# Essays on Fertility Differentials, Relative Consumption Concerns and Income Inequality

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# Contents

## Dedication

I dedicate this work to my mother **Violeta Simonyan** and to the bright memory of my late father **Alexander Japaridze**.

## Abstract

This thesis is composed of three studies that examine topics related to fertility differentials, relative consumption concerns and income inequality. The first study examines the link between income inequality and increased indebtedness of low-income households due to relative consumption concerns. In an environment of increased income inequality in the US, low-income households were able to match the new "consumption standards" set up by richer high-income households only due to increased availability of credit which, contrary to the common wisdom, led to significant welfare losses. The second study examines the effect of relative consumption concerns on household fertility outcomes. The model developed in the second study demonstrates that higher income of neighbors, who set higher "consumption standards," makes a low-income household divert more resources to consumption by reducing fertility. The empirical investigation confirms that indeed, in early 2000s US household in less equal areas had fewer children than in more equal areas. Finally, motivated by the importance of fertility differentials discussed in the second study, the third study examines the evolution of household fertility outcomes that was expressed in the significant reduction in variation of completed fertility. A model is developed that makes explicit distinction between boys and girls. In this model, low levels of female labor force participation generate a son-preferring bias which results in fertility differentials across households. The model shows that increases in participation rates reduce the son-preferring bias and induce reduction in fertility differentials in line with the existing empirical evidence.

## Résumé

Cette thèse est composée de trois études portant sur des sujets liés aux différences de fécondité, des préoccupations de la consommation relative et de l'inégalité des revenus. Le premier chapitre étudie le lien entre l'inégalité des revenus et l'augmentation de l'endettement des familles à faible revenu causé par des préoccupations pour la consommation relative. Dans un environnement de l'augmentation de l'inégalité des revenus aux États-Unis les familles à faible revenu ont pu faire correspondre les nouvelles "normes de consommation" mises en place par les plus riches familles seulement en raison de la disponibilité accrue du crédit qui, contrairement à la sagesse commune, a conduit à les pertes de bien-être importants. Le deuxième chapitre étudie l'effet des préoccupations de la consommation relative sur les résultats de la fécondité des famille. Un modèle développé dans le deuxième chapitre démontre que revenu plus élevé de voisins, qui a fixé des "normes de consommation" plus élevés, fait famille à faible revenu détourner davantage de ressources à la consommation en réduisant la fertilité. Les investigations empiriques confirme qu'en effet, dans le famille américain dans les zones moins égales avait moins d'enfants que dans les zones plus égales. Enfin, le troisième chapitre étudie l'évolution des résultats de la fécondité des familles qui a été exprimé dans la réduction significative de la variation de la fécondité achevée. Un modèle est développé qui fait la distinction explicite entre les garçons et les filles. Dans ce modèle, un faible taux de participation à la marché du travail féminine génèrent un biais préférant fils qui se traduit par des différences de fécondité entre les familles. Le modèle montre que l'augmentation des taux de participation réduisent le biais préférant fils et induisent une réduction des écarts de fécondité en ligne avec les données empiriques existantes.

## Preface

This thesis contains three studies, each of which is an original scholarship. All three studies are distinct contributions to knowledge in macroeconomics and demographic economics. The first study of this thesis is a co-authored with Francisco Alvarez-Cuadrado. The core theoretical results as well as steady-state numerical exercises are developed by us parallely with cross-validation. The theoretical extension (section 4) is done by Francisco Alvarez-Cuadrado, while the dynamic numerical exercises as well as implementation of the econometric analysis is done by me. The second and the third studies are authored solely by me.

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# Introduction

This thesis is composed of three studies that examine topics related to fertility differentials, relative consumption concerns and income inequality. Each of these socio-economic phenomena is an important topic for economic research and such studies offer interesting input into policy making. The notion of relative consumption concerns, often related to "conspicuous consumption", is a well known phenomenon and there is always an interest in its economic implications for a household and an economy. It is recognized that such behavior may affect key decision outcomes as consumption, saving, fertility, borrowing, etc. Certain consequences of relative consumption concerns such as lack of pension saving, increased indebtedness and insolvency can have important consequences for the public finance and monetary policy. Income inequality, with such a movement as "Occupy Wall Street," the publishing of "The Capital in XXI century," etc. is in the focus of researchers, policy makers and is of significant concern for the general public. Income inequality can be especially serious issue when households exhibit relative consumption concerns. The increasing gap between income of the rich and the median income implies that average households have hard time matching the "consumption standards" set up by the rich households and may make the average households reduce saving, investment in human capital, healthcare expenditure, abstain from having additional children, etc. in order to "keep up with the Joneses." Such responses potentially can lead to reduction in growth rates, reduction of social mobility and welfare, sparking sentiment of injustice and weakening of democratic institutions and affect demographic trends in the society. Among these implications demographic changes deserve a thorough study as demographic issues are clearly important challenges faced by many nations—be it fertility rates below replacement rate in developed nations or high fertility rates in developing nations. Remarkably, most of the demographic models aimed at explaining demographic trends and possibly helping with policy making decisions are solely focused on the total fertility rate: the average number of children per mother. However due to this focus on average fertility these models miss an important chunk of information about human fertility behavior which is "encrypted" in the evolution of distribution of completed fertilities.

Thus, this thesis aims at examining the effect of cross-sectional and temporal variation of income inequality on debt accumulation and fertility outcomes of households that exhibit relative consumption concerns, as well as proposing a modeling approach which can augment our understanding of cross-sectional fertility differentials. This is a manuscript-based thesis. The three research studies are written with the intent of publication. To guide from one study to another, after each study there is a short section that connects it to the next study of the dissertation.

The first study examines the link between income inequality and increased indebtedness of low-income households due to relative consumption motives. In an environment of increased income inequality that took place in the recent 30 years in the US, the consumption of high-income households increased—setting new "consumption standards"—which low-income households tried to match. It is shown that increased availability of credit to low-income household, which allowed them to get close to these new "consumption standards" is associated with significant welfare losses. The second study examines how relative consumption concerns affect another important outcome of household decision making, namely the fertility. A model developed in this study demonstrates that higher income of neighbors, who set higher "consumption standards", makes low-income household divert more resources to consumption by reducing fertility. Thus, one should expect that areas with higher income inequality should be characterized by lower fertility rate than areas with lower income inequality. The empirical investigations confirms that indeed, US household in less equal areas had on average fewer children than in more equal areas. The existence cross-sectional fertility differentials indicates the need for investigating household fertility behavior beyond changes in national or regional levels of total fertility rate. The third study examines the evolution of household fertility outcomes that was expressed in significant reduction in variation of competed fertility. A model is developed that makes explicit distinction between boys and girls. In this model low levels of female labor participation generate a bias against girls and this bias results in fertility differentials across households. The model shows that increases in participation rates induce reduction in fertility differentials in line with the existing empirical evidence.

# Part I
# Trickle-Down Consumption, Financial Deregulation, Inequality, and Indebtedness

**Francisco Alvarez-Cuadrado* and Irakli Japaridze**

**Abstract**

Over the last thirty years the U.S. experienced a surge in income inequality coupled with increasing levels of borrowing. We model an OLG economy populated by two types of household that care about how their consumption compares to that of their peers. In this framework individual debt-to-income ratios decrease with income, increases in consumption of rich households lead to increases in consumption of the rest, and aggregate borrowing increases with income inequality. We calibrate our model to evaluate the welfare implications of the process of financial liberalization that began in the 1980s. Our analysis suggests that some of the financial developments that lead to the recent expansion of credit may have decreased, rather than increased, welfare.

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# 1 Introduction

Over the last three decades the U.S. financial service sector grew enormously, partly as a result of the process of financial deregulation that began in the 1980s. At its peak in 2006 value added in this sector contributed 8.3% to GDP compared to 4.9% in 1980. Over the same period income inequality and household borrowing surged. As shown in **Figure 1**, the share of income of the top 5% of the U.S. income distribution that was around 21% in 1980 rose to 34% by 2010. Over these thirty years real median income grew at an annual rate of 0.7%, while real average income of the top 5% increased by a factor of 2.5 as the richest 5% of U.S. households captured 54% of the real increase in U.S. GDP. Over the same period the ratio of total household debt to GDP doubled, increasing roughly from 0.49 to 0.96.[1] Furthermore this increase in indebtedness was concentrated in the bottom 95% of U.S. households. **Figure 2** illustrates the divergence in debt-to-income ratios across the top 5% and the rest of U.S. income distribution. In view of this evidence it is natural to ask the following questions. Are the trends in inequality and borrowing related? Are households in the bottom 95% borrowing to compensate for the ground they have lost in terms of income relative to the top 5%? Did the process of financial liberalization that facilitated this credit expansion improve welfare?

The objective of this paper is to provide some tentative answers to these questions. We proceed in three steps. First, using the Survey of Consumer Finances (SCF) we document that debt-to-income ratios systematically decrease across the income distribution. We confirm that this gradient is not driven by consumption smoothing in the face of transitory income shocks or by demographic variation across income groups. Furthermore, we verify that the divergent patterns illustrated in **Figure 2** are not driven by compositional changes in different waves of the SCF. Second, we present a simple model of interpersonal comparisons that is consistent with the evidence summarized in the previous two figures. Third, we calibrate this model to replicate some key features of the U.S. economy before the 1980s, specifically the level of labor income inequality and the variation in debt-to-income ratios between the top

[1] This increase in debt-to-income ratios is not only driven by slower income growth but rather reflects genuine increases in indebtedness, since the growth rate of average real debt accelerated in the early 1980s.

5% and the bottom 95% of U.S. households. We use this calibrated economy as the ground to evaluate the welfare implications of the process of financial liberalization that began in the early 1980s. Interestingly, our results suggest that some of the financial developments that lead to the recent expansion of credit may have decreased, rather than increased, welfare.

We model an OLG economy populated by two types of households, the rich and the rest. Both types live for three periods and care about how their consumption compares to that of their peers including those above them in the income distribution. The strength of these interpersonal comparisons declines through the life cycle. Financial markets are imperfect in the sense that the need for monitoring borrowers to prevent default induces a borrowing-lending spread and that low-income households face a borrowing limit. In this context we characterize analytically several interesting results. First, individual debt-to-income ratios decrease with income. Second, increases in income of rich households lead to increases in (first- and second-period) consumption by the rest of the income distribution, trickle-down consumption as in Bertrand and Morse (2013). Third, keeping the timing of income unchanged, increases in (lifetime) income inequality lead to increases in the aggregate debt-to-income ratio. Fourth, the effects of financial liberalization on welfare are non-monotonic, for instance as the borrowing-lending spread falls welfare first decreases and then increases. This is so because the distortions associated with interpersonal comparisons induce households to devote an inefficiently large fraction of resources to consumption in the first period of life at the expense of consumption in later periods. This intertemporal reallocation of resources is made possible by borrowing. In this context, the reduction in borrowing associated with financial frictions prevents households from engaging in conspicuous consumption increasing welfare.

Additionally, our analysis highlights the role of inequality and financial deregulation as two important factors behind the increase in U.S. debt-to-income ratios. Understanding the determinants of indebtedness is important for several reasons. First, increases in debt, either private (Eggertsson and Krugman, 2012; Kumhof, et al., 2013) or public (Reinhart and Rogoff, 2011), seem to play an important role in the development of financial crises and the pace of subsequent recoveries. Second, greater indebtedness affects the sensitivity of household spending to changes in the interest rate and therefore the effectiveness of monetary policy. And third, highly-indebted households are more exposed to shocks to asset prices through greater leverage in their balance sheets.

Different aspects of this project are closely related to Christen and Morgan (2005), Becker and Rayo (2006), Alvarez-Cuadrado and Long (2012), Kumhof, et al. (2013), Bertrand and Morse (2013), Coibin, et al. (2014) and Frank, et al. (2014). Christen and Morgan (2005) provide evidence that rising income inequality through its effect on conspicuous consumption has contributed to increased consumer borrowing, particularly credit card debt. Becker and Rayo (2006) present a theoretical model where a consumer participating in the status race, who wishes to smooth her consumption over time, must increase her level of debt in order to finance the necessary durables. Our modeling approach extends the framework in Alvarez-Cuadrado and Long (2012) to allow for borrowing and credit market imperfections. Kumhof, et al. (2013) present a theoretical model with two types of agents, top and bottom earners, where higher leverage arises endogenously in response to growing inequality. Their analysis emphasizes the role of indebtedness and default on the onset of financial and real crises. Bertrand and Morse (2013) find that, consistent with a status-driven explanation, rising income and consumption at the top of the income distribution induce households in the lower tiers of the distribution to consume a larger share of their income. In contrast to this view that emphasizes the importance of demand for credit for the increase in indebtedness, Coibin, et al. (2014) present evidence that suggests that the observed increase in indebtedness is mainly driven by developments in the supply side of the credit market. Our model incorporates both channels. Upward-looking interpersonal comparisons increase the demand for credit after an increase in top-income inequality and financial liberalization shifts out the supply of credit. Finally, Frank, et al. (2014) present an static model of status that gives rise to expenditure cascades, i.e. increases in consumption at the top induce increases in consumption in the rest of the income distribution.

Our paper also complements the growing literature on interdependent preferences, which includes Corneo and Jeanne (1998), Ljungqvist and Uhlig (2000), Liu and Turnovsky (2005), and Alonso-Carrera, et al. (2008) among others, by exploring the implications of interpersonal comparisons for borrowing. Our paper is also related to the recent literature on income and consumption inequality and draws on the abundant literature on the recent history of the U.S. financial liberalization. We will briefly discuss these streams of literature in the next section.

The rest of the paper is organized as follows. Section 2 documents some recent developments in the U.S. and discusses some of the relevant literature. Section 3 sets out the basic model and characterizes the competitive solution. Section 4 uses a simplified version of the model to explore the interaction between inequality and indebtedness. Section 5 presents a numerical analysis of the welfare changes associated with financial deregulation. Section 6 offers some concluding remarks, while the Appendix provides some technical details.

## 2 Some Trends in the U.S.

The objective of this section is twofold. First, we explore the robustness of the patterns documented above. Specifically, we confirm that the cross-sectional gradient in debt-to-income ratios is not an artifact purely driven by consumption smoothing in the face of transitory income shocks or by demographic variation across the income distribution. Furthermore, we verify that the time-series evolution of the debt-to-income ratios is not driven by compositional changes in the SCF samples. Second, we briefly discuss two developments that turn out to influence some of our modeling choices; the nature of the increase in inequality and the expansion of the financial industry.

### 2.1 The evolution of debt-to-income ratios

In a seminal paper, Dynan, et al. (2004) find a strong positive relationship between saving rates and measures of lifetime income. We follow a similar approach to explore the robustness of the patterns illustrated in **Figure 2**. We proceed with our analysis in two phases. First, we explore the differences in debt-to-income ratios between the top 5% and the bottom 95%. Second, we document its time-series evolution. We use eight waves of the SCF from 1989 to 2010.[2] Our benchmark measure of debt includes principal residence

[2]See Bucks, et al. (2006) for a detailed description of this dataset. Our results remain unchanged when we exclude the last wave of the survey that took place in the aftermath of the financial crisis.

debt, other lines of credit, debt for other residential property, credit card debt, installment loans, and other debt. The denominator of the debt-to-income ratio, total income minus capital gains, includes wages, self-employment and business income, taxable and tax-exempt interest, dividends, food stamps and other support programs provided by the government, pension income and withdrawals from retirement accounts, and Social Security income. We will also explore the robustness of our results to narrower measures of debt and income. We restrict our sample to households with heads between 30 and 59 years of age. As a result we avoid dealing with issues relevant to very young households, such as liquidity constraints, and to very old ones, such as retirement or acute health problems. We also drop households with income below \$1,000 or above \$4,000,000 (both in 2010 dollars) or debt-to-income ratios abnormally high (above 10). For each wave of the survey and for each 10-year age group separately we classify families into the top 5% and the bottom 95% of the income distribution. We estimate median regressions with different measures of the debt-to-income ratio as the dependent variable and a constant term and dummies for the top 5%, age and education of the head of the household, and household size, as independent variables. Both Dynan and Kohn (2007), for the U.S., and Bover et al (2014), for a sample of 11 E.U. countries, document the importance of these socio-demographic variables to account for the variation of debt-to-income ratios. The estimated coefficient on the constant term corresponds to the median debt-to-income ratio for households in the bottom 95% of the income distribution with one to four members and with heads between 40 and 49 years old who hold a college degree, the most numerous category in our sample. Bootstrapped standard errors for the coefficients, based on 500 replications, are shown in parentheses.

Column 1 of **Table 1** indicates that the median borrowing rate of the bottom 95% exceeds that of the top 5% by roughly 60%. One may think that these results are driven by mortgage debt, since arguably for households in the bottom 95% home values represent a larger fraction of their income than for those in the top 5% and home purchases are typically financed with debt. Column 2 casts doubts on this explanation. Although mortgage debt is the most important component of total debt, using a measure of debt that excludes mortgages we find that the median debt-to-income ratio of the bottom 95% exceeds that of the top 5%

by even a larger factor. In line with the findings in Dynan and Kohn (2007) and Bover, et al. (2014) our estimates suggest that debt-to-income ratios fall for older households and increase with educational attainment and, to some extent, with household size. Nonetheless, any economist trained to see the world through the permanent income hypothesis will regard these results with caution. At the end of the day borrowing, together with saving, are the most important tools for households to smooth consumption in the face of transitory income shocks. The main contribution of Dynan, et al. (2004) involves the use of IV techniques to deal with the measurement error induced by transitory income shocks in the context of the saving-income relationship. Next, we extend their analysis to the relationship between borrowing and income. These authors instrument for permanent income using the reported value of owned vehicles (a measure of consumption), lagged income exploiting the 1983-89 SCF panel, and education. We use the first two instruments and abstract from the third one since it has been well documented that education has an independent effect on debt-to-income ratios. Starting in 1995, the SCF includes a measure of the value of income that the household would expect to receive in a "normal" year, normal income. Besides the instruments from Dynan, et al. (2004) we also include normal income both as an instrument and as a direct measure, or a proxy, for permanent income.

We follow a two-stage estimation procedure. In the first stage, we regress current income on one of the instruments and the set of control variables. We use the fitted values of this regression to classify households, for each 10-year age group separately, into the top 5% and the bottom 95% of the distribution of permanent income. In the second stage, we estimate median regressions as in the exercise that uses current income. When the value of vehicles is used as an instrument, we exclude from our measure of debt the outstanding value of loans used to finance vehicles. Columns 3 to 10 of **Table 1** report the results of these exercises. The basic message is consistent across specifications; households in the bottom 95% of the distribution of permanent income have debt-to-income ratios larger than those at the top 5%.

Next we turn to explore the time-series evolution of debt-to-income ratios for both income groups. For this purpose we expand the previous specifications introducing a time trend and an interaction between this trend and the top 5% dummy. If the patterns in **Figure 2** are robust one would expect a positive coefficient in the time trend, capturing the secular increase in the median debt-to-income ratio of the bottom 95%, and a negative coefficient in the interaction that captures the slower increase in the debt-to-income ratio of the top 5%. This slower increase turns into a decrease if the sum of both coefficients is negative. **Table 2** reports the results of these exercises using measures of current and permanent income. The signs of the two relevant coefficients are as expected and in all specifications their sum suggests that the median debt-to-income ratio of the top 5% increased much slower than that of the bottom 95% over the last 20 years. For instance, using total debt as the measure of borrowing and normal income as an instrument for permanent income (column 4), the estimates suggest that the median debt-to-income ratio of the bottom 95% increased by roughly 20 percentage points (0.009 x 21 years) between 1989 and 2010 an increase three times larger than that of the top 5%. Since these exercises control for education, age, and family size, it is unlikely that changes in the demographic composition of the U.S. population over the sample period lie behind the patterns illustrated in **Figures 1** and **2**.

Finally, **Table 3** summarizes the results of some additional verifications. For compactness, we abstract from the time-series component and we focus on total debt reporting only results for current income and normal income as an instrument for permanent income. Specifications that abstract from mortgage debt, use other instruments, or include the time-series component do not change the qualitative nature of the results. Although all specifications include controls for age, education, and household size these coefficients are not reported since they are consistent with those in the previous tables. Since our income measure includes capital income one might suspect that the classification of families into the bottom 95% and the top 5% is determined by systematic differences in borrowing (or saving) propensities across individuals. Columns 1 and 2 reproduce our benchmark exercise using only labor income, wages, to classify households into income groups. Columns 3 and 4 report results using a narrower measure of debt, consumption loans. In both exercises, the benchmark result remains unchanged. The next specification includes a dummy for home ownership. The coefficient on this dummy is large, positive, and significant, suggesting that home ownership is a important determinant of debt-to-income ratios. Nonetheless, borrowing rates of the bottom 95% exceed those of the top 5% for both home-owners and renters. In the last two columns of **Table 3**, we report the results of median regressions of debt-to-income ratios on a continuous measure of income and a dummy for those households in the bottom quintile of the income distribution where the fraction of credit-constrained individuals is likely to be high (Jappelli, 1990). The coefficient on the measure of income is negative and significant suggesting that the differences in borrowing rates are not restricted to the bottom 95%-top 5% partition of the income distribution but are a more general phenomenon. Additionally, all these results are robust in a sample that excludes households that derive their income from self-employment.[3]

All these results suggest that the patterns documented in **Figure 2** are not an artifact of our choice of debt or income measures, or of demographic changes in the composition of the US population, or of systematic (non-income related) differences between the top 5% and the bottom 95%, but rather genuine differences in the borrowing choices between these two income groups.

### 2.2 Income inequality

Income inequality in the U.S. increased markedly over the past three decades. Most of this increase can be traced back to gains made by those near the top of the income distribution. Autor, et al. (2008) find that, since the 1980s, upper tail U.S. wage dispersion has increased significantly while lower tail dispersion has actually declined. Piketty and Saez (2003) further document the importance for inequality of changes at the very upper-end of the income and wage distributions.

At a fundamental level there are two alternative approaches to introduce income heterogeneity in aggregate models. First, following Bewley (1977) and Aiyagari (1994) agents have identical endowments and heterogeneity emerges as a result of idiosyncratic transitory shocks, i.e. variation in the transitory component of earnings. Second, along the lines of Stiglitz (1969), heterogeneity results from variation in endowments across individuals, i.e.

[3] Carr and Jayadev (2013) document similar patterns in the Panel Study of Income Dynamics for the period 1999-2009. After dividing the sample into income tertiles they find that, in the lower tertile debt grew around 10 percentage points. In contrast the high income tertile deleveraged over the period, with a cumulative reduction of about 5 percentage points.

variation in the permanent component of earnings.[4] In the spirit of the former, Krueger and Perri (2006) and Iacoviello (2008) explore the interaction between income inequality and borrowing. Krueger and Perri (2006) use a standard incomplete markets model to account for the divergent patterns in consumption and income inequality that they document using the Consumer Expenditure Survey (CEX). They conclude that the increase in household borrowing is consistent with an increase in income inequality driven by increases in the dispersion of transitory income shocks. Iacoviello (2008) interprets the recent increase in the U.S. aggregate debt-to-income ratio as the optimal response of households to increases in the volatility of transitory income shocks. Nonetheless, recent empirical evidence casts important doubts on these interpretations of the recent increase in inequality. Primiceri and van Rens (2009) use CEX repeated cross-section data to decompose changes in income into permanent and transitory components. They find that changes in the permanent component explain all of the increase in inequality in the 1980s and 1990s. Using Social Security Administration longitudinal earnings data, Kopczuk, et al. (2010) find that virtually all of the increase in the variance in annual (log) earnings since 1970 is due to increases in the variance of the permanent component of earnings. Debacker, et al. (2013) using a large panel of tax returns find that the entire increase in cross-sectional inequality in male labor earnings over the period 1987-2009 was driven by an increase in the dispersion of the permanent component of earnings. All this evidence aligns with the second theoretical approach that emphasizes the importance of endowments as a source of inequality. As a result, our analysis will follow this approach abstracting from transitory income shocks and social mobility.

### 2.3 Democratization of credit

During the 30 years leading to the Great Recession the U.S. financial service sector grew enormously. At its peak in 2006 value added in this sector contributed 8.3% to GDP compared to 4.9% in 1980 implying an average growth rate twice that of the preceding 30 years (Greenwood and Scharfstein, 2013). In particular more than one-quarter of this growth can be attributed to increases in credit intermediation activities. Aside from changes in the demand for credit, there are several supply-side factors that have contributed to this process

[4] Whether a change in inequality is driven by transitory or permanent income components has important welfare implications.

sometimes referred to as the "democratization of credit" (Black and Morgan, 1999; Dynan and Kohn, 2007).

First, financial innovation allowed for the expansion of credit supply relaxing borrowing constraints. A salient example is the process of securitization and the development of the "originate-to-distribute" model of credit (Mayer, 2011), under which mortgage brokers originate loans and then sell them to institutions that securitize them. Since brokers do not bear the ultimate costs of default, they have incentives to extend credit to marginal applicants that previously were credit constrained. Mian and Sufi (2009) provide extensive evidence along these lines; in particular they find that after 2002 the mortgage denial rates for subprime ZIP codes fell disproportionately coinciding with an almost doubling of the fraction of originated mortgages sold to non-government-sponsored entities. Their preferred interpretation suggests that moral hazard on behalf of originators is a key determinant behind this expansion of credit. Levitin and Wachter (2012) find that between 2003 and 2007 the spread of private-label mortgage backed securities over maturity-matched Treasuries fell substantially even as mortgage risk, non-prime loans, increased. They interpret this negative relation between risk and the risk premium as caused by a shift in the supply of mortgage finance.

Second, the expansion of credit bureaus and innovations in information technology, such as computerized credit scoring models or automated underwriting systems, also contributed to the outward shift in credit supply. Athreya, et al. (2012) find that improvements in information on borrowers' default risk account for all of the increase in unsecured credit between 1983 and 2004. In the context of mortgage loans, the gains in efficiency associated with these innovations lead to reductions in the price charged by lenders. For instance, the fees associated with 30-year-fixed-rate mortgage fell from 2.5% of the principal in 1985 to about 0.5% in 2005 (U.S. Department of Housing and Urban Development, 2006).

Third, a series of regulatory changes also contributed to the expansion of credit. Rajan (2010) argues that a political response to the surge in income inequality was to expand credit to low-income groups to support their consumption levels in the face of stagnant levels of income.[5] A few examples along these lines may include the 1978 Marquette decision, the

[5]In contrast to Rajan (2010) where weaker credit standards result from political pressures of low-income households, Mian, et

Garn-St. Germain Depository Institutions Act, the Second Mortgage Market Enhancement Act, or the 1992 Housing and Community Development Act. In the Marquette decision the U.S. Supreme Court effectively abolished state usury laws allowing the extension of credit to high-risk and low-income borrowers (Moss and Johnson, 1999). The Garn-St. Germain Depository Institutions Act of 1982 deregulated savings and loan associations raising the ceiling on interest they can pay on deposits, providing them with Federal Deposit Insurance, and allowing them to enter new lines of business like commercial real estate and consumer lending. In 1984, with the support and leadership of the financial industry, the administration passed the Second Mortgage Market Enhancement Act which declared AA-rated mortgage-backed securities to be legal investments equivalent to Treasury securities for federally chartered banks state-chartered financial institutions, and Department of Labor-regulated pension funds. The Housing and Community Development Act of 1992 reduced capital requirements for Fannie Mae and Freddie Mac and over the 1990s the Federal Housing Administration expanded its loan guarantees to cover bigger mortgages with smaller down-payments.[6]

All this evidence suggests that an outward shift in credit supply is an important factor contributing to the increase in household borrowing. As a result, our theoretical analysis incorporates a simple mechanism that aims to capture these changes in the credit conditions.

# 3 The Model

Consider a closed economy populated by overlapping generations of households. Time is discrete and infinite with $t = 0, 1, 2, ...\infty$.

## 3.1 Production

Every period firms produce a composite good that can be consumed or invested. Output, $Y_t$, is produced combining physical capital, $K_t$, labor, $L_t$, and labor-augmenting technology, $A_t$. The production function takes the familiar Cobb-Douglas specification,

al. (2010) and Acemoglu (2011) provide evidence suggesting that these weaker standards resulted from the increasing lobbying efforts of the financial industry.

