.4. Small open economy

We assume that the economy is open and capital is perfectly mobile. Furthermore, the economy is small relative to the rest of the world, which implies a constant domestic real interest rate equal to the world interest rate r. The marginal productivity of capital (R) is therefore equal to the world real interest rate gross of depreciation:

$$r + \delta = R = \alpha k^{\alpha-1} = \alpha \frac{Y}{K}, \tag{13}$$

where Y is aggregate output and K is total capital used in production. The capital to output ratio is determined by the real interest rate r, the depreciation rate δ and the capital share α. Given the CRS production function, the capital to labor ratio (k) is constant and given by:

$$k = \frac{K}{L} = \left(\frac{r+\delta}{\alpha}\right)^{\frac{1}{\alpha-1}}. \tag{14}$$

Since capital is perfectly mobile and the interest rate is fixed, firms demand capital from the rest of the world if aggregate domestic assets fall short of demand for capital. If total assets exceed capital demand, households will export capital. Let K^{dom} denote the domestic supply of capital and

$K^{for} = K - K^{dom}$ be the amount of foreign capital that is used in domestic production.[8]

The aggregate resource constraint of this economy is as follows:

$$C + I + G + NX = Y \tag{15}$$

In a stationary equilibrium, investment replaces the depreciating proportion of the total capital stock, $I = \delta K$. Net exports, or the current account, amount to the difference between current *inflows* K^{for} and *outflows* $(1+r)K^{for}$. The goods market market equilibrium in the small open economy then requires that domestic savings (S) are equal to investment plus net exports such that :

$$S = Y - (C + G) = I + NX = \alpha Y - rK^{dom}. \tag{16}$$

1.5. Recursive formulation

The household maximization problem can be written recursively. The state space of the recursive problem X is the Cartesian product of the possibility sets of skill levels (i), assets (a), and productivity levels (ϵ) for all households in the economy, i.e. $X : I \times A \times E$ with $I : i \in \{s, u\}, a \in [\underline{a}, \infty), \epsilon \in E$.

Let $V(i, a, \epsilon)$ denote the discounted expected life-time utility of a household of skill type i with asset holdings a and labor productivity ϵ. Since the decision to work is a discrete choice, the value function $V(i, a, \epsilon)$ is obtained by taking the maximand between the indirect utility from working and the indirect utility from not working:

$$V(i, a, \epsilon) = \max_{\mathbf{1}=[0,1]} [V(1, i, a, \epsilon); V(0, i, a, \epsilon)] \tag{17}$$

where $\mathbf{1}(i, a, \epsilon)$ is the policy function for labor force participation.

The indirect utility of a household that participates in the labor market is as follows:

$$V(1, i, a, \epsilon) = \max_{a', c} u(c) - q_i + \beta_i \mathbb{E}\{V(i, a', \epsilon')|\epsilon\} \tag{18}$$

$$\text{s.t.} \qquad c + a' = w_i\epsilon + (1 + r)a - T(W, D) \tag{19}$$

$$a' \geq \underline{a} \tag{20}$$

The indirect utility of a households that does not participate in the labor market is as follows:

8 Strictly speaking, it is indeterminate whether firms will use foreign or domestic capital in production because capital is perfectly substitutable irrespective of its origin. Only net figures, i.e. the capital account balance, are determined. For simplicity, we assume that firms first use domestic, then foreign capital.

$$V(0,i,a,\epsilon) = \max_{a',c} u(c) + \beta_i \mathbb{E}\{V(i,a',\epsilon')|\epsilon\} \tag{21}$$

$$\text{s.t.} \qquad c + a' = \Omega + (1+r)a \tag{22}$$

$$a' \geq \underline{a} \tag{23}$$

The tax credit received by a household depends on her AGI and thereby on her labor supply and savings choices which means that the household internalizes the tax credit function in her decision-making. The standard Euler equation is therefore altered and her intertemporal optimality condition is:

$$\frac{\partial u(c)}{\partial c} = \beta_i \left(1 + r - \frac{\partial T(W,D)}{\partial D}\right) \mathbb{E}\frac{\partial u(c')}{\partial c'} + \mu, \quad \mu \geq 0. \tag{24}$$

where μ denotes the Lagrange multiplier on the borrowing constraint.

The households' intertemporal optimality condition dictates that whenever the borrowing constraint is binding, *ceteris paribus* current marginal utility from consumption is higher and consumption is lower. Since the net tax payment depends on a households' AGI they directly affect their return on savings. If $\partial\Upsilon(W,D)/\partial D < 0$, that is, if the tax credit benefits low asset holders, the household faces a *tax* on asset holdings. A steep tax credit function *ceteris paribus* translates into lower savings and higher current consumption. On the other hand, in the presence of such a tax credit, a household with low asset holdings benefits from receiving a higher transfer, which reduces his consumption volatility.

DEFINITION 1 (Stationary Competitive Equilibrium). Given a borrowing limit $\underline{a}$, an exogenous interest rate r, an gross income tax schedule $\tau(AGI)$ and a tax credit function $\Upsilon(W,D)$, a stationary competitive equilibrium is a set of positive wages w_i, a positive quantity of aggregate labor supply L and capital supply K, time invariant decision rules $a'(i,a,\epsilon), \mathbf{1}(i,a,\epsilon)$ and a probability distribution $\lambda(i,a,\epsilon)$ such that:

1. Equilibrium wages w_i satisfy the static optimization problem of the representative firm formulated in section 1.2
2. The policy functions $c(i,a,\epsilon), a'(i,a,\epsilon), \mathbf{1}(i,a,\epsilon)$ solve the household maximization problem formulated in section 1.5
3. The probability distributions $\lambda(i,a,\epsilon)$ are stationary distributions s.t.

$$\lambda(i,a',\epsilon') = \int_\epsilon \int_{a:a'(i,a,\epsilon)} \lambda(i,a,\tilde{\epsilon}) df(\tilde{\epsilon}'|\tilde{\epsilon}) \tag{25}$$

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

$$L = \int_X \mathbf{1}(i,a,\epsilon) n(i,a,\epsilon) \epsilon d\lambda(i,a,\epsilon). \tag{26}$$

5. Government consumption (G) is the gap between tax revenues and transfers:

$$G = \int_X \mathbf{1}(i,a,\epsilon)T(W,D)d\lambda(i,a,\epsilon) - \int_X (1-\mathbf{1}(i,a,\epsilon))\Omega d\lambda(i,a,\epsilon) \quad (27)$$

6. Domestic firms demand capital such that the marginal product of capital $R = r + \delta$, and

$$K = K^{for} + K^{dom}, \quad (28)$$

where $K^{dom} := \int_X a'(i,a,\epsilon)\lambda(i,a,\epsilon)$ is aggregate supply of domestic capital and K^{for} is the aggregate supply of foreign capital.

