On the Distribution of Wealth and Labor Force Participation

Minchul Yum*

University of Mannheim

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Abstract

The labor force participation rate has been shown to be nearly flat across wealth quintiles in recent studies. I further document that correlations between wealth and labor force participation are close to zero, in both the aggregate and various sub-groups, using data from the Survey of Consumer Finances. Standard incomplete markets models, however, counterfactually predict a highly negative correlation between wealth and labor force participation. Using a fairly standard incomplete markets model calibrated to match the distribution of wealth, I 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 elasticity almost doubles. Moreover, since the higher aggregate elasticities are largely driven by more elastic labor supply behaviors of households with low productivity, higher labor income taxes considerably raise output per hours worked, mitigating welfare losses of the distortionary taxes.

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

JEL codes: E24, E21, J22

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1 Introduction

The wealth effect on labor supply at the extensive margin appears to be weak 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 that labor supply at the extensive margin falls sharply with wealth.[2] In this paper, I explore the role of government transfers and capital income taxation in resolving this discrepancy between the data and the model with respect to the joint distribution of wealth and labor force participation. 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 match the U.S. 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 SCF data. Using the model economy, 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 model improves 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. Therefore, the apparently weak wealth effects on labor supply observed in the cross-sectional data are reconciled with the individual preference which allows for reasonably income

[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.

effects at the individual level.[3]

The economic mechanisms behind the importance of transfers and capital income taxation in resolving the discrepancy are straightforward. In fact, income effects at the individual level plays an important role. A key reason why the standard version of the incomplete markets model predicts a strong negative rank correlation between wealth and participation is that most of the wealth poor households counterfactually choose to participate in the labor market. Note that in this class of models, households can self-insure against idiosyncratic productivity risk through savings (Aiyagari, 1994) or labor supply (Pijoan-Mas, 2006). Transfers serve as an additional insurance instrument, particularly for those who lack wealth accumulation for self-insurance. As a result, the negative effects of government transfers on labor force participation are disproportionately stronger for 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 strongly negative correlation between wealth and participation is also because the participation rate of the wealth rich is too low in the standard version of the incomplete markets model compared to the data. As wealth (and thus capital income) is heavily concentrated, the presence of capital income taxation disproportionately affects asset holdings of the wealth rich. Thus, capital income taxation plays a role of promoting labor force participation of these richer households disproportionately, thereby effectively mitigating the negative slope of participation rates according to wealth.

In light of the quantitative success in better accounting for the distribution of wealth and labor force participation, I use the model to explore its implications for the aggregate labor supply elasticity.[4] Note that, in an incomplete markets model with endogenous labor supply at the extensive margin (e.g., Chang and Kim, 2006, 2007; and Alonso-Ortiz and Rogerson, 2010), it is the distribution of households, not a single utility function parameter, which shapes the aggregate employment

[3] I also explore an alternative way of resolving this discrepancy by directly changing the preference specification. In fact, the model can generate a much flatter relationship between wealth and labor supply even without transfers and capital income taxation when the intertemporal elasticity of substitution is allowed to be substantially larger than 1. 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). Another possibility of the GHH preference (Greenwood, Hercowitz and Huffman, 1988) generates a strongly increasing profile of participation rates by wealth, which is also counterfactual. See Section 5 for more details.

[4] 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.

response to wage changes. An important contribution has been made by Chang and Kim (2006) who investigate the endogenous distribution of wealth as a determinant of the aggregate labor supply elasticity in this class of models. A contribution of this paper relative to this literature is to investigate implications of the joint distribution of wealth *and labor force participation* for the aggregate labor supply elasticity.