[6]In a similar vein, the risk-based capital regulation introduced by the 1988 Basel Accord offered banks a capital incentive to invest in mortgage-backed securities. With a risk weight of 20% for Fannie and Freddie securities and 50% for individual residential mortgage whole loans, financial institutions were allowed to increase their leverage by two to five times. This made mortgages a very attractive asset type.

$$Y_t = K_t^{\alpha} \left(A_t L_t\right)^{1-\alpha}, \tag{1}$$

where $0 < \alpha < 1$ measures the elasticity of output to capital. Technology grows at an exogenous rate, $\frac{A_{t+1}}{A_t} = 1 + g$. Since markets are competitive, factors are paid their marginal products,

$$w_t = (1-\alpha) K_t^{\alpha} \left(L_t\right)^{-\alpha} A_t^{1-\alpha} \tag{2}$$

$$r_t = \alpha K_t^{\alpha-1} \left(A_t L_t\right)^{1-\alpha} - \delta, \tag{3}$$

where capital is assumed to depreciate at the exponential rate $\delta$. Finally, we denote the gross return to capital by $R_t \equiv 1 + r_t$.

### 3.2 Households

Individuals live for three periods: "youth," "middle-age," and "old-age." At the end of each period a new generation is born and therefore there are three generations alive at any point in time. Each generation is composed of a continuum of mass 1 of individuals. All generations are identical.

Within a generation, there are two types of individuals, denoted by the superscripts $H$ and $L$, who differ in their productive endowment with $l^H > l^L > 0$. There is a fraction $0 < \mu < 1$ of type-$H$ individuals with the remaining being type-$L$ individuals. When $\mu = 0.05$ type-$H$ households represent the top 5% of the income distribution and one can think of changes in their productive endowments as driving the permanent component of inequality discussed in the previous section.

Each individual works in the first two periods of his life being retired in the third period. Let's focus on a type $i = \{H, L\}$ individual born in period $t$. His labor earnings when young are given by $w_{t,t}^i \equiv l^i w_t$, where the first subscript indicates his generation and the second one refers to the timing of income. As a result, his first-period budget constraint is given by

$$c_{t,t}^i = w_{t,t}^i + b_{t,t}^i \tag{4}$$

where we denote by $c^i_{t,t}$ and $b^i_{t,t}$ his levels of consumption and one-period borrowing respectively.

Labor earnings in the second period of his life are given by $w^i_{t,t+1} = hl^i w_{t+1}$ where $h > 1$ is an exogenous measure of the productive effect of experience which is common across types. Therefore, his second-period budget constraint is given by

$$c^i_{t,t+1} + R^x_{t+1} b^i_{t,t} = w^i_{t,t+1} + b^i_{t,t+1} \tag{5}$$

where the superscript $x = \{b, l\}$ denotes whether an individual was a borrower or a lender (saver) in the first period.

In the third period of his life the type $i$ individual born in period $t$ is retired. In this period his only source of income is the gross return on his middle-age savings which, in the absence of a bequest motive, is fully consumed in this last period. As are result his old-age budget constraint is given by[7]

$$c^i_{t,t+2} = -R_{t+2} b^i_{t,t+1}. \tag{6}$$

In order to capture the outward shift in credit supply, we will consider two types of financial market imperfections. First, although we assume individuals can lend any amount at the lending interest rate given by (3), $r^l_t \equiv r_t$, we introduce a distinction between firms that can borrow at this rate and households that need to pay a default premium. We follow Galor and Zeira (1993) by assuming that households can evade debt payments with a cost. Financial intermediaries can avoid such defaults by monitoring borrowers, but these activities are costly. Assume that if a financial intermediary spends an amount $z$ in monitoring a borrower, this borrower can still evade re-payment but only at a cost $\pi z$, where $\pi > 1$. As we will see, these costs create a capital market imperfection, where households can borrow only at a rate that exceeds the lending rate, $r^b_t > r^l_t$. If a household borrows an amount $p$ and financial intermediation is competitive, the default premium should exactly cover the

[7]As we will see middle-age households always choose a positive amount of saving, $b^i_{t,t+1} < 0$, and therefore we omit the superscript $x = \{b, l\}$ on the third-period budget constraint.

monitoring costs leading to the following zero-profit condition

$$pr_t^b = pr_t + z \tag{7}$$

and the financial intermediary chooses the level of monitoring to be high enough to make default disadvantageous for the borrower,

$$p\left(1 + r_t^b\right) \leq \pi z. \tag{8}$$

Combining this incentive compatibility constraint, (8), with the zero-profit condition, (7), we determine the borrowing interest rate as

$$r_t^b = \frac{1}{\pi - 1} + \frac{\pi}{\pi - 1} r_t \tag{9}$$

that including the repayment of principal becomes,

$$R_t^b = 1 + r_t^b = \frac{\pi}{\pi - 1} R_t. \tag{10}$$

A first measure of the laxity of credit is given by the difference between the borrowing and lending interest rates, the interest rate spread, as a fraction of the (gross) lending rate, $\frac{r_t^b - r_t^l}{R_t^l} = \frac{1}{\pi - 1}$.

Second, besides the interest rate spread, financial markets present an additional friction, a credit constraint. By assumption, this friction only affects type-$L$ individuals. This constraint limits the amount of middle-age wages that type-$L$ individuals can use to finance first-period consumption,

$$b_{t,t}^L \leq \xi \frac{w_{t,t+1}^L}{R_{t+1}^b}. \tag{11}$$

Following Aghion, Bacchetta and Banerjee (2004), the fraction $0 \leq \xi \leq 1$ of the present value of future labor income that sets the borrowing limit is our second measure of the laxity of credit.

Individual preferences are given by the following life-cycle utility function

$$U_t^i = \ln\left(c_{t,t}^i - \gamma_0 \tilde{c}_{t,t}^i\right) + \beta \ln\left(c_{t,t+1}^i - \gamma_1 \tilde{c}_{t,t+1}^i\right) + \beta^2 \ln\left(c_{t,t+2}^i - \gamma_2 \tilde{c}_{t,t+2}^i\right) \tag{12}$$

where $\beta < 1$ is the subjective discount factor.

In line with the evidence on interpersonal comparisons discussed in the introduction, our key behavioral assumption is that the satisfaction derived from consumption does not depend on the absolute level of consumption itself but rather on how it compares to the level of consumption of some reference group. Furthermore, we assume that the importance of positional concerns, captured by $0 \leqslant \gamma_2 < \gamma_1 < \gamma_0 < 1$, decreases with age. Several pieces of evidence align with this assumption. First, the work of development psychologists and sociologists (Coleman, 1961, Simmons and Blyth, 1987, Corsaro and Eder, 1990) suggests that interpersonal comparisons and peer effects are more pronounced early in life. Second, during their youth and middle-age, people work, find partners, raise children, and they are exposed to, and therefore influenced by, a wide variety of social networks. Third, Heffetz (2011) conducts a survey on the degree of positionality of 31 categories of goods and services. He finds that expenditures that are concentrated in late periods of life, for instance medical care or bequests (life insurance), rank in the bottom third of the visibility index. To the extent that the degree of visibility is an important determinant of interpersonal comparisons, this evidence suggests that positional concerns decline with age. Fourth, more direct evidence comes from Charles, et al. (2009) and Alvarez-Cuadrado and El-Attar (2012). Charles, et al. (2009), use CEX data to document important differences in the consumption patterns for visible goods across races that they attribute to differences in the income characteristics of the reference group. These differences disappear when they restrict their sample to older households indicating that the importance of positional (visible) consumption decreases with age. Using PSID data Alvarez-Cuadrado and El-Attar (2012) evaluate the impact of reference income, measured as average local income, on individual saving decisions. They find that the negative (positive) impact of reference income on saving (consumption) decreases with age.

Following Ljungqvist and Uhlig (2000) we adopt an additive specification for relative consumption, where $\tilde{c}_{t,t+1}^i$ is the reference level of consumption of a middle-age type-$i$ individual born at $t$.[8] As Frank (1985, p. 111) points out "the sociological literature on reference group theory stresses that an individual's personal reference group tends to consist of others who are similar in terms of age". Consequently, our specification restricts interpersonal comparisons to individuals within the same generation, as opposed to Abel (2005) and Alonso-Carrera, et al. (2008). Furthermore, Veblen (1899), Duesenberry (1949), and Frank (2007) eloquently argue that the behavior of successful individuals or groups sets the standard for the rest of the community. Ferrer-i-Carbonell (2005) provides convincing microeconometric evidence on the importance of upward-looking comparisons as a determinant of subjective well-being. Dynan and Ravina (2007) explore the effects on self-reported well-being of income at the ninetieth percentile of an individual's education-occupation-state group. Their results suggest that happiness of individuals above this percentile is little affected by a further increase in their income relative to this benchmark, but on the contrary individuals below this point do care to improve their position relative to the ninetieth percentile. Finally, Drechsel-Grau and Schmid (2013, 2014) estimate the effects on individual consumption of reference consumption, defined as the consumption level of all households who are perceived to be richer than the individual in question. Their estimates suggest that a 1% increase reference consumption is associated with an increase in own consumption of 0.3%. In view of this evidence, we assume the reference group of rich households is made up only of rich households while the reference group of type-$L$ households is composed of a weighted average of both types, with $(1-\rho)$ being the weight placed on rich households. As a result, reference consumption levels for the two groups are given by

$$\tilde{c}^H_{t,t} = c^H_{t,t} \qquad \text{and} \qquad \tilde{c}^L_{t,t} = \rho c^L_{t,t} + (1-\rho)c^H_{t,t}. \tag{13}$$

Finally, we place restrictions on the distribution of productive endowments to guarantee that everyone's relative consumption is positive.

### 3.3 Model solution

As a result of the interest rate spread we need to consider two separate regimes that

[8] According to the terminology of Clark and Oswald (1998), our preference specification is "comparison-concave" and therefore individuals tend to emulate their neighbors.

depend on whether it is optimal for young households to borrow or lend. We refer to these two regimes as borrowing and lending.[9] Combining (4)-(6) we reach the following lifetime budget constraint

$$c^i_{t,t} + \frac{c^i_{t,t+1}}{R^x_{t+1}} + \frac{c^i_{t,t+2}}{R^x_{t+1}R_{t+2}} = w^i_{t,t} + \frac{w^i_{t,t+1}}{R^x_{t+1}} \equiv y^{i,x}_t \tag{14}$$

where $y^{i,x}_t$ is the present value of life-time income of a type-$i$ individual born in period $t$ operating in regime $x$.

This lifetime budget constraint simply states that the present value of consumption expenditures should be equal to the present value of lifetime income. Capital markets allow agents to time their consumption independently of the timing of their income.

Let's begin with the borrowing regime where we impose the following constraint

$$c^i_{t,t} \geqslant w^i_{t,t} \tag{15}$$

that requires non-negative borrowing for young households.

Each household takes factor prices and the choices of the other households as given and chooses consumption to maximize (12) subject to (11), (14), and (15). The solution to this problem is characterized by the following optimality conditions, where $\mu^i \geqslant 0$ and $\phi^i \geqslant 0$ are the Lagrange multipliers associated with the credit constraint and non-negative borrowing respectively,

$$\frac{1}{\left(c^i_{t,t} - \gamma_0 \tilde{c}^i_{t,t}\right)} = \frac{\beta R^b_{t+1}}{\left(c^i_{t,t+1} - \gamma_1 \tilde{c}^i_{t,t+1}\right)} + \mu^i - \phi^i \tag{16}$$

$$\frac{1}{\left(c^i_{t,t+1} - \gamma_1 \tilde{c}^i_{t,t+1}\right)} = \frac{\beta R_{t+2}}{\left(c^i_{t,t+2} - \gamma_2 \tilde{c}^i_{t,t+2}\right)} \tag{17}$$

together with (14) and the complementarity conditions associated with (11) and (15).

We proceed with the solution of the model in two stages. First, given the optimal choice of first-period consumption, $c^i_{t,t}$, we determine the remaining choices. Second, we characterize the optimal level of first-period consumption.

[9] Of course, it may also be optimal to neither borrow nor lend. In order to keep notation simple, we will limit the use of the borrowing and lending superscripts, $x = \{b, l\}$, to the interest rate and life-time income.

Let's begin by characterizing the behavior of rich households. Given first period consumption, $c^H_{t,t}$, we can solve (13), (14) and (17) to reach

$$c^H_{t,t+1} = \frac{(1-\gamma_2)}{\beta(1-\gamma_1)} \frac{c^H_{t,t+2}}{R_{t+2}} = -\frac{(1-\gamma_2)}{\beta(1-\gamma_1)} b^H_{t,t+1} = \frac{(1-\gamma_2)}{(1-\gamma_2)+\beta(1-\gamma_1)} R^b_{t+1} \left( y^{H,b}_t - c^H_{t,t} \right) \quad (18)$$

$$b^H_{t,t} = c^H_{t,t} - w^H_{t,t} \geqslant 0. \quad (19)$$

Since, by assumption, financial intermediaries do not impose borrowing limits on rich households, $\mu^H = 0$, using (13) we can express (16) as

$$\frac{1}{c^H_{t,t}(1-\gamma_0)} = \frac{\beta R^b_{t+1}}{c^H_{t,t+1}(1-\gamma_1)} - \phi^H. \quad (20)$$

Within the borrowing regime we need to explore two candidate solutions, a corner solution and an interior solution. In the corner solution, $\phi^H > 0$, and therefore (15) implies that

$$c^H_{t,t} = w^H_{t,t}. \quad (21)$$

Combining (18), (20) and (21) one can see that the corner solution is optimal when the interest rate charged to borrowers exceeds the marginal rate of substitution between young- and middle-age consumption evaluated at (21), the endowment point,

$$R^b_{t+1} > \frac{(1-\gamma_1)(1-\gamma_2)\, w^H_{t,t+1}}{\beta(1-\gamma_0)\left[(1-\gamma_2)+\beta(1-\gamma_1)\right] w^H_{t,t}} \equiv \frac{\partial U^H_t / \partial c^H_{t,t}}{\partial U^H_t / \partial c^H_{t,t+1}}. \quad (22)$$

In the interior solution, $\phi^H = 0$, we combine (18) and (20) to reach

$$c^H_{t,t} = \psi^H y^{H,b}_t \quad (23)$$

where $0 < \psi^H \equiv \dfrac{1}{1+\beta\dfrac{(1-\gamma_0)}{(1-\gamma_1)} + \beta^2 \dfrac{(1-\gamma_0)}{(1-\gamma_2)}} < 1.$

As a result, conditional on being in the borrowing regime, first-period consumption for a rich household is given by

$$c^{H,b}_{t,t} = \max\left\{ w^H_{t,t}, \psi^H y^{H,b}_t \right\}. \quad (24)$$

A similar reasoning implies the following level of first-period consumption in the lending regime

$$c_{t,t}^{H,l} = \min\left\{w_{t,t}^{H}, \psi^{H} y_t^{H,l}\right\}. \tag{25}$$

Notice that since preferences are quasi-concave and the constraint set is convex the necessary conditions are also sufficient. So if there is an interior solution in the borrowing (lending) regime, then we can conclude that there is no interior solution in the lending (borrowing) regime, and hence the interior solution is optimal.[10] Furthermore, **Figure 2** suggests that the empirically relevant case is given by the interior solution of the borrowing regime and therefore, in the remaining of the paper, we will concentrate in this case. As a result, we further restrict our use of the superscript $b$ to the borrowing interest rate.

To sum up, in the interior solution of the borrowing regime, optimal choices for rich households are given by

$$c_{t,t}^{H} = \frac{c_{t,t+1}^{H}}{\beta R_{t+1}^{b}} \frac{(1-\gamma_1)}{(1-\gamma_0)} = \psi^{H} y_t^{H} \tag{26}$$

$$b_{t,t}^{H} = \left(\psi^{H} - 1\right) w_{t,t}^{H} + \psi^{H} \frac{w_{t,t+1}^{H}}{R_{t+1}^{b}} = \psi^{H} y_t^{H} - w_{t,t}^{H} > 0 \tag{27}$$

$$c_{t,t+2}^{H} = -R_{t+2} b_{t,t+1}^{H} = \beta^2 R_{t+1}^{b} R_{t+2} \frac{(1-\gamma_0)}{(1-\gamma_2)} \psi^{H} y_t^{H} \tag{28}$$

where $\psi^{H}$is a measure of the marginal (average) propensity to consume when young. In the interior solution of the borrowing regime, rich households always borrow when young and save for retirement in their middle-age.

Next, let's characterize the optimal choices of type-$L$ households. We restrict our analysis to the interior solution of the borrowing regime, $\phi^{L} = 0$. As before we divide the solution in two stages. First, we determine middle- and old-age choices given first-period consumption. Second, we solve for consumption when young. Combining (13), (14), (17), (26) and (28) we

[10] Notice that we can consolidate (24) and (25) as $c_{t,t}^{H} = \max\left\{\min\left\{w_{t,t}^{H}, \psi^{H} y_t^{H,l}\right\}, \psi^{H} y_t^{H,b}\right\}$. If a household is in the interior solution of the borrowing regime, i.e. $\psi^{H} y_t^{H,b} > w_{t,t}^{H}$, since $y_t^{H,l} > y_t^{H,b}$ it is clear that $\min\left\{w_{t,t}^{H}, \psi^{H} y_t^{H,l}\right\} = w_{t,t}^{H}$ and therefore the household is in the corner solution of the lending regime.

reach

$$
\begin{aligned}
c^L_{t,t+1} &= \frac{\left[(1-\gamma_2\rho)\,R^b_{t+1}\left(y^L_t - c^L_{t,t}\right) + \beta^2 R^b_{t+1}\,(1-\rho)\,\gamma_3\psi^H y^H_t\right]}{(1-\gamma_2\rho)+\beta\,(1-\gamma_1\rho)} \qquad (29)\\
c^L_{t,t+2} &= \frac{\beta R_{t+2}\left[(1-\gamma_1\rho)\,R^b_{t+1}\left(y^L_t - c^L_{t,t}\right) - \beta R^b_{t+1}\,(1-\rho)\,\gamma_3\psi^H y^H_t\right]}{(1-\gamma_2\rho)+\beta\,(1-\gamma_1\rho)}\\
b^L_{t,t} &= c^L_{t,t} - w^L_{t,t} > 0 \qquad b^L_{t,t+1} = -\frac{c^L_{t,t+2}}{R_{t+2}}
\end{aligned}
$$

where $\gamma_3 \equiv \dfrac{(\gamma_1-\gamma_2)\,(1-\gamma_0)}{(1-\gamma_2)\,(1-\gamma_1)} > 0$.

Next we turn to the determination of first-period consumption. Since type-$L$ households are potentially credit constrained when young, we need to consider two cases depending on whether the credit constraint binds, $\mu^L > 0$, or not, $\mu^L = 0$. We will use the superscript $Z = \{C, U\}$ to denote the "constrained" and "unconstrained" cases respectively. When the credit constraint binds, the borrowing limit determines consumption when young that combined with (29) yields the following choices

$$
\begin{aligned}
c^{L,C}_{t,t} &= w^L_{t,t} + \xi\frac{w^L_{t,t+1}}{R^b_{t+1}} \qquad (30)\\
c^{L,C}_{t,t+1} &= \frac{\left[(1-\gamma_2\rho)\,(1-\xi)\,w^L_{t,t+1} + \beta^2 R^b_{t+1}\,(1-\rho)\,\gamma_3\psi^H y^H_t\right]}{(1-\gamma_2\rho)+\beta\,(1-\gamma_1\rho)}\\
c^{L,C}_{t,t+2} &= \frac{\beta R_{t+2}\left[(1-\gamma_1\rho)\,(1-\xi)\,w^L_{t,t+1} - \beta R^b_{t+1}\,(1-\rho)\,\gamma_3\psi^H y^H_t\right]}{(1-\gamma_2\rho)+\beta\,(1-\gamma_1\rho)}\\
b^{L,C}_{t,t} &= \xi\frac{w^L_{t,t+1}}{R^b_{t+1}} \qquad b^{L,C}_{t,t+1} = -\frac{c^{L,C}_{t,t+2}}{R_{t+2}}.
\end{aligned}
$$

Similarly when the credit constraint is not binding, we combine (13), (16), (26), and (29) to determine the optimal choices of type-$L$ individuals given by

$$
\begin{aligned}
c^{L,U}_{t,t} &= \psi^L\left[(1-\gamma_1\rho)\,(1-\gamma_2\rho)\,y^L_t + \phi_0\psi^H y^H_t\right] \qquad (31)\\
c^{L,U}_{t,t+1} &= \beta R^b_{t+1}\psi^L\left[(1-\gamma_0\rho)\,(1-\gamma_2\rho)\,y^L_t + \phi_1\psi^H y^H_t\right]\\
c^{L,U}_{t,t+2} &= \beta^2 R_{t+2}R^b_{t+1}\psi^L\left[(1-\gamma_0\rho)\,(1-\gamma_1\rho)\,y^L_t - \phi_2\psi^H y^H_t\right]\\
b^{L,U}_{t,t} &= \psi^L\left((1-\gamma_1\rho)\,(1-\gamma_2\rho)\,y^{L,b}_t + \phi_0\psi^H y^{H,b}_t\right) - w^L_{t,t} > 0 \qquad b^{L,U}_{t,t+1} = -\frac{c^{L,U}_{t,t+2}}{R_{t+2}}
\end{aligned}
$$

where $\psi^L \equiv \dfrac{1}{(1-\gamma_1\rho)(1-\gamma_2\rho)+\beta(1-\gamma_0\rho)((1-\gamma_2\rho)+\beta(1-\gamma_1\rho))} > 0$,

$$\phi_0 \equiv (1-\rho)\beta\left\{((1-\gamma_2\rho)+\beta(1-\gamma_1\rho))\frac{(\gamma_0-\gamma_1)}{(1-\gamma_1)}+\beta(1-\gamma_1\rho)\gamma_3\right\} > 0,$$

$$\phi_1 \equiv (1-\rho)\left[\beta^2(1-\gamma_0\rho)\gamma_3-(1-\gamma_2\rho)\frac{(\gamma_0-\gamma_1)}{(1-\gamma_1)}\right],$$

and $\phi_2 = (1-\rho)\left\{(1-\gamma_1\rho)\dfrac{(\gamma_0-\gamma_2)}{(1-\gamma_2)}+\beta(1-\gamma_0\rho)\gamma_3\right\} > 0.$

In the presence of interpersonal comparisons, consumption of type-$L$ households depends, not only on their lifetime income, $y_t^L$, but also on the lifetime income of rich households, $y_t^H$. The impact of reference income on consumption and borrowing choices is determined by the varying importance of interpersonal comparisons through the life-cycle. Since, by assumption, these comparisons decrease with age, positional concerns increase first-period consumption and borrowing at the expense of retirement consumption and saving.

Finally, comparing (30) and (31) we reach the following condition that determines whether the credit constraint binds,

$$\xi \leq \left[\psi^L\left((1-\gamma_1\rho)(1-\gamma_2\rho)y_t^L+\phi_0\psi^H y_t^H\right)-w_{t,t}^L\right]\frac{R_{t+1}^b}{w_{t,t+1}^L} \tag{32}$$

Since the amount of "desired" borrowing, the term in square brackets, depends on the timing of income, for a given value of $\xi$ the likelihood that the constraint binds increases with the weight of the middle-age wage in lifetime income.

### 3.4 Dynamics of the aggregate capital stock

Combining the levels of borrowing of young households with the savings of middle-age workers, the evolution of the stock of capital in period $t+1$ is given by

$$K_{t+1} = -\mu b_{t,t}^H-(1-\mu)b_{t,t}^L-\mu b_{t-1,t}^H-(1-\mu)b_{t-1,t}^L. \tag{33}$$

Although this evolution depends on whether type-$L$ households are credit constrained or not, the resulting dynamic systems have similar properties and therefore we proceed with a general analysis that drops the superscript $Z=\{C,U\}$.[11] At this stage it is convenient

[11] We refer the interested reader to the Appendix where we provide detailed derivations of the dynamic equations and the stability of the steady state in each of the two cases.

to define $x_{t+1} \equiv \frac{hw_{t+1}}{w_t R^b_{t+1}}$, the growth factor of discounted labor income over the life cycle. Under the assumption that capital fully depreciates, we replace (2) and (3) in the expression for $x_{t+1}$ and divide (33) by $w_t$ to express it as

$$x_{t+1} = a + \frac{b}{x_t}, \qquad a, b > 0. \tag{34}$$

Denoting capital per unit of effective labor as $k_{t+1} \equiv \frac{K_{t+1}}{A_{t+1}L}$, its law of motion is given by

$$k_{t+1} = x_{t+1}\frac{\alpha}{h}\frac{1}{(1+g)}\frac{\pi}{\pi-1}(k_t)^{\alpha}. \tag{35}$$

The system (34)-(35) has a unique non-trivial steady state $(x^*, k^*)$ that is globally stable. Since the slope of the transition function is negative, the path of $x_t$ is oscillatory.

# 4 Some Simple Results

In this section we simplify the previous framework along several dimensions. Our goal is to provide simple analytical characterizations of the interactions between income inequality, financial liberalization, indebtedness, and welfare. All the channels explored through these simple exercises will be still at work in the general model to which we will return to for our numerical analysis.

## 4.1 Trickle-down consumption, inequality, and indebtedness

For the sake of illustration we focus on a single generation and restrict interpersonal comparisons to the first two periods of life, i.e. $\gamma_0 = \gamma_1 = \gamma$ and $\gamma_2 = 0$.[12] Furthermore, let's abstract from financial market imperfections, so there is no credit constraint, $\xi = 1$, and the borrowing and lending interest rates coincide and are given by (3). Finally, let's assume that the timing of income is such that both types of households find optimal to borrow. Under these assumptions, choices for rich households are given by (23)-(28) with

[12] Since we focus on a single generation we drop the generational subscript, furthermore to simplify notation we denote the first, second, and third periods of life by 0, 1, and 2.

$\psi^H \equiv \dfrac{1}{1+\beta+\beta^2(1-\gamma)}$ and choices for type-$L$ households simplify to

$$c_0^L = \frac{c_1^L}{\beta R_1} = \psi^L \left[ y^L + \beta^2 \gamma (1-\rho) \psi^H y^H \right] \tag{36}$$

$$b_0^L = \psi^L \left[ y^L + \beta^2 \gamma (1-\rho) \psi^H y^H \right] - w_0^L > 0 \tag{37}$$

$$c_2^L = -R_2 b_1^L = \beta^2 R_1 R_2 \psi^L \left[ (1-\gamma\rho) y^L - (1+\beta) \gamma (1-\rho) \psi^H y^H \right] \tag{38}$$

where $0 < \psi^L \equiv \dfrac{1}{1+\beta+\beta^2(1-\gamma\rho)} < \psi^H$.

The following propositions summarize some of the implications of upward-looking interpersonal comparisons.

**Proposition 1**: **The cross-section of debt-to-income ratios.** *Under our assumptions, individual debt-to-income ratios,* $b_{rate}^i \equiv \dfrac{b_0^i}{w_0^i}$*, decrease through the income distribution.*

**Proof.** Combining the definition of debt-to-income ratio with (27) and (37) it follows that[13]

$$b_{rate}^L - b_{rate}^H = \psi^H \psi^L \beta^2 \gamma (1-\rho) \frac{y^H \left( w_0^H - w_0^L \right)}{w_0^L w_0^H} > 0.$$

In the absence of interpersonal comparisons, $\gamma = 0$, or when they are not upward-looking, $\rho = 1$, borrowing is proportional to income and therefore the debt-to-income ratio is constant in the cross-section. The introduction of upward-looking interpersonal comparisons diverts resources from less positional uses, retirement consumption, to more positional ones, first-period consumption, and this diversion falls with income. As a result, type-$L$ households borrow a larger fraction of their income than their richer neighbors.

**Proposition 2: Trickle-down consumption.** *Under our assumptions, increases in first- and second-period consumption (income) of rich households lead to increases in first-*

[13] Since lifetime income is proportional to first-period wages similar results are obtained when the debt-to-income ratio is defined using lifetime income.

*and second-period consumption of type-L households:*

$$\frac{\partial c_0^L}{\partial y^H} = \psi^H \frac{\partial c_0^L}{\partial c_0^H} = \frac{1}{\beta R_1} \frac{\partial c_1^L}{\partial y^H} = \psi^H \frac{\partial c_1^L}{\partial c_1^H} = \psi^L \beta^2 \gamma \left(1-\rho\right) \psi^H > 0.$$

As a result of upward-looking interpersonal comparisons, increases in the level of consumption of the rich shift the frame of reference that defines consumption standards for the rest. As a result, consumption expenditures trickle-down the income distribution and type-$L$ households increase first- and second-period consumption expenditures at the expense of retirement consumption. This mechanism is a tractable two-type version of the expenditure cascades described by Frank, et al. (2014) by which increased consumption by households at the top leads others just below them in the income scale to spend more. Finally, notice that in the absence of interpersonal comparisons, $\gamma = 0$, or when this comparisons are not upward-looking, $\rho = 1$, the level of consumption of type-$L$ households is independent of that of rich households and trickle-down consumption disappears.

