

The General Equilibrium Incidence of the Earned Income Tax Credit

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Abstract

The Earned Income Tax Credit is the *de facto* largest anti-poverty program in the US, utilized by over 20% of the labor force, yet all prior analysis has used partial equilibrium assumption on wages. I derive the general equilibrium incidence of targetted wage subsidies allowing for elastic labor supply and imperfect labor substitution across labor markets and apply this to the EITC. To quantify spillover effects, I estimate the general equilibrium incidence of the 1993 EITC expansion by combining labor supply elasticities estimates and tax changes during the 1990s. To highlight how the spillover effects alter policy recommendations between programs, I simulate the partial versus general equilibrium incidence of two equal sized tax reforms: an expansion of the EITC and of a hypothetical Negative Income Tax. In both situations, I find that spillovers are economically meaningful.

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1. Introduction

The Earned Income Tax Credit is the *de facto* largest anti-poverty program in the United States, with up over 20% of all workers receiving some share of the \$67 billion expenditure, yet all prior analysis has essentially used partial equilibrium assumptions on gross wages when analyzing policy effects. Given the scope of the EITC, its place in anti-poverty policy discussions, and the importance of labor market outcomes on its overall efficacy, this oversight looms large.

I revisit the effect of the EITC on gross wages and earnings by deriving the general equilibrium incidence of targeted wage subsidies, allowing for heterogeneous tax changes and labor supply responsiveness and imperfectly substitutable labor markets. I show that targeted wage subsidies create spillover effects on ineligible workers, which then feed-back and cause cascading wage effects leading to ambiguous labor demand net-effects despite the unambiguous labor supply effects. The mechanism is simple. A subsidy that increase labor supply of some *initial* set of workers will increase the marginal product of all *other* workers; this causes labor demand to increase for the *other* workers; the resulting quantity increase in *other* workers will increase the marginal product of the *initial* workers; and so on. . .

Because the magnitude of spillovers are theoretically ambiguous, I use two approaches to quantify their impact on policy efficacy. First, I calculate the empirical general equilibrium incidence of the 1993 expansion by estimating heterogeneous labor supply and substitution elasticities using federal and state policy variation over the 1990s. I show that the incidence can be calculated using a function of elasticities, market shares, and tax rate changes. With these ingredients in hand, I quantify the spillover effects created by the truly massive expansion of the EITC between 1992 and 1995. I find that the spillovers are ... **to do**.

Second, I highlight how different wage subsidy policies have very different spillover effects on workers by simulating two equal-sized tax reforms: an expansion of the EITC versus a hypothetical Negative Income Tax policy, a form of Universal Basic Income.

Thus, I offer a general equilibrium extension to [Rothstein \(2010\)](#), who compares these hypothetical reforms in partial equilibrium. My simulation finds that spillovers are economically meaningful when anticipating policy effects. I find that gross wage decreases predicted by the EITC's labor supply effects are 42% smaller in in GE compared to PE, while increases predicted by the NIT are 40% smaller. In PE, a NIT *appears* to be the unambiguously more cost effective approach to transfer income to low wage workers; however in GE, the EITC generates greater net-earning among to low and high wage workers. That is, I show that spillovers attenuate the 'bad' effects of the EITC as well as the 'good' of the NIT.

The overarching message of this paper is that the impact of general equilibrium spillovers of conditional wage subsidies, such as existing EITC or proposed UBI, on labor market outcomes are of first order importance. Further, because the labor market is central to the distribution of goods and services in the economy, tax policy aimed at alleviating the burden of the working poor can nevertheless have unintended consequences across all sectors of the economy.

This work is part of a long running effort to understand and quantify the economic and social effects of the Earned Income Tax Credit. The Earned Income Tax Credit is a large federal tax expenditure program designed to encourage work by subsidizing earned income using a non-linear benefit schedule. In 2017, the EITC disburses \$67 billion to 27 million workers, which is 18% of the labor force ([Internal Revenue Service, 2017](#)). Roughly 40% of all single parent families and 25% of married parent families are eligible for the EITC, and 40% of all families where the primary earner has less than a high school degree are EITC eligible ([Nichols and Rothstein, 2016](#)). This massive intervention in the labor market should have economically meaningful impacts on labor market sorting and equilibrium.

Previous studies, have consistently found that the EITC benefit structure successfully encourages labor force participation and increases employment rates for eligible groups – primarily unmarried women workers with children and low levels of education. See either two comprehensive survey articles – [Hotz and Scholz \(2003\)](#); [Nichols and Rothstein \(2016\)](#)

– or two specific applications of the labor supply effects – Eissa and Liebman (1996); Eissa and Hoynes (2004) – for a general overview of prior EITC studies.¹ However, few papers have studied the EITC’s effect on wages due to the supply shifts. As a large labor market intervention, we should expect distortionary effects on labor allocations in potentially unpredictable ways. However, most papers in the EITC labor literature assume that the EITC has had no effect on gross wages (Dickert et al., 1995; Eissa and Liebman, 1996; Saez, 2002; Eissa and Hoynes, 2004; Chetty et al., 2013).² As noted by Hotz and Scholz (2003), this assumption had never been tested in first decade of EITC research.

Leigh (2010) and Rothstein (2010) study the wage incidence in partial equilibrium.³ In partial equilibrium, we expect that a supply increase with fixed demand should cause wages to fall, with the amount governed by the relative supply and demand elasticities. The fall in gross wages reduces the overall cost effectiveness of the EITC as a means of transferring income to low-income workers. Leigh (2010), using state and federal variation, finds that a 10% increase in EITC generosity leads to a 5% decrease in the real wages of high school dropouts, and, using a simulated instrument within gender-age-education labor market cells, finds that 10% increase in cell labor supply leads to a 9% decrease in cell real wages. Rothstein (2010), using a calibrated labor market and simulated tax change, finds that for every dollar of intended transfer real wages decrease by \$0.34. These results imply that the EITC is not *as effective* a program as policy makers may believe and may be an unintended transfer to non-targetted groups. Lee and Saez (2012) allow for endogenous wages and argue that combined with an EITC with optimal minimum wage policy can prevent some of the incidence effect; however, the authors do not actually attempt to calculate the incidence.⁴

¹In addition, there are many papers that assess the social impact of the EITC on various outcomes – health (Dahl and Lochner, 2012; Evans and Garthwaite, 2014; Hoynes et al., 2015); education (Maxfield, 2015; Han, 2016; Bastian and Micheltore, 2018); and marriage & fertility (Dickert-Conlin and Houser, 2002; Baughman and Dickert-Conlin, 2003, 2009).

²Some of these papers are explicit (Eissa and Liebman, 1996; Saez, 2002; Chetty et al., 2013) and others are implicit in by holding wages fixed when simulating labor market effects (Dickert et al., 1995; Eissa and Hoynes, 2004).

³Azmat (2019) studies the incidence, also in partial equilibrium, of a conceptually similar Working Families Tax Credit program in the UK. She finds that, due to differences in salience unique to the UK program, gross wages fall by 7% for claimants and 1.7% for non-claimants.

⁴This is despite using a general equilibrium argument elsewhere in the paper when designing the optimal minimum wage policy.

My primary theoretical contribution is to show general equilibrium incidence effects are conceptually and quantitatively important to consider in assessing large conditional wage subsidies due to two channels. First, when all tax changes are in the same direction, the partial equilibrium incidence is the *upper bound* on the magnitude of the gross wage changes. Intuitively, this is because the behavior of all other economic agents is held fixed so wage spillover effects are ignored. Similar to [Agrawal and Hoyt \(2018\)](#), I show that general equilibrium incidence is the sum of the partial incidence and two other ‘first order’ terms that incorporate labor market spillovers. I show that these two general equilibrium terms are in the opposite direction of the partial effect.

Second, I show that when workers may switch factor markets (such as low to high skill), there are additional spillover effects of incentivising low wage work through subsidies. In short, a low wage subsidy will encourage low wage work, both by new workers entering the labor force and incumbent workers switching from high wage work. Past EITC work has only considered intensive *hours* choices but not *skill/sector* choices. I show that the general equilibrium incidence with switching is between the partial and the general incidence without switching. This is because switching magnifies the supply increase in a subsidized market and mitigates the response in other markets, so the effect is closer to the partial incidence. Practically, sorting into lower wage sectors may also reduce longer term wage growth for these workers, which is potentially important to policymakers.

My primary empirical contribution is to quantify the importance of the spillovers. First, I calculate the empirical spillover effects of the 1993 EITC expansion. To do so, I estimate labor supply and substitution elasticities using EITC policy variation in the 1990s, which captures the empirically relevant worker wage-responsiveness for the reforms. Because the model highlights how the incidence depends on heterogeneous labor supply responses, I estimate elasticities that vary based on education attainment, marriage status, and parental status. On their own, these estimates are a contribution because neither the taxable income nor labor supply literatures provide estimates of elasticities that vary at this demographic granularity. Additionally, I calculate the EITC induced Average Tax Rate changes between 1993 and 1994, and apply the general

equilibrium incidence formula to calculate the direct and spillover effects on gross wages and net-earnings. I find **not done yet**.

Next, to highlight how the spillovers manifest across different policies, I simulate two equal-sized tax reforms. I consider a hypothetical policy goal of transferring \$100million to workers through an EITC expansion versus a Negative Income Tax. In my preferred general equilibrium specification, an intended dollar of EITC spending delivers \$1.28 of net-earnings to workers while the NIT delivers only \$1.08 of intended dollars. These results are driven by different factors that are important for policy makers to balance. Foremost, the EITC increases welfare because there are positive marginal product spillovers on higher skill workers which feeds back to increase labor demand for the low-skill EITC workers despite their labor supply increase. The NIT increases welfare because the government is transferring consumption from *other* markets and allowing the subsidized workers to decrease labor supply to drive up their wages, which decreases market output and causes negative marginal product spillovers for all other workers.

My results contrast sharply with the partial equilibrium analysis of Rothstein (2010) who finds that the NIT is the unambiguously more cost effective program. This is for two reasons. First, because I model the GE spillovers, I show that spillovers attenuate the ‘bad’ effects of the EITC and the ‘good’ of the NIT. Second, I use a more empirically relevant estimate of the substitution elasticity that is closer to the literature consensus. Rothstein’s main specification uses a substitution elasticity of $\rho = -0.3$ while I estimate a value of -2.5 .⁵ Mechanically, this choice will exaggerate the effects of tax changes, as the theory shows.

I also reconsider an issue brought up in Rothstein (2010) about whether the EITC is an unintended transfer to firms at the expense of workers. This is similar to arguments that low wage firms are able to keep their workers’ wages low because the firms know that anti-poverty programs will ‘fill the gap’. I show that this argument is inconsistent with a partial equilibrium analysis, given his assumptions of zero profits and constant returns

⁵Rothstein’s estimate is based on a value estimated in Rothstein (2008) using a novel labor market definition, but the labor market definitions used in Rothstein (2010) is closer to the immigration literature which consistently estimates a larger elasticity.

to scale. However, with a slightly augmented model in general equilibrium, I show that his conclusion is possible and worthy of consideration.

The rest of the paper is organized as follows. In section 2, I describe the Earned Income Tax Credit program. In section 3, I describe the labor market model and its assumptions. In section 4, I derive the partial equilibrium wage incidence and discuss the assumptions needed. In section 5, I derive the general equilibrium wage incidence in a two type model, a model that allows workers to switch sectors, and a model with heterogeneous tax changes and arbitrary number of types. In section 6, I estimate the general equilibrium incidence of the 1993 EITC expansion. In section 7, I simulate the hypothetical EITC vs NIT policy reforms. Finally, I conclude by briefly summarizing the results and describing how these results affect considerations of the EITC.

2. The Earned Income Tax Credit

2.1. Background on the EITC

The Earned Income Tax Credit is a large federal tax expenditure program designed to encourage work by subsidizing earned income using a non-linear benefit schedule. The EITC is now the *de facto* largest anti-poverty program in the United States. In 2017, the EITC disburses \$67 billion to 27 million workers, which is 18% of the labor force ([Internal Revenue Service, 2017](#)). Roughly 40% of all single parent families and 25% of married parent families are eligible for the EITC, and 40% of all families where the primary earner has less than a high school degree are EITC eligible ([Nichols and Rothstein, 2016](#)). This massive intervention in the labor market should have economically meaningful impacts on labor market sorting and equilibrium.

Previous studies, have consistently found that the EITC benefit structure successfully encourages labor force participation and increases employment rates for eligible groups – primarily unmarried women workers with children and low levels of education. See either two comprehensive survey articles [Hotz and Scholz \(2003\)](#); [Nichols and Rothstein \(2016\)](#)

or Eissa and Liebman (1996); Eissa and Hoynes (2004) for two specific applications of the labor supply effects. However, few papers have studied the EITC's effect on wages due to the supply shifts. Indeed, the many papers in the EITC literature assume that there was no effect on gross wages (Dickert et al., 1995; Eissa and Liebman, 1996; Saez, 2002; Eissa and Hoynes, 2004; Chetty et al., 2013).⁶ Leigh (2010) and Rothstein (2010) study the wage incidence in partial equilibrium.⁷ In partial equilibrium, a supply increase with fixed demand should cause wages to fall, with the amount governed by the relative supply and demand elasticities. This fall in gross wages reduces the overall cost effectiveness of the EITC as a means of transferring income to low-income workers. Leigh (2010), using state and federal variation, finds that a 10% increase in EITC generosity leads to a 5% decrease in the real wages of high school dropouts, and, using a simulated instrument within gender-age-education labor market cells, finds that 10% increase in cell labor supply leads to a 9% decrease in cell real wages. Rothstein (2010), using a calibrated labor market and simulated tax change, finds that for every dollar of intended transfer real wages decrease by \$0.34.

However, when there are multiple (substitutable) factors with heterogeneous tax changes, the partial equilibrium analysis ignores the spillover feedback effects on marginal product across factor markets. Specifically, a supply increase in one market will increase the marginal product of other factors, causing a factor demand increase in those other markets, causing an increase in the marginal product of the first market, which creates a feedback loop by again increasing the marginal product of other factors. Thus, the general equilibrium forces counteract the negative wage effects by allowing for firms to increase factors demands. Ultimately, the balance of the partial equilibrium and spillover effects will determine the overall cost effectiveness of the EITC and the opportunity cost of other potential programs.

⁶Some of these papers are explicit (Eissa and Liebman, 1996; Saez, 2002; Chetty et al., 2013) and others are implicit in by holding wages fixed when simulating labor responses (Dickert et al., 1995; Eissa and Hoynes, 2004) and other effects.

⁷Leigh studies the incidence, also in partial equilibrium, of a conceptually similar Working Families Tax Credit program in the UK. She finds that, due to differences in salience unique to the UK program, gross wages fall by 7% for claimants and 1.7% for non-claimants.

3. Model

In this section, I layout a general equilibrium model of the labor market to investigate the effect of targetted labor subsidies. The primary assumptions are that worker utility is quasi-linear in consumption, production technology is constant returns to scale, and worker characteristics are observed by all market participants. To make analysis simpler, I abstract from other taxation issues by assuming the subsidy is financed by lump-sum taxes on workers, except I allow for an unemployment benefit. I initially analyze a three factor model – two labor types and capital – to show the economic forces involded; however, I also generalize to an arbitrary number of labor types.

3.1. Labor Supply

Let there be workers $i \in \mathcal{N}$ with utility defined over a composite consumption good and labor, $u_i: \mathcal{X} \times \mathcal{L} \rightarrow \mathbb{R}$. Workers maximize utility by making a discrete labor supply choice over whether to participate in the labor market or not, given prices and wealth. Further, assume that utility is quasi-linear with respect to final good consumption. Without loss of generality, the labor supply choice can be represented by:

$$\arg \max_{L=\{0,1\}} \{V_i(b_i, m_i; L_i = 0), V_i(w_i, m_i; L_i = 1)\} \quad (1)$$

$$= \arg \max_{L=\{0,1\}} \{0, T_i(w_i, m_i) + v_i - b_i\}, \quad (2)$$

where $T_i(\cdot)$ is a mapping from wages, unearned income, and transfers to final good consumption implied by the worker's budget set, b_i is the unemployment benefit, and v_i combines the disutility of effort and any potential opportunity cost of *not* participating in the labor force.