For this purpose, the model economy with different specifications is used to study the effects of higher labor income tax rates on labor supply, as in Krusell, Mukoyama, Rogerson and Şahin (2008, 2010). The quantitative 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. Specifically, the extensive margin elasticity implied by the baseline specification is around 0.45, which almost doubles 0.2 obtained from the standard version of the incomplete markets model. This considerably lower aggregate elasticity in the standard version of the incomplete markets model is because labor supply decisions of the wealth poor (constituting a significant percentage of the population) are very insensitive to after-tax wage changes for the same reason why the labor force participation rate of these wealth poor households is very high. I find that the baseline model, which matches the distribution of wealth and participation considerably well, generates highly elastic labor supply responses of the poor households to labor tax changes, thereby leading to the higher aggregate labor supply elasticity. 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 distortionary labor income taxation might differ when the distribution of wealth and labor force participation varies. One widely held piece of conventional wisdom is that the labor supply elasticity is tightly linked to the welfare losses of distortionary labor income taxation (e.g., Keane, 2011). The quantitative analysis reveals that this conventional wisdom is weakened when heterogeneous households' labor supply response to tax changes differs across productivity distribution. In the baseline model, a higher labor tax rate has disproportionately stronger effects on households with low productivity, thereby changing the composition of the labor force substantially. Consequently, output per hours worked (or average labor productivity) rises sharply, meaning that the efficiency loss in terms of output is not as dramatic as the large fall in aggregate hours in the baseline model. Since households value leisure, this suggests that higher aggregate labor supply elasticities could dampen the welfare losses of distortionary taxes as long as (endogenous) labor productivity increases considerably.

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. 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. I further show that correlations are close to 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 the theoretical exploration of channels affecting the cross-sectional relationship between wealth and participation. Mustre-del-Rio (2015) is one exception and examines this issue. Using a quantitative partial equilibrium 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 preference, and investigate the role of institutional features such as government transfers and capital tax income as important factors shaping the cross-sectional relationship between wealth and labor supply.

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. 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

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.

the model economy. Section 4 explains how the model is calibrated across different specifications. Section 5 presents the main quantitative analysis regarding the distribution of wealth and labor force participation in the model compared to the data. Section 6 explores the aggregate implications of matching the near-zero correlations between wealth and labor force participation. Section 7 concludes.

2 Wealth and labor force participation in the United States

The key statistics of interest in this paper regard 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 distinguishing 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

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.

is between 18 and 70.[5] 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. More details are available in Appendix.

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 correla-

[5] 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.

tions 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 statistic since the 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 zero. These correlations clearly demonstrate that wealth effects on labor supply at the extensive margin appear to be weak when examined in the cross-sectional data. As highlighted in Introduction, 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.[6]

Table 1 also reports correlations within 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 they 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 within these sub-groups. Interestingly, when correlations are computed within different 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

[6] 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.

more consistent with the data. It is a relatively standard incomplete markets general equilibrium model with heterogeneous households in the tradition of Imrohoroğlu (1989), Huggett (1993) and Aiyagari (1994). Several key features include uninsurable idiosyncratic shocks along with incomplete asset markets and borrowing constraints, which result in households' precautionary savings for self-insurance. Another key feature in the model economy considered in this paper is the endogenous labor supply at the extensive margin (i.e., labor force participation) (Chang and Kim, 2006). The model environment described below is the baseline specification. In the following quantitative analysis, I will also consider alternative specifications which are simply nested specifications of the baseline specification to represent a standard version of the incomplete-markets model.

Households:

The model economy is populated by a continuum of infinitely-lived households. Since the analysis in this paper is based on a stationary environment, I omit the time index and present the household's dynamic decision problem recursively. In each period, households are distinguished by their net worth 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.[7] 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:

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

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

$$\leq (1 - \tau_l) w x_i z_m n + (1 + r) a + T \quad \text{if } a \leq 0 \tag{3}$$

[7]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 useful when heterogeneity in labor supply behavior across the distribution of wage is studied and when preferences without income effects (GHH) are considered.

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 $(1-\tau_k)ra$, 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, I assume that the period utility function follows

$$U(c,n) = \log(c) - \Gamma n. \tag{4}$$

As labor supply is indivisible, households can work for either $\bar{n}$ hours or zero. This simplifies the disutility of work as a parameter $\Gamma > 0$.

Firm:

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

$$\max_{K,L} \{F(K,L) - (r+\delta)K - wL\} \tag{5}$$

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:

$$F(K,L) = K^{\alpha}L^{1-\alpha}. \tag{6}$$

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

$$r = F_1(K^d, L^d) - \delta \tag{7}$$

$$w = F_2(K^d, L^d). \tag{8}$$

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.[8] 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.

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

$$a'^* = g(a, x_i, z_m) \tag{9}$$

$$n^* = h(a, x_i, z_m) \tag{10}$$

2. Given factor prices r, w, the firm optimally chooses the factor demands following (7) and (8);

3. Markets clear;

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

$$\sum_{i=1}^{N_x} \sum_{m=1}^{N_z} \int x_i h(a, x_i, z_m) \mu(da, x_i, z_m) = L^d = L; \tag{12}$$

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

[8] 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.