7. The goods market clears, such that aggregate output is the sum of consumption, investment, government spending, investment and net exports. Net exports satisfy[9]

$$NX = r(K - K^{dom}). \quad (29)$$

2. Quantification

We now outline our strategy to quantify the model economy. We discuss the parameters that are fixed and then the data targets used to calibrate the remaining parameters. Finally, we assess the ability of our model to match important untargeted moments.

2.1. Parametrization

We set the annual interest rate to 3%, and the coefficient of relative risk aversion to 1.5.[10] The borrowing limit is set to the average annual adjusted gross income as in Athreya (2002) and Mateos-Planas and Seccia (2006).

2.1.1. Labor productivity

The model features two types of households that differ permanently in their skill level: households are either high skilled or low skilled. We follow the literature and define as high skilled households where the household head has completed some higher education (above high school), and low skilled households are the remaining households. The labor productivity for both skill groups follows an AR(1) process with group specific persistence and variance parameters. The values are reported in table 1.

2.1.2. Tax function and EITC schedule

We approximate the income tax schedule using the parametric specification proposed by Gouveia and Strauss (1994) - see equation 11. Guner et al. (2014)

9 Domestic savings are equal to $S = Y - (C+G) = Y - (1-\alpha)Y - rK^{dom} = \delta K + rK^{for}$.

10 Section A3 provides a robustness analysis on the risk aversion parameter.

TABLE 1
Preference, productivity and capital market parameters

Parameter		Value	Source
Risk aversion	γ	1.50	
Interest rate	r	0.03	
Borrowing limit	$\underline{a}$	-0.52	
Share of skilled	π_s	0.45	CPS 2010
Share of unskilled	π_u	0.55	CPS 2010
Productivity			
Persistence for skilled	ρ_s	0.97	Krueger and Ludwig (2016)
Persistence for unskilled	ρ_u	0.93	Krueger and Ludwig (2016)
Std dev. for skilled	σ_s	0.10	Krueger and Ludwig (2016)
Std dev. for unskilled	σ_u	0.14	Krueger and Ludwig (2016)

show that this functional form provides the best fit relative to the alternative specifications proposed by Heathcote et al. (2014) and Guner et al. (2011). It fits particularly well the income tax incidence for households with an AGI ranging from the mean of US household up to 3 times the mean AGI. However, this specification does not accommodate negative tax rates and matches poorly the tax incidence for households at the bottom of the income distribution. Since we combine the GS approximation with an explicit modelling of the EITC, our model also features negative effective tax rates for households at the bottom of the income distribution.

The values of the income tax function $\tau(AGI)$ parameters are taken from Guner et al. (2014) which they estimate using individual level data from the U.S. Internal Revenue Service (IRS). In particular they provide estimates for income tax function *net of EITC and welfare payments*. This is important for our exercise because it allows us to disentangle the effect of changes in the EITC holding the remainder of the tax system constant. Table 2 reports the parameter values of the tax function for married households (see Guner et al. 2014, table 10).

The tax credit depends on following household characteristics: gross earned income (AGI), filing status, number of dependent children and capital income. A tax filer is only eligible for tax credits if income from capital is below USD 3'100 (IRS 2010).[11] The five parameters that determine the EITC schedule are taken directly from the tax code (IRS) and reported in table 2. We use parameters that describe the EITC schedule for married households that file taxes jointly and have one qualifying child. We do so for three reasons. First,

11 See section A2 for an exhaustive description.

TABLE 2
Income tax and tax credit parameters

Parameter		Value	Source
EITC schedule			
Phase-in, slope	β_{in}	0.34	IRS 2010
Max. tax credit, plateau	T	3162	IRS 2010
Phase-out, intercept	α_{out}	6727.91	IRS 2010
Phase-out, slope	β_{out}	-0.16	IRS 2010
Capital income threshold	$\bar{D}$	3100	IRS 2010
Income Tax function parameters			
	b	0.247	Guner et al. (2014)
	s	0.001	Guner et al. (2014)
	p	1.850	Guner et al. (2014)

the median number of children under 18 in married households that file taxes jointly is 1 (CPS 2010).[12] Second, we choose to focus on married households because 62.3% of U.S. individuals are married (CPS, 2010). Thirdly, 94.77% of married households file taxes jointly (CPS 2010). Although we model only one type of household, our tax system is representative since we capture the features of the tax credit schedule that affects about 60 percent of the population.

2.2. Calibration

We now discuss our calibration strategy. The type specific utility costs of supplying labor q_i are set to match the share of high and low skilled households that work full time which we computed using data from the CPS (2010). The discount factors β_i are set to match the average wealth to income ratio of each skill groups which we measure using the Survey of Consumer Finance (2010). The labor demand shifter (λ) in the production function is such that the wage skill premium is 1.80. Parameter ρ is chosen to generate an elasticity of substitution across labor types of 1.45. The welfare payment parameter Ω is such that it amount to 20% of average gross income (AGI) in the model economy. The depreciation rate δ is chosen to amount to 0.08, to match a capital output ratio of 3. Finally, the capital share α is set to 0.33 which means that our model has a labor share of 0.66.

12 The average number of children in such households is 1.27.

TABLE 3
Calibrated parameters

Parameter		Value	Target	Value	Source
Depreciation rate	δ	0.08	Capital-output Ratio	3.00	
Capital share	α	0.33	Labor share	0.66	
Production function parameter	ρ	0.31	Elas. of substitution	1.45	Murphy and Katz (1992)
Production function parameter	λ	0.65	Skill premium	1.80	Heathcote et al. (2010)
Utility cost of working, skilled	q_s	0.81	Labor force participation - skilled	0.85	CPS 2010
Utility cost of working, unskilled	q_u	1.36	Labor force participation - unskilled	0.70	CPS 2010
Discount factor, skilled	β_s	0.97	Wealth to income ratio - skilled	4.35	SCF 2010
Discount factor, unskilled	β_u	0.96	Wealth to income ratio - unskilled	2.57	SCF 2010
Welfare	Ω	0.10	Welfare relative to mean AGI	0.20	Holter et al. (2019)

2.3. Untargeted moments

We discuss moments of interest that are not calibrated. A key statistic for the purpose of our exercise is the Frisch labor supply elasticity. In our calibrated model, a 1% change in average wages leads to a 0.56% change in aggregate labor supply, which is in line with the estimates from the micro literature (Chetty 2012, Pistaferri 2003, Chang et al. 2019). Another important statistic is the overall size of the EITC as a share of GDP. In our model, 0.92% of GDP is spent on the EITC, while in the data they amount to 0.96% of GDP. [13] Our calibrated models also generates a distribution of income that is relatively close to its empirical counterpart. These moments are reported in table 4. In terms of take-up of the EITC, our calibrated model generates an overall take-up of 28.5% (0.42*0.55 + 0.12*0.45 = 28.5, see table 6) while in the data, the equivalent number is 32% in 2010 for the United States. [14]

