On the Distribution of Wealth and Labor Force Participation

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March 2017

Abstract

The labor force participation rate has been shown to be nearly flat across wealth quintiles in recent studies. Using data from the Survey of Consumer Finances, I find that correlations between wealth and labor force participation are close to zero, in both the aggregate and various sub-groups. Standard incomplete markets models, however, counterfactually predict a highly negative correlation between wealth and labor force participation. In this paper, I develop a fairly standard incomplete markets model and show that government transfers and capital income taxation can make the model substantially more consistent with the data. In addition, as the model's fit with the distribution of wealth and participation improves, I find that the aggregate labor supply elasticitiy becomes substantially larger. Since the higher aggregate elasticities are largely driven by more elastic labor supply behaviors of low-wage households, higher labor income taxes considerably raise output per hours worked. This compositional change in the labor force mitigates welfare losses of distorting labor income taxation.

Keywords: wealth distribution, labor force participation, government transfers, income taxation, labor supply elasticity

JEL codes: E24, E21, J22

*Department of Economics, University of Mannheim, Germany, e-mail: minchul.yum@uni-mannheim.de. This paper is based on an earlier version entitled "Wealth and Labor Supply in an Incomplete Markets Model." I thank Klaus Adam, Florin Bilbiie, Antoine Camous, Sebastian Findeisen, Jordi Gali, Tom Krebs, Dmitry Matveev, Patrick Pintus, and seminar participants at the PSE/Banque de France/Fondation France-Japon-EHESS workshop and the University of Mannheim for helpful comments. I am also grateful to Yongsung Chang and Yongseok Shin for comments and discussions that were helpful at the early stage of this work.

1 Introduction

The wealth effect on labor supply at the extensive margin appears to be weak when examined in cross-sectional U.S. data. For example, several recent studies have shown that the labor force participation rate is nearly flat across wealth quintiles in the U.S. (e.g., see Chang and Kim, 2007 and Ferriere and Navarro, 2016 for the evidence in the Panel Study of Income Dynamics; and Mustre-del-Rio, 2015 for the evidence in the National Longitudinal Survey of Youth). Using data from the 1992-2007 waves of the Survey of Consumer Finances (SCF), I find that not only is the participation rate nearly flat across wealth quintiles, but correlations between wealth and labor force participation are very close to zero.[1]

These empirical facts are at odds with a standard incomplete markets model that predicts a strong cross-sectional wealth effect on labor supply at the extensive margin.[2] In this paper, I quantitatively explore the role of government transfers and capital income taxation to resolve this discrepancy between the data and the model regarding the distribution of wealth and labor force participation.[3] To this end, I develop a fairly standard incomplete markets model in which decisions of consumption-savings and labor supply at the extensive margin are endogenous. The model economy is calibrated to the U.S. to match micro-level heterogeneity, as observed in the SCF. In particular, using a labor productivity process augmented with a highly productive state in the spirit of Castaneda, Diaz-Gimemez and Rios-Rull (2003) and Kindermann and Krueger (2014), the model replicates the highly concentrated distribution of wealth in the U.S. Using the model, I find that government transfers and capital income taxation are quantitatively important in rendering the model much more consistent with the data regarding the distribution of wealth and labor force participation. Specifically, the rank correlation between wealth and participation implied by the

[1] In the literature, the SCF has been recognized as one of the best data sources to capture a highly concentrated distribution of wealth. See e.g., Diaz-Gimenez, Glover, and Rios-Rull (2011); and Kuhn and Rios-Rull (2015) for recent reviews that describe various aspects of inequality in the U.S. using the SCF.

[2] Chang and Kim (2007), Mustre-del-Rio (2015) and Ferriere and Navarro (2016) show that the participation rate declines with wealth quintiles in a standard incomplete markets model with log utility for consumption. According to my model representing a standard incomplete markets model, the rank correlation between wealth and labor force participation is -0.44, whereas it is 0.03 in the SCF data.

[3] Alternatively, one could focus on the role of the elasticity of intertemporal substitution for consumption. In fact, the model with a power utility function is able to generate flatter participation rates by wealth quintiles if the elasticity of intertemporal subsitution is considerably larger than 1 (this result is available upon request). However, these large values do not lie within the range of its empirical estimates (see e.g., Browning, Hansen, and Heckman, 1999; and Guvenen, 2006). Instead, this paper focuses on the role of non-preference-related channels, thereby maintaining the standard household preference.

model changes from -0.44 in the standard version of the incomplete markets model to -0.05 in the baseline specification that incorporates both transfers and capital income taxation.

To isolate the importance of each element for such quantitative success, I compare the results from the introduction of transfers and capital income tax separately to the results from the standard version of the incomplete markets model.[4] First, a specification in which transfers exist but capital taxation is absent reveals that the role of transfers in resolving the discrepancy is quantitatively significant; the inclusion of transfers alone improves the rank correlation from -0.44 to -0.15. One key reason why the standard version of the incomplete markets model predicts a strong negative rank correlation between wealth and participation is that almost all of the first two wealth quintiles, who hold few asset holdings, choose to participate in the labor market. In contrast, the participation rate of the wealth poor in the first two quintiles (77.7% and 86.8%, respectively) are near the aggregate participation rate of 83.8% in the data. The inclusion of transfers in the model lowers labor force participation rates of the first two wealth quintiles substantially, effectively improving the fit of the model at the left tail of the wealth distribution. On the other hand, a specification in which only capital income taxation is introduced to the model reveals that capital income taxation also contributes to improving the fit of the model by affecting the labor supply decision of the wealth rich. Note that the strongly negative correlation between wealth and participation is also because the participation rate of the wealth rich at the top wealth quintile is too low (57.6%) in the standard version of the incomplete markets model (compared to 83.1% in the data). The inclusion of capital income taxation leads more households at the top wealth quintile to participate in the labor market (62.0%). Therefore, capital income taxation also reduces the absolute size of the negative rank correlation between wealth and participation from -0.44 to -0.40.

The economic mechanisms behind the importance of transfers and capital income taxation are straightforward. First, as highlighted above, transfers have a disproportionate impact on labor supply decisions of the wealth poor households. Note that in an incomplete markets model, households can self-insure against idiosyncratic productivity risk through savings or labor supply (Pijoan-Mas, 2006). Transfers serve as an additional insurance instrument, however, particularly for those who lack wealth accumulation for self-insurance. As a result, the presence of government transfers re-

[4] All model specifications are calibrated to match the same statistics including the overall participation rate, interest rate (or capital-output ratio) and dispersion of wealth and earnings distributions.

duces participation rates of the wealth poor, thereby improving the counterfactual prediction of the standard incomplete markets model that the labor force participation rate of the wealth poor is too high. On the other hand, the presence of capital income taxation largely influences labor supply decisions of the wealth rich. As wealth is heavily concentrated, capital income is also highly concentrated. Thus, the presence of capital income taxation disproportionately affects the wealth rich, which, in turn, promotes labor force participation of these richer households. As a result, capital income tax effectively mitigates the negative slope of participation rates according to wealth, bringing the model closer to the data.

In light of the quantitative success in better accounting for the distribution of wealth and labor force participation, I first use the model to explore its implications for the aggregate labor supply elasticity.[5] Note that, in an incomplete markets model in the tradition of Huggett (1993) and Aiyagari (1994), which endogenizes the labor supply decision of households at the extensive margin, it is the distribution of households, not a single utility function parameter, which shapes the aggregate employment response to wage changes. For example, Chang and Kim (2006) investigate the endogenous distribution of wealth as a determinant of the aggregate labor supply elasticity in this class of models. As transfers and capital tax are found to be crucial in bringing the model closer to the data in terms of the distribution of wealth *and labor force participation*, this paper contributes to the literature by investigating implications of matching the joint distribution of wealth and participation for the aggregate labor supply elasticity.