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 externally. These parameter values are fixed across different specifications. The second set of parameters is calibrated to match the target statistics in the micro data from the SCF. These parameter values are re-calibrated across different specifications so that the different specifications are comparable to each other in terms of key macroeconomic variables and the degree of inequality generated by the model. The model-implied statistics should be obtained numerically since the model cannot be solved analytically. The equilibrium decision rules and the value functions of households are computed using a standard nonlinear method.[9]

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.[10] 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.[11]

To obtain an empirically reasonable distribution of household wealth, 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 ordinary productivity states while x_8 is an exceptionally productive

[9] Specifically, I solve the decision rules and value functions on the grids of the state variables. Capital is a continous variable in the model is stored in 200 log-spaced grid points, and is interpolated using the cubic spline interpolation when evaluating the expected future value in Equation (1). To approximate the distribution of capital (or wealth), I use a finer log-spaced grid with 3,000 points. The main results are robust to a greater number of grid points. More computational details are available upon request.

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

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

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

I now discuss the calibrated values of the above parameters. I begin with parameters that are externally calibrated. 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.[12] 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 $\sigma_z = 0.1$.[13]

The second set of six parameters are internally calibrated to match six target statistics in the SCF data. Therefore, 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 consider three alternative specifications. These are nested versions of the baseline model. Model (b) restricts the size of transfers and the capital tax rate to be zero. This alternative

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

[13] The role of transitional shocks is minimal in this framework with infinitely-lived households. See e.g., Blundell, Pistaferri and Preston (2008) for discussions. The main results of this paper are nearly identical regardless of 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). This is helpful for computing statistics across the wage distribution as well as for calibrating the model with the GHH preference.

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
$\beta =$	.9654	.9436	.9512	.9570	Discount factor
$x_s =$	29.5	28.6	31.3	24.5	High productivity state
$\pi_{up} =$	.00427	.01129	.00490	.01175	Prob of moving up to x_s
$\pi_{down} =$	.00404	.01175	.00512	.01016	Prob of falling from x_s
$\phi =$	.0650	.0368	.0411	.0395	Borrowing constraint

specification serves as a benchmark environment representing the standard incomplete-markets models that abstract from government transfers and capital taxation.[14] 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 transfers to 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 borrowing limit $\underline{a}$ is linked to income by assuming $\underline{a} = \phi Y$. Then, ϕ captures the tightness of overall credit markets. The relevant target for ϕ is chosen as the wealth share by the first quintile.

Table 3 shows that the model is able to match the six target statistics very precisely, in all of the specifications. The above calibration strategy also implies that all the specifications have the same macroeconomic aggregate ratios such as the capital-to-output ratio (2.65) and the capital-to-labor

[14] 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 3: Target statistics: model vs data

	U.S. Data	Model			
		(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 5th quintile (%)	83.8	83.8	83.7	83.8	83.8
Wealth share by 1st quintile (%)	-.25	-.25	-.25	-.25	-.25

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 only 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 of earnings 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 its 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 in the data 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 The distribution of wealth and labor force participation

The exercises in the previous section suggest that the assumptions on institutional features such as transfers and capital taxation may not be crucial if one is only interested in matching the marginal

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	59.0	-0.3	0.3	3.4	12.7	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.

distribution of wealth. In this section, however, I show that these institutional features do matter when it comes to the joint distribution of wealth and labor force participation.[15]

I begin by exploring 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 80.5%, which is much closer to the data (77.7%). In addition, the participation rate of the top wealth quintile is considerably higher (77.2%) in Model (a), much closer to the data (83.1%) relative to a low participation rate of 57.5% implied by Model (b).

[15] Some quantitative results in this section requires simulated data (e.g., correlations) when the discretized equilibrium distributions are not sufficient. These statistics are based on 500,000 households simulated using the model solutions.

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; $T = 0$	-0.42	-0.18
	(+0.01)	(+0.02)

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)).

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. To isolate the importance of each element for such quantitative success, I also present correlations obtained from the introduction of transfers and capital income tax separately. Table 5 summarizes these correlation estimates.