3. Results

We quantify the effects of tax credit policies such as the EITC. In particular, we vary the *generosity* of the tax credit program and increase the amount of tax credit paid out for a constant gross income range of tax credit eligibility. We model this increase in generosity by multiplying the calibrated EITC schedule $\Upsilon(W, D)$ by a factor $(1 + \eta)$. This modeling choice mimics the state level tax credit supplements that exist in most US states and top up the federal EITC schedule.[15] Our results can therefore be compared with

13 Refundable tax credits amount to 144.3 billions of dollars in 2010. Source: Table 3.12, NIPA (2010).

14 In 2010, 78.83 million families resided in the US (Census) and 26 millions tax filers received the EITC (IRS).

15 US States top up the federal tax credit by a percentage η while the tax credit eligibility criteria are identical across states. In some cases, this supplement is conditional on number of children

TABLE 4
Untargeted moments

		Model	Data	Source
EITC to GDP ratio (%)	$\frac{\Upsilon}{Y}$	0.92	0.96	NIPA (2010) table 3.12
Income (%)	Q1	2.78	3.00	Rios-Rull and Kuhn (2016)
	Q2	11.42	6.50	
	Q3	16.40	10.90	
	Q4	24.07	18.10	
	Q5	45.33	61.40	

those from the literature that uses the across state variation in top-ups as a the source of variation to measure the labor supply and wage effects of the EITC (Leigh 2010). By augmenting the tax credit paid out, this policy experiment changes the progressivity of the tax schedule for the income range of eligible households. In figure 2 we illustrate how an increase in tax credit generosity affects the tax credit schedule (left panel) and the effective average tax schedule, and tax progressivity (right panel). In the benchmark economy ($\eta = 0$), the implied transfer to income ratio for eligible low income households is 38% while it increases to 56% when tax credit generosity is increased by 50% ($\eta = 0.5$). [16] We also analyze how alternative financing scenarios affect our results. In our main exercise, the tax credit expansion is funded by an increase in average and marginal taxes. Also we propose two alternative scenarios: first, a targeted increase in tax progressivity and also a scenario where the increase in transfer expenditures is unfunded. An overview of the three financing scenarios is provided in table 7.

The discussion of the results is organized as follows. In section 3.1, we describe the effects on aggregates, distributions, individual decisions both across stationary equilibria as well as accounting for transitional dynamics. Finally we provide a discussion of the welfare implications of the tax credit reforms in section 3.2.

and filing status. Further detail on the current EITC state supplements can be found here: https://www.irs.gov/Credits-&-Deductions/Individuals/Earned-Income-Tax-Credit/States-and-Local-Governments-with-Earned-Income-Tax-Credit.

16 Note that the effective average tax schedule without EITC does not allow for negative tax rates since the income tax schedule is approximated using the Gouveia and Strauss (1994) specification as argued in subsection 2.1.2.

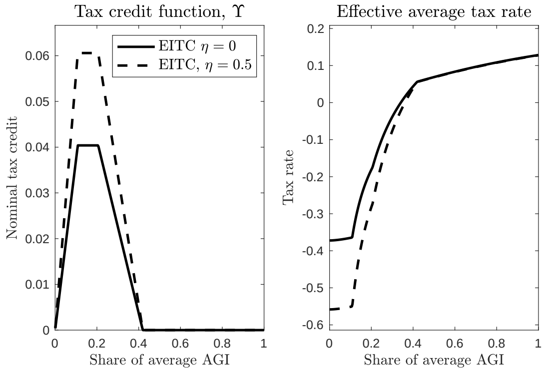


FIGURE 2: Effect of an EITC expansion on tax credit (left) and tax rates (right).

3.1. Aggregate and distributional effects of the EITC

3.1.1. Steady state comparison

Table 5 reports the response of economic aggregates when tax credit generosity (η) is set either to 10% or 50%. In the benchmark experiment (*scenario I*) the tax credit expansion is financed by an increase in the average tax rate.[17] An expansionary tax credit policy increases labor force participation across skill groups, however more so for low skilled households than high skilled households. When tax credit payments are increased by 10% ($\eta = 0.1$), labor force participation of low skilled household increases by 0.97 p.p. (0.70*1.39) and 0.12 p.p. (0.85*0.14) for high skilled households. The aggregate effect on labor market participation therefore amounts to 1.1 percentage points. Since skill types are imperfect substitutes, the wage response to increased tax credit generosity differs by skill groups. The share of low skilled relative to high skilled workers in the labor force is higher, which reinforces this effect. While the wage for low skilled households falls by 0.35 percent, the wage of high skilled labor increases by 0.2 percent. As a result the skill premium rises. Empirical estimates in the literature support qualitatively these predictions - see tables 4 and 5 Leigh (2010), and table 3 in Rothstein (2010).

What are the economic mechanisms that drive this model response? The increase in labor force participation is the result of two effects. First, higher tax credit generosity lowers effective tax rate which raises households' labor supply. Second, higher tax credit generosity crowds out private savings, which raises labor supply further. At the same time, all households face an increase in the average tax rate on total income. This offsets part of the decrease in the effective average tax rate due to the tax credit for low-

17 This corresponds to an increase in the value of parameter b in equation 11.

TABLE 5
Aggregate effects of Tax Credit policies.

Policy variable	η =0.1			η =0.5		
Financing scenario	I	II	III	I	II	III
GDP	0.40	0.37	0.46	1.99	1.75	2.34
Savings (LS)	-6.41	-6.29	-6.36	-34.05	-32.96	-33.61
Savings (HS)	-0.82	-0.54	-1.41	-3.79	-1.83	-8.02
Participation (LS)	1.39	1.38	1.40	7.31	7.16	7.27
Participation (HS)	0.14	0.09	0.24	0.65	0.33	1.28
Wage (LS)	-0.35	-0.36	-0.31	-1.73	-1.81	-1.49
Wage (HS)	0.20	0.20	0.18	0.99	1.04	0.85
Wealth income ratio (LS)	-6.28	-6.16	-6.23	-33.26	-32.21	-32.82
Wealth income ratio (HS)	-0.98	-0.68	-1.56	-4.57	-2.58	-8.55

Note: Units are in percentage change from the steady state of the calibrated economy. *Scenario I:* : tax credit expansion is financed by an increase in average tax rate (benchmark). *Scenario II:* tax credit expansion is financed by a decrease in government consumption. *Scenario III:* tax credit expansion is finance by an increase in the average tax rate for household with income above AGI.

income households. Furthermore, it lowers the after-tax return to savings, reinforcing the crowding-out effect on savings. However, the effects on low-skilled households are only marginally affected by these effects, as can be inferred from a comparison with *scenario II* where the tax credit expansion is unfinanced. [18]

After the reform, households are on average poorer. Weber (2014) shows empirically that the EITC indeed reduces the incentive to save among EITC recipients in the US. This evidence validates the behavioral response of our model. The drop in savings is more pronounced for low skilled than high skilled households. This is largely because low skilled households are more likely to qualify for a tax credit and if they do, they receive a higher amount. There is also an indirect general equilibrium effect via wages: for low skilled households, the labor earnings effect and the effect of an increased tax credit are both negative whereas for high skilled households the labor earnings effect is positive because their average wage increases (see figure 3). The fall in savings for low skilled households is therefore due to two effects: lower earnings and improved public insurance. For a large part of the population the second effect dominates: public insurance in the form of higher tax credits crowds out private insurance.