For this purpose, I use different specifications in the model to examine the consequences of higher labor income tax rates, as in Krusell, Mukoyama, Rogerson and Şahin (2008, 2010). The analysis reveals that the aggregate labor supply elasticity, induced by labor tax changes, is considerably larger when the model better replicates the distribution of wealth and participation. For example, the extensive margin elasticity implied by the baseline specification is around 0.55, which is substantially larger than the 0.2 obtained from the standard version of the incomplete markets model. I show that this considerably lower elasticity in the standard version of the incomplete markets model is because, in the absence of government transfers, labor supply decisions of the wealth poor (constituting a significant percentage of the population) are highly insensitive to tax

[5] The aggregate labor supply elasticity is central to various questions in macroeconomics and related areas, ranging from the efficiency costs of taxation to business cycle fluctuations. See e.g., King and Rebelo (1999), Keane (2011) and Keane and Rogerson (2012) for literature reviews.

changes for the same reason these wealth poor households have very high participation rates. Since wealth and productivity are positively correlated, this implies that households with low productivity are less sensitive to wage changes in the standard version of incomplete markets models. This matters for the aggregate elasticity because empirical evidence suggests that labor supply at the extensive margin is more elastic at the left tail of the wage distribution (Juhn, Murphy and Topel, 1991). I find that the baseline model, which matches the distribution of wealth and participation considerably well, generates highly elastic labor supply responses of low-wage households to labor tax changes, thereby leading to the higher aggregate labor supply elasticity. Overall, this exercise highlights the importance of overturning the counterfactually negative relationship between wealth and participation, since the model would substantially understate the magnitude of aggregate labor supply elasticities.

Finally, I also examine the related question of how welfare losses due to labor income taxation might differ across different specifications. One widely held piece of conventional wisdom is that a higher labor supply elasticity implies a larger welfare loss of distorting labor income taxation (e.g., Keane, 2011). The quantitative analysis reveals that this conventional wisdom does not hold when heterogeneous households' labor supply response to tax changes differs across productivity distribution. Specifically, although the baseline model endogenously generates an aggregate labor supply elasticity that is roughly two to three times larger than models that abstract from transfers, it predicts the size of welfare losses at nearly half of that predicted by the standard version of an incomplete markets model. In the baseline model, an increase in labor tax leads to disproportionately more low-wage households to leave the labor force, thereby significantly changing the composition of the labor force. The consequent rise in output per hours worked (or average labor productivity) plays a role in dampening the welfare losses of higher labor income taxes. This highlights the importance of having heterogeneous labor supply responses shape the average labor productivity in the economy, which is shown to be a crucial element in evaluating welfare consequences of taxation.

The cross-sectional relationship between wealth and labor force participation has received little attention in the literature. The flat participation rates across wealth quintiles in the U.S., which I find using data from the SCF, is consistent with the existing evidence in Chang and Kim (2007), Mustre-del-Rio (2015) and Ferriere and Navarro (2016) using different data sets such as the NLSY and the PSID. In addition to the flat profile of participation rates by wealth quintiles, my paper also documents near zero correlations between wealth and labor force participation in the aggregate. I further show that correlations are near zero or moderately positive within various groups divided by gender, education, age or year. This clearly demonstrates the discrepancy between the data and standard incomplete markets models, the latter of which predict counterfactually negative correlations.

Moreover, there has been almost no attention paid to theoretical exploration of channels affecting the cross-sectional relationship between wealth and participation. Mustre-del-Rio (2015) is one exception and explicitly examines this issue. Using a rich quantitative model with two-person households, Mustre-del-Rio (2015) finds that ex-ante heterogeneity in disutility of work across gender and skills is key in reversing the counterfactual prediction of the model. In this paper, I take an alternative approach in assuming that all households have the same preferences, and show that the presence of transfers and capital tax income can change the model-implied correlations between wealth and participation substantially closer to zero, as observed in the data.

Broadly speaking, this paper builds on the literature that emphasizes the role of government transfers as an insurance mechanism. For example, Hubbard, Skinner, and Zeldes (1995) show that social insurance in the form of government transfers discourages precautionary saving, especially for low-income households. In this paper, I highlight that the role of government transfers as social insurance extends to labor supply decisions, and plays an important role in bringing correlations between wealth and participation closer to zero, as it is in the data. Moreover, my paper relates to the literature which emphasizes the role transfers play in affecting labor supply and understanding macroeconomic aggregates, such as Floden and Linde (2001), Rogerson (2007), Ljungqvist and Sargent (2008), Alonso-Ortiz and Rogerson (2010), and Oh and Reis (2012) among others.

The paper is organized as follows. The next section documents the cross-sectional relationship between wealth and participation using data from the SCF. Section 3 presents the environment of the model economy. Section 4 explains how the model is calibrated across different specifications. Section 5 presents the main quantitative analysis and results. Section 6 concludes.

Figure 1: Participation rates by wealth quintiles in the US

Note: This figure is based on the 1992-2007 waves of the Survey of Consumer Finances. Survey weights are used and inflation is adjusted for wealth.

2 Wealth and labor force participation in the United States

The focus of this paper is on the cross-sectional relationship between wealth and labor force participation. This section uses the 1992-2007 waves of the Survey of Consumer Finances (SCF) to document their relationship in the United States. A special feature of the SCF is that it collects detailed information about various household assets and liabilities, particularly of those who are at the upper tail. Hence, the SCF is often recognized as one of the best surveys to capture a highly concentrated distribution of wealth in the U.S. The facts documented in this section are based on pooled samples from the six waves of the SCF (1992-2007) whose age is between 18 and 70.[6] Wealth is defined as the net worth, which is the sum of financial and non-financial asset holdings minus total liabilities. In all statistics, survey weights are used and dollar amounts are adjusted to 2013 dollars.[7]

[6] I exclude households whose age is greater than 70 since it is less likely for them to use the labor supply margin actively for various reasons (e.g., due to health). However, the key facts documented in this section are quite robust to the inclusion of these samples.

[7] See Appendix for more details.

Table 1: Correlations between wealth and labor force participation

		Corr(wealth,participation)	
		Spearman	Pearson
Overall		**0.03**	**0.00**
By gender	Male	-0.02	-0.01
	Female	0.06	-0.01
By education	No college	0.02	-0.00
	College	-0.06	-0.03
By age	Young (29 or below)	0.15	0.02
	Prime (30-54)	0.20	0.02
	Old (55 or above)	0.18	0.06
By year	1992	0.04	0.01
	1995	0.04	0.01
	1998	0.00	-0.01
	2001	0.04	-0.01
	2004	0.02	-0.01
	2007	0.04	0.01

Note: The data source is the 1992-2007 waves of the Survey of Consumer Finances. Survey weights are used and inflation is adjusted for wealth.

Figure 1 plots labor force participation rates by wealth quintiles in U.S. data. It is clear that the profile of participation rates is quite flat across wealth quintiles around the overall participation rate of 83.8%. A careful look reveals that households in the first wealth quintile has a moderately lower participation rate (77.7%), and those in the second wealth quintile has a slightly higher participation rate (86.8%). Then, the participation rate declines very weakly as we move toward richer households. However, the overall shape of the participation rate across wealth quintiles is nearly flat. This flat profile I find in the SCF data set is consistent with the existing evidence based on different data sets such as the NLSY and the PSID (Chang and Kim, 2007; Mustre-del-Rio 2015; and Ferriere and Navarro, 2016).

