2020

Essays on savings, housing, and taxation

BOSTON UNIVERSITY

GRADUATE SCHOOL OF ARTS AND SCIENCES

Dissertation

ESSAYS ON SAVINGS, HOUSING, AND TAXATION

by

MANNI YU

B.A., Central University of Finance and Economics, 2014

Submitted in partial fulfillment of the

requirements for the degree of

Doctor of Philosophy

2020

Approved by

First Reader

Laurence J. Kotlikoff, Ph.D.
Professor of Economics

Second Reader

Adam Guren, Ph.D.
Assistant Professor of Economics

Third Reader

Pascual Restrepo, Ph.D.
Assistant Professor of Economics

Fourth Reader

Stefania Garetto, Ph.D.
Associate Professor of Economics

For my mother Kaiqin, father Shunjie, fiancé Nan, and thousands of mountains in Dazhou, Sichuan, China.

Acknowledgements

I can still remember clearly the scenes of my first day in Boston. I came with the enormous ambition to do research at Boston University. From that day on, I have been continuously receiving help and goodwill from my advisors, colleagues, coauthors, and friends.

I owe the most gratitude to my main advisor Prof. Larry Kotlikoff. We met in his public finance course in the first semester of my second year. It turns out that we had a lot of flexible time to discuss the classical papers in the field. I love to ask questions and Larry is really good at answering them. We became very good friends and Larry would share great news of his family. He also trusted me to take care of his cute cat Riley. Larry always gives me very detailed guidance when I do research. He would walk me through my projects step by step and help me think whether the conclusions and assumptions are correct or reasonable. He helped me a lot in finding the right direction and providing a concrete plan at the same time. Larry is super responsible, easy to connect with, and rigorous when discussing academic questions. I worked as a research assistant for one of Larry's project. To help me be familiar with the project, Larry invited Darryl Koehler, an engineer and software programmer who had been working on the project, to teach me FORTRAN and explain the code part. Darryl flew all the way from Wisconsin and we spent three days together with Larry for the very first days of the year 2016. Larry taught me how to write by writing together with me on the same project in his office. I learned some techniques in academic writing. But most importantly, Larry always stresses the importance of writing, which was neglected by me before I work with him. Before I go on the market, I was so stressed and once cannot stop crying in his office. Larry comforted me with soothing words and I still remember that. What impressed me more is that Larry then did his best as an advisor to help me with my research. There are still a lot of things flashing in my head. Without Larry, I am not able to finish this dissertation.

I would also like to thank the rest of my dissertation committee members: Prof.

Adam Guren, Prof. Pascual Restrepo, and Prof. Stefania Garetto. I am extremely thankful to Pascual for meeting frequently with me and helping me make progress on my job market paper when he was super busy. I am so inspired when I talk with him and see his insight into economics. I am also grateful to Adam, who always gives me honest and pragmatic advice. He knows the most important thing that I should do next. I also learned a lot of empirical skills, terminology, and literature from him. I want to thank Stefania for helping me successfully organize the defense.

I would like to thank Prof. Stephen Terry and Prof. Jianjun Miao, who are not my dissertation committee members but spent time talking about my research and gave me useful suggestions.

I am glad that I have very good coauthors: Prof. Larry Kotlikoff, Prof. Alan Auerbach, Darryl Koehler, Elias Ilin, and Victor Ye. I want to thank them for supporting me in my research projects. They are all curious and knowledgeable people. I learned a lot from them and am impressed by their enthusiasm for research.

I would like to thank Prof. Christophe Chamley, who is a friend of mine. Without him, I may not have been in Boston.

Finally, I want to thank my fiancé Nan Zhao, who is a Ph.D. candidate in the same program. We met in Boston and fell in love. Without him, I cannot imagine what my life would be like today. He was always there for me no matter what mistakes I made or obstacles I met. Nan is brilliant and hard-working and I learned a lot from his quality and knowledge in economics.

ESSAYS ON SAVINGS, HOUSING, AND TAXATION

MANNI YU

Boston University, Graduate School of Arts and Sciences, 2020

Major Professor: Laurence J. Kotlikoff, Professor of Economics

ABSTRACT

This dissertation consists of three essays on topics in macroeconomics.

Chapter One studies whether the rich save a larger fraction than other economic groups. We use The Fiscal Analyzer, a detailed life-cycle consumption-smoothing program, to calculate lifetime net resources, including private wealth, human wealth, and net taxes. We identify a strong negative relationship between the average propensity to consume and lifetime net resources. The average propensity to consume decreases on each component of lifetime net resources except for liquid assets. The results do not change if we consider heterogeneous borrowing constraints among households. Results of models indicate that bequest motives could explain why the rich save more.

Chapter Two measures the work disincentives, including explicit taxes and implicit loss of benefits, of the elderly. We use The Fiscal Analyzer to calculate remaining lifetime marginal net tax rates. We find that Uncle Sam is inducing the elderly to retire. The marginal net taxation of labor earnings is extremely high. A significant increase in earnings leads to a higher marginal net tax rate than earning a small extra amount of money. There is enormous dispersion in effective marginal remaining lifetime net tax rates facing households with the same age and resource level. Current-year marginal net tax rates can dramatically understate the work disincentives facing the elderly.

Chapter Three explores the different implications of housing price and labor pro-

ductivity on the skill ratio. I construct a spatial equilibrium model with two skill types of households. When the housing supply increases in the more developed region, the skill ratio in both regions decreases and both types of labor get higher utility. When the labor productivity of high-skilled labor in the more developed region increases, the skill ratio increases in the more developed region and decreases in the less developed region and only the high-skilled labor get higher utility.

Contents

List of Tables

List of Figures

List of Abbreviations

ACA	....	The affordable Care Act
AIME	....	Average Indexed Monthly Earnings
APC	....	Average Propensity to Consume
ARF	....	Adjustment of the Reduction Factor
CAMS	....	Consumption and Activities Mail Survey
CPS	....	Current Population Survey
CRRA	....	Constant Relative Risk Aversion
DYNASIM	....	Dynamic Simulation of Income Model
ERA	....	Early Retirement Age, 62 years old
FICA	....	Federal Insurance Contributions Act
GPO	....	Government Pension Offset
HRS	....	Health and Retirement Study
IV	....	Instrumental Variable
NIPA	....	National Income and Product Accounts
NRA	....	Normal Retirement Age, then 65 years old
OLG	....	Overlapping Generations
OLS	....	Ordinary Least Square
PIA	....	Primary Insurance Amount
PIH	....	Permanent Income Hypothesis
SCF	....	Survey of Consumer Finances
SNAP	....	Supplemental Nutrition Assistance Program
SPM	....	Supplemental Poverty Measure
SS	....	Social Security
SSI	....	Supplemental Security Income
TANF	....	Temporary Assistance for Needy Families
TIPS	....	Treasury Inflation Protected Securities
TFA	....	The Fiscal Analyzer
WEP	....	Windfall Elimination Provision

Chapter 1

The Rich Save More: Evidence from the Health and Retirement Study

1.1 Introduction

In this paper, we ask the question of whether the rich save more than other economic groups out of their *remaining lifetime net resources*. We define remaining lifetime net resources (also referred to as net resources or resources) as the sum of private and human wealth, deducting lifetime net taxes. The answer to this question is crucial to important issues in economics and sociology. First, it has important implications for intergenerational mobility because, if the rich do save more and leave a bequest to their children, the next generation of the rich will have access to more resources, making them more likely to maintain their social status and making intergenerational mobility low. This may lead to such negative consequences as human wealth misallocation and macroeconomic inefficiency. Second, since the distribution of wealth is serially correlated, it becomes harder to reduce inequality. Third, the distribution of wealth can affect aggregate consumption and savings through heterogeneous household behavior, influencing the growth of the economy.

Another motivation for our paper is that a number of popular and influential models only generate constant consumption and saving rates. In these models, wealth inequality is exclusively generated by wage inequality. However, empirical evidence in the U.S. (see Straub (2018)) shows that wage inequality is not enough to generate wealth inequality. Straub (2018) showed that, in an Aiyagari (1994) model, the consumption and saving rates are independent of changes in labor income shares.

Thus, any redistribution of permanent incomes cannot affect consumption and saving rates, indicating constant consumption and saving rates. Models with precautionary-savings motives, in general, induced by different types of frictions, such as idiosyncratic risk (see Aiyagari (1994)), liquidity constraints (see Carroll (1998)), and labor income uncertainty (see Gourinchas and Parker (2002)), all generate a constant saving rate. Although precautionary-savings models produce decreasing consumption rates in current income, they generate constant consumption rates in permanent income. Firm-side assumptions could also be flexible. Models with monopolistic competition also have the constant saving rate feature, just as the perfect competition models do.

We start by checking the consumption rate generated by a standard macroeconomic model. In the standard model, a representative agent works to earn a constant stream of nontaxable wage incomes each period and saves in one asset, paying a constant interest rate with no tax. We assume a CRRA utility function without uncertainty or idiosyncratic shocks. Also, there is no heterogeneity in interest rate, impatience factor, and risk tolerance. We define remaining lifetime resources to be the sum of asset value and the present value of future earnings in the model. Then, the consumption rate out of remaining lifetime resources is constant and the same across all households. It is determined only by interest rate, impatience factor, and risk tolerance and, not influenced by household remaining lifetime resources. So the standard model could not generate a decreasing consumption rate. As we mentioned before, even a wider range of models have constant consumption and saving rates results.

Instead, we propose two models that could generate heterogeneous consumption rates. One is a model with heterogeneous interest rates, impatience factors, and risk tolerances. The other is a model with bequest motives where the bequest utility function has a smaller coefficient of relative risk aversion than the utility function. Other assumptions in the two models are the same as in the standard model. The different implications of the two models are that, when there is an unexpected small exogenous shock to resources, the consumption rate in the model with heterogeneity would not change but would change in the model with bequest motives.

Next, we use the 2014 wave of Health and Retirement Study (HRS) and the 2015 wave of Consumption and Activities Mail Survey (CAMS) for regression analysis. The first step is to measure remaining lifetime net resources or household resources over the life cycle, including all relevant items. The credibility of our study relies on such precise measurement. Using HRS data and *The Fiscal Analyzer* (TFA), a detailed life-cycle consumption-smoothing program that incorporates borrowing constraints, we estimate each part of the remaining lifetime net resources.

The present value of private wealth is the sum of the market value of assets. To measure human wealth, we use the earnings history of households, included in the restricted HRS data, to forecast future earnings. We group households into different cells in each wave by age, sex, and education, and use successive waves to estimate annual earnings growth rates by age and year for individuals in each sex and education cell. We project future earnings for each particular cell until age sixty-seven (when we assume individuals claim retirement benefits) by using average historical growth rates by age, net of average overall earnings growth plus an assumed future annual real growth rate of one percent. Heterogeneity within cells is generated by a random walk process of permanent component and a serially uncorrelated transitory component. We calculate the present value of future earnings as human wealth. The discount factors we use are capital returns, calculated cell by cell using a similar procedure. The finely calculated future earnings and discount factors, based on earnings history and referring to comparable peers, lead to more reliable results.

We calculate net taxes as taxes deducting transfers to household resources. It is a big challenge to include all major federal and state tax and transfer programs and most previous studies failed to do this. However, TFA includes information about thirty tax and welfare programs, each containing the tax rate for every bracket at state and federal level and specific eligibility and benefits for welfare programs, depending on the economic situation and demographics of individual households. We have access to the restricted data of HRS that enables us to know the geographical location of households, which is also crucial to calculating their exact net taxes.

Once we have the measure of resources, we can check the relationship between consumption rates and resources. OLS regression suffers from the endogeneity issue that consumption behavioral factors may be connected with the ability to accumulate wealth. We calculate large return rates by changes in values of total assets as the wealth luck instrument. Then, we use eight waves of the HRS and the CAMS data from the year 2000 to 2014 to construct a panel data of household total private assets. Abnormally large return rates causally increase resources and we assume households receive large return rates because of pure luck. Our key result is that consumption rates decrease in resources in the IV regression. The average propensity to consume (APC) decreases significantly and economically from 0.09 for the bottom 20% resources quintile to about 0.01 for the top 20% resources quintile. The difference is about 3 standard deviations. By testable implications in the model part, we conclude that bequest motives can explain why the rich save more. The Durbin-Wu-Hausman test shows that there is a systematic difference in IV and OLS estimators. This is not necessarily caused by heterogeneity. First, there may be measurement errors in resources. Second, most reasonable cases of heterogeneity would predict a downward OLS bias. Thus, heterogeneity plays little role in explaining why the rich save more. Our conclusion is that, the rich save more and bequest motives can explain why.

Then we run some robustness checks. First, we constructed borrowing constraint indicator by taking the inverse of the number of years before the first jump in consumption. Our main results remain the same. We also break net resources into its three main components: private wealth, human wealth, and net taxes, or further breaking private wealth into liquid assets and illiquid assets. The consumption rate is irresponsive to liquid assets and decreasing in all others.

The rest of the paper is organized as follows. Section 1.2 reviews the related literature. Section 1.3 describes three models and checks the model-generated consumption rate. Section 1.4 introduces key definitions and the software TFA, sets up the reduced form, and introduces the regression strategy. Section 1.5 summarizes the data we use. Section 1.6 shows the OLS and IV regression results and some robustness checks. Section 1.7 concludes with results and future plans.

1.2 Literature Review

Our paper relies on the theory of the saving rate and consumption function, and, more specifically, on consumption as a function of lifetime resources. The pioneering work of Friedman (1957) empirically tested the permanent income hypothesis (PIH), showing that consumption is a linear function of permanent income. But there is no consensus on the relationship between consumption and permanent income. Mayer (1966) and Mayer (1972) showed that the marginal propensity to consume is not equal to average propensity, thus requiring special hypotheses to reconcile with the permanent income hypothesis (PIH) and leading the PIH to be invalid. The disagreement partly results from measurement errors and data quality issues. Little research on these issues has appeared after the upsurge in the 1950s and 1960s.

The relatively new work of Dynan et al. (2004) addressed the question do the rich save more and showed a strong positive relationship between saving rates and current income. The relationship still holds when income is instrumented by lagged or future income or education. The biggest problem of their work is, although they have proxies for permanent income (lifetime net resources in our paper), they did not measure it directly. We seriously doubt the credibility of their results because of the measurement errors and this is one of the reasons why the question is still debated. High current income does not necessarily indicate high lifetime net resources. The four proxies that Dynan et al. (2004) use can only partially resolve the issue because they are all instruments on earnings and not on private wealth or net taxes, the measurement of which are complicated and crucial. Therefore, their proxies for human wealth cannot explain earnings completely. In addition to education, ability is another important determinant of labor earnings. Our methodology, comparatively, is much stronger because it directly and accurately measures every component of lifetime net resources.

Straub (2018) estimated the elasticity of consumption to permanent income from a simultaneous equations model, inspired by results from an overlapping generations (OLG) model with endogenous bequest distribution. The estimated elasticity is about 0.7, so consumption is concave in permanent income. Straub (2018) successfully reduced measurement errors by computing permanent income as the symmetric average over log residualized incomes from one of the simultaneous equations and proposing two instrumental variables. But we think our paper pioneers the direct measurement of lifetime net resource, a major contribution to this literature.

Kaplan and Violante (2014) showed large liquid assets holders have small propensities to consume out of additional transitory income, and large illiquid assets holders have small propensities to consume out of news about future income. The different roles of liquid and illiquid assets intrigue us and, in order to study them separately, we break private wealth in lifetime net resources into two components and check their relationship with consumption separately.

Although the answer to the question of whether the rich save more is still debated, some research has assumed yes is the answer and asked why. Carroll (1998) argued that the rich save more because wealth is luxury goods or could generate a flow of services such as power. Dynan et al. (2004) tested different models and found that hyperbolic preferences and bequest motives could explain why the rich save more but uncertainty could not.

Our paper is also broadly linked to consumption and saving studies of the elderly. Hurd and Rohwedder (2003), Hurd and Rohwedder (2006) and Hurd and Rohwedder (2008) resolved the retirement consumption puzzle using the Health and Retirement Study (HRS) and the Consumption and Activities Mail Survey (CAMS), the same data sets we use. They found low-wealth households with poor health conditions are forced to retire early. The decline rate of consumption for this small group of people is high, but the decline rate is small at the population level. Hurd and Rohwedder (2013) investigated the age pattern of saving, also using the HRS and the CAMS. They showed that singles dissave after age 65, and couples actively save to keep wealth unchanged. Resolving the puzzle and investigating the pattern rely on their knowledge of the data and we make use of it from their work.

1.3 Model Explanations

In this section, we build a canonical model in which we incorporate bequest motives and heterogeneous parameters, such as impatience factor, risk tolerance, and assets return. The model collapses into the following three types of models under certain restrictions: a standard model, a model with bequest motives, and a model with heterogeneous parameters. We explore the relationship between consumption rate and lifetime resources in the models and compare them with the data.

Time is continuous, and there is no uncertainty or aggregate risk. Households earn wage income w and save through one asset a. We assume a CRRA utility function with coefficient of relative risk aversion σ_i. Households die with probability p at each age for simplicity. The utility from bequeathing $V^B(a)$ is CRRA with a smaller coefficient of relative risk aversion $\sigma_i^B < \sigma_i$, i.e. $V^B(a) = \dfrac{a^{1-\sigma_i^B} - 1}{1 - \sigma_i^B}$. Impatience factor ρ_i and assets return r_i are heterogeneous. Households Hamilton-Jacobi-Bellman equation is presented as follows:

$$\rho_i V(a) = \max_{a,c} \frac{c^{1-\sigma_i} - 1}{1 - \sigma_i} + V'(a)(r_i a + w - c) + p(V^B(a') - V(a')) \tag{1.1}$$

We define the lifetime resources x in this model as the sum of physical wealth and present value of wage earnings.

$$x = a + w/r_i \tag{1.2}$$

1.3.1 Standard Model

In the standard model without bequest motives and heterogeneity, where $\sigma_i^B = \sigma_i = \sigma$, $\rho_i = \rho$, and $r_i = r$, the Euler equation is given by

$$\frac{\dot{c}}{c} = \frac{r - \rho}{\sigma} \tag{1.3}$$

Combining the Euler equation and the dynamics of physical wealth, we can show that consumption rate c/x is the same for each household, not depending on resources.

$$\frac{c}{x} = r + \frac{\rho - r}{\sigma} \tag{1.4}$$

One thing to notice is that the constant consumption and saving rate result in the standard model above could be applied to wider contexts with discrete time, finite horizon, other utility forms, uncertainty, or borrowing constraint.

1.3.2 Explanation One: A Model with Heterogeneous Parameters

With heterogeneous parameters and without bequest motives, i.e., $\sigma_i^B = \sigma_i$, the model could generate heterogeneous consumption rate.

$$\frac{c}{x} = r_i + \frac{\rho_i - r_i}{\sigma_i} \tag{1.5}$$

The model with heterogeneous parameters provides an ex-ante explanation of why the rich save more. For example, if the agent with large lifetime resources is born to be more patient with a smaller ρ_i, the consumption rate would be smaller for this agent. When there is unanticipated exogenous small shock to resources, households consumption rates would not change in this economy.

1.3.3 Explanation Two: A Model with Bequest Motives

With bequest motives and without heterogeneous parameters, i.e., $\rho_i = \rho$, $r_i = r$, and $\sigma^B < \sigma_i = \sigma$, the model could generate consumption rates that change with lifetime resources.

$$\frac{c}{x} = r - \frac{\dot{a}}{x} \tag{1.6}$$

where a is one solution of the differential equation,

$$\begin{aligned}\rho V(a) = \frac{[(1-p)V'(a) + pa^{-\sigma^B}]^{\frac{\sigma-1}{\sigma}-1}}{1-\sigma} + [(1-p)V'(a) \\ + pa^{-\sigma^B}]\{ra + w - [(1-p)V'(a) + pa^{-\sigma^B}]^{-\frac{1}{\sigma}}\}\end{aligned} \tag{1.7}$$

This model provides an ex-post explanation of why the rich save more. When there is an unanticipated small exogenous positive shock to resources, consumption rates would decrease for each household in this economy.

We notice that the testable implications of the above two models are different. Suppose the null hypothesis is that there is no heterogeneity. We construct the wealth luck instrumental variable as a proxy of resources shock to check which model is true, implicated by data. We will discuss how to make use of the implications and interpretations in the IV methodology section 1.4.5.

1.4 Methodology

In this section, we talk about our methodology in the empirical analysis, introducing some key concepts and definitions and the software program we use to compute some of the variables. Then, we formulate baseline regressions based on the reduced forms. Finally, we discuss the need for instrument variables and the strategy.

1.4.1 Concepts and Definitions

We define the average propensity to consume (APC) out of remaining lifetime net resources, in contrast to other studies that define the propensity to consume out of current disposable income or wealth. We define remaining lifetime net resources through two equations: (1) remaining lifetime net resources, R, is defined to be remaining lifetime gross resources, R^G, minus the present value of remaining lifetime net taxes (taxes paid less transfer payments received), T, as

$$R = R^G - T \tag{1.8}$$

and (2) remaining lifetime gross resources is composed of human wealth, H, and private net wealth, W, as

$$R^G = H + W \tag{1.9}$$

where human wealth is the present value of lifetime earnings and private net wealth is the market value of all assets.

1.4.2 The Fiscal Analyzer

We use The Fiscal Analyzer (TFA) to compute the remaining lifetime net resources and all its components for each of the households in the Health and Retirement Study (HRS). As described in Auerbach et al. (2019), TFA is a detailed life-cycle consumption-smoothing program that incorporates borrowing constraints. TFA calculates remaining lifetime net taxes and remaining lifetime spending, along all survival trajectories, and then converts them to present values. TFA includes all federal and state income and sales tax provisions in effect as well as all federal and most state-specific transfer programs.

The specific list of tax and transfer programs included in our calculations are outlined in the Table 1.1.

TFA's Consumption-Smoothing Dynamic Program

TFA's lifetime consumption smoothing procedure begins with the reading of household demographic and economic data. The demographic data includes marital status, birth dates of each spouse/partner, maximum ages of life of spouse/partners, birth dates of children, and ages at which children will leave the household. The economic data includes detailed measures of earnings and assets (for both the past and the future).[1] TFA assumes inflation and rates of return on regular and retirement account assets, household debts, and current primary home data.[2] Preferences about the desired degree of consumption smoothing are also included (i.e., the preferred age-living standard path).[3] The degree and timing of future changes in Social Security benefits, federal taxes, state taxes, and payroll taxes, are also incorporated into the calculations.

TFA's default assumption, which can be changed, is that the household seeks to have the same living standard per household member through time. The program obeys the specified desired standard of living profile to the extent possible without violating the household's borrowing constraint. The program simultaneously calculates not just the household's smoothest living standard path, but also its time-varying demands for life insurance (and, thus, the living insurance premiums it will pay each year) and each of the above-referenced taxes and transfer payments.[4]

Imputing Past and Future Earnings Based on the Health and Retirement Study

The restricted section of the Health and Retirement Study contains data on respondents' past earnings histories. We have access to this data and use it to calculate

[1]These include past Social Security covered labor earnings, current labor earnings and projected future labor earnings, regular (non-retirement account) assets, 401(k) and other deductible retirement account assets, Roth retirement assets, current and projected future contributions to each type of retirement account, retirement-account withdrawal choices (start and end date, annuitization and order of withdraws as between Roth and 401(k)-type accounts), Social Security benefit collection choices, defined benefit pensions, and information on retirement income from non-Social Security-covered employment (this triggers Social Security WEP and GPO provisions).

[2]Rent, mortgage amounts, mortgage lengths, mortgage payments, property taxes, condo fees, homeowners insurance, maintenance, etc. are included, as well as up to two future changes in the primary home, symmetric data on the current vacation home data and up to two changes in the vacation home and other real estate properties.

[3]Other items included are funeral expenses, desired bequests, current life insurance (face and cash values), preferences about maintaining living standards of survivors, contingent plans (e.g., what survivors will earn and how they will change their housing), and the maximum amount the household can borrow.

[4]The precise algorithm is proprietary to Economic Security Planning, Inc., which uses it in its commercial lifetime financial planning tools. But its details are available to academic researchers upon receipt of a request emailed to www.kotilkoff@gmail.com, subject to the signing of a non-disclosure agreement.

Social Security benefits. To forecast future earnings using past waves of the Current Population Survey through 2013, we follow the methodology used in Auerbach et al. (2016) and Auerbach et al. (2018). Future mortality of household members, assumed to begin at age 55 and end with certain death at age 100, is also projected using the method described in Auerbach et al. (2016) and Auerbach et al. (2018). And, as in that study, the present value of human resources, spending, and net taxes are calculated as probability-weighted averages of their outcomes for all possible survivor paths for either a single person or married couple. Auerbach et al. (2019) provides details of updates to TFA subsequent to the Auerbach et al. (2016) and Auerbach et al. (2018) studies.

1.4.3 Reduced Form

We define the average propensity to consume (APC) out of remaining lifetime net resources:

$$a_i = \frac{C_i}{R_i} \tag{1.10}$$

where C_i is consumption of household i at year 2014, R is remaining lifetime net resources of household i, and a_i is the APC of household i. Notice that a_i is not defined when remaining lifetime net resources is zero.

We assume APC to be a function of a vector of variables Z:

$$a = f(Z) \tag{1.11}$$

where Z in standard theory includes interest rate, impatience factor, and utility function parameters. In our analysis, we suggest that Z may also include remaining lifetime net resources R itself. APC may also be affected by other individual characteristics, such as age, health condition, size of the family, etc. To summarize, we propose $Z =$ (interest rate, impatience factor, utility function parameters, R, age, health condition, size of the family,...) .

Suppose the f function has the following linear form:

$$a_i = \beta + \gamma R_i + \Gamma X_i \tag{1.12}$$

where the constant term β includes the impact of interest rate, impatience factor, coefficient of risk aversion, etc. X_i includes all other impact factors except the net resources, including demographic variables.

According to equation 1.10 and 1.12, consumption could be expressed as a function of the net resources and all other variables X_i as follows:

$$C_i = \beta R_i + \gamma R_i^2 + \Gamma R_i X_i \tag{1.13}$$

where consumption C_i is not defined when remaining lifetime net resources is zero.

We formulate our baseline regressions according to equation 1.12 and 1.13.

1.4.4 Baseline Regression

Baseline Regression One

We propose two regression forms in our analysis. Based on the reduced form in equation 1.12, we suggest the baseline regression on APC and show results in both log resources and level of resources:

$$a_i = \beta + \gamma R_i + \Gamma X_i + \mu_i \tag{1.14}$$

The parameter of interest is γ. If γ is negative, consumption rate is decreasing, and the rich save more.

$$\gamma = \frac{\partial a_i}{\partial R_i} < 0 \tag{1.15}$$

Baseline Regression Two

Based on the reduced form in equation 1.13, we suggest the following baseline regression on consumption:

$$C_i = \alpha + \beta R_i + \gamma R_i^2 + \Gamma R_i X_i + \mu_i \tag{1.16}$$

where we include a constant term for flexibility purpose, even it does not show up in the reduced form. Compared with the first baseline regression, we allow the definition of consumption when resources are zero. The average propensity to consume a_i of household i based on the above regression 1.16 is

$$a_i = \alpha/R_i + \beta + \gamma R_i + \Gamma X_i \tag{1.17}$$

If the APC is decreasing, the rich save more and consume less.

$$\frac{\partial a_i}{\partial R_i} = \gamma - \frac{\alpha}{R_i}\frac{1}{R_i} < 0 \tag{1.18}$$

Since α is the consumption when resources are zero, $\frac{\alpha}{R_i} < 1$ for most households. Thus $\frac{\alpha}{R_i}\frac{1}{R_i}$ is small enough and we should expect $\gamma < 0$ in most cases.

1.4.5 IV Regression

Why We Need IV

According to our baseline regressions, we can get an unbiased estimate of γ if we can measure remaining lifetime net resources precisely and choose the right group of control variables such that all independent variables are uncorrelated with the error term.

The exogeneity assumption could be violated easily here. We are concerned that potential behavior factors that could affect resources accumulation may also be linked with preferences towards saving or consumption. For example, a hard worker could also be more patient. Thus, there are the households which gain more human wealth as well as net resources and also save more. We have shown that risk tolerance, impatience factor, and investment ability could affect consumption rate, as shown in the model. If there is no heterogeneity, they are shown in the constant term β in the baseline regression one. If there is heterogeneity, they enter into the error term as omitted variables and correlate with resources. Because of restrictions in HRS data which does not contain that information on households, lifetime net resources may just be picking heterogeneity.

Suppose the true population model is

$$a = \beta + \gamma R + \Gamma X + \Sigma_j \phi_j B_j \tag{1.19}$$

and we are omitting the individual behavioral factors $B_j's$. The relationship between B_j, R and X is

$$B_j = \psi_j + \omega_j R + \Omega_j X \tag{1.20}$$

Then, the OLS regressor is biased and

$$\text{plim}_{N\to\infty} \widehat{\gamma}^{OLS} = \gamma + \Sigma_j \phi_j \omega_j \tag{1.21}$$

We summarize the impact of different individual behavioral factors on the OLS regressor in Table 1.2. If $\omega_j > 0$, the specific behavior B_j increases the ability to gain resources. If $\phi_j > 0$, the specific behavior B_j increases the preference for consumption. There are examples of both upward and downward bias of a behavior. Whether the OLS estimator is upward biased or downward biased depends on the aggregate effect of those behavioral factors. Most reasonable behavioral factors would predict a downward bias in the OLS coefficient.

Construct Wealth Luck Instruments

As we discussed in the model section, if there is an unanticipated small exogenous positive shock to resources, we can distinguish between the heterogeneity and bequest motives explanation. An ideal instrument would be a free lottery. But because of data limitation, we try the following way instead. First, we calculate the return of total assets of households and define households with abnormally high positive/negative return as having good/bad luck. We define the wealth luck indicators as follows.

Step 1: Compute annualized total assets return rate from year t to $t+2$ (wave n to $n+1$):

$$r_{it}^{a} = 0.5 * [a_{i,t+2}/(a_{it} + 2w_{it} - 2c_{it}) - 1] \tag{1.22}$$

where a_{it}, w_{it}, and c_{it} are total assets, wage income, and consumption of household i at year t.