A tax credit expansion also has non-trivial distributional effects. Table 6 reports aggregate measures for the tax credit (take-up and average ratio to AGI) as well as earnings inequality, relative wealth and the skill premium. First, the expansion increases EITC-take up by 0.2 percentage points among the low-skilled, which is due to the increase in participation. The expansion is then also reflected in an increase in the transfer to AGI ratio: those who receive

18 By unfinanced we mean that government consumption adjusts.

TABLE 6
Distributional effects of Tax Credit policies.

Policy variable	steady-state	η =0.1			η =0.5		
Financing Scenario	-	I	II	III	I	II	III
EITC take-up (LS)	0.42	0.44	0.44	0.44	0.51	0.51	0.51
EITC take-up (HS)	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Transfer to AGI Ratio (LS)	0.04	0.05	0.05	0.05	0.07	0.07	0.07
Transfer to AGI Ratio (HS)	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Relative wealth (HS/LS)	3.40	3.61	3.61	3.58	4.96	4.98	4.71
Gini earnings	0.43	0.43	0.43	0.43	0.42	0.42	0.42
Gini earnings post tax	0.39	0.39	0.39	0.39	0.38	0.38	0.38
Skill premium	1.80	1.82	1.82	1.82	1.90	1.90	1.90

All entries are in reported in level.

the transfer already now receive more, and households with low productivity who now participate have a high transfer to AGI ratio. Second, higher tax credits increase wealth inequality: relative wealth of high-skilled households increases as the crowding-out effect on savings of low-skilled households is stronger. Third, it increases the skill premium. In response to the reform, both skill groups increase their labor supply and low skilled households increase their labor supply more than high skilled. As the macro elasticity of labor supply is low in our calibrated economy, the wage effect on the skill premium is stronger for all policy experiments considered in our analysis. Second, the tax credit reduces earnings inequality directly through the increase in the participation of low skilled households with lower earnings. However, the effect is quantitatively small, matching the small increase in participation. Furthermore, the fall in low-skilled wage partly offsets this effect.

With regard to economic aggregates, increased tax credit generosity raises output as a result of the increase in labor force participation which increases the demand for capital by domestic firms. Given the small economy assumption, capital supply is matched by an increase in the foreign capital supply at a constant interest rate r. Relaxing this assumption is unlikely to overturn our results for the following reasons. If the interest rate were an equilibrium object, our main channels, i.e. the crowding out effect on saving and the increase in labor force participation, would trigger an increase in the equilibrium interest rate. This channel would indeed mitigate the fall in savings, reduce wages and thereby reduce the expansionary effect of the tax credit reform on GDP. However, as we show in section 3.1.1, the wage effects are largely dominated by the insurance effects for the range of tax credit expansions we consider. Therefore for the general equilibrium channel to quantitatively dominate the effects that prevail, the wage effect would need to be large. This is unlikely for the magnitude of tax credit reforms we consider.

TABLE 7
Overview of the financing scenarios

Scenario	Funding instrument	Description
I	Average tax rate	The average tax rate increases while government spending remains unchanged.
II	Government spending	The value of government spending changes while tax rates remain unchanged.
III	Tax progressivity	The average tax rate increases for households with above mean AGI while government spending remains unchanged.

In our calibrated economy relaxing the small open economy assumption is unlikely to overturn our results. [19]

Financing scenarios
We now discuss whether our results are robust to alternative financing scenarios, and contrast the effects of an expansionary tax credit reform to two alternative financing scenarios. [20] In *scenario II* the tax credit expansion is unfunded and we let government spending adjust. In *scenario III*, it is financed by an increase in the income tax rate for households with an adjusted gross income above the mean. Table 7 provides an overview of these funding scenarios and table 5 shows the aggregate effects of an expansionary tax credit reform for all financing scenarios.

The unfunded scenario (*scenario II*) helps to disentangle two important effects of the tax credit reform: (a) how much of the reform is self-financed, and (b) how important are second-round effect through different forms of financing. In response to the tax credit expansion, expenditures for welfare payments fall because labor force participation increases while the *nominal* value of welfare payments ω is held constant across experiments.[21] Tax revenues may also rise due to the increase in participation, but the overall effect depends on how the distribution of households changes. We find that tax revenues increase and about one third of the reform is self-financed.

Qualitatively, the effects of tax credit generosity are independent of the financing scenarios. Quantitatively, the labor supply and savings responses of the high-skilled households are stronger, while those of the low-skilled

19 For an in-depth discussion of the SOE assumption, we refer the reader to section A3.3.

20 Recall that in this economy, government spending G is neutral.

21 The *nominal* anchor of the tax function, i.e. average income, is kept constant across experiments as we want people with the same nominal income across economies to pay the same nominal amount of taxes.

households change only marginally when the tax credit expansion is financed by changes in income tax progressivity. Since adjusted gross income (i.e. labor *and* capital income) is taxed, the necessary increase in the tax schedule to finance the tax credit reform crowds out savings. When progressivity is increased (*scenario III*), high skilled households systematically reduce their saving more than in the case of a shift in tax schedule (*scenario I*). This is because higher tax progressivity lowers the return to savings and provides insurance, disincentivizing savings: they now face a larger tax increase than in *scenario I*, and the tax will also be higher when they are most productive. Lower savings induce a substitution away from savings towards labor supply. In contrast, low-skilled households' savings response does not differ much across financing scenarios. It is slightly lower when progressivity of the income tax is increased compared to when progressivity is kept constant, because they are now less likely to face an increase in the tax rate, but receive the same increase in tax credit generosity in all scenarios.

Effect of tax credit generosity on saving and work incentives

The key effect of the EITC is on labor force participation. What mechanisms drive the labor supply response? The increase in labor market participation could either be due to the increase in the incentives to work or due to the crowding out of saving caused by increased tax credit generosity. We decompose the change in participation as follows:

$$\Delta H^\eta = \int_X \mathbf{1}^\eta(X)d\lambda^\eta(X) - \int_X \mathbf{1}(X)d\lambda(X) \tag{30}$$

$$= \underbrace{\int_X \Delta\mathbf{1}(X)d\lambda(X)}_{\equiv\lambda\Delta\mathbf{1}\ :\ \text{Effect 1}} + \underbrace{\int_X \mathbf{1}^\eta(X)\Delta\lambda(X)dX.}_{\equiv\mathbf{1}^\eta\Delta\lambda\ :\ \text{Effect 2}} \tag{31}$$

where $\mathbf{1}^\eta(x)$ and $\lambda^\eta(x)$ are the policy function and the stationary distribution in steady state with tax credit generosity η, ΔH^η is the total change in participation, $\lambda\Delta\mathbf{1}$ the increase in participation due to higher work incentives holding the distribution constant and $\mathbf{1}^\eta\Delta\lambda$ is the increase in participation solely due to a change in the savings behavior, holding households' participation decision constant. The decomposition is reported in Table 8.