To quantitatively establish the relationship between wealth and labor force participation, it is helpful to present correlations between the two variables. Table 1 reports cross-sectional correlations between wealth and labor force participation using the same data set. In addition to the conventionally used Pearson correlation coefficient that captures the strength of linearity, I also report the Spearman's correlation coefficient that uses the rank of each variable instead of the level. This is a useful statistics since labor force participation is a discrete variable.

The first row of Table 1 reveals that both correlations are indeed very close to zero. Specifically, the Spearman correlation is slightly positive (0.03) and the Pearson correlation is essentially close to zero. These correlations clearly demonstrate weak wealth effects on labor supply at the extensive margin in the cross-sectional data. The near zero correlations are at odds with standard incomplete markets model since this class of models typically predict that correlations between wealth and participation are substantially negative.[8]

Table 1 also shows correlations in more disaggregated groups. First, it is interesting to note that even within narrower groups divided by gender and education (as shown in the second to fifth rows of Table 1), correlations between wealth and participation stay relatively close to zero. The rank correlation (Spearman) between wealth and participation ranges from -0.06 (for college graduates) to 0.06 (female), but its values are mostly around zero for different groups. The Pearson correlations are in general smaller in absolute term, but the basic message is the same: wealth and participation are nearly uncorrelated in these sub-groups. Interestingly, when correlations are computed within age groups, the rank correlation becomes moderately positive ranging from 0.15 to 0.20. This, in fact, makes the discrepancy between the model and the data even more puzzling since the standard model implies strongly *negative* rank correlations. Finally, Table 1 also reports correlations for each year. The Pearson's correlation ranges from 0.00 to 0.04 and the Spearman's correlation ranges from -0.01 to 0.01 over time. Therefore, these estimates clearly demonstrate that the near-zero correlations are quite robust over time.

3 Model

In this section, I describe the model economy that will be used (i) to illustrate the counterfactual prediction of a standard incomplete markets model regarding the relationship between wealth and participation; and (ii) to explore the role of transfers and capital income tax in rendering the model more consistent with the data. It is a relatively standard incomplete markets general equilibrium model with heterogeneous households. Several key features include uninsurable idiosyncratic shocks along with incomplete asset markets and borrowing constraints, which result in households' precautionary savings for self-insurance (Huggett, 1993; Aiyagari, 1994). Another key feature in the model economy considered in this paper is the endogenous labor supply at the extensive margin

[8] As I investigate in more detail in Section 5, my calibrated model representing a standard incomplete markets model implies the Spearman and Pearson correlations of -0.44 and -0.20, respectively.

(i.e., labor force participation). The model environment described below is the baseline specification. In the quantitative analysis, I will also consider alternative specifications which are simply nested specifications of the baseline specification with some appropriate extra restrictions.

Households:

The model economy is populated by a continuum of infinitely-lived households. Since the analysis in this paper focuses on a stationary equilibrium, I omit the time index and present the household's recursive dynamic decision problem in a stationary environment. In each period, households are distinguished by their asset holdings a, the permanent component of productivity x_i and the transitory component of productivity z_m. I assume that x_i takes a finite number of values N_x and follows a Markov chain with transition probabilities π^x_{ij} from the state i to the state j. The transitory component z_m also has a finite support with the number of states equal to N_z, and follows an i.i.d process with the probability of the state m equal to π^z_m.[9] The competitive factor markets imply that households take as given the wage rate per efficiency unit of labor w and the real interest rate r. The dynamic decision problem which each household faces in each period is captured by the following functional equation:

$$V(a, x_i, z_m) = \max_{\substack{a' > \underline{a}, \\ n \in \{0, \bar{n}\}}} \left\{ \log c - \Gamma n + \beta \sum_{j=1}^{N_x} \pi^x_{ij} \sum_{q=1}^{N_z} \pi^z_q V(a', x'_j, z'_q) \right\} \tag{1}$$

$$\begin{aligned} \text{subject to} \quad c + a' &\leq (1-\tau_l) w x_i z_m n + (1 + r(1-\tau_k))a + T \quad \text{if } a > 0 &(2) \\ &\leq (1-\tau_l) w x_i z_m n + (1+r)a + T \quad \text{if } a \leq 0 &(3) \end{aligned}$$

where households maximize utility depending on current consumption c and time spent on hours of work n as well as the expected future value discounted by a discount factor β. A variable with a prime denotes its value in the next period. The budget constraint states that the sum of current consumption and asset demands for the next period a' should be less than or equal to the sum of net-of-tax earnings $(1-\tau_l)wx_iz_mn$, current asset holdings a, net-of-tax capital income

[9] In this class of models with infinite horizons, transitory shocks can be effectively self-insured by savings, and plays a minor role in terms of key decision rules and statistics. One main reason for introducing transitory shocks is to make the wage distribution richer and smoother. This is quantitatively useful since part of my analysis in the following section is to investigate heterogeneity in labor supply behavior across the distribution of wage.

$(1-\tau_k)ra$, and lump-sum transfers T. As shown in (3), when a is non-positive, households are not subject to capital income taxation. Households take as given government policies such as τ_l, τ_k and T. Households can borrow up to a borrowing limit $\underline{a} \leq 0$. Finally, as labor supply is indivisible, households can work for either $\bar{n}$ hours or zero. $\Gamma > 0$ captures disutility of work.

Firm:

Aggregate output Y is produced by a representative firm. The firm maximizes its profit

$$\max_{K,L} \{F(K,L) - (r+\delta)K - wL\} \tag{4}$$

where $F(K,L)$ captures a standard neoclassical production technology in which K denotes aggregate capital, L denotes aggregate efficiency units of labor inputs, and δ is the capital depreciation rate. The aggregate production function is assumed to be a Cobb-Douglas function with constant returns to scale:

$$F(K,L) = K^{\alpha}L^{1-\alpha}. \tag{5}$$

The above optimization problem provides the factor demand for capital K^d and labor L^d satisfying

$$r = F_1(K^d, L^d) - \delta \tag{6}$$

$$w = F_2(K^d, L^d) \tag{7}$$

Government:

There is a government that taxes labor earnings at a fixed rate of τ_l and capital income at a fixed rate of τ_k. The government provides lump-sum transfers T to households using the collected tax revenue while balancing its budget each period. The baseline specification assumes that government use the collected labor income tax revenue to finance lump-sum transfers T.[10] The government purchase G is determined such that the government budget constraint is balanced. Since the role of government purchase on labor supply is out of scope of this paper, I assume that G is either not valued by households or valued by households in an additively separable manner.

[10] This assumption that the capital tax revenue is not included in the transfers to households helps to isolate the role of transfers and capital income taxation separately in the following quantitative analysis.

Equilibrium:

A stationary recursive competitive equilibrium is a collection of factor prices r, w, equilibrium aggregate quantities K, L, the household's decision rules $g(a, x_i, z_m)$, $h(a, x_i, z_m)$, government policy variables τ_l, τ_k, G, T, a value function $V(a, x_i, z_m)$, and a measure of households $\mu(a, x_i, z_m)$ over the state space such that

1. Given factor prices r, w and government policy τ_l, τ_k, G, T, the value function $V(a, x_i, z_m)$ solves the household's decision problems defined above, and the associated household decision rules are

$$a'^* = g(a, x_i, z_m) \tag{8}$$

$$n^* = h(a, x_i, z_m) \tag{9}$$

2. Given factor prices r, w, the firm optimally chooses the factor demands following (6) and (7);

3. Markets clear;

$$\sum_{i=1}^{N_x}\sum_{m=1}^{N_z}\int g(a, x_i, z_m)\mu(da, x_i, z_m) = K^d = K \tag{10}$$

$$\sum_{i=1}^{N_x}\sum_{m=1}^{N_z}\int xh(a, x_i, z_m)\mu(da, x_i, z_m) = L^d = L; \tag{11}$$

4. Government balances its budget: that is, the sum of G and T is equal to labor tax revenues and capital tax revenues; and

5. The measure of households $\mu(a, x_i, z_m)$ over the state space is the fixed point given the decision rules and the stochastic processes governing x_i and z_m.