The crucial determinant of individual borrowing, (27) and (37), is the timing of income. For a given level of lifetime income, an increase in the first-period (second-period) wage is associated with a decrease (increase) in borrowing. As a result and in order to isolate the effects of inequality on borrowing it is sensible to restrict the analysis to instances in which the timing of income is the same for both types and does not change as inequality changes. In the analysis that follows we explore the effects of this particular type of inequality.

**Proposition 3. Inequality and indebtedness.** *An increase in lifetime income inequality that leaves* $\frac{w_0^H}{y^H} = \frac{w_0^L}{y^L}$ *unchanged, and therefore does not affect the timing of income, leads to an increase in the aggregate level (rate) of borrowing.*

**Proof.** Defining the share of total income received by rich households by $y_s^H \equiv \frac{y^H}{y^H + y^L}$, we combine (27) and (37) to derive the aggregate (average) debt to (permanent) income ratio, $b_{rate}^{agg}$, as

$$b_{rate}^{agg} = y_s^H b_{rate}^H + \left(1 - y_s^H\right) b_{rate}^L = \left(\psi^L - \frac{w_0^L}{y^L}\right) + 2\beta^2 \gamma \left(1-\rho\right) \psi^L \psi^H y_s^H \qquad (39)$$

which is increasing in the share of income received by rich households, $y_s^H$, and therefore in inequality.[14]

In this framework, where upward-looking interpersonal comparisons matter, an increase in income inequality increases the aggregate level of borrowing and therefore the economy-wide debt-to-income ratio. Although the fraction of lifetime income borrowed by rich households, $b^H_{rate}$, remains unchanged, it is clear from (37) that the increase in inequality is associated with an increase in the debt-to-income ratio of type-$L$ households. Intuitively, after an increase in inequality, type-$L$ households, in an attempt to keep up with the consumption patterns of their richer neighbors, increase the share of resources they devote to first-period (and second-period) consumption. This can only be achieved through additional borrowing. This result aligns well with the empirical evidence provided by Bertrand and Morse (2013) who report that up to one quarter of the decline in the US personal savings rate over the last three decades could be attributed to the effect of income inequality through trickle-down consumption.

### 4.2 Financial liberalization and welfare: analytical results

In this subsection we consider the effects of relaxing, one at a time, each of the financial market imperfections. We still focus on a single generation and we further simplify the problem by assuming this generation is composed of identical type-$L$ households. In this case we can aggregate individual choices and solve the representative agent problem. Additionally, we eliminate the retirement period and restrict interpersonal comparisons to the first-period of life, so $\gamma_0 = \gamma > \gamma_1 = 0$. In order to explore the welfare effects of financial development we assume the timing of income is such that the representative agent wants to borrow. Finally, we assume prices are constant and therefore we abstract from general equilibrium effects mediated through changes in the real wage and the return to capital.[15] All these auxiliary assumptions will be relaxed in the numerical section that follows.

#### 4.2.1 Credit constraint

Since changes in the credit constraint only affect welfare when the borrowing limit is

[14] See the Appendix for a detailed derivation.

[15] One can think of a small open economy where prices are determined at the world level. Our representative household borrows from the rest of the world when young and repays in the second period of its life.

binding we shall focus on this specific case. Combining (32) with our simplifying assumptions, the credit constraint is binding as long as $\xi$ satisfies

$$\xi \leq \left(\frac{1}{1+\beta(1-\gamma)} y^L - w_0\right)\frac{R_1}{w_1} = \frac{1-\beta(1-\gamma)\dfrac{w_0 R_1}{w_1}}{1+\beta(1-\gamma)} \equiv \overline{\xi} \tag{40}$$

and in this case the optimal consumption choices for the credit constrained representative household are given by,

$$c_0 = w_0 + \xi\frac{w_1}{R_1} \quad \text{and} \quad c_1 = (1-\xi)\, w_1. \tag{41}$$

Combining (12) with (41) we denote the level of welfare associated with this solution as

$$U(\xi) = \ln\left((1-\gamma)\left(w_0 + \xi\frac{w_1}{R_1}\right)\right) + \beta\ln\left((1-\xi)\, w_1\right). \tag{42}$$

The following proposition summarizes the welfare consequences of a relaxation of the credit constraint.

**Proposition 4: The expansion of credit and welfare I.** *Under a binding credit constraint as the fraction of future resources $\xi$ that could be borrowed to finance current consumption increases, welfare first increases and then declines.*

**Proof:** The result follows from the differentiation of (42):

$$\frac{\partial U}{\partial \xi} = \frac{1+\beta}{\left(\dfrac{w_0 R_1}{w_1} + \xi\right)(1-\xi)}\left(\frac{1-\beta\dfrac{w_0 R_1}{w_1}}{1+\beta} - \xi\right)$$

and therefore

$$\begin{array}{lll} \dfrac{\partial U}{\partial \xi} > 0 & \text{when } \xi < \dfrac{1-\beta\dfrac{w_0 R_1}{w_1}}{1+\beta} \equiv \underline{\xi} \\ \dfrac{\partial U}{\partial \xi} = 0 & \text{when } \xi = \underline{\xi} \\ \dfrac{\partial U}{\partial \xi} < 0 & \text{when } \underline{\xi} < \xi \leq \overline{\xi}. \end{array}$$

The interaction of two opposing effects drives the response of welfare to changes in the borrowing limit. First, access to credit allows agents to smooth consumption across periods. Second, since interpersonal comparisons lead to inefficiently high levels of first-period consumption, access to credit allows agents to engage in wasteful increases in conspicuous consumption. The beneficial effects associated with the former dominate as long as the constraint is relatively severe, $\xi < \underline{\xi}$, with the negative effects associated with conspicuous consumption dominating thereafter. In order to gain intuition about this result it is worth to compare the competitive solution with that of a centrally-planned economy. The central planner internalizes the effects of relative consumption on individual welfare, although we assume he is still constrained by the borrowing limit. Under these assumptions, the marginal utility of first-period consumption in the centrally-planned economy becomes $\frac{1}{c_0}$, while its competitive counterpart is given by $\frac{1}{(1-\gamma)\,c_0}$. Since the *private* marginal utility of first-period consumption exceeds its *social* counterpart by a factor $\frac{1}{1-\gamma}$, the representative household overvalues first-period consumption. As a result its willingness to increase current consumption at the expense of future consumption, the *private* marginal rate of substitution, is inefficiently high. Panel A in **Figure 3** provides a simple numerical illustration. For low levels of the borrowing limit, $\xi < \underline{\xi} = 0.25$, first-period consumption is so low that the *private* and *social* marginal rates of substitution exceed the intertemporal price of consumption. As a result, as the borrowing limit increases, so do first-period consumption and welfare, both, in the competitive and in the planned solutions. Once the borrowing limit reaches $\underline{\xi}$, first-period consumption in the centrally planned economy is no longer credit constrained and therefore further increases in the borrowing limit have no effects on the intertemporal allocation of resources or on welfare. This contrasts with the laissez-faire solution where increases in the borrowing limit beyond $\underline{\xi}$ lead to additional increases in first-period consumption. Nonetheless, these additional increases, which result from the overvaluation of current relative to future consumption, decrease welfare. In this context, the introduction of a credit constraint may be welfare-improving since it acts as a quota limiting the extent to which interpersonal comparisons divert resources from useful second-period expenditures to wasteful first-period consumption.[16]

[16] Several authors have explored the welfare effects of borrowing limits. For instance, Jappelli and Pagano (1994, 1999) and Obiols-Homs (2011). The former find that the decrease in aggregate saving associated with a relaxation of the credit constraint

#### 4.2.2 Interest rate spread

Reductions in the interest rate spread, increases in $\pi$, only affect welfare when the representative agent is in the interior solution of the borrowing regime and therefore we shall focus in this case.[17] As a result optimal consumption choices are given by

$$c_0 = \frac{1}{1+\beta(1-\gamma)}\left(w_0 + \frac{\pi-1}{\pi}\frac{w_1}{R_1}\right) \quad \text{and} \quad c_1 = \frac{\beta(1-\gamma)}{1+\beta(1-\gamma)}\left(\frac{\pi}{\pi-1}R_1 w_0 + w_1\right). \tag{43}$$

Using the counterpart of (22) it is easy to see that the interior solution for the borrowing regime arises when the parameter that governs the individual cost of default, $\pi$, satisfies

$$\pi > \frac{w_1}{w_1 - \beta R_1 w_0 (1-\gamma)} \equiv \underline{\pi} > 0 \tag{44}$$

where the last inequality combines the fact that borrowing is positive, $b_0 = c_0 - w_0 > 0$, with (43).

Combining (12) with (43) we denote the level of welfare associated with this solution as

$$U(\pi) = \ln\left(\frac{(1-\gamma)}{1+\beta(1-\gamma)}\left(w_0 + \frac{\pi-1}{\pi}\frac{w_1}{R_1}\right)\right) + \beta\ln\left(\frac{\beta(1-\gamma)}{1+\beta(1-\gamma)}\left(\frac{\pi}{\pi-1}R_1 w_0 + w_1\right)\right). \tag{45}$$

The following proposition summarizes the welfare consequences of a decrease in the borrowing-lending spread.

**Proposition 5: The expansion of credit and welfare II.** *In the interior solution of the borrowing regime, as the interest rate spread falls (as $\pi$ increases) welfare first decreases and then increases.*

**Proof:** The result in this proposition follows from the differentiation of (45):

$$\frac{\partial U}{\partial \pi} = \frac{\pi(w_1 - \beta R_1 w_0) - w_1}{c_0(1+\beta(1-\gamma))R_1\pi^2(\pi-1)}$$

may reduce growth and welfare in the context of an endogenous growth model. The latter find that the increase in the interest rate that follows from a reduction in credit constraints reduces welfare of those debtors that are not liquidity constrained. Finally, Nakajima (2012) explores the welfare effects of a relaxation of credit constraints in a model with preferences featuring temptation and self-control. In this context credit constraints serve as a commitment device that attenuates the overborrowing associated with hyperbolic discounting.

[17] Although changes in the spread do affect the threshold between the corner solution and the interior solution within the borrowing regime.

where[18]

$$\begin{aligned} \frac{\partial U}{\partial \pi} &< 0 \qquad \text{when } \underline{\pi} < \pi < \frac{w_1}{w_1 - \beta R_1 w_0} \equiv \overline{\pi} \\ \frac{\partial U}{\partial \pi} &= 0 \qquad \text{when } \pi = \overline{\pi} \\ \frac{\partial U}{\partial \pi} &> 0 \qquad \text{when } \pi > \overline{\pi}. \end{aligned}$$

In the interior solution of the borrowing regime decreases in the interest rate have two opposing effects on welfare. First, since young households borrow, as the cost of doing so decreases the present value of their life-time income increases. This positive income effect allows for increases in current and future consumption increasing welfare. Second, the substitution effect associated with the decrease in the relative price of current consumption shifts resources from second- to first-period uses. Since agents overvalue first-period consumption, this substitution effect has perverse welfare consequences at least for low levels of financial development. Panel B in **Figure 3** illustrates this process. In the presence of high financial frictions, $\pi \in (\underline{\pi}, \overline{\pi})$, the borrowing interest rate is so high that the planner finds optimal to remain in the corner solution of the borrowing regime, equating consumption to wages in each period. In these same circumstances, competitive agents, driven by invidious comparisons, borrow against their future income to finance inefficiently high levels of first-period consumption. As a result, in the early stages of financial liberalization welfare falls. After a certain threshold is reached, $\overline{\pi}$, the positive income effect associated with further decreases in the interest rate dominates and, as a result, welfare increases.

These last two propositions emphasize the ambiguous welfare implications of some of the developments behind the expansion of credit of the last 30 years. In view of this ambiguity, in the next section we calibrate our model and explore numerically the welfare implications of an outward shift in credit supply.

## 5 Numerical Analysis

In order to explore the welfare implications of the democratization of credit we calibrate the

[18] Notice that the definition of $\overline{\pi}$ imposes an additional restriction on the timing of income, $w_1 - \beta R_1 w_0 > 0$.

model to reproduce some key features of the U.S. economy prior to the 1980s. Then, under the assumption that the economy begins in the steady state associated with this calibration, we introduce three shocks; an increase in the dispersion of labor endowments (wage inequality), a reduction in financial frictions, and a decrease in the borrowing limit. Our welfare analysis compares the pre-shock steady state with the transition and the post-shock steady state.

### 5.1 Calibration

Panel A of **Table 4** summarizes the parameter values upon which our simulations are based. The model period is 20 years. Households begin their economic life at age 25, move to their middle age at age 45, retire at age 65, and die at age 85. We begin with those parameters that are common across steady states. We set $\beta = 0.45$, which implies an annualized subjective discount rate of 4% in line with the business cycle literature (see Cooley and Prescott, 1995) and assume full depreciation consistent with the choice of period length. We target the average capital income share in the U.S. economy over the second half of the last century using the elasticity of output to capital $\alpha = 0.35$. We set the rate of productivity growth, $g = 0.49$, which implies an annualized growth rate of 2%, to match the average growth rate of per capita real output in the U.S. over the same period. Card and DiNardo (2002) construct wage-experience profiles for U.S. men using the March Current Population Survey. According to their estimates hourly wages double after 20 years of experience. This estimate implies that wages grow at an exponential rate of 3.4% per year of experience. Assuming that wage-experience profiles increase at this rate for the first 30 years of the working life and then stabilize, this estimate implies a value of $h = 1.75$. This choice is not far from the ratio of the wage rate at age 55 relative to the wage rate at age 25 estimated to be 1.9 by Roys and Seshadri (2013) using the Panel Study of Income Dynamics. The evidence on the parameters governing interpersonal comparisons, the $\gamma$'s, is sparse. Ravina (2007), using measures of consumption constructed from more than 2,500 credit-card accounts finds an estimate of $\gamma$ of 0.29. Alvarez-Cuadrado, et al. (2015) report an estimate of 0.31, Maurer and Meier (2008) report estimates that range from 0.11 to 0.44 and the estimates of upward-looking interpersonal comparisons provided by Drechsel-Grau and Schmid (2013, 2014) suggest a value of $\gamma$ close to one third. Since the samples in all of these papers included households ages 25 to 65, we complement this evidence with the previously discussed results from Charles, et al. (2009) and Alvarez-Cuadrado and El-Attar (2013) that suggest that the strength of interpersonal comparisons declines with age. Along the lines suggested by this evidence we set $\gamma_0 = 0.4, \gamma_1 = 0.2$, and $\gamma_2 = 0.1$ in our benchmark calibration. We set $\mu = 0.05$ so that type-$H$ households represent the top 5% of the U.S. income distribution. Finally, we set the weight of consumption of the top 5% in the reference group of type-$L$ individuals, $1 - \rho$, equal to 0.1 stressing the importance of upward-looking comparisons. In the absence of a borrowing limit, when interpersonal comparisons only take place within group, $\rho = 1$, debt is proportional to income. In this sense $\rho$ determines the gap between the *desired* debt-to-income ratios of the two types, where by desired we mean the debt-to-income ratio chosen by a type-$L$ individual if the credit constraint did not bind.[19] Given the uncertainty surrounding the values of $\rho$ and the $\gamma$'s, we will explore the sensitivity of our welfare calculations to changes in these preference parameters.

Next we turn to the steady-state specific parameters. The pre- and post-shock productive endowments are set to match the share of labor income of the top 5% of the U.S. income distribution in the 1960s and in the 2000s respectively. These shares are calculated using data from the updated version of Piketty and Saez (2003). At this stage we still need to pin down two additional parameters; the borrowing limit, $\xi$, and the cost to evade re-payment $\pi$ that is inversely related to the borrowing-lending spread. Given our previous parameter choices, we set the initial and final values of $\xi$ and $\pi$ to approximate the average debt-to-income ratios of the top 5% and bottom 95% of U.S. households ages 25 to 45 from the SCF prior to the 1980s and in the 2000s.[20] Since the model focuses on net debt, this calibration uses a measure of non-collateralized debt that excludes mortgages.

## 5.2 Financial liberalization and welfare: numerical results

In order to explore the welfare implications of the process of financial liberalization that began three decades ago and its interaction with inequality we introduce simultaneously

[19] This desired level of borrowing is calculated using $b_{t,t}^{L,U}$ in (31) evaluated at the prices consistent with the relevant steady state.

[20] Notice that while $\rho$ affects the *desired* level of borrowing of the bottom 95%, $\pi$ determines their *actual* level of borrowing.

three unanticipated permanent shocks to our initial steady state. First, keeping the aggregate productive endowment constant we change its allocation between the two types of households to reflect the increase in labor income inequality. Second, we raise the credit limit for type-$L$ households, $\xi$. And third, we reduce the borrowing-lending spread through an increase in the cost to evade repayment, $\pi$. Panel B of **Table 4** compares debt-to-income ratios and measures of inequality across steady states. By construction the initial calibration captures well the debt-to-income ratios and the shares of labor income of the top 5% in both the initial and final steady states. The cross-sectional variation in saving and borrowing that results from upward-looking interpersonal comparisons allows the model to map inequality in endowments (labor income) into inequality in total income. Since we abstract from bequests, an important source of wealth accumulation particularly at the top of the income distribution, the model misses the level of total income inequality although it captures its change through time.[21] While the share of total income of the top 5% generated by the model falls short of its data counterpart by almost 4 percentage points, the 51% increase in this share between the initial and final steady states is very similar to the 61% increase observed in the data over the last thirty years. Finally, our calibration delivers a marginal product of capital in the range of 8.5% slightly above the long-run real return on the S&P 500 stock index.

#### 5.2.1 Initial steady state

In order to understand the initial steady state configuration it is useful to consider the case that abstracts from upward-looking interpersonal comparisons, $\rho = 1$, summarized in the first column of **Table 5**. Since in this case type-$L$ households are not credit constrained their debt-to-income ratio coincides with that of rich households and it is roughly 0.27, i.e. they borrow roughly one fourth of their yearly wage. This is so since the determinants of this ratio (the timing of income, the age-specific degree of interpersonal comparisons, and reference income relative to own income that determines relative consumption) are the same for both types of households. From this exercise it becomes clear that, in this framework, upward-looking interpersonal comparisons are key to generate the cross-sectional variation in

[21] Kotlikoff and Summers (1981) have decomposed wealth into its life-cycle and inherited components. Their decomposition suggests that the inherited component ranges from 46 to 81 percent. Davies and Shorrocks (1999) have concluded that a reasonable estimate for this inherited component lies in the range of 35-45 percent.

debt-to-income ratios. In the initial steady state the desired debt-to-income ratio of type-$L$ individuals is 0.66 amounting to two-thirds of their yearly wage. Nonetheless, the credit constraint lowers their actual debt-to-income ratio to 0.28. Relative to a world without upward-looking comparisons, the higher debt-to-income ratio of type-$L$ individuals increases the demand for credit bidding up the borrowing interest rate and reducing the debt-to-income ratio of rich households to 0.26.

Finally, in terms of inequality, the share of labor income of the top 5% maps into varying shares of consumption at different ages for this same group. In the initial steady state a share of labor income of 17% leads to a share of consumption that increases from 16.99% of total first-period consumption up to 17.43% of total retirement consumption. The tilt that interpersonal comparisons induce towards consumption when young is particularly strong for type-$L$ households that in their attempt to keep up with the level of consumption of the top 5% in the first period fall further behind their richer neighbors in the remaining two periods of their lifetime. It is worth noticing that in the absence of upward-looking comparisons labor income inequality leads to the same amount of consumption inequality, which remains constant across age groups.

#### 5.2.2 Final steady state

Now we turn to explore the steady state that results after the three shocks are introduced. The decrease in financial frictions lowers the interest rate spread by almost one third, from 57 to 41 basis points. As a result both types of households find optimal to increase their borrowing. Nonetheless, the mechanical increase in first-period consumption of the top 5% that results from the increase in labor income inequality shifts upwards the frame of reference of the bottom 95%. As a result the bottom 95% increase their desired borrowing rate even further to almost 1.1 years worth of wages. Together with the higher credit limit that results from the reduction in the severity of the borrowing constraint, this increase in the demand for credit of type-$L$ young households requires a higher return on savings to induce the adequate supply of credit from middle-age savers. This places upward pressure on the interest rate. As a result, and despite the decrease in the spread, the interest rate faced by borrowers actually increases by 11 basis points and the debt-to-income ratio of the top 5% falls by roughly 50%, from 0.26 in the initial steady state to 0.13 in the final one. At the same time the debt-to-income ratio of the bottom 95% almost doubles, increasing from 0.28 to 0.51. Overall, the increase in borrowing by type-$L$ households, through its effects on the interest rate, displaces part of the borrowing of the rich. Finally, in terms of consumption inequality, the patterns in the final steady state are similar, although much more pronounced, that those in the initial steady state. For instance, the share of consumption of the top 5% increases from 24.6% for first-period consumption up to 26.9% for retirement consumption.

#### 5.2.3 Transitional dynamics

**Figure 4** illustrates the transitional dynamics between steady states. The three shocks are introduced at the end of period $t$. Most of the adjustment of the capital stock and the debt-to-income ratio of rich households and almost all of the adjustment in the debt-to-income ratio of the bottom 95% take place in the first 20-year period. The main source of sluggishness results from the choices of the generation born at $t$ that entered their middle-age at the time of the shocks, but despite of this, the convergence of the model economy is very fast.[22]

#### 5.2.4 Welfare

The last rows of **Table 5** report welfare changes for both types of households. These gains are equivalent variation measures, calculated as the percentage change in the lifetime flow of relative consumption necessary to equate the level of welfare in the initial steady state to that of the case under consideration.[23] In contrast to representative agent models, welfare calculations in OLG economies are subject to a certain degree of arbitrariness. To cope with this we consider four different measures that use the pre-shock steady state as their benchmark. First, we calculate the welfare change for a generation born when the post-shock steady state is already in place. We label this measure as the "long-run" welfare change. Second, we consider a generation born immediately before the shocks. We label this welfare change as "short-run". Third, we consider discounted "intertemporal" welfare

[22] Although the transitional path is in fact oscillatory the cycles are not evident to the naked eye.
[23] The calculation of welfare changes follows the methodology described in Ireland (1994).

changes where we compare the pre-shock steady state with the transitional path and the post-shock steady state discounting each generation at the subjective discount rate, $\beta$. Finally, we consider welfare changes holding "prices constant". The rationale for this last measure will become evident shortly.

Since the qualitative conclusions that emerge from any of the measures of welfare are similar, in the discussion that follows we restrict our attention to the long-run welfare change. Then we will highlight the differences that arise when we use other measures of welfare.

The combined effect of the three shocks leads to a welfare *gain* for a rich household roughly equivalent to 44%, i.e. for a household in the top 5% to be indifferent between the initial and the final steady states its relative consumption in each period of life in the initial steady state should be increased by 44%. The welfare *loss* for a household in the bottom 95% is very large, roughly 24% of its initial steady state relative consumption.

#### 5.2.5 Decomposition of welfare changes

In order to understand the contribution of each shock to these changes in welfare it is interesting to consider the impact of one shock at a time. The last three columns of **Table 5** do so.

**The effects of inequality.**

Not surprisingly, the increase in inequality is the main factor behind these welfare changes. Since the increase in inequality rises the productive endowment of the rich by 47%, their consumption and therefore their welfare increase by a similar amount. Although the decrease in the productive endowment of type-$L$ households is barely 10%, they experience a welfare loss of 23%. This loss not only captures the decrease in consumption associated with their lower endowment but also the increase in reference consumption associated with the rise in consumption expenditures of the top 5%. The welfare loss associated with the latter seems to be larger than the one associated with the former. Comparing the final steady state, column 3, with the one that only considers the increase in inequality, column 4, one begins to see that the combined effects on welfare of financial liberalization turn out to be negative. Welfare in the final steady state falls by 2.3 percentage points for the top 5% and 1.2 percentage points for the bottom 95% relative to the only-inequality steady state. These welfare losses are an approximation of the joint effects of the two measures of financial liberalization. Next, we turn to evaluate each of these two developments separately.

**The effects of credit limits.**

Column 5 in **Table 5** considers a scenario where only the credit limit is relaxed. Since neither the borrowing-lending spread nor inequality change, the increase in borrowing by the bottom 95% increases the interest rate crowding out part of the demand for credit of the top 5% that reduce their borrowing rate down to 20%. Nonetheless the aggregate borrowing rate increases, from 27% to 39%, reducing the rate of capital accumulation. As a result of the lower steady state levels of capital and income, welfare for both types of households declines.[24] The welfare losses associated with the higher borrowing limit are substantial, exceeding 1% of the initial steady state level of relative consumption for both types. These losses are roughly two times the ones found by Nakajima (2012) in the presence of hyperbolic discounting.

**The effects of the spread.**

Finally, column 6 in **Table 5** considers a scenario where only the borrowing-lending spread changes. As in the final steady state the reduction in spread increases the desired level of borrowing for both types. Nonetheless since the supply of credit available for the bottom 95% is limited by a relatively stringent credit constraint rich households take advantage of the decrease in spread to increase first-period consumption. As a result their borrowing rate increases by more than 60%, from 26% to 43% of their yearly wage. Notice that the increase in the interest rate that keeps in check borrowing by the top 5% in the final steady state is absent in this case since type-$L$ households remain constrained at the initial steady state level of credit. As in the case of the credit constraint, the lower spread increases the aggregate borrowing rate reducing the pace of capital accumulation. As a result steady state output declines and so does welfare for both types of households. It is worth noticing that these welfare losses take place despite the increase in the fraction of resources available for private

[24] The interest rate in our economy exceeds the rate of output growth before and after the shocks. Therefore the reported welfare losses are not driven by any of our steady states being dynamically inefficient.

consumption and investment that result from a decrease in wasteful monitoring expenditures by more than one half, from 0.11% to 0.05% of GDP, associated with the increase in the cost of default, $\pi$.

#### 5.2.6 Alternative measures of welfare

So far we have focused on welfare comparisons across steady states, the long-run welfare change. When we turn to short-run welfare changes the qualitative features are similar although the size of gains and losses is consistently smaller, since the shocks only affect the last two-periods of the generation born right before the shocks. According to this measure, financial liberalization provided a small welfare gain for the generation that entered their middle-age right after the shocks. Not surprisingly, the intertemporal welfare changes lie somewhere in between the previous two measures.

The welfare losses associated with a higher credit limit and the reduction in the spread capture not only the negative effects of envy on borrowing but also the decrease in income that results from the decrease in steady state capital. In order to focus on the interaction between financial liberalization and interpersonal comparisons, abstracting from the general equilibrium effects associated with price changes, we introduce an additional measure of welfare that keeps the capital stock constant at the initial steady state level. This measure, reported in the last two rows of **Table 5**, captures the change in welfare that results from changes in the timing of consumption holding the level of income unchanged. Even according to this metric, the increase in the credit limit and the reduction in the spread are associated with welfare losses for both types of households, ranging from one tenth to one fifth of a percentage point of the initial steady state level of relative consumption. Of course, holding prices constant, the decrease in the borrowing limit has no effect on the welfare of the top 5%.[25]

#### 5.2.7 Sentitivity analysis

Given the limited empirical evidence on the value of the parameters that govern the degree

[25] At the prices associated with initial steady state a central planner that acknowledges the effects of individual consumption on others' welfare that result from interpersonal comparisons chooses a negative level of borrowing, i.e. in the planner's solution young households are savers.

of interpersonal comparisons, the $\gamma$'s, and the composition of the reference group for type-$L$ households, $\rho$, it is worth to explore the robustness of these welfare changes to variations in these parameter values. **Table 6** summarizes the results of this sensitivity analysis where the borrowing limit and the borrowing-lending spread are adjusted to ensure that debt-to-income ratios are consistent with those in the data before and after the shocks. The results are intuitive. Increases in the share of consumption of the top 5% that enters the reference level of the bottom 95%, $\rho$, or on the strength of interpersonal comparisons, $\gamma_i$, lead to larger welfare losses for the bottom 95% relative to our baseline calibration. In terms of the welfare consequences of the decrease in financial frictions, these exercises suggest that the qualitative implications of our benchmark analysis are robust. In all scenarios, the decrease in the borrowing-lending spread and the increase in the borrowing limit are associated with welfare losses for both types of households. These results contrast with those obtained in the case that abstracts from interpersonal comparisons, $\gamma_0 = \gamma_1 = \gamma_2 = 0$, reported in last two rows of **Table 6**. In this case, the desired debt-to-income ratio is the same across types so the model cannot match the cross-sectional variation in the data. As an alternative we simply focus on the average debt-to-income ratio in the 1960s and 2000s. This requires increasing the value of the wage-experience profile to $h = 2$. This exercise suggests that in the absence of interpersonal comparisons both types would have benefited from financial liberalization with welfare gains in the order of one fifth of a percentage point of the initial steady state level of relative consumption. Nonetheless, as we have just pointed out, this calibration is not consistent with the observed variation in debt-to-income ratios at a point in time or with their evolution over the last thirty years.