For low income households in both skill groups, the direct effect (*Effect 1*) is important and it dominates the insurance effect (*Effect 2*). This group responds positively to lower average and marginal tax rates, and in the case of low skilled households they use part of the additional income to reduce debt or increase savings. For households with average productivity, however, the work incentive effect (*Effect 1*) is dominated, as improved public insurance lowers the marginal benefit of working for the purpose of self-insurance.

TABLE 8
Decomposition of the increase in participation for high and low skilled households. Effect due to 1: Higher incentives to work. 2: Lower incentives to save - cf. equation (30)

Skill group	Low				High			
Labor productivity	Low		Average		Low		Average	
Effect	1	2	1	2	1	2	1	2
$\eta = 0.1$	0.001	0.013	-0.678	0.888	0.001	0.002	-0.009	0.028
$\eta = 0.5$	0.240	0.040	-3.798	4.997	0.005	0.005	-0.053	0.130

These results suggest that intertemporal effects are of second order for low income workers who receive the highest tax credit relative to their income, but they become more important for households with income levels that are at least on the phase-out range of the EITC schedule. This is not entirely surprising as the poorest households in the distribution do not hold savings or may even be borrowing constrained. However, the individual relevance of the two margins and their interaction is an important factor in the evaluation of the program and has so far not been considered in the literature.

Wage versus transfer effect
What drives households' responses to increased tax credit generosity? To answer this question, we decompose the effect from increased tax credit generosity into a wage and a transfer effect which we plot in figure 3. [22] Our decomposition shows that households' labor supply response to increased tax credit generosity is mostly driven by the transfer effect, but also by the indirect wage effect (see figure 3). Quantitatively the transfer effect dominates the wage effect. The wage effect strengthens the crowding out of savings for the high skilled population, but does not affect low skilled savings' decision. In this sense, tax credit is an effective policy instrument to raise labor force participation, but it crowds out private savings substantially, in particular for the low skilled population. An important caveat is that the dominance of the transfer effect is to some extent also an endogenous result due to the relative

22 We isolate the wage effect by solving the model holding the nominal tax credit payment constant and imposing the wage and tax payment that prevails in the new stationary equilibrium. To isolate the transfer effect, we solve the model holding the wage constant at the value of the benchmark equilibrium and we feed the model the tax schedule of the post-reform stationary equilibrium.

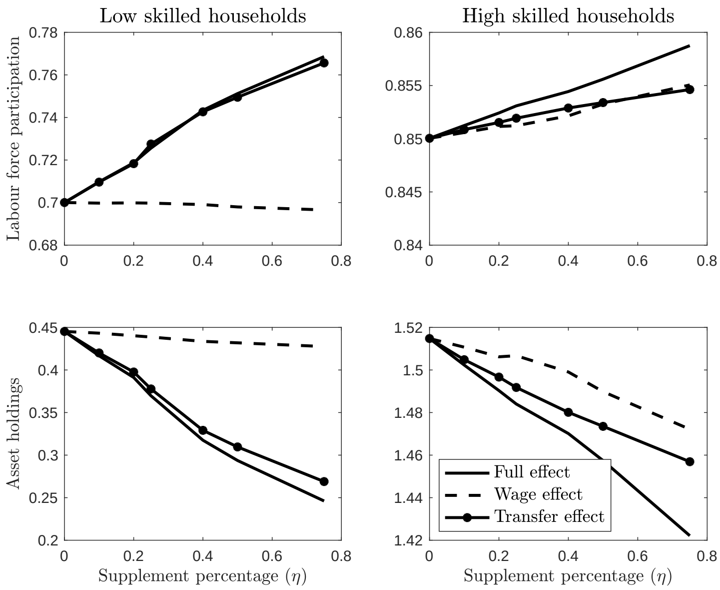


FIGURE 3: Partial effects of increased tax credit generosity on aggregates. Upper panel: Labor force participation. Lower panel: Asset holdings. The wage effect is the response of participation and savings due to the change in the wage and tax payments, while transfer payments are kept fix. The transfer effect is the response of participation and savings due to changes in the transfer payments schedule only, while wages and tax payments are kept fix.

magnitude of changes in wages and tax credits: the change in the wage is smaller than the increase in transfers.

Our results confirm the concern on adverse wage responses due to tax credit policies Meyer (2010), but highlight that the direct effect dominates on average for the poor low skilled population. However, it is important to distinguish between the targeted population and the non-targeted population, as will become clear in our welfare analysis (section 3.2).

3.1.2. Transition

To complete our analysis of tax credit policies on economic aggregates, we compute the transition path of the economy following an increase in tax credit generosity of 10% ($\eta = 0.1$). The transition path of the main economic aggregates is reported in figure 5. In the first period after the reform, labor force participation adjusts downwards sharply. Based on the post reform level of tax credit generosity, households hold more assets than is optimal. As a consequence, households reduce their labor supply initially, and dis-save until the economy reaches its new steady state. Aggregate domestic asset holdings

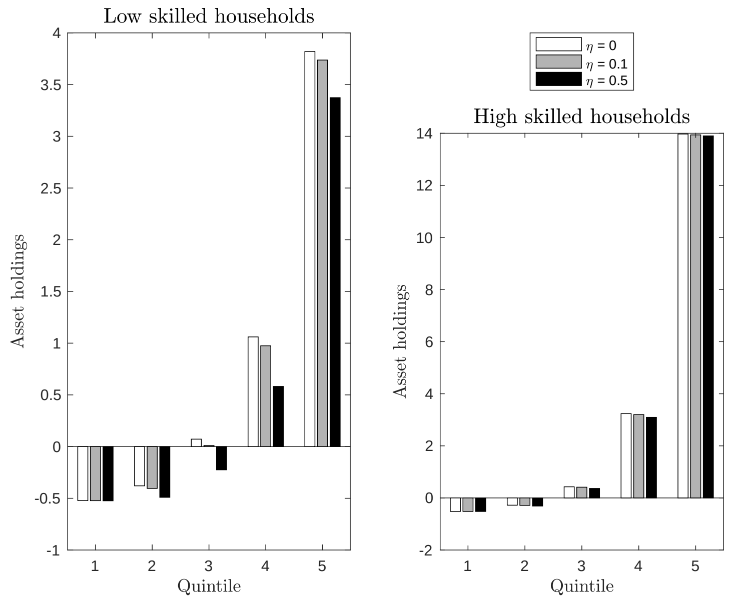


FIGURE 4: Asset holdings across quintiles for selected expansions in generosity, by skill type, in levels. Left: Low skilled. Right: High skilled. The columns show asset holdings by total income quintiles for values of the EITC supplement, $\eta = 0$ (benchmark economy), 0.1, and 0.5.

fall slowly over time, while the path for capital employed in production mirrors that of aggregate labor supply. [23] Such wealth effect on labor supply have been documented in the context of inheritances by Holtz-Eakin et al. (1993). Conversely, as private assets are decumulated, labor supply rises over the transition path to reach the level of labor force participation that is higher than the pre-reform level.