The third row of Table 5 reveals that correlations implied by Model (b) are substantially negative. This finding 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 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. For this purpose, it is useful to consider the nested versions of the model that shut down each element separately. Consider Model (c) which has transfers but abstracts from capital taxation. The fourth row of Table 5 shows that the correlations change quite dramatically. The presence of transfers alone increases the Pearson correlation from -0.44 to -0.15 and the Spearman correlation from -0.20 to -0.07. This suggests that the role of transfers in improving the model's prediction on the cross-sectional relationship between wealth and participation is quantitatively substantial. Next consider Model (d) which only incorporates capital income taxation and shuts down transfers. The last row of Table 5 shows that Model (d) generates the Spearman correlation of -0.42 and the Pearson correlation of -0.18, 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 alone is so powerful in improving the cross-sectional relationship between wealth and participation. Before we move on, it is important to note that there are interaction effects when transfers and capital income taxation coexist. In other words, the increment of correlations 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.

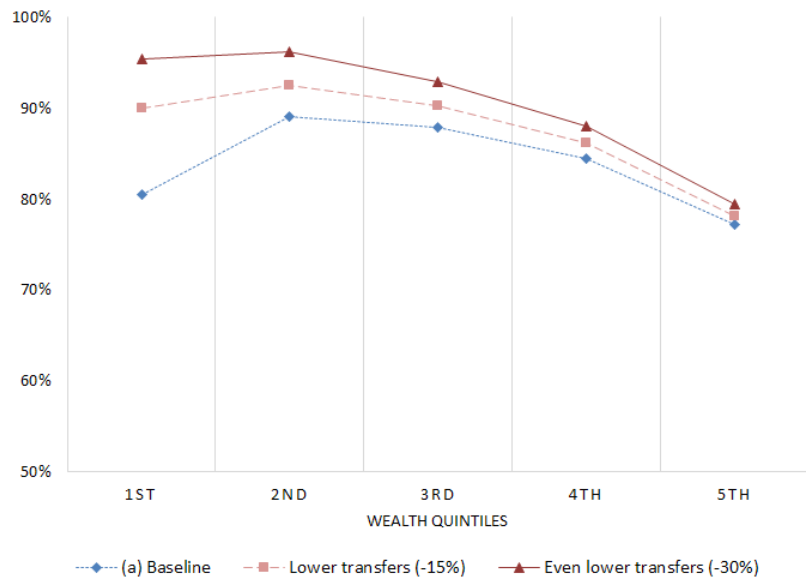
Inspecting the mechanism:

I now investigate the mechanism through which transfers and capital taxation affect correlations between wealth and participation. Figure 3 illustrates the role of the presence of transfers and capital taxation through partial-equilibrium exercises using Model (a). Specifically, the top panel of Figure 3 plots labor force participation rates by wealth quintiles in the benchmark case (dotted line), which are the same as those in Figure 2, as well as the couterparts in the cases when the size of transfers is reduced by 15% (dashed line) and 30% (solid line). The bottom panel of Figure 3 plots the same statistics when the capital tax rate is reduced by 15% and 30%. These exercises shut down general equilibrium considerations by holding the equilibrium prices fixed at the baseline level in order to illustrate the partial effects of each channel more clearly.

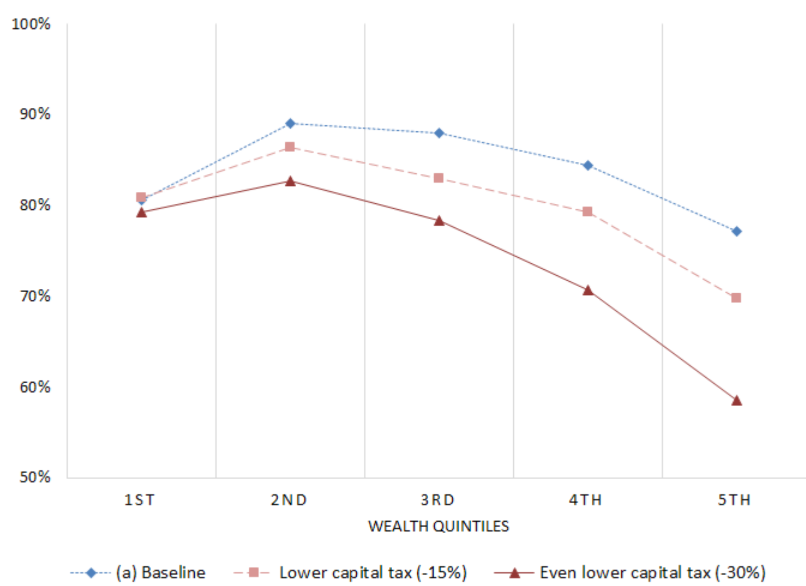
From the top panel of Figure 3, it is clear that smaller transfers have negative income effects,