Let v_i be drawn from some distribution, $F_i(v)$, which potentially depends on other fixed worker attributes. Taking prices, the transfer function, and v_i as given, the problem yields worker output demand and labor supply functions, $X_i^D(w_i, m_i)$ and $L_i^S(w_i)$.⁸ The

⁸With specific distributional assumptions on $F(v)$ the expected labor supply of each worker is continuous; e.g., with Type-1 Extreme Value, $\Pr(L_i = 1 \mid \chi) = e^{T_i} / (e^{b_i} + e^{T_i})$.

model implies a threshold labor supply strategy:

$$L_i = 1 \iff v_i \leq \tilde{v}_i(w_i) = T_i(w_i, m_i) - b_i, \quad (3)$$

where the threshold depends on the market wage, net unearned income, and unemployment benefit for the worker.

Let worker i be described by a vector of demographics, $d_i = (e_i, k_i)$, which can be partitioned into a subvector that determines productivity, e , and one that is unrelated to productivity (conditional on e), k . For example, suppose workers are described by education levels and parental status, but only education affects marginal product.⁹ Given perfect information and perfect labor competition, all workers with the same e will earn the same wage, w .

By integrating over workers of the same demographic, the aggregate labor supply functions are:

$$L_d^S = F_d(\tilde{v}_d)N_d \quad \& \quad L_e^S = \sum_k L_{(e,k)}^S \quad \& \quad L^S = \sum_e L_e^S. \quad (4)$$

Using the above, I define the labor supply elasticity as:

$$\frac{\partial L^S}{\partial w} \frac{w}{L} = \sum_d \left(\frac{F_d(\tilde{v}_d)N_d}{L} \right) \left(\frac{w \cdot f_d(\tilde{v}_d)}{F_d(\tilde{v}_d)} \right) \equiv \sum_d (\vartheta_d \cdot \epsilon_d^S), \quad (5)$$

which is a weighted sum of the market specific labor supply elasticities.¹⁰

3.2. Production

Suppose that there are $j \in \mathcal{J}$ potential producers, each endowed with one unit of capital¹¹ and can hire labor to produce a homogenous consumption good. Firms face

⁹I maintain throughout the assumption that (e_i, w_i) are monotone.

¹⁰Returning to the TLEV example, this would imply an elasticity $\epsilon_d^S = \frac{\partial T_d}{\partial w_d} w_d F_d(\tilde{v}_d)(1 - F_d(\tilde{v}_d))$.

¹¹That is, $k_j = 1$ for all producers.

heterogenous costs of supplying their unit of capital, c_j ,¹² that is drawn from some distribution, $G(\mathbf{c})$.

Technology is represented by a nested constant elasticity of substitution production function:

$$q_j^S = Q(\{L_{e',j}\}_e, K_j) = A \left[\left(\sum_e \theta_{e'} (L_{e',j}^D)^{\frac{1+\rho}{\rho}} \right)^{\frac{\rho}{1+\rho}} \right]^\alpha K_j^{(1-\alpha)} \quad (6)$$

$$= A \cdot \mathbf{L}_j^\alpha K_j^{(1-\alpha)}, \quad (7)$$

where $L_{e,j}^D$ is the type e labor demand for producer j and \mathbf{L}_j is the labor aggregate. The elasticity of substitution between labor types is parameterized by $\rho = d \ln[L_{e''}/L_{e'}]/d \ln[w_{e''}/r_{e'}] < 0$. The elasticity of substitution between aggregate labor and capital is (-1) by assumption. This technology assumes these elasticities are constant and features constant returns to scale (CRS). The primary modeling benefit to this technology is that it allows for tractable solutions with indefinite numbers of different factors, which will come up later.¹³ Firms hire labor to maximize profit, given prices, $\pi_j = p \cdot Q(\{L_{e',j}\}_e, K_j) - \sum_e w_{e'} L_{e'} - r K_j$. Aggregate output is defined as $q^S = \int_j q_j^S dj$. In order to solve the model, I choose to normalize $p := 1$.

Given price taking, zero profits, and identical CES production functions, all firms choose the same factor input bundle, and by CRS this implies that the aggregate production function is also CES:

$$q^S = Q(\{L_{e'}\}_e, K) = A \left[\left(\sum_e \theta_{e'} (L_{e'}^D)^{\frac{1+\rho}{\rho}} \right)^{\frac{\rho}{1+\rho}} \right]^\alpha K^{(1-\alpha)}. \quad (8)$$

In this set up, the firm capital supply is synonymous with firm entry, which is determined by firm capital supply costs, c_j . By zero profits, $Q(\{L_{e',j}\}_e, K_j) - \int_{i \in L_j} w_i L_i = r$, again where each firm only has one unit of capital. As with workers, firms will enter based on a

¹²Alternatively, firms have heterogeneous entry costs.

¹³Specifically I use the fact that the substitution effect between two factors only depends on the pair's factor prices. As shown in Matsuyama and Ushchev (2017), this property requires throwing out many potential homothetic demand systems.

threshold condition: $c_j \leq \tilde{c}(r)$. In equilibrium, this will determine the aggregate capital supply function, $K^S(r)$. A firm's 'producer surplus' is profit minus the cost of entry, $r - c_j$. The capital supply elasticity, $\epsilon_K^S = r \cdot \frac{g(\tilde{c})}{G(\tilde{c})}$.

3.3. Transfer System

For simplicity, I assume that the government initially uses lump-sum taxation, n_i , with an unemployment benefit, b_i , and then imposes a targetted labor subsidy, τ_i . The changes in lump-sum tax policy to pay for the subsidy have no behavioral effects, and there are no changes in the unemployment benefit. I model the subsidy as a unit excise tax/subsidy, $T_i(w_i, m_i) = (w_i + \tau_i) + (m_i - b_i)$. I suppose that the benefit and subsidy amounts are functions of earnings, which the government observes, and demographics conditions, which the government can verify. Thus, the benefit and the transfer function varies at the demographic level, $\{b_d, \tau_d\}$. In the EITC context, the subsidy is only for low income workers with children.¹⁴

In the analysis, I consider a differential change in the tax rate, $d\tau_d$, starting from a tax of zero.¹⁵ To model the targetted aspect of the labor subsidies, let the set of demographics be partitioned into a condition that concerns labor market variables and one that concerns non-labor market variables: $d = (e, k)$. Let k determine overall eligibility and let e determine the size of the subsidy. For example, if $(e, k) \in \{0, 1\}^2$ proxy for education and parental status and the subsidy targets low income workers with children, then

$$d\tau_d = \begin{cases} \tau & \text{if } d = (0, 1) \\ 0 & \text{if } d \neq (0, 1). \end{cases}$$

¹⁴Technically, the EITC gives a small ($\leq \$500$) subsidy to workers without children, but this is often assumed to have no behavioral effects on these workers.

¹⁵If there were no unemployment benefit, then this would imply the initial equilibrium is efficient. With the benefit, it is efficient conditional on the benefit.

Given the labor market assumptions above, this implies the following e -group labor supply function:

$$L_e^S(w_e, \tau_e) = L_{e,k_0}^S(w_e) + L_{e,k_1}^S(w_e + \tau_e). \quad (9)$$

3.4. Equilibrium in Three Factors

For exposition, I show equilibrium in three factors and then generalize to arbitrary factors. In equilibrium, the factor markets clear when all factors are paid their marginal product and firms make zero profits, which then clears the output market. Due to the CRS assumption, the scale of production cannot be determined so the scale of factor demands cannot be determined (without utilizing equilibrium relationships). Fortunately, the nested CES production function can be solved in terms of factor input and price ratios.

For the CES labor aggregator function, the factor demand ratios equal a function of the factor price ratio. For the two labor factors, (L_0, L_1) :

$$\frac{L_0^D}{L_1^D} = \left(\frac{w_0/\theta_0}{w_1/\theta_1} \right)^\rho \quad (10)$$

The labor aggregate and capital also have a CES relationship:

$$\frac{\mathbf{L}^D}{K^D} = \left(\frac{\bar{w}/\alpha}{r/(1-\alpha)} \right)^{-1}, \quad (11)$$

where \bar{w} is a labor cost index.

Thus, the equilibrium conditions for the model can be derived by equating the factor demand for supply functions and enforcing zero profits using the unit cost function, with

output price normalized to one:

$$\text{Labor Clearing} \quad \frac{L_0^S(w_0, \tau_0)}{L_1^S(w_1, \tau_1)} = \left(\frac{w_0/\theta_0}{w_1/\theta_1} \right)^\rho \quad (12)$$

$$\text{Factor Clearing} \quad \frac{L^S(w_0, w_1, \tau_0, \tau_1)}{K^S(r)} = \left(\frac{\bar{w}/\alpha}{r/1-\alpha} \right)^{-1} \quad (13)$$

$$\text{Zero Profits} \quad P = c(w_0, w_1, r) := 1 \quad (14)$$

$$\text{Labor Cost Index} \quad \bar{w} = \left(\theta_0 \left(\frac{w_0}{\theta_0} \right)^{1+\rho} + \theta_1 \left(\frac{w_1}{\theta_1} \right)^{1+\rho} \right)^{\frac{1}{1+\rho}} \quad (15)$$

Definition 3..1 (General Equilibrium). An equilibrium is an allocation of consumption goods and factor supplies and prices such that equations 13, 14, and 15 hold for the economy described above.

3.5. Equilibrium with Many Labor Factors

The above equilibrium only considers three factors of production, L_0 , L_1 and K . A more general model allows for many more factors of production. Specifically, suppose that labor is much more differentiated in terms of marginal product so that there are E types of labor. This creates $E + 1$ different factors of production from the perspective of the firm.¹⁶ However, suppose that the nested CES structure remains.¹⁷

Thus the equilibrium system becomes:

$$\text{Labor Clearing} \quad \frac{L_e^S(w_e, \tau_e)}{L_{e'}^S(w_{e'}, \tau_{e'})} = \left(\frac{w_e/\theta_e}{w_{e'}/\theta_{e'}} \right)^\rho, \forall e' \in \mathcal{E} \quad (16)$$

$$\text{Factor Clearing} \quad \frac{L^S(\{(w_e, \tau_e)\}_{e \in \mathcal{E}})}{K^S(r)} = \left(\frac{\bar{w}/\alpha}{r/1-\alpha} \right)^{-1} \quad (17)$$

$$\text{Zero Profits} \quad P = c(\{w_e\}_{e \in \mathcal{E}}, r) := 1 \quad (18)$$

$$\text{Labor Cost Index} \quad \bar{w} = \left(\sum_e \theta_e \left(\frac{w_e}{\theta_e} \right)^{1+\rho} \right)^{\frac{1}{1+\rho}} \quad (19)$$

¹⁶I could additionally suppose that there are other material factors of production other than capital, and treat the aggregate capital as a material factor index.

¹⁷Thus, even though there are more types of labor there is still a single (partial) elasticity of substitution between labor types.

3.6. Welfare

The market surplus if worker i participates, facing prices $\{T_d(w)\}$, is

$$S_{i,d} = U_{i,d}(L_i = 1) - U_{i,d}(L = 0) = \tilde{v}_d - v_i. \quad (20)$$

This implies the aggregate *participation* surplus is:

$$S_d = \left[T_d(w)F(\tilde{v}_d) - \int_{\underline{v}}^{\tilde{v}_d} v f(v) dv \right] N_d = (\tilde{v}_d - E[v \mid v < \tilde{v}_d]) L_d^S \quad (21)$$

Total welfare is equal to the sum of non-participating workers consuming their non-labor income plus the sum of participating worker surplus:¹⁸

$$TW_d = \left[(m_d - n_d) + (b_d) \cdot (1 - F(\tilde{v}_d)) + w_d \cdot F(\tilde{v}_d) - \int_{\underline{v}}^{\tilde{v}_d} v f(v) dv \right] N_d \quad (22)$$

$$= [(m_d - n_d) + b_d + (w_d - b_d - E[v \mid v < \tilde{v}_d])F(\tilde{v}_d)] N_d \quad (23)$$

$$= (m_d - n_d + b_d)(N_d) + (w_d - b_d)L_d^S \quad (24)$$

Market aggregate surplus and welfare are given by $S = \sum_d S_d$ and $TW = \sum_d TW_d$. This states that total welfare in this model is the net-consumption of non-workers plus the net-consumption of workers minus the workers' disutility of labor.

4. Partial Equilibrium Incidence

In this section, I present the partial equilibrium incidence and show implications of the partial analysis. This section is lighter on details because it effectively replicates Rothstein (2010) using a more fleshed out model.

Return to the three factor model, where labor types are $d = (e, k) \in \{0, 1\}^2$. Suppose that the government is only subsidizing labor for the $(0, 1)$ group. I find the partial

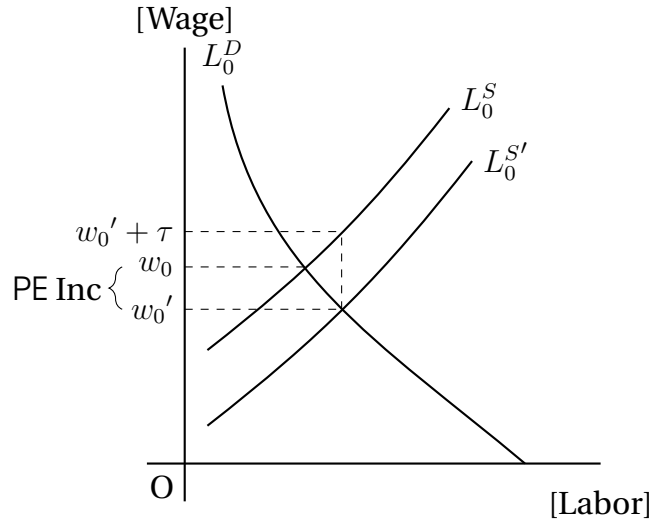
¹⁸Here I assume that non-labor income can also be described demographically; extending this to individual idiosyncratic amounts is simple but adds unnecessary messiness.

equilibrium incidence by totally differentiating the labor clearing condition (equation 13) while holding $\{L_1, K, w_1, r\}$ constant.¹⁹ This yields (when $\hat{\tau} > 0$):

$$\hat{w}_0^{\text{PE}} = \left(\frac{\epsilon_{0,1}^S}{\epsilon_0^S - \rho} \right) \cdot \sigma_0 \cdot \hat{\tau} < 0, \quad (25)$$

where σ_e is the share of type $e = 0$ workers that have $k = 1$, $\hat{x}_e = x_e/w_e$ is the percent of wage change for the e -group, and ϵ_e^S and $\epsilon_{e,k}^S$ are the group and sub-group supply elasticity, respectively.²⁰

Figure 1 – Partial Equilibrium Incidence



This drawing is based on Lee and Saez (2012) and incorporates an equilibrium in the capital market. The partial equilibrium incidence, denoted \mathfrak{p} , is observed by value $[\mathfrak{p} \cdot w]$.

This implies, as in Rothstein (2010), that the partial equilibrium labor demand elasticity for labor is constant, equivalent for all labor types, and equal to the labor elasticity of

¹⁹Note, I ignore the factor clearing and zero profits condition because in partial equilibrium these equations cannot simultaneously be true given other fixed variables *and* have non-zero change in gross wages. For instance, the totally differentiating the zero profit condition, with the other variables fixed implies, that $L_0 \cdot dw_0 = 0$, which can only be true if $dw_0 = 0$, implying that the subsidy has no partial equilibrium effect at all!

²⁰Note, $\epsilon_e^S = \sigma_e \epsilon_{e,1}^S + (1 - \sigma_e) \epsilon_{e,0}^S$.

substitution. To see why this is the case, consider the following:²¹

$$L_0^D(w_0) = L_1^S(w_1(w_0)) \cdot \left(\frac{w_0/\theta_0}{w_1(w_0)/\theta_1} \right)^\rho \quad (26)$$

$$\implies \eta_0^D = \rho + \frac{\partial w_1}{\partial w_0} (\epsilon_1^S - \rho). \quad (27)$$

When $\frac{\partial w_1}{\partial w_0} = 0$ by partial equilibrium assumption, then the demand elasticity is only the substitution elasticity between factors.