Overall, this analysis suggests that the welfare consequences of the democratization of credit are far from obvious. In fact if these results are taken literally one is likely to conclude that some of the recent financial developments have decreased, rather than increased, welfare.

# 6 Conclusions

Income inequality in the U.S. increased substantially over the last three decades. This surge in inequality coincided with an unprecedented growth of the financial industry partially driven by a large increase in credit intermediation activities. The expansion of credit coupled with the increase in inequality resulted in a doubling of the aggregate debt-to-GDP ratio over the same period. Furthermore, the evolution of debt-to-income ratios has varied systematically across the income distribution. While this ratio increased substantially for households in the bottom 95% it barely rose, or actually fell, for those households in the top 5% of the U.S. income distribution.

We first document, using SCF data, that the systematic variation in debt-to-income ratios across the income distribution is not driven by consumption smoothing in the face of transitory income shocks or by variation in socio-demographic characteristics correlated with income.

Second, we present a simple OLG economy with two types of households that is consistent with these developments. Our key assumption is that individuals engage in age-specific upward-looking interpersonal comparisons. In this context, an increase in the share of income (consumption) of the rich shifts up the frame of reference for the rest of the income distribution that responds increasing their consumption. Nonetheless, this process of trickle-down in consumption in the first periods of life is only possible at the expense of consumption at later periods. As a result borrowing by non-rich households increases and so does the aggregate debt-to-GDP ratio. We calibrate a version of the model to replicate the evolution of debt-to-income ratios for the top 5% and the bottom 95% of the U.S. income distribution over the last thirty years.

Third, we use this calibrated economy to explore the welfare changes associated with two measures of financial liberalization; a relaxation of borrowing constraints and a decrease in the borrowing-lending spread. Our analysis suggests that the large expansion of credit that began in the 1980s may be associated with important welfare losses. In the light of these results it is difficult not to think about Mr. Volcker's remarks: "The most important financial innovation that I have seen in the past 20 years is the automatic teller machine, that really helps people and prevents visits to the bank and it is a real convenience. How many other innovations can you tell me of that have been as important to the individual as the automatic teller machine, which is more of a mechanical innovation than a financial one?"[26]

[26] Paul Volcker's address in the Wall Street Journal Future of Finance Initiative in the U.K. that took place in December of

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# 8 Figures and Tables

**Table 1.** Median regressions of debt-to-income ratio on current and permanent income.

| | Current Income | | Permanent Income | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dependent variable | Debt | Debt – Mort. | Debt | | | | Debt – Mortgage | | | |
| Instrument | | | Norm. Inc. (as proxy) | Norm. Inc. | Lagged Income | Vehicles† | Norm. Inc. (as proxy) | Norm. Inc. | Lagged Income | Vehicles† |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Constant (Bottom 95%) | 1.046*** | 0.115*** | 1.073*** | 1.075*** | 0.839*** | 0.833*** | 0.111*** | 0.114*** | 0.095*** | 0.029*** |
| | (0.008) | (0.001) | (0.012) | (0.011) | (0.036) | (0.009) | (0.001) | (0.002) | (0.005) | (0.001) |
| Top 5% | -0.383*** | -0.089*** | -0.392*** | -0.411*** | -0.255*** | -0.100*** | -0.093*** | -0.010*** | -0.040*** | -0.016*** |
| | (0.010) | (0.002) | (0.015) | (0.015) | (0.090) | (0.017) | (0.002) | (0.003) | (0.013) | (0.002) |
| Ages 30-39 | -0.017* | 0.031*** | 0.021 | 0.017 | -0.138*** | -0.028*** | 0.038*** | 0.038*** | -0.007 | 0.011*** |
| | (0.009) | (0.002) | (0.013) | (0.013) | (0.051) | (0.011) | (0.002) | (0.003) | (0.007) | (0.001) |
| Ages 50-59 | -0.136*** | -0.018*** | -0.127*** | -0.121*** | -0.191*** | -0.109*** | -0.015*** | -0.013*** | -0.041*** | -0.008*** |
| | (0.008) | (0.002) | (0.013) | (0.012) | (0.043) | (0.010) | (0.002) | (0.003) | (0.006) | (0.0012) |
| No high school | -0.868*** | -0.081*** | -0.921*** | -0.929*** | -0.450*** | -0.725*** | -0.085*** | -0.089*** | 0.036*** | -0.020*** |
| | (0.013) | (0.002) | (0.02) | (0.019) | (0.060) | (0.016) | (0.003) | (0.004) | (0.009) | (0.002) |
| High school diploma | -0.515*** | -0.008*** | -0.529*** | -0.542*** | -0.249*** | -0.480*** | -0.003 | -0.01*** | 0.007 | -0.006*** |
| | (0.009) | (0.002) | (0.014) | (0.013) | (0.044) | (0.011) | (0.002) | (0.003) | (0.006) | (0.001) |
| Some college | -0.236*** | 0.032*** | -0.242*** | -0.265*** | | -0.184*** | 0.044*** | 0.037*** | | 0.017*** |
| | (0.010) | (0.002) | (0.015) | (0.015) | | (0.013) | (0.002) | (0.003) | | (0.001) |
| 5-8 members | 0.213*** | 0.011*** | 0.243*** | 0.285*** | 0.172*** | 0.223*** | 0.008*** | 0.015*** | -0.003 | 0.005*** |
| | (0.010) | (0.002) | (0.016) | (0.015) | (0.053) | (0.014) | (0.002) | (0.003) | (0.008) | (0.001) |
| 9-12 members | 0.049 | 0.001 | 0.077 | 0.083 | -0.086 | 0.120 | 0.011 | 0.026 | 0.039 | 0.039*** |
| | (0.078) | (0.015) | (0.118) | (0.114) | (0.326) | (0.100) | (0.016) | (0.024) | (0.047) | (0.011) |
| Pseudo $R^2$ | 0.036 | 0.015 | 0.036 | 0.036 | 0.036 | 0.035 | 0.016 | 0.016 | 0.015 | 0.003 |
| Sample size | 101,372 | 101,372 | 81,637 | 81,637 | 2,141 | 101,372 | 81,637 | 81,637 | 2,141 | 101,372 |

Notes: The numerator of the debt-to-income ratio is either total debt or total debt minus mortgage debt, the denominator is total household income less realized capital gains. For columns (1) and (2) the dummy for the Top 5 % is constructed using this income measure for each age group and for columns (3) and (7) this dummy is constructed using normal income. Normal income is what households report as expected income in a "normal year". In the remaining columns the dummy for the Top 5 % is constructed using measures of permanent income. Permanent income is estimated using an OLS regression of current income on instruments and a set of controls. The omitted category includes households with 1-4 members, with the head having a college degree and aged 40-49. Bootstrapped standard errors are reported in parentheses. *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Sources: Data comes from wave reports (1989-2010) and a panel (1983-1989) of the SCF.

† When vehicles owned are used as an instrument the measure of debt excludes the value of outstanding loans used to finance vehicles.

**Table 2.** Median regressions of debt-to-income ratio on current and permanent income and time.

| | Current Income | | Permanent Income | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dependent variable | Debt | Debt – Mort. | Debt | | | Debt – Mortgage | | |
| Instrument | | | Norm. Inc. (as proxy) | Norm. Inc. | Vehicles† | Norm. Inc. (as proxy) | Norm. Inc. | Vehicles† |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Constant (Bottom 95%) | 0.877*** | 0.102*** | 0.922*** | 0.915*** | 0.719*** | 0.086*** | 0.088*** | 0.029*** |
| | (0.010) | (0.001) | (0.018) | (0.022) | (0.014) | (0.003) | (0.004) | (0.001) |
| Top 5% | -0.287*** | -0.065*** | -0.329*** | -0.314*** | -0.127*** | -0.067*** | -0.073*** | -0.002 |
| | (0.019) | (0.002) | (0.038) | (0.048) | (0.036) | (0.007) | (0.010) | (0.004) |
| Time | 0.0115*** | 0.001*** | 0.009*** | 0.009*** | 0.009*** | 0.001*** | 0.001*** | 0.000 |
| | (0.000) | (0.000) | (0.001) | (0.001) | (0.001) | (0.000) | (0.001) | (0.000) |
| Time x Top 5% | -0.006*** | -0.002*** | -0.004* | -0.006** | 0.002 | -0.002*** | -0.002*** | -0.001*** |
| | (0.001) | (0.000) | (0.002) | (0.003) | (0.002) | (0.000) | (0.000) | (0.000) |
| Ages 30-39 | -0.00791 | 0.031*** | 0.022** | 0.012 | -0.023** | 0.040*** | 0.040*** | 0.011*** |
| | (0.007) | (0.001) | (0.011) | (0.013) | (0.011) | (0.002) | (0.003) | (0.001) |
| Ages 50-59 | -0.132*** | -0.017*** | -0.126*** | -0.122*** | -0.113*** | -0.014*** | -0.012*** | -0.008*** |
| | (0.007) | (0.001) | (0.010) | (0.013) | (0.011) | (0.002) | (0.003) | (0.001) |
| No high school | -0.814*** | -0.081*** | -0.895*** | -0.901*** | -0.707*** | -0.084*** | -0.090*** | -0.021*** |
| | (0.011) | (0.001) | (0.016) | (0.019) | (0.017) | (0.003) | (0.004) | (0.002) |
| High school diploma | -0.504*** | -0.011*** | -0.515*** | -0.530*** | -0.476*** | -0.004** | -0.011*** | -0.006*** |
| | (0.007) | (0.001) | (0.011) | (0.013) | (0.012) | (0.002) | (0.003) | (0.001) |
| Some college | -0.228*** | 0.030*** | -0.238*** | -0.248*** | -0.199*** | 0.042*** | 0.034*** | 0.017*** |
| | (0.009) | (0.001) | (0.012) | (0.015) | (0.013) | (0.002) | (0.003) | (0.001) |
| 5-8 members | 0.216*** | 0.010*** | 0.234*** | 0.267*** | 0.210*** | 0.007*** | 0.016*** | 0.005*** |
| | (0.009) | (0.001) | (0.013) | (0.016) | (0.014) | (0.002) | (0.003) | (0.001) |
| 9-12 members | -0.0113 | -0.001 | 0.013 | 0.026 | 0.154 | 0.011 | 0.027 | 0.033*** |
| | (0.067) | (0.007) | (0.094) | (0.118) | (0.101) | (0.017) | (0.024) | (0.011) |
| Pseudo $R^2$ | 0.039 | 0.015 | 0.037 | 0.036 | 0.037 | 0.016 | 0.017 | 0.003 |
| Sample size | 101,372 | 101,372 | 81,637 | 81,637 | 101,372 | 81,637 | 81,637 | 101,372 |

Notes: The numerator of the debt-to-income ratio is either total debt or total debt minus mortgage debt, the denominator is total household income less realized capital gains. For columns (1) and (2) the dummy for the Top 5 % is constructed using this income measure and for columns (3) and (7) this dummy is constructed using normal income. Normal income is what households report as expected income in a "normal year". In the remaining columns the dummy for the Top 5 % is constructed using measures of permanent income. Permanent income is estimated using an OLS regression of current income on instruments and a set of controls. The omitted category includes households with 1-4 members, with the head having a college degree and aged 40-49. Bootstrapped standard errors are reported in parentheses. *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Sources: Data comes from wave reports (1989-2010) and a panel (1983-1989) of the SCF.

† When vehicles are used as an instrument the measure of debt excludes the value of outstanding loans used to finance vehicles.

**Table 3.** Some robustness checks.

| | Labor income | | Consumer debt | | Home ownership | | Continuous measure of income | |
|---|---|---|---|---|---|---|---|---|
| Dependent variable | Debt/income | | Consumer debt/income | | Debt/income | | Debt/income | |
| Income measure | Current labor income | Permanent labor income | Current income | Permanent income | Current income | Permanent income | Current income | Permanent income |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Constant (Bottom 95%)†† | 0.980*** | 1.010*** | 0.060*** | 0.064*** | 0.228*** | 0.221*** | 3.024*** | 3.764*** |
| | (0.010) | (0.011) | (0.001) | (0.001) | (0.010) | (0.012) | (0.047) | (0.100) |
| Top 5% | -0.383*** | -0.475*** | -0.039*** | -0.039*** | -0.083** | -0.117** | | |
| | (0.014) | (0.019) | (0.002) | (0.002) | (0.039) | (0.052) | | |
| Own house | | | | | 1.117*** | 1.165*** | | |
| | | | | | (0.008) | (0.010) | | |
| Own house x Top 5% | | | | | -0.729*** | -0.601*** | | |
| | | | | | (0.040) | (0.053) | | |
| Bottom quintile | | | | | | | -3.086*** | -3.713*** |
| | | | | | | | (0.135) | (0.147) |
| Ln(income) | | | | | | | -0.176*** | -0.229*** |
| | | | | | | | (0.004) | (0.008) |
| Ln(income) x Bottom quintile | | | | | | | 0.230*** | 0.278*** |
| | | | | | | | (0.013) | (0.013) |
| Pseudo $R^2$ | 0.017 | 0.027 | 0.008 | 0.005 | 0.161 | 0.163 | 0.058 | 0.036 |
| Observations | 91,512 | 73,074 | 49,786 | 39,756 | 104,497 | 81,637 | 101,372 | 78,166 |

Notes: The measure of permanent income is constructed normal income as an IV and a set of controls. All regressions include controls (non-reported) for age categories, household size and educational categories for the head of the household. The omitted category includes households with 1-4 members, with the head having a college degree and aged 40-49. For columns (1) and (2) the dummy for the Top 5 % is constructed using labor income. Columns (3) and (4) consider a narrower measure of debt that excludes mortgages, consumer debt. Columns (5) and (6) include a dummy for home ownership. Columns (7) and (8) include a continuous measure of income, a dummy for the bottom quintile and year dummies (non-reported). Bootstrapped standard errors are reported in parentheses. *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.
Sources: Data comes from wave reports (1989-2010) and a panel (1983-1989) of the SCF.
††In columns (7) and (8) the intercept cannot be interpreted as the borrowing rate of the bottom 95%.

**Table 4:** Calibration: Parameter values, targets and model outcomes.

| Panel A: Parameters | | | | | | |
|---|---|---|---|---|---|---|
| Steady-state specific: | Initial | Final | General: | | | |
| $l^H$ | 3.4 | 5 | $\beta$ | 0.45 | $\mu$ | 0.05 |
| $l^L$ | 0.87 | 0.79 | $\delta$ | 1 | $\rho$ | 0.90 |
| $\xi$ | 0.0283 | 0.053 | $\alpha$ | 0.35 | $\gamma_0$ | 0.40 |
| $\pi$ | 10.05 | 14 | $h$ | 1.75 | $\gamma_1$ | 0.20 |
| | | | $g$ | 0.49 | $\gamma_2$ | 0.10 |

| Panel B: Model and data targets | Model | | Data | |
|---|---|---|---|---|
| | Initial | Final | 1960s* | 2000s |
| Debt-to-income top 5% | 0.26 | 0.13 | 0.26 | 0.14 |
| Debt-to-income bottom 95% | 0.28 | 0.51 | 0.27 | 0.50 |
| Share of labor income top 5% | 17% | 25% | 17% | 25% |
| Share of total income top 5% | 17.1% | 25.9% | 21% | 34% |

Sources: Data on share of labor income of the top 5% is from the updated version of Piketty and Saez (2003). Data on debt-to-income ratios is from the Survey of Consumer Finances. Households with heads with ages 25-45 and excluding mortgage debt.

* Our initial steady state uses data from the 1962-3 wave of the SCF since the next wave with full available data is from 1989.

**Table 5:** Numerical results.

| | Within group comparisons | Initial steady state | Final steady state | One shock at a time: Inequality | One shock at a time: Credit limit | One shock at a time: Spread |
|---|---|---|---|---|---|---|
| Difference with baseline calibration | $\rho = 1$ | | | $\pi_1 = \pi_0$<br>$\xi_1 = \xi_0$ | $l_1^i = l_0^i$<br>$\pi_1 = \pi_0$ | $l_1^i = l_0^i$<br>$\xi_1 = \xi_0$ |
| **Debt-to-income ratios** | | | | | | |
| Top 5% | 0.27 | 0.26 | 0.13 | 0.18 | 0.20 | 0.43 |
| Bottom 95% | 0.27 | 0.28 | 0.51 | 0.27 | 0.50 | 0.28 |
| Bottom 95% (desired) | 0.27 | 0.66 | 1.08 | 1.00 | 0.66 | 0.74 |
| Aggregate | 0.27 | 0.27 | 0.41 | 0.25 | 0.39 | 0.31 |
| **Interest rates** | | | | | | |
| Lending rate | 8.05% | 8.15% | 8.42% | 8.22% | 8.34% | 8.19% |
| Borrowing rate | 8.62% | 8.72% | 8.83% | 8.79% | 8.91% | 8.59% |
| Spread | 0.57% | 0.57% | 0.41% | 0.57% | 0.57% | 0.40% |
| Monitoring expenditures (% of GDP) | 0.12% | 0.11% | 0.7% | 0.11% | 0.16% | 0.05% |
| **Inequality (share of the top 5%)** | | | | | | |
| Labor income | 17.00% | 17.00% | 25.00% | 25.00% | 17.00% | 17.00% |
| Capital income | 17.00% | 17.45% | 27.51% | 26.38% | 18.79% | 17.03% |
| Total income | 17.00% | 17.14% | 25.85% | 25.44% | 17.63% | 16.98% |
| First-period consumption | 17.00% | 16.99% | 24.65% | 24.91% | 16.67% | 17.10% |
| Second-period consumption | 17.00% | 16.86% | 25.35% | 24.79% | 17.56% | 16.63% |
| Third-period consumption | 17.00% | 17.43% | 26.86% | 26.22% | 18.19% | 17.18% |
| **Welfare change (gain if positive)** | | | | | | |
| *Long-run: welfare change for a generation born in the final steady state* | | | | | | |
| Top 5% | | | 44.12% | 46.43% | -1.22% | -0.40% |
| Bottom 95% | | | -24.39% | -23.21% | -1.55% | -0.20% |
| *Short-run: welfare change for the generation born right before the shock* | | | | | | |
| Top 5% | | | 17.02% | 16.82% | 0.21% | -0.04% |
| Bottom 95% | | | -5.99% | -6.15% | 0.19% | -0.04% |
| *Intertemporal: discounted sum at a rate $\beta$ for all generations after the shock* | | | | | | |
| Top 5% | | | 29.29% | 29.44% | -0.01% | -0.08% |
| Bottom 95% | | | -14.15% | -14.06% | -0.12% | -0.05% |
| *Constant prices: initial steady state prices** | | | | | | |
| Top 5% | | | 46.78% | 47.06% | - | -0.19% |
| Bottom 95% | | | -23.03% | -22.89% | -0.15% | -0.09% |

Notes: The subscripts 0 and 1 stand for the initial and final steady state respectively.
* With constant prices, a change in the credit limit of the bottom 95% has no impact on the choices of the top 5%

**Table 6.** Welfare Changes: Sensitivity analysis.

| Sensitivity | | Final steady state | One shock at a time: Ineq. | One shock at a time: Credit limit | One shock at a time: Spread | Final steady state | One shock at a time: Ineq. | One shock at a time: Credit limit | One shock at a time: Spread |
|---|---|---|---|---|---|---|---|---|---|
| | | Long-run welfare change | | | | Constant-price welfare change** | | | |
| Baseline | Top 5% | 44.1% | 46.4% | -1.2% | -0.4% | 46.8% | 47.1% | - | -0.2% |
| | Bottom 95% | -24.4% | -23.2% | -1.5% | -0.3% | -23.0% | -22.9% | -0.1% | -0.1% |
| $\rho = .95$ | Top 5% | 44.5% | 46.7% | -1.0% | -0.3% | 46.8% | 47.0% | - | -0.2% |
| | Bottom 95% | -17.2% | -15.8% | -0.7% | -0.2% | -15.7% | -15.6% | -0.2% | -0.1% |
| $\rho = .85$ | Top 5% | 43.7% | 46.1% | -1.3% | -0.5% | 46.7% | 47.0% | - | -0.2% |
| | Bottom 95% | -33.2% | -32.6% | -1.4% | -0.4% | -32.5% | -32.3% | -0.0% | -0.2% |
| $\gamma_0 = .45$ $\gamma_1 = .25$ $\gamma_2 = .15$ | Top 5% | 44.1% | 46.3% | -1.2% | -0.4% | 46.8% | 47.0% | - | -0.2% |
| | Bottom 95% | -28.6% | -27.5% | -1.5% | -0.3% | -27.3% | -27.2% | -0.1% | -0.1% |
| $\gamma_0 = .35$ $\gamma_1 = .15$ $\gamma_2 = .05$ | Top 5% | 45.1% | 46.5% | -0.6% | -0.6% | 46.8% | 47.1% | - | -0.2% |
| | Bottom 95% | -20.6% | -19.9% | -0.7% | -0.7% | -19.7% | -19.6% | -0.1% | -0.1% |
| No envy* | Top 5% | 45.1% | 47.0% | - | -1.0% | 47.2% | 47.0% | - | 0.2% |
| | Bottom 95% | -10.8% | -9.6% | - | -1.0% | -9.5% | -9.6% | - | 0.2% |

Notes: The financial friction parameters, $\pi$ and $\xi$, are chosen to set debt-to-income ratios consistent with the baseline calibration (and therefore with the data). Aside from the parameter under consideration, the remaining ones are set according to Table 4.

* Since preferences are homothetic the borrowing rate of both types of household coincide. As a result, we set these rates for both groups equal to the average borrowing rate in the data. Notice that the borrowing limit for poor households is not binding.

** With constant prices, a change in the credit limit of the bottom 95% has no impact on the choices of the top 5%

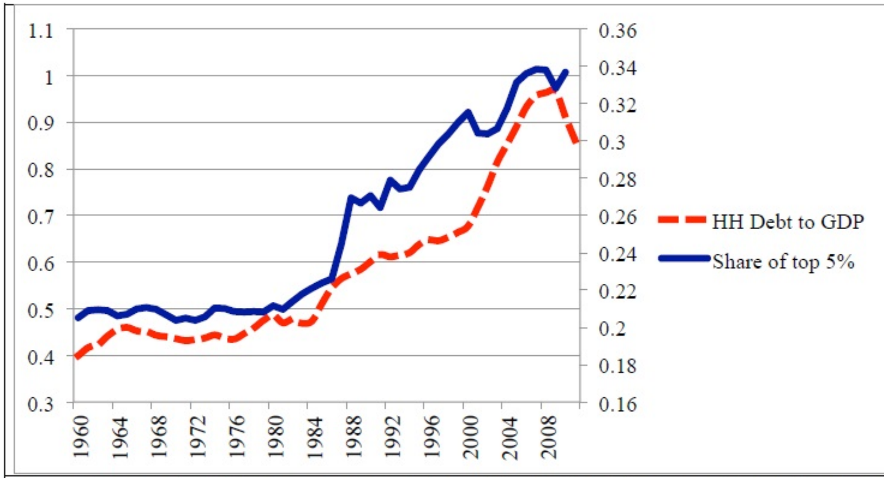


**Figure 1.** Aggregate debt to income ratio and share of the top 5% of the income distribution (right scale).

Sources: Share of income from Piketty and Saez (2011) and debt from the Federal Reserve Economic Data, Federal Bank of St. Louis.

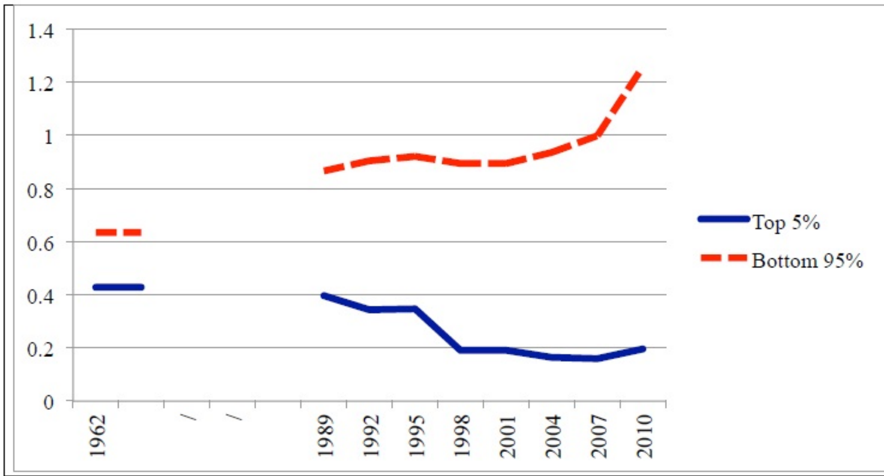


**Figure 2.** Debt-to-income ratios for the top 5% and the bottom 95% of the US income distribution. Income is calculated at total income minus capital gains and the measure of debt includes mortgages.

Source: Survey of Consumer Finances of the Board of Governors of the Federal Reserve System.

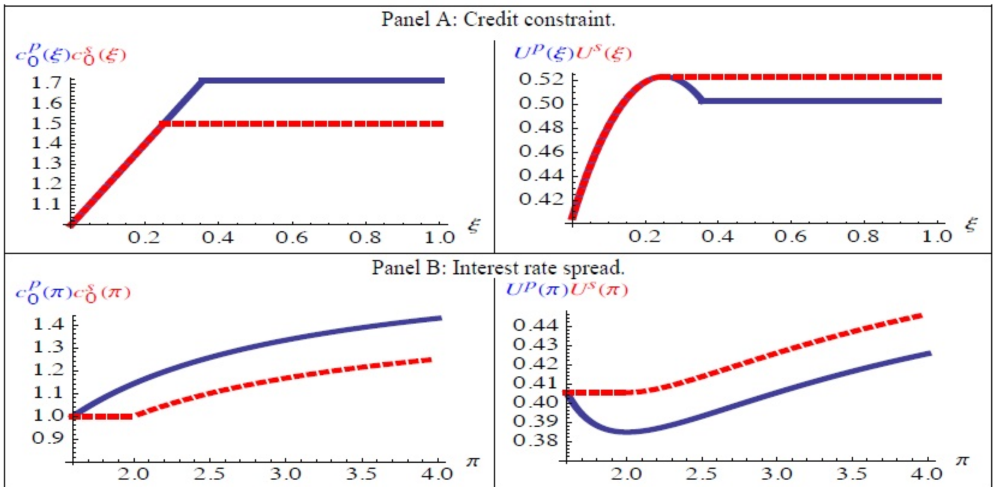


**Figure 3.** Financial Development and Welfare. Competitive (solid-blue line, $p$ for private) and centrally planned (dashed-red line, $s$ for social) solutions. Parameter values: $\beta = R_1 = w_0 = w_1 / 2 = 1; \gamma = 0.25$

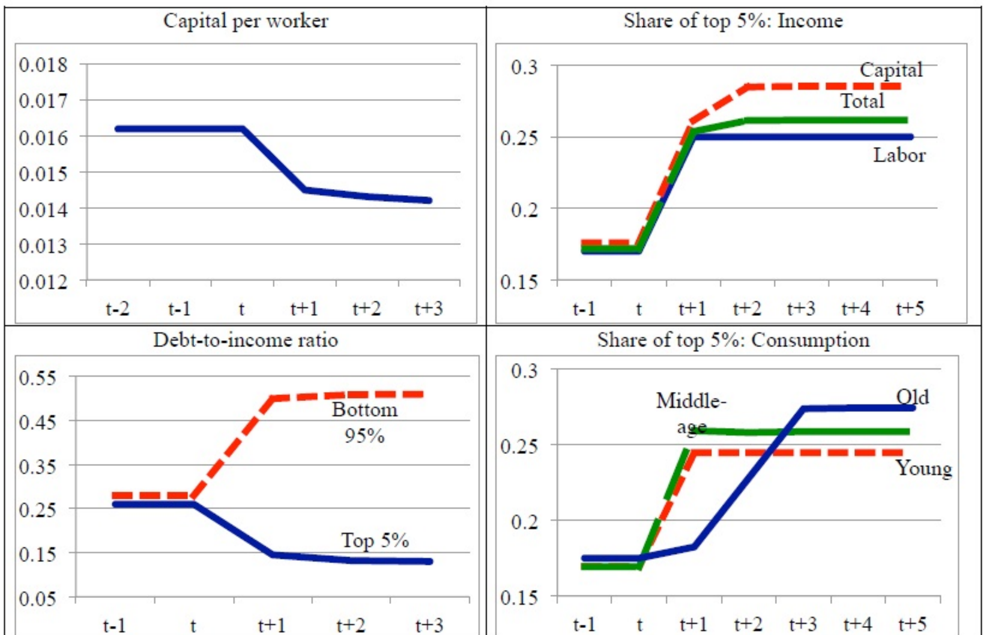


**Figure 4.** Transitional dynamics after the three shocks. Each period is 20 years.

# 9 Appendix

This section provides details on the derivation of some results.