Step 2: Define the two-sided luck indicator for household i at year t

$$\mathrm{Z}_{it} = \begin{cases} -1 & r_{it}^{a} < -i\% \\ 0 & -i\% \leqslant r_{it}^{a} \leqslant i\% \\ 1 & r_{it}^{a} > i\% \end{cases} \tag{1.23}$$

where i = 5, 10, 15, 20, 25, 30. For robustness check, we also try the one-side good luck indicator and the one-side bad luck indicator where

$$\mathrm{Z}_{it}^{good} = \begin{cases} 0 & r_{it}^{a} \leqslant i\% \\ 1 & r_{it}^{a} > i\% \end{cases} \tag{1.24}$$

$$\mathrm{Z}_{it}^{bad} = \begin{cases} -1 & r_{it}^{a} < -i\% \\ 0 & -i\% \leqslant r_{it}^{a} \end{cases} \tag{1.25}$$

Step 3: Define assets-weighted luck for household i using luck indicators from all years for household i

$$\mathrm{Z}_{i} = \Sigma_{t} \overline{a_{t}^{i}} \mathrm{Z}_{it} \tag{1.26}$$

$$\overline{a_{t}^{i}} = \Sigma_{j \in age_{i}} a_{jt}/N \tag{1.27}$$

where $\overline{a_{t}^{i}}$ is the average assets of households who have the same age as household i.

We also try the unweighted luck indicator defined as follows:

$$\mathrm{Z}_i = \Sigma_t \mathrm{Z}_{it} \tag{1.28}$$

Assumptions

The null hypothesis is that there is no heterogeneity $H_0 : \rho_i = \rho, r_i = r, \sigma_i = \sigma$. The relevance assumption is that the wealth luck instrument has a causal effect on lifetime net resources. And the assumption is satisfied by construction since the wealth luck instrument represents large positive or negative returns which increase or decrease wealth as well as lifetime net resources.

The exclusion restriction is that the wealth luck instrument should affect consumption rate only through resources and cannot be correlated with the error term in the baseline regression. One concern about the validity of our instrument is that we do not consider the possibility of different portfolios. If the null hypothesis is true, we can expect there would be no difference in household portfolios. The portfolio risks are the same, and the return rates calculated using changes in total private assets in equation 1.22 do not need to be adjusted for risks. If we construct the wealth luck IV by using risk-adjusted returns, the null hypothesis is rejected by considering heterogeneous portfolios. Another concern is that large returns may not only be caused by luck. People can persistently earn high returns, not because of luck, but, for example, because they make better investment decisions. If this reason is true, the null hypothesis is rejected because there are households not experiencing persistent high returns, meaning the ability to invest is heterogeneous. Persistent high returns could also be caused by less risk aversion. Households with less risk aversion can systematically earn higher market returns. Again, this rejects the null hypothesis. The third concern is that we are comparing returns with some certain cutoffs. This does not take the changes in the market environment into account. It can be resolved by also comparing how many standard deviations are household returns away from the average returns at the same time. We will incorporate this tactic into the next version. To summarize, we assume that both abnormally high and infrequent return are of pure luck. The wealth luck instrument is not correlated with risk tolerance, impatience factor, or investment ability that we are concerned about. Thus, the instrument is exogenous.

We summarize the testable implications of the two explanations in table 1.3. As long as the OLS and IV results are systematically different, heterogeneity exists. As long as the IV coefficient of resources is negative and significant, there is a causal effect of wealth on consumption rate and bequest motives explain why the rich save more.

2SLS

Because the second baseline regression on consumption requires multiple instruments and is demanding, we focus on the IV strategy for the first baseline regression on APC which requires only one instrument. We use the log form of resources for interpretation purposes. The first stage of the IV regression is

$$log(R_i) = \delta + \Theta Z_i + \Lambda X_i + \mu_i \tag{1.29}$$

The second stage of the IV regression is

$$APC_i = \beta^{IV} + \gamma^{IV} \widehat{log(R_i)} + \Gamma^{IV} X_i + \mu_i \tag{1.30}$$

where $\widehat{R_i}$ is the predicted value of the net resources from the first stage.

1.5 Data

1.5.1 Data Overview

We use the household-level financial data from the Health and Retirement Studies (HRS) and consumption data from the Consumption and Activities Mail Survey (CAMS) ans also use the 2014 HRS and 2015 CAMS data to run the baseline and IV regressions. To construct the instruments, we are using eight waves of the HRS from 2000 to 2014 and the CAMS from 2001 to 2015. Our calculation of remaining lifetime net resources is based on the HRS using the TFA. The HRS data also provides us the group of control variables.

1.5.2 2014 Health and Retirement Study

The HRS is a national longitudinal survey of individuals over the age of 50 and their spouses or partners and is conducted every two years. It contains information on demographics, income, assets, health, cognition, family structure, health care, housing, job, expectations, and insurance. The first wave was conducted in 1992 and we are using the latest 2014 wave. In the 2014 wave, the HRS interviewed 18,747 respondents belonging to 12,746 households. In this paper, we are working with the household-level data.

Table 1.4 shows average demographic statistics by remaining lifetime net resources quintile. The age(s) of the main and second respondents, if any, are about the same, around 60s to 70s. Households with higher net resources tend to have more adults and children. Disability is an indicator variable which equals one if the respondent is disabled and zero if not. Households with higher net resources are less likely to be disabled. Education is an indicator variable, which equals zero if the respondent has less than high school education, one if high school education, and two if some college or more education. The average education level for the main respondent in all groups is above high school. The second respondent has an average education level lower than the main respondent. The education level of both respondents increases as net resources increase. The race as an indicator variable is equal to one if the respondent is White and zero if Black. If there is a second respondent, the race of the two respondents is the same in most cases. Most respondents are White. Health is a self-rated indicator variable valued from 1 to 5, where 1 represents excellent health, and 5 represents poor health. In general, respondents with higher net resources would rate themselves healthier, the second respondent feels better about their health condition than the first respondent, and there is not much difference in the two respondents' health rating. The cash-constrained indicator is the indicator of the severity of cash constraint. We will talk about the procedure of constructing it in section 1.6.3. The larger the indicator number is, the more severe the cash constraint is for the particular household. Households with higher net resources are less constrained.

1.5.3 2015 Consumption and Activities Mail Survey

A random sample of 8,039 households from HRS 2014 was asked to participate in the 2015 wave of CAMS and 5,423 responded. CAMS has three main topics: Part A is about activities or uses of time; Part B collects data on spending, including anticipations and realizations about changes in spending at retirement; and Part C asks for information about marital status and labor force participation.

CAMS questions are about household *spending.* However, for the purposes of this paper, we are interested in household *consumption.* Consumption is different from spending on items like durables (e.g., automobile, television, computer, etc.) and housing in which the purchase occurs in one period, but the item provides utility for more than one period. Specifically, we distinguish between durables spending and consumption; transportation spending and consumption; and housing spending and consumption. Nondurables spending and consumption are the same since utility is obtained immediately after the purchase and there is no element of savings.

Total consumption is a sum of four components: durables, nondurables, transportation, and housing. Durables goods include refrigerators, washing machines and dryers, dishwashers, televisions, computers, and furnishings. Nondurable goods include clothing, gasoline, groceries, utilities such as electricity, and entertainment or services such as dining and trips/vacations. We follow RAND and calculate the transportation consumption as a flow of services which comes from the total value of vehicles observed in the HRS. The consumption of housing is the sum of the rental equivalent of the owned house, property tax, homeowners' insurance, plus any actual rent the household pays for additional properties. For renters, housing consumption is identical to housing spending and equal to the rent.

Table 1.5 shows total consumption in the year 2014 and all subcategories of consumption as a fraction of remaining lifetime resources. For total consumption and each category of consumption, the rich consume more at an absolute level but less as a fraction of net resources. Households consume nondurable goods most, accounting for about 60% of all consumption, and durable goods least, accounting for less than 1%. Housing and transportation hold the same proportion of consumption for the group with the lowest net resources. But the richer households consume more housing than transportation.

1.5.4 Variables from TFA

We apply TFA to each household in the 2014 HRS to project future net taxes and human and nonhuman wealth and calculate their present values. Human wealth is the present value of all future earnings. Nonhuman (or private) wealth includes all financial assets (stocks, bonds, mutual funds, checking and saving accounts) and real estate assets minus the value of all liabilities. Net taxes include federal and state taxes that households have to pay minus the transfer payments it receives. All variables from TFA represent discounted present values.

Table 1.6 shows net resources and each category of resources as the percentage of net resources by remaining lifetime net resources quintile. The big differences in net resources are mostly generated by private wealth inequality. Since they are deducted from gross resources, net taxes decrease the inequality in net resources and occupy a larger share when net resources increase. The inequality in human wealth first increases and then decreases as net resources increase. The inequality in private wealth is always larger than that in human wealth.

1.5.5 Data Set Construction

Data is constructed in several steps. First of all, data from the CAMS is merged with the data from the HRS and then with results of the TFA. Second, we remove all non-responses and drop observations with negative or zero total income and with remaining lifetime net resources less than 5000. Table 1.7 shows how many observations we are losing at each step.

1.6 Empirical Results

1.6.1 Baseline Results

Baseline Regression One

In figure 1·1, we plot consumption rate on quintiles of lifetime net resources using both predictions of the standard model and data-generated items. The decreasing pattern still holds clearly whether we use level or log forms of resources. The standard model predicts that the consumption rate is a horizontal line. Our data shows that the consumption rate is decreasing as lifetime net resources increase. The standard model fails to generate facts consistent with the data. Now the model leaves us with two possible explanations: bequest motives and heterogeneity. If heterogeneity is the reason for decreasing APC, each point in the graph is generated by different return rates, impatience factors, and risk aversion. The rich are born to be more patient, better at investment, and more risk averse. A poor person who becomes rich because of a lottery game would be an outlier and spend much more than his or her peers. A random redistribution of resources would destroy the decreasing pattern. If the rich save more because of bequest motives, the decreasing pattern will remain after a random redistribution of resources because, with more resources, marginal utility in consumption decreases faster than marginal utility in bequeathing. It is optimal to leave a greater proportion of resources to descendants.

We discussed our baseline regression in section 1.4.4. We include the following key demographic variables in control variables X in our baseline regression: child count, adult count, age, disability, and health. The regression result on APC is represented in Table 1.8. Coefficients of resources are negative and significant in all forms and groups. Thus, consumption rate is decreasing in resources. The average APC for the full sample is 0.057, which means an average household spends 5.7% of its lifetime resources today. The full-sample results with log resources show that when net resources increase 1%, APC decreases by 0.0003, which is about 0.5% of the sample average APC. If lifetime net resources of household A are twice that of household B, household A will keep 3% of its resources in its pocket rather than spending 100% more. As the HRS and TFA computed data indicates, there is huge inequality in resources. One household's resources could be 2^n times that of another and n is up to 7. Thus, the extra resources kept in the pocket are huge. Lifetime net resources are presented in millions for results with levels. The full-sample results with the level of resources show that, when net resources increase by one million which is about the average resources of the third quintile, APC decreases by 0.01, about 1/6 of the sample average APC. The coefficients of control variables are not consistent in the log and level forms in the full sample.

To demonstrate how quickly APC decreases, we divide households by resources into five quintile groups. Table 1.9 shows the predicted APC decreases quickly when net resources increase. For all regressions, the average APC for the lowest group is about 0.08. The average APC for the highest group is about 2 standard errors smaller, around 0.03.

The key coefficients of the worker and retiree groups seem to be different in Table 1.8. We use the following regression to test whether the two groups are statistically different.

$$a_{it} = \beta + \gamma R_{it} + \Gamma X_{it} + \kappa \mathbb{1}(\text{retired}) + \delta \mathbb{1}(\text{retired}) R_{it} + \Delta \mathbb{1}(\text{retired}) X_{it} + \mu_{it} \quad (1.31)$$

where $\mathbb{1}(\text{retired})$ is an indicator of retiree group. The coefficients and t-stats of retiree group indicator and interaction terms are shown in table 1.10. The joint p-values show that the two groups are statistically different and that the difference between the two groups is economically significant. The consumption rate in the retiree group decreases at about 1.5 times the worker group speed as resources increase.

Baseline Regression Two

We include the same set of key demographic variables as the first baseline regression to interact with resources as control variables. The regression result on consumption is represented in Table 1.11. Resources are in millions. The coefficients of the square term of remaining lifetime net resources are negative and significant for all groups, indicating that the rich have smaller APC and save more. Because it is difficult to recognize the impact of resources on APC directly from the table, we show the estimated APC from each regression in Table 1.12. The APC decreases quickly as resources increase. For all regressions, the average APC for the lowest group is about 0.10. The average APC for the highest group is about 2 standard errors smaller, around 0.03. The estimated APC is of the same magnitude as the estimated APC of the first baseline regression for each quintile cohort.

The number of children does not matter significantly. In this HRS data, most of the households are about to retire or already retired, as suggested by summary statistics of age in Table 1.4. The child-rearing expenses including housing, food, care, and education for those older parents would be much smaller than that for younger parents, who are not in our sample, because major parental expenses made on children are from birth through early adulthood. The number of adults would significantly affect consumption. The three groups of regressions show that with one more adult in a family with one million resources in total, the consumption would increase by 5631 for the current year. Elderly households consume more in the worker group and less in the retiree group. Disabled households consume less in the worker group and more in the retiree group. The effect of age and disability is not significant for the full sample. Health condition is only significant for the full sample. Households with worse health conditions consume less and save more for the bad conditions precautionarily.

We formally test the difference between the worker and retiree group by the following specification.

$$\begin{aligned} C_{it} &= \alpha + \beta R_{it} + \gamma R_{it}^2 + \Gamma R_{it} X_{it} + \theta \mathbb{1}(\text{retired}) \\ &\quad + \kappa \mathbb{1}(\text{retired}) R_{it} + \delta \mathbb{1}(\text{retired}) R_{it}^2 + \Delta \mathbb{1}(\text{retired}) R_{it} X_{it} + \mu_{it} \end{aligned} \tag{1.32}$$

The results are shown in table 1.13. The two groups are significantly different. The coefficient of the interaction term of retiree indicator and square term of resources are positive and significant. The consumption for the worker group decreases quickly as resources increase, which is opposite to the group difference test result of the first baseline regression on APC. Age and disability play different roles in the worker and retiree group.

1.6.2 Wealth Luck as IV

We talked about how we construct the wealth luck instruments in section 1.4.5. The wealth luck indicators are strongly correlated with lifetime net resources by construction. We assume high return is pure luck, and thus the wealth luck instrument is not correlated with risk tolerance, impatience factor, and investment ability. The instrument is exogenous. We use past waves of HRS to construct panel data of household private wealth (total assets).

Figure 1·2 shows the histogram of annualized private wealth return from the year 2012 to the year 2014. The return of private wealth varies a lot in the sample and ranges from -85 to 172. Over eighty percent of the return is within [-2, 2]. About fifty percent of the households have wealth returns larger than 20% or less than -20%. Figure 1·3 shows the histogram of wealth luck indicators.

Table 1.14 shows the first stage results of the two-sided assets-weighted luck IV regressions with different cutoffs. The validity of the instrument is robust to different cutoffs of luck definition. Wealth luck indicator is positively correlated with resources. An agent with one million in net resources and one more year of luck in investment increases net resources by 7.57% if we set the luck cutoff to be 20%.

Table 1.15 shows the main IV results of the two-sided assets-weighted luck IV regressions with different cutoffs. Using wealth luck as an instrument, APC is still decreasing in resources. If there is only heterogeneity, the main IV results would predict a constant consumption rate. According to the testable implications summarized in table 1.3, we conclude that the relationship between resources and consumption rate is casual. Bequest motives explain why the rich save more. The coefficient is about 1.7 times the OLS coefficient in table 1.8 full-sample log regression (1). When net resources increase 1%, APC decreases by 0.0005, which is about 1% of the sample average APC. If lifetime net resources of household A are twice that of household B, household A will keep 5% of its resources in the pocket rather than spending 100% more.

We use the Durbin-Wu-Hausman test to check whether the IV and OLS regressors of resources are different. The null hypothesis is that there is no systematic difference in γ^{IV} and γ^{OLS}. Under the null hypothesis, the following statements are true and equivalent: (1) γ^{OLS} is efficient and consistent, (2) there is no endogeneity issue, and (3) there is no heterogeneity if there is no measurement error in resources. The p-value of the test is 0.02649, which is smaller than 0.05. Thus, we can reject the null hypothesis. It is still too early to conclude whether heterogeneity plays a role or not. First, the bias in OLS could be caused by measurement errors in resources, not heterogeneity. We can use another measure of resources as an instrument; for example, future or lagged resources can eliminate measurement error. We will include the result in the next version. Second, the upward biased OLS regression result is consistent with the case where people who are better at investment also spend extravagantly. But the most reasonable forms of heterogeneity would predict a downward bias in

OLS, as we discussed in table 1.2. So there seems to be little role for heterogeneity in abilities to invest, impatience factors, and risk tolerances. The coefficients of all control variables keep the same sign and level of significance. We show the first stage and main IV results of other definitions of luck in the Appendix. These results also support both bequest motives and heterogeneity explanations.

We present the estimated APC with different cutoffs in table 1.16. The APC decreases quickly. The APC of the highest resources group is about 3 standard deviations smaller than that of the lowest resources group.

1.6.3 Borrowing Constraints

The baseline and IV regression control for some key demographic variables. Besides the demographic factors that may be linked to consumption behavior, borrowing constraints exercise important influence on household consumption behavior. When a borrowing condition is binding, households are constrained at their borrowing limit, although without it they might consume more. Thus, constrained households have a lower propensity to consume out of their lifetime net resources.

The Borrowing Constrained Indicator

We identify borrowing-constrained households and construct a borrowing-constrained severity indicator, using the TFA. We calculated it using the following procedure. First, we use the TFA to calculate the standards of living through the household lifetime. If households are not borrowing-constrained for their full life, their consumption is totally smoothing. Otherwise, there is a jump in their consumption at some time. During the years before the jump, households are borrowing-constrained. Then, we calculate the number of years before the standard of living rises for the first time. Cash-constrained indicator is the inverse of the number of years. Therefore, the higher the indicator number is, the fewer years a particular household is constrained for and, thus, more severe is the cash constraint because fewer resources are available during those years. Through our way of constructing the cash-constrained indicator, we are not able to distinguish between the households who are either never constrained or forever constrained because there would be no jump in consumption in those cases. We are still working on this issue case by case.

Before analyzing the impact of borrowing constraints on consumption, it would be helpful to understand the borrowing-constraint indicator better. We analyze the indicator by net lifetime resource percentiles and by age groups and compare constraints among workers and retirees.

First, we check the relationship between the borrowing-constrained indicator and the MPC out of cash-on-hand. We define cash-on-hand as the sum of total household annual income, checking accounts, savings accounts, and value of financial assets, including stocks, bonds, and CDs. The resources that are available to cash-constrained households are cash-on-hand plus some amount of money they can borrow, usually a small fraction of their wealth. Thus, the marginal propensity to consume out of cash-of-hand approaches one for those households. Figure 1·4 plots the median MPC out of cash-on-hand on the number of years for which households are constrained before the first consumption jump. The least severely constrained group, with the number of years constrained larger than 10 and borrowing constrained indicator valued 0 - 0.1, has the lowest MPC out of cash-on-hand, which is consistent with the definition of being borrowing-constrained.

Then, we calculate the median borrowing constrained indicator and median consumption to the cash-on-hand ratio for each net resource quintile group. As we can see from Figure 1·5 (a), the borrowing constraints are the most severe for the first quintile, and the first quintile has the highest MPC out of cash-on-hand.

Next, we calculate the same values for each age cohort. Figure 1·5 (b) illustrates that borrowing constraints are the most severe for the elderly and the MPC out of cash-on-hand falls significantly with age.

Finally, we examine the difference in these values across retirees and workers.

Figure 1·6 shows that the borrowing constraints are more severe for retired people in each of the net resource percentiles while the ratio of consumption to cash on hand is smaller for retired people in each of the net resource percentiles.

Borrowing Constrained Indicator and Consumption Rate

Based on the first baseline and IV regression with a two-sided and assets-weighted luck instrument generated by total assets, we add cash-constrained indicator as one of the control variables. The results are presented in Table 1.17 and Table 1.18 correspondingly. In the IV regression, households which are constrained for 1 year have a 1.4% lower consumption rate than households that are constrained for 10 years. More importantly, our key result still holds. APC is decreasing with net resources and the coefficient has the same magnitude as previous regressions. The IV regression coefficient is larger in absolute value than the OLS coefficient. By considering heterogeneous borrowing constraints, we still arrive at the result that both heterogeneous impatience factors or risk tolerance or investment ability and bequest motives explain why the rich save more.

Based on the second baseline OLS regression, we add cash constrained indicator interacting with net resources as one of the control variables. The results are presented in Table 1.19. Again, our key result still holds. The coefficient of the square term of net resources is negative and significant. APC is decreasing in net resources, and the rich consume less and save more. The net resources have a similar impact on APC quantitatively as the baseline regression. All other control variables have the same interpretation and the quantitative impact is similar to the baseline regression. Because we just have one instrument, we are not able to run IV regression for this specification.

For the full sample, the more severely constrained households consume less. Households which are borrowing-constrained for one year consume 7557 dollars less than households which are borrowing-constrained for over ten years if both of them have one million resources. This is quantitatively large, about 13% of the average consumption. For some reason, the worker group and retiree group separately are not significantly affected by cash constraint. The result for the full sample is intuitive.

1.6.4 Breaking Down the Households' Wealth

In this section, we break net resources into the three main parts, i.e., private wealth, human wealth, and net taxes. We want to know whether the consumption rate is decreasing in each part of net resources. We see that consumption rate is decreasing in net resources, private wealth, human wealth, and net taxes from Figure 1·7. To check more rigorously by controlling other demographic characteristics, we perform regression analysis. Here we are only able to show the OLS regression results because IV regression requires multiple instruments.

Based on the first baseline regression, we propose the following regression:

$$a_{it} = \beta + \gamma_w W_{it} + \gamma_h H_{it} + \gamma_t T_{it} + \Gamma X_{it} + \mu_{it} \tag{1.33}$$

The results are shown in Table 1.20. Coefficients of each part of net resources are significant and negative; thus, APC is decreasing in private wealth, human wealth, and negative net taxes, i.e., net transfers. We do not show results in log forms because many households have negative net taxes and would provide few observations. APC does increase as the level of net taxes increases. Although the tax system is sophisticated, with roughly 30 tax-transfer programs, with different rules households are able to figure out the direct impact of taxes on consumption. This result is important to our contribution to measuring net taxes precisely. Consumption rate increases significantly as net taxes increase; thus net taxes play an important role and cannot be neglected.

Another way to check whether the consumption rate is responsive to each part of the three main components is to instrument net resources with each part. The coefficient of net resources by instrumenting represents the contribution of each part.

The results are shown in Table 1.21. We get results consistent with Table 1.20. APC responds to each part of net resources.

We further categorize private wealth into liquid assets and illiquid assets. We define liquid assets to be the sum of cash, checking, savings, money market accounts, and mutual funds, stocks, bonds, and T-Bills. The rest of private wealth are illiquid assets, including housing net of mortgages and home equity loans, retirement accounts, life insurance, etc. We plot the consumption rate on liquid and illiquid assets in Figure 1·8. The consumption rate on illiquid assets is clearly decreasing. We use a formal regression result to check the observations with the graph. The regression specification is

$$a_{it} = \beta + \gamma_L A_{it}^L + \gamma_{IL} A_{it}^{IL} + \gamma_h H_{it} + \gamma_t T_{it} + \Gamma X_{it} + \mu_{it} \quad (1.34)$$

where A^L and A^{IL} are liquid and illiquid assets correspondingly.

The results are shown in Table 1.22. Again, we only show results in levels because by taking logs many observations would drop because of negative net taxes, liquid assets, and illiquid assets. APC does not change with liquid assets and decreases with illiquid assets. One possible reason is that there is a significant number of hand-to-mouth households which consume their liquid assets and the MPC is always close to one out of liquid assets. APC still decreases as human wealth increases and net taxes decrease. Interpretations of control variables are consistent with the baseline results.

We apply the same experiment for the second baseline regression on consumption and show the two sets of regression results in Table 1.23. APC is decreasing in private wealth, human wealth, and illiquid assets. APC does not respond to net taxes, which contradicts the result regressing on consumption rate. The magnitude of the estimated APC is consistent with the baseline regression. Interpretations of control variables are consistent with the baseline results.

1.7 Conclusion

This paper empirically answers the long-debated question of whether the rich save more than other economic groups. We use the software *The Fiscal Analyzer* (TFA) to precisely measure remaining lifetime net resources. The main challenge is estimating human wealth and net taxes. We have access to the restricted data of HRS and forecast future earnings based on the earnings history of households. We calculate accurate net taxes, based on the geographic location of households. And we construct wealth luck as an instrument to resolve the endogeneity issue caused by consumption behavioral factors that are also linked with the ability to accumulate wealth. The IV regression result shows that the consumption rate decreases significantly quickly when lifetime net resources increase. Thus the rich save more and the relationship is causal.

We show that a standard model could only generate a constant consumption rate. Thus we consider two alternatives: a model with bequest motives and a model with heterogeneity. Testable implications of the two models show that the rich save more because of bequest motives. The upward bias in OLS regression indicates that there is little role for heterogeneity. The statistically and economically significant IV coefficient shows that bequest motives play a role.

One direction worth exploring is to investigate the quantitative impact of decreasing consumption rates on inequality and intergenerational wealth distribution. It is still unclear whether the influence is economically meaningful. Welfare analysis should be conducted as well we policy analysis, accordingly.

Table 1.1: List of Tax and Transfer Programs Included in TFA

Taxes	Personal Income Tax (federal and state)
	Corporate Income Tax (federal and state)
	FICA Tax (federal)
	Sales Taxes (state)
	Medicare Part B Premiums (federal)
	Estate and Gift Tax (federal)
Transfer Programs	Earned Income Tax Credit (federal and state)
	Child Tax Credit (federal)
	Social Security Benefits (federal)
	Supplemental Security Income (SSI) (federal)
	Supplemental Nutritional Assistance Program (SNAP) (state)
	Temporary Assistance for Needy Families (TANF) (state)
	Medicaid
	Medicare (federal)
	The Affordable Care Act (ACA) (state)
	Section 8 Housing Vouchers (state and county)
	Childcare Assistance (state and county)

Table 1.2: Bias Caused by Behavioral Factors B_j in the OLS Estimator

Bias	Formula	Example
Upward	$\phi_j \omega_j > 0$	Better investors spend money more extravagantly.
Downward	$\phi_j \omega_j < 0$	Hard workers are more patient. Better investors are more risk averse. Highly-educated people are better at investment.

Table 1.3: Testable Implications of the Two Explanations

model		implications	
heterogeneity	bequest motives	$\gamma < 0$ and significant	OLS and IV
yes	no	no	different
no	yes	yes	same
yes	yes	yes	different

Table 1.4: Demographics by Net Resources Quintile

	Lowest	Second	Third	Fourth	Highest	Top 5%	Top 1%
Age (Respondent 1)	72.80	68.37	64.84	62.73	61.67	61.72	62.94
Age (Respondent 2)	77.21	70.95	65.15	63.25	61.85	63.09	63.12
Child Count	0.04	0.09	0.16	0.28	0.27	0.22	0.17
Adult Count	1.20	1.62	1.72	1.79	1.89	1.90	2.00
Household Count	1.24	1.71	1.88	2.07	2.15	2.12	2.17
Disability (Respondent 1)	0.16	0.22	0.14	0.11	0.07	0.02	0.05
Disability (Respondent 2)	0.08	0.18	0.15	0.12	0.06	0.05	0.00
Education (Respondent 1)	1.24	1.36	1.58	1.72	1.83	1.94	1.96
Education (Respondent 2)	0.70	0.85	0.95	0.95	0.99	1.00	1.00
Race (Respondent 1)	1.13	1.08	1.07	1.04	1.02	1.02	1.02
Race (Respondent 2)	1.13	1.06	1.06	1.04	1.01	1.02	1.02
Health (Respondent 1)	3.05	2.84	2.69	2.47	2.19	1.90	2.12
Health (Respondent 2)	3.12	3.07	2.71	2.57	2.34	2.07	1.91
Cash Constrained	0.33	0.20	0.14	0.08	0.04	0.03	0.03

Table 1.5: Average Consumption by Net Resources Quintile

	Lowest	Second	Third	Fourth	Highest	Top 5%	Top 1%
Total Consumption	32520.05	45287.95	54968.62	67161.07	90431.53	125782.10	141310.23
Consumption (% of Net Resources)							
Total	8.537	6.779	5.678	4.637	3.006	2.185	1.412
Durables	0.050	0.050	0.032	0.036	0.025	0.017	0.004
Nondurables	5.068	4.134	3.261	2.581	1.688	1.296	0.920
Housing	1.625	1.248	1.165	0.986	0.684	0.500	0.353
Transportation	1.795	1.348	1.220	1.033	0.609	0.371	0.135

Table 1.6: Average Resources by Net Resources Quintile

	Lowest	Second	Third	Fourth	Highest	Top 5%	Top 1%
Net Resources	396352.32	672796.33	970941.55	1450357.50	3382358.83	6189685.59	10381832.34
Resources (% of Net Resources)							
1. Private Wealth	24.29	30.27	35.61	45.25	67.85	87.44	100.33
(1) Regular Assets	7.66	8.88	12.91	17.46	32.97	53.52	70.27
(2) Primary Home Equity	15.32	18.31	16.27	15.75	12.21	10.20	7.68
(3) Other Real Estate Assets	0.65	1.31	1.97	3.69	4.37	6.86	12.25
(4) Retirement Account	0.66	1.77	4.46	8.35	18.30	16.85	10.13
2. Human Wealth	7.20	9.95	22.75	32.93	34.49	25.15	10.81
(1) Employment Income PV	5.51	7.51	18.14	27.53	30.00	22.56	9.96
(2) Self-Employment Income PV	0.08	0.10	0.07	0.01	0.52	0.52	0.00
3. Net Taxes	-68.51	-59.78	-41.64	-21.81	2.34	12.59	11.14
(1) State Taxes PV	0.07	0.13	0.46	0.94	1.64	1.38	0.96
(2) Federal Taxes PV	0.36	0.61	1.85	4.03	8.23	8.80	5.36

Table 1.7: Data Cleaning

	N of Observations
Original HRS-2014	12,746
Merging with CAMS-2015	6,523
Merging with TFA Results	3,250
Remove Non-Responses	3,043
Remove Total Income ≤ 0	3,052
Remove Remaining Lifetime Net Resources < 5000	2,717

Table 1.8: Baseline Regression on APC for the Full Sample, Workers and Retirees

	C/R					
	Full Sample		Workers		Retirees	
	(1) log	(2) level	(3) log	(4) level	(5) log	(6) level
R	-0.0308***	-0.0109***	-0.0229***	-0.00840***	-0.0354***	-0.0133***
	(-18.23)	(-11.99)	(-10.37)	(-8.44)	(-14.63)	(-9.02)
$nchild$	0.00367	0.00224	-0.0000968	-0.00140	0.0106**	0.01000**
	(1.63)	(0.95)	(-0.04)	(-0.64)	(2.34)	(2.11)
$nadult$	0.00750***	-0.00263	0.00663**	-0.000650	0.00704**	-0.00404
	(3.27)	(-1.17)	(2.21)	(-0.23)	(2.14)	(-1.23)
age	0.0000432	0.000398***	0.000421**	0.000597***	-0.000118	0.000186
	(0.39)	(3.57)	(2.52)	(3.54)	(-0.60)	(0.92)
$disability$	-0.00595**	-0.00391	-0.00642*	-0.00531	-0.00709	-0.00536
	(-2.11)	(-1.34)	(-1.88)	(-1.53)	(-1.61)	(-1.16)
$health$	-0.00261**	-0.000269	0.000130	0.00212	-0.00376**	-0.00182
	(-2.11)	(-0.21)	(0.08)	(1.32)	(-2.13)	(-0.99)
N	2169	2169	929	929	1240	1240
R^2	0.1588	0.0900	0.1432	0.1119	0.1611	0.0763

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.9: Estimated average APC (%) from Table 1.8

Regression	s.e.	Lowest	Second	Third	Fourth	Highest	Top 5%	Top 1%
(1) Full, log	2.06	8.18	6.77	5.81	4.75	2.66	0.68	-0.96
(2) Full, level	1.70	7.14	6.53	6.08	5.51	3.36	0.31	-4.25
(3) Workers, log	1.78	8.03	6.78	5.89	4.96	3.34	1.84	0.70
(4) Workers, level	1.53	7.10	6.48	6.00	5.43	3.72	1.33	-2.10
(5) Retirees, log	2.33	8.42	6.84	5.85	4.74	2.34	0.07	-1.89
(6) Retirees, level	1.96	7.34	6.75	6.39	5.86	3.29	-0.42	-6.06

Table 1.10: Test the Differences between Workers and Retirees

	C/R	
	(1) log	(2) level
$retired$	0.215***	0.0500**
	(3.97)	(2.21)
$R * retired$	-0.0125***	-0.00490***
	(-3.55)	(-2.69)
$nchild * retired$	0.0107**	0.0114**
	(2.20)	(2.27)
$nadult * retired$	0.000416	-0.00339
	(0.09)	(-0.73)
$age * retired$	-0.000539**	-0.000411
	(-1.97)	(-1.46)
$disability * retired$	-0.000669	-0.0000552
	(-0.11)	(-0.01)
$health * retired$	-0.00389	-0.00395
	(-1.51)	(-1.50)
N	2169	2169
R^2	0.1673	0.0975
Joint p-value	0.0025	0.0129

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Coefficients of R and X are not reported.