4.1. Implication of Partial Equilibrium Assumption

Suppose there are multiple labor types with heterogeneous subsidy changes, as in the Rothstein (2010) analysis. Suppose that one wants to use the partial equilibrium incidence formula to assess the impact of a targeted subsidy, as in Rothstein (2010). In a many labor factor model, this implies the partial equilibrium labor demand elasticity is:

$$\eta_e^D = \frac{d \ln[L_e^D]}{d \ln[w_e]} = \frac{d \ln[L_e^D/L_{e'}^D]}{d \ln[w_e/w_{e'}]} = \rho, \forall e, e' \in \mathcal{E}. \quad (28)$$

The above is true for e only when $d \ln[L_{e'}^D] = d \ln[w_{e'}] = 0$ for every other labor factor, but this can never be simultaneously true with multiple markets. Calculating the partial incidence for multiple labor markets is problematic since this requires a set of mutually exclusive conditions, especially when allowing for heterogeneous subsidies for different labor markets. In this case, using the Rothstein (2010) type analysis yeilds an ‘employment weighted average partial equilibrium effect’, which is not an object of theoretical or practical interest.

Note, it is **not** sufficient to assume that $\epsilon_{e'}^S = 0$ for some set of factors. Rather, the wage of all other factors must be held fixed. Since the wage equals (value) marginal product, this implies that the despite changes in ratios of labor types; e.g., the supply of low wage labor,

²¹In the CRS context, the scale of production and thus factors is unknown. In the two factor case, Lee and Saez (2012) show that in equilibrium, the supply responses of the second factor can be used to pin down the first factor’s demand and second factor’s price as only a function of the first factor’s price.

the marginal product of the high wage labor must be held fixed. But this is mechanically impossible.

4.2. Interpretation of Partial Equilibrium Results

In his analysis, Rothstein implies that decreases in gross wages are in effect a transfer to *firms* at the expense of workers: “this implies that employers of low-skill labor capture a portion of the intended EITC transfer” and “...targeted work subsidies produce unintended transfers to employers...” (Rothstein, 2010).²² While Rothstein’s partial equilibrium analysis is technically correct, the interpretation of his result, given the model and analysis he conducts, does not follow.

First, with zero profits, there are no explicit profits for firms. Rather, with CRS technology, if one factor price goes down, then another factor price must increase, so the analysis points to the *owners* of the other factors benefiting. Else, with marginal cost pricing, then the output price must decrease (but price is held fixed).

But, if one believes that entrepreneurs are themselves the owners of some other factors (such as capital in the model from the previous section), then firms/entrepreneurs may ‘capture’ the wage subsidy because their own factor payments increase. However, the production function in Rothstein (2010) only includes labor factors, so there is no possible factor to be owned by firms.²³

Nevertheless, the ‘all else equal’ for the partial incidence for a specific factor requires the prices and quantities of all other factors be held *fixed*, which means that owners of other factors *cannot* actually realize any factor price increases. Thus, a partial equilibrium story is incapable of yielding Rothstein’s conclusion about transfers to firms at the expense of workers. In order to render the conclusion about firm owners benefiting from changes in gross wages, one must use a general equilibrium analysis.

²²This is similar to the social critique that low wage firms, such as ‘big-box’ retail firms, are able to take advantage of anti-poverty programs such as SNAP and Medicaid.

²³In an earlier working paper, Rothstein’s production function did include capital but this was omitted in the published version.

5. General Equilibrium Incidence

In this section, I lead with the simple three factor model and then show the generalized version. For the three factor model, I will only consider a subsidy for the low income labor group, but in the generalized version I allow for each labor type to have its own group specific subsidy. Finally, for the three type model, I consider an extension where workers additionally have group-specific preferences, where the high income group have the option of working in either the low or high income group.²⁴

In all models, I show that the general equilibrium incidence includes other ‘first order’ terms, some of which do not go to zero as the market size becomes infinitesimal. Thus, partial equilibrium analysis cannot be justified on ‘second order’ spillover effects nor small open, market assumptions.

5.1. General Equilibrium Incidence with Three Factors

In this section, I use a three factor general equilibrium model to show how targeted labor subsidies affect the labor market equilibrium. Specifically, I show that the partial and general equilibrium incidence results are different because changing the relative supplies of labor – by initially incentivising low wage labor supply – causes changes in the relative marginal products and wages of all factors, so firms reoptimize their factor demands. This causes a cascade of labor supply and demand changes until equilibrium is achieved. In the end, the general equilibrium incidence formula is the partial equilibrium incidence plus a weighted sum of market responses for all other factors.

Define the demographic sub-group specific labor supply elasticity as $\epsilon_{e,k}$ for $k \in \{0, 1\}$, the capital supply derivative as $dK^S/dr = \kappa$, and the the cost shares $w_e L_e / (\bar{w}L + rK) = s_{L_e}$ and s_K similarly. Define the percent changes in wages and tax rates as $\hat{w} = dw/w$ and $\hat{\tau} = d\tau/w$, and define the demographic employment share as $\sigma_e = L_{(e,k_1)}/L_e$.

²⁴This is similar to the model used in [Saez \(2002\)](#).

To calculate the incidence, totally differentiate equations 13, 14, and 15 with respect to $\{w_0, w_1, r, \tau\}$. The system features three equations and three unknowns (dw_0, dw_1, dr) . Use Zero Profits to solve $dr = f(dw_0, dw_1)$, use Labor Clearing to solve $dw_1 = g(dw_0, d\tau)$, and then substitute into Factor Clearing for $dw_0 = h(d\tau)$. This yields (when $\hat{\tau} > 0$):

$$\hat{w}_1^{\text{GE}} = \left(\frac{-\epsilon_{0,1}\sigma_0}{(\epsilon_0 - \rho)} + \frac{\left(\frac{\epsilon_{0,1}\sigma_0}{(\epsilon_0 - \rho)} \right) s_0 \left(\frac{\epsilon_K + 1}{s_K} + \frac{1 + \rho}{s_L} \right)}{(\epsilon_0 - \rho) \left(1 + \left(\frac{\epsilon_K + 1}{s_K} + \frac{1 + \rho}{s_L} \right) \left(\frac{s_0}{(\epsilon_0 - \rho)} + \frac{s_1}{(\epsilon_1 - \rho)} \right) \right)} \right) \hat{\tau} \leq 0 \quad (29)$$

$$= (p_0 + \Gamma_0) \cdot \hat{\tau} \leq 0 \quad (30)$$

$$\implies p_0 \leq -\Gamma_0 \leq 0 \quad (31)$$

As in [Agrawal and Hoyt \(2018\)](#), the general equilibrium incidence as a linear function of the partial equilibrium incidence and general equilibrium effects. Note, only in the case that $s_0 = 0$ are $\hat{w}_0^{\text{PE}} = \hat{w}_0^{\text{GE}}$, which is a infinitesimal markets scenario that makes little sense in a two labor type model.

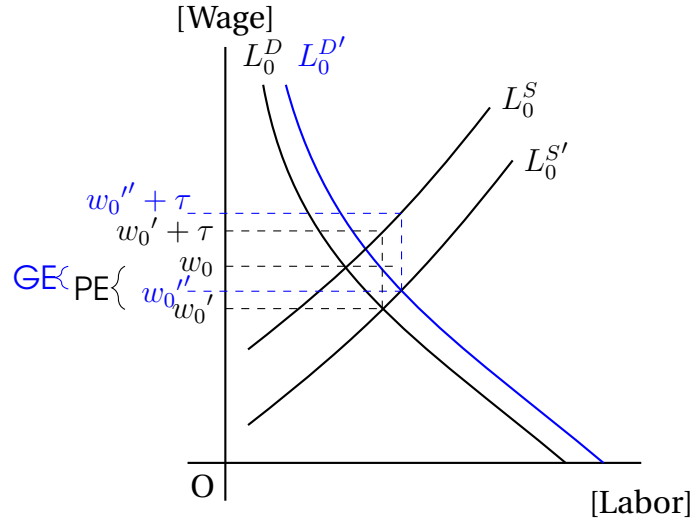
The most important aspect of equation 30 is that there are **two** ‘first order’ effects and understanding the reason for each. Partial equilibrium analysis is often justified on the basis of capturing the ‘first order’ effect while other effects are ‘second order’; however, this is not the case above. For this reason, the general equilibrium effects can *theoretically* be similar in magnitude as the partial equilibrium effect.

Note also that $\hat{w} < 0$, $p < 0$, and $\Gamma > 0$. This implies that the partial equilibrium incidence is the *upper bound* in the gross wage change, so the general equilibrium effects offset the partial equilibrium effects of the subsidy.

Intuitively, the partial equilibrium formula omits firm reoptimization (by demanding more capital and high wage labor) and factor reoptimization (by supplying more), and thus the *benefits* to the subsidized factor of these reoptimizations (increases in other factors increase the subsidized labor’s marginal productivity) are not present. Figure 2 provides a graphical comparison of the market outcomes.

The relative size of the two *opposing* wage effects depends on s_L , the curvature of factor demand ρ , and the behavioral supply responses of all factors. Thus, determining

Figure 2 – Two Factor Equilibrium with Subsidy
General Equilibrium Incidence



This drawing compares the partial equilibrium incidence with the general equilibrium incidence. The primary difference is that marginal product spillovers cause labor demand to shift right, which mutes the initial gross wage decline.

the magnitudes of the general and partial equilibrium effects is ultimately an empirical question. In table 1, I show that for various parameters, the general equilibrium incidence result can be quite far from the partial incidence. The relevant set of parameters are: $(\{(\epsilon_{e,k}, \tau_d)\}_d, \epsilon_K, \rho, s_L)$.

5.1.1. Visual Incidence Comparison

Here, I compare the gross wage incidence from a labor subsidy based on the two factor model with an exogenous, 1% tax change.²⁵ This shows the importance of different elasticity assumptions when calibrating the labor market effects. I use equation ?? for the partial equilibrium incidence and I use equation 30 for the general equilibrium incidence.

In table 1, I present the main parameters I use in the calibration and a summary of incidence results. I discuss these choices in more depth in the calibration section. For the low wage labor market I use $\epsilon_{0,k} \in \{0.75, 1.0\}$ for both $k \in \{0, 1\}$, based on Rothstein (2010) and Eissa and Liebman (1996). For the high wage labor market I use $\epsilon_{1,k} = 0.3$

²⁵That is I plot $\hat{w}_0/(\sigma_0 \hat{\tau})$, so that these results are not affected by the share of eligible workers.

for both $k \in \{0, 1\}$, based on Eissa and Hoynes (2004). For the elasticity of substitution I use $\rho \in \{-0.3, -1.0, -1.4\}$, based on Rothstein (2010) and Katz and Murphy (1992); Goldin and Katz (2009). For the supply elasticity of capital I use $\epsilon_K = 1.0$ as a conservative estimate. I set $s_L = 0.66$ based on the labor share of total cost for the economy in the 1990s; the 2015 value is closer to 0.61. I set $s_{L_0} = 0.125$ and $s_{L_1} = 0.535$, based on the 1992 March CPS and my own calculations.

The incidence results in the table show that the partial equilibrium results can be quite off. The more responsive the unsubsidized factor is to its own price changing, the less the gross wage change. At $s_L = 0.65$ for all of the elastic capital supply elasticities, the general equilibrium incidence is less than half of the partial equilibrium incidence.

Table 1 – Summary:
Parameters & Incidence Results

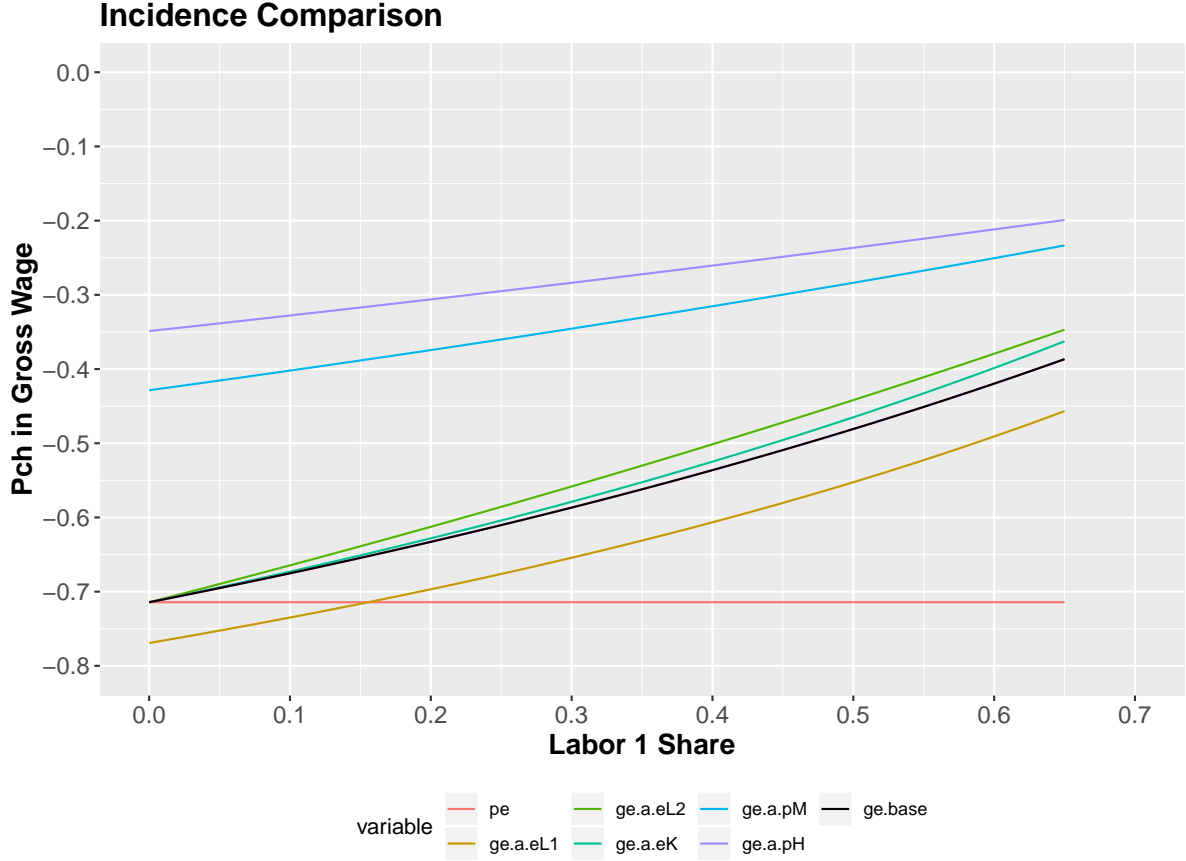
Parameter Specification	Incidence Results	
Baseline PE	-0.714	–
Baseline GE	-0.665	7.41%
$\epsilon_{L_0} = 1.0$	-0.726	-1.58%
$\epsilon_{L_1} = 0.5$	-0.652	9.59%
$\epsilon_K = 5$	-0.662	7.87%
$\rho_M = -1.0$	-0.395	80.70%
$\rho_H = -1.4$	-0.322	121.51%

Baseline: $\epsilon_0 = 0.75, \epsilon_1 = 0.3, \epsilon_K = 1, \rho = -0.3$
Incidence results computed at $s_{L_1} = 0.125, s_L = 0.66$
Percents are $(p - g)/g$, the over-estimation of PE incidence

In figure 3, I plot the partial and general equilibrium incidence of the gross wage at different labor cost shares ($s_{L_0} \in [0, 1]$). The flat line is the partial equilibrium incidence. The upward sloping lines are the general equilibrium incidence measures using different parameter specifications. As can be seen, only at $s_L = 0$ are the measures equivalent (at baseline values). The graph shows that the partial equilibrium incidence can overstate the magnitude of the wage decrease by over 100%, depending on the additional parameters.

The most influential parameter appears to be the substitution elasticity, ρ , followed by the low wage labor supply elasticity, ϵ_0 .