**Dynamics of the aggregate capital stock**

Combining the levels of borrowing of young households with savings of middle-age workers, the evolution of the stock of capital in period $t+1$ is given by

$$K_{t+1}^{X} = -\mu b_{t,t}^{H} - (1-\mu)\, b_{t,t}^{L} - \mu b_{t-1,t}^{H} - (1-\mu)\, b_{t-1,t}^{L}. \tag{46}$$

Since the dynamics of the capital stock depend on whether type-$L$ households are credit constrained or not, we need to consider two cases, $Z = \{C, U\}$. First, we characterize the evolution of capital when type-$L$ households are credit constrained. Combining (27), (28), and (30), with (46) we have

$$\begin{aligned} K_{t+1}^{C} \quad = \quad & -\mu\left[\psi^{H} y_{t}^{H} - w_{t,t}^{H}\right] - (1-\mu)\,\xi \frac{w_{t,t+1}^{L}}{R_{t+1}^{b}} + \mu\beta^{2} R_{t}^{b} \frac{(1-\gamma_{0})}{(1-\gamma_{2})} \psi^{H} y_{t-1}^{H} \\ & + \frac{(1-\mu)\,\beta}{(1-\gamma_{2}\rho) + \beta\,(1-\gamma_{1}\rho)} \left[ \begin{array}{c} (1-\gamma_{1}\rho)\,(1-\xi)\, w_{t-1,t}^{L} \\ -\beta R_{t}^{b}\,(1-\rho)\,\gamma_{3}\psi^{H} y_{t-1}^{H} \end{array} \right]. \end{aligned} \tag{47}$$

At this stage it is convenient to define $x_{t+1} \equiv \dfrac{h w_{t+1}}{w_{t} R_{t+1}^{b}}$, the growth factor of discounted labor income over the life cycle. Combining this definition with lifetime income, given by (14), and the fact that $w_{t,t}^{i} = l^{i} w_{t}$ and $w_{t,t+1}^{i} = l^{i} h w_{t+1}$, we can divide both sides of (54) by $w_{t}$ to reach[27]

$$\begin{aligned} \frac{K_{t+1}^{C}}{w_{t}} \quad = \quad & -\mu l^{H}\left[\psi^{H}\,(1+x_{t+1}) - 1\right] \\ & -(1-\mu)\,\xi l^{L} x_{t+1} + \mu\beta^{2} \frac{(1-\gamma_{0})}{(1-\gamma_{2})} \psi^{H} l^{H} h \left(1 + \frac{1}{x_{t}}\right) \\ & + \frac{(1-\mu)\,\beta}{(1-\gamma_{2}\rho) + \beta\,(1-\gamma_{1}\rho)} \left[ \begin{array}{c} (1-\gamma_{1}\rho)\,(1-\xi)\, h l^{L} \\ -\beta\,(1-\rho)\,\gamma_{3}\psi^{H} l^{H} h \left(1 + \dfrac{1}{x_{t}}\right) \end{array} \right]. \end{aligned} \tag{48}$$

[27] Notice that $w_{t-1} + h\dfrac{w_{t}}{R_{t}} = w_{t-1}\,(1+x_{t})$ and $R_{t}\left[\dfrac{w_{t-1}}{w_{t}} + \dfrac{h}{R_{t}}\right] = h\left[\dfrac{1}{x_{t}} + 1\right]$.

Under the assumption that capital fully depreciates, we replace (2) and (3) in the expression for $x_{t+1}$ to express the left-hand side of (48) as

$$\frac{K_{t+1}^C}{w_t} = \frac{K_{t+1}^C}{(1-\alpha)\left(K_t^C\right)^\alpha L^{-\alpha} A_t^{1-\alpha}} = x_{t+1} \frac{L}{h} \frac{\alpha}{(1-\alpha)} \frac{\pi}{\pi - 1} \tag{49}$$

where we use the fact that the labor force is constant.

As a result (48) can be written as a first-order difference equation

$$B^C x_{t+1} = C^C + D^C \left(1 + \frac{1}{x_t}\right) \Longrightarrow x_{t+1} = \frac{C^C + D^C}{B^C} + \frac{D^C/B^C}{x_t} \tag{50}$$

where

$$B^C \equiv \frac{L}{h} \frac{\alpha}{(1-\alpha)} \frac{\pi}{\pi-1} + \mu l^H \psi^H + (1-\mu)\xi l^L > 0,$$
$$C^C \equiv \mu l^H \left(1 - \psi^H\right) + \frac{(1-\mu)\beta(1-\gamma_1\rho)(1-\xi) h l^L}{(1-\gamma_2\rho) + \beta(1-\gamma_1\rho)} > 0,$$
$$\text{and } D^C = \beta^2 \psi^H l^H h \left(\mu \frac{(1-\gamma_0)}{(1-\gamma_2)} - \frac{(1-\mu)(1-\rho)\gamma_3}{((1-\gamma_2\rho) + \beta(1-\gamma_1\rho))}\right).$$

Similarly when the credit constraint does not bind for type-$L$ young workers, the dynamics of $x_{t+1}$ are given by

$$B^U x_{t+1} = C^U + D^U \left(1 + \frac{1}{x_t}\right) \Longrightarrow x_{t+1} = \frac{C^U + D^U}{B^U} + \frac{D^U/B^U}{x_t} \tag{51}$$

where

$$B^U = \frac{L}{h} \frac{\alpha}{(1-\alpha)} \frac{\pi}{\pi-1} + \mu l^H \psi^H + (1-\mu)\psi^L \left(l^L (1-\gamma_1\rho)(1-\gamma_2\rho) + l^H \phi_0 \psi^H\right) > 0,$$
$$C^U = \mu l^H + (1-\mu) l^L - \mu l^H \psi^H - (1-\mu)\psi^L \left(l^L (1-\gamma_1\rho)(1-\gamma_2\rho) + l^H \phi_0 \psi^H\right),$$
$$\text{and } D^U = \beta^2 \left[\mu l^H \frac{(1-\gamma_0)}{(1-\gamma_2)} \psi^H + (1-\mu)\psi^L \left(l^L (1-\gamma_0\rho)(1-\gamma_1\rho) - l^H \phi_2 \psi^H\right)\right] h > 0.$$

Additionally, we impose restrictions on the parameter values such that both $D^C$ and $C^U$ are positive.

Since the dynamic structure is similar in both cases we drop the superscript $Z = \{C, U\}$ and we write (50) and (51) in compact form as

$$x_{t+1} = a + \frac{b}{x_t}, \qquad a, b > 0. \tag{52}$$

Finally, given the dynamics of $x_{t+1}$, we use (49) to characterize the evolution of the aggregate capital stock as

$$K_{t+1} = x_{t+1}\frac{\alpha}{h}\frac{\pi}{\pi-1}\left(LA_t\right)^{1-\alpha}\left(K_t\right)^{\alpha}. \tag{53}$$

Denoting capital per unit of effective labor as $k_{t+1} \equiv \dfrac{K_{t+1}}{A_{t+1}L}$, its law of motion is given by

$$k_{t+1} = x_{t+1}\frac{\alpha}{h\left(1+g\right)}\frac{\pi}{\pi-1}\left(k_t\right)^{\alpha}. \tag{54}$$

Equation (52) determines the path of $x_t$ that can be replaced in (54) to determine the path of capital per unit of effective labor. The system (52)-(54) has a unique non-trivial steady state $(x^*, k^*)$. This steady state is given by the positive root of the equation $\left(x^*\right)^2 - ax^* - b = 0$ and $k^* = \left(\dfrac{\alpha x^*}{h\left(1+g\right)}\dfrac{\pi}{\pi-1}\right)^{\frac{1}{1-\alpha}}$. Since the slope of the transition function, (52), is always negative the path of $x_t$ is oscillatory.

Finally, notice that

$$\left|x_{t+1} - x^*\right| = \left|\frac{b}{x_t} - \frac{b}{x^*}\right| = \left|\frac{bx_{t-1}}{ax_{t-1}+b} - \frac{bx^*}{ax^*+b}\right| = \frac{b^2\left|x_{t-1}-x^*\right|}{\left(ax_{t-1}+b\right)\left(ax^*+b\right)} < \left|x_{t-1}-x^*\right|,$$

as a result the sequence $(x_t)$ converges to $x^*$ and therefore the steady state is globally stable.[28]

**Derivation of Proposition 3.**

Combining (27) and (37) with lifetime income, given by (14), we obtain the borrowing rates, $b^i_{rate}$, for both types of households

$$b^H_{rate} = \psi^H - \frac{w^H_0}{y^H} \tag{55}$$

$$b^L_{rate} = \psi^L - \frac{w^L_0}{y^L} + \beta^2\gamma\left(1-\rho\right)\psi^L\psi^H\frac{y^H}{y^L}. \tag{56}$$

Using the share of income received by rich households, $y^H_s \equiv \dfrac{y^H}{y^H+y^L}$, we can express the aggregate borrowing rate as

[28] A full characterization of the dynamics of the capital stock needs to consider cases where there are endogenous changes in regime, i.e. along the transition the credit constraint binds or not depending on factor prices. In our numerical exercises the credit constraint is always binding.

$$b_{rate}^{agg} = y_s^H b_{rate}^H + \left(1 - y_s^H\right) b_{rate}^L \tag{57}$$

that combined with (55) and (56) becomes,

$$\begin{aligned}
b_{rate}^{agg} &= y_s^H \left(\psi^H - \frac{w_0^H}{y^H}\right) + \left(1 - y_s^H\right)\left(\psi^L - \frac{w_0^L}{y^L} + \beta^2\gamma\left(1-\rho\right)\psi^L\psi^H\frac{y^H}{y^L}\right) \\
&= \psi^L - \frac{w_0^L}{y^L} + y_s^H\left(\psi^H - \frac{w_0^H}{y^H} - \psi^L + \frac{w_0^L}{y^L}\right) + \left(1 - y_s^H\right)\beta^2\gamma\left(1-\rho\right)\psi^L\psi^H\frac{y^H}{y^L} \\
&= \psi^L - \frac{w_0^L}{y^L} + \left(\psi^H - \frac{w_0^H}{y^H} - \psi^L + \frac{w_0^L}{y^L} + \beta^2\gamma\left(1-\rho\right)\psi^L\psi^H\right) y_s^H \\
&= \psi^L - \frac{w_0^L}{y^L} + \left(\psi^H - \psi^L + \beta^2\gamma\left(1-\rho\right)\psi^L\psi^H\right) y_s^H \\
&= \left(\psi^L - \frac{w_0^L}{y^L}\right) + 2\beta^2\gamma\left(1-\rho\right)\psi^L\psi^H y_s^H.
\end{aligned}$$

Since the timing of income affects the level (rate) of borrowing and we want to abstract from this mechanical effect, we concentrate on changes in inequality that leave the timing of income unchanged. As a result we assume that the timing of income for both types of households is the same, $\frac{w_0^H}{y^H} = \frac{w_0^L}{y^L}$, that we use in the fourth line of the previous derivation.

# 10 Connecting Text (Implication of relative consumption concerns for household fertility)

The previous study was aimed at examining the effect of relative consumption concerns on the households behavior in the light of the recent increases in income inequality which implied increasing reference consumption levels for the lower income households. The focus of the study was the borrowing decision of households which was studied with Overlapping Generations Model. One may argue that presence of relative consumption concerns may affect not only intertemopral allocation of consumption, but also other households choices such as fertility, consumption of “status” goods, human capital investment, etc. The next study develops a fertility model where households have relative consumption concerns and tests empirically its implications on household fertility decision making. This study is yet another contribution to our understanding of the effect of “envy” on household behavior expressed in such an important macroeconomic variable as the fertility rate.

# Part II
# Envy, Inequality and Fertility

**Irakli Japaridze**

**Abstract**

This study seeks to examine the consequences of "keeping up with the Joneses" on household fertility outcomes. "Envy" is introduced in a simple "quality-quantity" trade-off type of fertility model, where the trade-off is induced by the fact that being out of the labor market due to child-bearing being more expensive for people with higher human capital levels. The effect of introducing upward-looking "envy" in the model is that households, notably low-income ones, reduce fertility in an attempt to emulate consumption levels of their high-income neighbors. This effect is stronger the larger the reference consumption—that is, in areas with higher income inequality, which are characterized by longer right tails of income distributions. It follows that if households indeed tend to "keep up with the Joneses," one should expect lower fertility rates in areas with higher income inequality compared to more equal areas. The empirical analysis using the American Community Survey confirms that indeed households residing in more unequal metropolitan areas tend to have fewer children than households residing in more equal metropolitan areas.

## 1 Introduction

This study seeks to understand the implications for fertility outcomes of income inequality when households exhibit relative consumption concerns. Why would one expect that relative consumption concerns ("keeping up with the Joneses") should have any effect on household fertility behavior? A household which has relative consumption concerns derives utility not from the absolute level of consumption, but rather from the relative level of consumption. This latter is usually defined as a difference or a ratio between an absolute consumption level and some type of benchmark or reference consumption level. A household that tries to "keep up with the Joneses" usually has higher marginal utility from consumption for every dollar spent on consumption goods and thus tends to dedicate more resources to consumption than a household that cares about absolute consumption. Obviously, dedicating a larger share of resources to consumption may come at the expense of saving, fertility, investment in human capital of children, etc.

What is the role of local income inequality? A household's reference consumption is determined by those who live in close proximity, within small geographic areas where households interact frequently and can get their perceptions of desirable living standards. Note that the variation in local inequality (as will be shown later) is mostly due to the variation in the right tail of the local income distribution. So if households exhibit upward-looking relative consumption concerns—that is to say, when households try to match consumption of those whose income is higher then theirs—then variation in income inequality implies variation in the reference consumption level. So even identical households living in areas with different income inequality may have different fertility outcomes due to different levels of consumption of "the Joneses" they try to emulate. This variation in local income inequality allows us to test empirically the implications of the existence of relative consumption concerns on fertility.

To identify the fertility implications of "keeping up with the Joneses," I present a simple "quality-quantity" trade-off type of fertility model. In this model, high-income households have a higher opportunity cost of having children than low-income households, as having a child comes with a fixed time cost. So high-income households find it optimal to substitute child quantity with quality. Low-income households, whose opportunity costs are lower (due to lower earnings per unit of time) and education costs are high relative to their income, opt for more children, but equip each with little human capital. The effect of introducing "envy" in this model is that households (notably low-income households) reduce fertility. Moreover, this reduction in fertility generated by "envy" is stronger the larger the benchmark consumption—that is, in areas with higher income inequality. Thus, the model demonstrates that in the presence of "envy" motives, one should expect lower fertility rates in areas with higher income inequality compared to less unequal places. This implication is tested using American Community Survey (ACS) data, which can identify a household's place of residence (metropolitan area) and allow us to construct measures of local income inequality. There are more than 500 identifiable locations allowing for cross-sectional variation in income inequality. The prediction that fertility is lower in more unequal locations is supported empirically: households in the least unequal areas have more children than in the most unequal areas, and the differential ranges from 0.17 to 0.33 children, depending on the measure of income inequality employed. This supports the importance of "keeping up with the Joneses" for understanding household fertility behavior.

Thus this study achieves two things – first, it offers additional support to the "keeping up with the Joneses" by finding empirical evidence of the effect of envy on fertility. This first result further reinforces the idea that policy makers should take into account households' relative consumption concerns/envy, when they make decisions regarding financial regulation, taxation of consumption/inheritance, social security, etc. Second, it offers a possibility that increasing income inequality may not necessarily lead to ever-increasing income inequality, possibility of which is often found in the literature. For example in de la Croix and Doepke (2003) a macroeconomic shock resulting in an increased variation in income (inequality) can lead to increasing fertility differentials between high and low-income households. This happens due to "quality-quantity" trade-off, which implies that those whose income decreased have more children while those whose income increased have less. More children born to low-income households further increase income inequality in the next generation, thus kicking in a vicious cycle of ever-increasing inequality. However these studies do not take into account that desire to "keep up with the Joneses" may be a restraining factor on the fertility of low-income households.

In essence, this suggested relationship between a household's relative consumption concern and fertility is a reformulation of Easterlin's hypothesis. Easterlin (1975) states that agents acquire their concept of "normal" living standards during their formative years, and thus their reference group consists of their parents. This hypothesis is used to explain the "baby boom" and "baby bust" phenomena. It states that after the Great Depression the younger generation faced better economic perspectives than their parents and so increased their fertility, while the subsequent generation faced worse economic perspectives and so reduced their fertility. The reformulation involves substituting inter-temporal (inter-generational) comparisons with cross-sectional (intra-generational) comparisons, meaning that households compare not to their parents, but rather to their peers whose consumption levels are visible due to the proximity of habitation. The rest of the paper is organized in the following manner. Section 2 presents the relevant literature on interrelations between relative consumption concerns, inequality and fertility. Section 3 describes the model and its implications for the fertility of households. Section 4 presents the econometric exercises aimed at testing the model implications found in Section 3. Section 5 concludes.

## 2 Literature

The most relevant theoretical studies for my research are two papers on fertility and "status" goods by Leibenstein (1975) and Antrup (2010). Both have the concept of "status" or "rank" consumption. The difference is that in Leibenstein (1975) the "status" refers to the parents only, while Antrup's households have "rank" consideration for themselves and their children. Both studies show that if income is distributed more equally, low-income households may have a chance to compete for "status". To fend them off, the high-income households must increase their consumption of "status" goods (to maintain differentiation between high and low statuses) so that high-income households may decrease their fertility. This implies possibility to observe a lower average fertility in more equal areas, which is contrary to results obtained in this study. This difference in the results stems from the fact that in Leibenstein

(1975) and Antrup (2010) top-ranked/rich household are downward-looking – households care about the distance between them and the rest of the population, while in my study I stick to the upward-looking low-income households. [1]

Kremer and Chen (2002) and de la Croix and Doepke (2009) develop models where more unequal societies are characterized by larger fertility differentials between high and low-income households. Although their results are somehow similar to what I obtain (finding the possibility of negative correlation between fertility and inequality), the primary difference between our studies is that I introduce "envy" in a "quality-quantity" trade-off fertility model. Due to inclusion of "envy", changes in income inequality affect fertility in two channels: "quality-quantity" trade-off and the effect of increased consumption of "the Joneses". The existence of strong "envy", unlike previous two papers, can explain the empirically observed positive income-fertility relationship.

The most relevant empirical studies are papers by Micevska (2001) and Gennari and Scalone (2009). Micevska (2001) studies the interrelation between inequality and fertility allowing for relative income/status type of preferences. She finds that during depression in Eastern Europe inequality was negatively correlated with fertility, and in her model the results are driven by what is perceived as a minimum subsistence level of consumption. If that level is high in a developing country, fertility may drop as the poor will have fewer children. Gennari and Scalone (2009) study the effect of affluence on fertility. They define affluence as a difference between the proportion of those who think they earn subsistence-level income and the proportion of those who think they do not earn it. It is shown that the higher the proportion of people happy with their income the higher is fertility. Similarly to them Chaudhury (1977), working on the related relative income and fertility interrelationship, finds that for Canada relative income is positively related to completed fertility (especially for higher income households), where relative income is the aspiration income, that is what one may expect to have based on education, age and other socioeconomic characteristics. Colleran et al. (2015), tested the link between fertility differentials, wealth inequality and status in rural Polish communities finding that the higher inequality implied higher and more

[1] The discussion of empirical relevance of upward-looking "envy" can be found in Alvarez-Cuadrado and Japaridze (2016).

varying fertility.

In general, the idea that some sort of concept of living standards, either objective or subjective, affects the perceived cost of children and thus affects fertility outcomes is fairly common. For example Hotz et al. (1997) state that better, that is more expensive, neighborhoods may induce a "quality-quantity" trade-off. Kohler et al. (2002) states that rising scarcity of housing is behind the decreasing fertility in Europe. Simon and Tamura (2009), on the example of US, empirically demonstrate that higher value of housing was associated with lower fertility. One may note that housing prices tend to be tightly correlated with local income inequality. Thus, in Simon and Tamura (2009) some part of the effect of higher housing prices might be coming from higher levels of income inequality.

# 3 A Simple Model to Illustrate the Relationship Between Fertility and Inequality

## 3.1 The model

I augment the model found in de la Croix and Doepke (2003) by introducing relative consumption concerns in the same fashion as it is done in Alvarez-Cuadrado and Japaridze (2016). Assume a community of households indexed by $i = [1..N]$. All of the households present at time $t$ were born at time $t-1$ during which they were endowed by their parents with human capital $h_t^i$. Households are active at time $t$ during which they earn wage $w_t$ on their human capital $h_t^i$. During their lifetime they consume, have children and educate them in schools. At the end of time $t$ they die. For each household $i$, the other members of the community constitute its reference group whose average consumption level is $\widetilde{c}_t$. The utility function of the household $i$ is described by

$$U^i = ln\left(c_t^i - \xi \widetilde{c}_t\right) + \omega ln\left(n_t^i h_{t+1}^i\right). \tag{1}$$

Note that preferences are defined over the number of children $n_t^i$, their human capital $h_{t+1}^i$ and the relative consumption, which is defined as a difference between the level of a household's absolute consumption $c_t^i$ and the reference (benchmark) consumption level defined as a fraction $\xi \in (0,\,1)$ of $\widetilde{c}_t$. The strength of parental altruism towards children is defined by the parameter $\omega \in (0,\,1)$.

The budget constraint of the household is

$$c_t^i + e_t^i n_t^i = w_t h_t^i \left(1 - \phi n_t^i\right). \tag{2}$$

The household is endowed with one unit of time. Given the household's level of human capital $h_t^i$ and the real wage per unit of human capital $w_t$, the potential real income of each household is $w_t h_t^i$. However, raising a child requires a constant fraction $\phi \in (0,\,1)$ of that time endowment. So having $n_t^i$ children implies that the household has $w_t h_t^i (1 - \phi n_t^i)$ at its disposal for spending on consumption and investment in the human capital of its children. Children's human capital is produced according to

$$h_{t+1}^i = \mu \left(\theta + e_t^i\right)^{\eta} \left(h_t^i\right)^{\tau}, \tag{3}$$

where $\mu$ is a measure of efficiency in the production of human capital, $\theta$ measures the innate skills that can be augmented by a perfectly substitutable investment $e_t^i$ made by the parents. The $\eta \in (0,\,1)$ guarantees the human capital production function's concavity in $e_t^i$. Otherwise one may have just one child and endow it with a high level of $e_t^i$. Note that the human capital formation also depends on the human capital of parents $h_t^i$, which captures the inter-generational transmission of abilities and the fact that the accumulation of human capital is also affected by the quality of parental input. For example, more educated parents can be more efficient at helping their children with school assignments, etc. Alternatively, human capital here can be thought of as something more than education (e.g., connections, better entourage, etc.) and children clearly can inherit some part of this parental human capital.

The household maximizes its utility (1) by choosing the consumption $c_t^i$, the number of children $n_t^i$ and the investment in the human capital of each child $e_t^i$, subject to the budget constraint (2). Substituting (2) for consumption in the utility function (1) and solving the utility maximization problem we find the optimal investment in human capital $\widehat{e}_t^i$, the number of children $\widehat{n}_t^i$ and the consumption $\widehat{c}_t^i$.[2]

[2]Note that I assume that household will be always in the interior regime, that is it will dedicate positive amount of income

$$\hat{e}_t^i = \frac{w_t h_t^i \phi \eta - \theta}{1 - \eta} \tag{4}$$

$$\hat{n}_t^i = \frac{\omega \left( w_t h_t^i - \xi \widetilde{c}_t \right) (1 - \eta)}{(1 + \omega) \left( w_t h_t^i \phi - \theta \right)} \tag{5}$$

$$\hat{c}_t^i = \frac{w_t h_t^i + \omega \xi \widetilde{c}_t}{(1 + \omega)}. \tag{6}$$

The resulting solution to the household's problem, described by the expressions (4), (5) and (6), delivers a familiar "quality-quantity" trade-off. Specifically, households with higher $h_t^i$ have fewer children and invest more in their human capital. The "quality-quantity" trade-off is induced by the fact that the constant fraction $\phi$ implies a higher level of lost income to high-income households, while the cost of investment goods is relatively cheaper. Thus, high-income households find it optimal to substitute quantity of children for quality. Low-income households, on other hand, find the opportunity cost of having a child relatively low and, given that investment in child human capital is more expensive relative to their income, they tend to have more children who are endowed with little human capital. Note that $\widehat{n}_t^i$ and $\widehat{c}_t^i$ depend also on the reference consumption level $\xi \widetilde{c}_t$, which, if taken as an exogenous parameter, positively affects $\hat{c}_t^i$ and negatively $\hat{n}_t^i$. Note also that these effects increase in strength the bigger the $\xi$. When $\xi = 0$, we are back to the solution found in de la Croix and Doepke (2003). Recall that my goal is to obtain testable implications of variation in the intensity of envy (determined by the income inequality in the community) on average fertility levels across those communities. Thus, in the next subsection I study a society consisting of many communities which are different from each other in the level of income inequality of their residents.