Table 1.11: Baseline Regression on Consumption for the Full Sample, Workers and Retirees

	Full Sample	Workers	Retirees
	(1)	(2)	(3)
	Current Consumption		
R	21233.6***	4760.2	28085.2***
	(4.43)	(0.58)	(3.77)
R^2	-1480.9***	-1654.8***	-861.8***
	(-9.69)	(-7.12)	(-3.92)
$nchild * R$	743.7	182.9	1965.7
	(0.80)	(0.15)	(1.15)
$nadult * R$	5630.7***	4171.7*	5322.1***
	(4.10)	(1.83)	(3.15)
$age * R$	-28.31	268.3***	-190.7**
	(-0.56)	(2.94)	(-2.18)
$disability * R$	-465.0	-4182.9**	4250.0*
	(-0.32)	(-2.05)	(1.79)
$health * R$	-1852.7***	-860.2	-1437.9
	(-2.78)	(-0.82)	(-1.63)
Constant	28451.9***	30705.8***	28561.1***
	(19.92)	(11.06)	(18.11)
N	2169	929	1240
R^2	0.2591	0.2318	0.2608

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.12: Estimated APC (%) from Table 1.11

	s.e.	Lowest	Second	Third	Fourth	Highest	Top 5%	Top 1%
(1) Full	2.54	9.70	6.49	5.23	4.28	3.15	2.26	1.46
(2) Workers	2.95	10.88	7.14	5.65	4.54	3.25	2.26	1.40
(3) Retirees	2.46	9.43	6.33	5.11	4.20	3.16	2.41	1.83

Table 1.13: Test the Differences between Worker and Retiree Group

	C
$retired$	-2144.7
	(-0.71)
$R * retired$	23325.0**
	(2.11)
$R^2 * retired$	793.0**
	(2.47)
$nchild * R * retired$	1782.8
	(0.81)
$nadult * R * retired$	1150.4
	(0.42)
$age * R * retired$	-459.0***
	(-3.61)
$disability * R * retired$	8433.0***
	(2.63)
$health * R * retired$	-577.7
	(-0.42)
N	2169
R^2	0.2764
Joint p-value	0.00

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Coefficients of R, R^2 and RX are not reported.

Table 1.14: First Stage IV Regression by Total Assets with Two-sided and Assets-weighted luck

Cutoff	(1) 5%	(2) 10%	(3) 15%	(4) 20%	(5) 25%	(6) 30%
Z	0.0418***	0528***	0.0612***	0.0793***	0.0863***	0.0841***
	(5.168)	(5.903)	(6.278)	(7.475)	(7.492)	(6.730)
Other Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
N	2,105	2,105	2,105	2,105	2,105	2,105
R^2	0.326	0.329	0.330	0.336	0.336	0.332
IV F-stat	26.71	34.84	39.42	55.88	56.13	45.30

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.15: IV Regression by Total Assets with Two-sided and Assets-weighted luck

Cutoff	(1) 5%	(2) 10%	(3) 15%	(4) 20%	(5) 25%	(6) 30%
log(R)	-0.0550***	-0.0580***	-0.0530***	-0.0515***	-0.0540***	-0.0515***
	(0.0154)	(0.0137)	(0.0126)	(0.0106)	(0.0107)	(0.0117)
Other Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
N	2,105	2,105	2,105	2,105	2,105	2,105
R^2	0.061	0.036	0.075	0.086	0.068	0.086
Durbin pval	0.0759	0.0233	0.0460	0.0265	0.0133	0.0459

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.16: Estimated average APC (%) from IV regressions in Table 1.15

Cutoff	s.e.	Lowest	Second	Third	Fourth	Highest	Top 5%	Top 1%
5%	3.41	9.22	7.26	5.83	4.12	0.57	-2.88	-5.78
10%	3.59	9.36	7.34	5.84	4.05	0.31	-3.33	-6.39
15%	3.30	9.13	7.22	5.83	4.17	0.73	-2.60	-5.40
20%	3.21	9.05	7.18	5.82	4.21	0.87	-2.37	-5.08
25%	3.35	9.17	7.24	5.83	4.15	0.65	-2.74	-5.58
30%	3.21	9.05	7.18	5.82	4.21	0.87	-2.37	-5.08

Table 1.17: OLS Regression with Cash-Constrained Indicator

	Full Sample		C/R Workers		Retirees	
	(1) log	(2) level	(3) log	(4) level	(5) log	(6) level
R	-0.0311***	-0.0104***	-0.0240***	-0.00857***	-0.0357***	-0.0124***
	(-17.48)	(-11.28)	(-10.66)	(-8.55)	(-13.84)	(-8.23)
cashconstrained	-0.00176	0.0101***	-0.0191**	-0.0111	-0.00137	0.0116**
	(-0.50)	(2.84)	(-2.37)	(-1.36)	(-0.30)	(2.58)
Other Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
N	2169	2169	929	929	1240	1240
R^2	0.1589	0.0934	0.1484	0.1137	0.1611	0.0813

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.18: IV Regression with Cash-Constrained Indicator

	C/R					
	Full Sample		Workers		Retirees	
	(1) log	(2) level	(3) log	(4) level	(5) log	(6) level
R	-0.0527***	-0.0497***	-0.0536***	-0.0318***	-0.0479***	-0.0748*
	(-4.75)	(-3.42)	(-3.92)	(-3.32)	(-3.00)	(-1.81)
$cashconstrained$	-0.0154**	-0.0182	-0.0391***	-0.0341**	-0.00839	-0.0295
	(-2.03)	(-1.61)	(-3.06)	(-2.43)	(-0.81)	(-1.05)
Other Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
N	2105	2105	894	894	1211	1211
R^2	0.0869	.	.	.	0.1390	.

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.19: OLS Regression with Cash-Constrained Indicator for the Full Sample, Workers and Retirees

	Full Sample	Workers	Retirees
	(1)	(2)	(3)
	Current Consumption		
R	20347.0***	4517.7	27790.9***
	(4.23)	(0.55)	(3.73)
R^2	-1466.6***	-1669.8***	-854.9***
	(-9.59)	(-7.19)	(-3.88)
$cashconstrained * R$	-7556.5**	-13292.3	-2847.8
	(-2.02)	(-1.63)	(-0.72)
Other Control Variables	Yes	Yes	Yes
N	2169	929	1240
R^2	0.2605	0.2340	0.2611

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.20: Breakdown of the Remaining Lifetime Net Resources

	C/R (1)	C/R (2)
W	-0.0140***	-0.0136***
	(-12.01)	(-11.53)
H	-0.0234***	-0.0223***
	(-6.63)	(-6.32)
T	0.0403***	0.0395***
	(6.20)	(6.08)
$cashconstrained$		0.00977***
		(2.76)
Other Control Variables	Yes	Yes
N	2169	2169
R^2	0.0987	0.1019

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.21: Instrument Net Resources with Private Wealth, Human Wealth, and Net Taxes

	C/R		
	(1)	(2)	(3)
Instrument R with	W	H	T
R	-0.00985***	-0.00955***	-0.00610***
	(-10.25)	(-2.94)	(-3.94)
$cashconstrained$	0.0105***	0.0107**	0.0131***
	(2.95)	(2.56)	(3.58)
Other Control Variables	Yes	Yes	Yes
N	2169	2169	2169
R^2	0.0933	0.0930	0.0842

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.22: Further Breakdown of Private Wealth

	C/R	
	(1)	(2)
A^L	-0.000798	-0.000569
	(-0.55)	(-0.39)
A^{IL}	-0.0153***	-0.0148***
	(-11.31)	(-10.88)
H	-0.0204***	-0.0194***
	(-5.87)	(-5.56)
T	0.0335***	0.0329***
	(5.29)	(5.19)
cashconstrained		0.0106***
		(3.00)
Other Control Variables	Yes	Yes
N	2169	2169
R^2	0.0926	0.0964

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.23: Breakdown of the Household Resources

	Consumption			
	(1)	(2)	(3)	(4)
R	24516.7***	23622.3***	22699.4***	21794.3***
	(4.65)	(4.47)	(4.32)	(4.13)
$W * R$	-1503.3***	-1491.3***		
	(-6.64)	(-6.59)		
$A^L * R$			-25.28	-13.12
			(-0.07)	(-0.04)
$A^{IL} * R$			-1679.5***	-1668.3***
			(-7.18)	(-7.13)
$H * R$	-2137.5***	-2128.9***	-1450.6**	-1443.6**
	(-2.92)	(-2.91)	(-1.98)	(-1.97)
$T * R$	1707.8	1711.0	438.2	445.1
	(1.27)	(1.27)	(0.33)	(0.33)
$cashconstrained * R$		-7543.3**		-7653.2**
		(-2.02)		(-2.05)
Other Control Variables	Yes	Yes	Yes	Yes
N	2169	2169	2169	2169
R^2	0.2599	0.2613	0.2647	0.2662

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1·1: Average Propensity to Consume on Resources

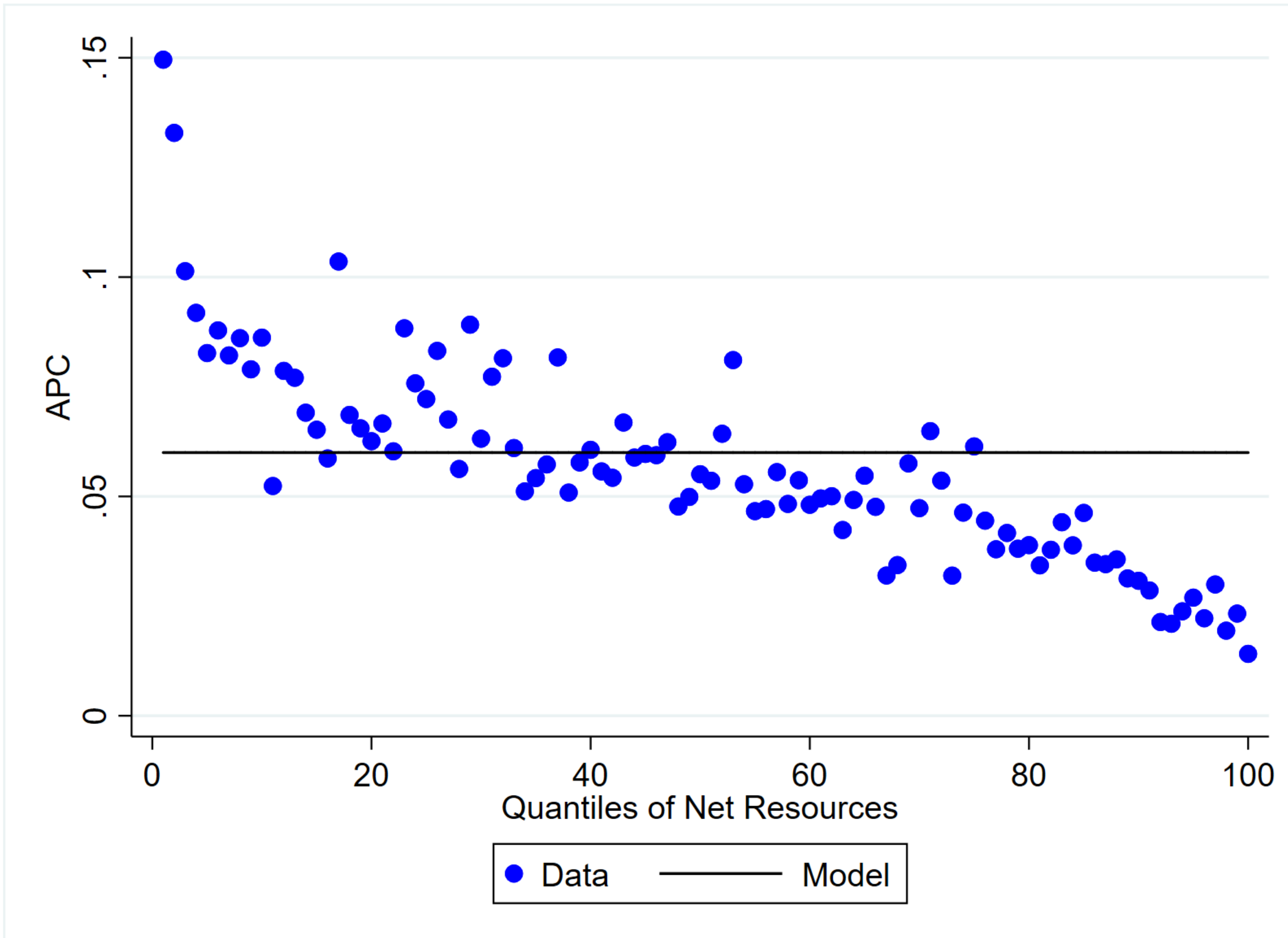
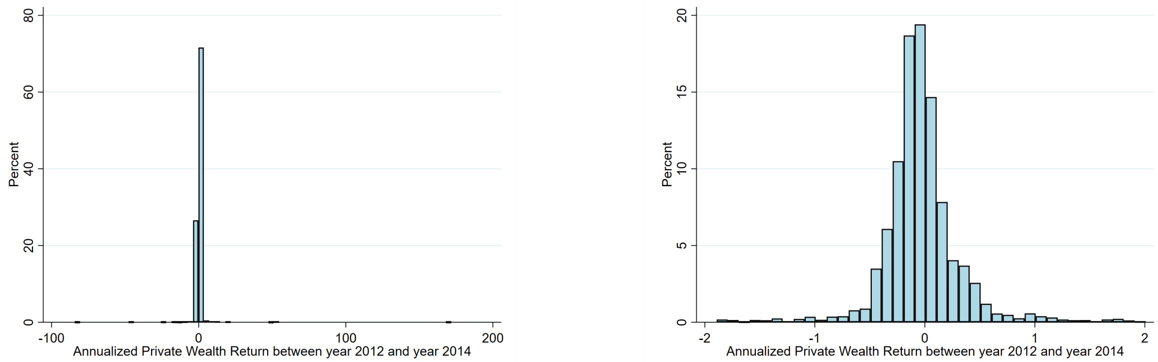


Figure 1·2: Histogram of Annualized Total Assets Return



(a) Full Histogram

(b) Histogram with Return Ranged from -2 to 2

Figure 1·3: Wealth Luck IV with 20% Threshold

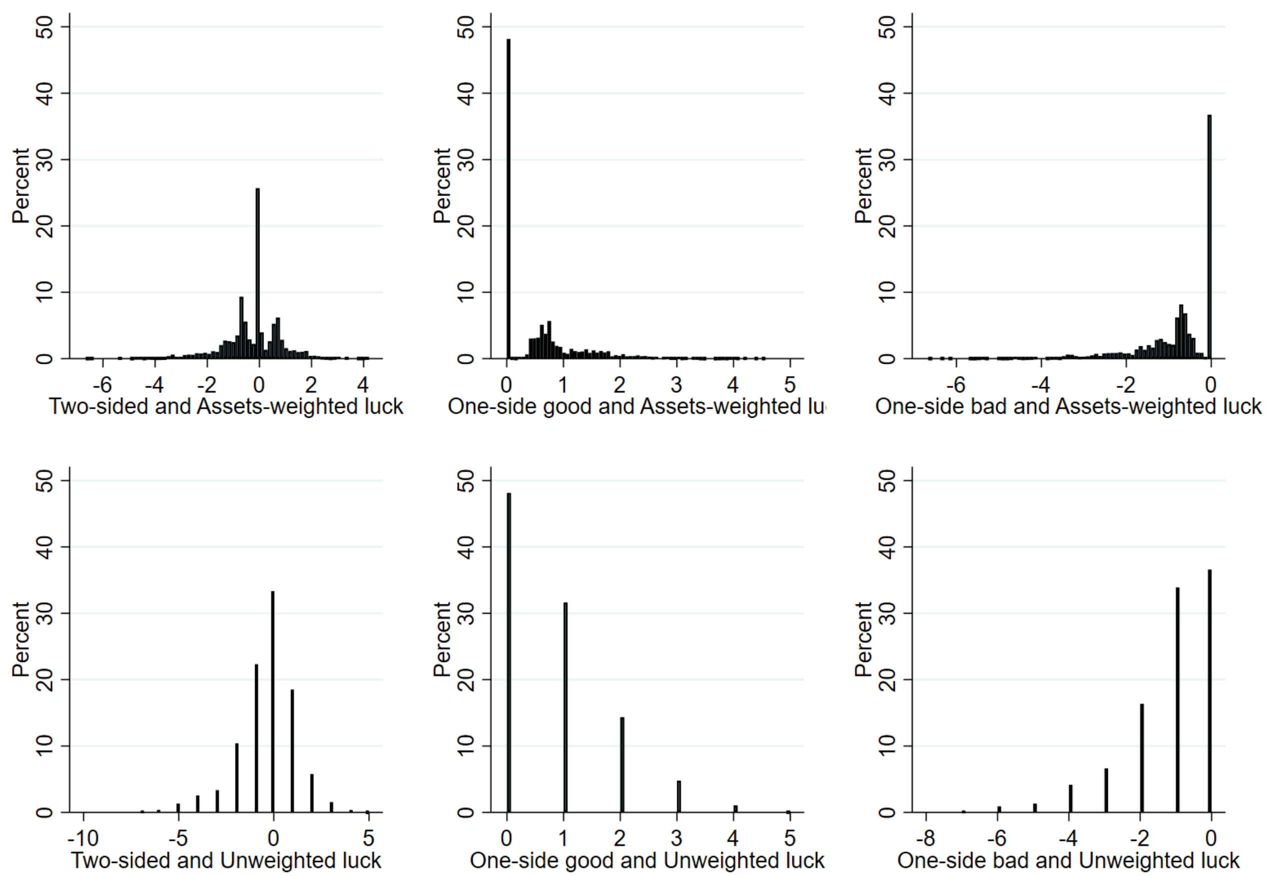


Figure 1·4: MPC out of Cash-on-Hand

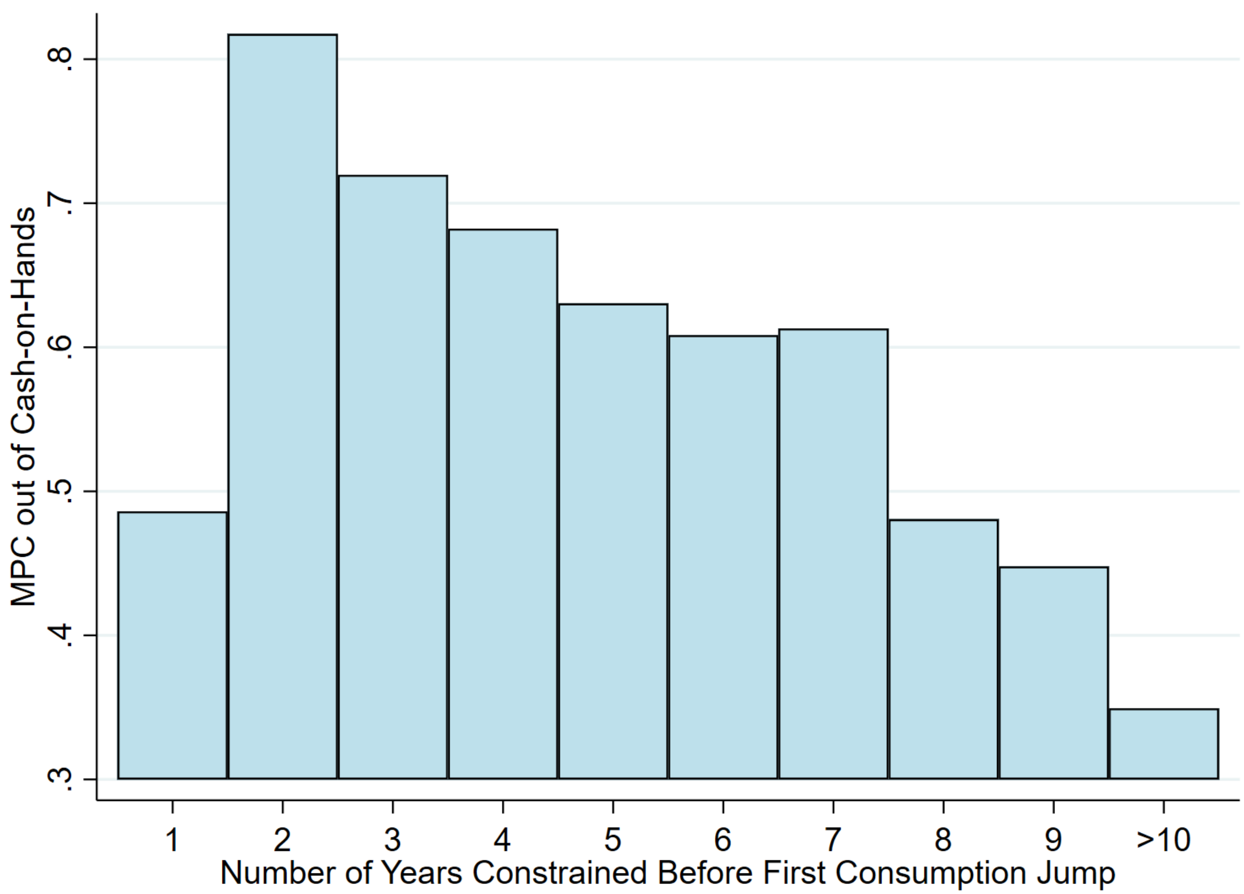
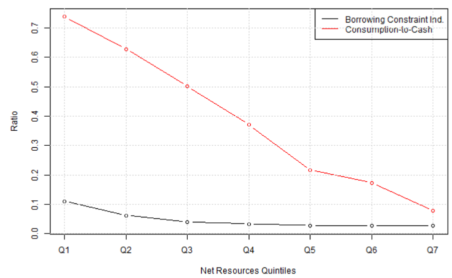
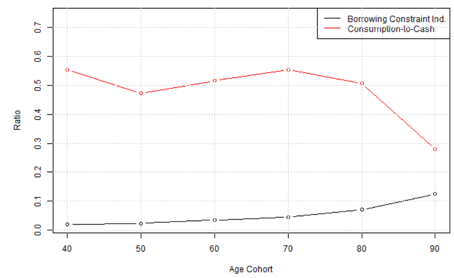


Figure 1·5: Breakdown of Borrowing Constrained Indicator

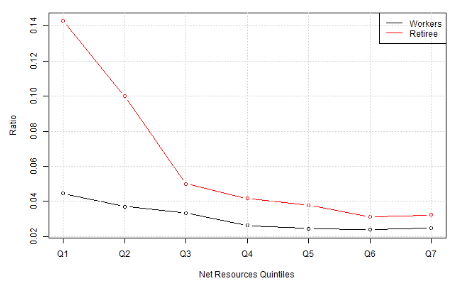


(a) Breakdown by Net Resource Quintiles

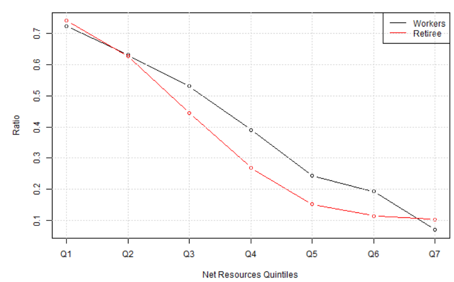


(b) Breakdown by Age Cohort

Figure 1·6: Comparison between Retirees and Workers



(a) Borrowing Constrained Indicator



(b) Consumption to Cash-on-Hands Ratio

Figure 1·7: Average Propensity to Consume on Resources

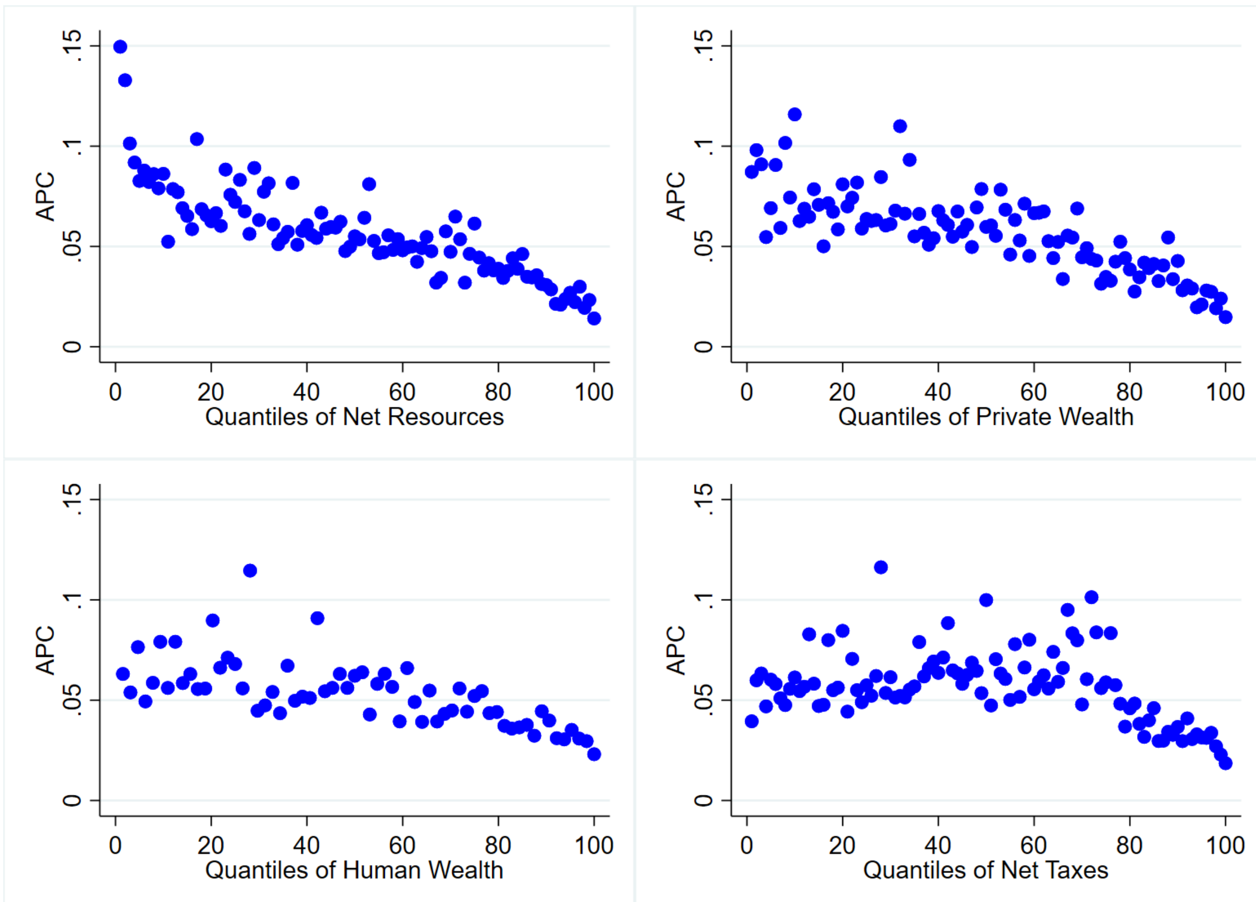
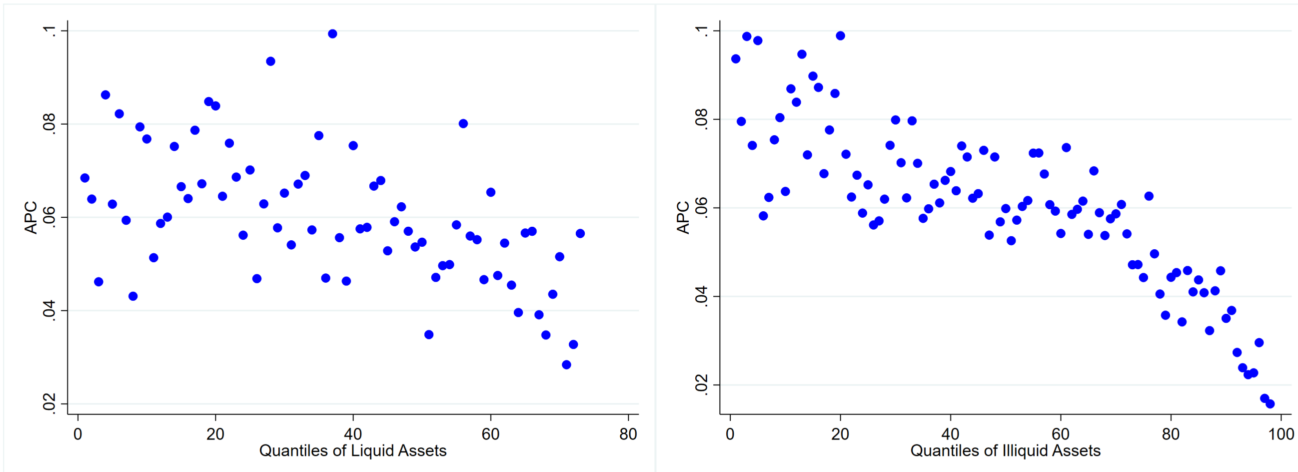


Figure 1·8: Breakdown of Private Wealth into Liquid Assets and Illiquid Assets



(a) Liquid Assets

(b) Illiquid Assets

Chapter 2

Is Uncle Sam Inducing the Elderly to Retire?