Figure 3 – Incidence Comparison Across Specifications



5.1.2. Equivalent Variation

Since utility is quasi-linear, the equivalent variation is exactly equal to the change in worker surplus. Nevertheless, I show this below.

The change in total welfare for group d is (again evaluated at initial $\tau_d = 0$):

$$dTW_d = \left[(dw + d\tau_d)F(\tilde{v}_d) + (w_d - b_d) \left((dw + d\tau_d) \left(\frac{\partial \tilde{v}}{\partial w} \right) f(\tilde{v}_d) \right) - \tilde{v}_d \left((dw + d\tau_d) \left(\frac{\partial \tilde{v}}{\partial w} \right) f(\tilde{v}_d) \right) \right] \cdot N_d \quad (32)$$

$$= (dw_d + d\tau_d) \left(F(\tilde{v}_d) - \left(\frac{\partial \tilde{v}}{\partial w} \right) f(\tilde{v}_d) (w_d - b_d - \tilde{v}_d) \right) \cdot N_d \quad (33)$$

$$= (\hat{w}_d + \hat{\tau}_d)(w_d \cdot L_d^S), \quad (34)$$

where $\tilde{v}_d = w_d - b_d$. As before, the aggregate welfare change is the size weighted sum of the group changes: $dTW = \sum_d dTW_d$.

The welfare change is equal to the net income effect on incumbent workers. The change is intuitive. Since utility is quasi-linear the change in consumption is equal to the change in utility. This is due to an envelope condition where the disutility of effort by the *enterants* is offset by their consumption change, so only effects on the incumbent workers contribute to the welfare changes.

As noted at the start, since preferences are quasi-linear, the change in total welfare is equal to the equivalent variation for the policy. The goal is to find for each worker the amount to make the worker *ex ante* indifferent to the policy change: $U_{i,t_0} + EV_i = U_{i,t_1}$. Before and after the policy, these are the worker's choices:

$$\max_{L=\{0,1\}} \{b_d, w - v_i\} \quad (35)$$

$$\max_{L=\{0,1\}} \{b_d, w + dw_d + d\tau_d - v_i\}. \quad (36)$$

There are four possible behavioral responses:

$$0 \rightarrow 0 : EV_i = 0 \quad (37)$$

$$0 \rightarrow 1 : EV_i = w_d + dw_d + d\tau_d - v_i - b_d = \tilde{v}_{d,t_1} - v_i = \tilde{v}_{d,t_0} + dw_d + d\tau_d - v_i \quad (38)$$

$$1 \rightarrow 0 : EV_i = b_d - w_d + v_j = v_i - \tilde{v}_{d,t_0} \quad (39)$$

$$1 \rightarrow 1 : EV_i = dw_d + d\tau_d \quad (40)$$

For a differential change in the subsidy, marginal enterants ($0 \rightarrow 1$) and exiters ($1 \rightarrow 0$) are indifferent in the two regimes, so the *EV* for these two cases is also 0. A non-differential change in the subsidy will cause these terms to be non-zero for some measure of the switchers.

The aggregate *EV* for the economy is going to be the weighted sum of the different *EV* amounts, where the weights are based on the number of workers in each behavioral

category. Note, for any group d , $\tilde{v}_{d,t_1} > \tilde{v}_{d,t_0}$ iff $dw_d + d\tau_d > 0$; else, the opposite. This means that for any d , there are only switchers in one direction, $0 \rightarrow 1$ or $1 \rightarrow 0$.

For any group, the total EV_d is the summation of the remaining incumbent workers and the switcher group:

$$EV_d = (dw_d + d\tau_d)L_d + (\tilde{v}_{d,t_0} - E[v \mid v \in [\tilde{v}_{d,t_0}, \tilde{v}_{d,t_1}]])dL_d^S \quad (41)$$

$$= (\hat{w}_d + \hat{\tau}_d)(w_d \cdot L_d^S) \quad (42)$$

Again, only if there is a differential subsidy change does the second term disappear. Equation 41 abuses some notation because it may be the case that $\hat{v}_{d,0} > \hat{v}_{d,1}$, but this only requires understanding that the sign of the second term is implied by the direction.

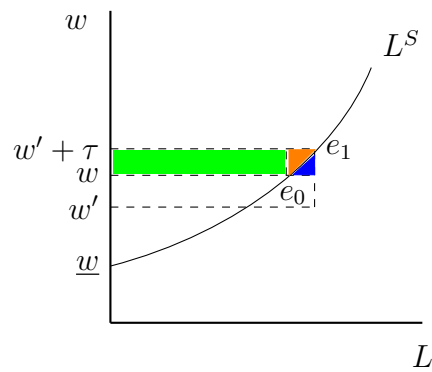
As stated, the equivalent variation in equation 42 is equal to the change in total welfare in equation 34. Graphically, these ideas are quite simple to represent, see figures 4 and 5.

For the case when there is a subsidy, the *ex ante* worker surplus is the area $(\underline{w} : w : e_0)$, and the *ex post* surplus is the area $(\underline{w} : (w' + \tau) : e_1)$. The subsidy causes overall worker surplus to increase, but there is also an increase in labor effort from new enterants. With quasi-linear utility, the change in surplus can be expressed in terms of expenditure amounts. The dotted box $(w' : e_1)$ is the entire expenditure by the government. The green box is the net increase in earnings by incumbent workers. The orange area is the added surplus of enterant workers, and the blue area is the additional labor effort by these workers.

When aggregate labor supply is linear, then the orange and blue area will cancel each other out. With a differential change in the subsidy, the aggregate labor supply elasticity will be roughly linear. With a discrete subsidy change, when aggregate labor supply is non-linear, and *concave-up* (i.e., positive second derivative, traditional textbook case), then the orange area will be slightly larger than the blue area. In this case, the green expenditure is a lower bound on the aggregate equivalent variation.

In figure 5, I show the change in worker surplus change for a group that experiences a wage fall without a subsidy. The orange and blue areas will cancel out for a small enough

Figure 4 – Surplus of Group with Subsidy



Boxes:

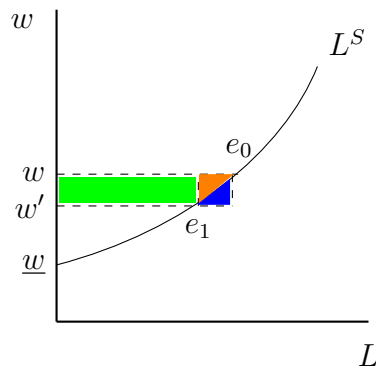
Green: $(dw + d\tau) \cdot L_0$

Orange: $(dw + d\tau) \cdot dL/2 + \delta$

Blue: $(dw + d\tau) \cdot dL/2 - \delta$

change in the wage. This leaves only the income change for the incumbent workers who continue to participate because the worker who leave the market are (almost) exactly compensated by their decreased labor effort.

Figure 5 – Surplus of Group without Subsidy: Wage Fall



Boxes:

Green: $(dw) \cdot L_0$

Orange: $(dw) \cdot dL/2 + \delta$

Blue: $(dw) \cdot dL/2 - \delta$

5.2. General Equilibrium Incidence with Many Worker Types

Adding additional types of labor in this context is relatively simple. Here, I allow for each labor type to have a heterogeneous tax change, and I solve the equations in the same manner as before using substitution after totally differentiating. Let worker types be indexed by $e \in \{0, 1, 2, \dots, E\} = \mathcal{E}$.²⁶ I solve the general equilibrium wage change for type 0 labor group, and can the labor-group clearing condition (equation 17) to solve for any other group.

The general equilibrium incidence for type 0 labor is:

$$\hat{w}_0^{\text{GE}} = \frac{-\epsilon_{(0,1)}\sigma_0\hat{\tau}_0}{\epsilon_0 - \rho} + \frac{\Lambda \left(\sum_e \frac{s_e \epsilon_{(e,1)} \sigma_e \hat{\tau}_e}{\epsilon_e - \rho} \right)}{(\epsilon_0 - \rho) \left(1 + \Lambda \left(\sum_e \frac{s_e}{\epsilon_e - \rho} \right) \right)} \quad (43)$$

$$= (\mathbf{p}_0)\hat{\tau}_0 + \Psi_0(\{\tau_e\}_{e \in \mathcal{E}}) \quad (44)$$

$$\text{where } \Lambda = \left(\frac{\epsilon_K + 1}{s_K} + \frac{1 + \rho}{s_L} \right). \quad (45)$$

Generally, one cannot sign the expression without knowing the direction of each $\{\tau_d\}_d$. This is similar to [Agrawal and Hoyt \(2018\)](#) in the context of taxing multiple consumer goods. For example, if the own tax change is large but all other tax changes are small, then very likely the partial equilibrium term will dominate, so the expression is negative. However, if the own tax change is small but all other are large and positive, then the general equilibrium spillovers will dominate, so the expression is positive.

Again, this shows that generally there will be **three** first order terms with respect to the tax change. Only if both of the general equilibrium spillover terms are small will $w^{\text{GE}} \approx w^{\text{PE}}$. Note, with multiple tax changes, it is no longer sufficient to suppose that $s_0 \approx 0$ for the GE terms to disappear. Now one needs to assume that $E[s_e \sigma_e \tau_e] \approx 0$.

²⁶In the calibrated model, $|\mathcal{E}| = 72$ based on age, education, and marital status of women.

5.3. Model with Market Switching

Here, I return three factor model but I allow the high wage workers, $e = 1$, to switch between markets. Additionally, I allow for a differential tax change in both labor markets.

This set up is similar to the model used in Saez (2002), only simplified to fewer employment groups. This allows $e = 1$ workers to substitute between unemployment, low wage work, and high wage work. Workers with $e = 0$ are only able to adjust between unemployment and low wage work.

For example, in the EITC context, suppose that high wage mothers see the net low-wage sector wage increase relative to high-wage work, and if this worker is marginally attached to high wage work, then there she will switch to low wage work. Alternatively, if a $e = 1$ worker without children originally chose low-wage work, then the potential real wage decrease relative to the high-wage sector will cause this worker to choose high wage work.

In this framework notation can get messy because workers of the same (e, k) can earn different wages, so I would need to track both worker type and worker labor choice for four different types of workers and three sectors. This is not conceptually difficult, but messy. I assume that $e = 1$ workers are paid equal to $e = 0$ if they participate in the low-wage sector. One foundation for this is that low-wage work involves some set tasks that cannot benefit from high-wage worker's skills, so workers of both e types will have the same marginal product.²⁷

Let the labor supply of a type (e, k) worker be denoted as $L_{g,k}^e$, where $g \in \{0, 1\}$ designates low or high wage labor group. Let $\epsilon_{g,k}^e$ be the extensive labor supply elasticity, and for type $e = 1$ workers let $\chi_k^{g \rightarrow g'}$ be the cross wage elasticity with respect to sector choice for workers. The latter elasticity is only concerned with incumbent workers who potentially switch sectors. I suppress the group conditional demographic shares, $\sigma_{g,k}^e$, to ease notation.

²⁷Note, this rules out pricing power by firms to create a separating equilibrium among worker types.

This implies the following equilibrium system (suppressing labor supply arguments):

$$\text{Labor Clearing} \quad \frac{L_{0,0}^0 + L_{0,0}^1 + L_{0,1}^0 + L_{0,1}^1}{L_{1,0}^1 + L_{1,1}^1} = \left(\frac{w_0/\theta_0}{w_1/\theta_1} \right)^\rho \quad (46)$$

$$\text{Factor Clearing} \quad \frac{L_{0,0}^0 + L_{0,0}^1 + L_{0,1}^0 + L_{0,1}^1}{K^S(r)} = \left(\frac{\bar{w}/\alpha}{r/1-\alpha} \right)^{-1} \quad (47)$$

$$\text{Zero Profits} \quad P = c(w_0, w_1, r) := 1 \quad (48)$$

The general equilibrium incidence for this model is:

$$\hat{w}_0^{\text{GE}} = \frac{-(\epsilon_{0,1} - \tilde{\chi}_1^{1,0})\hat{\tau}_0}{(\epsilon_0 - \tilde{\chi}^{1,0} - \rho)} + \frac{\Lambda \left(\sum_d \left(\frac{s_d \hat{\tau}_d (\epsilon_{d,1} - \tilde{\chi}_1^{-d,d})}{(\epsilon_d - \tilde{\chi}^{-d,d} - \rho)} \right) \right)}{1 + \sum_d \left(\frac{s_d \Lambda + \tilde{\chi}_1^{-d,d}}{(\epsilon_d - \tilde{\chi}^{-d,d} - \rho)} \right)} \quad (49)$$

$$= (\mathfrak{p}_0 + \Gamma_0 + \mathcal{X}_0)\hat{\tau}_0 + \Psi_0(\hat{\tau}_2) + \mathfrak{X}_0(\hat{\tau}_2) \quad (50)$$

where $\epsilon_{d,1}$ and $\tilde{\chi}_k^{g,g'}$ incorporate the relevant share of workers based on $\sigma_{g,k}^e$. As before, $\Lambda = \left(\frac{\epsilon_K + 1}{s_K} + \frac{1 + \rho}{s_L} \right)$.

The main difference is that the supply elasticities are more complicated, fittingly, because supply is not inelastic between markets. There are now **five** first order terms in the incidence analysis, each capturing a different effect on the wage.

This shows an additional consequence of partial equilibrium analysis. If worker have the ability to switch which sector in which they participate, then a partial equilibrium analysis will hold the supply of the other markets fixed. This ‘prevents’ optimal movement even among the market understudy since no worker can switch between sectors, only between unemployment and low wage work.

6. Empirical Incidence of the EITC

In this section, I connect the theory to data by estimating labor market elasticities and tax changes, and then using these parameters to estimate the general equilibrium incidence of the EITC expansions over the 1990’s. I can write the tax incidence model from the previous section as a (nearly) linear simultaneous system that is essentially two-stage

least squares of observable market variables. These equations allow me to estimate the labor market elasticities.

Using the elasticities and calculated EITC average tax rate changes, I calculate the partial incidence using equation 25 and the general incidence using equation 43.²⁸ Under the assumptions of the model, I can calculate both terms across years using the policy variation over the 1990's. The most fundamental threats for my incidence estimates are the degree which my labor market definitions are misspecified and employers have monopsony power in the labor market. My labor market definitions are more accurate as the within-market substitutability of workers increases but the between-market substitutability is imperfect. As for monopsony, given the great deal of aggregation across industry and occupation, this concern is hopefully averaged away.

In the next section, I will use the estimated elasticities to simulate the incidence of two equal sized hypothetical tax reforms. I consider an expansion of the EITC versus an NIT program. This analysis allows me to compare the spillovers of the two programs.

6.1. Estimating Labor Market Elasticities

²⁸I focus on the general equilibrium incidence without market switching since at this time there are not well known cross-sector net-wage elasticities.

6.1.1. Estimating Equations and Identification

Using equation 43, I can specify the equilibrium incidence as a linear simultaneous system:

$$\begin{bmatrix} \hat{w}_{gst} \\ \hat{L}_{gst} \\ d\hat{w}_{gst} \\ d\hat{L}_{gst} \end{bmatrix} = \begin{bmatrix} p_{gst}\hat{\tau}_{gst} + \Psi_{gst} \\ \sigma_g\hat{w}_{gst} \\ (p_{gst}\hat{\tau}_{gst} - p_{0st}\hat{\tau}_{0st}) + d\Psi_{gst} \\ \rho d\hat{w}_{gst} \end{bmatrix} \quad (51)$$

$$= \begin{bmatrix} p_{gst} & 0 & 1 & 0 \\ \sigma_g \cdot p_{gst} & 0 & \sigma_g & 0 \\ p_{gst} & -p_{0st} & 0 & 1 \\ \rho p_{gst} & -\rho p_{0st} & 0 & \rho \end{bmatrix} \cdot \begin{bmatrix} \hat{\tau}_{gst} \\ \hat{\tau}_{0st} \\ \Psi_{gst} \\ d\Psi_{gst} \end{bmatrix} + \begin{bmatrix} e_{gst}^w \\ e_{gst}^L \\ u_{gst}^w \\ u_{gst}^L \end{bmatrix}, \quad (52)$$

where $p_{gst} = \frac{-\sigma_g}{\sigma_g - \rho}$ is the partial equilibrium incidence, σ_g is the labor market specific labor supply elasticity, ρ is the economy-wide labor substitution elasticity, and $\{\Psi, d\Psi\}$ are general equilibrium terms.²⁹ The term $d\hat{x}_g = \hat{x}_g - \hat{x}_0$, is the difference in changes between market g some base labor market $g' = 0$.