Figure 3: Effects of transfers and capital taxation on participation rates by wealth quintiles

(i) The role of transfers



(ii) The role of capital income taxation



Note: In the top panel, the size of transfers is reduced while holding equilibrium prices constant at the baseline level (partial equilibrium). In the bottom panel, the capital tax rate is reduced while holding equilibrium prices constant at the baseline level. Model (a) is used for both figures.

thereby increasing the participation rates across the whole distribution. More importantly, note that this effect is particularly stronger for the wealth poor households. This substantial change in the labor supply behavior of the wealth poor is largely driven by the lack of insurance means in the presence of smaller 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 when the size of transfers becomes lower. This significantly worsens their value of not working, leading to a stronger incentive to work despite the fact that their productivity is very low. This is why the figure shows that the lower transfers induce more of the wealth poor households to participate in the labor force, thereby making the relationship between participation rates and wealth more negative.

I now move on to the role of capital income taxation. The bottom panel of Figure 3 shows that a lower capital tax rate tends to reduce participation rates across the whole distribution. Intuitively, a lower capital tax encourages capital accumulation, which in turn discourages labor supply due to income effects. More importantly, note that the participation rates by wealth becomes less flatter when the capital tax rate declines. This is because the decline in the labor force participation rate is more prominent for the richer households. The key is to note that capital taxation disproportionately affects the savings decision of the wealth rich. Since the distribution of wealth is highly concentrated (in both the model and the data), capital income is also highly concentrated. When the capital income tax rate declines, the wealth rich, who have a sizeable amount of capital income, benefits more in terms of capital gains. This means that wealth effects on labor supply should be stronger 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 richer households.

Effects of alternative preference specifications:

This paper highlights the role of institutional features such as government transfers and capital income taxation while taking a standard utility function consistent with the balanced growth path (King, Plosser and Rebelo, 1988). Since one could conjecture that labor supply differences across the distribution of wealth would naturally be altered by changing the utility functional form, I briefly explore a possibility of accounting for the near-zero cross-sectional correlations using alternative

Table 6: Effects of alternative preference specifications

Participation rate	by wealth quintile				
	1st	2nd	3rd	4th	5th
U.S. Data SCF (1992-2007)	77.7	86.8	85.9	85.4	83.1
Model (b) with $T = 0$ and $\tau_k = 0$					
Benchmark	100.0	99.7	88.4	73.6	57.5
(i) CRRA $\sigma = 0.5$	86.9	84.4	85.2	85.9	76.7
(ii) log GHH	53.7	81.1	90.2	95.1	94.9

utility functions.

The first alternative utility function I consider is the constant relative risk aversion utility (CRRA) in which σ is not necessarily equal to 1:

$$U(c, n) = \frac{c^{1-\sigma}}{1-\sigma} - Bn. \tag{13}$$

The second alternative utility function is according to the GHH preference (Greenwood et al., 1988), which shuts down income effects at the individual level:

$$U(c, n) = \frac{(c - Bn)^{1-\sigma}}{1-\sigma}. \tag{14}$$

For the GHH utility function, I set $\sigma = 1$ as in the benchmark case of this paper.[16] The model with alternative utility functions is re-calibrated to match the same target statistics according to the calibration strategy in Section 4.[17]

Table 6 reports the participation rates by wealth quintiles for the two alternative cases. The third row of Table 6 shows the case with the CRRA utility function with $\sigma = 0.5$. It is interesting to note that the model is able to generate a much flatter participation rates by wealth even without transfers and capital taxation. The key feature of this specification is that the intertemporal elasticity of substitution ($1/\sigma$) is higher than the log-utility case, which makes the observed cross-sectional income effects on labor supply appear much weaker. However, it should be noted that

[16] In case of the GHH preference, I set $\underline{a} = 0$ and provides a very small transfers ($0.001\tau_l wL$). This does not affect the key message and should be imposed because of the non-negativity restriction: $c - Bn \geq 0$.