### 3.2 Model solution for an economy with high- and low-income households

The population in each community consists of two types of household: the high-income household (superscript $H$), constituting a fraction $\alpha$ of the population; and the low-income household (superscript $L$), which constitutes the remaining population. The difference between these households is that the high-income households were endowed by the parents with more human capital ($h_t^H > h_t^L$). One may think of high-income households as those in the

to its children as $w_t h_t^i > \theta / (\eta \phi)$.

top 10 percentile of the income distribution of their area, while low-income households would constitute the "rest." The $\left(h_t^H - h_t^L\right)/h_t^L$ gap, in other words the inequality, is what differentiates one geographic area from another. I assume both horizontal and vertical comparisons; that is, a household compares itself to those with comparable income and to those who have higher income. Thus, for low-income households, the reference consumption $\widetilde{c}_t^L$ they want to match is a weighted average of mean consumption of high- (weight $\rho$) and low-income (weight $(1-\rho)$) households. The weight of high income households in $\widetilde{c}_t^L$ need not be equal to $\alpha$, but instead can be lower than it, as low-income households may attach higher weight to the average consumption of high-income households. Note, however, that since high-income households are at the top, their reference group consists only of other high-income households whose average income they try to match, which yields the reference levels of consumption (7)

$$\widetilde{c}_t^H = c_t^H,\ \widetilde{c}_t^L = \rho c_t^H + (1-\rho)\, c_t^L. \tag{7}$$

Note that variation in income inequality across geographic areas implies variation in $\widetilde{c}_t^H$ and $\widetilde{c}_t^L$ faced by households in each of those areas. So the goal of this exercise is to see how exogenous variation in $h_L$ and $h_H$ (affecting $\left(h_t^H - h_t^L\right)/h_t^L$ gap) across geographic areas is transmitted via $\widetilde{c}_t^H$ and $\widetilde{c}_t^L$ into variation in fertility rates across geographic areas. Substituting (7) into (6) the optimal consumption levels for the household types are (8), with the reference consumption levels being (9), fertility decisions being (10) and (11), and human capital investment levels being (12).

$$c_t^H = \frac{w_t h_t^H}{A},\ c_t^L = \frac{w_t h_t^L A + \omega\xi\rho w_t h_t^H}{AB} \tag{8}$$

$$A = 1 + \omega - \omega\xi,\ B = 1 + \omega - \omega\xi\,(1-\rho)$$

$$\widetilde{c}_t^H = \frac{w_t h_t^H}{A},\ \widetilde{c}_t^L = \frac{(1-\rho)\, w_t h_t^L A + \rho w_t h_t^H\,(B + (1-\rho)\,\omega\xi)}{AB} \tag{9}$$

$$n_t^H = \frac{\omega\,(1-\eta)}{(1+\omega)\,(w_t h_t^H \phi - \theta)}\left(w_t h_t^H - \xi\frac{w_t h_t^H}{A}\right) \tag{10}$$

$$n_t^L = \frac{\omega\,(1-\eta)}{(1+\omega)\,(w_t h_t^L \phi - \theta)}\left(w_t h_t^L - \xi\frac{(1-\rho)\, w_t h_t^L A + \rho w_t h_t^H\,(B + (1-\rho)\,\omega\xi)}{AB}\right) \tag{11}$$

$$e_t^H = \frac{w_t h_t^H \phi\eta - \theta}{1-\eta},\ e_t^L = \frac{w_t h_t^L \phi\eta - \theta}{1-\eta} \tag{12}$$

Note that consumption level of low-income households, as expected, is determined not only by their own income, but also by the income of the high-income households, whose consumption enters into the reference consumption level of the low-income households. However, the presence of envy affects not only consumption levels, but also fertility as $w_t h_t^H$ is present also in solution for $n_t^L$. From the optimal education choices (12) as well as the derivatives (13) and (14), we can see that within each household type there is still a "quality-quantity" trade-off.

$$\frac{\partial n_t^H}{\partial h_t^H} = \gamma(1-\eta)\frac{w_t\theta(\xi-1)}{(w_t h_t^H\phi-\theta)^2} < 0 \tag{13}$$

$$\frac{\partial n_t^L}{\partial h_t^L} = \frac{\gamma(1-\eta)}{(1+\gamma)}\left[\frac{w_t h_t^L}{w_t h_t^L\phi-\theta}\left(1-\frac{\xi(1-\rho)}{B}\right)\right] < 0 \tag{14}$$

$$\frac{\partial n_t^L}{\partial h_t^H} = -\frac{\omega(1-\eta)\rho w_t(B+(1-\rho)\omega\xi)}{(1+\omega)(w_t h_t^L\phi-\theta)AB} < 0 \tag{15}$$

But more importantly the fertility choice of a low-income household (11) is affected not only by its own level of human capital (that is, its own income), but also by the human capital level of high-income households. So the income of high-income households tends to increase $c_t^H$, which makes low-income households divert more resources towards consumption as they try to emulate high-income households. This redirection of resources towards consumption comes at the expense of the number of children.

### 3.3 The goal of the empirical study

The goal of the empirical study is to verify the theoretical implications of relative consumption concerns on fertility outcomes. Those implications depend on the nature of variation in local income inequality, for example whether that variation is due to mean-preserving variation in income variance across metropolitan areas or due to variation in skewness of income distributions. To identify the nature of variation I use data from ACS 2010 1% sample to construct two widely used income inequality measures for each metropolitan area identified in the sample (details in Subsection 4.2). These inequality measures are the ratio of income at 90th and 10th percentiles of income distribution and the Gini coefficient. In the same sample, I separate households into "top-earners" (personalized by households whose income is at 90th percentile) and the "rest" (the low-income majority personalized by households with median income). **Figure 1a** presents the distributions of the income of the "top-earners" and the "rest." The distribution of median income is more "peaked" with little variation, while income at 90th percentile has a bigger variation (in fact, the lower value is closer to 80, so it has a very skewed distribution) and is less "peaked."[3] But even this little variation in median income does not correlate much with inequality, as evidenced by the correlation between median income and inequality measures (less than 0.1). On the other hand, the measures of income inequality and income at the 90th percentile have a correlation of 0.4 and above. The correlation between inequality measures and skewness (estimated by Pearson's second coefficient of skewness) is in the range of 0.4-0.65, depending on the measure of inequality used. The **Figures 1b** and **1c** depict the fitted lines from the regression of median income and income at the 90th percentile on inequality measures. These confirm that the assumption on the nature of variation in income inequality is close to reality. An alternative way of highlighting the correspondence between the variation in inequality and the variation in skewness is to use the modified Gini coefficient $G_2$, proposed by Gastwirth (2012). This measure captures the structural changes in the distribution, specifically skewness, better than the Gini coefficient. The $G_2$ is easily computed from the standard Gini coefficient by replacing mean income in its formula by median income. The **Figure 1d** presents the fitted line of the OLS regression of $G_2$ on the Gini coefficient. Note that the regression line is steeper than the 45 degree line, which shows that higher inequality was also associated with higher skewness.[4] Given relatively little variation in the income of the "rest" compared to the income of the "rich" across metropolitan areas I make the following

[3]In fact assumption on constant median income across metropolitan areas is not crucial. This is due to the fact that if variation in median income is caused by proportionally re-scaled income distribution and price level (from the ACS 2010 data it follows that the correlation between median housing price, a proxy for the price level, and the median income is more than 0.6), the real income gap between the "top-earners" and the "rest" does not vary (constant inequality) so fertility should be the same. However if variation in median income is due to variation in the shape of income distribution implying variation in the real income gap between the "top-earners" and the "rest" (affecting fertility decisions of households across metropolitan areas), it will be captured by variation in income inequality measures.

[4]If higher inequality was not associated with more right-skewed distribution then $G_2$ and Gini coefficient would coincide and we will have a 45 degree line.

simplifying assumption: in more unequal areas, high-income households are richer than high-income households in less unequal areas, while low-income households across different areas are identical. So the model presented in this section, resulting in the derivatives (13) and (15), coupled with the assumption about the nature of variation in income inequality across metropolitan areas imply that households in more unequal areas (larger $\left(h_t^H - h_t^L\right)/h_t^L$ gap) are expected to have fewer children. For high-income households, this holds good, because in more unequal areas high-income households are richer than in less unequal areas, so they would have fewer children due the "quality-quantity" trade-off. For low-income households, this holds good, because the fertility of low-income households decreases in the income of high-income households. This effect is stronger in more unequal areas, because high-income households in their reference group are richer than high-income households in less unequal areas. Testing this implication of the fertility model with relative consumption concerns is the goal of the empirical part of this research.[5]

### 3.4 The effect of "envy" on the fertility-income relationship

Note that the nature of variation in income inequality found in ACS data can complicate the interpretation of my empirical results. Specifically, variation in income inequality across areas can generate negative relationships between income inequality and fertility rates even if households do not exhibit relative consumption concerns. This can happen due to high-income households in more unequal areas having fewer children than high-income households in less unequal areas. And even with the assumption of identical low-income households having identical fertility across metropolitan areas, in the regression analysis we will have a negative correlation between inequality and the fertility rate. Note, however, that if this negative correlation between income inequality and the fertility rate comes from the "quality-quantity" trade-off, it implies that in econometric estimations we should have a negative coefficient on the income variable. If we observe a negative coefficient on the income variable, then it is hard to tell if "envy" is driving the results or the "quality-quantity" trade-off. If,

[5] Although not present here due to arithmetical complexity, the less general model where parents have positional concerns in terms of the human capital of their children, described by a utility function $ln\left(c_t\right) + \omega ln\left(n_t\left(h_{t+1} - \varphi\widetilde{h}_t\right)\right)$ where $\widetilde{h}_t$ is the average human capital in the generation $t$, qualitatively has the same implications, that is wider income gap between high and low-income households imply lower fertility for both high and low-income households.

on the other hand, the coefficient on the income variable is positive, it would support the hypothesis that a negative correlation between income inequality and the fertility rate is due to relative consumption concerns. To demonstrate, I present expression (16) of the difference between the fertility rate of high- and low-income households

$$n_t^L - n_t^H = \frac{\omega(1-\eta)}{(1+\omega)} \cdot \frac{w_t\theta\left(h_t^H - h_t^L\right) + \xi\widetilde{c}_t^H\left(w_t h_t^L - \theta\right) - \xi\widetilde{c}_t^L\left(w_t h_t^H - \theta\right)}{\left(w_t h_t^L\phi - \theta\right)\left(w_t h_t^H\phi - \theta\right)}. \tag{16}$$

Signing this expression is tedious; however, assuming $\rho = 1$, that is, the reference group of low-income households would consist only of high-income households ($\widetilde{c}_t^L = \widetilde{c}_t^H$), then

$$n_t^L - n_t^H = \frac{\omega(1-\eta)}{(1+\omega)} \cdot \frac{w_t\left(h_t^H - h_t^L\right)\left((1-\omega) - \xi\left(\omega + \phi w_t h_t^H\right)\right)}{A\left(w_t h_t^L\phi - \theta\right)\left(w_t h_t^H\phi - \theta\right)} \tag{17}$$

Note that $\left((1-\omega) - \xi\left(\omega + \phi w_t h_t^H\right)\right)$ is more likely to be negative the bigger the $\xi$. This means that a strong desire to emulate high-income households may result in low-income households having fewer children than high-income households. This is an important feature of this model, and I will show in the empirical section of the paper that the estimated coefficient of the income variable is indeed positive. The positive fertility-income relationship gives more support to the model described in Subsection 3.1 than to the potential alternative hypothesis that fertility differentials between high and low income inequality areas result merely from variation in the structure of income distribution.[6]

## 4 Empirical strategy

I examine the relationship between local income inequality and fertility for US metropolitan areas in a similar fashion as Simon and Tamura (2009) examine the relationship between fertility and cost of living space and Coibion et al. (2014) examine the relationship between debt-to-income ratio differentials and inequality. That is to say, the regression includes an individual-level dependent variable (fertility) and individual-level (income, age, education,

[6] Note that from de la Croix and Doepke (2009) it follows that it is possible to have of lower average fertility in jurisdictions with higher inequality due to lower fertility of the richest who send their children to private schools, but this hypothesis also requires to have in cross-section that high-income households have fewer children than low-income households.

etc.) and geographic area-level (median income, inequality, etc.) independent variables. Geographic area-level variables are constructed for US metropolitan areas, as it is common for the studies on relative consumption concerns to concentrate on small geographic areas like metropolitan areas, counties, cities, or school districts, where households interact frequently and develop perceptions of desirable living standards. I use the American Community Survey (ACS) data available through Integrated Public Use Microdata Series-USA (IPUMS-USA). This data is used to construct local income inequality measures that will be used in the regression analysis. To deal with any potential simultaneity between income and fertility, baseline results will also include estimations using an instrument for household income. Note that these estimations will have some caveats related to issues such as multicollinearity and comparability of prices across metropolitan areas. These caveats are addressed in the concluding subsection, which also discusses the sensitivity of the results to the use of alternative measures of income inequality.

### 4.1 Data

I construct a sample of married, spouse-present households which were living in the same housing unit (the issues with internal migration are discussed in the section 5) in the previous year using data from ACS 2010 1 % sample. I exclude households where children have grandparents present in the household as their presence has ambiguous effect on fertility. On one hand grandparents may provide child care services, effectively reducing the cost of childbearing. On the other hand, if they have serious health conditions, they may require informal care at home. As often women take charge of providing informal care to elder members of the household, this may affect their fertility plans. The household in the sample reside in 543 identifiable metropolitan areas. [7] Note that the metropolitan area may contain several counties. However, I find that metropolitan areas are the appropriate unit as they are defined based on “economic and cultural links”, which is what I need in order to argue

[7] I use variable “CONSPUMA” to identify households at metropolitan area level.

that households within a metropolitan area are visible to each other and thus are the proper "Joneses" for each other. To quantify fertility of households I use the variable specifying the number of own children in the household (children present in the household at the time of interview rather than children parents have). Note that for older woman it is possible that children have left the household, which means number of children present in the household will be fewer than she actually has. For this reason I limit my sample to women aged 18-40 years, in order to minimize the probability that children have left parental homes. I also exclude households with step-children as number of children in those households may not be the ideal number planned by the current spouses. The complete list of individual-level and metropolitan area-level variables is presented in the **Table** 1. Overall, the ACS 2010 1 % sample contains records on 3,061,692 individuals living in 1,283,676 households. After imposing all sample restriction I am left with some 130,000 households, that is on average 240 households per metropolitan area.

### 4.2 Income inequality measures

In addition to variables contained in the ACS data, I construct two conventional measures of income inequality as follows. Within each metropolitan area, the income percentiles are calculated and households are assigned a rank (from 1 to 10, where 10 corresponds to the top 10 percent of income distribution) based on their location in the income distribution. Then, for each of the 543 metropolitan areas, I constructed

1. a Gini coefficient for each metropolitan area $c$ ($GINI_c$) and
2. a ratio of incomes at 90th and 10th percentiles of the income distribution in the metropolitan area $c$ ($I_c^{90/10}$).

[8]

[8] Using the Gini coefficient, the least unequal city identified was Hampton, Virginia, where the $GINI_c$ was equal to 0.19, while the most unequal city identified was Los Angeles-Long Beach, California (followed by New York City, New York), where the $GINI_c$ was equal to

I also constructed two alternative measures of income inequality, which unlike more conventional measures better capture the changes in the right tail of income distributions. These two alternative measures are the adjusted $G_2$ and the income share of the top 10 percent of income distribution. The four measures of income inequality have a high level of correlation between each other (well above 0.5) with the exception of the correlation between the $I_c^{90/10}$ and the income share of the top 10 percent, which is 0.287. This indicates that the $I_c^{90/10}$, unlike the $GINI_c$, does not capture well the variation in the right tails of income distributions across metropolitan areas. As variation in the income share of the "top-earners" across metropolitan areas is a focus of the model developed in the previous section, estimation results obtained using the $GINI_c$ should be given priority over the results obtained using the $I_c^{90/10}$.[9]

### 4.3 Estimation

To identify the effect of relative consumption concerns on fertility outcomes, I estimate (18)[10]

$$y_{i,c} = \alpha + \beta \cdot INC_{i,c} + \gamma I_c + \epsilon X_{i,c} + \varepsilon_{i,c}, \tag{18}$$

where variables of interest are the area-level variables $I_c$ ($I_c^{90/10}$ and $GINI_c$), which is the measure of income inequality for each metropolitan area $c$, and $INC_{i,c}$, which is the income measure of a household $i$ residing in a metropolitan area $c$. The prior belief for the coefficient of the variable $I_c$ is that it should be negative—that is, residing in a metropolitan area with high income inequality is associated with lower fertility. There is no prior belief for the coefficient of the variable $INC_{i,c}$, although, as it was stated in Subsection 3.4, a positive $\beta$ will help confirm the presence of relative consumption concerns. Note that by

0.46. Using the $I_c^{90/10}$ measure of inequality, the least unequal city identified was again Hampton, Virginia, where income at the 90th percentile was only 2.6 times that at the 10th percentile. The most unequal city identified was Springfield, Massachusetts (followed by New York City, New York), where the $I_c^{90/10}$ was equal to 15.96.

[9]However as we will see there will not be a need to give priority as estimates with both measures give consistent results supporting the hypothesis of negative interrelation between fertility rate and inequality.

[10]The estimation is similar to the one found in Simon and Tamura (2009), but in addition to the controls used by them includes local income inequality measure and household income measure.

using total household income ($TOTINC_{i,c}$) as $INC_{i,c}$, one encounters the problem of the comparability of dollar values between different areas, as one dollar in rural Vermont is not equivalent to one dollar in New York City. One of the ways of dealing with this issue is to adjust income by some variable that captures price levels in the area. A natural candidate is housing price. However, housing price itself is an important variable, which ideally should be in the regression, otherwise the $I_c$ might capture the negative effect of housing price on fertility (established in Simon and Tamura (2009)). Therefore, instead of adjustment, in the estimation of (18), I use median housing price and median income to control for price differences between metropolitan areas.

The vector $X_{i,c}$ also contains other metropolitan area-level and individual-level variables, in addition to the metropolitan area-level median housing price per room and median household income.[11] The metropolitan area-level variables include the mean labor force participation rate of females in the area, the percentage of college graduates in the metropolitan area, while the individual-level variables include the age groups of spouses, the racial profile of the female in the household, the years of schooling of spouses, the labor force status of the female of the household, etc. The area-level variables are intended to capture unobserved factors that may be affecting relative prices or tastes for quality and quantity of children (which may thus affect the sorting of households across metropolitan areas).[12] For example, one may argue that cities with higher median income or higher labor force participation of women may indicate places that have more alternative uses of time for women, thus raising the opportunity cost of childbearing and child-rearing. Similarly, the proportion of males/females with a college degree in the metropolitan area may be capturing unobserved propensities of more educated households to prefer quality over quantity. In all regressions, the standard errors are clustered on the metropolitan area level.

A common concern in estimations of reduced-form equations like (18) is that inclusion of income can induce a simultaneity bias in the estimation. The reason for this is that in-

[11]Note that by inclusion of metropolitan area-level median income and median housing price variables I control for the proportional shifts in income distributions, while the variation in the shape of income distributions is captured by inequality measures.

[12]The area-level variables which are supposed to control for sorting on unobserved variables (affecting relative prices, quality and quantity preferences) across metropolitan are constructed after imposing sample demographic restrictions as it is reasonable to assume that they should be the relevant ones for the demographics of the sample. However one may argue that the housing market may not segmented by the demographic characteristics of people within the metropolitan area. However the the correlation between median housing prices constructed before and after imposition of demographic restrictions is almost 0.99, so I abstain from presenting estimations with unrestricted housing prices.

come and fertility may be determined simultaneously. Note that in our case, when we use family income, which also includes female earnings, the simultaneity bias could be stronger as exogenous fertility preferences may affect the labor supply decision of the female (and thus earnings) just as income affects fertility decisions. In addition to concerns about simultaneity bias, one tends to think that households make long-term decisions (including fertility decisions) based on permanent income, which itself can be thought of as a proxy of wealth. To address these concerns, I estimate (18) using a two-stage least square (2 SLS) technique where $INC_{i,c}$ (measured by $TOTINC_{i,c}$) is treated as an endogenous variable and $WAGE_{i,c}$ is the wage income of the male of the household, which is the excluded exogenous variable (instrument). The validity of $WAGE_{i,c}$ as an instrument stems from the fact that unlike female income, the income of the male of the household is unlikely to be correlated with exogenous fertility preferences. Additionally, wage earnings tend to be good predictors of permanent income as they are usually stable and do not contain highly volatile components like capital gains, business income, etc. Note that in the 2 SLS estimation of (18) the income inequality measures are constructed from $TOTINC_{i,c}$ rather than from the first-stage estimated total income of households. This should not be a problem; what matters are the incomes at the 90th and 10th percentiles in each metropolitan area $c$ rather than *who* are at the 90th and 10th percentiles. Due to idiosyncratic shocks, households may change their position in the income distribution, but such changes are not important for our purposes. What is crucial is the gap between the incomes of "top-earners" and the "rest" and how this varies across metropolitan areas, a variation which is captured by the measures of income inequality.[13] Thus, the baseline results of this empirical exercise consist of four regressions altogether: OLS and 2 SLS regressions with two measures of local income inequality ($I_c^{90/10}$, $GINI_c$).

### 4.4 Baseline results

The regression results are presented in **Table 2**. The first two columns show the OLS estimation of (18), where I use $TOTINC_{i,c}$ as $INC_{i.c}$. The first column shows the estimation results where inequality is measured by the $GINI_c$ while in the second column it is measured

[13] Earlier versions of the paper included regressions where income inequality measures were constructed from the predicted income after the first stage of 2 SLS procedure. The results qualitatively are the same as the ones presented above.

by the $I_c^{90/10}$. The third and the fourth columns show the 2 SLS estimations of (18), where $INC_{i,c}$ is $TOTINC_{i,c}$ instrumented by $WAGE_{i,c}$. The only difference between the third and fourth columns is that in the third column inequality is measured by the $GINI_c$ while in the second column it is measured by the $I_c^{90/10}$. The estimation delivers two important results. First, the negative coefficient on the income inequality measure ($\gamma < 0$) indicates that a household in an area with higher income inequality tends to have fewer children. The illustration of the economic significance of the effect of local inequality on fertility is presented in **Table 3** (OLS) and **Table 5** (2 SLS). The "Mean # children" is the predicted number of children at means of explanatory variables. The "1 St. Dev." indicates the percentage change (relative to "Mean # children") in fertility if inequality increases by one standard deviation. The "Least unequal" refers to the percentage by which fertility is reduced in the least unequal area (relative to a hypothetical perfectly equal area), while the "Most unequal" refers to the same thing in the most unequal area. The $\triangle$(Least-Most) indicates the fertility differential between the least and most unequal areas. The effects are presented for both measures of income inequality. Thus, the **Tables 3** and **5** show, for instance, that the fertility differential between the least unequal and the most unequal metropolitan areas, if inequality is measured by the $GINI_c$, is about 0.211 (**Table 3**) and 0.258 (**Table 5**) children.

Second, the positive coefficient on the income variable ($\beta > 0$) indicates a positive relationship between fertility and income. As discussed above in subsection 3.4 if the negative fertility-income inequality relationship was "mechanical" due to the variation in income inequality driven by the variation in the right tails of local income distribution one should have expected negative fertility-income relationship. [14] So the structure of income distribution can describe fertility differentials, but it can not explain the positive fertility-income relationship. By contrast, the model that incorporates "envy" can generate both lower average fertility in areas with higher income inequality levels and positive fertility-income relationship. Thus, this second result— the empirically observed positive fertility-income relationship, gives more

[14] Note that it is not unheard of in the literature to have positive conditional correlation between fertility and income in cross section for developed nations and US in particular as evident from O'Malley Borg (1989), Jones et al. (2008), Rosenzweig and Schultz (1985), and Shields and Tracy (1986). One may argue that if finding positive fertility-income relationship is not uncommon, have $\beta > 0$ may not be the best way of proving that it is my theory that explains the negative inequality-fertility relationship. Thus, I also estimate equation (18) excluding households who are in top 10 % of their local income distribution and still coefficient of $I_c$ is negative and statistically significant.

credit to “keeping up with the Joneses” as an explanation for fertility differential patterns observed in **Table 2** than to the alternative explanation. Note that I do not use completed fertility as dependent variable, so in theory a positive income-fertility relationship can exists as earnings and fertility tend to increase over time. However all regressions control for female age, which should help to avoid having income-fertility relationship due to life-cycle considerations.

The rest of the coefficient estimates for all four regressions are as expected. More educated women, women in the labor force and white women tend to have fewer children than less-educated women, women out of the labor force and women of color. We also see that women residing on farms and in households that are below the poverty line tend to have more children. There is a statistically significant negative effect of housing prices on fertility.

## 4.5 Robustness exercises

To verify the robustness of the results, I conduct several exercises. First, I discuss the issue of multicollinearity between inequality and median housing prices, and I check the Variance Inflation Factors (VIFs) for these variables. Second, I estimate (18) by replacing $INC_{i.c}$ with a dummy variable for the top 10 percentile of the local income distribution as an alternative way of controlling for the price level variation across metropolitan areas. Third, I check the sensitivity of the main results by using the alternative measures of income inequality, notably those that are more sensitive to changes in the right tail of the income distribution.

### 4.5.1 Multicollinearity

Note that high housing prices in the metropolitan area may be correlated with higher levels of inequality; thus, having both variables in one regression may cause multicollinearity issues. To assess the severity of the multicollinearity, Variance Inflation Factors (VIF) were calculated for the regressions presented in **Tables 2, 4**, **6** and **8**. This confirmed that housing prices and inequality in the regressions did not create significant multicollinearity issues; the VIFs for the variable of interest $I_c$ and for housing prices were less than 5. Because the coefficients on the variable of interest $I_c$ are statistically significant at least at 5% in the baseline regressions, multicollinearity is not a serious issue.

#### 4.5.2 Using a unit-free income dummy for a "top-earner"

The issue with compatibility of incomes between metropolitan areas was discussed in Subsection 4.3. In the estimation of (18), the variation in price levels across metropolitan areas was controlled for by using area-level housing prices and median incomes. Note, however, that in theoretical derivations we have two groups, high-income and low-income households, and the absolute values of income do not play a significant role. What matters is how rich the "top-earners" are compared to the "rest", which is captured by inequality measures. The positive fertility-income relationship is found to be possible *between* income groups, while *within* income groups we firmly have a "quality-quantity" trade-off. So to argue in favor of "envy" driving the results, instead of the alternative explanation described in Section 3, we should empirically observe positive fertility differentials between "top-earners" and the "rest". Thus, I construct a dummy variable $RICH_{i,c}$, which takes the value of 1 if the household $i$ is in the top 10 percentile of the income distribution in the metropolitan area $c$. By definition $RICH_{i,c}$ does not have a dollar value, so with $RICH_{i,c}$ I do not have the problem of compatibility of incomes (e.g. a household income of 60000 dollars in rural Vermont could be characterized as rich, while in New York City it could be characterized as poor). Using $RICH_{i,c}$, the Vermonter would probably be assigned a value of 1, while the New Yorker would probably be assigned a value of 0. **Table** 4 presents the estimation of (18) using $RICH_{i,c}$ as $INC_{i,c}$. In the first column of **Table** 4, income inequality is measured by $Gini_c$, in the second column by $I_c^{90/10}$, in the third column by Gastwirth's $G_2$ and in the fourth column by $I_c^{90/50}$. **Table** 7 presents the economic significance of the results. Note that, as in the baseline estimations, we observe two important features: [1] being in a more unequal area—that is, in an area where the "top-earners" earn much more than the "rest"—is correlated with a lower fertility rate ($\gamma < 0$); and [2] being in the top 10 percentile is associated with slightly a higher fertility rate compared to the "rest" ($\beta > 0$). Obviously, the idea can be generalized if, for example, we assume three categories: the rich, the middle and the poor. The poor will try to match the middle, and the middle will try to match the rich. Again, the important factors are the income gaps between these three groups. In fact, one could add more income categories.

However, I think the focus on the original two-group case (the "top-earners" and the "rest") is justified because most of the changes in the income distribution are concentrated in the right tail. I also constructed the dummy variable $RICH_{i,c}^{wage}$, which assigns a value of 1 if the household is in the top 10 percentile of the local $WAGE_{i,c}$ distribution. The results of the estimations are presented in **Table** 6, which has the same structure as **Table** 4. Note that, when using $WAGE_{i,c}$, fertility differentials between "top-earners" and the "rest" are greater, which is expected since it is not uncommon to find a significantly positive relationship between a male's income and fertility. The rest of the estimated coefficients have signs and magnitudes comparable to the ones found before.

#### 4.5.3 Alternative measures of inequality

I use three alternative measures of inequality: Gastwirth's $G_2$, the ratio of income at 90th percentile and median income ($I_{90/50}$) and the income share of the top 10 percent of income distribution. Note that all three measures, not conventionally used in the literature, are focused on the changes that happen in the right tail of the income distribution. The estimation results of (18) using these measures of inequality are found in **Table 8**. In the first column of **Table 8,** income inequality is measured with Gastwirth's $G_2$, in the second column with $I_c^{90/50}$ and in the third column by the income share of the top 10 percent of income distribution. Qualitatively, we find the same as in the previous estimations: residing in a metropolitan area with higher income inequality is associated with lower fertility. The quantitative results (**Table 7** presents the economic significance) show that the effect of inequality is comparable to the results obtained for conventional measures of inequality, although the fertility differentials between households in the least and most unequal areas are greater when using $I_{90/50}$ (0.33).

## 5 Conclusion

In this study I examine the possible effects of local income inequality on household reproductive behavior when they have positional concerns in their consumption decisions. The study is a contribution to the literature that studies the effect of relative consumption concerns on the household behavior. A significant portion of this literature is aimed at understanding implications for household saving/borrowing decisions and welfare implications for the society. However the positional concerns may affect also reproductive behavior. Recall Easterlin (1975) who states that households, when making fertility decisions, take care not about their absolute income, but rather how it compares to the income/consumption level of a reference group. In my study, unlike Easterlin (1975), I assume that households' reference group is not their parents, but rather their peers living in close proximity whose income/consumption is well-visible for the neighbors; a fairly standard assumption in the "keeping up with the Joneses" literature. Modeled in this fashion, it becomes clear that variation in local income inequality, that is a variation in income of the reference group for the low-income household, should generate variation in fertility. More specifically, a simple "quality-quantity" trade-off fertility model when augmented to allow for "envy" demonstrates that in presence of positional concerns one should expect lower fertility rate in areas with higher income inequality. This is due to the fact that more unequal areas are characterized by highly right-skewed income distribution, that is high-income households in more unequal areas are richer than high-income households in the less unequal areas. Thus, high-income households due to "quality-quantity" trade-off have fewer children in more unequal areas. In addition to lower fertility, the high-income households in more unequal areas have also higher consumption, that is to say, low-income households in more unequal places face higher consumption of the reference group. Trying to match the high consumption level of the high-income households the low-income households have fewer children and dedicate more of their resources towards consumption. The main goal of this study is to test empirically the implications of this static fertility model. The empirical analysis using US data from the ACS 2010 sample confirms that indeed, areas with higher income inequality are characterized by lower fertility rates and this difference is quite significant; ranging from 0.17 to 0.33 depending on the model specifications. Note that the positive fertility-income relationship observed empirically prevents us to think that the negative inequality-fertility relationship can be a result of structural changes in the income distributions as for this alternative explanation to be true, we must observe negative fertility-income relationship caused by the "quality-quantity" trade-off. The results of this study further confirms the existence of relative consumption concerns and offers a possibility that macroeconomic shocks increasing income inequality may not always lead to a spiraling growth in inequality — a concern often found in macroeconomic literature.