While the model could be estimated non-linearly using a numerical method of moments search, in practice, I separate the estimation based on which labor market parameters I am targeting. This will be less efficient but ensures that the model is estimated transparently using linear instrumental variable models. Thus, I separately estimate σ_g using the first pair of equations (group level) and then estimate ρ using the second equations (group differences).

²⁹These terms depend on weighted averages of the tax changes across labor markets in a state-year. I detail how I account for them after introducing the data.

For a given set of tax instruments, Z , which I will describe after the data is introduced, I estimate the parameters using two separate two-stage least squares models. Despite using a single source of tax induced variation, [Zoutman et al. \(2018\)](#) show that imposing knowledge about which side of the market is tax/subsidized allows researchers to alternatively estimate supply and demand parameters using the same set of instruments. I augment this by using variation within and between markets to identify the different parameters. In addition, I use labor market-year (d_{gt}) and state-year (d_{st}) fixed effects to control for underlying trends in the data.

The labor supply elasticities, σ_g , are estimated using variation *within* labor markets and across state-years:

$$\ln[w]_{gst} = \pi_0 + Z_{gst}\Pi_1 + [Z_{gst} \cdot d_g] \Pi_d + \pi_3 d_{gt} + \pi_4 d_{st} + e_{gst}^w \quad (53)$$

$$\ln[L]_{gst} = \beta_0 + \sigma_1 \ln[w]_{gst} + \sigma_d [\ln[w]_{gst} \cdot d_g] + \beta_3 d_{gt} + \beta_4 d_{st} + e_{gst}^L. \quad (54)$$

The implied elasticity for a given labor market is $\sigma_g = \sigma_1 + \sigma_{d(g)}$

Conversely, the substitution elasticity, ρ , is estimated using variation *between* labor markets across state-years:

$$\ln[w]_{gst} - \ln[w]_{0st} = \gamma_0 + [Z_{gst} - Z_{0st}] \Gamma_1 + \gamma_3 d_{gt} + \gamma_4 d_{st} + u_{gst}^w \quad (55)$$

$$\ln[L]_{gst} - \ln[L]_{0st} = \alpha_0 + \rho [\ln[w]_{gst} - \ln[w]_{0st}] + \alpha_3 d_{gt} + \alpha_4 d_{st} + u_{gst}^L. \quad (56)$$

Given that each model is potentially overidentified, I use Two-Step Efficient IVGMM routines for my primary specifications. Because the labor supply model is non-linear in the endogenous variable, w , I additionally consider a two-step control function approach. Under the additional assumption that

$$E[e^L \mid w, Z] = E[e^L \mid e^w] = g(e^w), \quad (57)$$

for some $g(\cdot)$, then the control function will be more efficient. In practice, I specify $g(e^w) = \vartheta \cdot e^w$, which can be interpreted as the linear projection of the structural error on

the first stage residual.³⁰ Since the control function is estimated, I bootstrap the standard errors with clustering by demographic groups.

6.1.2. Estimation Variable Definitions and Construction

Labor markets segments are defined by four education categories, eight age groups, and marriage status — this makes 72 markets.³¹ Each segment pools workers with and without children. For every market, g , I have a state-year panel.³²

I define labor supply as the sum of all hours divided by the sum of all persons:

$$L_{gst} = \frac{\sum_{i \in (gst)} a_i h_i}{\sum_{i \in (gst)} a_i}, \quad (58)$$

where a_i is the sample weight and h_i is the usual hours worked for worker i . This corresponds to the average units of labor supplied to the market per worker in terms of hours. Alternative measures include: total workers in the labor force, labor force participation rates, employment totals or rates, and full time equivalent units.

I define market level log real wages as the mean log real wage for all workers:

$$w_{gst} = \frac{\sum_{i \in (gst)} b_i \ln[w_i]}{\sum_{i \in (gst)} b_i}, \quad (59)$$

where $b_i = a_i \cdot h_i$ is the product of hours worked and the sample weight, as is standard in wage regressions, and w_i is the real wage. This value can be interpreted as a geometric mean wage, which corresponds to an hours weighted productivity index [Borjas et al. \(2012\)](#). I calculate the real wage by dividing weekly earnings by hours worked and then deflate this using the the BLS CPI All Items Research Series ([U.S. Department of Labor, 2019](#)).

³⁰Additionally, I have considered semiparametric approaches such as [Robinson \(1988\)](#)'s estimator, a fractal polynomial approach with an AIC model selection criterion, and a penalized spline regression; all three yield nearly identical elasticity results as the linear specification.

³¹That is, 72 markets for each gender, but I will only focus on women workers for my empirical analysis.

³²Other than the splitting the markets by state, this follows the definition used in the baseline specification of [Rothstein \(2010\)](#).

The main EITC tax parameter that I use is the average tax rate associated with EITC benefits. I calculate this as the hypothetical difference in EITC benefits from actual labor supply versus no labor supply, divided by actual earned income:

$$\tau_i = \frac{E_i^{\text{act}} - E_i^{\text{cf}}}{w_i \cdot h_i}. \quad (60)$$

I calculate τ_{gst} using the sample weighted mean. I describe exactly how this is calculated after introducing the data.

I also use other EITC statistics as instruments, such as the EITC marginal tax rate, the portion of the labor market in the ‘phase-in’ region, and the overall share of workers receiving EITC benefits.

6.1.3. Estimation Data

I combine two sets of information to estimate the elasticities, the Current Population Survey and the 1990 US Census 1% sample, (Flood, King, Ruggles and Warren, 2018; Ruggles, Flood, Goeken, Grover, Meyer, Pacas and Sobek., 2018).

First, I use the CPS Merged Outgoing Rotation Group (MORG) samples and the Annual Social and Economic (ASEC) samples for labor market information by state and year. The MORG is roughly 100k households per month while the ASEC is roughly 100k in March of every year. These two samples ask detailed employment, earnings, and household structure information. Second, I use the 1990 US Census 5% sample to calculate labor market specific simulated EITC tax instruments. For the ASEC and Census, I use the NBER Internet Taxsim to calculate tax parameters (Feenberg and Coutts, 1993).³³

The MORG sample does not ask detailed information about non-labor earnings but does as about labor supply and wage information. This data is technically at the monthly level and is pooled for annual analysis.³⁴ I use this dataset for market wages and labor quantities. The ASEC sample is much smaller but the detailed non-labor income inform-

³³Assuming that Taxsim calculates an accurate adjusted-gross-income which is necessary for EITC calculations, I can replicate NBER Taxsim’s EITC results using a hand collected EITC parameter database.

³⁴See for example Leigh (2010); Rothstein (2008).

ation allows for calculating average tax rates. I use this dataset to calculate ‘true’ EITC based ATRs that vary by state and year, along with the other statistics such as percent of labor market with positive EITC.

For the Census, I use earnings information to calculate the same EITC statistics as in the ASEC sample for each year. As I am using the same fixed demographics, the time-series variation within labor markets is entirely due to policy changes. The cross-sectional variation between labor markets is due to initial conditions before the 1993 expansion and state reforms. In this way, the tax instruments are similar to ‘shift-share’ instruments.³⁵

6.1.4. Empirical Tax Instruments

There are two ways of using EITC policy variation as an instrument for market variables. First, one can use the EITC policy parameters directly, such as maximum EITC benefit given number of children which varies at the state-year level (Leigh, 2010; Bastian and Micheltore, 2018). This variable is very simple to implement but is constant across all labor markets in a state.

The second method is using a simulated tax instrument, similar to Gruber and Saez (2002); Rothstein (2008). Using a fixed distribution of worker characteristics, one calculates average tax rates due to the EITC over multiple years of policy changes. By fixing the distribution of workers, endogenous changes in ATRs due to changes in labor market variables are purged. This construction allows the instrument to vary at the labor market-state-year level.

To calculate this, I need to estimate the true EITC benefits and the counterfactual EITC benefits if the worker did not work. I calculate the true EITC benefits, E_i^{act} , by using Taxsim on the actual data, where E is the federal and state EITC benefit. To calculate the counterfactual benefits, E_i^{cf} , I set the worker’s labor earnings equal to zero but leaving

³⁵See the following on recent analysis concerning the general identifying assumptions of these instruments: Adao, Kolesár and Morales (2018); Borusyak, Hull and Jaravel (2018); Goldsmith-Pinkham, Sorkin and Swift (2018).

all else equal and rerun Taxsim.³⁶ Finally, I calculate the EITC Average Tax Rate as the difference in the actual minus the counterfactual benefits over earned income using equation 60.

As stated above, I use the 1990 Census to calculate the tax instrument. I replicate the data for each tax year and send the data to Internet Taxsim. To avoid issues of ‘bracket-creep’, I inflate monetary values by the BLS CPI All Items Research Series but do not change any other quantity.

The above only calculated the EITC ATR for a specific labor market, τ_{gst} . However, the total incidence also depends on a weighted sum of tax changes in *other* labor markets within a state-year, $\Psi_g(\{\tau_{g'}\}_{g' \in \mathcal{E}})$. Thus, I need an empirical counterpart for the Ψ_{gst} terms, but this depends on the parameters that I wish to estimate – see equation 43. I approximate the function by creating six different averages of the tax change for across labor markets and then match this to a given market:

$$\Psi_{gst} = h(\{\tau_{g'st}\}_{g' \in G}) \quad (61)$$

$$\approx \gamma_1 \bar{\tau}_{d_1(g),st} + \gamma_2 \bar{\tau}_{d_2(g),st} + \gamma_3 \bar{\tau}_{d_3(g),st} + \gamma_4 \bar{\tau}_{d_4(g),st} + \gamma_5 \bar{\tau}_{d_5(g),st} + \gamma_6 \bar{\tau}_{d_6(g),st} + \nu_{gst}. \quad (62)$$

Three of the terms correspond to averages across all women and the other three are only across unmarried mothers, since this group experienced was most exposed to the tax change.

For example, if \tilde{g} is married women with some college between ages of 25 and 30, then $\bar{\tau}_{d_1(\tilde{g})st}$ equals the average EITC ATR for women with some college pooled across age groups, $\bar{\tau}_{d_2(\tilde{g})st}$ equals the average EITC ATR for women between ages of 25 and 30 pooled across education groups, and $\bar{\tau}_{d_3(\tilde{g})st}$ equals the average EITC ATR for women with some college between ages of 25 and 30. Variables 4 – 5, are similar except they are conditional averages for unmarried mothers. Thus $\bar{\tau}_{d_4(g),st}$ is the average EITC ATR for unmarried mothers with some college pooled across age groups, and so on. I also create these two averages for the expected share of women / unmarried mothers receiving EITC in a cell.

³⁶In married couple tax units, the counterfactual is with respect to the wife's labor supply decision. I assume the husband's earned income remains unchanged.

6.1.4..1 Labor Supply Instruments

Thus, for every group \tilde{g} , I have up to 10 simulated instruments:

1. the EITC ATR for \tilde{g} : $\tau_{\tilde{g}st}$
2. the portion of g' workers with positive EITC: $z_{\tilde{g}st}$
- 3-8. six EITC ATR approximation averages: $\{\bar{\tau}_{d(\cdot)(\tilde{g})st}\}$
- 9,10. two additional approximation averages: $\{\bar{z}_{d_3(\tilde{g})st}, \bar{z}_{d_6(\tilde{g})st}\}$.

My main specification uses all 10 IVs; however, I additionally use a ‘light’ version that only includes $\{\tau_{\tilde{g}st}, z_{\tilde{g}st}, \bar{\tau}_{d_3(\tilde{g})st}, \bar{\tau}_{d_6(\tilde{g})st}, \bar{z}_{d_3(\tilde{g})st}, \bar{z}_{d_6(\tilde{g})st}\}$.

6.1.4..2 Labor Substitution Instruments

Note, the labor substitution elasticity depends on the relative wage, $\ln[w_{gst}/w_{0st}]$. The identifying variation must also come from tax changes across markets. Thus, I use ‘relative EITC ATRs’ to instrument for relative wages:

$$\tau_{(\tilde{g},0)st} = \frac{\tau_{\tilde{g}st}}{\tau_{0st}}. \quad (63)$$

Similarly, I construct relative instruments using the other instruments $\{z_{\tilde{g}st}, \bar{\tau}_{d_3(\tilde{g})st}, \bar{\tau}_{d_6(\tilde{g})st}\}$.

6.1.5. Estimation Summary Statistics

In this section, I show summary statistics for the estimation primary variables for the empirical models; see appendix A for additional summary details. Table 2 features the difference in means before and after 1994 (tax year 1993) for the labor supply, wages, and the tax changes divided by marriage and parental status to highlight the identification using EITC policy tax changes.

The first two variables are averages of the EITC Average Tax Rates, where the first is the instrument calculated from the 1990 Census and the second is the actual tax changes using the ASEC samples for comparison. In the initial period, both tax rates are quite similar; however, in the post period, the true tax rates are lower (implying a larger credit). This is due to endogenous labor supply increases reacting to the tax rates in the true rates

Table 2 – Summary Statistics for Estimation Sample

	1990 - 1994		1996-2000		Difference	
	Mean	SD	Mean	SD	b	t
Unmarried Women w/ Children						
EITC ATR - 1990 Census	-0.08	0.04	-0.14	0.08	-0.06***	-40.86
EITC ATR - ASEC	-0.08	0.06	-0.16	0.11	-0.08***	-34.20
Log Hours Per Person - MORG	3.08	0.54	3.19	0.44	0.11***	8.55
Log Real Wage - MORG	2.15	0.31	2.47	0.33	0.32***	39.09
Observations	2560		3854		6414	
Unmarried Women w/o Children						
EITC ATR - 1990 Census	0.00	0.00	-0.01	0.01	-0.01***	-69.49
EITC ATR - ASEC	0.00	0.00	-0.01	0.01	-0.01***	-32.69
Log Hours Per Person - MORG	3.32	0.37	3.28	0.35	-0.05***	-5.01
Log Real Wage - MORG	2.15	0.31	2.47	0.33	0.32***	39.47
Observations	2589		3864		6453	
Married Women w/ Children						
EITC ATR - 1990 Census	0.00	0.00	0.00	0.01	0.00***	14.72
EITC ATR - ASEC	0.00	0.01	0.00	0.02	0.00	1.92
Log Hours Per Person - MORG	3.03	0.40	3.10	0.34	0.07***	8.34
Log Real Wage - MORG	2.23	0.30	2.58	0.32	0.35***	54.45
Observations	3809		5349		9158	
Married Women w/o Children						
EITC ATR - 1990 Census	0.00	0.00	0.00	0.00	-0.00***	-7.65
EITC ATR - ASEC	0.00	0.00	0.00	0.00	-0.00***	-4.53
Log Hours Per Person - MORG	3.27	0.39	3.29	0.34	0.02**	2.68
Log Real Wage - MORG	2.23	0.30	2.58	0.32	0.35***	54.49
Observations	3844		5336		9180	

All data from CPS Samples 1990 to 2000 and 1990 US Census
EITC ATRs calculated using Taxsim

but not the simulated rates, as the instrument calculation does not alter labor supply decisions.³⁷ This can also be seen in figures 7 and 6, which I describe below.

Next, I show the change in log total hours per person in the submarket-state-year cell. This can be thought of as the average number of ‘labor units’ supplied. For unmarried women with children and married women labor supply increased over the 1990s, but decreased slightly for unmarried women without children. We see the largest increase for unmarried women with children.

Finally, I show the change in log real wages in the market-state-year cell.³⁸ Despite labor supply increases for most labor groups, there are meaningful wage increases for every group in this period. This seems counterintuitive unless rightward shifts in labor demand caused the labor quantity increases. To untangle these forces, I use the changes in tax policy that should only directly affect the worker’s incentive to supply labor to estimate the labor supply elasticities.