4 Calibration

The model is calibrated to U.S. data. A model period is equal to one year. There are two sets of parameters. The first set of parameters is calibrated without simulating the model. These parameter values are fixed across different specifications. The second set of parameters is calibrated using model simulations to match the target statistics in micro data from the SCF. Therefore, these parameter values are recalibrated so that the different specifications are comparable to each other. A set of steady-state equilibrium prices are found by numerically finding w and r at which factor supplies by the households' decision rules are close enough to factor demands by the representative firm. The decision rules and the value functions of households are computed using a standard nonlinear method. Specifically, I solve the decision rules and value functions on the grids of the state variables, and interpolate the expected value function using the piecewise polynomial cubic spline interpolation when evaluating the future value in Equation (1).

Before I discuss how the parameters are calibrated, it is necessary to specify the labor productivity processes. Note that the literature has found that the class of models considered in this paper is able to endogenously generate a reasonably high degree of wealth inequality that can be found in the data sets such as the PSID. Nevertheless, it is also known that the model requires extra features to replicate a very high degree of wealth inequality observed in the SCF that better captures the right tail of the distribution.[11] Such features include discount factor shocks (Krusell and Smith, 1998), a highly skewed productivity process (Castaneda et al., 2003) and voluntary bequests (De Nardi, 2004) among others.[12]

To better account for labor supply decisions of households whose wealth holdings are empirically reasonable, I take an approach following Castaneda et al. (2003) and Kindermann and Krueger (2014). Specifically, I assume that x_i can take among eight values (i.e., $N_x = 8$): $x_i \in \{x_1, ..., x_8\}$ with $x_1 < x_2 < ... < x_8$. The first seven values are considered as *standard* productivity states while x_8 is an exceptionally productive state. Then, $\{x_i\}_{i=1}^{7}$ and the transition probabilities among these states, $\{\pi_{ij}^{x}\}_{i,j=1}^{7}$, are obtained as a discrete approximation of the AR(1) process following the Rouwenhorst (1995) method with the persistence of ρ_x and the standard deviation of innovations σ_x. The 7 by 7 Markov transition matrix is then extended in a parsimonious way. First, I assume that the highest productivity state x_8 can be only reached from x_7 with the probability of $\pi_{78} \equiv \pi_{up}$. Second, the probability of staying in the highest state x_8 is given by $\pi_{88} \equiv 1 - \pi_{down}$ and the probabilities of falling down from x_8 are equally distributed; that is, $\{\pi_{8j}\}_{j=1}^{7} = \pi_{down}/7$. As is shown later, this minimal extension of the standard labor productivity process with additional

[11] See e.g., Heathcote, Perri and Violante (2010) for discussions on the observed wealth inequality across different data sets.

[12] See e.g., De Nardi (2015) for the survey of the literature on these features.

Table 2: Parameter values chosen internally using simulation

	Model specifications				
	(a)	(b)	(c)	(d)	
	Baseline	$T = \tau_k = 0$	$\tau_k = 0$	$T = 0$	Description
$\Gamma =$	1.073	1.945	1.051	2.088	Disutility of work
$\beta =$	.965	.944	.951	.957	Discount factor
$x_s =$	29.5	28.6	31.3	24.5	High productivity state
$\pi_{up} =$	.00427	.01127	.00488	.01175	Prob of moving up to x_s
$\pi_{down} =$	.00405	.01171	.00511	.01016	Prob of falling from x_s
$\underline{a} =$	-.0696	-.0356	-.0431	-.0395	Borrowing limit

three parameters that are internally calibrated allows the model to replicate the distributions of earnings and wealth in an effective and parsimonious way.

I now discuss calibrated values of the parameters that have been defined so far. I begin with parameters that can be externally calibrated without simulating the model. These parameters are either commonly used in the quantitative macroeconomics literature or are mostly independent of the model specification settings. The first parameter α in the aggregate production function is set to 0.36, consistent with the capital share in the aggregate U.S. data. The annual capital depreciation rate δ is equal to 0.096, as is standard in the real business cycle literature. I set the hours of work $\bar{n}$ conditional on working to 0.4, which corresponds to 40 hours per week, assuming that the total available time for work is 100 hours per week. In line with the literature, the tax rate on labor earnings τ_l is set to 0.3 (Krusell et al. 2008, 2010; Alonso-Ortiz and Rogerson, 2010) and the tax rate on capital income τ_k is set to 0.38.[13] For the normal labor productivity process, I set $\rho_x = 0.94$ and $\sigma_x = 0.205$ following Alonso-Ortiz and Rogerson (2010). For the transitory shocks, I set $\sigma_z = 0.1$.[14]

The second set of six parameters are internally calibrated to match six target statistics in the SCF data. The values of these parameters are dependent on the model specifications. In addition to the baseline specification introduced in the previous section (denoted as Model (a) henceforth), I

[13] This capital income tax rate is similar to 0.397 in Domeij and Heathcote (2004) and 0.36 in Trabandt and Uhlig (2011).

[14] The role of transitional shocks is minimal in this framework with infinitely-lived households. See e.g., Blundell, Pistaferri and Preston (2008) for discussions. For example, I obtain nearly identical results with or without the transitional shocks. As discussed earlier, the main purpose of introducing transitory shocks is to make the wage distribution smoother than the eight discrete states (the number of the permanent component of productivity) so that statistics across the wage distribution can be better approximated.

Table 3: Target statistics: model vs data

	U.S.	Model			
	Data	(a)	(b)	(c)	(d)
Target statistics	(SCF)	Baseline	$T = \tau_k = 0$	$\tau_k = 0$	$T = 0$
Participation rate (%)	83.8	83.8	83.8	83.8	83.8
Steady-state interest rate	.040	.040	.040	.040	.040
Gini earnings	.571	.571	.571	.571	.571
Gini wealth	.819	.819	.819	.819	.819
Wealth share by 1st quintile (%)	-.25	-.25	-.25	-.25	-.25
Wealth share by 5th quintile (%)	83.8	83.8	83.7	83.8	83.8

consider three alternative specifications. These are nested versions of the baseline model. Model (b) restricts the amount of transfers and the capital tax rate to be zero. This alternative specification serves as a benchmark environment representing the standard incomplete-markets models that abstract from government transfers and capital taxation.[15] To disentangle the relative importance of transfers and capital income taxation, Model (c) keeps transfers but shuts down capital income taxation. Lastly, Model (d) maintains capital income taxation but sets the amount of transfers to be zero.

Table 2 summarizes the six parameters, the values of which are jointly determined by simulating the model for each specification. Specifically, the calibrated values of the six parameters minimize the distance between target statistics obtained from the data and those obtained from the model-generated data. The first parameter Γ determines the size of disutility of work. The relevant target is set as the overall participation rate of 83.8% in the samples from the SCF. The next parameter β is the discount factor, and is calibrated to match the steady state real interest rate of 4%. Next, the target statistics for the three parameters related to the productivity processes (i.e., x_s, π_{up}, and π_{down}) are set as the Gini indices for earnings and wealth as well as the wealth share by the fifth wealth quintile in the spirit of Castaneda et al. (2003). The relevant target for the borrowing limit $\underline{a}$ is chosen as the wealth share by the first quintile.

Given the clearly defined target statistics, Table 3 shows that the model can match the six target statistics very precisely, in all of the specifications. The above calibration strategy also implies

[15] In the literature, it is quite common to abstract from government when it comes to study labor supply in an incomplete markets framework (e.g., Chang and Kim, 2006, 2007; Domeij and Floden, 2006; Pijoan-Mas, 2006; Chang, Kwon, Kim and Rogerson, 2014 among others).