[17] The calibration results are available upon request. Although it is not reported, the model with alternative utility functions also does a good job of matching the marginal distribution of earnings and wealth.

the values of σ smaller than one do not lie within the range of its empirical estimates (see e.g., Browning, Hansen, and Heckman, 1999; and Guvenen, 2006). In the case of the GHH preference, the labor force participation rate tends to strongly increase with wealth. Since the work decision is solely determined by productivity under the GHH preference, the wealth-poor households, most of which have low productivity, feature a very low labor force participation rate. Note that this is also counterfactual since the participation rate is nearly flat in U.S. data. Based on the above exercise, the following section proceeds with the benchmark utility specification (4).

6 Aggregate implications of matching the distribution of wealth and labor force participation

The previous section has 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 incomplete markets models with endogenous labor supply, this paper further asks the relevance of matching the observed labor force participation rates by wealth, especially from macroeconomic perspectives.

6.1 Implications for the aggregate labor supply elasticity

This subsection begins by exploring its implications for the aggregate labor supply elasticity. To this end, Table 7 compares the effects of labor income tax changes for the aggregate hours worked across different specifications considered in the previous section. 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 control the transfer-to-output ratio at the benchmark level with the tax rate of 30% for each specification. This is because the size of transfers would endogenously change when the labor income 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 hold constant the size of transfers relative to output when the labor income tax changes, and assume that the additional tax revenue, if any, is spent as G.

Table 7: Aggregate hours change with respect to labor income tax changes in general equilibrium

	Aggregate participation rate relative to $\tau = 0.3$					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	97.3	93.9	89.8	85.8	0.46	0.45
(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	97.4	94.1	89.7	85.5	0.47	0.46
(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 transfers-to-output ratio is controlled at the benchmark level for each specification.

An interesting result emerges in Table 7. Comparing the first two rows, the same labor income tax changes lead to strikingly different aggregate labor supply responses.[18] 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 14.2%. This drop is substantially larger than a 6.7% fall, implied by Model (b).

To facilitate the comparison of responsiveness to tax changes, the last two columns report two extensive margin elasticities. One is obtained as a slope coefficient α_1 from the following regression equation (e.g., Chetty, Guren, Manoli and Weber, 2012)

$$\ln LFP = \alpha_0 + \alpha_1 \ln(1 - \tau_l) + \varepsilon \tag{15}$$

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 a one percentage change in the net-of-tax rate. The other extensive margin elasticity is obtained as a slope coefficient β_1 from the equation augmented with the equilibrium wage in the regressor,

$$\ln LFP = \beta_0 + \beta_1 \ln(1 - \tau_l)w + \varepsilon, \tag{16}$$

since the aggregate component of wages w is an endogenous object in the model economy. The

[18] Recall that Model (a) and Model (b) have been calibrated to generate the same (unconditional) labor force participation rate, the same equilibrium interest rate, and the same degree of cross-sectional dispersion of earnings and wealth.

differences in the estimates of extensive margin elasticities between Model (a) and Model (b) are substantial. The elasticity implied by the baseline specification is around 0.45, which is more than twice as large as 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 8 summarizes percentage point changes in participation rates by wealth quintiles as well as by wage quintiles following an increase in τ_l 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 a substantially higher 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 7. In particular, Table 8 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 8 also reports changes in labor force participation rates by productivity (or wage) quintiles.[19] Across all specifications, there is a common qualitative pattern that labor supply becomes less elastic for households with higher productivity.[20] This implies that the aggregate labor supply elasticity is largely shaped by the responsiveness of low wage households in all specifications. Given

[19] 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.

[20] This is consistent the empirical evidence (Juhn, Murphy, and Topel, 1991) that the extensive margin partial elasticity increases with wage.

Table 8: 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 productivity quintiles				
(Unit: % point)	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
(a) Baseline	-21.7	-11.7	-7.5	-9.5	-9.2	-28.4	-15.7	-6.4	-1.9	-0.2
(b) $T = \tau_k = 0$	0.0	-3.8	-7.4	-6.9	-9.8	-8.4	-6.4	-5.3	-4.4	-1.9
(c) $\tau_k = 0$	-27.7	-4.3	-7.9	-10.6	-10.2	-28.2	-14.6	-7.2	-3.1	-0.5
(d) $T = 0$	0.0	-4.2	-6.5	-5.5	-8.0	-8.0	-5.5	-4.5	-3.2	-1.4

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

this, it is important to note that there is a large difference in the degree of this pattern. Specifically, in the presence of transfers as in Model (a) and Model (c), households with low productivity are substantially more responsive to tax changes than in the models that abstracts from transfers. Recall that when the model does not incorporate transfers as in Model (b) and Model (d), the labor force participation rate of the wealth-poor households is extremely high. Since a majority of the wealth poor have low productivity, this implies that in the absence of transfers, many unproductive households choose to work despite their low market wage. 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 exercise highlights that matching the cross-sectional distribution of wealth and participation matters for shaping not only distributional features in stationary equilibrium, but also the comparative static behavior of the model economy.