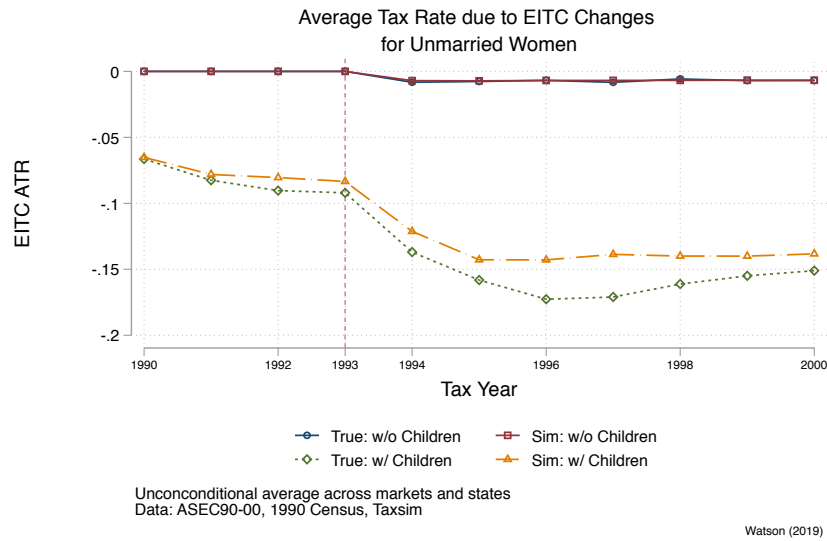
Returning to the claim that the tax rates change due to endogenous labor supply decisions, in the next to figures I plot simulated EITC ATRs and the share of workers receiving positive EITC benefits against their true counterparts. In figure 6, I plot the EITC ATRs. The primary policy change for unmarried mothers occurred over the period from tax-year 1993 to 1996, while for unmarried women without children, there was effectively only the one-time change in tax year 1993. For unmarried mothers, the empirical average ATR is unambiguously less than the simulated that holds labor supply fixed. Given that we know from above that gross-wages and labor supply increased, this is consistent with workers entering the labor force at low wages.

Next, in figure 7, I plot the simulated share of unmarried workers with positive EITC relative to the true share, that shows a large increase in the share with positive EITC relative to the simulated around the time of the EITC expansion for women with children

³⁷While, this could be due to earnings decreases (from lower wages or less supply) causing workers to qualify for more credits, but given that table 2 shows across the board wage and labor supply increases, this is unlikely.

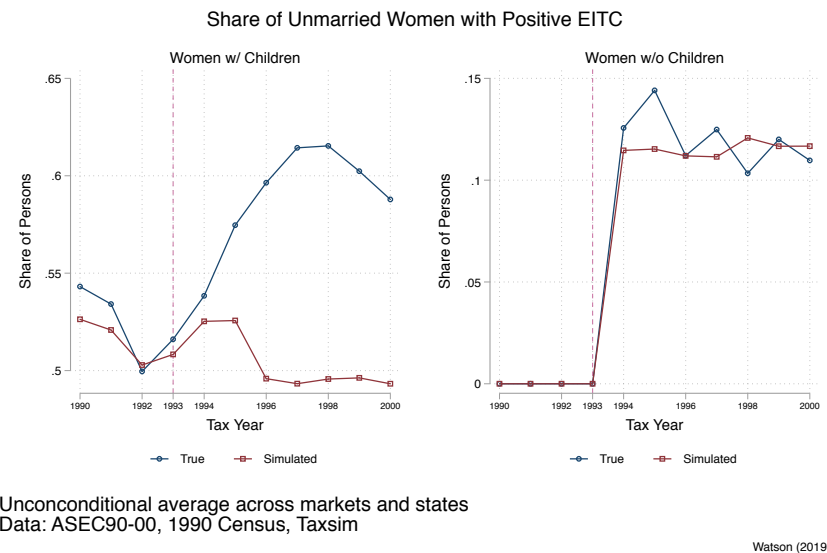
³⁸Thus, the wage changes are the same for workers with children and without, as the model implies. In table 9 in appendix A, I show the wage change by submarket, where there are level differences but the per/post differences are essentially the same for both groups.

Figure 6 – Simulated vs True Share Receiving EITC



but not those without. An often made assumption is that the change in EITC policy towards workers without children is not enough to affect behavior. The figure shows this is a reasonable assumption because we are able to predict average ATRs for workers without children only using the 1990 distribution of labor supply and inflation.

Figure 7 – Simulated vs True Share Receiving EITC



6.2. Estimation Results

6.2.1. Elasticity Estimates

Table 3 displays estimated elasticities.³⁹ I present three sets of results: Model 1 with ten instruments, Model 2 with six, and Model 3 using a control function approach.⁴⁰ I estimate the first two models using two-step efficient GMM with clustered standard errors at the labor-market and parental-status level. I estimate Model 3 using the same instruments as Model 1, but save the first stage residuals, and then estimate the structural equation with the residual as an additional regressor and use clustered bootstrap standard errors.

Models 1 and 2 both show that labor supply responsiveness decreases with education, that having children makes one more responsive to wages, and that married women are more responsive than unmarried women. Model 3 has much less variation in the elasticities, and the education gradient is less steep. I prefer Model 1 because it has the strongest first stage and the estimates seem the most plausible. The main difference between the estimates is that Model 1 is *less* elastic than Model 2 and 3 with a clear education-level gradient. In practice, the less elastic Model 1 estimates should yield the most conservative estimates of incidence effects.

My estimate for the labor supply elasticity for unmarried mothers with low education attainment is quite similar to other estimates. I estimate the values $\{0.72, 0.91, 0.94\}$ while Rothstein (2008) estimates a value of 0.75 and Meyer and Rosenbaum (2001) estimate 0.83 for participation for work in an average week.⁴¹ In all three models, I can reject that the labor supply elasticities for unmarried women are the same for workers with and without children. This can imply a violation of “parallel trends” when using difference in difference methods because workers will respond differently to labor market effects on gross wages.

My estimates for married women with low education are higher than previous estimates. I estimate the values $\{0.87, 0.99, 1.04\}$ while Eissa and Hoynes (2004) estimate 0.27

³⁹The underlying regression tables are presented in appendix XXX **this is not yet done.**

⁴⁰Section 6.1.4. describes the instruments used.

⁴¹Additionally, Dickert et al. (1995) calibrate a labor supply estimate of 0.85 and the difference in differences result from Eissa and Liebman (1996) implies an elasticity of 1.16.

for similarly educated married women.⁴² Bargain and Peichl (2016) survey labor supply elasticities across countries and show estimates for married women range from almost perfectly inelastic to 1.5 for the United States.

Table 4 presents estimates of the labor substitution elasticity between labor markets. Each column uses different sets on ‘relative’ instruments, as discussed in section 6.1.4. in equation 63. Each specification yields a statistically significant elasticity with a consensus estimate of about -2.55 . For each estimate I report the cluster robust standard error in parentheses. Additionally, I report the Weak IV Robust confidence interval based on Andrews (2018). Under all specification, I can reject that the substitution elasticity is inelastic, which is in line with the immigration literature (Katz and Murphy, 1992; Goldin and Katz, 2009; Borjas et al., 2012). It is worth noting that the main specification of Rothstein (2010) uses a value of $\rho = -0.3$, which is far from the consensus estimates.⁴³ A more inelastic estimate of ρ will tend to imply larger magnitude incidence effects since ρ is in the denominator of equations 25 and 43.

6.2.2. Incidence Estimates – TO BE COMPLETED

Remark. In this part I plan on estimating the incidence effects of the 1993 EITC expansion using the estimated elasticities and the tax changes in 1993/1994. Using the standard errors on the elasticities, I can provide a standard error on the incidence estimates that captures the uncertainty due to my estimation.

7. Comparing EITC to NIT

In this section, I use my estimated labor market elasticities to compare two hypothetical policy reforms. I consider an equal sized expansion of the EITC versus an NIT program.⁴⁴

⁴²One reason for the difference could be that Eissa and Hoynes (2004) estimate a joint labor supply decision while I hold constant the married partner’s labor supply and treat this as non-labor income for the wife.

⁴³Also worth emphasizing is that Rothstein (2010) uses multiple different values of ρ in additional robustness calculations.

⁴⁴I follow the same outline as Rothstein (2010) for the simulations; this analysis has been greatly aided by his dedication to providing transparent research.

Table 3 – Labor Supply Elasticity Estimates by Labor Groups

Model 1: Full				
	Unmarried		Married	
	w/o Children	w/ Children	w/o Children	w/ Children
Less HS	0.54	0.72	0.76	0.99
	(0.10)	(0.09)	(0.09)	(0.09)
HS	0.40	0.58	0.62	0.85
	(0.08)	(0.07)	(0.07)	(0.07)
Some College	0.40	0.58	0.62	0.86
	(0.09)	(0.08)	(0.08)	(0.08)
BA Plus	0.10	0.28	0.32	0.56
	(0.09)	(0.09)	(0.08)	(0.08)
Model 2: Light				
	Unmarried		Married	
	w/o Children	w/ Children	w/o Children	w/ Children
Less HS	0.70	0.91	0.89	1.04
	(0.17)	(0.16)	(0.15)	(0.15)
HS	0.56	0.77	0.75	0.90
	(0.15)	(0.14)	(0.13)	(0.13)
Some College	0.56	0.78	0.75	0.90
	(0.16)	(0.14)	(0.14)	(0.14)
BA Plus	0.17	0.38	0.35	0.50
	(0.14)	(0.13)	(0.13)	(0.12)
Model 3: Control Function (Full)				
	Unmarried		Married	
	w/o Children	w/ Children	w/o Children	w/ Children
Less HS	0.78	0.94	0.90	0.87
	(0.20)	(0.21)	(0.20)	(0.20)
HS	0.70	0.85	0.81	0.78
	(0.20)	(0.20)	(0.19)	(0.20)
Some College	0.73	0.88	0.84	0.81
	(0.20)	(0.21)	(0.20)	(0.20)
BA Plus	0.64	0.80	0.76	0.73
	(0.21)	(0.22)	(0.21)	(0.21)
Obs	KP rl LM		KP rk Wald F	MOP Effective-F

Table 4 – Labor Substitution Elasticity Estimates Across Labor Markets

	(1)	(2)	(3)
ρ	-2.55	-2.60	-2.00
Wald SE	(0.56)	(0.50)	(0.44)
WIVR CI	[-3.85,-1.58]	[-3.83,-1.70]	[-3.65,-1.60]
KP rk Wald F	51.06	30.20	17.67
Anderson-Rubin F	28.39	19.33	10.36
MOP Effective-F	51.90	20.61	11.84
# IVs	1	2	4
Obs	9,674	9,674	9,674

All data from MORG 90-00, 1990 Census; EITC ATRs calculated using Taxsim. Wald Standard Errors clustered by (140) demographic groupings. Weak IV Robust CIs based on Andrews (2018) and Sun (2018). Model controls: log relative total cell size, FEs for Edu-Age-Year, State-Year, and Initial-Wage-Pct-Year. Models vary by instruments used, as discussed in text, KP rk Wald F is cluster robust Cragg-Donald stat; AR is cluster robust F stat on first stage coefs. MOP Effective-F is an alternative weak-IV F-statistic (Olea and Pflueger, 2013; Pflueger, 2015).

Using the two tax reforms, I calculate the partial incidence using equation 25 and the general incidence using equation 43.⁴⁵ This analysis allows me to compare the spillovers of the two programs.

Using my preferred specification, I find that for the EITC wages decrease by only a seventh of the PE amount and for the NIT wage only increase a seventh of the PE amount. For the EITC, I find that the PE net transfer to workers is only 35% of the intended amount, but is 91% accounting for spillovers. For the NIT, I find that the PE net transfer is 163% of the intended amount, but is down to 109% after spillovers.⁴⁶

Essentially, I come to nearly the opposite conclusion of Rothstein (2010) in that the EITC seems unambiguously more cost effective transfer program. This is because EITC labor supply increases in *other* markets provide a countervailing wage effect to the own market supply increase. This ends up increasing aggregate production, having a stimulative effect on the economy (holding output price fixed). For NIT, incentivising workers to exit the labor force causes widespread marginal product declines that dominates the

⁴⁵I focus on the general equilibrium incidence without market switching since at this time there are not well known cross-sector net-wage elasticities.

⁴⁶My PE results differ from Rothstein (2010) because of different sample creation; I am able to replicate his results when using his sample. Further details are in the data section below.

transfer. This ends up decreasing aggregate output. The NIT is only able to increase wages because labor supply is decreased.

However, I find substantial heterogeneity among demographic groups and I find that the equivalent variation of the NIT is greater than the EITC. Most notably unmarried workers *without* children see net earning declines under an EITC expansion despite other groups clearly benefiting. Under the NIT, married workers *without* children see net earnings declines; however, these are not as large as the unmarried women.

The equivalent variation is greater under the NIT compared to the EITC. This is mechanical because the wage decreases for the EITC and increases for the NIT, and the reforms are created to have equal size. Nevertheless, because the partial equilibrium exaggerates the change in gross wages, the GE incidences shows that the programs are much closer in equivalent variation measures.

7.1. Simulating the Tax Reforms

7.1.1. Data

For the simulations, I use survey responses from the 1993 March Current Population Survey Flood et al. (2018), which correspond to the 1992 tax year labor market variables.

The incidence sample is restricted to women ages 16 to 65 with reasonable labor market observations.⁴⁷ I drop women who are full or part time students and have not participated in the labor force for over one year, women who have negative tax unit self-employment earnings, and women who are in the armed forces.⁴⁸

7.1.1.1 Assignment of Children

I use Census coded family unit ID, household record numbers, and relationship pointers to link EITC eligible children to (most likely) parents. This process requires some subjectivity in assignment.

⁴⁷The main criterion is that wage (= Total Earnings / Total Hours) is between \$0.50 and \$100.

⁴⁸I additionally drop married workers with absent, non-separated spouses because of missing income information, as well as women who are in group quarters.

IPUMS constructs family relationship information, such as number of own children, based on its own definition of a family which differs from the Census definition. For very traditional, nuclear families there is no conflict. However, whenever there are any additional members of a family outside of a nuclear family, complications ensue. When creating tax units, the Census definition is closer to the spirit that researchers are aiming to capture; however, the Census does not include any way of directly linking dependents to their care-givers, so the researcher must do this.

Thankfully, in almost all cases, children follow their parents in the record layout. I combine this fact along with household relationship pointers, family relationship pointers to assign children.

7.1.1.2 Summary Statistics

In table 5, I present summary statistics on the incidence sample of women. There are two primary differences between my sample and that of Rothstein (2010), who uses nearly the same criteria. Summary statistics for his sample are in the appendix.

First, Rothstein drops all unmarried women below age 24 if these women do not have children, regardless of labor force / education status. This is sometimes done in the empirical literature in order to perform difference-in-difference estimation; however, it is not obvious that it should be done in the setting which is mostly theoretical. Because I believe many of these workers are within-market rivals of unmarried women with children, I include them in my simulations. This increases the women in the sample by roughly 6,000 workers and changes the average age of unmarried women without children from 41 to 33.

Second, I change the distribution of allocated qualified children compared to Rothstein. In the end, Rothstein assigns about two thousand more workers at least one EITC dependents than my procedure. Rothstein allocates children in a similar manner as I do, but at one point indiscriminantly assigns children to the household head family in the household. Under the assumption that a the household head family would claim a child of another family, his procedure is correct.

The two changes I make, more workers in the sample and fewer EITC claimants, should mitigate the incidence effects. In an appendix, I use the Rothstein sample with my own tax incidence formulae and show this is the case. The effects of sample creation are noticable, but not substantial.