Table 4: Earnings and Wealth share, by quintiles of each variable: data and model

Unit: %	Earnings quintile					Wealth quintile				
	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
U.S. Data										
SCF (1992-2007)	0.6	6.9	13.1	21.3	58.2	-0.3	1.0	4.2	11.2	83.8
Model										
(a) Baseline	1.0	8.5	12.8	18.6	59.1	-0.3	0.5	3.6	12.4	83.8
(b) $T = \tau_k = 0$	0.8	7.8	13.1	19.8	58.4	-0.3	0.2	3.3	13.0	83.7
(c) $\tau_k = 0$	1.0	8.4	12.9	18.8	58.9	-0.3	0.3	3.4	12.8	83.8
(d) $T = 0$	0.8	7.8	13.1	19.9	58.4	-0.3	0.3	3.3	12.8	83.8

Note: The first row for the U.S. is obtained from the author's calculations using data from the 1992-2007 waves of the Survey of Consumer Finances.

that all the specifications have the same macroeconomic aggregate ratios such as the capital-to-output ratio (2.65) and the capital-to-labor ratio (4.58). However, this does not necessarily imply that the different specifications have the same predictions along other (distributional) dimensions. Therefore, Table 4 presents some important statistics regarding distributions of households under the different model specifications.

I begin by examining earnings distributions implied by different specifications of the model economy. In the left panel of Table 4, the share of earnings held by each quintile is reported. Although the model is calibrated to match the overall dispersion of the earnings distribution (i.e., the Gini coefficient), the model actually does a good job of accounting for more detailed distributional aspects as well. For instance, in both the data and all specifications of the model, the share of earnings held by the top quintile is close to 60% whereas less than 10% of earnings are held by the first two quintiles. Table 4 also reports the share of wealth by wealth quintiles both from the data and from the model economy across different specifications. When it comes to wealth distribution, recall that the calibration not only targets the overall dispersion but also the wealth shares by the first and fifth quintiles directly. The model does a very good job of replicating the wealth distribution as well. Specifically, in both the model and the data, the first two wealth quintiles hold a very tiny fraction of wealth of the overall economy whereas the highest two wealth quintiles hold more than 95% of the total wealth of the economy.

5 Quantitative analysis

This section presents the main quantitative results of this paper. The statistics in the following experiments are based on 500,000 households simulated using the model economy.

5.1 The distribution of wealth and labor force participation in the model

This subsection explores the role of transfers and capital income taxation in rendering the prediction of standard incomplete markets models more consistent with the data regarding the distribution of wealth and participation. To do so, Figure 2 displays conditional participation rates by wealth quintiles implied by Model (a) that incorporates both transfers and capital income taxation (blue dotted line) as well as Model (b) that shuts down transfers and capital income taxation (red dashed line). I also present the data benchmark (green solid line) along with the model results. First, note that Model (b) predicts that labor supply strongly declines with wealth, which is consistent with the previous findings using standard incomplete markets models (Chang and Kim, 2007; Mustre-del-Rio, 2015; and Ferriere and Navarro, 2016). This is in sharp contrast to what we observe in the data showing that labor supply behavior at the extensive margin does not have a clear monotone relationship with wealth.

A striking result to note in Figure 2 is that Model (a) does a great job of replicating the relatively flat profile in the data. In particular, the participation rate of the bottom wealth quintile in Model (a) is 80.2%, which is much closer to the data (77.7%). In addition, the participation rate of the top wealth quintile is considerably higher (77.3%) in Model (a), much closer to the data (83.1%) relative to a low participation rate of 57.6% implied by Model (b).

Although the discrepancy in participation rates by wealth quintiles in the data and in the model has been discussed in the literature, one of the contributions of this paper is to investigate correlations between wealth and labor force participation. To this end, I compute both Spearman (rank-based) and Pearson (level-based) correlations implied by the model, and compare them to the empirical counterpart in the SCF data set. Table 5 summarizes the correlation estimates.

The third row of Table 5 reveals that correlations implied by Model (b) are substantially negative, which is consistent with the negative profile of participation rates by wealth quintiles in Figure 2. In particular, the rank correlation (Spearman) between wealth and participation is -0.44, which

Figure 2: Participation rates by wealth quintiles: models vs data

Note: Model (a), plotted with the blue dotted line, incorporates both transfers, financed by labor income taxation, and capital income taxation. Model (b), plotted with the red dashed line, restricts both transfers and the capital tax rate to be zero. Both models are recalibrated to match the common targets including the distribution of earnings and wealth as well as the aggregate participation rate. U.S. data are based on the 1992-2007 waves of the Survey of Consumer Finances. The green solid line for the US is the same as the one in Figure 1.

Table 5: Correlations between wealth and participation: model vs data

	Corr(wealth,LFP)	
	Spearman	Pearson
U.S. data (SCF)	0.03	0.00
Model		
(a) Baseline	-0.05	-0.02
	(+0.39)	(+0.18)
(b) $T = \tau_k = 0$	-0.44	-0.20
Decomposition:		
(c) With transfers; $\tau_k = 0$	-0.15	-0.07
	(+0.28)	(+0.13)
(d) With capital tax; $T = 0$	-0.40	-0.17
	(+0.04)	(+0.03)

Note: Spearman's correlation captures statistical dependence between the ranking of wealth and participation whereas Pearson's correlation is based on the level of the two variables. Numbers in parentheses are changes relative to the correlation in the standard version of the incomplete markets model (i.e., Model (b)).

is at odds with 0.03 in U.S. data. The Pearson correlation in Model B is less negative (-0.20) than the rank correlation although it is quite far from the Pearson correlation of 0.00 in U.S. data. The second row of Table 5, which reports the correlations implied by the baseline specification, clearly shows the quantitative success of improving the cross-sectional relationship between wealth and participation implied by the model. Specifically, in Model (a), the Spearman correlation is -0.05 and the Pearson correlation is -0.02, both of which are much closer to the near-zero correlations in the data.

The natural question that follows is which element is quantitatively more important in bringing the model closer to the data. Furthermore, to understand the underlying mechanisms behind this quantitative success, it is useful to consider the nested versions of the model that shuts down each element separately. I first consider Model (c) that shuts down capital taxation but keeps transfers. The fourth row of Table 5 shows that the correlations change quite dramatically. The addition of transfers increases the Pearson correlation from -0.44 to -0.15 and the Spearman correlation from -0.20 to -0.07. Based on the changes in correlations, we can conclude that the role of transfers in improving the model's prediction on the cross-sectional relationship between wealth and participation is quantitatively substantial.

The upper panel of Figure 3 is helpful to investigate the mechanism through which transfers helps to achieve correlations between wealth and participation that are much closer to zero. It is clear that Model (c) makes the participation rates of the bottom two wealth quintiles much smaller. At the same time, it may appear that the participation rates of the top two wealth quintiles become greater as well at first glance. However, note that, if I do not re-calibrate the model to control for the overall economy-wide participation rate of 83.8%, the fall in participation rates happen uniformly across the wealth distribution due to wealth effects. Therefore, the key observation to note here is that participation rates of the first two wealth quintiles declines substantially even after I re-calibrate the model which results in shifting up the participation rates across the whole distribution. This means that transfers have quantitatively substantial effects on labor supply behavior of the first two wealth quintiles.