The dynamics of wages for high- and low-skilled households exhibit opposite patterns. On impact, wages adjust because capital is fixed. Low-skilled wages increase whereas high-skilled wages fall. This is because low-skilled households are more affected by the tax credit reform. Their savings pattern will be affected more in the long run; therefore, the wealth effect is stronger for this group and the adjustment in participation is more pronounced than that of low-skilled. The negative effect on participation induced by the insurance

23 Note that in the small open economy, the capital labor ratio is constant. The capital stock used in production therefore adjusts through capital in- and outflows along the transition according to $K_t = \frac{K}{L} L_t$. Consequently, its path is proportional to that of aggregate labor supply.

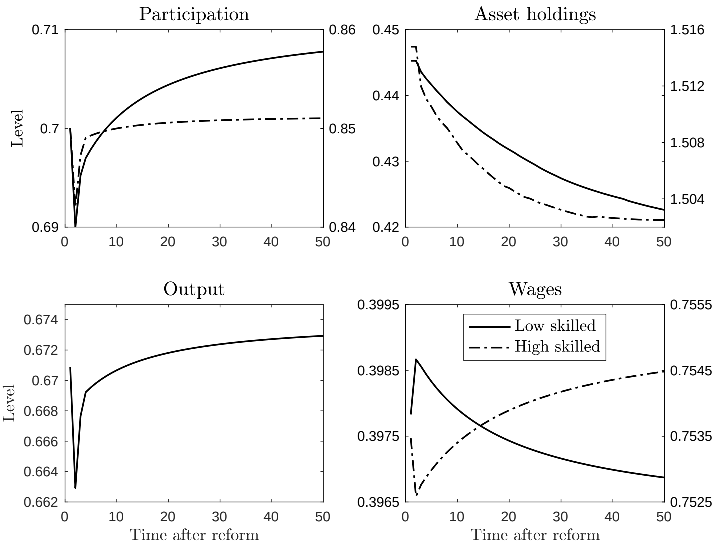


FIGURE 5: Transition path of the economy after an unanticipated permanent tax credit reform ($\eta = 0.1$). Left axis: Low-skilled, Right axis: High-skilled.

component of the tax credit is stronger than the subsidy component, which increases the incentive to work through a reduction in the marginal tax rate.

3.2. Welfare Effects

What are the welfare implications of expansionary tax credit reforms? In this subsection, we evaluate welfare using two metrics. First we compare steady states (labelled *long-run*) and then provide a welfare measure that takes into account the transition path to the new steady state (labelled *short-run*). Thereafter we compute the share of households that would support the reform. For all measures, we employ utilitarian welfare weights.

We define aggregate welfare as

$$\begin{aligned} W(X) &= \int_X V(X) d\lambda(X) \\ &= \pi_u \int_{a,\epsilon} V(a,\epsilon,i=u) d\lambda(a,\epsilon,i=u) + \pi_s \int_{a,\epsilon} V(a,\epsilon,i=s) d\lambda(a,\epsilon,i=s) \end{aligned}$$

where $W(X)$ is households' expected discounted lifetime utility over assets, productivity states and household types, and the subscripts s, u denote skilled and unskilled households.

Let W^0 denote welfare in the calibrated steady state without policy reform and W_k^η denote welfare with a tax credit reform of magnitude η evaluated using metric $k = \{SR, LR\}$. We distinguish between short-run welfare (SR) -

TABLE 9
Ex-ante consumption equivalents for a tax credit policy expansion of 10%.

	$\Delta_{short-run}$	$\Delta_{long-run}$
Low-skilled	0.41	-0.38
High-skilled	0.17	0.20
Aggregate	0.31	-0.14

welfare in the period when the reform takes place, which takes into account the transition path - and long-run welfare (LR), which evaluates welfare across stationary equilibria. We use these welfare measures to compute Δ_k the change in consumption at all times that would make households indifferent between the pre and post reform economy. [24] We compute the consumption equivalent welfare using the following equation:

$$\Delta_k = \left(\frac{W_k^\eta + \frac{Q^0}{1-\beta}}{W^0 + \frac{Q^0}{1-\beta}} \right)^{\frac{1}{1-\gamma}} - 1, \tag{32}$$

where $\Delta_k > 0$ implies that the reform is welfare improving, and Q^0 is disutility from supplying labor in the benchmark steady state. Table 9 reports the permanent consumption equivalent change by skill group and in the aggregate.

The short-run results bear qualitative and quantitative differences with respect to the long-run results. According to the short-run welfare measure, an expansionary tax credit policy is welfare improving. In contrast, long-run aggregate welfare falls. This outcome is driven by low-skilled households, who on average prefer the status-quo.

Welfare of low skilled households depends on two opposing forces. On the one hand, higher targeted transfers improve insurance and thereby welfare. On the other hand, lower equilibrium wages and lower savings imply welfare losses. The drop in equilibrium wages for low-skilled household is offset by higher tax credit for household with low productivity realizations, but this is not the case for high productivity low skilled households who do not qualify for tax credits.

In the short run, low skilled households gain from higher tax credit generosity because (a) their consumption profile becomes smoother due to increased transfer payments, (b) short term increases in wages, and (c) positive

24 Cf Athreya (2002), Alonso-Ortiz and Rogerson (2010), Domeij and Heathcote (2004). In Domeij and Heathcote (2004) Δ is defined as the *average* welfare gain, which is equivalent given our focus on ex-ante welfare.

short and medium term wealth effects. In the long run, only the insurance effect prevails, which is small relative to the negative effect on expected lifetime utility stemming from (b) and (c). Wealth effects constitute the most important component of low skilled households' welfare loss, as we illustrate further below. Most importantly, these welfare effects are triggered by improved insurance of the reform, and not by the general equilibrium effect, as shown in section 3.1.1.

In contrast, high skilled households are better off according to both welfare measures. This outcome can be explained by two compounding factors. First,high skilled households receive a higher wage and increase consumption in the long-run as documented in the partial equilibrium analysis. Second, poorer high skilled households receive higher tax credits and are better insured against adverse labor productivity shocks. The insurance channel increases their expected life time utility further. By revealed preferences their welfare is higher, at least in *Scenario II*. In fact, as tax credits and wages increase, if households change their asset holdings, they must be better-off, since their pre-reform consumption-savings bundle is still in their budget set.

Finally, wealthy non-working households are largely unaffected by the reform and their expected welfare differences approach zero since the probability of being eligible for tax credits falls with wealth. In the short run, high-skilled wages falls significantly, but they also experience a positive wealth effect. This is why (a)$\Delta_{long-run}$ is *higher*. However, since the general equilibrium response of wages is small relative to the wealth effect, and savings are depleted less in the long run than for low-skilled households, it remains positive also in the short run.