Table 5 – Summary Statistics for Incidence Sample

	Age	Anykids	Married	Get Eic
Unmarried Women	33.25	0.00	0.00	0.00
Married Women	47.54	0.00	1.00	0.00
Unmarried Mothers	34.51	1.00	0.00	0.66
Married Mothers	36.90	1.00	1.00	0.10
Total	37.99	0.45	0.57	0.11
	Less HS	HS Only	Less BA	BA+
Unmarried Women	0.26	0.26	0.30	0.18
Married Women	0.15	0.42	0.23	0.21
Unmarried Mothers	0.25	0.39	0.26	0.10
Married Mothers	0.13	0.38	0.28	0.22
Total	0.19	0.35	0.27	0.19
	Worker	Wage	Share of Workers	Cost Share
Unmarried Women	0.73	10.09	0.30	0.19
Married Women	0.69	11.17	0.25	0.17
Unmarried Mothers	0.68	9.60	0.12	0.07
Married Mothers	0.72	10.83	0.33	0.22
Total	0.71	10.54	1.00	0.66

All data from 1993 March CPS, Women from Tax Units, Wage in \$1993
All variables weighted by CPS March Supplement Wt \times Hours

The most notable feature of the data is that the EITC is heavily concentrated in the unmarried women with children segment, but this segment is also the smallest in labor cost terms and labor supply term. This implies that since their market share is reasonably small, that the GE effects are likely to be closer to the PE incidence, all else equal.

7.1.2. Labor Markets

As before in the empirical section, labor markets segments are defined by four education categories, eight age groups, and marriage status — this makes 72 markets. Again, each segment pools workers with and without children, and across industry and occupations. However, for this simulation, I do not split the sample based on state of residence. I do this to allow for comparison to the baseline specification of Rothstein (2010).

7.1.2..1 Two Assumptions

In addition to the economic environment, I need to use two strong assumptions for the simulation. First, there are no other factors used by firms other than the labor factors as specified and a material factor index, called capital. This assumption allows me to ignore other worker groups, such as men, and aggregate all other factor changes into a single variable. Second, the wage share of each labor market is also its cost share; this omits any non-wage labor costs. This assumption is necessary to calculate the demographic based cost shares which are not available in any other statistical product that is produced.

7.1.3. Parameters

The partial equilibrium analysis only requires two structural parameters, a supply elasticity (which may vary by labor market) and a elasticity of substitution.

7.1.3..1 Labor Supply Elasticities

I use the labor supply elasticities estimated in the previous section. These vary by marriage, parental, and education status which yields twelve elasticities, as seen in table 6. I use values based on the results from Model 1 in table 3 from section 6.2.1.. The main specification from Rothstein (2010) used the value 0.75 for all women, regardless of demographic characteristics.

7.1.3..2 Labor Substitution Elasticity

I present results using two different values: -0.30 , -2.50 . The first value is from Rothstein

Table 6 – Labor Supply Elasticity Estimates by Labor Groups

	Unmarried		Married	
	w/o Children	w/ Children	w/o Children	w/ Children
Less HS	0.54	0.72	0.76	0.99
HS	0.40	0.58	0.62	0.85
Some College	0.40	0.58	0.62	0.86
BA Plus	0.10	0.28	0.32	0.56

Elasticities from section 6.2.1. table 3 Model 1.

(2010), which is based on his 2008 working paper that used a wage-based labor market designation, and the second value is my estimate from the previous section. Note, -0.30 is considerably lower than estimates from the prior wage inequality literature as well as my own estimate when using demographic based labor markets, which Rothstein (2010) uses.⁴⁹ Thus, it is possible that prior partial equilibrium results are based on an outlier estimate of the substitution elasticity.

7.1.3.3 Cost Shares

The labor cost share in 1992 was roughly 66% of total cost. To calculate the labor market specific cost share, I sum total earnings by labor market, calculate the ratio of each market to the sum of all markets, and then multiply this by 0.66:

$$s_{L_d} = \left(\frac{\sum_{i \in L_d} W_{id}}{\sum_j \sum_{i \in L_j} W_{ij}} \right) \cdot \left(\frac{\text{Total Wages}}{\text{Total Factor Payments}} \right) \quad (64)$$

I do not include worker benefits or other non-wage payments. If total compensation – thus cost – is a uniform percent mark-up over earnings which is roughly similar across labor groups, then the approximation will perform well, as the mark-up terms will cancel out.

⁴⁹Katz and Murphy (1992) and Goldin and Katz (2009) find $\rho \approx -1.4$ when basing their estimation on demographic groups, and Card and Lemieux (2001), who find substitution elasticities < -2 when substituting between education groups of similar aged (male) workers. See Borjas et al. (2012) for more discussion comparing methods.

7.1.3..4 Capital Supply Elasticity

I have not found a definitive summary of the capital supply elasticity. As such, I use the value of 1 as a conservative estimate. [Goolsbee \(1998\)](#) estimates a short-run elasticity of about 1 and a medium run elasticity over three years of 2. For robustness, I also consider the value 2.

7.1.4. Simulated Tax Reforms

In the model presented earlier, I use a linear subsidy system and abstract from any other taxes. In reality, individual tax rates are highly complex and non-linear. To implement the simulation, I replace the excise taxes with average tax rates, calculated using the reported income data and NBER Taxsim ([Feenberg and Coutts, 1993](#)).⁵⁰

To get the initial tax parameters, I form tax units based on family living arrangements and use TAXSIM. I form tax unit status based on family living arrangements. Married workers with present spouses are always joint filers. Separated or married workers with absent spouses are always single filers. Non-married adults who are not EITC qualifying children are always single filers. All workers who are EITC qualifying children are dependents.

I follow [Rothstein \(2010\)](#) exactly in simulating two tax reforms. First, I use TAXSIM to estimate the initial vector of initial tax parameters. Second, for all tax units, I set the earned income of the tax-unit-head-woman – either the head of family for single women or the wife of a married household – with zero, and then I rerun TAXSIM. The primary output of these calculations are adjusted gross income, EITC amounts, and federal tax amounts. I then calculate the change in average tax of the woman choosing to work for those tax units where the head-woman works. Third, I use these variables to simulate an expenditure equivalent Negative Income Tax program.

Next, I suppose that the governments wish to increase the generosity of the EITC or NIT by \$100 million. Governments do this by naively ignoring labor market and behavioral

⁵⁰Currently, I do not consider an intensive hours margin, so I do not consider marginal tax rates. This accords with the preferred specification in [Rothstein \(2010\)](#).

effects, and distribute the increase in expenditure based on the share of EITC/NIT each worker received prior:

$$\text{Subsidy}_{i,\text{Reform}} = \left(\frac{\$100m}{\sum_i \text{Subsidy}_{i,\text{Initial}}} \right) \cdot \text{Subsidy}_{i,\text{Initial}}. \quad (65)$$

This change in the subsidy for each worker is then aggregated to the worker's labor market to find the simulated tax change in the market to use in the incidence calculation:

$$\hat{\tau}_d = \sum_{i \in L_d} \left(\frac{\text{Subsidy}_{\text{Reform}} - \text{Subsidy}_{\text{Initial}}}{\text{Tax Unit Adj Gross Income}} \right)_i \quad (66)$$

7.1.5. Simulation Outputs

The simulation uses the hypothetical tax reforms to calculate labor market responses to the policy change. From the labor market changes, I calculate two main objects of interest: the change in net-earnings and the equivalent variation. The former is a measure of the change in aggregate economic activity due to the tax reform, as net-earnings equal overall output of the economy. The latter is an evaluative tool for cost-benefit analysis, which roughly is the necessary payment to make workers indifferent between receiving the payment and implementing the tax reform.

If the equivalent variation is positive, then the policy is worthwhile to consider; otherwise, workers would be willing to pay the government *not* to implement the policy. These measures differ because the net-earnings measure does not incorporate that the change in labor supply increases the aggregate disutility of labor effort.

To calculate these objects, I find the change in labor supply and the change in earnings due to the tax reform using the incidence formula in equation 30 and the labor supply elasticity. The change in net-earnings is calculated using the new wages, the new labor supply, and the transfer. I calculate the equivalent variation using equation 42. This measure uses the change in wages and transfer at the initial labor supply.

7.2. Simulation Results

Table 7 displays three sets of incidence results for the EITC and NIT simulated tax reforms for the aggregate labor market based on different parameterizations. Table 8 displays the aggregate effects for specific demographic groups. The first two columns replicate the partial equilibrium analysis of Rothstein (2010) on my sample.⁵¹ Columns 3-9 use heterogeneous supply elasticities and compare between partial and general equilibrium incidence. I highlight columns 6-9 which use my preferred specification based on the estimated elasticities in section 6.2.1.. The main takeaway from the table is that the dramatic difference between the programs in partial equilibrium is reversed in general equilibrium and somewhat exaggerated by a small labor substitution elasticity.

The main effects of interest are the change in wages, net-earnings (*NetEarn*), and the equivalent variation of the policy (*EV*). The change in wages shows the amount that wages fall per dollar of EITC transferred to workers based on the incidence formula. The change in net-earnings represents the *ex-post* policy consumption of the workers, which taken literally represents the impact on Gross Domestic Product. The equivalent variation is the payment required to make a worker indifferent between the *ex-post* policy allocation versus the *ex-ante* policy allocation plus the payment:

$$\{EV_i \mid V_i(p_0, m_0 + EV_i) = V_i(p_1, m_1)\}. \quad (67)$$

If the aggregate equivalent variation is positive, then the policy passes the Hicks compensation test as the policy ‘winners’ would be willing and able to compensate the policy ‘losers’.

In Table 7, I show the aggregate labor market effects across all demographic groups. There are several interesting and important differences between the columns; however, the most important is that the general equilibrium spillovers are economically meaningful for both reforms and that these spillovers make the EITC look better as a policy choice. For example, the PE difference between wages [columns (6,7)] is \$0.27 but the GE

⁵¹The difference between columns (1,2) and table 5 column 1 in Rothstein (2010) are directly due to differences in our sample of workers, where Rothstein is using a strict sub-sample of my analysis.

Table 7 – Incidence Results:
Aggregate Effects: All Women

Dollars	Rothstein		$\rho = -0.3$				$\rho = -2.5$			
	“PE”		“PE”		GE		“PE”		GE	
	EITC	NIT	EITC	NIT	EITC	NIT	EITC	NIT	EITC	NIT
	(1)	(2)	(3)	(4)	(5)	(6)	(6)	(7)	(8)	(9)
Intended	1.00	0.55	1.00	0.55	1.00	0.55	1.00	0.55	1.00	0.55
Labor	0.13	-0.16	0.14	-0.17	0.36	-0.42	0.32	-0.42	0.35	-0.46
Wage	-0.46	0.53	-0.48	0.55	-0.07	0.08	-0.12	0.15	-0.07	0.09
Earnings	-0.34	0.37	-0.34	0.38	0.29	-0.34	0.20	-0.26	0.28	-0.37
NetEarn	0.66	1.37	0.66	1.38	1.29	0.66	1.20	0.73	1.28	0.63
EV	0.54	1.52	0.52	1.55	0.93	1.08	0.88	1.15	0.93	1.08
PE/GE	-	-	-	-	0.59	1.44	-	-	0.95	1.06
NIT/EITC	-	2.81	-	2.98	-	1.16	-	1.31	-	1.16

Units in table are changes in dollars of earnings, LM changes summarized across demographic groups
Earnings = Wage + Labor; Net Earnings = Earnings + Transfer, Equivalent Var. = Wages + Transfer
All data from 1993 March CPS, Women from Tax Units
Labor supply elasticities in table 6, except 'Rothstein' which uses $\varepsilon^L = 0.75$ for all

difference [columns (8,9)] is only \$0.16. This is because GE effects attenuate the gross wage changes.

An additional important insight is that the partial equilibrium results concerning the difference in net-earnings are dependent on the inelastic labor substitution elasticity in columns. The PE net-earnings in column (3) is only \$0.66 for every dollar of EITC but is \$1.20 in column (6); similarly the values are \$1.55 and \$1.15 for the NIT columns (4,7). Thus, using a more realistic labor substitution elasticity results in a complete reversal of the PE conclusions for net-earnings reported by Rothstein (2010).

Finally, the relative equivalent variation measures do *not* reverse from PE to GE; however, the differences are attenuated. The NIT still has a greater EV measure in GE because the EITC encourages labor force participation among those with relatively greater disutility of labor relative to the incumbent workers, while the NIT discourages labor supply among the incumbent workers with the relatively greater disutility. That is, since there is less 'leisure' in the economy, the EV cost of the EITC is greater than the NIT.

The conclusion from the partial equilibrium analysis is that a NIT is a better policy if the goal is to transfer income to low income workers. However, important to point out is that the EITC increases welfare by increasing consumption. Notice that net-total earnings increases by more than \$1 for every \$1 of additional EITC spending, and that the change in private earnings is positive. For the NIT, the net-total earnings are less than \$1 and the private earnings are actually negative! The NIT is only able to increase welfare by paying to keep some workers out of the labor force and causing firms to have to pay the remaining workers more. The overall effect is a decrease in private output from these markets.

Table 8 displays the aggregate effect on different demographic groups. For single mothers, the general equilibrium wage effects are similar to the partial equilibrium effects. In general equilibrium, net *earnings* increase for single mothers more from an EITC reform than the NIT reform; although, the welfare change is greater for the NIT than the EITC. As an anti-poverty program, the EITC does a better job at increasing net

earnings for single mothers than the NIT but does so by also requiring greater labor supply and less leisure, as measured by the equivalent variation.

For single women without children, the EITC appears to create a greater spillover compared to the NIT. Only for this group is the EV for the EITC negative, implying these workers are actively hurt by the transfer program. These workers are unable to avoid the wage decreases due to the EITC but do not get any transfer. As before, the partial equilibrium effects are attenuated by the general equilibrium effects.

Married mothers and married women both do better from the EITC in terms of earnings and welfare. Only for married women without children is the NIT causing a welfare loss because the NIT is decreasing these worker's marginal product without any subsidy, which the married mothers receive.

Table 8 – Incidence Results:
Aggregate Effects: Subgroups of Women

Dollars	Rothstein “PE”		$\rho = -0.3$				$\rho = -2.5$			
			“PE”		GE		“PE”		GE	
	<u>EITC</u>	<u>NIT</u>	<u>EITC</u>	<u>NIT</u>	<u>EITC</u>	<u>NIT</u>	<u>EITC</u>	<u>NIT</u>	<u>EITC</u>	<u>NIT</u>
	(1)	(2)	(3)	(4)	(5)	(6)	(6)	(7)	(8)	(9)
Unmarried Mothers										
NetEarn	0.73	0.54	0.64	0.61	0.71	0.52	0.88	0.47	0.89	0.36
EV	0.31	0.80	0.30	0.80	0.35	0.74	0.46	0.71	0.46	0.70
Unmarried Women										
NetEarn	-0.59	0.37	-0.51	0.30	-0.31	0.06	-0.13	0.07	-0.11	0.04
EV	-0.32	0.20	-0.34	0.20	-0.18	0.02	-0.09	0.05	-0.07	0.03
Married Mothers										
NetEarn	0.50	0.33	0.50	0.33	0.69	0.10	0.44	0.15	0.47	0.11
EV	0.53	0.45	0.54	0.47	0.65	0.34	0.50	0.37	0.52	0.35
Married Women										
NetEarn	0.03	0.13	0.03	0.15	0.19	-0.03	0.01	0.05	0.03	0.02
EV	0.02	0.07	0.02	0.08	0.11	-0.02	0.01	0.03	0.02	-0.01

Units in table are changes in dollars of earnings. LM changes summarized across demographic groups
Earnings = Wage + Labor; Net Earnings = Earnings + Transfer, Equivalent Var. = Wages + Transfer
All data from 1993 March CPS, Women from Tax Units
Labor supply elasticities in table 6, except 'Rothstein' which uses $\varepsilon^L = 0.75$ for all

The analysis above emphasizes that the targeted nature of the program — subsidizing workers with children — can significantly affect the welfare of the untargeted workers. Single women without children see large welfare declines with the EITC because of decreases wages which reduce worker consumption. Married women without children see welfare increases from the EITC for the opposite reason. Interestingly, despite almost no NIT spillover on single workers without children, the NIT spillovers on married workers with children are very negative.