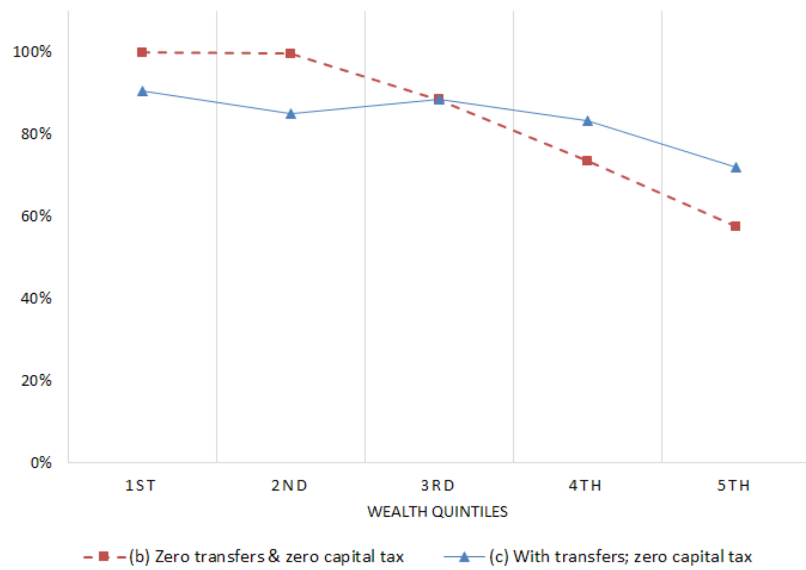
I argue that this substantial change in the labor supply behavior of the wealth poor is largely driven by the lack of insurance means for those who do not have savings in the absence of government transfers. As shown in Table 4, the first and second quintiles hold few wealth holdings. Since the wealth poor households lack savings and are near the borrowing constraint, their consumption would become very low in the absence of transfers. This leads to a strong incentive to work, even for the wealth poor households whose productivity is very low. In contrast, the presence of transfers significantly improves the value of not working for the wealth poor households, thereby inducing some of the wealth poor households whose productivity is low to leave the labor force.

I now move on to the role of capital income taxation in affecting the cross-sectional relationship between wealth and participation by examining the results from Model (d) that only incorporates capital income taxation and shuts down transfers. The last row of Table 5 shows that Model (d) generates the Spearman correlation of -0.40 and the Pearson correlation of -0.16, both of which are closer to the data, yet not very far from the counterfactual correlations implied by Model (b). In other words, the capital tax rate per se is not as powerful as transfers in improving the cross-sectional relationship between wealth and participation.

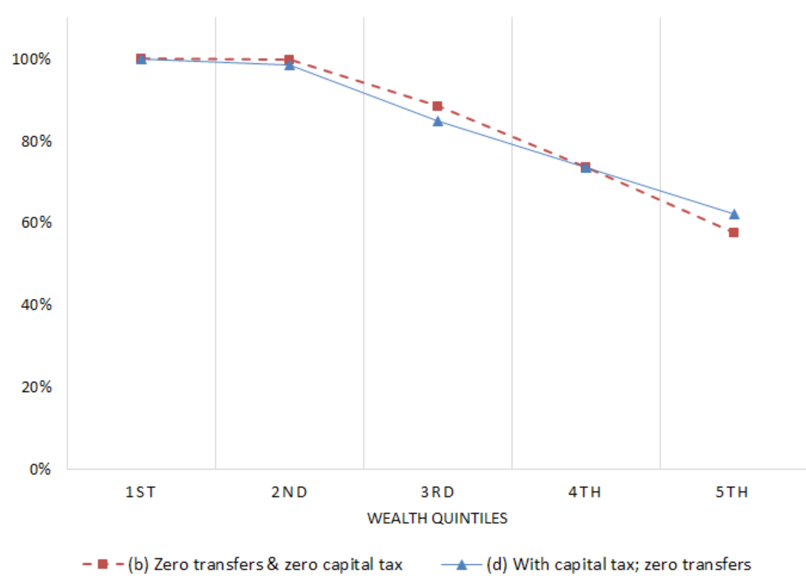
It is instructive to visually investigate changes in participation rates by wealth when I only introduce capital income taxation in Model (d). The bottom panel of Figure 3 shows the role of capital income taxation. Note that participation rates across the wealth distribution becomes slightly flatter when the model marginally introduce capital taxation. This is consistent with a slight decrease in the absolute value of the negative correlations between wealth and participation in Table 5. More importantly, this figure illustrates that this flattening is driven by the higher participation

Figure 3: Participation rates by wealth quintiles: Decomposition

(i) The role of transfers



(ii) The role of capital income taxation



Note: Model (b) abstracts from both transfers and capital income taxation. Model (c) incorporates transfers, financed by labor income taxation, while restricting the capital tax rate to be zero. Model (d) capital income taxation while restricting transfers to be zero. All models are re-calibrated to match the common targets including the distribution of earnings and wealth as well as the aggregate labor force participation rate.

rate of the fifth wealth quintile. The key to understanding the role of capital income taxation is to note that it disproportionately affects the savings decision of the wealth-rich households. Since the distribution of wealth is highly concentrated (in both the model and the data), capital income is also highly concentrated. In the presence of capital income taxation, the wealth rich, who have a sizeable amount of capital income, lose more in terms of capital gains. As they hold fewer assets, this, in turn, has negative wealth effects on labor supply, thereby leading to higher participation rates for the wealth rich. Simply put, capital income taxation works as a mechanism that helps overturn the counterfactual negative slope of participation rates by wealth through its disproportionate impact on wealth accumulation of richer households.

Finally, it is important to note that there are interaction effects when transfers and capital income taxation coexist. In other words, the increment of correlations that is obtained by adding both channels is greater than the sum of correlations increments, obtained by adding each of the transfer channel and the capital income taxation channel separately. Therefore, the above finding of the quantitatively small role of capital income taxation alone should not be simply taken to conclude that capital income taxation is not quantitatively important in improving the model's prediction on the distribution of wealth and participation.

5.2 Implications for aggregate labor supply elasticity

In the previous subsection, I have demonstrated that incorporating transfers and capital income taxation into an otherwise standard incomplete markets model can effectively alter the counterfactual prediction on the cross-sectional relationship between wealth and labor force participation. Although this finding per se is important for a better understanding of properties of incomplete markets model with endogenous labor supply, this paper further asks the relevance of matching the observed labor force participation rates by wealth, especially from macroeconomic perspectives. This subsection begins by exploring its implications for the aggregate labor supply elasticity.

To this end, Table 6 compares the effects of labor income tax changes for the aggregate participation rate across different specifications. The reported values are relative to the benchmark case with the labor income tax rate of 30% that is normalized to 100. In this experiment, I keep the amount of transfers constant at the benchmark case with the tax rate of 30% for Model (a) and Model (c). This is because the amount of transfers endogenously change when the labor income

Table 6: Aggregate hours change with respect to labor income tax changes in general equilibrium

	Aggregate participation rate relative to $\tau = 0.3$					Implied extensive margin elasticity	
$\tau_l =$	0.30	0.35	0.40	0.45	0.50	α_1 in Eq (12)	β_1 in Eq (13)
(a) Baseline	100.0	96.8	92.4	88.3	82.7	0.56	0.54
(b) $T = \tau_k = 0$	100.0	98.6	97.1	95.3	93.3	0.21	0.20
(c) $\tau_k = 0$	100.0	97.2	92.3	88.2	82.5	0.58	0.56
(d) $T = 0$	100.0	98.8	97.5	96.0	94.2	0.18	0.17

Note: Aggregate participation rates reported are relative to the benchmark case with the labor income tax rate of 30% for each specification (normalized to 100). The amount of transfers is fixed at the benchmark level for each specification.

tax rate varies under the assumption of the balanced government budget constraint. This would generate additional forces that amplify the effects of tax changes, which would not exist in the absence of transfers. In order to isolate the role of transfers in shaping the distribution of wealth and participation, I thus keep the amount of transfers fixed with respect to the labor income tax changes, and assume that the additional tax revenue is spent as G.