2.1 Executive Summary

Many, if not most, baby boomers appear at risk of suffering a major de cline in their living standard in retirement. With federal and state government finances far too encumbered to significantly raise Social Security, Medicare, and Medicaid benefits, boomers must look to their own devices to rescue their retirements, namely, working harder and longer. However, the incentive of boomers to earn more is significantly limited by a plethora of explicit federal and state taxes and implicit taxes arising from the loss of federal and state benefits as one earns more. Of particular concern is Medicaid and Social Security's complex earnings test and clawback of disability benefits. This study measures the work disincentives confronting those age 50 to 79 from the entire array of explicit and implicit fiscal work disincentives. Specifically, the paper runs older respondents in the Federal Reserve's 2013 Survey of Consumer Finances through The Fiscal Analyzer — a software tool designed, in part, to calculate remaining lifetime marginal net tax rates.

We find that working longer, say an extra five years, can raise older workers' sustainable living standards. But the impact is far smaller than suggested in the literature, in large part because of high net taxation of labor earnings. We also find that many baby boomers now face or will face high and, in very many cases, extremely high work disincentives arising from the hodgepodge design of our fiscal system. A third finding is that the marginal net tax rate associated with a significant in crease in earnings, say $20,000 per year, arising from taking a fulltime or parttime job (which could be a second job) can, for many elderly, be dramatically higher than that associated with earning a relatively small, say $1,000 per year, extra amount of money. This is due to the various income thresholds in our fiscal system. We also examine the elimination of all transfer program asset and income testing. This dramatically lowers marginal net tax rates facing the poor. Another key finding is the enormous dispersion in effective marginal remaining lifetime net tax rates facing seemingly identical households, that is, households with the same age and resource level. Finally, we find that traditional, currentyear (i.e., static) marginal tax calculations relating this year's extra taxes to this year's extra income are woefully off target when it comes to properly measuring the elderly's disincentives to work.

Our findings suggest that Uncle Sam is, indeed, inducing the elderly to retire.

2.2 Introduction

Ten thousand baby boomers are retiring each day. Many, if not most, are either poorly or very poorly prepared to finance retirements that may last longer than they worked. One marker of this problem is the financial reliance of retirees on Social Security. Social Security was designed to provide a basic floor to a retiree's living standard. But it provides at least 90% of financial support to over one-third of elderly households, and almost two-thirds of older households receive at least half of their income from Social Security.[1]

This heavy reliance on Social Security is not due to particularly generous levels of Social Security benefits. Instead, it reflects the wide spread failure of retirees to save for their retirements. One recent survey reports that 40% of baby boomers have no retirement savings whatsoever.[2] Data from the 2013 Survey of Consumer Finances show that median assets, including retirement accounts, of households age 55 to 64

[1] https://www.ssa.gov/policy/docs/chartbooks/fast_facts/2015/fast_facts15.html#pagei.

[2] www.cnbc.com/2015/04/13/retiring-well-not-most-baby-boomers.html.

equal just $537,225. Thirty-five percent of these households hold less than half of this amount, and 21% hold less than one-fifth of this amount. These and other dismal statistics hold dire implications for the economic well-being of baby boomers through time. According to Munnell et al. (2013), over half of today's workers, including boomers who are now retiring, will be unable to maintain their living standards in retirement.

In fact, the baby boomers' retirements could well prove financially more stressful than those of current retirees. This is a particularly dire possibility as the financial condition of today's fully retired generations is, itself, quite dire. In 2015, over one--fifth of married or partnered retirees and almost half of single retirees received 90% or more of their income from Social Security.[3] In that year, half of married or partnered retirees and three-quarters of single retirees received half or more of their income from Social Security.[4] Even those who initially have retirement savings are hardly set. Poterba et al. (2012) report that over half of the elderly outlive their financial assets.

The absolute level of income is another means to assess retirement finances. Roughly half of those now over 65 have less than $25,000 in annual income.[5] This is remarkably low given that the current poverty threshold for a single person is $11,800.[6] The Supplemental Poverty Measure (SPM) adjusts the official poverty measure for taxes, the value of food stamps and other in-kind benefits, the costs of out-of-pocket medical spending, geographic differences in housing expenses, and other factors. Based on this measure, one in seven people age 65 and older (15%) are poor compared to one in ten under the official measure. The SPM poverty rate among the

[3]https://www.ssa.gov/policy/docs/chartbooks/.

[4]A caveat is in order. Andrew Biggs suggests that these Social Security estimates may overstate retirees' dependence on the system. (See http://andrewgbiggs.blogspot.dk/2008/03/how-dependent-are-retirees-on-social.html.)

[5]http://kff.org/medicare/issue-brief/poverty-among-seniors-an-updated-analysis-of-national-and-state-level-poverty-rates-under-the-official-and-supplemental-poverty-measures/.

[6]https://www.payingforseniorcare.com/longtermcare/federal-poverty-level.html.

elderly is far higher for minorities - 28% for Hispanics and 22% for African Americans.

Why might baby boomers have a harder time financing their retirements than today's retirees? First, many baby boomers, particularly those with higher incomes, can expect to live longer. Indeed, one study predicts a 10% increase in their length of retirement.[7] Second, boomers are likely, on a riskadjusted basis, to earn lower real returns on their savings given the prevailing real interest rates. Today's 30-year TIPS (Treasury Inflation Protected Securities) yield is less than 100 basis points. In 1998, when 30-year TIPS were first introduced, they yielded above 300 basis points.[8]

Third, thanks to the legislated increase in the full retirement age, many will experience lower Social Security replacement rates. Fourth, the failure to index the thresholds at which the first 50% and then 85% of Social Security benefits are subject to federal income taxation means that a growing number of boomers will experience an ever higher rate of Social Security benefit taxation. Indeed, these third and fourth factors imply significantly lower long-run Social Security replacement rates over the next 15 years. Ellis et al. (2014) foresee an almost 15% decline in the replacement rate between now and 2030.[9]

Fifth, there are now extra Medicare premiums facing those with higher incomes. Moreover, the thresholds at which these premiums take effect are also not inflation indexed. Sixth, the Affordable Care Act included two new high-income Medicare taxes. One levies an additional .9% tax on wage earnings above specified thresholds. The other applies a 3.8% rate to asset income above the same thresholds. Again, these thresholds are, by law, explicitly and intentionally not indexed to inflation.

Seventh, out-of-pocket health care costs as well as the cost of supple mental health insurance (major medical) policies will likely continue to rise. These out--of-pocket costs include increases in out-of-pocket Medicare Part B costs due to three factors—higher Medicare premiums, higher Medicare Part B copayments, and health

[7] Ellis, Munnell, and Eschtruth (2014, figure 3.1 and table 3.1).

[8] `https://research.stlouisfed.org/fred2/tags/series?t=30year\%3Btips`.

[9] Ellis, Munnell, and Eschtruth (2014, figure 3.3).

care costs of outpa tient care not covered by Medicare Part B.[10] Indeed, rising out--of-pocket Medicare costs are projected to absorb roughly 2% more of baby boomers' Social Security benefit checks by 2030.[11] Eighth, out-of-pocket copays and deductibles for Medicare Part D, which covers prescription drug expenses, are also projected to rise in real terms.[12]

Ninth, current retirees can rely to a far greater extent on defined-benefit pensions than is the case for baby boomers. According to Form 5500 fillings, the US Department of Labor indicates that since 1975, the num ber of participants in defined-benefit pensions has been constant at around 40 million. This is true despite a near doubling of total US employment.[13] Meanwhile, participation in defined-contribution plans has increased from 11.5 million in 1975 to 92 million in 2013.[14] Instead, apart from Social Security, baby boomers will be relying primarily on their 401(k) and other defined-contribution retirement accounts. But participation in such retirement accounts has been very disappointing. Only 67% of boomers have retirement accounts of any kind and, as stated, many of those with retirement accounts have very low balances.[15]

Raising Social Security's benefit levels significantly could alleviate the boomers' financial plight, as well as that of many current poor and low-income elderly. But Social Security is 32.2% underfunded, that is, it is in extremely difficult financial straits.[16] What about the rest of the government's fiscal enterprise? Does it have the

[10]This is in addition to the prospect of having to face the high-income Medicare premium due to inflation raising nominal, but not real incomes.

[11]Ellis, Munnell, and Eschtruth (2014, 39).

[12]`http://kff.org/medicare/fact-sheet/the-medicare-prescription-drug-benefit-fact-sheet`.

[13]`https://fred.stlouisfed.org/series/PAYEMS`.

[14]`https://www.dol.gov/ebsa/pdf/historicaltables.pdf`.

[15]`http://time.com/money/4258451/retirement-savings-survey/`.

[16]According to table VIF1 in the 2016 Social Security Trustees Report, the system faces a $32 trillion fiscal gap over the infinite horizon. This is the difference between (a) the present value of the system's projected future benefit outlays, and (b) the sum of the present value of the system's projected future taxes and its current trust fund. The $32 trillion fiscal gap is 32.3% of the present value of projected future Social Security taxes. Consequently, the Social Security system is 32.3% underfinanced. Stated differently, it needs a 32.3% immediate and permanent tax hike to continue paying promised benefits through time. Since such tax hikes appear unlikely in the current political environment, the system seems to be in no position to raise its expenditures even further to help

financial wherewithal to subsidize far higher Social Security benefits? The answer is clearly no, according to estimates by Auerbach and Gale (2016), based on recent Harris (2012) projections.[17]

If the boomers are short on regular assets, short on retirement-account assets, short on defined-benefit pensions, short on Social Security benefits, long on explicit and implicit taxes, and the government can't help, boomers have but one option to maintain their living standards—earn more by working more at their current jobs, delaying their retirements, or returning to work if they have already retired.

This is far easier said than done. Hour constraints at their current jobs, age discrimination, increasing preference for leisure, and health limitations are four major factors that limit older workers' abilities and desire to raise their earnings through time. Older workers also experience age-related declines in productivity (see Kotlikoff and Gokhale (1992)) and, where applicable, negative private-pension accrual associated with ongoing work (see Kotlikoff and Wise (1989)).

Another major roadblock to higher earnings of older workers is government--imposed work disincentives operating through the tax and transfer system, which can limit the willingness of the elderly to work harder and longer. These work disincentives entail both explicit marginal taxation, such as FICA payroll taxes, implicit taxation associated with the loss of government benefits, such as food stamps, and increased premiums for such benefits as a result of increased earnings—for example, the income-based premiums for Medicare Part B.

This paper studies labor-supply work disincentives facing the elderly. Specifically, it measures the remaining lifetime marginal net tax rates of household heads and spouses/partners ages 50 through 79 included in the 2013 Federal Reserve Survey of Consumer Finances (SCF). The analysis is comprehensive, incorporating all major

bail out the baby boom generation.

[17] Auerbach and Gale estimate that the infinite horizon fiscal gap for the entire federal government is between 6 and 11% of GDP—between a third and more than half of government revenues, on an annual basis, depending on which government forecast of medical spending growth one uses.

federal and state explicit and implicit taxes that were in place in 2013.[18] Of particular concern is the potentially huge perceived work disincentive facing those in their early sixties associated with Social Security's complex earnings test. We say "perceived" because Social Security's Adjustment of the Reduction Factor (ARF), which occurs at full retirement age, largely undoes the earnings test's work disincentive. But perception of the ARF seems so limited that we assume here that it is ignored completely.

2.2.1 Summarizing Our Methodology

Our methodology, at its core, is very simple. We run all SCF households through The Fiscal Analyzer (TFA)—a detailed lifecycle consumption-smoothing program, developed in Auerbach, Kotlikoff, and Koehler (2016), which incorporates both borrowing constraints and life span uncertainty. In the course of doing its consumption smoothing, TFA determines how much each household can spend in present expected value, where the term *expected* references averaging over different longevity outcomes and spending encompasses all expenditures, including terminal bequests net of estate taxes. Suppose, for example, that earning an extra $1,000 raises a household's expected present value of lifetime spending by $700. In this case, the household faces a 30% marginal net tax rate.

In forming these remaining lifetime net tax rates, TFA incorporates all major federal and state tax transfer programs. There are roughly 30 such programs, including many one would not necessarily associate with the taxation of labor supply, such as the corporate income tax, the estate tax, food stamps, and, as mentioned, income-related Medicare Part B premiums. Measuring marginal net tax rates facing workers from all major fiscal programs is a major departure from common practice. Other studies of marginal labor taxation consider, at most, a subset of the universe

[18] The implicit taxation of labor earnings under Obamacare due to the loss in health insurance premium subsidies and increase in premiums associated with higher income is not included in this study.

of fiscal programs such as the combination of the federal income and FICA payroll taxes. But other fiscal policies can have even larger impacts on work incentives. An example here is the potential dramatic loss in all Medicaid benefits by low-income workers who earn too much extra money.[19] In the extreme, "too much" can be as little as one dollar.

Constructing remaining *lifetime* rather than current-year marginal net tax rates is an innovation as well, but it is also theoretically appropriate. Households do not necessarily spend discrete increments to their current earnings in the year they earn them. Indeed, doing so would be inconsistent with the objective of consumption smoothing, which includes financing spending in retirement. Instead, they spread/smooth extra resources, potentially over all future years. Precisely how much more a household spends immediately versus in the future depends not just on its preferences, but also on borrowing constraints it may face over time. It also depends on the extent to which the household can transform current saving into future spending. This transformation process depends, of course, on asset-income taxation, which one would not typically associate with the taxation of labor supply. Yet determining the present expected value of extra spending arising from extra earnings, taking into account the household's consumption-smoothing preference[20] and capacities to transform current

[19]We count Medicare and Medicaid at their government costs notwithstanding the potential for providers to add on costs that participants do not receive or for participants not to value $1 of benefits in these programs at $1 as discussed in Finkelstein et al. (2015).

[20]The precise nature of consumption smoothing depends on preferences. At present, we assume all households wish to maintain a stable living standard per household member through time, where living standard is defined as discretionary spending per effective adult with an adjustment for economies in shared living. However, our methodology can accommodate any desired profile of relative consumption by age. The inclusion of borrowing constraints leads to higher relative consumption by age among those so constrained. We will, in future work, consider alternative assumption about the desired age-consumption profile. Assuming that people wish, other things equal, to have lower spending when old than when young would reduce the impact of asset-income taxation. This would be particularly important for the rich who have relatively more assets. On the other hand, it may be that the rich have relatively steeper age-consumption profiles. For purposes of this study, our objective is to describe the fiscal system people face assuming they share the same intertemporal preferences. This lets us isolate the impact of the fiscal system. We also assume that households know their future labor earnings and asset returns, a simplification that we hope to relax in future work.

saving into future spending, produces precisely the theoretically appropriate weighted average of year-specific marginal net taxes on labor supply.[21]

The third nonstandard feature of our analysis is the systematic incorporation of survival outcomes. Households don't live for sure for specific numbers of future years. Instead, their members die at unpredictable dates. Thus, a 40-year-old single woman whose maximum age of life is 100 has 60 different survival paths to consider. If the 40-year-old is married to another 40-year-old, the couple has 3,600 survival paths to consider. TFA determines spending and net taxation along all such paths, and its measure of the expected present value of future spending arising from additional earnings weighs the spending along each survival path (e.g., the husband dies in five years and the wife in 22 years) by the probability of that particular survival path. To ensure that all resources are fully spent no matter the particular survival path, the present value of terminal bequests net of estate taxes arising at the end of each path is treated as spending. Moreover, any estate taxes associated with the gross bequests are properly discounted and included as part of the household's total expected present value of remaining lifetime taxes.

2.2.2 Summarizing Our Findings

Our first set of findings concern the degree to which working an additional five years would raise the elderly's sustainable living standard. We find that if all elderly now working were to continue to work for five more years, they would, on average, raise their sustainable living standards (annual discretionary spending per household member with an adjustment for economies in shared living) by roughly 5 to 8% de pending on their age and position in the resource distribution. These figures can be considerably lower for older elderly and considerably higher—as high as 13%—for younger elderly.

[21] An example of a yearspecific marginal net tax on labor supply is the amount one can spend exactly 20 years from now from earning an extra amount of money today, assuming all the extra money was allocated solely to spending more in exactly 20 years.

Turning to work disincentives, we find high median effective marginal net remaining lifetime net tax rates for all elderly from 50 to 79, with the exception of elderly of lesser means age 70 and above. For cohorts age 50–54, 55–59, 60–64, and 65–69, median net tax rates follow a common pattern. They are in the 30 to 40% range for the lowest resource quintile rising to near or above 40% for the second and third quintile, and close to or above 50% for the next two quintiles. Among the richest (measured by resources—the sum of net worth plus human wealth) 5% and 1%, median marginal net tax rates can exceed 60%.

We also examine the elimination of all transfer program asset and income testing. This dramatically lowers marginal net tax rates facing the poor and lower-resource households. The impact on higher-resource households is, as one would expect, considerably smaller.

We also find an enormous dispersion in effective marginal net tax rates even holding fixed the level of household resources. For example, nearly one-fifth of elderly in the lowest quintile face marginal net tax rates above 60%. Almost a quarter face marginal net tax rates below 20%. In the top resource quintile, a full third of elderly are in 60% or higher marginal net tax brackets, whereas 14% are in brackets below 40%.

The above-cited marginal net tax rate results are based on separately increasing the household head's and/or spouse/partner's earnings by $1,000 for just one year. But marginal net tax rates can be quite different, indeed, generally higher in the context of earning more for longer periods of time. This is due to Medicare income limits, Social Security earnings test limits, and Social Security income taxation thresholds, all of which come into play if extra earnings are sufficiently high. For example, increasing each elderly respondent's earnings by $10,000 for 10 years produces particularly high effective marginal net tax rates.

Consider, for example, the impact of this particular experiment on those age 62 through 65, 80% of whom are collecting Social Security benefits. Among the bottom-resource quintile in this sample, nearly two in five face marginal net tax rates above 80%. Over half face marginal net tax rates above 50%. Among this sample's top-resource quintile, over 80% face marginal net tax rates above 50%, and over half face rates above 60%. Many of these households face the earnings test, which reduces benefits as an individual's labor market earnings increase. In our base specification, we assume that households perceive that the earnings test is a pure tax on benefits, that is, that they ignore the increase in future benefits that result. This seems reasonable, given the opacity and complexity of the Adjustment of the Reduction Factor formula. If individuals do understand the future benefits that result, their marginal tax rates would generally be lower, but still high. For example, Social Security recipients between ages 62 and 65 (i.e., those who potentially face the earnings test) in the middle quintile of the resource distribution would face a lifetime marginal tax rate of 47.7% rather than 55.1%. However, it is also possible that understanding that future Social Security benefits will increase raises lifetime marginal tax rates because this will induce a loss of other, means-tested benefits, notably Medicaid.

2.3 Literature Review

There are three types of prior studies that bear on our analysis. One type considers the general nature of labor supply among the elderly. The second considers the impact of policy changes on labor supply, and the third attempts direct measurement of marginal tax rates.

Haider and Loughran (2010) use the Current Population Survey and the Health and Retirement Study to provide a broad survey of the employment of the elderly, which they define as those over age 64. The authors show that more educated, wealthier, and healthier elderly people are the most likely to work. But even among those who do work past age 64, employment is marked by voluntary or involuntary limitations on hours worked and relatively low wages attributable to the relatively heavy concentration of elderly employment in services. The authors also find that a disproportionate proportion of the working elderly are self-employed. This arguably constitutes evidence for age discrimination.

Forman and Chen (2008) document the general long-term decline in labor force participation of older men. This trend has reversed in recent years. The labor force participation rate of those over age 55 is now 35%, up from 30% a quarter century ago. Moreover, the BLS forecasts a 40% elderly participation rate by the early 2020s. Unfortunately, this projected rise appears too little, too late, to fix the baby boomers' retirement financing problem.

While our paper is perhaps the first to integrate the effects of the broad range of fiscal programs on the incentives for work by the elderly, there have been significant contributions estimating the impact of public-pension provisions on retirement incentives and retirement, including Kotlikoff and Wise (1989). Arguably, the most important is Gruber and Wise (1999), who compile analyses of the implicit tax rates on individuals over age 55 imposed by the various publicpension provisions in several leading economies (Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, the United Kingdom, and the United States), including early retirement provisions and delayed retirement credits. They find a wide variation in incentives, with implicit tax rates at the early retirement age ranging from –1% (in the United States) to 141% (in the Netherlands), and also find that there is a strong negative relationship between the "tax force" to retire (the sum of implicit tax rates between the early retirement age and age 69) and the labor force participation rate of males ages 55–65. While these estimates of incentives are important, they do not incorporate the effects of other significant fiscal programs, which can have a substantial additional impact on work incentives.

A number of other studies have examined how specific policies affect the labor supply of the elderly. Haider and Loughran (2008) and Song and Manchester (2007) reported that, starting in 2000, the elimination of the earnings test for those who were at or above full retirement age had little influence on the elderly's labor supply.

Using HRS data, Johnson et al. (2003) showed that for an increase in health insurance premiums of $1,000, men (women) ages 51 to 61 are less likely to retire early by 0.17 (0.24) percentage points because of lack of retiree benefits. Thus, an expanded Medicare program covering individuals above age 61 would increase the retirement rate, although the impact is small.

Coile and Gruber (2007) analyzed the impact of two policies on the retirement rate. Raising the ERA (early retirement age, 62 years old) and NRA (normal retirement age, then 65 years old) by three years would, by their estimates, lead to a decrease in the average retirement rate of 1 to 3 percentage points (varying because of different assumptions in the model) for both men and women. Moving to a more generous policy, say, a system with a common replacement rate of 60% at age 65, would increase the average retirement rate by 2 to 3 percentage points.

Samwick (1998) estimated that the increase in pension coverage by 50% in the postwar period resulted in a 5% increase in the retirement rate of those ages 50–70, or 27% of the actual reduction of labor force participation. Munnell et al. (2008) maintain that maincareer jobs are no longer the norm for one's terminal job. This suggests that lower wages in second-career jobs may be inducing earlier retirement in the form of taking Social Security benefits early and then earning just up to the point at which the earnings test comes into play. French and Jones (2011) use HRS data to show that if the Medicare eligibility age were in creased from age 65 to 67, workers ages 60 to 69 would work 0.074 more years on average; elimination of two years of Social Security benefits would lead to an additional 0.076 years of work.

Our method of computing lifetime marginal net tax rates is to compare the increase in the expected present value of spending with the increase in the expected present value of future lifetime earnings. Many previous papers have adopted similar concepts when calculating marginal tax rates, but without the detail or comprehensiveness of our forward-looking calculations, which incorporate the current and future effects of a broad range of tax and transfer programs.

Joines (1981) estimates current marginal federal income tax rates for the US tax system, estimating increments of personal income tax liability using a tax schedule inferred from taxes paid and income received by individuals in adjacent income classes. This is unlike our approach in several respects, as we incorporate actual tax systems, include transfer payments as well, and measure taxes and income over time, in present values. Feldstein and Samwick (1992) develop a method similar to ours to calculate lifetime marginal net tax rates associated with Social Security taxes and benefits, estimating for different types of individuals (varying by income, age cohort, gender, and marital status) the incremental net tax rate on additional labor earnings, in present value. Our methodology extends such an approach to include a broad range of tax and transfer programs, not just Social Security.

Romich (2006) uses data from residents of Wisconsin to calculate marginal tax rates, considering both federal transfer programs like Temporary Assistance for Needy Families (TANF) and state programs, for example, the Homestead Credit, a housing subsidy for low-income tax filers. Family spending on child care and rents are hypothetical and the same for all families in this research, and calculations are based on current net taxes and income.

The closest antecedents to this study are those by Gokhale and Kotlikoff (2002) and Gokhale et al. (2002). Their methodology is largely similar to ours, but leaves out alternative life-span paths and also is based on stylized, that is, hypothetical households. They, too, report remarkably high marginal tax rates on labor supply facing Americans at different levels of annual earnings. But since they are providing illustrative calculations, they are not able to evaluate the dispersion in marginal net tax rates.

2.4 Methodology, Data, and Past and Future Earnings Imputations

The appendix to Auerbach et al. (2016) describes precisely how TFA makes its calculations, but the basics of our approach can be captured in three equations.

2.4.1 Methodology

Equation 2.1 defines remaining lifetime resources, R, as

$$R = H + W \tag{2.1}$$

where H, human wealth, is the present value of lifetime earnings and W is private net wealth. The measure R constitutes the lifetime resources available before taxes are paid or transfer payments are received.

Equation 2.2 defines remaining lifetime spending, S, as

$$S = R - T \tag{2.2}$$

where T stands for the present value of remaining lifetime net taxes (taxes paid less transfer payments received).

Equation 2.3 clarifies our calculation of a household's remaining lifetime marginal net tax rate, τ.

$$\tau = 1 - \Delta S/\Delta R = \Delta T/\Delta R \tag{2.3}$$

Note that equations 2.1 and 2.2 hold along any realized survival path since the present value of realized spending has to equal the present value of realized resources net of realized net taxes.[22] Hence, each of the variables, R, T, and S can be viewed as expected present values, that is, as weighted averages across all realized future

[22] Again, our treatment of the present value of bequests net of estate taxes as part of S and our inclusion of the present value of estate taxes as part of T, ensures that all resources are either spent by the household or paid to government. (If T is negative, which is certainly can be, the payment to the government is negative.)

survival paths of the path-specific realized present values of the variables, with the weights being the probability of the particular survival path occurring.

Formula 2.3 is quite general. It holds no matter the nature of the in crease in labor earnings and, thus, human wealth, H. Consequently, we can just as easily use TFA to calculate the marginal net tax rate when H rises, say, due to a \$1,000 increase in current-year earnings or a \$20,000 increase in all current and future years earnings until retirement.

2.4.2 Data

As mentioned, our primary data come from the 2013 Survey of Consumer Finances (SCF). We also use all past waves of the Current Population Survey (CPS) to impute past Social Security-covered earnings to our households as well as to project future covered earnings.

Table 2.1 provides a count of our sample households by cohort and resource percentile. In total, we have 2,658 households with heads ages 50–79. As one would expect, the majority are in the younger age groups. Only 254 are age 75–79. Our percentile groups are formed using sample household population weights, and the households are distributed to the different resource percentiles based on their ranking across all SCF households, not just those 50–79. Note that the number of households in the top 5% and top 1% categories are larger than one would expect based on a nonstratified, random sample. But the SCF oversamples the rich.

The SCF provides the value of W, the household's (i.e., household head's and spouse's, if married) tangible wealth. All inputs from the 2013 survey are transformed into 2015 dollars and all provisions of all fiscal systems are from 2015. The 2013 SCF has 6,015 families.[23] Appendix B in Auerbach et al. (2016) details our sample selection and coding decisions. It makes clear that we attempted to include all observations

[23] Missing data are imputed randomly and presented in five different SCF data sets called implicates. We report results only for the first implicate, but we have run our analysis with the other implicates and found no significant differences in results. The time required to process all households in the SCF for one implicate is roughly 16 hours.

in the SCF. Unfortunately, the SCF data does not include state identifiers. We may, in future work, randomly assign households to different states. But in this study we assume that all SCF respondents reside in Ohio, which is unexceptional in terms of its state tax system and tax rates.

A key component of our calculations involving saving and wealth is the before-tax rate of return on household saving. For this, we use the average return on wealth for the period 1948–2015 based on data from the National Income and Product (NIPA) accounts and the Federal Reserve's Flow of Funds data. The numerator for each year equals the share of national income not going to wages and salaries (including the portion of proprietors' income we impute to labor). The denominator is aggregate wealth of the household sector plus financial wealth (negative if a net liability) of the federal, state, and local government sectors. The resulting average real before-tax rate of return is 6.371%. To calculate nominal rates of return, we assume an inflation rate of 2%.

2.4.3 Imputing Future and Past Labor Income

To form H, the present expected value of future labor earnings, we need to forecast, for each individual, a trajectory of future labor earnings. In addition, we need to "backcast" past earnings in order to calculate Social Security-covered earnings, which enter into the calculation of future Social Security benefits.

In forecasting and backcasting labor earnings, we statistically match Current Population Survey (CPS) households to SCF households. In particular, we define cells in each wave of the CPS by age, sex, and education,[24] and use successive waves to estimate annual earnings growth rates by age and year for individuals in each sex and education cell. These cell growth rates are used to backcast each individual's earnings history. We also project future earnings for each particular cell defined by age and demographic group until age 67 (when we assume individuals claim retirement ben-

[24] In cases where cells have fewer than 25 observations, we merge cells for adjoining ages and assume that average growth rates for these merged cells hold for all included ages.

efits) by using average historical growth rates by age, net of average overall earnings growth, and plus an assumed future annual general real growth rate of 1%.[25]

These past and future growth-rate estimates are for cell aggregates and do not account for earnings heterogeneity within cells. To deal with such heterogeneity, we assume that observed individual deviations in earnings from cell means are partially permanent and partially transitory, based on an underlying earnings process in which the permanent component (relative to group trend growth) evolves as a random walk and the transitory component is serially uncorrelated. We also assume that such within-cell heterogeneity begins in the first year of labor force participation.