6.2 Welfare costs of distortionary 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 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 compensating variation premium in consumption under the utilitarian social welfare function. (e.g., Alonso-Ortiz and Rogerson, 2010). Specifically, the aggregate welfare loss associated with a higher tax τ_l' is defined as the proportional increase ω in consumption for all households in an alternative economy with τ_l' that is required to equalize the welfare measure:

$$\int E_t \sum_{s=t}^{\infty} \beta^{s-t} U(c_{s,\tau_l=0.3}, n_{s,\tau_l=0.3}) d\mu_{\tau_l=0.3} = \int E_t \sum_{s=t}^{\infty} \beta^{s-t} U((1+\omega)c_{s,\tau_l'}, n_{s,\tau_l'}) d\mu_{\tau_l'}. \tag{17}$$

Note that in the presence of transfers, the assumption of balanced government budgets implies that higher labor taxes lead to larger transfers, which in turn tend to increase aggregate welfare measures through the redistribution channel. To focus on the welfare loss that is caused by the distortionary nature of higher taxes, I control the size of transfers relative to output at the level with the labor tax rate of 30% for each specification.[21]

Table 9 summarizes the welfare cost results for each specification of the model. 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 30.8% lower aggregate welfare in terms of consumption. This indicates that distortionary labor taxes involve substantial efficiency losses. Second, 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 21.2% in Model (a), which is significantly smaller in magnitude than 30.8% in Model (b). This result may appear to be

[21] By controlling for the endogenous response of transfers, the comparison of the effects of labor tax changes becomes fair across all of the specifications including those that abstract from transfers. This assumption is also consistent with the previous subsection on the aggregate labor supply elasticity.

Table 9: Welfare costs of higher labor income taxes, by different specifications

	Aggregate welfare relative to $\tau = 0.3$ (unit: %)				
$\tau_l =$	0.30	0.35	0.40	0.45	0.50
(a) Baseline	0.0	-4.5	-9.4	-15.0	-21.2
(b) $T = \tau_k = 0$	0.0	-6.3	-13.4	-21.5	-30.8
(c) $\tau_k = 0$	0.0	-4.2	-8.8	-14.0	-19.8
(d) $T = 0$	0.0	-6.8	-14.6	-23.6	-34.0

Note: Aggregate welfare costs are computed as the percentage increase in consumption that is required for all households in an alternative economy (with a higher tax rate) to be indifferent to being in the benchmark economy (with the labor tax rate of 0.3) . To focus on the implications of distortionary taxes, the transfer-to-output ratio is controlled at the benchmark level for each specification.

Table 10: Changes in aggregate welfare and some macroeconomic variables

(unit: % change)	Aggregate welfare	C	Y	H	Y/H	Gini wealth
(a) Baseline	-21.2	-22.8	-6.2	-14.2	+9.3	-3.7
(b) $T = \tau_k = 0$	-30.8	-26.6	-5.9	-6.7	+0.8	-4.0

Note: 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 ratio of transfers to output is controlled at the benchmark level for each specification.

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 from Model (c) and Model (d), suggest 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 underlying mechanism behind the above result, it is useful to look at the implications of labor tax changes for macroeconomic aggregates across different specifications. Table 10 reports changes in aggregate consumption C, aggregate output Y, aggregate hours worked H and output per hours worked (Y/H or average labor productivity) when the labor tax τ_l increases from 0.3 to 0.5. First, note that the aggregate consumption fall is larger in Model (b) consistent with the aggregate welfare result. On the other hand, output declines more in Model (a) than in Model (b) (-6.2% versus -5.9%), which is in line with the larger size of the aggregate labor supply elasticity. Nevertheless, note that the output effects of labor tax changes in Model (a) and Model (b) are quantitatively quite close to each other, relative to the large gap in the employment effects of labor tax changes (-14.2% versus -6.7%). As a result, the next column shows that output per