An interesting result emerges in Table 6. Although Model (a) and Model (b) have been calibrated to generate the same degree of cross-sectional dispersion of earnings and wealth, the same labor income tax changes lead to strikingly different aggregate labor supply responses. Specifically, when labor taxes are increased from 0.3 to 0.5, Model (a) predicts that the participation rate in the overall economy would decrease by nearly 17%. This drop is substantially larger than a 7% fall, implied by Model (b).

To facilitate the comparison of responsiveness to tax changes, the last two columns report extensive margin elasticities obtained from the following regression equation (e.g., Chetty, Guren, Manoli and Weber, 2012)

$$\ln LFP = \alpha_0 + \alpha_1 \ln(1 - \tau) + \varepsilon \tag{12}$$

where the dependent variable is the log of the labor force participation rate and the regressor is the log of the net-of-tax rate. The extensive margin elasticity can be captured by α_1, which measures the percentage change in the participation rate with respect to the percentage change in the net-of-tax rate. I also compute the slope from the equation augmented with the equilibrium wage in the regressor such as

$$\ln LFP = \beta_0 + \beta_1 \ln(1-\tau)w + \varepsilon \tag{13}$$

since the aggregate component of wages w is an endogenous object in the model economy. The difference in the estimates of extensive margin elasticities between Model (a) and Model (b) is substantial. The elasticity implied by the baseline specification is around 0.55, which is nearly three times larger than 0.2 implied by Model (b). The results from the other specifications, Model (c) and Model (d), in the last two rows reveal that the presence of transfers is quantitatively important for the higher aggregate labor supply elasticity.

It is instructive to look at labor supply responses across the distribution of households to understand the source of such a large discrepancy in the aggregate elasticity. Table 7 summarizes percentage point changes by wealth quintiles as well as by wage quintiles following an increase in the labor income tax rate from 0.3 to 0.5. The changes across wealth quintiles reveal important findings. First, although the drops in the participation rate are quite uniform from the third to the fifth wealth quintiles, the key difference across different specifications arises in the first two wealth quintiles who hold few assets. In particular, it is worth pointing out that Model (b) and Model (d), both of which abstract from transfers, predict that households in the first quintile do not respond to 20 percentage point increases in the labor income tax rate. In fact, recall that these households are the ones who choose to work regardless of their productivity because their outside option without transfers and savings is to have consumption close to zero. As the marginal utility of consumption near the consumption level of zero is so high, these households are found to be not willing to leave the labor force even with much lower net wages. In contrast, Model (a) and Model (c), both of which allow the wealth-poor households to have some non-labor income from government transfers show that the wealth poor are actually quite responsive to wage changes, leading to greater changes in the aggregate labor force participation rate, as evidenced in Table 6. In particular, Table 7 shows that Model (a) predicts that the households at the lowest two wealth quintiles are considerably more responsive to tax changes than the other wealth quintiles.

Table 7 also reports changes in participation rates by wage quintiles.[16] In all specifications, there is a common pattern that when the wage (or productivity) is higher, labor supply becomes

[16] Recall that individual wage is based on individual's productivity. Therefore, in the model, this information is also available for those who do not work.

Table 7: Inspecting the mechanism: Extensive margin responses by wealth and wage quintiles

	Changes in participation rates following an increase in τ_l from 0.3 to 0.5									
	by wealth quintiles					by wage quintiles				
(Unit: % point)	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
(a) Baseline	-26.7	-16.7	-9.4	-10.6	-9.6	-34.8	-19.4	-7.7	-2.2	-0.2
(b) $T = \tau_k = 0$	0.0	-3.7	-7.4	-6.9	-9.9	-8.4	-6.4	-5.3	-4.4	-1.9
(c) $\tau_k = 0$	-34.3	-8.1	-9.5	-11.5	-10.5	-35.1	-17.5	-8.3	-3.5	-0.5
(d) $T = 0$	0.0	-4.1	-6.5	-5.5	-8.0	-8.1	-5.5	-4.4	-3.1	-1.4

Note: Numbers reported are percentage point changes relative to the benchmark case when the labor income tax rate changes from 0.3 to 0.5.

less elastic.[17] This implies that the aggregate labor supply elasticity is largely shaped by the responsiveness of low wage households. Given this, it is important to note that there is a large difference in the slope of the participation rate responsiveness to tax changes. Specifically, in the presence of transfers as in Model (a) and Model (c), low-wage households are substantially more responsive to tax changes, thereby making the slope steeper Recall that when the model does not incorporate transfers as in Model (b) and Model (d), many of the wealth-poor households choose to work. Since a majority of the wealth poor have low productivity, this implies that in the absence of transfers, many low-wage households choose to work despite their low market wage. This mechanism led to very high participation rates of the first two wealth quintiles in Model (b) and Model (d). Table 7 reveals that this mechanism also leads to less elastic labor supply of *low-wage* households and, consequently, highly inelastic labor supply behavior of the *wealth poor* households in the absence of transfers. This highlights the importance of matching the cross-sectional distribution of wealth and participation in shaping the comparative static behavior of the model.

5.3 Welfare costs of distorting labor taxes

The previous subsection has found that the aggregate labor supply elasticity implied by the model becomes much larger when the model better replicates the distribution of wealth and participation. A closely related question is how welfare costs of higher labor income taxes differ across different

[17] This is consistent with Juhn et al. (1991) who find that the extensive margin partial elasticity is considerably stronger at the bottom of the wage distribution.

Table 8: Welfare costs of higher labor income taxes, by different specifications

	Aggregate welfare relative to $\tau = 0.3$ (unit: %)					Extensive margin elasticity	
$\tau_l =$	0.30	0.35	0.40	0.45	0.50	α_1 in Eq (12)	β_1 in Eq (13)
(a) Baseline	0.0	-3.8	-7.6	-11.2	-15.0	0.56	0.54
(b) $T = \tau_k = 0$	0.0	-5.9	-11.8	-17.7	-23.5	0.21	0.20
(c) $\tau_k = 0$	0.0	-3.6	-7.1	-10.7	-14.2	0.58	0.56
(d) $T = 0$	0.0	-6.4	-12.8	-19.1	-25.4	0.18	0.17

Note: Aggregate welfare costs are computed as percentage of consumption that is required for the households in the the benchmark economy (with the labor tax rate of 0.3) to be indifferent to being in an alternative economy (with a higher tax rate). To focus on the implications of distorting taxes, the amount of transfers is fixed at the benchmark level for each specification.

specifications. A widely held piece of conventional wisdom is that a higher labor supply elasticity is associated with a larger welfare cost of labor income taxation since it distorts work incentives more strongly, leading to larger efficiency costs (e.g., Keane, 2011). Clearly, this is the case within representative agent frameworks or more generally, within a framework in which the aggregate labor supply elasticity is tightly linked to the curvature of disutility of hours worked. This subsection revisits this conventional wisdom on the tight link between the aggregate labor supply elasticity and welfare losses of higher taxes through the lens of the model economy in which heterogeneity in households' responsiveness to tax or wage changes arises endogenously.

To this end, I compute aggregate welfare costs with respect to higher labor income taxes across different specifications of the model economy. The aggregate welfare costs are measured as a percentage change in consumption required for households in the benchmark economy with the labor income tax rate of 30% to be indifferent to being in an alternative economy with a higher tax rate. Note that in the presence of transfers, the assumption of balanced government budgets implies that higher labor taxes lead to greater amounts of transfers, the latter of which in turn tend to increase aggregate welfare measures through the redistribution channel. To focus on the welfare loss that arises from higher distorting taxes, I hold the amount of transfers fixed at the labor tax rate of 30% for the specifications with $T > 0$ (i.e., Model (a) and Model (c)). By shutting down the endogenous response of transfers, this assumption also allows us to compare the effects of labor tax changes across all of the specifications including those that abstract from transfers.[18]

[18] This assumption is also consistent with the previous subsection on the aggregate labor supply elasticity.