In particular, suppose that, at each age, for group i, earnings for each individual j evolve (relative to the change in the average for the group) according to a shock that includes a permanent component, p, and an i.i.d temporary component, e. Then, at age a (normalized so that age 0 is the first year of labor force participation), the within-group variance will be$a\sigma_p^2 + \sigma_e^2$. Hence, our estimate of the fraction of the observed deviation of individual earnings from group earnings, $y_{ij}^a - \overline{y}_i^a$, that is permanent is $a\sigma_p^2/(a\sigma_p^2 + \sigma_e^2)$. This share grows with age as permanent shocks accumulate. Using this estimate, we form the permanent component of current earnings for individual $j, \widehat{y}_{ij}^a$,

$$\widehat{y}_{ij}^a = \overline{y}_i^a + \frac{a\sigma_p^2}{a\sigma_p^2 + \sigma_e^2}(y_{ij}^a - \overline{y}_i^a) = \frac{a\sigma_p^2}{a\sigma_p^2 + \sigma_e^2} y_{ij}^a + \frac{\sigma_e^2}{a\sigma_p^2 + \sigma_e^2} \overline{y}_i^a \tag{2.4}$$

and assume that future earnings grow at the group average growth rate.[26] Further, we make the simplifying assumption that the permanent and temporary earnings shocks have the same variance, a reasonable one based on the literature (e.g., Moffitt and

[25] The appendix to Auerbach et al. (2016) provides full details of our use of the CPS data in forming our backcasts and forecasts.

[26] Because we ignore earnings uncertainty in our calculations, we set all future permanent and temporary shocks to zero.

Gottschalk (2011); Meghir and Pistaferri (2011)), so that equation 2.4 reduces to:

$$\widehat{y}_{ij}^{a} = \frac{a}{a+1} y_{ij}^{a} + \frac{1}{a+1} \overline{y}_{i}^{a}$$

For backcasting, we assume that earnings for individual j were at the group mean at age 0 (i.e., the year of labor force entry), and diverged smoothly from this group mean over time, so that the individual's estimated earnings t years prior to the current age a are:

$$\overline{y}_{i}^{a-t} + \frac{a-t}{a} (\widehat{y}_{ij}^{a} - \overline{y}_{i}^{a}) \frac{\overline{y}_{i}^{a-t}}{\overline{y}_{i}^{a}} = \frac{t}{a} \overline{y}_{i}^{a-t} + \frac{a-t}{a} \widehat{y}_{ij}^{a} \frac{\overline{y}_{i}^{a-t}}{\overline{y}_{i}^{a}} \tag{2.5}$$

That is, for each age we use a weighted average of the estimate of current permanent earnings, deflated by general wage growth for group i, and the estimated age-a group-i mean also deflated by general wage growth for group i, with the weights converging linearly so that as we go back we weight the group mean more and more heavily, with a weight of 1 at the initial age, which we assume is age 20.

2.4.4 Intended and Imputed Ages of Retirement and Social Security Collection in the SCF

Table 2.2 provides the distribution of retirement ages specified in our data for the different age cohorts. In forming this table and producing our results, we use respondents' stated retirement ages and assume they stop working entirely thereafter. For those who say they will never retire, we set their retirement age to the larger of (a) their current age plus three years, and (b) age 70. All working respondents are required by the SCF to answer the survey's question concerning their intended age of retirement. A relatively high share of the sample's individuals was already retired at the time they were interviewed by the SCF. Among those still working, a remarkably small share specify ages 62 or 66 for the ages at which they will retire. Indeed, among those between 50 and 59 who are still working, over half say they will either retire at or after age 70 or never retire. Either the respondents chose not to take this question seriously or they have, as a group, highly unrealistic expectations about how long they will be able or want to work. This may help explain why so many baby boomers appear so poorly financially prepared for retirement. Nonetheless, we use respondents' projected retirement age to specify, as indicated above, when respondents entirely stop earning money.

Unfortunately, the SCF does not ask respondents their intended dates for collecting their Social Security retirement benefits. As a result, we need to impute these dates. Our method is very simple. For each individual, we set the age of retirement benefit collection at the actual or imputed retirement age, or age 70 if the actual or imputed retirement age is later. We also set the ages for collection of spousal benefits and widows' benefits at the respondent's full retirement age. Unfortunately, the public-use SCF sample does not tell us if single respondents are divorced, widowed, or never married. As we have no information on the former spouse in the case of divorcees (whose ex may or may not be alive) or the decedent spouse in the case of widows, we are forced, in this study, to treat all single respondents as never married. We do assume that married spouses file for their spousal benefits starting at full retirement age and that married spouses who become widowed start receiving their widow's benefit at full retirement age. These collection ages are then subject to override by Social Security's deeming provisions.[27]

The SCF can be used to determine the ages that respondents who are already collecting first began collecting their retirement benefits. Table 2.3 presents these data. Note that almost half of respondents report taking their retirement benefit as soon as it became available, at age 62. Almost one-quarter took it at 65. All told, over 90% of respondents receiving Social Security took their retirement benefit at or below the current full retirement age, 66, and, obviously, well before age 70. This appears to be due, in part, to the inability of households to make it financially to 70 without Social Security. This liquidity constraint can, itself, reflect a decision by such households to

[27]For example, a couple who are both 55-year-olds in 2013 and indicate that they will take their retirement benefits at 70 will, under the assumption that they both take their spousal benefit at 66, be forced to take their retirement benefit at 66 as well. This reduces or raises their lifetime benefits depending on their relative sizes and absolute levels of past covered earnings.

stop working because they believe that, due to the earnings test, it doesn't pay. This assumes, of course, that they are unaware of the Adjustment of the Reduction Factor. Another explanation is that older Americans do not appreciate longevity risk and, instead, assume they will die "on time" (i.e., at their life expectancies) or earlier. As a result, they can easily undervalue the far higher benefits available from waiting to collect benefits at higher ages.

2.4.5 Projecting Mortality

A key element of our calculations is uncertain lifetimes, based on assumed mortality probabilities that vary by age, sex, and, of particular relevance for our calculations, the level of resources. We utilize estimates from the recent study by the National Academies of Sciences et al. (2015), which modeled mortality as a function of age, sex, birth year, and income quintile, where income was measured using a truncated AIME calculation based on earnings between ages 40 and 50 and the variable for couples was set equal to the sum of spouses' truncated AIME divided by the square root of 2.[28] We follow the same procedure to sort households to determine their quintile for purposes of assigning mortality profiles, except that we use a full AIME measure, imputed to age 60 in cases where individuals have only partial earnings records. Mortality is assumed to begin starting at age 55.

Note that the resource definition used for assigning mortality profiles is different from that used in our analysis below, for example, not including wealth and being based on average earnings until age 60, rather than resources as of the individual's current age. However, there should be considerable overlap between the two methods of classification.

[28]We are grateful to Bryan Tysinger for providing the code for these calculations.

2.5 Federal and State Fiscal Institutions

Table 2.4 lists the roughly 30 different fiscal institutions included in our analysis. The major elements in the table that concern the elderly are the federal personal income tax, Ohio's state income tax, Ohio's sales tax, the federal corporate income tax, the FICA tax, Social Security benefits, Medicaid benefits, Medicare benefits, Medicare Part B premiums, food stamps, Supplemental Security Income, and disability benefits.[29]

As the table shows, the federal personal income tax has many components that separately influence the rate of marginal net taxation. These components include progressive tax rates, the Earned Income Tax Credit, the Alternative Minimum Tax, preferential taxation of capital gains and dividends, the taxation of Social Security benefits, Medicare's new high-income payroll and asset-income taxes, and the phase-out of deductions and exemptions.

Figure 2·1 shows a breakdown of average lifetime resources, taxes, and transfer payments by resource quintile. The 4th quintile, for example, references all households ranked from 61st to 80th in the distribution of remaining lifetime resources (the present value of remaining lifetime earnings plus household net wealth). All observations are pooled in this figure. The appendix (http://www.nber.org/data-appendix/c13866/ appendix_c13866.pdf) presents comparable figures, but for the specific cohorts. Figure 1 shows the relative and absolute importance of different types of assets and sources of income in determining overall resources. It does the same for the components of taxes and transfer payments. What we see is largely what we expect. Here are five examples. First, a disproportionate share of the assets of the

[29] We ignore housing subsidies, which are also income tested, because based on our understanding subsidized apartments and other forms of housing subsidies are limited in number and are allocated on a waiting-line basis. While the incidence of the corporate income tax may fall on workers to a large extent, the corporate income tax represents a marginal tax assessed on additional asset income since any given worker's additional saving (arising from additional earnings) will entail receiving a lower return due to the corporate tax, but that worker's work and saving responses to the tax will be too small to influence the system's overall incidence.

top 20% is represented by regular assets as opposed to retirement accounts or home equity. Second, the poorest 20% of households have dramatically lower assets, on average, than households in other cohorts. Third, self-employment income is particularly important for the top quintile. Fourth, federal income taxes matter far more for higher-resource quintiles. And fifth, Social Security and Medicare benefits are the major transfer payments for all resource quintiles, with Medicaid benefits also playing a significant role for the poor.

Although figure 2·1 tells us about averages in the data developed and used in this study, it does not directly bear on the main question of this study—the size of marginal effective remaining lifetime net tax rates. The reason is simply that our tax and transfer system is highly nonlinear. Consequently, a tax or transfer that is quite small, on average, can have a huge impact on marginal work incentives.

2.5.1 Social Security's Earnings Test

Of particular interest and concern when it comes to the elderly's incentives to work is Social Security's earnings test. For those who file for their Social Security benefits early (before full retirement age, currently 66), which represents roughly over three--quarters of retirees, the earnings test can increase their effective marginal net tax rate by up to 50 percentage points.

We say "can" for four reasons. First, during the year one reaches full retirement age benefits are reduced 33¢, not 50¢ for each additional dollar earned, and only through the day one reaches full retirement age. Second, earnings have to exceed an exempt amount before they trigger benefit cuts. The 2016 annual exempt amounts were $15,720 for those between age 62 and January 1st of the year they will reach full retirement age, and $41,880 between January 1st of the year they will reach full retirement age and the day they reach full retirement age.

Third, Social Security's Adjustment of the Reduction Factor, if understood, undoes the labor supply tax associated with the earnings test. It does so at full retirement age by raising all of the specific type of benefits lost under the earnings test to fully offset, on an actuarial basis, the earnings test's confiscation of those benefits. Indeed, those earning enough to lose all their benefits in a given year may face no marginal taxation from the clawback of Social Security benefits.

Fourth, for those who understand Social Security's Adjustment of the Reduction Factor (ARF) provision, the clawback may, thus, only be temporary. We emphasize the world "may" for two reasons. First, for households that are borrowing constrained, but do understand the Adjustment of the Reduction Factor, the value of receiving higher benefits in the future will not fully offset the loss of benefits now as the marginal utility of consumption in the present exceeds that in the future. Second, the ARF only raises the specific benefit that was lost due to the earnings test. For those who will receive a different benefit after full retirement age (e.g., a widow's benefit rather than a retirement benefit) having a higher benefit that one is not actually receiving is of no avail to those who were hit by the earnings test.[30]

The ARF is, however, sufficiently complex that very few workers subject to the earnings test appear to understand it. As a consequence, many workers who take Social Security early and are subject to the earnings test may perceive they are facing either a 50% or a 33% marginal Social Security tax when, in fact, their effective marginal tax arising from the earnings test is zero. This concern about misperception of the earnings test is supported by the propensity of workers potentially subject to the earnings test to bunch their earnings at or just below the earnings test exempt amounts.[31]

Workers can, of course, avoid the earnings test entirely by simply waiting until

[30] One additional factor in our calculations is that the ARF is not actuarially fair on a discounted present value basis, given the before-tax rate of return used in our calculations. The ARF is based on an underlying roughly 3% real return. But our TFA model uses the average return on assets in the economy in the postwar period, which as discussed in Auerbach et al. (2016), is 6.371%. This return has been remarkably stable, exhibiting a standard deviation of just .49%. The fact that the real pretax return to assets is over twice the 3% used to form the ARF means that, in our calculations, the ARF offsets somewhat less than half of the earnings test, even assuming that it is correctly perceived by workers (i.e., that the fourth caveat raised above does not hold).

[31] See Friedberg (2000).

full retirement age to file for their benefits. But doing so raises another question of perception. Many workers who become eligible for Social Security may not realize that waiting to collect their benefits will fully, indeed, in most cases, more than fully compensate them for foregoing benefits in the short run. They may not be aware or understand the actuarial adjustments associated with waiting to collect. They may not realize that the higher benefits from waiting are real not nominal, that is, they are above and beyond future adjustments for inflation. And they may not understand the nature of actuarial calculations. In this regard, many workers appear to focus on their life expectancy, not their maximum age of death in considering their future longevity.

Social Security encourages this behavior by referencing life expectancy in different parts of its website and by providing a life expectancy calculator on their website.[32] For those convinced they will die at their life expectancy, waiting to collect a higher benefit will be perceived as actuarially unfair even when it is fair or more than fair. This misperception will lead workers to take their benefits as soon as possible, at which point the complete or partial misperception of the ARF coupled with misperception of the AFR's real actuarial adjustments can leave workers in 33 to 50% higher perceived marginal tax brackets. Marginal tax rates of 33 to 50% represent a significant work disincentive on their own, but they come on top of other explicit and implicit marginal taxes.

In our basic calculations we assume that the elderly do not understand the AFR and we do not, therefore, incorporate it in our results. We do, however, show the sensitivity of our results to this assumption and, thereby, the potential impact of the earnings test on work disincentives.

[32] www.ssa.gov/planners/lifeexpectancy.html.

2.6 How Much Can The Elderly Raise Their Living Standards By Working More?

As a starting point for our analysis, we note the findings of Butrica et al. (2006), who use the Urban Institute's Dynamic Simulation of Income Model (DYNASIM) to study the financial impact of the elderly's working longer.[33] Their study suggests that workers' living standards can be raised by over 50% based on just five additional years of work from age 50 onward. To quote their study:

> Workers, according to DYNASIM3, could increase their annual income by an average of 5% from age 50 onward for one additional year of work, and 25% for five additional years of work.

If these findings are accurate, policies that discourage work by the elderly would be of far greater concern than many analysts, including us, have assumed. Consequently, we felt it important to repeat their analysis. Our results are shown in tables 2.5 and 2.6. The sample used in these tables encompasses those age 50–79 who are currently working. In the exercise, we extend the retirement age of both the household head and spouse/partner by either one or five years and assume workers earn the amounts projected based on our above-described method. Even though many, if not most, respondents do not likely understand the ARF, we include it in our analysis since the household will end up with this extra income and our goal here is to understand all the returns from working. The tables include working single households as well as households with couples where at least one spouse/partner is working. Hence, the weighted average percentage increase in lifetime spending reflects only what working households can expect, on average, if they postpone their retirements. For all house-

[33] DYNASIM, the tool that Butrica et al. (2006) uses, ages a starting self-weighting sample of about 100,000 individuals from the 1990 to 1993 Survey of Income and Program Participation in yearly increments to 2050. Parameters in DYNASIM are estimated from longitudinal data sources. DYNASIM can project retirement age and Social Security takeup age, and simulate major sources of retirement income like SS benefits and pension income.

holds, including nonworking households, in any given cell the percentage increase in spending will be smaller.

Among those ages 60–64, the percentage gain for working five years more is 15.7% for those in the lowest quintile, 10.0% for those in the third quintile, 7.6% for those in the top quintile, and 5.1% for those in the top 1%. The corresponding figures for all households (not just those with at least one worker) are 8.1%, 7.9%, 6.4%, and 3.8%.

In the case of a one-year retirement extension, the results for the 60–64 year-old cohort for the same four percentile groups are 6.2%, 2.6%, 1.9%, and 1.2%. The percentage increases averaged across all households in this cohort are 3.2%, 2.1%, 1.6%, and .9%.

If we consider a younger cohort, those age 50–54, the results from working five additional years for the lowest, middle, and highest quintiles and the top 1% are 8.9%, 9.7%, 8.2%, and 7.7% among working households. Since most households in this age range are working, the results averaged across all households are not much smaller.

These percentage increases, even considering just working households, are much smaller than Butrica et al. (2006) report. Indeed, across all cells in tables 2.5 and 2.6, the largest percentage increase in the remaining lifetime discretionary spending is 20.0% for the lowest quintile in the age 70–74 cohort. Part of the reconciliation in the two sets of results is that Butrica et al. (2006) are considering gross income, not net income or discretionary spending. Discretionary spending is, of course, financed out of net remaining lifetime resources. This would make their percentage changes larger than ours. Another reason their changes should be larger is that discretionary spending is financed, in part, out of household assets, both regular and retirement account assets. Consequently, any given percentage change in labor earnings should have a smaller percentage impact on discretionary spending to the extent that the household has assets. This also explains why our percentage changes in discretionary spending are lower for cohorts in higher resource percentiles. A third reason for why we are finding a smaller percentage change in living standard is our inclusion of all transfer payments. The fourth and probably most important reason for the differences in results is that Butrica et al. (2006) assume that all extra funds earned are saved through retirement and then used to purchase an annuity.[34]

2.7 The Elderly's Rates of Remaining Lifetime Marginal Net Taxation

We first consider median remaining lifetime marginal net tax rates arising from a $1,000 increase in current-year earnings. This is on top of our baseline projection of future earnings for the workers. Table 2.7 shows the results by resource quintile and the top 5 and top 1 percentiles for the entire sample, as well as for specific cohorts. These and all other medians were constructed taking into account SCF household sample weights.

The median rates in most cells are remarkably high. Take, for example, those age 55–59 in the third resource quintile. Their median marginal net tax rate is 46.2%, meaning that half those in this cell face even greater work disincentives. Or, consider those age 70–74 in the highest quintile; their median marginal net rate is 57.6%. At the very top end of the resource distribution, median rates exceed 60% for all age groups except the oldest. The basic pattern of median rates rising with resources holds for all age groups except those 75–79, where there is a significant drop in going from the first to the second quintile, but with median rates rising thereafter for higher resource groups.

Tables 2.8 and 2.9 repeat Table 2.6's exercise, except their increments to current-year earnings are $10,000 and $20,000, respectively.[35] These larger earnings increments incur higher median marginal net tax rates. For example, the just-mentioned age 55–59 third quintile median marginal net rate is 49.3% in table 2.9 compared to

[34] Presumably a nominal annuity will be front-loaded in terms of its impact on consumption, given the fact that inflation will erode the future purchasing power of the annuity.

[35] Again, these earnings are in addition to baseline projected future earnings.

46.2% in table 2.7, and the top 1% of those 75–79 have a 64.2% median marginal rate in table 9 compared with a 59.3% median rate in table 2.7.

These particular cell differences are small, but for other cells the differences in marginal net taxation from a $1,000 increase in current earnings versus a $20,000 increase can be major. Take, for instance, the lowest age 50–54 quintile. Its median marginal net tax rate is 38.0% in the case of a $1,000 earnings increment and 77.4% in the case of a $20,000 earnings increment. This reflects the loss of the poor's Medicaid benefits associated with earning so much more. Loss of Medicaid also plays a role in raising the median rate of 32.7% for those in the lowest quintile ages 60–64, aris ing from a $1,000 increment to current earnings to 82.5%, arising from a $20,000 increment. But the earnings test also comes into play for many respondents between 62 and 64 who are collecting Social Security because it puts them above the threshold at which the earnings test's 50% marginal rate comes into play. Figures 2 and 3, which consider $1,000 and $20,000 earnings increments lasting for one year, provide a good snapshot of the level of median marginal net tax rates facing all those age 50–79.

Table 2.10 considers the same increments to earnings, but lasting not one year, rather through retirement. Here again we consider median marginal net tax rates, but to economize on space, we group all age groups together. The table shows that for those in the lowest quintile, the median marginal net tax rate can be dramatically higher depending on the length of time the higher earnings continue. For example, a $10,000 increase for one year produces a median net tax rate of 40.8%. But the same $10,000 increase, if extended through retirement, produces an 82.5% marginal net rate! And this prohibitively high rate is just the median, meaning that half of the elderly in the lowest quintile lost more than 82.5 cents on the dollar were they to earn an extra $10,000 through retirement!

2.7.1 Marginal Net Taxation Facing Social Security Recipients

For Social Security recipients, the tax rates embodied in the Social Security system's rules are of paramount importance. As already discussed, though, these rules are both complex and poorly explained, meaning that the impact on work and retirement incentives depends very much on how these rules are perceived.

To illustrate the importance of these perceptions, table 2.11 provides alternative estimates of median lifetime tax rates exclusively for Social Security recipients, ages 62–65 (individuals who could face the earnings test by earning additional current labor income). The first three columns of the table repeat the calculations from tables 2.7-2.9 for Social Security recipients. The remaining three columns provide marginal tax rates under the alternative assumption that individuals correctly perceive how ARF works. As one would expect, estimated marginal tax rates generally decline with this assumption, as individuals understand that losing current benefits through the earnings test is in good part offset by earning higher future benefits.

For example, those in the middle quintile earning an additional $20,000 in the current year would face a median marginal tax rate of 55.1% if ARF is not taken into account, but 47.7% if ARF is correctly understood. What is initially surprising, though, is that marginal tax rates may increase when the effects of ARF are included in the calculation. This can be seen by comparing marginal tax rates for those in the lowest quintile earning an additional $20,000, whose median marginal tax rate rises from 74.7% to 77.2%. Such low-resource individuals can face higher marginal net tax rates from earning extra income with the ARF turned on and assumed to be fully understood because the extra ARF income leaves them (prior to earning more money) close to Medicaid and other means-tested, transfer-payment thresholds.

As discussed (see fn. 28), the ARF, though conceived to provide an actuarial offset to the earnings test, will provide only a partial offset to the extent that actual rates of return exceed those on which the ARF adjustment is based, as is the case for our assumed rate of return. As an alternative, one can consider the impact of simply eliminating the earnings test, which is an equivalent—in present value—to an exact actuarial offset, including one that would take into account differential mortality across income groups.

Table 2.12 provides estimates of marginal tax rates for Social Security recipients ages 62–65 for our base case (with no ARF) and under the assumption that the earnings test is eliminated. The first three columns of the table repeat those in table 11, and the last three columns show median marginal tax rates assuming the earnings test is eliminated. These columns can be compared to the corresponding columns of table 11 to see how much of a difference the alternative assumptions about the earnings test (ARF vs. elimination) make.

In making this comparison, it is important to keep in mind that while both ARF and eliminating the earnings test increase the present value of resources, relative to an earnings test without ARF, the timing of their adjustments differs. ARF offsets the current reduction in benefits caused by the earnings test with an increase in future benefits, while eliminating the earnings test simply increases current benefits. This difference is what underlies the big difference in median marginal tax rates for the lowest-income quintile earning an additional $20,000 in the current year. While ARF actually increases the perceived marginal tax rate (as discussed above), eliminating the earnings test reduces the marginal tax rate from 74.7% to 54.7% because individuals in this group will be much less subject to increased future benefit loss.

For higher-resource groups, benefit phase-outs are less important; for these groups, eliminating the earnings test typically reduces median tax rates slightly more than incorporating ARF, because by our assumptions the ARF is not fully actuarially fair. For example, individuals in the highest quintile earning an additional $20,000 experience a decline in their median marginal tax rate from 66.8% to 59.4% under elimination of the earnings test, but to 61.8% when including the ARF.

2.7.2 The Impact of Eliminating All Income and Asset Tests of Transfer Programs

Table 2.13 shows how marginal net tax rates would look were all income and assets tests of all transfer programs jointly eliminated. The table considers a one-year $20,000 increase in earnings and can be directly compared with table 9.

As one would expect, median rates are dramatically lower for poor and lower--income households. For example, take the cohort age 50–54. The first quintile median marginal net tax rate is 77.4% with the transfer program marginal taxation included (i.e., as reported in table 2.9). It is 31.5% without (as reported in table 2.13). For the third quintile in this cohort, the two rates are 47.4% and 41.1%. Or, consider those ages 60–64. The first quintile's table 2.9 median rate is 82.5%, but it is only 27.6% in table 2.13. For those in this age range in the third quintile, the median rate falls from 47.0% to 39.2%.

2.7.3 The Dispersion of Remaining Lifetime Marginal Net Tax Rates

Figure 2·4 and table 2.14 show the remarkable dispersion of remaining marginal net tax rates across all SCF sample respondents (i.e., household heads and, where applicable, their spouses or partners) ages 50 to 79. The figure and table consider the marginal lifetime net tax rates arising from a $20,000 increase in earnings for one year. The figure and table are limited to observations with marginal tax rates ranging from zero to 200%. Dispersion results for other hypothetical increases in earnings lasting one or more years are quite similar. Note from the figure that most of the very high marginal net tax rates are those of respondents who are collecting either Medicaid benefits, Social Security benefits, or both.

The fact that the median remaining lifetime net tax rates range from high to very high may be expected given the seemingly independent design of so many tax systems and subsystems as well as so many transfer payments programs, all of which incorporate implicit tax schedules through the income testing of the benefits they provide. But what we find remarkably surprising is the enormous variation in marginal net tax rates among households within the same cohort and quintile of the resource distribution.

Cohort-specific tables in the appendix show that the dispersion holds within each age group, but the dispersion tends to be much greater at lower resource levels. Anyone familiar with optimal tax theory would likely view the dispersion in marginal net tax rates displayed in figure 2·4 with chagrin. It appears to be strongly at odds with what that body of theory recommends. In particular, it does not recommend net tax rates so high as to effectively lock large numbers of older workers, particularly the poor and the rich, out of the work force.

Consider, for example, the implications for those age 60–64 earning \$20,000 more for one year. Among the lowest quintile, 51% will lose more than 80 cents of every extra dollar earned, 8% will lose between 61 and 80 cents, and 7% will lose between 51 and 60 cents. Hence, two-thirds of the poorest members of this cohort that face marginal net tax rates above 50% and over half face marginal net tax rates above 80%. Among those in the top quintile, 39% are in a 61 to 80% marginal net tax bracket and 33% are in a 51 to 60% marginal net tax bracket. Hence, almost three-quarters are in marginal net tax brackets that exceed 50%.

Very high marginal net taxation holds for a significant minority of the poor of all cohorts. It is also present for many of the upper-middle class and the rich—at all ages. For example, take those age 70–74. Sixty-five percent of those in the fourth quintile face a marginal net tax rate between 51 and 60% on earnings of \$20,000 in the current year. In the top quintile of this cohort, 83% lose more than half the additional \$20,000, and almost half lose between 61% and 80%.

2.7.4 Maximum and Minimum Marginal Net Tax Rates

Another way to assess the variance in marginal net tax rates is to consider the maximum and minimum rates. Tables 15 and 16 present these values again for the case of a one-year, $20,000 increase in earnings. The highest rate recorded in table 14, which presents maximums, is 627.9%. This for a respondent whose household is in the lowest-resource quintile in the cohort 65–69.

Table 2.16's minimum marginal net tax rates are far smaller, but many of the figures are still fairly high. For example, in the top quintile of those age 55–59, the lowest rate is 32.5%. The table's lowest rate is 8.8%—the minimum marginal net tax rates for the lowest quintiles ages 50–54, as well as 65–69. Thus, in the case of the poorest 65–69-year-olds, the marginal net tax rates range from 8.8% to 627.9%—quite a range!

The household with a marginal lifetime net tax rate of 8.8% is a single woman, age 66, with a young child (age five) in her care. Her primary source of income is Social Security, but she also receives food stamps and Supplemental Security Income. She owns a modest home and has a small mortgage. The low marginal tax rate she faces is due to her having the child in her home. If she earns an additional $20,000 in the current year, her federal taxes will decrease. Indeed, she will receive a federal income tax refund due to the Child Tax Credit and the Earned Income Tax Credit. Her food stamp benefits will, however, be reduced in the current year but that is more than offset by the refund, leaving her with a small positive marginal net tax rate.

The household with the marginal lifetime net tax rate of 627.9% is a married couple whose husband is age 65 and wife is age 61. The husband is currently collecting Social Security and has modest self-employed income of roughly $8,000 per year. The wife is disabled and receives Social Security Disability Income. They own a modest home with no mortgage. Their high marginal tax rate is due to the loss of their Medicaid benefits in the years prior to the wife reaching age 65. The additional $20,000 in the current year increases their Modified Adjusted Gross Income, which determines their Medicaid eligibility. The additional labor earnings in the current year eliminate their current-year Medicaid eligibility. But, since they save a portion of the additional income and, as a result, have more assets in asset income, after the first year, they also lose Medicaid eligibility in future years. Indeed, they lose it for four years in a row.

2.7.5 Comparing Current and Remaining Lifetime Marginal Net Tax Rates

Table 2.17 presents current-year marginal net tax rates defined as the change in this year's net taxes divided by the increment to earnings—$1,000 in this case. The figures in this table should be compared with those in table 2.7, reproduced here in bold font, which also consider a one-year, $1,000 rise in labor earnings, but take into account that households smooth their consumption over time. Accordingly, the present values of their net taxes exceed what they pay in the current year.

The differences are strikingly large. Consider the 31.6% median lifetime marginal net tax rate for the lowest quintile age 50–79 (in bold font). This is over twice the 14.8% median current year net tax rate (in normal font). Or, take those age 60–64 in the third quintile. Their remaining lifetime marginal net tax rate, in bold, is 41.6%, but their current-year marginal net tax rate is only 31.1%. A third example is the richest 1% of those ages 70–74. Their median remaining lifetime marginal net tax rate is 67.4%, far higher than the 43.6% rate current-year net tax rate.

2.8 Conclusion

This paper provides a comprehensive analysis of the marginal net taxation of the elderly by running observations from the 2013 Federal Reserve's Survey of Consumer Finances (SCF) through The Fiscal Analyzer, a lifecycle consumption-smoothing program specially designed to incorporate all major federal and state fiscal programs including the federal corporate income tax, personal federal and state income taxes, FICA taxes, state sales taxes, estate taxes, Social Security benefits, Social Security's earnings test, food stamps, Social Security disability benefits, Medicare benefits, Medicare Part B premiums, and Medicaid benefits.