Two further decompositions are helpful to understand this result. First, we report the fraction of households that would support the reform in table 10, before accounting for changes in the distribution of households, i.e. wealth effects. Support for the reform is assessed by comparing expected lifetime utility of each household (across the asset, productivity and skill space). This metric demonstrates the direct effects from increased insurance and changes in equilibrium wages in the long-run. Most households gain from the extension using this metric. The higher productivity low skilled households are the only group who receive a lower wage and do not benefit much from higher tax credit generosity at the same time.
Second, we further decompose aggregate welfare changes $\Delta_{long-run}$ into an aggregate and a distributional component to illustrate the negative average effect in the long-run following Domeij and Heathcote (2004). For both skill types, the distributional effect is positive. However, the aggregate effect is large and negative for low skilled households, thus leading to welfare losses on average for this skill group. This result is driven by low-skilled households who adjust their savings most and experience negative wealth effects.

TABLE 10
Share of the population (π) that benefits from a tax credit expansion of 10%.

	$\pi_{short-run}$	$\pi_{long-run}$
Low-skilled	1.00	0.72
High-skilled	1.00	1.00
Aggregate	1.00	0.85

In sum, the aggregate welfare loss in the long-run is due to a change in the long-run distribution of households towards lower asset holdings, which is most pronounced for low-skilled households, while insurance is improved for all households. General equilibrium effects counteract the incentive to lower savings for high-skilled households, while they accentuate it further for the low-skilled.

4. Conclusion

This paper bridges the empirical literature on the EITC and the literature on taxation with household heterogeneity and conducts a positive analysis of the EITC. While the research on tax credit is dense, we know little about its effect on individuals' savings decision, and on its redistributive impact, in particular towards individuals that are not directly affected by tax credit policies. We quantify the labor supply, wage and savings responses of a once and for all EITC extension across stationary equilibria and on the transition path.

Our results show that the EITC successfully redistributes income towards the poor working population without distorting incentives to work. However, the tax credit reduces the incentive to save for a large part of the targeted population. Both effects of the tax credit have non trivial distributional effects: the increase in labor supply contributes to an increase of the skill premium, and the crowding out of savings leads to an increase in wealth inequality. Our analysis is more nuanced and shows that the EITC might contribute to a widening the wage gap, but that for the eligible population, these adverse wage effects are dominated by the direct transfer effect of tax credits. As for the population that is only indirectly affected via wage effects, we show that when we take into account transitional dynamics, a large part of the wage drop is compensated by a short run increase in wages and higher consumption in the long term due to the depletion of savings along the transition path. Our welfare analysis shows that a majority of the population benefits from tax credit policies, except for the high income households within the low skilled population. Once we take into account transitional dynamics, these welfare losses disappear.

Looking forward, our results motivate further research on the savings response to the EITC. Future research should also how family structure matters for the mechanisms highlighted herein.

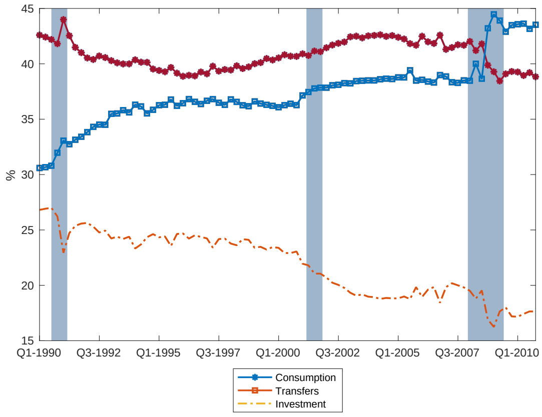


FIGURE A1: US federal government transfer programs, 1990-2011.

Transfers are defined as the sum of social benefits, subsidies and capital transfers. Shaded areas denote NBER recessions *Source:* FRED II.

Appendix: Appendix

A1. A time series perspective on federal transfer programs

Over the past 20 years, a compositional shift within the U.S. federal budget took place: transfer programs are the most prominent federal fiscal policy instrument and transfers amount to 38% of total government spending as of 2011. To gauge the relative importance of transfer policies, we plot in figure A1 the fiscal policy instruments as ratios of the federal budget allocated to benefits to persons. Disaggregating the federal government expenditure in transfers (federal benefit to persons) by program highlights the emergence of refundable tax credits as the most important transfer program alongside with unemployment insurance as shown in figure A2. Since 1990 the share of budget of federal benefits allocated to refundable tax credits was multiplied by a factor of 6. The promotion of tax credit policies was motivated by policy makers' belief that tax credit is a policy instrument that can simultaneously increase labor force participation and raise real relative wages of the low skilled (Blundell 2006).

A2. The Earned Income Tax Credit (EITC)

The EITC has, along side unemployment insurance, become an essential redistribution policy in the United States. Since its introduction in 1975, it steadily expanded, and the number of eligible recipients 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).

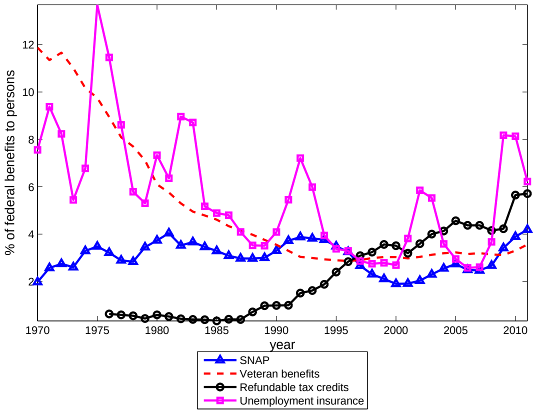


FIGURE A2: Transfer categories in total federal social benefits, 1970-2012.

Source: BEA NIPA table 3.12.

The EITC is a mean-tested transfer program, meaning households have to satisfy specific criteria to be eligible. The full list of criteria is outlined in table A1, while the shape of the tax credit is plotted in figure A3. The amount of tax credit received is a function of the households earned income (Adjusted Gross Income), the filing status, and number of eligible children. With regard to total annual earned income, the total tax credit schedule has three distinct regimes. In the first so-called 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

TABLE A1
Eligibility criterion for the Earned Income Tax Credit (EITC) program.

- Earned and Adjusted Gross Income (AGI) that is positive but below a threshold, that varies by filing status and family size as can be seen in figure A3).
- 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 $ 3,100.