If one considers dynamic setting, the internal migration should be taken into account. It is possible that higher income of the reference group, which a low-income household may not be able to match, may induce that household to migrate towards an area with lower income inequality. That is to say, migration decision and inequality can be interrelated. In this study I restrict my sample to households which did not change their place of residence at least within the last year. The discussion of the dynamics effects of inequality on fertility is outside the scope of this study and is left for future research.

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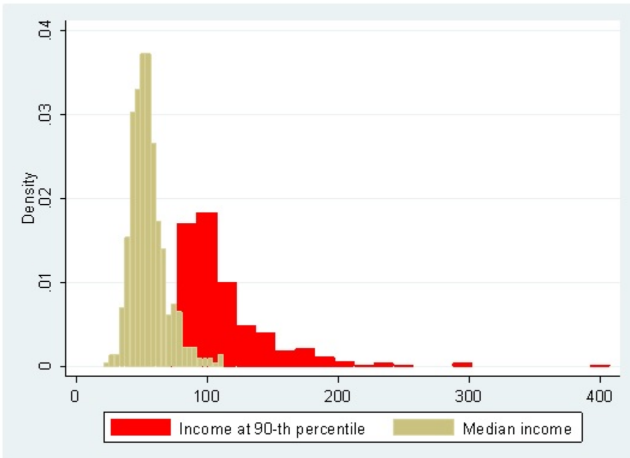
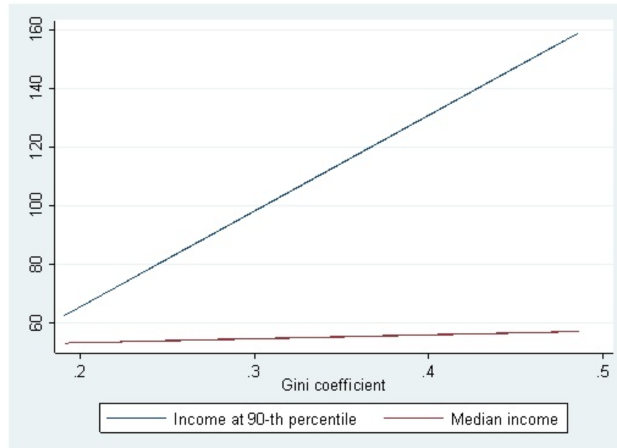
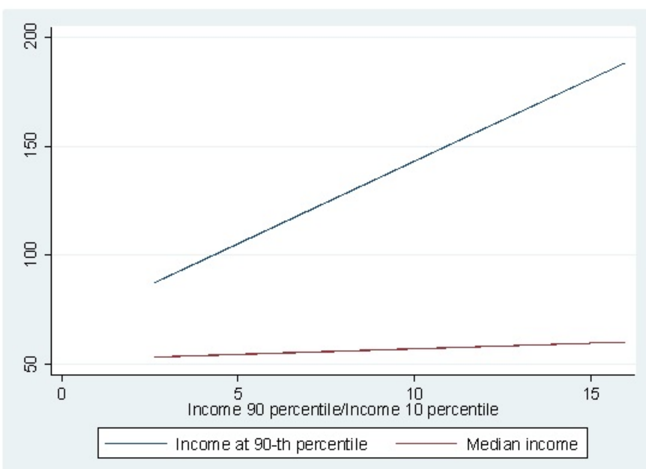
# 7 Figures and Tables



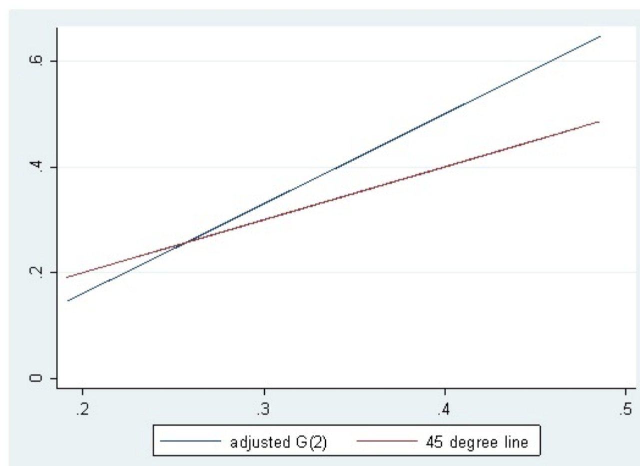

(a) Distribution of the income at 90th percentile and median income across metropolitan areas.




(b) Fitted values from the OLS regression of Income at 90th percentile and Median income eon Gini Coefficient.




(c) Fitted values from the OLS regression of Income at 90th percentile and Median income on $I_{90/10}$.




(d) Fitted values from the OLS regression of adjusted G(2) on Gini coefficient.

Figure 1: Relationship between income inequality and skewness of income distribution

Sources: Data comes from ACS 2010 1% sample available via IPUMS-USA.

| variable | mean | st. deviation | variable | mean | st. deviation |
|---|---|---|---|---|---|
| NCHILD | 2.186 | 1.213 | Mountain | 0.0444 | 0.206 |
| Male school years | 13.244 | 3.331 | Pacific | 0.116 | 0.320 |
| Female school years | 12.577 | 2.324 | reside in central city | 0.130 | 0.337 |
| Male age | 37.224 | 6.015 | not in the central city | 0.377 | 0.485 |
| Female age | 33.934 | 4.381 | Female LF status | 0.579 | 0.494 |
| Female Black | 0.071 | 0.257 | House value per room | 26.423 | 16.933 |
| Female other than Black or White | 0.018 | 0.131 | Poverty status | 0.035 | 0.184 |
| Foreign born | 0.045 | 0.208 | Live in farm | 0.003 | 0.057 |
| North eastern | 0.056 | 0.230 | Median HH income | 52.286 | 7.793 |
| Mid Atlantic | 0.162 | 0.369 | Inequality $(I_{90/10})$ | 5.816 | 1.623 |
| East north central | 0.208 | 0.406 | Inequality $(GINI)$ | 0.354 | 0.043 |
| West north central | 0.077 | 0.267 | % female college grads | 0.407 | 0.121 |
| South Atlantic | 0.163 | 0.369 | | | |
| East south central | 0.069 | 0.253 | | | |
| West south central | 0.103 | 0.303 | | | |

Table 1: Descriptive statistics

Sources: Data comes from ACS 2010 1% sample available via IPUMS-USA, dollar values are in thousands of 2000 US dollars. Weighting is done using personal weights.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | OLS | | 2 SLS | |
| **Variables** | | | | |
| **Individual-level variables** | | | | |
| **Income** | 0.001*** | 0.001*** | 0.002*** | 0.002*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Female Black | 0.179*** | 0.178*** | 0.196*** | 0.195*** |
| | (0.022) | (0.022) | (0.023) | (0.023) |
| Female other than Black or White | 0.142** | 0.144** | 0.130** | 0.131** |
| | (0.060) | (0.060) | (0.063) | (0.063) |
| Female school years | -0.054*** | -0.054*** | -0.056*** | -0.056*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Male school years | -0.024*** | -0.024*** | -0.027*** | -0.027*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Female LF status | -0.464*** | -0.463*** | -0.483*** | -0.483*** |
| | (0.012) | (0.012) | (0.013) | (0.013) |
| **Area-level variables** | | | | |
| Area FLFP | -0.415** | -0.381* | -0.389* | -0.337* |
| | (0.210) | (0.202) | (0.211) | (0.203) |
| % college grads | -0.514*** | -0.554*** | -0.498*** | -0.548*** |
| | (0.111) | (0.108) | (0.110) | (0.106) |
| Median HH income | 0.002 | 0.003* | 0.001 | 0.002 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Median house value per room | -0.004*** | -0.003*** | -0.004*** | -0.003*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **GINI** | -0.718*** | - | -0.877*** | - |
| | (0.266) | | (0.266) | |
| $\mathbf{I_{90/10}}$ | - | -0.018** | - | -0.021*** |
| | | (0.007) | | (0.007) |
| Intercept | 3.207*** | 3.022*** | 3.315*** | 3.076*** |
| | (0.238) | (0.187) | (0.242) | (0.190) |
| Observations | 130,912 | 130,895 | 117,402 | 117,387 |
| R-squared | 0.199 | 0.199 | 0.202 | 0.202 |

Table 2: OLS and 2 SLS Regressions for Children in the Household, 2010

Notes: The sample consist of one and two-generation households with both spouses present. Independent variable is the number of own children in the household. Data comes from American Community Survey 2010 1 % sample obtained through IPUMS. In columns (1) and (2) Income stands for $TOTINC_{i,c}$, while in columns (3) and (4) its stands for $TOTINC_{i,c}$ instrumented by $WAGE_{i,c}$ . Both $I_{90/10}$ (the ratio of incomes at 90ta and 10th percentiles) and GINI are constructed for each metropolitan area $c$. Dollar variables are in thousands of 2000 dollars. Sample is weighted by personal weights and standard errors are clustered on metropolitan areas. Regressors not reported in this table include dummies for US Census areas, for male and female age categories, poverty status and residence in farms. *** significant at less than 1%; ** significant at 5%; * significant at 10%.

| | Mean children | 1 St. Dev. | Least unequal | Most unequal | Δ(Least-Most) |
|---|---|---|---|---|---|
| $GINI$ | 1.646 | -0.031 % | -0.137 % | -0.349 % | 0.211 |
| $I_{90/10}$ | 1.647 | -0.029 % | -0.048 % | -0.290 % | 0.243 |

Table 3: Fertility differentials, OLS estimation of (18).

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| **Variables** | | | | |
| **Individual-level variables** | | | | |
| **RICH** | 0.097*** | 0.097*** | 0.097*** | 0.097*** |
| | (0.013) | (0.013) | (0.013) | (0.013) |
| Female Black | 0.172*** | 0.171*** | 0.171*** | 0.172*** |
| | (0.022) | (0.022) | (0.022) | (0.022) |
| Female other than Black or White | 0.145** | 0.146** | 0.146** | 0.146** |
| | (0.060) | (0.060) | (0.060) | (0.060) |
| Female school years | -0.052*** | -0.052*** | -0.052*** | -0.053*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Male school years | -0.022*** | -0.022*** | -0.022*** | -0.022*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Female LF status | -0.455*** | -0.455*** | -0.455*** | -0.455*** |
| | (0.012) | (0.012) | (0.012) | (0.012) |
| **Area-level variables** | | | | |
| Area FLFP | -0.424** | -0.399** | -0.385* | -0.381* |
| | (0.210) | (0.201) | (0.205) | (0.197) |
| % college grads | -0.523*** | -0.555*** | -0.524*** | -0.485*** |
| | (0.111) | (0.107) | (0.112) | (0.111) |
| Median HH income | 0.003** | 0.003** | 0.003** | 0.003* |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Median house value per room | -0.004*** | -0.003*** | -0.0034*** | -0.003*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **GINI** | -0.602** | - | - | - |
| | (0.267) | - | - | - |
| $\mathbf{I_{90/10}}$ | - | -0.016** | - | - |
| | - | (0.007) | - | - |
| $\mathbf{G_2}$ | - | - | -0.267** | - |
| | - | - | (0.135) | - |
| $\mathbf{I_{90/50}}$ | - | - | - | -0.102*** |
| | - | - | - | (0.033) |
| Intercept | 3.124*** | 2.976*** | 3.000*** | 3.092*** |
| | (0.239) | (0.187) | (0.207) | (0.204) |
| Observations | 131,293 | 131,276 | 131,293 | 131,293 |
| R-squared | 0.196 | 0.196 | 0.196 | 0.196 |

Table 4: OLS Regressions for Children in the Household, using dummy for the "top-earners" ($RICH$), 2010

Notes: The sample consist of one and two-generation households with both spouses present. Independent variable is the number of own children in the household. Data comes from American Community Survey 2010 1 % sample obtained through IPUMS. *Rich* is dummy variable for being in top 10 percentile of $INC_{i,c}$ distribution in metropolitan area $c$. GINI, $I_{90/10}$ (the ratio of income at 90-th and 10-th percentiles), $G_2$ and $I_{90/50}$ (the ratio of income at 90-th percentile and median income) are constructed for each metropolitan area $c$. Dollar variables are in thousands of 2000 dollars. Sample is weighted by personal weights and standard errors are clustered on metropolitan areas. Regressors not reported in this table include dummies for US Census areas, for male and female age categories, poverty status and residence in farms. *** significant at less than 1%; ** significant at 5%; * significant at 10%.

| | Mean children | 1 St. Dev. | Least unequal | Most unequal | $\Delta$(Least-Most) |
|---|---|---|---|---|---|
| $GINI$ | 1.653 | -0.038 % | -0.168 | -0.426 % | 0.258 |
| $I_{90/10}$ | 1.654 | -0.035 % | -0.056 | -0.341 % | 0.285 |

Table 5: Fertility differentials, 2 SLS estimation of (18).

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| **Variables** | | | | |
| **Individual-level variables** | | | | |
| **RICH$^{wage}$** | 0.197*** | 0.197*** | 0.197*** | 0.196*** |
| | (0.01) | (0.014) | (0.014) | (0.014) |
| Female Black | 0.176*** | 0.175*** | 0.175*** | 0.176*** |
| | (0.022) | (0.022) | (0.022) | (0.022) |
| Female other than Black or White | 0.146** | 0.147** | 0.147** | 0.147** |
| | (0.060) | (0.060) | (0.060) | (0.060) |
| Female school years | -0.052*** | -0.052*** | -0.052*** | -0.052*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Male school years | -0.024*** | -0.024*** | -0.024*** | -0.024*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Female LF status | -0.438*** | -0.438*** | -0.439*** | -0.439*** |
| | (0.012) | (0.012) | (0.012) | (0.012) |
| **Area-level variables** | | | | |
| Area FLFP | -0.436** | -0.410** | -0.397* | -0.392** |
| | (0.210) | (0.202) | (0.206) | (0.198) |
| % college grads | -0.517*** | -0.550*** | -0.519*** | -0.481*** |
| | (0.111) | (0.108) | (0.113) | (0.111) |
| Median HH income | 0.003** | 0.003** | 0.003** | 0.003* |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Median house value per room | -0.004*** | -0.003*** | -0.004*** | -0.003*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| **GINI** | -0.606** | - | - | - |
| | (0.268) | - | - | - |
| **$I_{90/10}$** | - | -0.016** | - | - |
| | - | (0.007) | - | - |
| **$G_2$** | - | - | -0.268** | - |
| | - | - | (0.135) | - |
| **$I_{90/50}$** | - | - | - | -0.101*** |
| | - | - | - | (0.033) |
| Intercept | 3.139*** | 2.987*** | 3.013*** | 3.101*** |
| | (0.240) | (0.187) | (0.207) | (0.205) |
| Observations | 131,293 | 131,276 | 131,293 | 131,293 |
| R-squared | 0.197 | 0.197 | 0.197 | 0.197 |

Table 6: OLS Regressions for Children in the Household, using dummy for the "top-earners" ($RICH^{wage}$), 2010.

Notes: The sample consist of one and two-generation households with both spouses present. Independent variable is the number of own children in the household. Data comes from American Community Survey 2010 1 % sample obtained through IPUMS. $RICH^{wage}$ is dummy variable for being in top 10 percentile of $WAGE_{i,c}$ distribution in metropolitan area $c$. GINI, $I_{90/10}$ (the ratio of income at 90-th and 10-th percentiles), $G_2$ and $I_{90/50}$ (the ratio of income at 90-th percentile and median income) are constructed for each metropolitan area. Dollar variables are in thousands of 2000 dollars. Sample is weighted by personal weights and standard errors are clustered on metropolitan areas. Regressors not reported in this table include dummies for US Census areas, for male and female age categories, poverty status and residence in farms. *** significant at less than 1%; ** significant at 5%; * significant at 10%.

| | Mean children | 1 St. Dev. | Least unequal | Most unequal | Δ(Least-Most) |
|---|---|---|---|---|---|
| $GINI$ | 1.646 | -0.026 % | -0.115 % | -0.292 % | 0.177 |
| $I_{90/10}$ | 1.646 | -0.026 % | -0.042 % | -0.253 % | 0.211 |

Table 7: Fertility differentials, OLS estimation of (18) using $RICH_{i,c}$.

| | (1) | (2) | (3) |
|---|---|---|---|
| **Variables** | | | |
| **Individual-level variables** | | | |
| **Income** | 0.002*** | 0.002*** | 0.002*** |
| | (0.000) | (0.000) | (0.000) |
| Female Black | 0.195*** | 0.195*** | 0.193*** |
| | (0.023) | (0.023) | (0.023) |
| Female other than Black or White | 0.131** | 0.131** | 0.132** |
| | (0.063) | (0.063) | (0.063) |
| Female school years | -0.056*** | -0.056*** | -0.056*** |
| | (0.002) | (0.002) | (0.002) |
| Male school years | -0.027*** | -0.027*** | -0.027*** |
| | (0.002) | (0.002) | (0.002) |
| Female LF status | -0.484*** | -0.484*** | -0.484*** |
| | (0.013) | (0.013) | (0.013) |
| **Area-level variables** | | | |
| Area FLFP | -0.341* | -0.317 | -0.317 |
| | (0.207) | (0.199) | (0.217) |
| % college grads | -0.490*** | -0.454*** | -0.557*** |
| | (0.112) | (0.110) | (0.109) |
| Median HH income | 0.001 | 0.001 | 0.002* |
| | (0.001) | (0.001) | (0.001) |
| Median house value per room | -0.004*** | -0.003*** | -0.004*** |
| | (0.001) | (0.001) | (0.001) |
| **$G_2$** | -0.422*** | - | - |
| | (0.134) | - | - |
| **$I_{90/50}$** | - | -0.140*** | - |
| | - | (0.033) | - |
| **Income Share of 10 %** | - | - | -0.423* |
| | - | - | (0.219) |
| Intercept | 3.157*** | 3.242*** | 3.058*** |
| | (0.211) | (0.209) | (0.216) |
| Observations | 117,402 | 117,402 | 117,387 |
| R-squared | 0.202 | 0.202 | 0.202 |

Table 8: 2 SLS Regressions for Children in the Household with alternative measures of income inequality, 2010

Notes: The sample consist of one and two-generation households with both spouses present. Independent variable is the number of own children in the household. Data comes from American Community Survey 2010 1 % sample obtained through IPUMS. Income stands for $INC_{i,c}$ instrumented by $WAGE_{i,c}$. $G_2$, $I_{90/50}$ and $Income\, Share\, of\, 10\,\%$ are constructed for each metropolitan area $c$. Dollar variables are in thousands of 2000 dollars. Sample is weighted by personal weights and standard errors are clustered on metropolitan areas. Regressors not reported in this table include dummies for US Census areas, for male and female age categories, poverty status and residence in farms. *** significant at less than 1%; ** significant at 5%; * significant at 10%.

| | Mean children | 1 St. Dev. | Least unequal | Most unequal | $\Delta$(Least-Most) |
|---|---|---|---|---|---|
| $G_2$ | 1.653 | -0.034 % | -0.080 % | -0.318 % | 0.237 |
| $I_{90/50}$ | 1.654 | -0.040 % | -0.179 % | -0.508 % | 0.329 |
| $Income\, share\, of\, top\, 10\,\%$ | 1.654 | -0.113 % | -0.034 % | -0.178 % | 0.144 |

Table 9: Fertility differentials, OLS estimation of (18), alternative measures of inequality

# 8 Connecting Text (Another point of view on cross-sectional fertility differentials)

The previous study stressed that fertility differentials among households are often the results of broad economic changes that happen in the society. The existence of fertility differentials and their dynamics are important factors which and can have effect on the growth rates of the economy. Never the less, it seems that most of the studies in macroeconomics, especially in growth literature, use fertility models that focus on representative agent whose fertility outcomes are meant to represent the total fertility rate. This over-focusing on total fertility rate can be problematic as this measure itself does not fully capture changes in the household fertility behavior. An illustrative example is this: in 1930s and 1970s the total fertility rate in the US was almost the same, around 2 children, yet in spite of similar means, the variation of the distribution of completed fertilities in 1930s was much greater. The models focused on total fertility rate in this case fail to capture changes that happened in the household fertility behavior. This fact motivated the third study of this thesis.

## Part III

# Female labor force participation and fertility differentials

**Irakli Japaridze**

**Abstract**

Even though the average number of children per women in the US was about the same in the 1930s and 1970s, there were important changes in the distribution of fertility over this time-period. In particular, the distribution of completed fertilities became more concentrated and the gender of the first child stopped predicting completed fertility. To explain these facts, I augment the "quality-quantity" model of fertility by explicitly distinguishing between girls and boys. Parents are aware that the gender of their children affects their future life-chances and economic well-being. The gender mix of the existing children thus becomes a state variable in the fertility decision of parents. Over the 20th century, women made significant strides in their economic position relative to men. This improvement affects the fertility decision because it raises the expected return from an additional child ("flow effect") and because it affects the expected return from existing daughters ("stock" effects). The first effect tends to increase fertility, while the second effect, for relatively concave utility functions, tends to decrease it, so that the distribution of completed fertilities becomes more concentrated in line with the data.

# 1 Introduction

After century-long continuous decline (**Figure 1**) the US total fertility rate (TFR) in the 20th century was relatively stable, however the household reproductive behavior continued to evolve even during the periods when stable TFR was recorded. More precisely, although in the US in 1930s and 1970s TFR was about the same, compared to 1930s, in 1970s proportions of women who had very few and very many children during their lifetime decreased implying a reduction in variation of completed fertility (**Figure 4**). Moreover, starting from 1970s, the first-born son stopped to be predictive of fewer children in the household as it was in 1930s. These changes, masked behind constant TFR, are rarely in focus of economic studies. Moreover, most of the models in the macroeconomics literature, which quantify fertility behavior by means of TFR can not explain these aspects of fertility. Yet, the mere fact of those changes implies changes in reproductive behavior of households, which must be explained in order to have reliable fertility models which can be used as a building block for macroeconomic frameworks (e.g. growth models with endogenous fertility) studying the effect of policy actions, demographic forecasting, etc. Thus, this study is aimed at identifying a modeling approach which can capture changes in the reproductive behavior of US women which manifested itself in reduced fertility differentials as well as weakening of the dependency of the number of children in the household on the gender of the first-born child. I show that that allowing a standard fertility model to make an explicit distinction between boys and girls alone can help to capture the above-mentioned two phenomena even in absence of traditional factors such as child mortality, contraceptive use, etc. Such results hint that within this modeling approach we can obtain more refined and reliable results while studying the effect in variation of the traditional fertility factors.

I propose to relax the often-made implicit assumption of the fertility models that all children who survived to adulthood will be employed. More specifically, I allow a fairly standard "quality-quantity" type fertility model where parents derive utility directly from the human capital of children to make an explicit distinction between boys and girls.[1] I

[1] The results are obtained also in Barro-Becker (1988) type model, in which parents derive utility from human capital of children indirectly, through utility functions of their children. The derivations for that model are available upon request.

use the labor force participation rate of married women (FLFP) as the probability of each girl becoming an employed woman while each boy is assumed to become an employed man. In this setup I demonstrate that no ex-ante differences among households are required to generate variation in the completed fertility (differentials), as well as that increases in the FLFP can reduce that variation in a way consistent with the available empirical evidence. Thus, just relaxation of the assumption that all children will be employed adults, alone can explain the existence and main features of the dynamics of the distribution of completed fertilities even if we do not use other important factors such as narrowing of the gender wage gap, the improvements in contraceptive techniques and their proliferation, urbanization, etc.

In my model FLFP is a source of uncertainty in addition to the uncertainty over the gender of the next child. At lower FLFP girls are "risky" assets, so prudent parents whose first-born children are girls tend to have another child hoping that it will be a boy. Those, whose first-born children are boys, abstain from having another child out of "fear" to have a girl whose expected return is small. This behavior is compatible with a phenomena often referred to as son-preferring differential stopping behavior (SP-DSB). As a result of the SP-DSB at lower FLFP girls on average have more siblings. More siblings coupled with lower expected return implies that girls receive less investment in their human capital formation both within and across households. Increase in FLFP affects the household decision through two channels: it affects the expected return from an additional child ("flow effect") as well the return from the existing children if there are girls among them ("stock" effects). If the first effect unambiguously increases fertility the direction of the second one depends on the interaction of opposite mean (expected return) and variance (uncertainty) effects. For relatively concave function it is shown that "stock" effect negatively affects fertility. Thus, the main contribution of the study is that increases in FLFP are shown to generate decrease in within-cohort fertility differentials as well as within-household and country-wide decrease in human capital investment gender gap. This decrease in fertility differentials is consistent with the main features of the distributions of the US women by number of children (women born in 1912-16 and 1946-1950). Particularly at higher FLFP, proportions of both large and small families decrease and the distribution becomes more concentrated.

Different aspects of this study are related to Hazan and Zoabi (2015), Galindev (2011), de la Croix and Doepke (2003), Bar, et al. (2015), Gobbi (2013), Aaronson, Lange and Mazumder (2014), Sah (1991), Kalemli-Ozcan (2003) and Portner (2001). Hazan and Zoabi (2015) discuss co-evolution of gender preferences and gender educational gap. As a by-product of this co-evolution they have variation in family size. The main driving force is increasing return to human capital. At lower return to human capital, families with first-born son end up with the least number of children while those with firs-born daughter(s) with the most. At higher return to human capital son-preference weakens so that households with first-born daughters end up with the same number of children as those with first-born sons. However such reduction in fertility differentials implies the distribution of the completed fertilities collapsing to the left extreme which is a bit different than what we observe for the US where parallel to the reduction in proportion of women with many children there was also a reduction in proportion of single-child and childless women (**Figure 4**). Note also, that this study assumes that all girls will be employed women. Once ex-ante uncertainty over gender of the newborn child is resolved, parents face no uncertainty, so they obtain that the marginal benefit from education is the same for boys and girls in the same family. Thus, there is no within-household gender educational gap, a mismatch with reality admitted by the authors. Contrary to this, in my study even after ex-ante uncertainty of child gender is resolved, there is still uncertainty over how many girls will end up being employed, which generates within-family gender educational differentials. Moreover, unlike the model in Hazan and Zoabi (2015), it also captures the reduction in proportion of single-child and childless women.

De la Croix and Doepke (2003) within "quality-quantity" trade-off framework find that income fertility differentials may decrease, Bar, et al. (2015) find that they may increase. Galindev (2011) argues that observed similarity in fertility patterns between high and low income households potentially can be explained by "conventional leisure goods becoming less luxury." However all of these studies envisage that when fertility differentials change, TFR will change too,often due to changes in the right-tail of fertility distribution as in Hazan and Zoabi (2015). Additionally, it is unclear whether people at lower extreme of **Figure 4** were always richer while those at higher extreme were poorer.

Gobbi (2013) discusses the changes in the left-tail of fertility distribution by focusing on the dynamics of the childless of US women. In her study the initial high levels of childlessness are explained by health and nutritional factors making childlessness involuntary. Increases in living standards and advances in medicine reduced the involuntary childlessness, however later developments (like growth in female wages) allowed voluntary childlessness to increase. Aaronson, Lange and Mazumder (2014) study the effects of the program aimed at reduction of education costs on the fertility behavior of the black population in US both on extensive and intensive margins. They find that proportion of childless women who were in child-bearing years decreased, while for those women who benefited from the program as children increased. The reduction in childlessness is explained by the "essential complementarity," meaning that to gain from the reduced cost of education, adults must have at least one child. Similar phenomenon is found in this study when analyzing the behavior of voluntary childless households.