Our findings show that older workers typically face high, very high, or remarkably high marginal net taxation on their extra earnings. Work disincentives are largest for those at the bottom and top ends of the resource distribution. The disincentives are also highly nonlinear; the marginal net tax rate facing those earning an extra $20,000 in the current year and those earning an extra $1,000 can be dramatic.

Another central finding is that the marginal net tax on earning any given amount, but for a longer period of time, is no higher than earning extra money over a shorter period of time. Finally, we find that marginal current-year net tax rates are very poor proxies for the more appropriate lifetime measures.

We also find a far smaller impact on marginal net tax rates than expected arising from the earnings test because either eliminating it or making workers cognizant of the ARF leaves them with higher incomes and thus closer to Medicaid and other transfer-payment thresholds. In other words, lessening the importance of one marginal net tax can enhance the strength of others. On the other hand, eliminating all earnings and asset tests of transfer programs leads to dramatically lower median marginal effective remaining lifetime net tax rates for poor and lower-income households.

Marginal net tax rates levied on the elderly can vary enormously even within a resource quintile for a given cohort. This is to be expected given that individual fiscal policies have not been designed with their overall impacts on work incentives in mind, but is quite at odds with the lessons of optimal tax theory.

A final key finding is that the current-year marginal net tax rates can dramatically understate the work disincentives facing the elderly because they incorrectly assume that all increments to earnings are spent in the same year they are earned.

We conclude by addressing the question posed in this paper's title, "Is Uncle Sam Inducing the Elderly to Retire?" Based on the work disincentives Uncle Sam imposes on the elderly, the answer seems clearly to be yes. But an open question is the extent to which the elderly correctly perceive these disincentives. Indeed, given the complexity and interactions of our fiscal system and the heretofore reliance on current-year marginal net tax rates, it is hard to believe that policymakers, themselves, are cognizant of the level and spread of the work disincentives they are imposing on the elderly.

Table 2.1: Number of Household Observations

Quintile	Age 50–79	Age 50–54	Age 55–59	Age 60–64	Age 65–69	Age 70–74	Age 75–79
Lowest	351	91	81	75	59	39	27
Second	359	97	78	71	56	36	27
Third	382	92	85	72	59	41	25
Fourth	450	102	100	85	72	50	28
Highest	1,116	237	243	216	179	146	89
Top 5%	642	136	143	125	102	90	58
Top 1%	382	80	82	78	55	56	32
Total	2,658	619	587	519	425	312	196

Table 2.2: Distribution of Intended/Imputed Age of Retirement (Percent of Cohort)

Cohort	Before 62 (%)	62 (%)	Greater Than 62 and Less Than 66 (%)	66 (%)	Greater Than 66 and Less Than 70 (%)	70 or Greater (%)	Never Retire (%)	Already Retired or Not Work (%)	Total (%)
50–54	14.0	3.9	14.4	0.7	3.7	11.5	32.0	19.9	100.0
55–59	9.5	4.6	12.5	2.4	5.5	17.3	25.8	22.5	100.0
60–64	2.5	1.9	13.2	4.7	5.0	11.5	22.4	38.7	100.0
65–69	0.8	0.6	1.0	1.2	5.8	14.2	17.1	59.3	100.0
70–74	0.5	0.2	1.4	0.3	0.8	11.3	10.0	75.6	100.0
75–79	0.0	0.0	0.8	0.5	0.0	5.9	5.5	87.2	100.0

Table 2.3: Ages at Which Social Security Recipients Began Collecting Benefits

Cohort	Share (Percent of Cohort)
62	49.1
63	5.6
64	6.2
65	23.2
66	7.8

Table 2.4: US Fiscal Systems and Subsystems Included in The Fiscal Analyzer

1. The US Personal Income Tax
Exemptions
Standard versus Itemized Deductions
The Earned Income Tax Credit
The Child Tax Credit
The Alternative Minimum Tax
Preferential Taxation of Capital Gains and Dividends
Taxation of Social Security Benefits
High-Income Medicare Payroll and Asset-Income Taxation
Progressive Tax Rates
Phase Out of Deductions and Exemptions
2. The FICA Tax
3. Social Security Benefits
Progressive Full Retirement Benefit (PIA) Calculation
Married/Divorced Spousal/Widow(er), Child, Disability, and Retirement Benefits
Early Retirement, Spousal, and Widow(er) Benefit Reductions
Earnings Test and Adjustment of the Reduction Factor
Recomputation of Benefits
Government Pension Offset and Windfall Elimination Provision
Delayed Retirement Credit
Deeming
Maximum Family Benefit
4. Social Security Disability Benefits
5. Supplemental Security Income
6. The US Corporate Income Tax
7. State Income Taxes for Ohio
8. State Sales Taxes for Ohio
9. Medicare Benefits
10. Medicaid Benefits for Ohio
11. Supplemental Nutrition Assistance Program (SNAP) for Ohio
12. Temporary Assistance to Needy Families (TANF) for Ohio
13. Medicare Part B Premiums
14. The Estate and Gift Tax

Table 2.5: Percentage Change in Remaining Lifetime Discretionary Spending If Retirement is Delayed by One Year

Resource Quintile	Age 50–54 (%)	Age 55–59 (%)	Age 60–64 (%)	Age 65–69 (%)	Age 70–74 (%)	Age 75–79 (%)
Lowest	2.2	3.8	6.2	3.6	4.5	0.5
Second	2.4	2.4	3.3	1.6	8.0	0.5
Third	2.4	2.6	2.6	2.1	8.8	0.1
Fourth	2.2	2.4	2.7	2.6	3.6	1.8
Highest	2.0	2.2	1.9	1.9	2.0	0.2
Top 5%	2.1	2.4	1.6	1.9	1.7	0.4
Top 1%	1.8	2.4	1.2	1.4	1.0	0.5

Table 2.6: Percentage Change in Remaining Lifetime Discretionary Spending If Retirement is Delayed by Five Years

Resource Quintile	Age 50–54 (%)	Age 55–59 (%)	Age 60–64 (%)	Age 65–69 (%)	Age 70–74 (%)	Age 75–79 (%)
Lowest	8.9	15.0	15.7	14.4	20.0	1.9
Second	9.7	8.6	13.1	7.3	14.7	1.8
Third	9.7	10.2	10.0	8.3	15.5	0.2
Fourth	9.1	9.6	10.2	9.8	7.9	4.5
Highest	8.2	9.5	7.6	7.8	7.6	1.1
Top 5%	8.8	10.4	6.8	7.8	6.7	1.5
Top 1%	7.7	10.7	5.1	5.6	4.8	2.0

Table 2.7: Median Remaining Lifetime Marginal Net Tax Rates by Cohort Resulting from a One-Year, $1,000 Increase in Current Earnings

Resource Quintile	Age 50–79 (%)	Age 50–54 (%)	Age 55–59 (%)	Age 60–64 (%)	Age 65–69 (%)	Age 70–74 (%)	Age 75–79 (%)
Lowest	31.6	38.0	36.5	32.7	32.2	22.3	38.4
Second	39.9	40.4	39.6	38.2	38.7	39.0	22.0
Third	43.9	41.1	46.2	41.6	46.5	47.0	27.0
Fourth	49.7	52.9	49.6	47.8	51.3	51.7	49.1
Highest	56.4	56.9	57.0	55.7	56.9	57.6	49.6
Top 5%	63.1	63.1	64.4	63.7	60.4	63.3	55.3
Top 1%	62.9	64.5	64.0	61.5	54.3	67.4	59.3

Table 2.8: Median Remaining Lifetime Marginal Net Tax Rates by Cohort Resulting from a One-Year, $10,000 Increase in Current Earnings

Resource Quintile	Age 50–79 (%)	Age 50–54 (%)	Age 55–59 (%)	Age 60–64 (%)	Age 65–69 (%)	Age 70–74 (%)	Age 75–79 (%)
Lowest	40.8	52.5	42.5	48.1	40.3	29.0	42.6
Second	44.1	42.6	39.8	41.7	43.1	44.4	28.9
Third	46.8	44.6	47.1	43.8	50.2	50.7	35.6
Fourth	51.3	52.5	50.1	50.3	54.2	52.3	52.5
Highest	59.3	60.4	60.3	59.2	59.8	58.7	52.7
Top 5%	65.3	65.5	66.7	65.5	65.3	64.9	59.3
Top 1%	66.2	68.4	64.9	64.1	63.5	67.8	64.2

Table 2.9: Median Remaining Lifetime Marginal Net Tax Rates by Cohort Resulting from a One-Year, $20,000 Increase in Current Earnings

Resource Quintile	Age 50–79 (%)	Age 50–54 (%)	Age 55–59 (%)	Age 60–64 (%)	Age 65–69 (%)	Age 70–74 (%)	Age 75–79 (%)
Lowest	47.8	77.4	53.2	82.5	46.5	35.3	43.9
Second	46.4	44.2	42.1	45.0	43.5	47.1	35.1
Third	48.9	47.4	49.3	47.0	51.1	51.1	41.5
Fourth	52.5	53.4	51.1	52.6	55.0	52.7	52.4
Highest	59.9	60.4	60.5	58.9	62.2	59.7	52.2
Top 5%	65.3	65.3	66.7	66.0	63.8	65.1	58.5
Top 1%	66.5	68.6	64.9	64.3	64.2	68.9	64.2

Table 2.10: Median Remaining Lifetime Marginal Net Tax Rates, Age 50–79 ($1,000, $10,000, and $20,000 Annual Increases in Earnings for One Year and through Retirement)

Resource Quintile	$1,000 Increase for One Year (%)	$1,000 Increase Through Ret. (%)	$10,000 Increase for One Year (%)	$10,000 Increase Through Ret. (%)	$20,000 Increase for One Year (%)	$20,000 Increase Through Ret. (%)
Lowest	31.6	77.4	40.8	82.5	47.8	35.3
Second	39.9	44.2	44.1	45.0	46.4	47.1
Third	43.9	47.4	46.8	47.0	48.9	51.1
Fourth	49.7	53.4	51.3	52.6	52.5	52.7
Highest	56.4	60.4	59.3	58.9	59.9	59.7
Top 5%	63.1	65.3	65.3	66.0	65.3	65.1
Top 1%	62.9	68.6	66.2	64.3	66.5	68.9

Table 2.11: Median Remaining Lifetime Marginal Net Tax Rates, Social Security Recipients, Ages 62–65 ($1,000, $10,000, and $20,000 Increases in Earnings for One Year With and Without ARF)

Resource Quintile	$1,000 Increase No ARF (%)	$10,000 Increase No ARF (%)	$20,000 Increase No ARF (%)	$1,000 Increase With ARF (%)	$10,000 Increase With ARF (%)	$20,000 Increase With ARF (%)
Lowest	28.1	51.4	74.7	27.8	47.8	77.2
Second	41.5	51.9	56.5	40.7	49.6	51.9
Third	41.6	49.5	55.1	41.6	45.4	47.7
Fourth	49.3	51.3	57.4	49.3	51.3	53.9
Highest	54.1	60.3	66.8	54.1	59.5	59.4

Table 2.12: Median Remaining Lifetime Marginal Net Tax Rates, Social Security Recipients, Ages 62–65 ($1,000, $10,000, and $20,000 Increases in Earnings for One Year With and Without Earnings Test, No ARF)

Resource Quintile	$1,000 Increase No ARF (%)	$10,000 Increase No ARF (%)	$20,000 Increase No ARF (%)	$1,000 Increase No Earnings Test and No ARF (%)	$10,000 Increase No Earnings Test and No ARF (%)	$20,000 Increase No Earnings Test and No ARF (%)
Lowest	28.1	51.4	74.7	26.5	41.5	54.7
Second	41.5	51.9	56.5	40.8	48.1	49.5
Third	41.6	49.5	55.1	45.3	50.4	52.3
Fourth	49.3	51.3	57.4	47.7	50.2	51.9
Highest	54.1	60.3	66.8	50.3	59.4	61.8

Table 2.13: Median Remaining Lifetime Marginal Net Tax Rates Assuming No Earnings or Asset Testing of Transfer Payments, Ages 50–79, $20,000 Increase in Earning for One Year

Resource Quintile	Age 50–79 (%)	Age 50–54 (%)	Age 55–59 (%)	Age 60–64 (%)	Age 65–69 (%)	Age 70–74 (%)	Age 75–79 (%)
Lowest	25.8	31.5	30.2	27.6	26.0	23.8	23.4
Second	36.6	37.8	35.3	34.8	39.9	33.7	25.9
Third	41.6	41.1	41.0	39.2	46.6	49.8	36.2
Fourth	47.8	48.6	47.4	45.5	53.5	52.3	50.2
Highest	58.1	59.0	58.7	57.0	62.3	58.0	51.3
Top 5%	65.1	65.2	66.4	65.1	63.1	66.1	56.6
Top 1%	66.6	66.8	65.1	64.1	65.0	68.9	64.2

Table 2.14: Marginal Lifetime Net Tax Rate (Share of Population by Range, Cohort 50–79, Resulting from a One-Year, $20,000 Increase in Current Earnings)

Quintile	Percent Below 0%	Percent 0% to 20%	Percent 21% to 30%	Percent 31% to 40%	Percent 41% to 50%	Percent 51% to 60%	Percent 61% to 80%	Percent Over 80%
Lowest	0	2	15	22	15	5	7	33
Second	0	0	5	27	30	17	8	13
Third	0	0	3	26	28	34	3	6
Fourth	0	0	2	14	29	46	7	2
Highest	0	1	1	3	17	33	44	1

Table 2.15: Maximum Lifetime Marginal Net Tax Rates Arising from a $20,000 increase in Current-Year Earnings

Resource Quintile	Age 50–54 (%)	Age 55–59 (%)	Age 60–64 (%)	Age 65–69 (%)	Age 70–74 (%)	Age 75–79 (%)
Lowest	301.5	299.1	287.7	627.9	226.5	414.8
Second	469.5	152.4	208.0	164.3	392.0	225.2
Third	136.7	196.8	108.2	104.9	272.0	131.8
Fourth	105.5	136.3	159.2	104.7	60.8	109.5
Highest	115.5	156.6	128.2	90.0	150.2	95.1
Top 5%	115.5	156.6	128.2	81.8	150.2	95.1
Top 1%	115.5	77.0	128.2	81.8	150.2	74.7

Table 2.16: Minimum Lifetime Marginal Net Tax Rates Arising from a $20,000 increase in Current-Year Earnings

Resource Quintile	Age 50–54 (%)	Age 55–59 (%)	Age 60–64 (%)	Age 65–69 (%)	Age 70–74 (%)	Age 75–79 (%)
Lowest	24.7	25.5	22.8	8.8	12.3	19.9
Second	14.8	27.1	25.3	17.6	21.7	17.8
Third	27.9	19.5	24.7	29.6	19.3	23.1
Fourth	30.3	28.7	28.4	20.3	33.8	22.0
Highest	22.9	32.5	17.8	17.0	14.7	21.2
Top 5%	22.9	39.5	23.4	40.1	29.5	25.8
Top 1%	45.1	46.4	23.4	46.4	49.6	56.1

Table 2.17: Current-Year (Not Bold) Versus Lifetime (Bold) Median Marginal Net Tax Rates (Resulting From $1,000 Increase in Current Earnings)

Resource Quintile	Age 50–79 (%)	Age 50–54 (%)	Age 55–59 (%)	Age 60–64 (%)	Age 65–69 (%)	Age 70–74 (%)	Age 75–79 (%)
Lowest	14.8	30.4	26.6	23.4	14.5	14.4	14.5
Lowest	**31.6**	**38.0**	**36.5**	**32.7**	**32.2**	**22.3**	**38.4**
Second	30.4	31.0	30.0	30.6	25.6	15.3	14.4
Second	39.9	40.4	39.6	38.2	38.7	39.0	22.0
Third	31.3	31.9	31.2	31.1	34.5	31.4	24.0
Third	**43.9**	**41.1**	**46.2**	**41.6**	**46.5**	**47.0**	**27.0**
Fourth	38.3	39.3	38.6	37.3	36.4	39.8	41.5
Fourth	**49.7**	**52.9**	**49.6**	**47.8**	**51.3**	**51.7**	**49.1**
Highest	39.7	36.1	39.2	39.7	41.3	41.6	40.7
Highest	**56.3**	**56.9**	**57.0**	**55.7**	**56.9**	**57.6**	**49.6**
Top 5%	41.4	39.7	39.6	41.7	41.6	44.5	42.0
Top 5%	**63.1**	**63.1**	**64.4**	**63.7**	**60.4**	**63.3**	**55.3**
Top 1%	43.7	43.0	44.0	43.6	34.5	43.6	45.0
Top 1%	**62.9**	**64.5**	**26.6**	**61.5**	**54.3**	**67.4**	**59.3**

Figure 2·1: Decomposing lifetime resources, taxes, and transfer payments

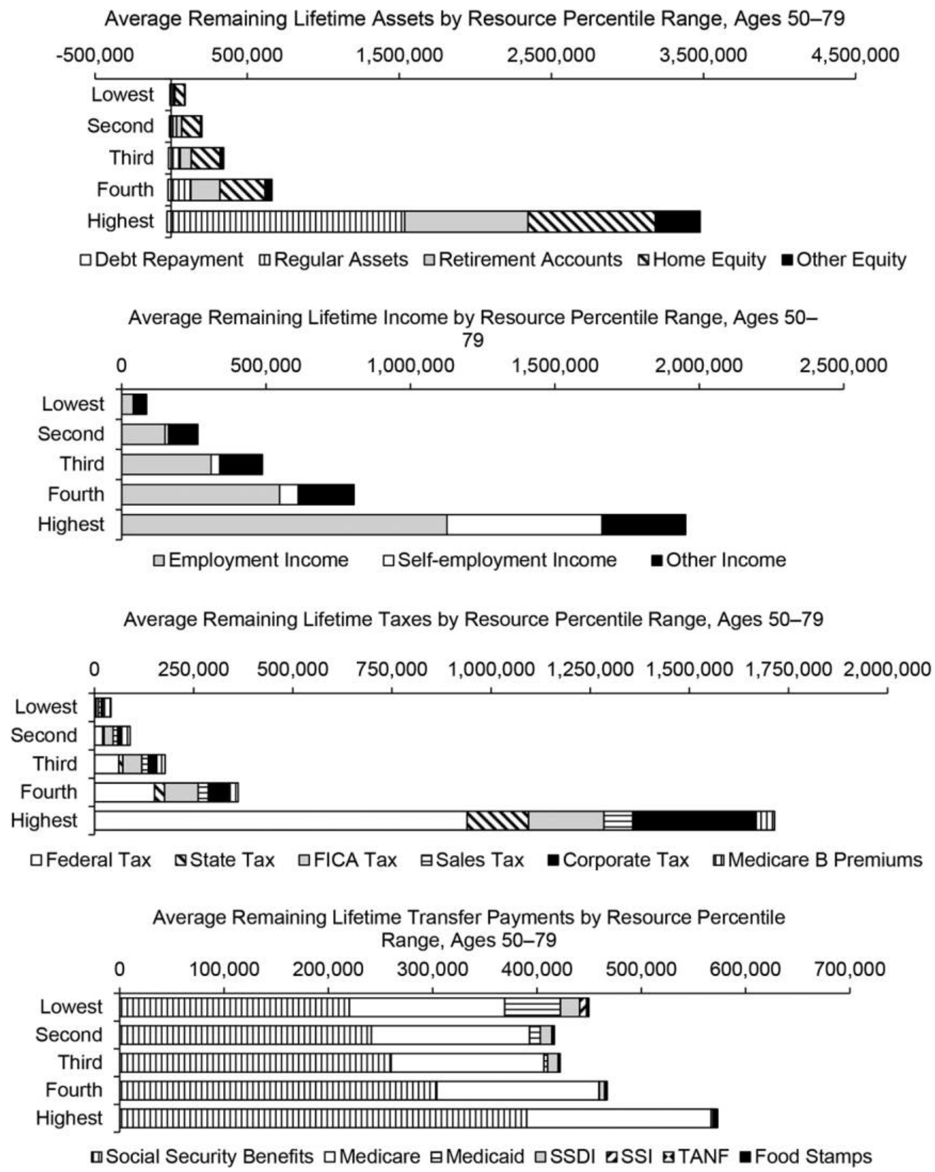


Figure 2·2: Median marginal lifetime net tax rates by percentile range, ages 50–79, based on a $1,000 increase in earnings for one year

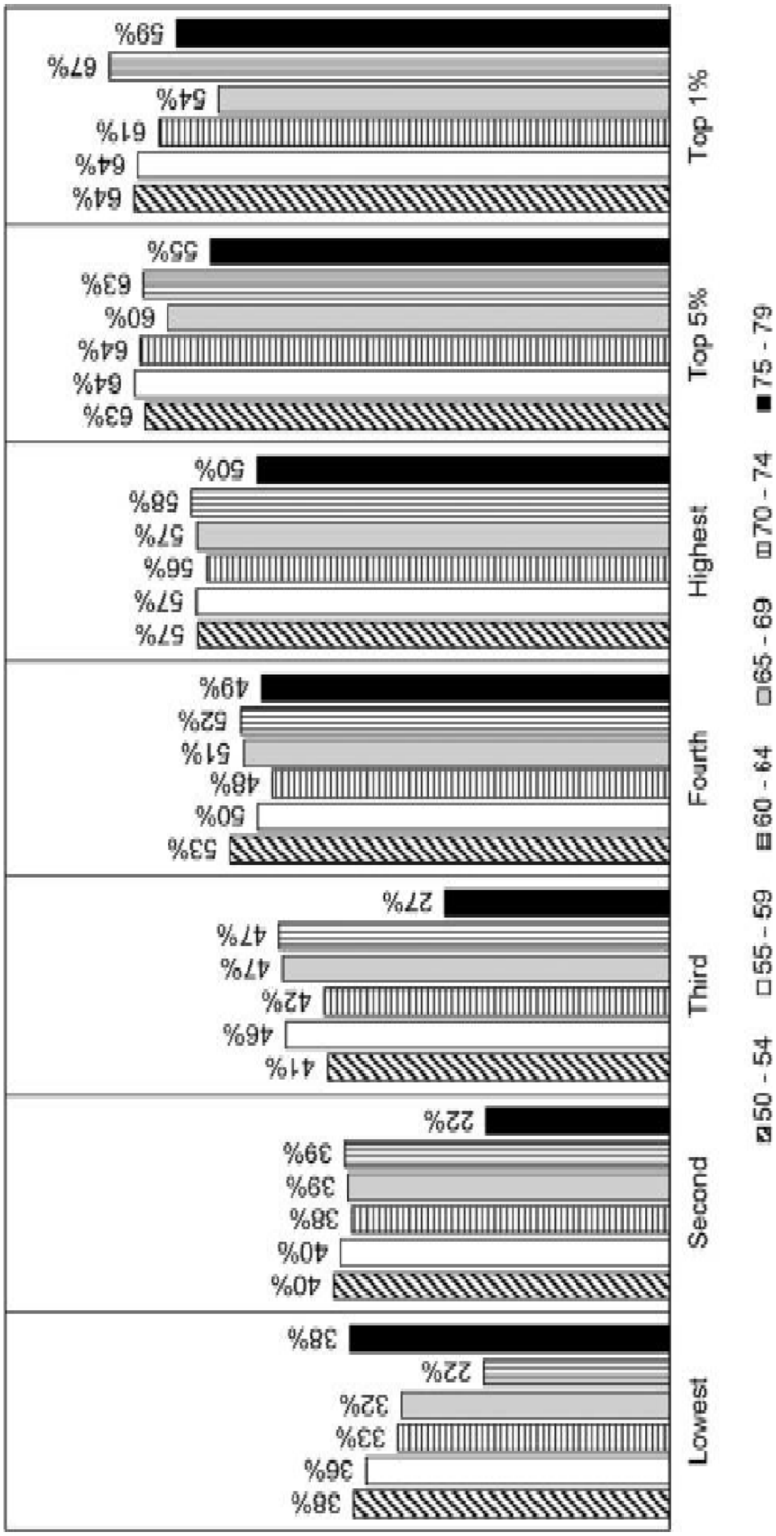


Figure 2·3: Median marginal lifetime net tax rates by percentile range, ages 50–79, arising from a $20,000 increase in earnings for one year

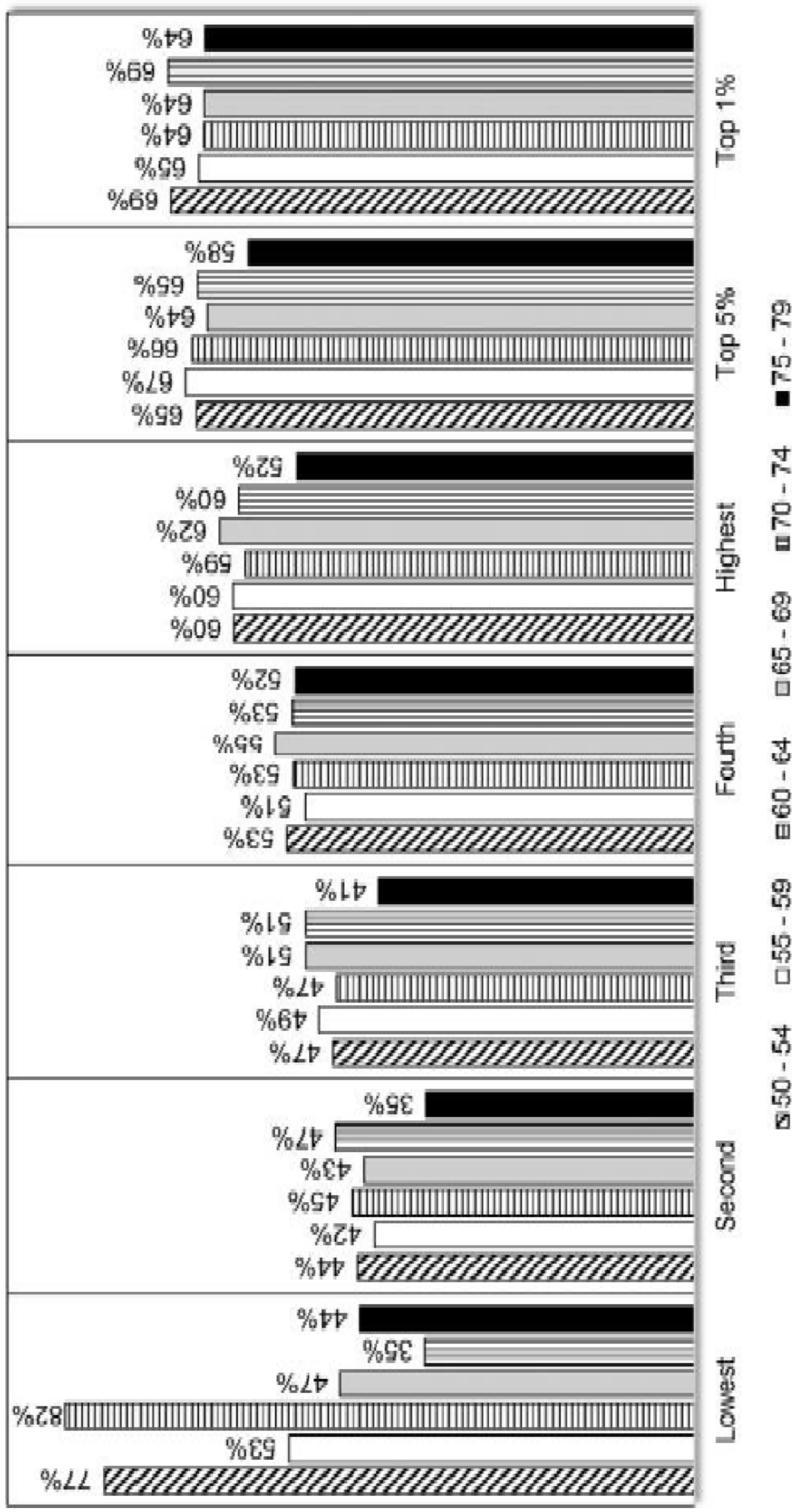
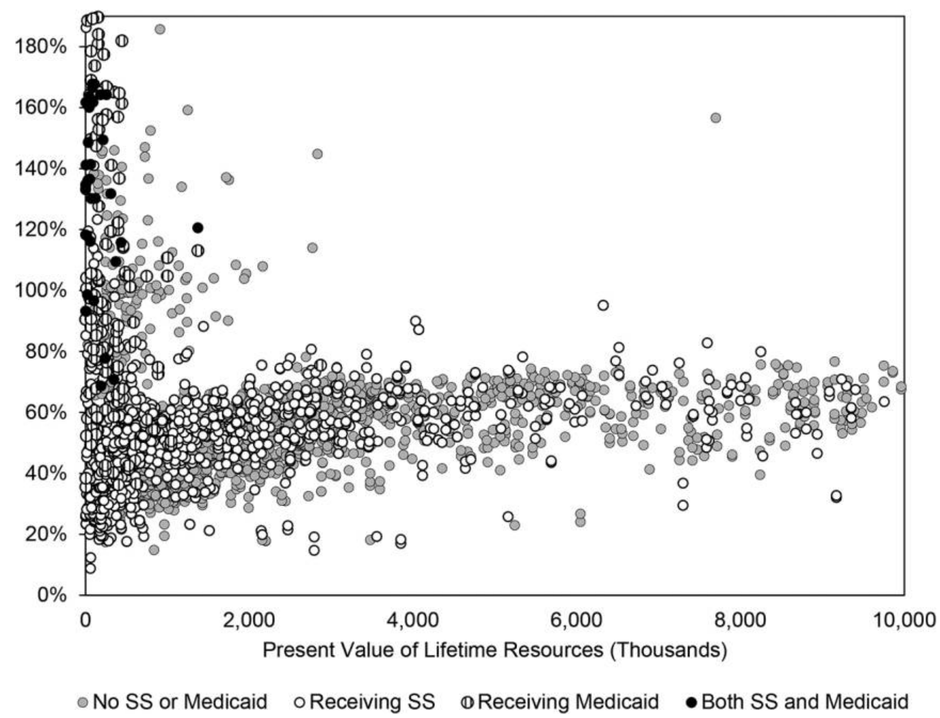


Figure 2·4: Distribution of marginal remaining lifetime net tax rates, ages 50–79, arising from a $20,000 increase in earnings for one year



Chapter 3

House Price, Labor Productivity, and Regional Migration in China

3.1 Introduction

This paper studies the impact of two different driving factors of regional migration in China using a spatial equilibrium model with heterogeneous households. Migrants in China have been a large group among the total population, stably at around 17.5% (240 million) since 2010.[1] It is important to research into the optimal labor allocation and welfare implications caused by different migration reasons. Housing cost is one important factor to take into account when migrating since housing consumption is a large part (around 21%) of total consumption in China.[2] Thus I incorporate housing consumption into households' utility and budget constraints.