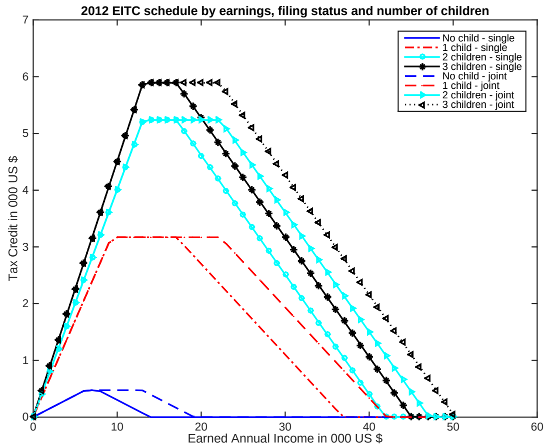


FIGURE A3: Earned Income Tax Credit (EITC) schedule.

Source: Publication 596, Internal Revenue Service (IRS).

function of earnings. Also the EITC pay-off is conditional on the household's capital income not being higher than a specified threshold, 3,100 US$.[25]

A3. Robustness

Here, we study the robustness of our main results relative to two alternative calibrations. The first alternative calibration (*Calibration 1*) is one where we change the borrowing limit and the second alternative calibration (*Calibration 2*) is one where we change the coefficient of relative risk aversion. In the two recalibrated economies we implement an expansionary tax credit of 10% ($\eta = 0.1$) and compare the results to the benchmark economy (see table A2).

A3.1. Borrowing limit

Relative to the benchmark economy, when borrowing is not allowed the responses to expansionary tax credit policy are qualitatively unchanged, but they are quantitatively smaller. The effects on savings and labor force participation are more muted because households can not take up debt and more households are borrowing constrained. As a consequence, labor force participation increases to a smaller extent. Conversely the general equilibrium effect on wages are also smaller.

25 A complete documentation of the EITC can be found in Nichols and Rothstein (2015) & Meyer (2010)

TABLE A2
Aggregate effects of Tax Credit policies : Robustness Analysis.

Policy variable		η =0.1	
Calibration	Benchmark calibration	Calibration 1: $\gamma = 5$	Calibration 2: $\underline{a} = 0$
GDP	0.40	0.25	0.22
Savings (LS)	-6.41	-7.61	-2.36
Savings (HS)	-0.82	-1.72	-0.54
Participation (LS)	1.39	0.53	0.75
Participation (HS)	0.14	0.08	0.09
Wage (LS)	-0.35	-0.16	-0.17
Wage (HS)	0.20	0.09	0.10
Wealth income ratio (LS)	-6.28	-6.21	-2.30
Wealth income ratio (HS)	-0.98	-1.52	-0.58

Note: Units are in percentage change from the steady state of the calibrated economy. Tax credit expansion is financed by an increase in average tax rate. *Benchmark*: calibrated economy presented in the paper. *Calibration 1:* economy calibrated as in the benchmark economy with a risk aversion parameter set to 5. *Calibration 2:* economy calibrated as in the benchmark economy with a borrowing limit set to 0.

A3.2. Risk aversion

In the recalibrated economy with a higher risk aversion, the model predictions remain qualitatively unaltered. Quantitatively there are some noticeable differences: the crowding out of savings is stronger and the labor force participation is weaker than in for the benchmark economy. Also the general equilibrium effects on wages are weaker.

A higher degree of risk aversion, enhances the precautionary motive *Ceteris paribus*. However, to match the wealth to income ratio and labor force participation, households have a lower discount factor and a higher fix cost of working. In response to the tax credit expansion, aggregate savings fall in this economy more than in the benchmark calibration. This is in part driven by lower discount factors. Also the higher utility cost of working implies that participation responds less to the increase in transfer. Savings in turn are more responsive as a result of the low elasticity of participation with respect to changes in the fix cost. This also makes the insurance effect more valuable, because households find it more costly to adjust labor supply. The tax credit expansion is still supported by the majority of households and bears positive welfare gains also for low-skilled households in the long-run perspective, because (a) general equilibrium effects are weaker and (b) the insurance effect is stronger for all households, including the high productivity low-skilled households, which were driving the long-run welfare losses in the benchmark economy.

A3.3. Small open economy

The small open economy (SOE) assumption is an important one but it is a useful benchmark. In what follows, we argue that for the magnitude of tax credit expansions that we consider, the general equilibrium effect via the interest rate leave our qualitative results unaltered. We now outline our reasoning and discuss how the main results would be affected if the SOE assumption were to be relaxed.

Expansionary Tax credit policies crowd out private saving and increase labor force participation. Both of these forces would increase the marginal product of capital and thereby the interest rate, which would mitigate the fall in savings. A fall in savings *ceteris paribus* lowers wages. Since the capital stock is made up of domestic savings, it is less likely that the tax credit policy will be expansionary on GDP. Hence both of these forces would weigh negatively on households' income and reduce the welfare gains, in particular for high skilled households.

Lastly, a negative effect on wages lowers the incentive to work and reduces labor force participation. However, as shown in section 3.1.1 the wage effect is small and dominated by the insurance effect in the range of tax credit expansions that we consider (see figure 3). To overcome the effect from insurance provided by the tax credit expansion, the wage effect would therefore need to be very large.

In conclusion, it seems unlikely that a more accentuated fall in the wage rate could overturn the welfare gains that we have found, at least for low to moderate expansions. We base this on our results for the relative strength of insurance effects and higher income and the response of savings. However, for large tax credit expansions, this would become increasingly likely, meaning that aggregate losses and indirect general equilibrium effects might outweigh additional benefits from insurance through higher tax credits. In fact, insurance effects are by construction limited due to the shape of the tax credit function. Beyond a certain level of tax credit expansion the gains from insurance are likely to be exhausted. In this extreme case, the indirect general equilibrium effects might indeed outweigh the additional insurance effects.

A4. Numerical method

A4.1. Solution method for the Stationary Competitive Equilibrium

We approximate the AR(1) processes with a discrete valued first order Markov process using the method by Tauchen (1986). Each skill group has 10 productivity states. The EITC schedule is non-monotone, has several kinks and depends both on earnings and the level of assets. Therefore, we use a standard value function iteration algorithm with a fine-spaced asset grid to solve the household problem. The asset grid has 2000 grid points with logarithmic spacing. We set the parameters outlined in section 2.1.

1. *Outer loop 1:* Guess values for the calibrated parameters outlined in section 2.2.
2. *Outer loop 2:* Guess prices w_s, w_u.
3. *Inner loop:* Solve for the policy functions using the value function iteration method and the Howard improvement algorithm. Given the policy

functions, solve for the two stationary distributions $\lambda(i = u, e, a)$ and $\lambda(i = s, e, a)$.
4. Use the policy functions and stationary distributions to compute aggregate statistics.
5. Check if implied prices coincide with initial guesses. If they don't, update prices and go to *step 2*.
6. Check if the calibrated parameters generate aggregate statistics match the empirical targets from table 3. If they don't, update parameters and go to *step 1*.

A4.2. Solution method for the policy experiment

We use the same method as above. We keep parameters at their calibrated value. For a given $\eta > 0$, we solve for equilibrium values w_u, w_s and a b (equation 11) that clears the government budget constraint, i.e. keeps G at its steady state value.

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