Table 8 summarizes the welfare cost results along with the extensive margin elasticities reported in Table 6. The first noticeable observation is that welfare costs of higher taxes are quantitatively substantial across all specifications. In particular, Model (b) implies that a 20-percentage point increase in the labor tax would lead to 24% lower aggregate welfare in terms of consumption. This indicates that distorting labor taxes involve substantial efficiency losses through the endogenous labor supply channel. Second, and more importantly, Model (a), which generates a substantially higher aggregate labor supply elasticity than Model (b), predicts much *smaller* welfare losses associated with higher taxes than does Model (b). Specifically, an increase in the labor income tax rate from 0.3 to 0.5 leads to a decrease in aggregate welfare by 15% in Model (a), which is significantly weaker in magnitude than 24% in Model (b). This result appears to be at odds with the conventional wisdom that associates a higher labor supply elasticity with a higher aggregate welfare loss following higher taxes. The last two rows, which report the results form Model (c) and Model (d), show that it is the presence of transfers that is key for the dampened welfare losses of higher labor taxes in Model (a).

To understand the mechanism behind this seemingly odd result, it is useful to investigate implications of labor tax changes for macroeconomic aggregates across different specifications. Table 9 reports changes in aggregate output Y, aggregate capital K, aggregate efficiency unit of labor or aggregate labor input L, aggregate hours worked and output per hours worked (or average labor productivity) when the labor tax τ_l increases from 0.3 to 0.5. In Table 9, note first that output falls more in Model (a) than in Model (b) (-7.5% versus -5.9%), which is in line with the larger size of the aggregate labor supply elasticity. Nevertheless, the output effects of labor tax changes from Model (a) and Model (b) are relatively similar, compared to the employment effects of labor tax changes (-17% versus -7%). As a result, Table 9 reveals a clear difference in the effects of tax changes on output per hours worked: average labor productivity increases considerably by 12.4% in Model (a) whereas it changes little (0.8%) in Model (b). This result is closely related to the finding in the previous subsection that, in Model (a) relative to Model (b), a higher aggregate labor supply elasticity is largely driven by low-wage households whose low productivity weakens the transmission of a fall in employment to a fall in aggregate labor input and output.

Given the finding that, in Model (a), a higher labor tax rate increases average labor productivity, thereby inducing strong selection effects, it is now clear why welfare losses of higher labor

Table 9: Average labor productivity and aggregate welfare

(unit: %)	Y	K	L	Aggregate hours	Average labor productivity	Aggregate welfare
(a) Baseline	-7.3	-9.3	-6.2	-17.3	+12.1	-15.0
(b) $T = \tau_k = 0$	-5.9	-8.4	-4.6	-6.7	+0.8	-23.5
(c) $\tau_k = 0$	-7.2	-8.5	-6.4	-17.5	+12.6	-14.2
(d) $T = 0$	-5.9	-9.7	-3.8	-5.8	-0.2	-25.4

Note: Aggregate labor productivity is defined as output divided by aggregate hours. The numbers reported are percentage changes in the case of the tax rate of 50%, relative to the benchmark case with the labor income tax rate of 30% for each specification. To focus on the implications of distorting taxes, the amount of transfers is fixed at the benchmark level for each specification.

income taxes are mitigated in Model (a). As households value leisure, if a similar output can be produced by a substantially fewer households (i.e., higher average labor productivity), this serves as a channel that boosts aggregate welfare. Therefore, in Model (a), despite a greater output fall, households require a less consumption compensation to be indifferent to living in the economy with a higher tax rate whereas, in Model (b), the near-zero change in average labor productivity does not mitigate welfare losses of higher labor income taxes. The upshot of this analysis is that the endogenous compositional change in the labor force, captured by output per hours worked, is crucial in evaluating welfare costs of distorting taxation.

6 Conclusion

In this paper, I have documented that labor force participation rates are relatively flat across wealth quintiles, and that cross-sectional correlations between wealth and labor force participation are very close to zero, according to the SCF. In contrast to these facts in U.S. data, I have shown that the wealth gradient of participation rates is clearly negative and the correlations are considerably negative in standard incomplete markets models. To explore the role of transfers and capital income taxation in resolving this discrepancy, I presented a relatively standard incomplete markets model that are calibrated to match the cross-sectional dispersion of wealth, and found that both transfers and capital income taxation can bring the counterfactually negative correlations between wealth and participation (e.g., the rank correlation of -0.44) closer to zero. Further, I showed that when the fit of the model with the distribution of wealth and participation improves, aggregate labor supply elasticities implied by the model become substantially larger because the labor supply of low-wage households becomes more elastic. Finally, I found that heterogeneity in labor supply responsiveness across the productivity distribution leads to a striking result that higher aggregate labor supply elasticities may not be necessarily associated with higher welfare costs since changes in average labor productivity could dampen the aggregate welfare losses of distorting labor taxes.

A key mechanism of this paper that brings the model closer to the data is the insurance role of transfers for those who have few wealth holdings. In this regard, it is worth noting that this paper abstracts from the insurance role of other potentially important factors such as spousal labor supply (Attanasio, Low, and Sanchez-Marcos, 2005) or the intensive margin of labor supply (Pijoan-Mas, 2006). This paper assumes a gender-neutral one-person household framework that abstracts from the within-household insurance channel as a starting point. It would be interesting to consider the role of family as an additional insurance mechanism that may interact with government policy and study which factor is quantitatively most relevant. In addition, as shown by Rogerson and Wallenius (2009), Chang, Kwon, Kim, and Rogerson (2014), and Erosa, Fuster, and Kambourov (2016), a model with both the intensive and extensive margins can introduce a non-trivial interaction between the two margins of labor supply.[19] These potentially interesting extensions are left for future work.

[19] Domeij and Floden (2006) and Pijoan-Mas (2006) focus on the intensive margin of labor supply. They consider incomplete markets environments that abstract from government transfers, and find that the decision rule of labor supply along the intensive margin features that households near the borrowing limit tend to work longer hours, conditional on individual productivity.

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A Data appendix

The source of statistics is the Survey of Consumer Finances (SCF). The SCF is a triennial cross-sectional survey on the representative U.S. households. To construct the main data set that are used to compute statistics, I pool the samples in the following waves: 1992, 1995, 1998, 2001, 2004, and 2007. I consider both men and women. Given the focus of this paper (i.e., wealth and labor supply at the extensive margin), it is important to keep the samples who are near retirement and are recently retired. This is not only because the old population constitutes a relatively large fraction of the wealth rich but also because retirement is also an important extensive margin labor supply decision. Nevertheless, I drop the samples whose age is greater than 70 since their decisions might depend on not only economic conditions but also on the health status. The number of the final sample is 22,485. When pooling the data, all dollar variables are inflation-adjusted to 2013 dollars. For all statistics reported, I use weights provided in the SCF. To construct earnings and wealth variables, I closely follow the definitions in Diaz, Glover and Rios-Rull (2011) and Kuhn and Rios-Rull (2015). Specifically, the variable of earnings is defined as wages and salaries of all kinds plus the 86 percent of the business income such as income from professional practices, businesses, and farm sources. Wealth is defined as the net worth of the households. In other words, it is the value of financial real assets of all kinds minus the value of all kinds of liabilities. See Diaz et al. (2011) and Kuhn and Rios-Rull (2015) for details about various sub-categories of assets and liabilities that are extensively covered in the SCF data set.