I build a 2-period Overlapping Generations (OLG) model with two types of agents, the high-skilled and the low-skilled, and two regions, rural or less developed region and urban or more developed region. New-born households can freely choose where to live. They only work when they are young. Young households consume goods and housing and buy risk-free bonds. Old households sell housing and bonds to consume. Each region has a representative firm that uses high-skilled labor, low-skilled labor, and capital to produce. Government owns housing and rebate housing income from the young to the old.

In this paper, I consider two interesting shocks to the economy. Figure 3·1 shows

[1]National Bureau of Statistics of China.
[2]National Bureau of Statistics of China.

that the residential area in the urban region grows much faster than in the rural region from the year 2002 to 2016. It is due to the urbanization process and city expansion in China. Thus the first shock is to increase housing supply in the urban region. When the urban region expands, both types of labor move into the urban region. Skill ratio and housing price decrease in both regions. Both types of labor gain higher utility.

Since wage income is the main source of wealth for households, I consider another shock where the labor productivity of the high-skilled labor increases in the urban region. It is from the observation that the urban region uses the high-skilled labor more and more intensively. When firms in the urban region would like to use high-skilled labor more intensively, the low-skilled has less comparative advantages in the urban region and thus moves out. The high-skilled is less needed to produce the same amount of output. Skill ratio increases in the urban region and decreases in the rural region. Housing price decreases in the urban region since supply does not change and demand decreases. The utility of high-skilled labor increases slowly and that of the low-skilled decreases fast. In aggregate, the social welfare decreases.

Related Literature This paper is closely related to spatial equilibrium models which could be traced back to Rosen (1979) and Roback (1982). Two recent works incorporate heterogeneous workers with different skills based on the classical spatial equilibrium model. Diamond (2016) estimated an empirical model with multiple cities and two types of households with different skills. The focus of Diamond (2016) is to find out the causes and welfare implications of the increased skill sorting in the US. Giannone et al. (2017) added more features such as dynamic structure based on Diamond (2016) and build the model with less micro aspects. Compared with those two works, the model in this paper is simplified and only keeps the essential setup of each sector. The purpose of the neat setup is to catch the change of key variables when I carry on the two experiments and lessen the burden of computation.

3.2 Model

3.2.1 Environment

The 2-period Overlapping Generations (OLG) economy has two types of agents: the high-skilled and the low-skilled. There are two regions in this economy: a rural or less developed region and an urban or more developed region. Time is discrete. There is no aggregate or idiosyncratic uncertainty. I depict three sectors: households, production, and the government.

Households

In each period, a new generation is born. For simplicity, I assume there is no population growth and the new generation has the same population N as the old one. In each new generation, I assume that a fixed fraction S^H of the population is high-skilled, and the rest are low-skilled. Suppose the rural region has a share $Sh1_t$ of the high-skilled among the two regions and $Sl1_t$ of the low-skilled among the two regions at period t. Table 3.1 shows the share of high-skilled and low-skilled young households in the two regions. I denote h_{1t} as the share of high-skilled rural young households among all young households. The other shares are denoted as l_{1t}, h_{2t}, and l_{2t} correspondingly.

Households solve the utility maximization problem in both regions and choose to live in region j where $j = argmax(V(c_{it}^{y*}, c_{i,t+1}^{o*}, z_{i,t}^{*}))$ for i = rural region, urban region.

Agents maximize the life-time utility when young in period t:

$$u(c_t^y, c_{t+1}^o, z_t) = \sigma_1 loga + logc_t^y + \beta logc_{t+1}^o + \sigma_2 logz_t \quad (3.1)$$

where a is the utility from amenity, β is the discount factor, σ_1 and σ_2 are utility parameters for amenity and housing correspondingly.

The first period represents the working period, from around 20 years old to 60 years old. The second period represents the retired period, starting from 60 years old. Before the first period, households choose a region, say j, delivering a higher utility to live. In the first period, all households supply one unit of labor and earn a wage income of w_{jt}, given the corresponding skill type in region j. They are born without endowment. They consume c_t^y with normalized price of 1, buy housing z_t at the price P_{jt} in region j, and buy b_t unit of bond. In the second period, households sell their housing at price $P_{j,t+1}$ and their bonds with gross return rate $1 + r_{j,t+1}^k - \delta$, where δ is the depreciation rate of capital. Agents also receive social security $s_{i,t+1}^o$ when old. All proceedings from selling assets and pensions are used to consume c_{t+1}^o. For notation purposes, I omit all subscripts for regions and superscripts for types in the households' problem. The budget constraint of households is given by

$$\begin{aligned} c_t^y + P_t z_t + b_t &\leq w_t \\ c_{t+1}^o &\leq P_{t+1} z_t + (1 + r_{t+1}^k - \delta) b_t + s_{t+1}^o \end{aligned} \tag{3.2}$$

The first-order conditions of the households lead us to the analytic solution.

$$\begin{aligned} c_t^{y*} &= \frac{w_t + \frac{s_{t+1}^o}{1 + r_{t+1}^k - \delta}}{1 + \beta + \sigma_2} \\ c_{t+1}^{o*} &= \beta(1 + r_{t+1}^k - \delta) c_t^{*y} \\ z_t^* &= \frac{\sigma_2 c_t^{y*}}{P_t - \frac{P_{t+1}}{1 + r_{t+1}^k - \delta}} \end{aligned} \tag{3.3}$$

Production

In each region, a firm produces output Y_t in period t with high-skilled labor H_t, low-skilled labor L_t, and capital K_t using constant returns to scale (CRS) technology. High-skilled and low-skilled labor are paid with w_{Ht} and w_{Lt}. Capital is hired at rate r_t. There is no depreciation. The CRS production function is assumed to be Cobb-Douglas:

$$Y_{it} = A L_{it}^{\gamma_i^L} H_{it}^{\gamma_i^H} K_{it}^{\alpha} \tag{3.4}$$

where A is the total factor productivity, and $\gamma_i^L + \gamma_i^H + \alpha = 1$ for $i =$ rural region, urban region.

An important assumption about labor productivity is that the firm utilizes high-skilled labor more intensively in the more developed region than in the less developed region, i.e. $\gamma_2^H > \gamma_1^H$ and $\gamma_2^L < \gamma_1^L$.

Denote each variable as per young capita, $y_{it} = \frac{Y_{it}}{N}$, $k_{it} = \frac{K_{it}}{N}$,$h_{1t} = \frac{H_{1t}}{N}$, $h_{2t} = \frac{H_{2t}}{N}$, $l_{1t} = \frac{L_{1t}}{N}$, $l_{2t} = \frac{L_{2t}}{N}$, then

$$y_{it} = A l_{it}^{\gamma_{it}^L} h_{it}^{\gamma_{it}^H} k_{it}^{\alpha} \tag{3.5}$$

Firms maximize profit, and factor prices are their marginal product:

$$\begin{aligned} r_{it}^k &= A\alpha l_{it}^{\gamma_i^L} h_{it}^{\gamma_i^H} k_{it}^{\alpha-1} \\ w_{it}^L &= A\gamma_i^L l_{it}^{\gamma_i^L-1} h_{it}^{\gamma_i^H} k_{it}^{\alpha} \\ w_{it}^H &= A\gamma_i^H l_{it}^{\gamma_i^L} h_{it}^{\gamma_i^H-1} k_{it}^{\alpha} \end{aligned} \tag{3.6}$$

Government

The government supply housing. There is no rental market. Households can only buy or sell housing as assets. Government rebates housing revenues to households as social security expenditures when they become old. Government sets housing prices such that the income of the government from selling housing in period t balance the spending in period t.

$$P_{1t}z_1 + P_{2t}z_2 = s_t^o \tag{3.7}$$

for $i =$ rural region, urban region.

Equilibrium

A stationary equilibrium is a tuple of variables $\{k_1, k_2, P_{1t}, P_{2t}, Sh1, Sl1\}$ such that: households and firms maximize their utility or profit, government has a balanced sheet, and (i) the two capital stocks satisfy capital market clearing condition or goods market clearing condition and free investment condition; (ii) the two housing prices satisfy the housing market clearing condition; (iii) the two population shares implied by the two capital stocks and prices equalize the indirect utility of both high-skilled and low-skilled labor in the two regions. Notice that any two of the conditions (i), (ii), and (iii) imply the third one.

(i) Capital Market Clearing

$$k_{1,t+1} + k_{2,t+1} = b_{1t}^H h_{1t} + b_{2t}^H h_{2t} + b_{1t}^L l_{1t} + b_{2t}^L l_{2t} \tag{3.8}$$

(i) Goods Market Clearing

$$\begin{aligned} & y_{1t} + y_{2t} + P_{1t}z_1 + P_{2t}z_2 \\ & - \{(k_{1,t+1} + k_{2,t+1}) - (1-\delta)(k_{1t} + k_{2t})\} \\ & = c_{1t}^{Hy} h_{1t} + c_{1t}^{Ho} h_{1,t-1} + c_{2t}^{Hy} h_{2t} + c_{2t}^{Ho} h_{2,t-1} \\ & + c_{1t}^{Ly} l_{Lt} + c_{1t}^{Lo} l_{1,t-1} + c_{2t}^{Ly} l_{2t} + c_{2t}^{Lo} l_{2,t-1} \end{aligned} \tag{3.9}$$

(i) Free Investment

$$r_{1t}^k = r_{2t}^k \tag{3.10}$$

(ii) Housing Market Clearing

$$\begin{aligned} z_1 &= z_{1t}^H h_{1t} + z_{1t}^L l_{1t} \\ z_2 &= z_{2t}^H h_{2t} + z_{2t}^L l_{2t} \end{aligned} \tag{3.11}$$

where $z_i \equiv Z_i/N$ and Z_i is housing supply in region i.

(iii) Spatial Equilibrium

$$\begin{aligned} V_{1t}^H &= V_{2t}^H \\ V_{1t}^L &= V_{2t}^L \end{aligned} \tag{3.12}$$

3.2.2 Analytical Result

Proposition 1. *The steady-state return of capital does not depend on the supply of housing or productivity of labor.*

Proof. Suppose the economy is in steady state. By households' optimal choice of consumption when young 3.3 and government's budget constraint 3.7, we get

$$\begin{aligned} c^y \equiv & c_1^{Hy}h_1 + c_1^{Ly}l_1 + c_2^{Hy}h_2 + c_2^{Ly}l_2 \\ = & \frac{w_1^{Hy}h_1 + w_1^{Ly}l_1 + w_2^{Hy}h_2 + w_2^{Ly}l_2}{1+\beta+\sigma_2} + \frac{s^o(h_1+l_1+h_2+l_2)}{(1+r^k-\delta)(1+\beta+\sigma_2)} \\ = & \frac{(1-\alpha)(y_1+y_2)}{1+\beta+\sigma_2} + \frac{P_1z_1+P_2z_2}{(1+r^k-\delta)(1+\beta+\sigma_2)} \end{aligned} \tag{3.13}$$

Combining housing market clearing condition 3.11 and households' optimal choice of housing 3.3, we get

$$\begin{aligned} P_1z_1 + P_2z_2 &= P_1(z_1^H h_1 + z_1^L l_1) + P_2(z_2^H h_2 + z_2^L l_2) \\ &= \frac{\sigma_2(1+r^k-\delta)}{r^k-\delta}c^y \end{aligned} \tag{3.14}$$

Combining 3.13 and 3.14, we get

$$c^y = \frac{1-\alpha}{1+\beta+\sigma_2-\frac{\sigma_2}{r^k-\delta}}(y_1+y_2) \tag{3.15}$$

By goods market clearing condition 3.9

$$\begin{aligned} & y_1 + y_2 + P_1z_1 + P_2z_2 = [1+\beta(1+r^k-\delta)]c^y \\ \Leftrightarrow & y_1 + y_2 + \frac{\sigma_2(1+r^k-\delta)}{r^k-\delta}c^y = [1+\beta(1+r^k-\delta)]c^y \\ \Leftrightarrow & y_1 + y_2 = [1+\beta(1+r^k-\delta) - \frac{\sigma_2(1+r^k-\delta)}{r^k-\delta}]\frac{1-\alpha}{1+\beta+\sigma_2-\frac{\sigma_2}{r^k-\delta}}(y_1+y_2) \\ \Leftrightarrow & [1+\beta(1+r^k-\delta) - \frac{\sigma_2(1+r^k-\delta)}{r^k-\delta}]\frac{1-\alpha}{1+\beta+\sigma_2-\frac{\sigma_2}{r^k-\delta}} = 1 \\ \Leftrightarrow & a(r^k)^2 + br^k + c = 0 \text{ where } a = \beta(1-\alpha) > 0, \\ & b = -\alpha(1+\beta) - (\sigma_2+\beta\delta)(2-\alpha) < 0, \\ & c = \sigma_2[1-(1-\delta)(1-\alpha)] + \delta[\alpha(1+\beta)+\sigma_2+(1-\alpha)\beta\delta] > 0 \end{aligned} \tag{3.16}$$

Suppose α, β, σ_2, δ are in reasonable value such that $b^2 - 4ac > 0$. This condition can be easily achieved with commonly used value of those parameter. For example, if we assume $\delta = 0$, $b^2 - 4ac$ is always positive. Since a, b, and c do not depend on housing supply z_1 and z_2 or labor productivity γ_1^H, γ_2^H, γ_1^L, γ_2^L, steady-state capital return would not be impacted by the supply of housing or productivity of labor. □

Notice that in the proof, the steady-state capital return could have two positive solutions. We cannot rule out any one of them because the system is so complicated. In all of our simulation examples, the larger solution is the stable steady-state capital return.

3.2.3 Calibration

The above model with 6 state variables is relatively complicated to solve, so we only have limited results for analytical solutions. It is more straightforward to simulate the economy. For illustrative purposes, the benchmark case calibration is applied with commonly used life-cycle parameters. $\beta = 0.99^{40} \approx 0.67$, $\alpha = 0.3$. In 2015, about 18% of employed households in China have college or above degree.[3] Thus I set $S^H = 0.18$. I normalize amenity in rural region to be one and assume amenity in urban region is higher, thus $a_1 = 1$, $a_2 = 2$. Households get much smaller utility from amenity than consumption, $\sigma_1 = 0.1$. In 2015, Chinese households housing expenditure is about 20% of total spending.[4] By $Pz = 0.2(Pz + c^y + c^o)$ and households FOC, $\sigma_2 = 0.55$. Total factor productivity in the urban region is set such that the wage income of low-skilled labor is not too small, $A_1 = 10$.[5] Since low-skilled labor in the rural region earns about half of the low-skilled in the urban region, I set $A_2 = 28$.[6] To estimate the labor productivity in the two regions, I use a formula induced from the first-order conditions of firms $\gamma^H/\gamma^L = \Sigma w_i^H/\Sigma w_j^L$. I first find out the high-skilled labor proportion in each region.[7] Then I look at the average disposable income of rural and urban households who are divided into five quantiles by their disposable income.[8] Then I assume the income is flat within each quantile group and calculate the wage income of the high-skilled and low-skilled in each region. The actual high-skilled labor productivity in each region should be higher. $\gamma_2^H = 0.33$, $\gamma_1^H = 0.15$,

[3] China Population and Employment Statistics Yearbook 2016, 3-1
[4] National Bureau of Statistics of China
[5] Or consumption could be smaller than one and utility might be negative.
[6] China Labour Statistical Yearbook, China Statistical Yearbook.
[7] China Labour Statistical Yearbook.
[8] China Statistical Yearbook.

$\gamma_2^L = 0.37$, $\gamma_1^L = 0.55$. Rural region housing supply is normalized to be one, $z_1 = 1$. According to National Bureau of Statistics of China[9], in 2012, urban residential area is 2.34×10^{16} m^2 and rural residential area is 2.38×10^{16} m^2. Thus $z_2 = 0.98$.

3.2.4 Steady State

Benchmark

The above benchmark economy has one stable steady state with $Sh1 = 0.0299$, $Sl1 = 0.1033$, $k1 = 0.0482$, $k2 = 1.6811$, $P1 = 0.1423$, $P2 = 3.8544$. The majority of high-skilled and low-skilled labor are both in the urban region. It indicates that if there is no migration costs or other obstacles, China's urbanization process should have been more complete. The total consumption and production as well as capital are higher in the urban region because 91% of the total population are in the urban region. Housing price in the urban region is higher. Wage of the high-skilled is higher in both regions. Indirect utility of high-skilled labor is about two times that of low-skilled labor. $rk = 2.9423$, thus annual return of capital is around 2.7%.

Comparative Statistics

Urban land as well as housing in China has been expanding with urbanization. At the same time, industrial structure in China is upgrading and many firms in the urban region use high-skilled labor more intensively. I consider two experiments: increasing the housing supply in the urban region and increasing the high-skilled labor productivity in the urban region. Figure 3·2 -3·4 plot the comparative statistics of the first experiment. Figure 3·5 -3·7 plot the comparative statistics of the second experiment.

Population and Skill Ratio In the housing supply experiment,

$$\frac{dh_1}{dz_2} < 0, \frac{dl_1}{dz_2} < 0, \frac{dh_2}{dz_2} > 0, \frac{dl_2}{dz_2} > 0 \tag{3.17}$$

[9] http://www.stats.gov.cn/tjsj/sjjd/201701/t20170120_1456174.html

As housing supply in the urban region increases, both high-skilled and low-skilled labor increase in the urban region and decrease in the rural region. Suppose the economy is in the benchmark steady state, thus the indirect utility of living in the rural region and the urban region equals for both types of labor. Now the housing supply in the urban region increases, if no one moves, then both types of households in the urban region would have a higher utility. Thus, both high-skilled and low-skilled labor move into the urban region from the rural region to reach the spatial equilibrium.

I define the skill ratio to be the number of high-skilled labor ratio the number of low-skilled labor. When the housing supply changes in the economy, there are two extreme cases. First, when housing supply in the urban region is zero, everyone lives in the rural region, thus the skill ratio in the rural region is $S^H/(1-S^H)$. When the urban region housing supply increases, both high-skilled and low-skilled labor in the rural region decrease. The high-skilled labor productivity in the urban region is higher, thus they can potentially benefit more in the urban region. Consequently, the percentage change of high-skilled labor is larger than that of the low-skilled. The skill ratio in the rural region decreases as housing supply in the urban region increases. Second, when housing supply in the urban region is infinity, everyone lives in the urban region, thus the skill ratio in the urban region is $S^H/(1-S^H)$. When housing supply in the urban region decreases, the low-skilled can benefit more than the high-skilled by moving to the rural region because their labor productivity in the rural region is higher than in the urban region. The percentage change of low-skilled labor is larger than the high-skilled. Thus the skill ratio in the urban region increases as urban housing supply decreases. Or, the skill ratio in the urban region decreases as housing supply in the urban region increases.

In the labor productivity experiment,

$$\frac{dh_1}{d\gamma_2^H} > 0,\ \frac{dl_1}{d\gamma_2^H} > 0,\ \frac{dh_2}{d\gamma_2^H} < 0,\ \frac{dl_2}{d\gamma_2^H} < 0 \tag{3.18}$$

When high-skilled labor productivity in the urban region increases, fewer high-skilled and low-skilled labor would live in the urban region. The reason is that fewer people are needed to produce the same amount of outputs. Low-skilled labor decreases faster because the comparative advantage to live in the rural area becomes higher as γ_2^H increases. As a result, in the urban region, both types of labor has to decrease and the skill ratio increases. For the rural region, since the low-skilled increases fast, the skill ratio decreases.

Capital In the housing supply experiment,

$$\frac{dk_1}{dz_2} < 0, \frac{dk_2}{dz_2} > 0 \tag{3.19}$$

Since both high-skilled and low-skilled labor increase in the urban region and decrease in the rural region, the capital has to increase in the urban region and decrease in the rural region, such that the capital returns in the two regions are equivalent.

In the labor productivity experiment,

$$\frac{dk_1}{d\gamma_2^H} > 0, \frac{dk_2}{d\gamma_2^H} < 0 \text{ for } \gamma_2^H < 0.66, \frac{dk_2}{d\gamma_2^H} > 0 \text{ for } \gamma_2^H > 0.67, \tag{3.20}$$

Since the total population in the rural region increases, the capital increases. As long as high-skilled labor productivity in the urban region is not too large, the capital would decrease as the population decreases.

Housing Price In the housing supply experiment,

$$\frac{dP_1}{dz_2} < 0, \frac{dP_2}{dz_2} < 0 \tag{3.21}$$

Housing price in both regions decreases. Compared with the benchmark steady state, when housing supply in the urban region increase, the housing price in the urban region would decrease immediately if no one moves. When people start to move out of the rural region, the housing price in the rural region also decreases. The housing price in the urban region would increase, but not higher than the benchmark. Otherwise the utility of living in the urban region would be lower than the rural region and the spatial equilibrium would not hold. In a word, the total housing supply in the economy increases and the total population in the economy does not change. As a result, both regions share the welfare gain by free migration between the two regions.

In the labor productivity experiment,

$$\frac{dP_1}{d\gamma_2^H} > 0, \frac{dP_2}{d\gamma_2^H} < 0 \tag{3.22}$$

The comparative statistics of housing price is intuitive. Since the housing supply does not change and only the population changes, housing price changes in the opposite direction as the population.

Wage, Consumption, and Production In the housing supply experiment,

$$\begin{aligned}
&\frac{dw_i^H}{dz_2} > 0, \frac{dw_i^L}{dz_2} < 0 \text{ for } i = 1, 2, \\
&\frac{dz_i^H}{dz_2} > 0, \frac{dz_i^L}{dz_2} > 0 \text{ for } i = 1, 2, \frac{ds^o}{dz_2} > 0 \\
&\frac{dc_i^{Hg}}{dz_2} > 0, \frac{dc_i^{Lg}}{dz_2} < 0 \text{ for } i = 1, 2, g = \text{y, o}, \frac{dC}{dz_2} < 0 \\
&\frac{dy_1}{dz_2} < 0, \frac{dy_2}{dz_2} > 0, \frac{d(y_1 + y_2)}{dz_2} > 0
\end{aligned} \tag{3.23}$$

Wage of high-skilled labor increases in both regions and wage of low-skilled labor decreases in both regions. Since the skill ratio in both regions decreases, the low-skilled labor increases faster in the urban region and decreases slower in the rural region. For high-skilled labor in the urban region, $\Delta w_2^H = \gamma_2^L \Delta l_2 + \alpha \Delta k_2 - \gamma_2^H \Delta h_2 > 0$ because the change of low-skilled labor in the urban region is larger than the high-skilled labor and dominates the change of wage. Similarly, the wage of high-skilled labor increases in the rural region and the wage of low-skilled labor in both regions decreases.

Individual housing consumption increases for both types of agents in both regions. This is intuitive since total housing supply increases in the economy and new-born households can freely choose where to live. Because rural population decreases, housing consumption increases per rural capita. Although urban population increases, housing consumption still increases for both types of labor because the supply increases.

Individual consumption is increasing in wage income and pensions. Pensions are the same for everyone, equaling the total market value of housing $P_1 z_1 + P_2 z_2$ in the two regions. The total market value of housing increases because the housing supply increases. Thus high-skilled labor increases their goods consumption. Over 90% of households lifetime wealth is wage income for both types of labor in both regions. Thus individual consumption mostly depends on the wage. Low-skilled labor decreases their goods consumption. Aggregate consumption of high-skilled labor in the urban region increases because both individual consumption and population increase. Aggregate consumption of low-skilled labor in the urban region also increases because the low-skilled labor in the urban region increases fast. Aggregate consumption in the rural region decreases because total population decreases. Aggregate consumption in the economy increases.

Since all three factors increase in the urban region and decrease in the rural region, the production increases in the urban region and decreases in the rural region. Aggregate production increases.

In the labor productivity experiment,

$$\frac{dw_1^H}{d\gamma_2^H} > 0,\ \frac{dw_1^L}{d\gamma_2^H} < 0,\ \frac{dw_2^L}{d\gamma_2^H} < 0,$$
$$\frac{dw_2^H}{d\gamma_2^H} > 0 \text{ for } \gamma_2^H < 0.37,\ \frac{dw_2^H}{d\gamma_2^H} \leq 0 \text{ for } 0.37 \leq \gamma_2^H < 0.62,\ \frac{dw_2^H}{d\gamma_2^H} > 0 \text{ for } \gamma_2^H > 0.62,$$
$$\frac{dz_1^H}{d\gamma_2^H} < 0,\ \frac{dz_1^L}{d\gamma_2^H} < 0,\ \frac{dz_2^H}{d\gamma_2^H} > 0,\ \frac{dz_2^L}{d\gamma_2^H} > 0,$$
$$\frac{ds^o}{d\gamma_2^H} < 0 \text{ for } \gamma_2^H < 0.64,\ \frac{ds^o}{d\gamma_2^H} > 0 \text{ for } \gamma_2^H > 0.65,$$
$$\frac{dc_1^{Hg}}{d\gamma_2^H} > 0 \text{ for } g = \text{y, o},\ \frac{dc_1^{Lg}}{d\gamma_2^H} < 0 \text{ for } g = \text{y, o},$$
$$\frac{dc_2^{Lg}}{d\gamma_2^H} < 0 \text{ for } \gamma_2^H < 0.64,\ g = \text{y, o},\ \frac{dC}{d\gamma_2^H} > 0$$
$$\frac{dc_2^{Hg}}{d\gamma_2^H} > 0 \text{ for } \gamma_2^H < 0.37,\ \frac{dc_2^{Hg}}{d\gamma_2^H} \leq 0 \text{ for } 0.37 \leq \gamma_2^H < 0.62,\ \frac{dc_2^{Hg}}{d\gamma_2^H} > 0 \text{ for } \gamma_2^H > 0.62,$$
$$\frac{dy_1}{d\gamma_2^H} > 0,\ \frac{dy_2}{d\gamma_2^H} < 0 \text{ for } \gamma_2^H < 0.67,\ \frac{dy_2}{d\gamma_2^H} > 0 \text{ for } \gamma_2^H > 0.68,$$
$$\frac{d(y_1+y_2)}{d\gamma_2^H} < 0 \text{ for } \gamma_2^H < 0.64,\ \frac{d(y_1+y_2)}{d\gamma_2^H} > 0 \text{ for } \gamma_2^H > 0.65 \tag{3.24}$$

We know that $\Delta w^H = \gamma^L \Delta l + \alpha \Delta k - \gamma^H \Delta h$, $\Delta w^L = \gamma^H \Delta h + \alpha \Delta k - \gamma^L \Delta l$. For the rural region, since the low-skilled labor increases more than the high-skilled, the wage of the low-skilled decreases and the wage of the high-skilled increases. For the urban region, not only the population but also γ_2^H changes. The change in the individual consumption of land is intuitive, since the supply does not change in each region and only the demand changes. Total market value of housing decreases since the price in the urban region decreases fast. Comparative statics of the consumption is again consistent with the wage, since the wage is the most important part of the wealth. Production in each region changes in the same direction as the capital.

Welfare In the housing supply experiment,

$$\frac{dV^H}{dz_2} > 0,\ \frac{dV^L}{dz_2} > 0,\ \frac{dW}{dz_2} > 0 \tag{3.25}$$

The indirect utility depends on the goods consumption and the housing consumption. Given the conditions of the spatial equilibrium, we only need to check the utility of households in one region, say, the urban region. For high-skilled labor, goods consumption in both periods and the housing consumption all increase, thus the indirect utility increases as well. For low-skilled labor, goods consumption in both periods decrease, but the housing consumption increases. Since the wage of low-skilled decreases much slower than the increase of their housing consumption, the indirect utility of the low-skilled also increases. The social welfare $W = S^H V^H + (1 - S^H) V^L$ increases.

In the labor productivity experiment,

$$\frac{dV^H}{d\gamma_2^H} > 0, \; \frac{dV^L}{d\gamma_2^H} < 0, \; \frac{dW}{d\gamma_2^H} < 0 \tag{3.26}$$

Again, we can only focus on the utility of households in the urban region. For the high-skilled labor, the housing consumption increases. The goods consumption first increases, then decreases, and finally increases. As a result, the indirect utility of the high-skilled increases slowly. For the low-skilled, both goods consumption and housing consumption decrease. So the indirect utility of the low-skilled decreases a lot. The social welfare decreases since low-skilled labor is the majority.

3.3 Conclusion

In this paper, I separately check the impact of city expansion and industrial upgrade to different groups of people in China. Specifically, I build a spatial equilibrium model with two types of agents who have different skill levels. By looking at the impact of increasing the housing supply and high-skilled labor productivity in the urban region, I study the direction of labor migration and its welfare implications. When the urban region expands, both types of labor move into the urban region, and the capital also increases in the urban region. The rural region has opposite comparative statistics for population and capital. In both regions, the housing price decreases. Both types of labor have higher utility. When firms in the urban region would like to use high-skilled labor more intensively, both high-skilled and low-skilled are crowed out, and the capital in the urban region also decreases. Housing price decreases in the urban region since the supply does not change and the demand decreases. The rural region has opposite comparative statistics for the above quantities or prices. The utility of high-skilled labor increases and that of the low-skilled decreases. In aggregate, the social welfare decreases. The model shows that the city expansion is good for everyone in the economy while the industrial upgrade only benefits the high-skilled labor.

The next step for this paper could be empirically checking which one of the two reasons is leading the migration process in China. I could use implications of comparative statistics of different variables to form the identification strategy.