Overall, the results suggest that the partial equilibrium effects are vastly different from the general equilibrium effects. In partial equilibrium, the NIT appears to be the unambiguously better program at helping low income workers. However, allowing for cross market spillovers muddles the policy recommendation. In aggregate, the EITC is unambiguously more cost effective at transferring income, yet there is a great deal of heterogeneity in net earnings across labor markets. If policy-makers truly wish to increase the welfare of single mothers workers and are willing to decrease welfare to other workers, then the NIT is a more cost effective program. However, the EITC creates greater aggregate welfare improvements with fewer directly harmed groups.

8. Conclusion

Conditional income transfers, such as the Earned Income Tax Credit, are a major anti-poverty tool that are relatively simple to implement since eligibility can be easily determined based on few income and demographic variables. This has led to the EITC becoming the *de facto* largest anti-poverty program in the United States and a direct subsidy to roughly 20% of the labor force ([Internal Revenue Service, 2017](#)).

I analyze how conditional tax subsidy changes affect aggregate wages when allowing for spillovers across labor markets. I find that when factors are substitutes, tax induced supply changes in one market will affect the marginal product of workers in other markets. This creates a spillover feedback cycle of changes in marginal products and wages across

labor markets. The result of these spillovers counteract the initial partial equilibrium wage effects, so the general equilibrium wage change is theoretically ambiguous.

In this paper I estimated heterogeneous labor supply elasticities and the labor substitution elasticity that governs labor demand. I combine these estimates with the empirical tax changes to calculate the empirical incidence of the 1993 EITC expansion. I find **XXXXX...**

In addition, I calibrate a labor market using the elasticities to simulate the partial and general equilibrium incidence of two equal sized tax reforms, one based on the EITC and another on the NIT. This model seeks to answer which program is more cost effective in transferring one dollar to workers. I find that in partial equilibrium, the NIT *appears* more cost effective; however, in general equilibrium the EITC *actually* is more cost effective. The difference in policy effectiveness is entirely due to marginal product spillovers that emerge in general equilibrium with imperfectly substitutable factors. Since the NIT *decreases* labor force participation in one labor market (which initially increases its marginal product), the marginal product of all other workers *decreases* which then *decreases* labor demand in the first market. Alternatively, when the EITC *increases* labor force participation in one market (decrease in marginal product), the marginal product of all other workers *increases* when then *increases* labor demand in the first market.

In my preferred general equilibrium specification, an intended dollar of EITC spending delivers \$1.28 of net-earnings to workers while the NIT delivers only \$1.08 of intended dollars. These results are driven by different factors that are important for policy makers to balance. Foremost, the EITC increases welfare because there of positive marginal product spillovers on higher skill workers which feeds back to increase labor demand for the low-skill EITC workers despite their labor supply increase. The NIT increases welfare because the government is transferring consumption from *other* markets and allowing the subsidized workers to decrease labor supply to drive up their wages, which decreases market output and causes negative marginal product spillovers for all other workers.

Disaggregating the results by demographic groups reveal substantial heterogeneity. Single women with children have greater net *earnings* due to EITC expansions, but have

greater net *transfers* under a NIT and more leisure time. Single women without children have moderate net earnings decreases due to the EITC because they face wage decreases yet receive no EITC benefits, but are largely unaffected by NIT expansions. Married women benefit under both policies but the benefits are greater under the EITC. This is because married workers receive the largest marginal product spillovers due to labor supply changes and are unlikely to receive transfers under either regime.

This study highlights how using partial equilibrium analysis of large scale tax reforms can be misleading about cost effectiveness. The model and calibration still make a number of simplifications worth pointing out. First, the production technology assumes a constant elasticity of substitution, so all factors are (imperfectly) substitutable in exactly the same way. This assumption is necessary for analytic results but is not necessary for the simulation which could be solved numerically. Second, the frictionless labor market assumptions – perfect competition, price taking – may not be realistic. In aggregate, these distortions may only matter marginally, but then the model obscures potentially important heterogeneity depending on firm concentration or anti-competitive behavior. Third, the model has abstracted from fully modeling the tax system or incorporating different industries or trade patterns. Modeling the tax system and requiring a balanced government budget (or debt policy) may remove some of the efficiency of the EITC if high productivity workers supply less labor. Only including a single output sector with no trading partners implies that there are no interesting output demand/price effects, which also may effect the efficiency of the EITC. For example, in a two sector model, factor intensity differences likely affect the tax incidence in the final goods market.

References

- Adao, Rodrigo, Michal Kolesár, and Eduardo Morales.** 2018. "Shift-share designs: Theory and inference." Technical report, National Bureau of Economic Research.
- Agrawal, David R, and William H Hoyt.** 2018. "Tax Incidence in a Multi-Product World: Theoretical Foundations and Empirical Implications." working paper.
- Andrews, Isaiah.** 2018. "Valid two-step identification-robust confidence sets for GMM." *Review of Economics and Statistics*, 100(2): 337–348.
- Azmat, Ghazala.** 2019. "Incidence, salience, and spillovers: The direct and indirect effects of tax credits on wages." *Quantitative Economics*, 10(1): 239–273.
- Bargain, Olivier, and Andreas Peichl.** 2016. "Own-wage labor supply elasticities: variation across time and estimation methods." *IZA Journal of Labor Economics*, 5 1–31.
- Bastian, Jacob, and Katherine Micheltore.** 2018. "The Long-Term Impact of the Earned Income Tax Credit on Children's Education and Employment Outcomes." *Journal of Labor Economics*, 36 1127–1163.
- Baughman, Reagan, and Stacy Dickert-Conlin.** 2003. "Did expanding the eitc promote motherhood?" *American Economic Review*, 93 247–251.
- Baughman, Reagan, and Stacy Dickert-Conlin.** 2009. "The earned income tax credit and fertility." *Journal of Population Economics*, 22 537–563.
- Borjas, George J, Jeffrey Grogger, and Gordon H Hanson.** 2012. "Comment: On estimating elasticities of substitution." *Journal of the European Economic Association*, 10(1): 198–210.
- Borusyak, Kirill, Peter Hull, and Xavier Jaravel.** 2018. "Quasi-experimental shift-share research designs." Technical report, National Bureau of Economic Research.
- Card, David, and Thomas Lemieux.** 2001. "Can falling supply explain the rising return to college for younger men? A cohort-based analysis." *The Quarterly Journal of Economics*, 116 705–746.

- Chetty, Raj, Emmanuel Saez, and John N. Friedman.** 2013. "Using Differences in Knowledge Across Neighborhoods to Uncover the Impacts of the EITC on Earnings." *American Economic Review*, 203 2683–2721.
- Dahl, Gordon B, and Lance Lochner.** 2012. "The impact of family income on child achievement: Evidence from the earned income tax credit." *American Economic Review*, 102 1927–56.
- Dickert-Conlin, Stacy, and Scott Houser.** 2002. "EITC and Marriage." *National Tax Journal* 25–40.
- Dickert, Stacy, Scott Houser, and John Karl Scholz.** 1995. "The Earned Income Tax Credit and Transfer Programs: a Study of Labor Market and Program Participation." *Tax policy and the economy*, 9 1–50.
- Eissa, Nada, and Hilary Hoynes.** 2004. "Taxes And The Labor Market Participation Of Married Couples: The Earned Income Tax Credit." *Journal of Public Economics*, 88 1931–1958.
- Eissa, Nada, and Jeffery B. Liebman.** 1996. "Labor Supply Response to the Earned Income Tax Credit." *Quarterly Journal of Economics*, 11 605–37.
- Evans, William N, and Craig L Garthwaite.** 2014. "Giving mom a break: The impact of higher EITC payments on maternal health." *American Economic Journal: Economic Policy*, 6 258–90.
- Feenberg, Daniel, and Elizabeth Coutts.** 1993. "An Introduction to the TAXSIM Model." *Journal of Policy Analysis and Management*, 12 189–194.
- Flood, Sarah, Miriam King, Steven Ruggles, and J Robert Warren.** 2018. "Integrated Public Use Microdata Series, Current Population Survey: Version 6.0 [dataset]." *Minneapolis, MN: IPUMS*.
- Goldin, Claudia Dale, and Lawrence F Katz.** 2009. *The race between education and technology*.: Harvard University Press.

- Goldsmith-Pinkham, Paul, Isaac Sorkin, and Henry Swift.** 2018. “Bartik instruments: What, when, why, and how.” Technical report, National Bureau of Economic Research.
- Goolsbee, Austan.** 1998. “Investment tax incentives, prices, and the supply of capital goods.” *The Quarterly Journal of Economics*, 113 121–148.
- Gruber, Jon, and Emmanuel Saez.** 2002. “The elasticity of taxable income: evidence and implications.” *Journal of public Economics*, 84 1–32.
- Han, Timothy.** 2016. “The Earned Income Tax Credit and Educational Attainment for its Recipients: Evidence from Personal Level Data of the Current Population Survey.” working paper.
- Hotz, V. Joseph, and John Karl Scholz.** 2003. “The Earned Income Tax Credit.” In *Economics of Means-Tested Transfer Programs in the United States*. ed. by Robert Moffitt, Chap. 3 141–197.
- Hoynes, Hilary, Doug Miller, and David Simon.** 2015. “Income, the earned income tax credit, and infant health.” *American Economic Journal: Economic Policy*, 7 172–211.
- Internal Revenue Service.** 2017. “Statistics for Tax Returns with EITC.” URL: <https://www.eitc.irs.gov/EITC-Central/eitcstats>.
- Katz, Lawrence F, and Kevin M Murphy.** 1992. “Changes in relative wages, 1963–1987: supply and demand factors.” *The quarterly journal of economics*, 107 35–78.
- U.S. Department of Labor, Bureau of Labor Statistics.** 2019. “CPI Research Series Using Current Methods (CPI-U-RS) [Dataset].”
- Lee, David, and Emmanuel Saez.** 2012. “Optimal minimum wage policy in competitive labor markets.” *Journal of Public Economics*, 96 739–749.
- Leigh, Andrew.** 2010. “Who Benefits from the Earned Income Tax Credit? Incidence among recipients, coworkers and firms.” *The B.E. Journal of Economic Analysis & Policy*, 10 1–43.

- Matsuyama, Kiminori, and Philip Ushchev.** 2017. “Beyond CES: Three Alternative Cases of Flexible Homothetic Demand Systems.” working paper.
- Maxfield, Michelle.** 2015. “The effects of the earned income tax credit on child achievement and long-term educational attainment.” *Institute for Child Success*.
- Meyer, Bruce D, and Dan T Rosenbaum.** 2001. “Welfare, the Earned Income Tax Credit, and the Labor Supply of Single Mothers.” *The Quarterly Journal of Economics*, 116 1063–1114.
- Nichols, Austin, and Jesse Rothstein.** 2016. “The Earned Income Tax Credit.” In *Economics of Means-Tested Transfer Programs in the United States*. ed. by Robert Moffitt, Chap. 2 137–218.
- Olea, José Luis Montiel, and Carolin Pflueger.** 2013. “A robust test for weak instruments.” *Journal of Business & Economic Statistics*, 31(3): 358–369.
- Pflueger, C. E.** 2015. “A robust test for weak instruments in Stata.” *Stata Journal*, 15(1): 216–225.
- Robinson, Peter M.** 1988. “Root-N-consistent semiparametric regression.” *Econometrica: Journal of the Econometric Society* 931–954.
- Rothstein, Jesse.** 2008. “The Unintended Consequences of Encouraging Work: Tax Incidence and the EITC.” *Working Paper*.
- Rothstein, Jesse.** 2010. “Is the EITC as Good as an NIT? Conditional Cash Transfers and Tax Incidence.” *American Economic Journal: Economic Policy*, 2 177–208.
- Ruggles, Steven, Sarah Flood, Ronald Goeken, Josiah Grover, Erin Meyer, Jose Pacas, and Matthew Sobek.** 2018. “Integrated Public Use Microdata Series USA: Version 9.0 [dataset].” *Minneapolis, MN: IPUMS*.
- Saez, Emmanuel.** 2002. “Optimal Income Transfer Programs: Intensive versus Extensive Labor Supply.” *Quarterly Journal of Economics*, 107 1039–1073.

Sun, Liyang. 2018. “Implementing Valid Two-Step Identification-Robust Confidence Sets for Linear Instrumental-Variables Models.” *The Stata Journal*, 18(4): 803–825.

Zoutman, Floris T, Evelina Gavrilova, and Arnt O Hopland. 2018. “Estimating both supply and demand elasticities using variation in a single tax rate.” *Econometrica*, 86 763–771.

A Additional Summary Statistics

In this appendix, I provide some additional summary statistic information for the estimation samples.

In table XXX, I display the summary statistics for the underlying MORG sample and Census sample.

In table 9, I display the number of observations by marriage and education group that are used in the incidence calculations. I only include market-state-year cells that have a minimum of five workers with children *and* five workers without children. This causes me to have an unbalanced panel of worker cells, but ensures that the market averages are calculated using a reasonable number of workers. The table itself also highlights demographic changes overtime. As can be seen, with population growth, the total number of cells goes from 14.2 thousand to 20.3 thousand. We can also see that the population acquired more education, as there is a decrease in workers without a high school degree to those with a college degree. Interestingly, there is an increase in unmarried women with some college but a decrease for married women, as this latter group shifts towards attaining their college degree.

Table 9 – Market State Year Observations for Estimation Sample

	Less HS		HS		Some College		BA Plus		Total	
Year	Unmarried	Married	Unmarried	Married	Unmarried	Married	Unmarried	Married	Unmarried	Married
1990	246	282	572	714	386	660	46	172	1,250	1,828
1991	258	252	536	738	428	658	46	176	1,268	1,824
1992	268	240	496	680	378	572	166	500	1,308	1,992
1993	210	216	512	684	418	584	158	510	1,298	1,994
1994	186	182	506	634	430	572	142	494	1,264	1,882
1995	182	180	494	602	444	590	176	522	1,296	1,894
1996	158	162	496	580	454	542	152	514	1,260	1,798
1997	156	140	494	550	454	536	160	532	1,264	1,758
1998	144	138	490	544	458	556	190	530	1,282	1,768
1999	154	116	506	546	484	562	218	556	1,362	1,780
2000	156	126	520	532	470	566	204	550	1,350	1,774
Total	2,118	2,034	5,622	6,804	4,804	6,398	1,658	5,056	14,202	20,292

All data from 1993 March CPS, Women from Tax Units, Wage in \$1993
All variables weighted by CPS March Supplement Wt × Hours

B Additional Simulation Results

In table 10, I present the EITC vs NIT simulation results using the labor supply elasticities from Model 2 in table 3. The results are largely the same as with the main specification results in table 7.

Table 10 – Incidence Results:
Aggregate Effects: All Women

Dollars	Rothstein		$\rho = -0.3$				$\rho = -2.5$			
	“PE”		“PE”		GE		“PE”		GE	
	<u>EITC</u>	<u>NIT</u>	<u>EITC</u>	<u>NIT</u>	<u>EITC</u>	<u>NIT</u>	<u>EITC</u>	<u>NIT</u>	<u>EITC</u>	<u>NIT</u>
Intended	1.00	0.55	1.00	0.55	1.00	0.55	1.00	0.55	1.00	0.55
Labor	0.13	-0.16	0.15	-0.17	0.43	-0.48	0.41	-0.48	0.46	-0.53
Wage	-0.46	0.53	-0.53	0.58	-0.08	0.09	-0.16	0.18	-0.09	0.10
Earnings	-0.34	0.37	-0.38	0.40	0.34	-0.39	0.26	-0.30	0.37	-0.43
NetEarn	0.66	1.37	0.62	1.40	1.34	0.61	1.26	0.70	1.37	0.57
EV	0.54	1.52	0.47	1.58	0.92	1.09	0.84	1.17	0.91	1.10
PE/GE	-	-	-	-	0.84	1.45	-	-	0.92	1.06
NIT/EITC	-	2.81	-	3.36	-	1.18	-	1.39	-	1.21

Units in table are changes in dollars of earnings, LM changes summarized across demographic groups
Earnings = Wage + Labor; Net Earnings = Earnings + Transfer, Equivalent Var. = Wages + Transfer
All data from 1993 March CPS, Women from Tax Units
Labor supply elasticities in table 6, except 'Rothstein' which uses $\varepsilon^L = 0.75$ for all