Table 11: Disentangling the welfare losses of labor taxation

(unit: % change)	Aggregate welfare	
Restrictions	(a) Baseline	(b) $T = \tau_k = 0$
- None	-21.2	-30.8
- Control for drop in C (-22.8%)	-21.2	-21.1
- Control for drop in C & ignore LS changes	-27.6	-26.5
Aggregate labor supply elasticity	0.45	0.20

Note: The first row reports the welfare losses from the equilibrium outcomes, also reported in Table 9. The second row controls for the percentage drop in aggregate consumption by providing transfers ex-post. In addition to this adjustment, the third row ignores utility changes due to labor supply decisions in computing welfare losses.

hours worked (Y/H) increases considerably by 9.3% in Model (a) whereas it changes little (0.8%) in Model (b).[22] Finally, the last column shows that both model specifications predict that the Gini coefficient of wealth would decline marginally (around 4%).[23]

Based on Table 10, the large difference in the welfare costs of distortionary labor taxes between the two model specifications appears to be not directly due to differences in the efficiency loss in terms of output or the distributional factor. The remaining section investigates the role of the presence of transfers in understanding the difference in welfare losses.

The presence of transfers affects the above welfare results via two channels. The first is its effect on the average level of consumption (the *consumption level effect*). In the presence of transfers, households consume more, which leads to a higher consumption-output ratio in Model (a) compared to Model (b). This leads to a larger *percentage* drop in aggregate consumption in Model (a) despite the fact that the decline of C/Y in level is very similar (12 percentage point) in both models. The second effect, the *selection effect*, is about the heterogeneous effects of transfers on labor supply, which have been investigated in this paper. That is, the presence of transfers alters the joint distribution of wealth and labor force participation, which in turn makes the labor supply behavior of households with low productivity substantially more elastic. This selection effect therefore increases the output per worker with respect to higher taxes, implying that the same output can be produced by fewer workers. Since the households dislike working, if a similar output can be produced by a substantially fewer households, this serves as a channel which mitigates

[22] Note that this result is closely related to the finding in the previous subsection that a higher aggregate labor supply elasticity in Model (a) is largely driven by the poor households whose low productivity weakens the transmission of a fall in employment to a fall in aggregate labor input (L) (and output).

[23] This should not be surprising given that I shut down the redistribution channel by holding the transfer-output ratio constant when τ_l increases.

the welfare losses of higher taxes.

I close the section by illustrating the above roles of transfers in affecting welfare results using a simple exercise. The first row of Table 11 replicates the welfare results presented in Table 9. The second row presents the welfare losses when I control for the percentage drop in consumption to eliminate the consumption level effect. This is achieved by computing a welfare cost according to (17) after providing lump-sum transfers (ex-post) of which the size is determined to match the 22.8% drop in aggregate consumption as in Model (a). Then, the welfare loss (21.1%) predicted by Model (b) actually becomes very close to 21.2% obtained in Model (a). Note that the consumption level effect has little to do with the model being able to match the joint distribution of wealth and labor force participation while the selection effect does. To quantify this effect, I further ignore work decisions (n and n') in computing a welfare loss according to (17). Then, because fewer people work with respect to a higher τ_l, the welfare losses in both models become larger. In particular, the fall is more significant in Model (a), which generates substantially larger employment effects of the labor tax. This implies that the welfare losses originally obtained in the first row are being mitigated by the fact that similar output is produced by substantially fewer workers (i.e., higher average labor productivity). And this result crucially depends on the property of the model regarding the joint distribution of wealth and labor force participation.

7 Conclusion

In this paper, I have documented that labor force participation rates are relatively flat across wealth quintiles, and wealth and labor force participation are nearly uncorrelated, 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 between wealth and labor force participation are considerably negative in standard incomplete markets models. To explore the role of transfers and capital income taxation in resolving this discrepancy, I have constructed a relatively standard incomplete markets models with different institutional features, all of which are calibrated to match the cross-sectional dispersion of earnings and wealth. I have found that the presence of 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 have shown that when the fit of the model with the distribution of wealth and participation improves, the aggregate labor supply elasticity implied by the model more than doubles mainly driven by the highly elastic labor supply behavior of the poor households. Finally, I have found that heterogeneity in labor supply responsiveness weakens the association between the aggregate labor supply elasticity and the welfare costs of distortionary 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). 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 intensive and extensive margins can introduce a non-trivial interaction between the two margins of labor supply.[24] These potentially interesting extensions are left for future work.

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

[24] 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.

dollars. For all statistics reported, I use weights provided by 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 a household. 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.

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