Table 3.1: Share of Different Types of Young Households in Region j at Period t

	Rural Region	Urban Region
High-skilled labor	$h_{1t} = S^H Sh1_t$	$h_{2t} = S^H(1 - Sh1_t)$
Low-skilled labor	$l_{1t} = (1 - S^H)Sl1_t$	$l_{2t} = (1 - S^H)(1 - Sl1_t)$

Figure 3·1: Residential Building Area in Urban and Rural China

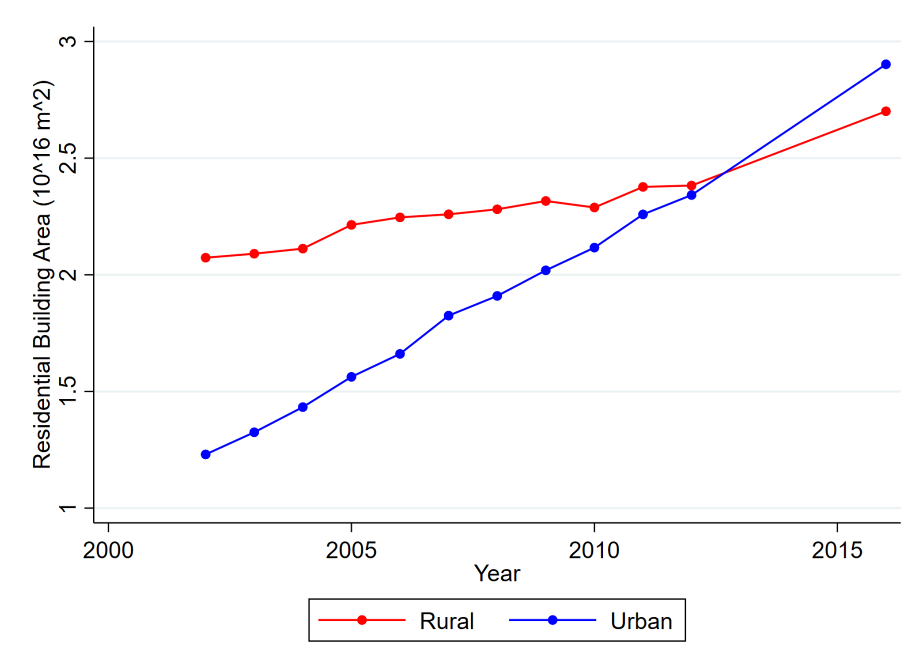


Figure 3·2: Comparative Statistics by increasing housing supply in urban region from 0.8 to 10

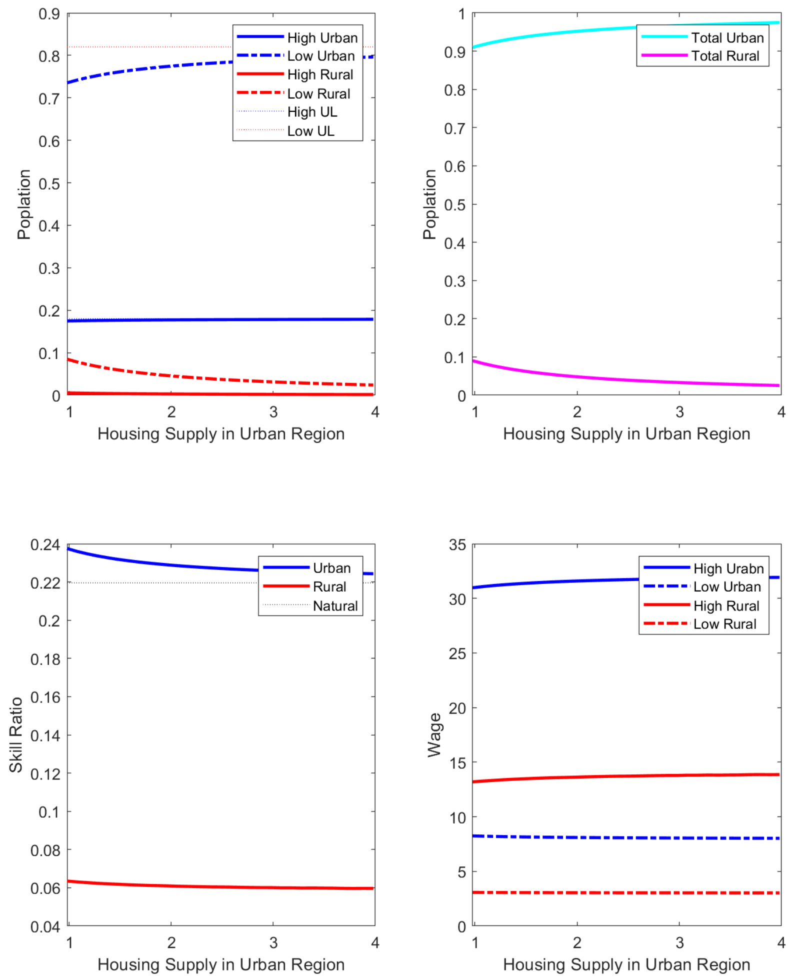


Figure 3·3: Comparative Statistics by increasing housing supply in urban region from 0.8 to 10

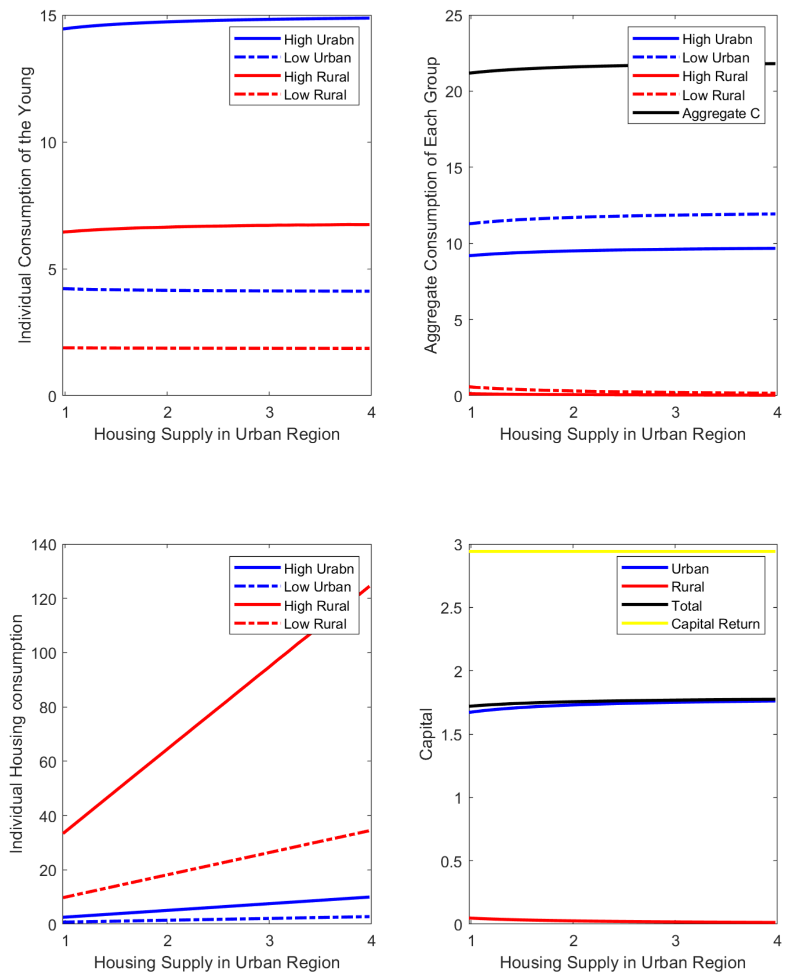


Figure 3·4: Comparative Statistics by increasing housing supply in urban region from 0.8 to 10

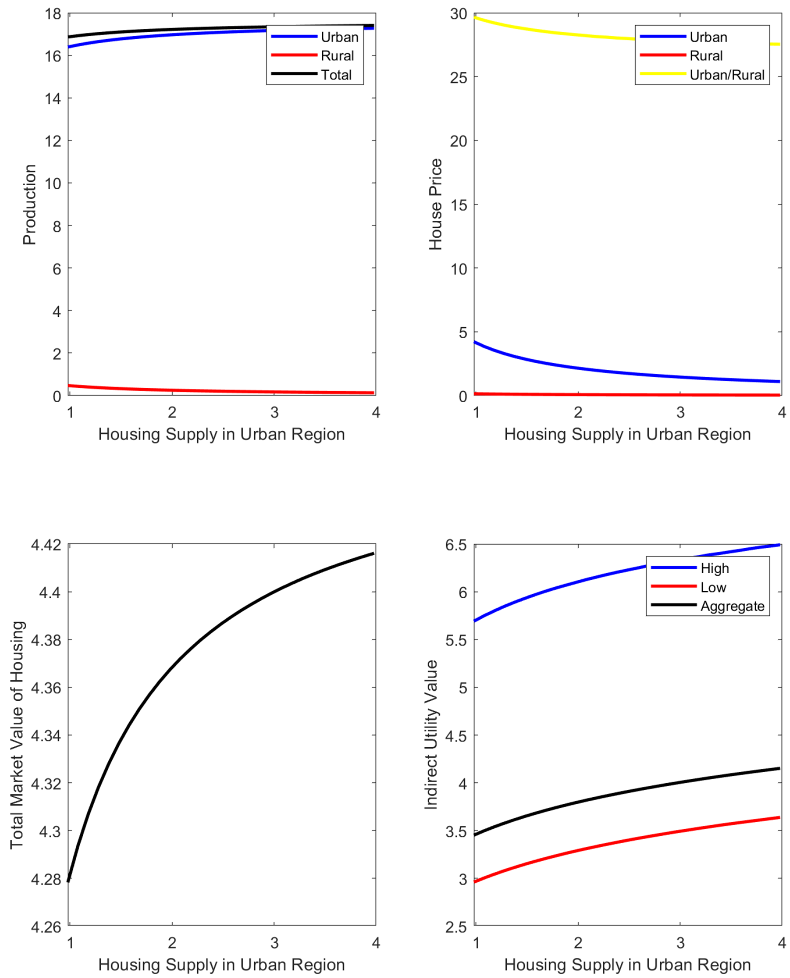


Figure 3·5: Comparative Statistics by increasing high-skilled labor productivity in urban region from 0.33 to 0.69

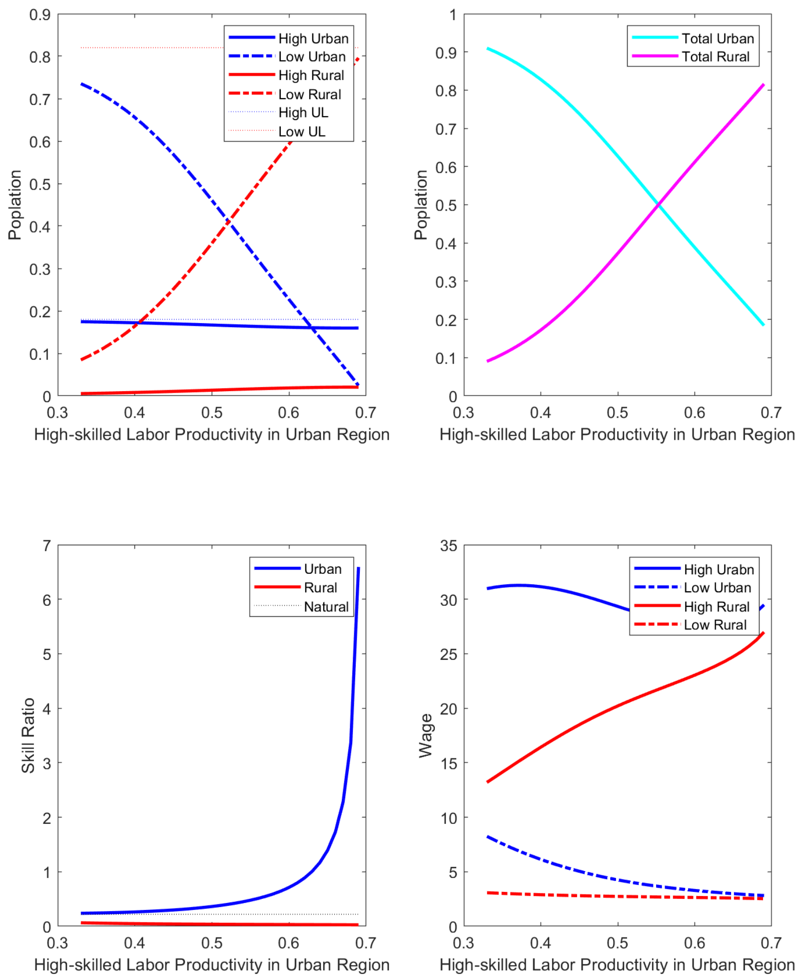


Figure 3·6: Comparative Statistics by increasing high-skilled labor productivity in urban region from 0.33 to 0.69

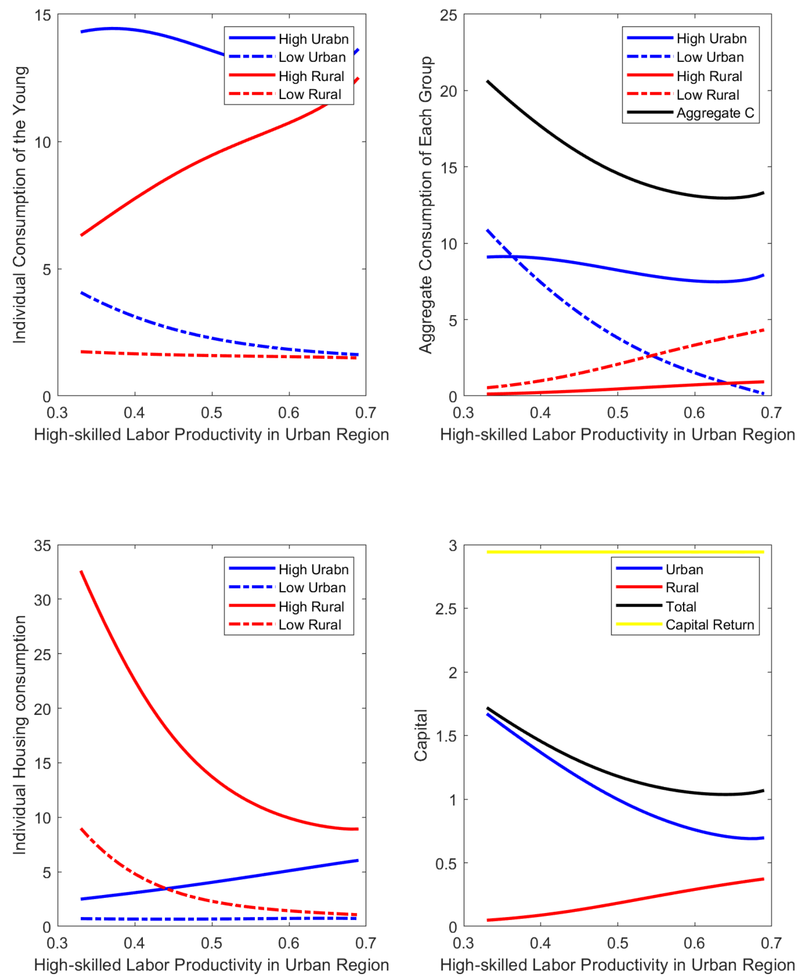
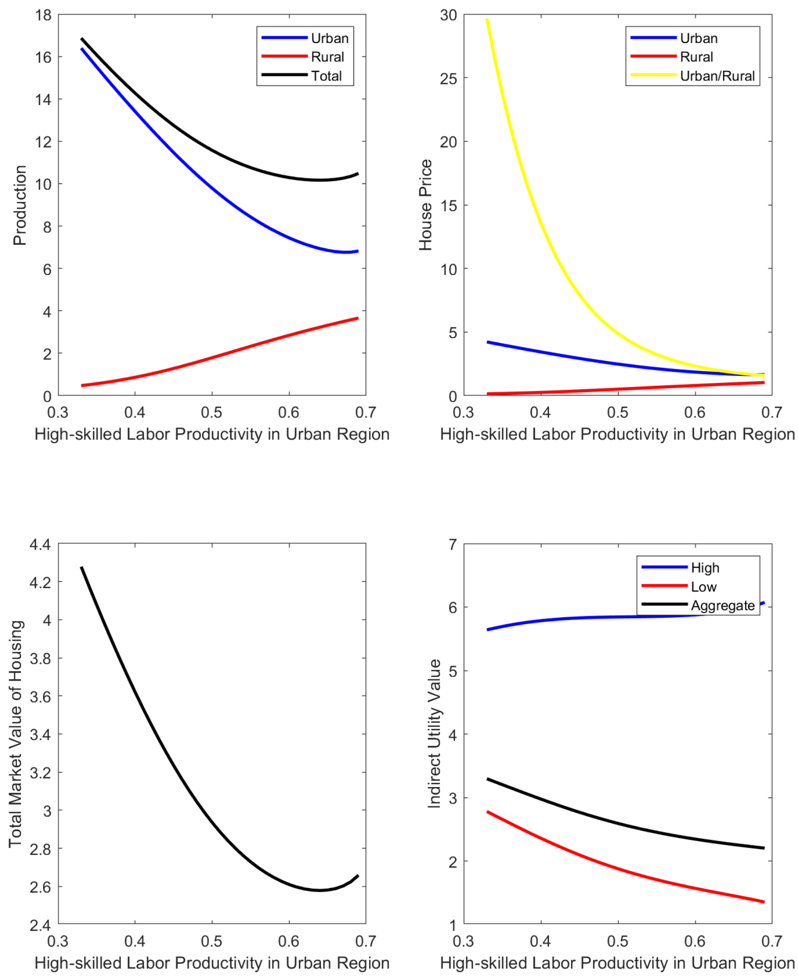


Figure 3·7: Comparative Statistics by increasing high-skilled labor productivity in urban region from 0.33 to 0.69



Appendix A

Additional Graphs and Tables

Table A.1: First Stage with One-side bad luck and Assets-weighted luck

VARIABLES	(1) 5%	(2) 10%	(3) 15%	(4) 20%	(5) 25%	(6) 30%
Luck	0.0414***	0.0614***	0.0766***	0.0967***	0.114***	0.117***
	(4.166)	(5.834)	(6.818)	(8.075)	(8.848)	(8.219)
Observations	2,105	2,105	2,105	2,105	2,105	2,105
R-squared	0.389	0.394	0.397	0.402	0.406	0.403
IV F-stat	17.36	34.03	46.48	65.20	78.29	67.55

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.2: Second Stage with One-side bad luck and Assets-weighted luck

VARIABLES	(1) 5%	(2) 10%	(3) 15%	(4) 20%	(5) 25%	(6) 30%
log(R)	-0.0511***	-0.0563***	-0.0516***	-0.0529***	-0.0565***	-0.0540***
	(0.0197)	(0.0144)	(0.0121)	(0.0103)	(0.00958)	(0.0102)
Observations	2,105	2,105	2,105	2,105	2,105	2,105
R-squared	0.096	0.062	0.094	0.085	0.061	0.078
Durbin pval	0.251	0.0462	0.0553	0.0160	0.00237	0.0102

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.3: First Stage with Two-sided luck and Unweighted luck

VARIABLES	(1) 5%	(2) 10%	(3) 15%	(4) 20%	(5) 25%	(6) 30%
Luck	0.0379***	0.0438***	0.0520***	0.0649***	0.0692***	0.0640***
	(6.396)	(6.807)	(7.401)	(8.499)	(8.360)	(7.051)
Observations	2,105	2,105	2,105	2,105	2,105	2,105
R-squared	0.396	0.397	0.399	0.404	0.404	0.398
IV F-stat	40.91	46.34	54.77	72.24	69.89	49.71

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.4: Second Stage with Two-sided luck and Unweighted luck

VARIABLES	(1) 5%	(2) 10%	(3) 15%	(4) 20%	(5) 25%	(6) 30%
log(R)	-0.0526***	-0.0569***	-0.0537***	-0.0523***	-0.0553***	-0.0500***
	(0.0129)	(0.0124)	(0.0113)	(0.00981)	(0.0101)	(0.0117)
Observations	2,105	2,105	2,105	2,105	2,105	2,105
R-squared	0.087	0.058	0.080	0.089	0.069	0.102
Durbin pval	0.0601	0.0176	0.0226	0.0134	0.00602	0.0652

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.5: First Stage with One-side bad luck and Unweighted luck

VARIABLES	(1) 5%	(2) 10%	(3) 15%	(4) 20%	(5) 25%	(6) 30%
Luck	0.0495***	0.0631***	0.0748***	0.0903***	0.101***	0.0990***
	(5.875)	(7.450)	(8.479)	(9.697)	(10.11)	(8.978)
Observations	2,105	2,105	2,105	2,105	2,105	2,105
R-squared	0.394	0.400	0.404	0.410	0.412	0.407
IV F-stat	34.52	55.50	71.89	94.03	102.1	80.60

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.6: Second Stage with One-side bad luck and Unweighted luck

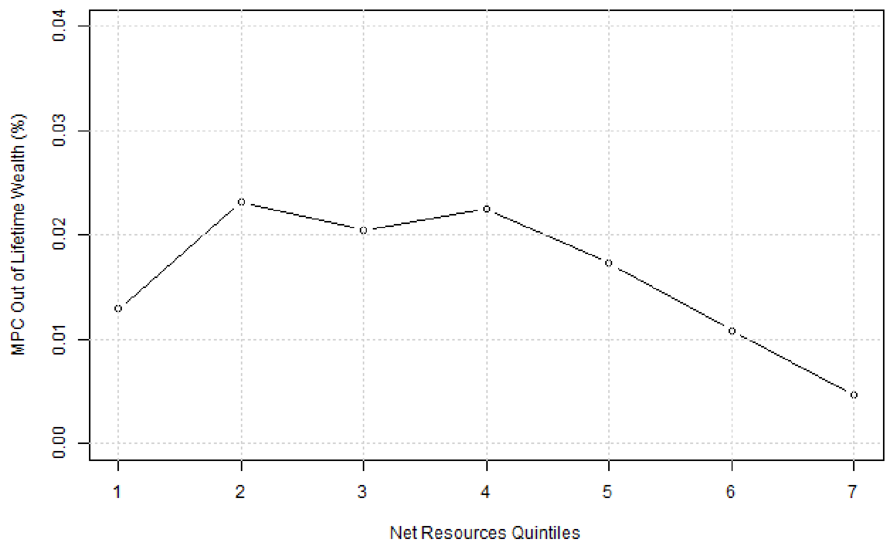
VARIABLES	(1) 5%	(2) 10%	(3) 15%	(4) 20%	(5) 25%	(6) 30%
log(R)	-0.0481***	-0.0524***	-0.0495***	-0.0503***	-0.0535***	-0.0477***
	(0.0139)	(0.0111)	(0.00974)	(0.00858)	(0.00834)	(0.00917)
Observations	2,105	2,105	2,105	2,105	2,105	2,105
R-squared	0.113	0.088	0.105	0.101	0.082	0.115
Durbin pval	0.163	0.0298	0.0309	0.0103	0.00204	0.0378

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.7: Regression of Consumption on Net Resources with Dummies

	C
$netres \times q1$	0.0013*
	(1.42)
$netres \times q2$	0.0023***
	(3.54)
$netres \times q3$	0.0025***
	(3.79)
$netres \times q4$	0.0023***
	(4.78)
$netres \times q5$	0.0017***
	(4.11)
$netres \times q6$	0.001***
	(2.66)
$netres \times q7$	0.0005*
	(1.15))
Controls	Yes
R^2	0.405
N	2,104

Figure A·1: MPC out of Net Lifetime Resources by Quintiles



References

Aiyagari, S Rao, "Uninsured idiosyncratic risk and aggregate saving," *The Quarterly Journal of Economics*, 1994, *109* (3), 659–684.

Auerbach, Alan J and William G Gale, "Once more unto the breach: The deteriorating fiscal outlook," *Washington, DC: Brookings Institution*, 2016.

_ , Laurence J Kotlikoff, and Darryl R Koehler, "US inequality, fiscal progressivity, and work disincentives: an intragenerational accounting," Technical Report, National Bureau of Economic Research 2016.

_ , _ , and _ , "The New Tax Bill: Winners and Losers," *Boston University, Department of Economics. Working paper*, 2018.

_ , _ , and _ , "The Fiscal Analyzer Online Documentation," *Online Appendix, Boston University*, 2019.

Butrica, Barbara A, Karen E Smith, and C Eugene Steuerle, "Working for a good retirement," *Working Papers, Center for Retirement Research at Boston College wp2006-8*, 2006.

Carroll, Christopher D, "Why do the rich save so much?," Technical Report, National Bureau of Economic Research 1998.

Coile, Courtney and Jonathan Gruber, "Fiscal effects of Social Security reform in the United States," in "Social Security Programs and Retirement around the World: Fiscal Implications of Reform," University of Chicago Press, 2007, pp. 503–532.

Diamond, Rebecca, "The determinants and welfare implications of US workers' diverging location choices by skill: 1980-2000," *American Economic Review*, 2016, *106* (3), 479–524.

Dynan, Karen E, Jonathan Skinner, and Stephen P Zeldes, "Do the rich save more?," *Journal of political economy*, 2004, *112* (2), 397–444.

Ellis, Charles D, Alicia H Munnell, and Andrew D Eschtruth, *Falling short: The coming retirement crisis and what to do about it*, Oxford University Press, 2014.

Feldstein, Martin and Andrew Samwick, "Social security rules and marginal tax rates," Technical Report, National Bureau of Economic Research 1992.

Finkelstein, Amy, Nathaniel Hendren, and Erzo FP Luttmer, "The value of medicaid: Interpreting results from the Oregon health insurance experiment," *NBER Working Paper no. 21308, Cambridge, MA*, 2015.

Forman, Jonathan Barry and Yung-Ping Chen, "Optimal Retirement Age," *Presented at the 2008 Retirement 20/20 Conference Defining the Characteristics of the 21st Century Retirement System Crystal Gateway Marriot, Washington, DC November 17–18*, 2008.

French, Eric and John Bailey Jones, "The effects of health insurance and self-insurance on retirement behavior," *Econometrica*, 2011, *79* (3), 693–732.

Friedberg, Leora, "The labor supply effects of the social security earnings test," *Review of Economics and Statistics*, 2000, *82* (1), 48–63.

Friedman, Milton, "The permanent income hypothesis. A theory of the consumption function," 1957.

Giannone, Elisa et al., "Skill-biased technical change and regional convergence," in "2017 Meeting Papers" number 190 Society for Economic Dynamics 2017.

Gokhale, Jagadeesh and Laurence J Kotlikoff, "The Adequacy of Life Insurance," *TIAA-CREF Institute, Working Paper No. RD72*, 2002.

_ , _ , and Alexi Sluchynsky, "Does It Pay to Work?," Technical Report, National Bureau of Economic Research 2002.

Gourinchas, Pierre-Olivier and Jonathan A Parker, "Consumption over the life cycle," *Econometrica*, 2002, *70* (1), 47–89.

Gruber, Jonathan and David A Wise, "Introduction to" Social Security and Retirement around the World"," in "Social Security and Retirement around the World," University of Chicago Press, 1999, pp. 1–35.

Haider, Steven J and David S Loughran, "The effect of the social security earnings test on male labor supply new evidence from survey and administrative data," *Journal of Human Resources*, 2008, *43* (1), 57–87.

_ **and** _ , "ELDERLY LABOR SUPPLY," *Workplace Flexibility: Realigning 20th-Century Jobs for a 21st-Century Workforce*, 2010, p. 110.

Harris, Edward, "The distribution of household income and federal taxes, 2008 and 2009," in "in" Congress of the United States, Congressional Budget Office 2012.

Hurd, Michael and Susann Rohwedder, "The retirement-consumption puzzle: Anticipated and actual declines in spending at retirement," Technical Report, National Bureau of Economic Research 2003.

Hurd, Michael D and Susann Rohwedder, "Some answers to the retirement-consumption puzzle," Technical Report, National Bureau of Economic Research 2006.

_ **and** _ , "The retirement consumption puzzle: actual spending change in panel data," Technical Report, National Bureau of Economic Research 2008.

_ **and** _ , "Wealth dynamics and active saving at older ages," in "Improving the Measurement of Consumer Expenditures," University of Chicago Press, 2013, pp. 388–413.

Johnson, Richard W, Amy J Davidoff, and Kevin Perese, "Health insurance costs and early retirement decisions," *ILR Review*, 2003, *56* (4), 716–729.

Joines, Douglas H, "Estimates of effective marginal tax rates on factor incomes," *Journal of Business*, 1981, pp. 191–226.

Kaplan, Greg and Giovanni L Violante, "A model of the consumption response to fiscal stimulus payments," *Econometrica*, 2014, *82* (4), 1199–1239.

Kotlikoff, Laurence J and David A Wise, *The Wage Carrot and the Pension Stick. Retirement Benefits and Labor Force Participation.*, ERIC, 1989.

_ **and Jagadeesh Gokhale**, "Estimating a firm's age-productivity profile using the present value of workers' earnings," *The Quarterly Journal of Economics*, 1992, *107* (4), 1215–1242.

Mayer, Thomas, "The propensity to consume permanent income," *The American Economic Review*, 1966, *56* (5), 1158–1177.

_ , *Permanent income, wealth, and consumption: a critique of the permanent income theory, the life-cycle hypothesis, and related theories*, Univ of California Press, 1972.

Meghir, Costas and Luigi Pistaferri, "Earnings, consumption and life cycle choices," in "Handbook of labor economics," Vol. 4, Elsevier, 2011, pp. 773–854.

Moffitt, Robert A and Peter Gottschalk, "Trends in the covariance structure of earnings in the US: 1969–1987," *The Journal of Economic Inequality*, 2011, *9* (3), 439–459.

Munnell, Alicia H, Natalia Orlova, and Anthony Webb, "How Important is Asset Allocation to Americans' Financial Retirement Security?," *The Market for Retirement Financial Advice*, 2013, p. 89.

_ **, Steven A Sass et al.**, *The decline of career employment*, Center for Retirement Research at Boston College Chestnut Hill, MA, 2008.

of Sciences, Engineering National Academies, Medicine, Committee on Population et al., *The growing gap in life expectancy by income: implications for federal programs and policy responses*, National Academies Press, 2015.

Poterba, James M, Steven F Venti, and David A Wise, "Were they prepared for retirement?: Financial status at advanced ages in the HRS and AHEAD cohorts," in "NBER Working Paper No. 17824. February" 2012.

Roback, Jennifer, "Wages, rents, and the quality of life," *Journal of political Economy*, 1982, *90* (6), 1257–1278.

Romich, Jennifer L, "Difficult calculations: Low-income workers and marginal tax rates," *Social Service Review*, 2006, *80* (1), 27–66.

Rosen, Sherwin, "Wage-based indexes of urban quality of life," *Current issues in urban economics*, 1979, pp. 74–104.

Samwick, Andrew A, "New evidence on pensions, social security, and the timing of retirement," *Journal of public economics*, 1998, *70* (2), 207–236.

Song, Jae G and Joyce Manchester, "New evidence on earnings and benefit claims following changes in the retirement earnings test in 2000," *Journal of Public Economics*, 2007, *91* (3-4), 669–700.

Straub, Ludwig, "Consumption, Savings, and the Distribution of Permanent Income," *Unpublished manuscript, Harvard University*, 2018.

CURRICULUM VITAE

[redacted]