The gender differentiation of children requires discrete choice models. In the fertility model where parents derive utility from the total income of children and FLFP is the probability with which each of the girls will be employed, FLFP is similar to child "survivability." This makes it possible to use theoretical results developed for the models with child mortality/survivability rates and compare prediction of the models. The discrete choice model in human fertility decision making in presence of risk of child mortality was introduced by Sah (1991). The main conclusion of Sah (1991) is that increase in child survivability reduces fertility. Kalemli-Ozcan (2003) uses fertility model (with logarithmic utility function) with parents deriving utility from total income of children. It is shown that increases in child survivability reduce fertility. Portner (2001) in a similar setting, with no strict restrictions on the form of the utility function, shows that increase in survivability is more likely to reduce fertility. Similar result, under the name of the "stock" effect is found in my study as the driving force of changes in the right-tail of fertility distribution.

The rest of paper is organized as follows. Section 2 documents empirical evidence on within-cohort fertility differentials, son-preferring differential stopping behavior and increased

FLFP. Section 3 presents the structure of the model. In Section 4 I study the effects of changing FLFP on fertility stopping decision of the households and its effect on distribution of women by number of children. In Section 5 I present a numerical exercise to visualize the effect of fertility stopping rules on the distribution of women by number of children and compare them to the empirical evidence. Section 6 concludes. The proofs are found in the Appendix.

## 2 Demographic trends

The objective of this section is to explore other-than-TFR measures of fertility, namely the distribution of women by number of children they ever had and the dependency of fertility stopping rule on the gender of children. It is shown that despite similar means, US fertility distribution in 1970s was more concentrated than in 1930s. In addition, I present empirical evidence that households in 1930s, unlike 1970s, exhibited son-preference. This section also documents significant increase in FLFP of married women between 1930s and 1970s.

### 2.1 Within-cohort fertility differentials

The TFR in the US was decreasing starting from the beginning of the 19th century (**Figure 1**). If in the beginning of 1800s the TFR was around 7 children (for white women, for black women it was a bit more), it was around 2 children at the beginning of the second quarter of the 20th century (**Figure 2**, **Figure 3**). After a brief period of an increase ("Baby Boom"), it returned to 2 children ("Baby Bust") and stayed around that number for the last 30 years. The periods of interest for this study is 1930s and 1970s when TFR was about 2 children.

For these periods consider another indicator of fertility behavior: the distribution of women by number of children (completed fertilities). **Figure 4** depicts the distribution of women by number of children ever born for the US women aged 45-49 born in 1912-1916 and 1946-1950. No matter how similar was average fertility (TFR) for these cohorts, their fertility behaviors (fertility stopping rules) differed significantly. In the earlier cohort some 60 percent of women had 1-3 children, less than a quarter of women had exactly 2 children and some 20 percent of women had more than 4 children, thus making average fertility a weak predictor of the completed fertility for a given mother. Women of the later cohorts are more homogeneous in their fertility behavior and almost 70 percent of women had 1-3 children, more than 35 percent had exactly two children and large families became much rarer. Note however, that the proportion of childless women, as well as women who had just one child in their lifetime decreased too. Overall the standard deviation of a completed fertility around TFR decreased from 1.9 to 1.4 so that the distribution became more concentrated around 2 children.

### 2.2 Empirical evidence of son-preferring differential stopping behavior

Childbearing by its nature is a consecutive decision making process. There is some evidence that the decision to have another child depends on the gender of the existing children in the household. In particular, the US households which at lower parity (first, second, third child) had a boy were much less likely to have another child. For example McDougal (1999) cites a number of 1970s US studies that show that boys were preferred as first or only child and more boys in the family were preferred too.

Dahl and Moretti (2008) have more thorough empirical study of the probability of progression to another child conditional on having girls versus having boys. They used 1940-2000 US Censuses and found that households whose first two, three, four children are girls have higher probability of having another child than those with two, three or four boys (gender effect). The gender effect was stronger for women aged 20-30 born in 1950s than for those born in 1970s. However women born earlier than 1940s seemed to have a weaker gender effect. Note that they only report the effect in case of two girls versus two boys. A potential explanation of weaker gender effect for the earlier cohorts may lie in the fact that earlier cohorts tended to have more children on average. If a household no matter what wants to have on average three children, one should expect weak gender effect for the first two children. This idea is supported in Dahl and Moretti (2008) by the fact that in developing countries where average fertility is much higher than in US, the gender effect gets stronger at higher parities. To get a better picture over time, ideally one may need to have longer time-span data to identify women born in the early 20th century, but the only data available for US which goes back in time to that extent is the Census and it unfortunately reports only children residing with families. If one chooses women above age 40 with a hope of having only those who are close to finishing their fertility cycle, there is a risk that some children left the household.

The Current Population Survey (CPS) fertility supplement can be used to cope with this problem. Supplements do not have complete fertility record, as they report gender of only first four children and the last child. However as shown in Rosenblum (2013) the gender of the first child (in absence of gender-selective abortions practiced at the first birth) can be a used to test the presence of the son-preferring fertility stopping rule (SP-DSB). The data is available only for 1990 and 1995 and fertility information is recorded only for those who were below the age of 66. Thus from 1990 I select women who are married, aged 60-65, who obviously finished childbearing, and have at least one child. From the 1995 sample I choose married woman who are between 45 and 50 years old. Additionally, to ensure that they finished childbearing, I choose those who stated that they do not intend to have additional children. Thus, the first cohort of women were having children in mid-1940s and mid-1950s while the second cohort were having children in 1970s. Having married women is important as dissolution of marriage or loss of a spouse can potentially destroy childbearing plans of a women for variety of reasons (like the cultural stigma of having children out of wedlock or the deterioration of financial situation because of staying single, etc.).

The following equation tests the presence of son-preferring fertility stopping rule

$$y_i = \alpha + \gamma X_i + \tau Z_i + u_i, \tag{1}$$

where $y_i$ is the number of live births, $X_i$ is a vector of variables which includes race, age at first birth, labor market status; $Z_i$ is an indicator variable of a first-born male child. Results of the regression (1) are in the **Table 1** and the **Table 2**. It is clear that women of the earlier cohort had fewer children if the first child was a boy. The OLS estimates (**Table 1**) indicate that women with a male first-born had 0.2 fewer children. For comparison, Rosenblum (2013) obtains 0.35 fewer child for India where son-preference is well-documented. The Poisson regression estimates (**Table 2**) indicate approximately 5 percent fewer children. The effect is statistically significant. Moreover, the effect of the first-born child's gender for the later cohort is negative but has a smaller magnitude and is not statistically significant. Being limited only to 1990 and 1995 the data allows me to go back no further than the 1925-1930 cohort, which is some 15-20 years later than the earlier cohort in **Figure 4**. But even this is enough to see that smaller gender effect for pre-1940s cohorts in Dahl and Morreti (2008) can be due to the problems with the data discussed above. To sum up, there is empirical evidence that early cohorts of US households exhibited son-preferring fertility stopping behavior. For the later cohorts, there is weak, if any, evidence for such fertility behavior.

### 2.3 Evolution of the labor force participation of the married women over time

The 20th century saw also significant changes in the composition of the workforce in the US (**Figure 5**) and other developed nations. An important phenomenon was the emergence of the married working women. Women were employed at the formal labor market throughout 19th century in quite large numbers, but these were mostly unmarried women. After marriage most of these employed women used to leave labor market. However from the early 20th century that trend started to change. As shown in **Figure 5,** the proportion of married women in labor force (FLFP) constantly rose during all of 20th century. If in the 1900s less than 5 percent were in the labor force, by 1990s this number rose to about 70 percent.

## 3 The Model

### 3.1 Preferences

I study the effects of increased FLFP on the example of a fertility model whose variation can be found in Galor and Weil (2000), de la Croix and Doepke (2003), Kalemli-Ozcan (2013), Hazan and Zoabi (20015), etc. The society consists of a continuum of identical households uniformly distributed on the unit interval. A household consists of a male and a female who jointly behave as one economic agent, and make decisions on having children and investment in human capital formation of children. A household derives utility from own consumption and from the total income of its children. This means that parents derive utility only from children who will be employed. All boys are assumed to become an employed adult. Each of the girl's probability of being employed is given by the current FLFP rate (in this model it is the best estimate of that probability in future). Altruistic parents enjoy children even if they are not employed. But there is no reason why this "pure" enjoyment of having an offspring should be different between sexes and it can be normalized to be 0.

As all girls have the same probability of being an employed woman, the expected number of employed girls is characterized by a binomial distribution so the household's expected utility function[2] is

$$U\left(c, e_b, e_g, b, g\right) = u\left(c\right) + \psi \sum_{i=0}^{g} \alpha^i \begin{pmatrix} g \\ i \end{pmatrix} \left(1-\alpha\right)^{g-i} v\left(b e_b^{\gamma} w + i e_g^{\gamma} w\right), \tag{2}$$

where $u\left(.\right)$ and $v\left(.\right)$ are twice differentiable concave functions. The $c$ is the lifetime consumption, $b$ is the number of boys in the household, each of whom gets $e_b$ of household resources invested in human capital formation, $g$ is number of girls in the household each of whom gets $e_g$ of household resources invested in human capital formation, $\psi$ is level of parental altruism. Child's human capital formation function is $H_k = e_k^{\gamma}$, where $k = \{b\,,\, g\}$, $0 < \gamma < 1$ and wage per unit of human capital is $w$. FLFP is probability of a girl becoming an employed women and is denoted by $\alpha$. The budget constraint is

$$c + b e_b + g e_g = y\left(1 - p\left(b+g\right)\right). \tag{3}$$

The household is endowed with unit of time which can earn income $y$. The $p \in (0,\, 1)$ is the fixed time cost of having a child. Presence of $p$ is crucial, otherwise households can continue having children until they get required number of boys, and a household with for example 3 boys will be equivalent to a household with 3 boys and any number of girls. I assume that unlike cost of having a child ($p$) the cost of education is in terms of consumption goods. However the the nature of costs of child-bearing and education do not play any significant role in this model as $\alpha$ does not enter $u\left(.\right)$, so the results hold if any of these costs or both are in terms of parental time or consumption goods.

[2]For example the expected utility from having 3 boys and 2 girls is $2\alpha\left(1-\alpha\right) v\left(3e_b^{\gamma} w + e_g^{\gamma} w\right) + \left(1-\alpha\right)^2 v\left(3e_b^{\gamma} w\right) + \alpha^2 v\left(3e_b^{\gamma} w + 2e_g^{\gamma} w\right)$ as it may be that just one of the girls will be employed and that can be any of the girls, none of the girls will be employed or both will be employed.

### 3.2 Description of the household's problem

The household follows a two-stage utility maximization procedure. In the first stage, for any number of boys and girls $(b,\ g)$, it determines how much investment will be made into the human capital of each boy and each girl. It is done by maximizing (2) subject to constraint (3) for each possible pair of $(b,\ g)$. In the second stage, given the human capital investment plan at every possible gender outcome of each consecutive pregnancy, the household develops a fertility stopping rule. At any possible $(b,\ g)$, if the household decides to have a child, with equal probability it will have $(b+1,\ g)$ or $(b,\ g+1)$ children. Let $V(b,g)$ stand for maximized utility $U(c, e_b, e_g, b, g)$ for a given $(b,\ g)$. The household will find it optimal to have another child only if the expected utility from having a child is more than staying with current number of children $(b,\ g)$; that is marginal utility from having another child $MU$ (4) must be positive. So at the moment the household starts having children it already has the complete plan of action regarding educational and fertility choices.

$$MU = 0.5V(b+1,g) + 0.5V(b,g+1) - V(b,g)\,. \tag{4}$$

Note that I have two sources of uncertainty: one comes from the fact that the gender outcome of the pregnancy is ex-ante unknown and the other comes from the fact that at the moment of educational and fertility decision making labor market status of each girl is unknown. This second source of uncertainty is incorporated in the expected utility function similar to incorporation of child survivability in studies like Sah (1991), Porter (2001), Kalemli-Ozcan (2003). Thus, the utility function used in this study is a combination of a utility function which has uncertainty over child gender and a utility function which has uncertainty over the "survivability" of children.

### 3.3 Son-preferring differential stopping behavior

The fact that at FLFP$<$1 not all girls may end up being employed women implies household whose first-born children are girls will tend to have another child hoping it will be a boy. To see this in a simple setup assume exogenous human capital case where each child is born with a unit of human capital which earns $w = 1$. Assume further a households A which has $(b+1,\, g)$ children and a household B which has $(b,\, g+1)$ children. The marginal utilities from having another child for these households at extremely low FLFP (I consider the case of $\alpha = 0$) are[3]

$$MU_A(b+1,g) = u(y(1-(b+g+2)p)) - u(y(1-(b+g+1)p)) + 0.5\psi(v(b+2) - v(b+1)),$$

$$MU_B(b,g+1) = u(y(1-(b+g+2)p)) - u(y(1-(b+g+1)p)) + 0.5\psi(v(b+1) - v(b)).$$

As $MU_A(b+1,g) < MU_B(b,g+1)$, even in case of $MU_A(b+1,g) = 0$ (utility maximizing fertility achieved) the household B will have another child as $MU(b,g+1) > 0$, so the household B will exhibit SP-DSB. Thus, even if we have ex-ante identical households, at low levels of FLFP households A and B will end up with different levels of completed fertility simply because at low FLFP they will exhibit SP-DSB and child gender determination is a stochastic process.

## 4 Effect of FLFP on the Decision Making of Households

In this section I study the effect of changing FLFP on household decision making. First I show how a change in FLFP affects fertility decision of the voluntary childless households. Then I move to the general setup and present the effect of changing FLFP on the first (education) and the second (fertility) steps of household utility maximization problem. As fertility reaction to changed FLFP in general case is ambiguous, subsections 4.5 and 4.6 study the households optimization problem in special cases: household has only boys and household has only girls. The effect of FLFP on household decision making in those special cases allows to understand what happened to the tails of the distribution of women by number of children observed in **Figure 4**.

[3] Fertility stopping rules for endogenous human capital case for all values of FLFP are presented in the section 5.

### 4.1 Marginal Households

Before turning towards the study of the effect of changed FLFP I need to define the Marginal Households. The effect of changed FLFP will be studied chiefly on the change in behavior of those households. The Marginal Household $MH$ $(b,\ g,\ \alpha_0)$ is a household which at a given number of children $(b,\ g)$ and FLFP $(\alpha_0)$ is indifferent between having another child or abstaining from having it—that is the $MU$ (5) is zero.

### 4.2 Changes in education and fertility choices for those households which at lower FLFP decided to stay childless

I start the study of the household behavior for those households which at lower FLFP decide to stay childless. Unlike the general case of a household which has $b$ boys and $g$ girls, in this simple case the effect of FLFP on education and fertility decision is mathematically tractable.

A household chooses to have a child if $MU$ (5) from having the first child is positive (for simplicity in all of the Section 4 the measure of parental altruism $\psi$ is assumed to be 1).

$$MU = 0.5\left(u\left(y\left(1-p\right)-e_b\right)+v\left(e_b^{\gamma}\right)\right)+0.5\left(u\left(y\left(1-p\right)-e_g\right)+\alpha v\left(e_g^{\gamma}\right)\right)-u\left(y\right). \qquad (5)$$

**Proposition 1.** In an environment with $\alpha_1$ such that $\alpha_1 > \alpha_0$ the $MH$ $(0,\ 0,\ \alpha_0)$ will definitely have another child as $MU$ (5) will be positive.

**Proof:** See Appendix A-1.

This result is similar to the "essential complementarity" discussed in Aaronson, Lange and Mazumder (2014). To gain from increased FLFP parents must have at least one child. Note that that a decrease in proportion of childless women is clearly observed in **Figure 4** where the later cohort contains 5 percentage points fewer childless women than the earlier cohort.

### 4.3 Change in the education decision for a household with an arbitrary number of boys and girls

Starting from this subsection, to facilitate analytical derivations, all results are obtained assuming logarithmic $u(.)$ and $v(.)$ functions.

Let us take a household with an arbitrary number of boys and girls $(b,\ g)$.

Substituting

$$c = y\left(1-(b+g)\,p\right) - be_b - ge_g$$

and

$$E\left[v\left(e_b, e_g, b, g\right)\right] = \sum_{i=0}^{g} \alpha^i \left(\begin{array}{c} g \\ i \end{array}\right) (1-\alpha)^{g-i}\, v\left(be_b^{\gamma}w + ie_g^{\gamma}w\right),$$

the FOC for investments in human capital are

$$e_g:\ u_{e_g}(e_b, e_g, b, g) + E\left[v_{e_g}\left(e_b, e_g, b, g\right)\right] = 0 \tag{6}$$

$$e_b:\ u_{e_b}(e_b, e_g, b, g) + E\left[v_{e_b}\left(e_b, e_g b, g\right)\right] = 0. \tag{7}$$

To know how the investment in human capital changes when FLFP changes I take the full derivative of (6) and (7) with respect to $\alpha$ which allows to establish the following proposition:

**Proposition 2.** For a given number of boys and girls $(b,\ g)$, $\partial e_b/\partial\alpha < 0$ and $\partial e_g/\partial\alpha > 0$.

**Proof:** See Appendix A-2.

Within a household, the increase in FLFP makes parents to relocate some of the resources from boys to girls. The intuition is simple: the human capital function is concave. At higher FLFP, investment in girls becomes less risky, the expected marginal return from education increases so investment in girls becomes more attractive. Obviously, when FLFP is 1 boys and girls are identical "assets" and all children regardless of gender will receive the same education. The same result is obtained numerically for relatively concave utility functions.

### 4.4 Change in fertility decision: the "stock" and "flow" effects

The effect of FLFP on investment in human capital of boys and girls is not hard to predict. In the extreme case of FLFP is 0, it is clear that no investment is made into the human capital of girls, while at FLFP is 1 boys and girls, being identical, are treated equally. The previous section helped to determine the trajectories at which investments in human capital for boys and girls will converge when FLFP increases.

To study the effect of increased FLFP on the decision to have another child assume that at arbitrary $\alpha = \alpha_0$ there is a $MH$ $(b,\ g,\ \alpha_0)$. My goal is to see whether this household definitely will or will not have another child in case it appears in an environment with $\alpha = \alpha_1$ such that $\alpha_1 > \alpha_0$. To do it I totally differentiate $MU$ (4) with respect to $\alpha$. Obviously, if the derivative of the marginal utility with respect to $\alpha$ ($MU_\alpha$) is positive the household will have an additional child while if it is negative the household will abstain from having another child. As $V(b+1,g)$, $V(b,g+1)$ and $V(b,g)$ are all utilities maximized by optimal level of investment in human capital of boys and girls, the Envelope Theorem states that change in marginal utility is equal to the direct effect of FLFP on the marginal utility function which is the expression (8)

$$\begin{gathered}MU_\alpha = 0.5\left(\partial E\left[v\left(e_b\left(b+1,g,\alpha_0\right),e_g\left(b+1,g,\alpha_0\right),b+1,g\right)\right]/\partial\alpha\right) - \\ -0.5\left(\partial E\left[v\left(e_b\left(b,g,\alpha_0\right),e_g\left(b,g,\alpha_0\right),b,g\right)\right]/\partial\alpha\right) + \\ +0.5\left(\partial E\left[v\left(e\left(b,g+1,\alpha_0\right),e_g\left(b,g+1,\alpha_0\right),b,g+1\right)\right]/\partial\alpha\right) - \\ -0.5\left(\partial E\left[v\left(e\left(b,g,\alpha_0\right),e_g\left(b,g,\alpha_0\right),b,g\right)\right]/\partial\alpha\right) \lesseqgtr 0,\end{gathered} \tag{8}$$

where $e_b(b+1,g,\alpha_0)$, $e_g(b+1,g,\alpha_0)$, $e_b(b,g+1,\alpha_0)$, $e_g(b,g+1,\alpha_0)$, $e_b(b,g,\alpha_0)$ and $e_g(b,g,\alpha_0)$ are optimal levels of investment in human capital for a household with $(b+1,\ g)$, $(b,\ g+1)$ and $(b,\ g)$ children at $\alpha = \alpha_0$ (see Appendix A-3 for details of the expression (8)). Unfortunately the sign of the expression (8) is hard to identify. One may think that different levels of education are behind the ambiguity of the expression (8). However, even in case of exogenous human capital (see Appendix A-4) the sign of the expression (8) is still ambiguous.

I identify two effects which can intuitively explain why we have ambiguous results. These effects are themselves complex interaction of certain phenomena, and I can separate these effects based on different directions they move the $MU_\alpha$. Intuitively I call them "flow" and "stock" effects. Increasing FLFP makes "flow" of utility from an additional child bigger so I call this the "flow effect". On the other hand, if the household already has girls, a change in FLFP will affect each girl, increasing the expected "stock" of utility from the existing "portfolio" of children so I call this the "stock effect." Note that the "stock effect" is bigger when a household has more girls. If we imagine this situation on a simplistic 2 dimensional graph, it will be the additional increased utility is added on the top of the increased existing utility. In case of concave utility function this implies increased or decreased marginal utility from having another child depending on the relative strength of each effects. What I propose is to consider two polar cases where only one of the effects will be present to see in which direction they move the $MU_{\alpha}$. So below I present the case of a household which has only boys, and the case of a household which has only girls.

### 4.5 Case 1: A household with only boys

To start, assume there is a household that has $b$ boys and is considering to have another child. In case the child is known to be a boy, the marginal utility from that child does not depend on FLFP, thus change in FLFP has no effect on decision to have another child or not. The "flow" effect is illustrated when this household knows that the next child will be a girl, as change in FLFP affects only that girl. In that case marginal utility from that additional girl is (9)

$$MU = V(b, 1) - V(b, 0). \tag{9}$$

**Intermediate result 1.** In an environment with higher FLFP, a household with $b$ boys has more incentives to have another child.

**Proof:** Appendix A-5.

This is due to $MU_{\alpha} > 0$. As the existing "stock" of children is not affected, only expected gain from an additional child increases while the marginal cost of having that child stays the same. This is what we have referred to as "flow effect". The same result holds true for the case with exogenous human capital of children (Appendix A-6) indicating that education is not the main driving force behind this result.

What if the gender of the next child is unknown? As described in subsection 4.4 the marginal utility from another child whose gender is unknown is just an average of marginal utilities from having a boy and a girl (10)

$$0.5\left(V\left(b+1,0\right)-V\left(b,0\right)\right)+0.5\left(V\left(b,1\right)-V\left(b,0\right)\right). \tag{10}$$

**Proposition** 3. In an environment with $\alpha_1$ such that $\alpha_1 > \alpha_0$ the $MH$ $(b, 0, \alpha_0)$ will definitely have another child as the $MU$ (10) will be positive.

**Proof.** The additive nature of the $MU$ (10) allows to look at the $MU_\alpha$ as a sum of derivatives of the marginal utility from the Intermediate result 1 and $MU$ of a household whose next child is surely a boy. In an environment with higher FLFP the $MU$ (10) of the $MH$ $(b, 0, \alpha_0)$ will be positive number at higher FLFP $(\alpha_1)$. This is due to fact that the derivative of marginal utility from having a boy is zero and, from the Intermediate result 1, the derivative of marginal utility from having a girl is positive.

### 4.6 Case 2: A household with only girls

Another special case is when a household has $g$ girls and consider having another child. Assume that it knows that the next child will be a boy. Here only the "stock" effect is in place as FLFP does not affect additional utility generated by this boy. The marginal utility from having a boy for this household is

$$MU=V\left(1,g\right)-V\left(0,g\right). \tag{11}$$

**Intermediate result 2.** In an environment with higher FLFP, a household with $g$ girls has less incentives to have the expected boy.

**Proof:** see Appendix A-7.

This is because the $MU$ (11) is decreasing function of FLFP ($MU_\alpha < 0$). It is tempting to think that once FLFP increases, the investment in human capital of girls becomes more valuable, so that the household decides to abstain from having another child in order to invest more in each girl. However this is not the case. Even in the case of exogenous human capital of children this result holds, and parents abstain from having another child (see Appendix

A-9). The observed phenomenon reflects the "prudence" of the household (see for instance Leland (1968)). An increase in FLFP means that the expected return and variance of that return change. This is due to the fact that in case of binomial distribution of the return on assets (children) the FLFP affects both the mean and the variance of the distribution. Due to the logarithmic utility function income and substitution effects caused by increased return cancel each other leaving only the effect of the changed variance, that is changed uncertainty. If FLFP is low, household will engage in precautionary saving, i.e. will have many children. As uncertainty over the number of employed girls decreases with higher FLFP, the household reduces its precautionary demand for children.

The same "prudence" is at work in another case, when a household with $g$ girls considers having another child and it is known to be a girl.

**Intermediate result 3.** In an environment with higher FLFP, a household with $g$ girls has less incentives to have the expected girl.

**Proof.** Appendix A-8.

This is because the $MU$ (11) is decreasing function of FLFP ($MU_\alpha < 0$). Note that the model with exogenous human capital of children delivers the same result[4]. As was mentioned before the FLFP is employed in the model as child survivability/mortality is employed in many fertility models making results comparable across the models. More specifically, when an all-girl household knows it will have a girl, my model is similar to the model developed by Kalemli-Ozcan (2003). Kalemli-Ozcan show that the increase in child survivability rate reduces marginal utility from another child implying reduction in fertility which is shown to be caused by a reduction in the precautionary demand for children. Similar is also a study by Portner (2001) where marginal utility (with no restriction on the form of the utility function) from another child is more likely to be decreasing in child survivability the more risk averse are parents and more positive is the third derivative (prudence). Additionally, Rosati (1996) states that increase in variance of the infant mortality rate increases demand for children.

Now assume there is a household with $g$ girls which considers having another child whose gender is ex-ante unknown. Given the stochastic nature of child gender determination the

[4]This case also allows to show analytically that in case of CRRA utility function with coefficient of risk aversion less than 1 the change in marginal utility, when FLFP increases, may be positive (Appendix A-9).

two states of the world are possible. In one of them the next child is a boy and in another it is a girl. Obviously marginal utility from having that child is the expected utility from having a child (equal-weighted sum of the utilities in two states of the world) minus current utility (12)

$$MU = 0.5\left(V\left(1,g\right) - V\left(0,g\right)\right) + 0.5\left(V\left(0,g+1\right) - V\left(0,g\right)\right). \tag{12}$$

**Proposition** 4. In an environment with $\alpha_1$ such that $\alpha_1 > \alpha_0$ the $MH$ (0, $g$, $\alpha_0$) will definitely abstain from having another child as $MU$ (12) will be negative.

**Proof.** The additive nature of the $MU$ (12) allows to look at the $MU_\alpha$ as sum of derivatives of marginal utility from the Intermediate results 2 and 3. The Intermediate result 2 states that for those who have only girls and the next child is a boy, increase in FLFP has negative effect on the marginal utility. The Intermediate result 3 states that if the next child is a girl, the change in marginal utility is negative too so that the $MU$ (12) of the $MH$ (0, $g$, $\alpha_0$) is negative for higher FLFP ($\alpha_1$).

### 4.7 Changes in the distribution of women by number of children

The study of the all-boy and all-girl household polar cases in subsections 4.4 and 4.5 is important for us to understand the concentration of the distribution of women by number of children we observe in the **Figure 4**. As it was stated earlier, low fertility households tended to be all-boys households or ones where the first-born children were boys while households with larger families tended to be all-girls households or ones where girls were the first-born children. Thus, from the Case 1 and Case 2 we can conclude that as FLFP increases, households on one extreme (few children) increase their fertility, while households on the other extreme (many children) decrease their fertility so that the distribution becomes more concentrated.

It is reasonable to conjecture that households with children of both genders will resemble the behavior of households in Case 1 and Case 2 depending on relative number of boys and girls in the household. This is an important feature of this study. The fertility stopping rules depend not only on the number of children, but also on the fertility history (gender mix of children) in the household. This is why $MU_{\alpha}$ is ambiguous in subsection 4.3 for a general case of a household with $b$ boys and $g$ girls.

To verify the conjecture on the behavior of household with an arbitrary number of boys and girls as well as to illustrate the evolution of the fertility stopping rules as FLFP increases I conduct a numerical exercise.

# 5 Numerical Exercise

## 5.1 Parameters

I assume two types of households. In Type I households female is in labor force, while in Type II households female is not in the labor force. The FLFP is the proportion of Type I households in the society. The expected utility functions used in the numerical exercise are (13) for Type I and (14) for Type II.

$$\begin{aligned} U_I = {} & u\left(\left(y_m - (b+g)\,p - be_b - ge_g\right) + y_f\left(1 - z\,(b+g)\right)\right) + \\ & +\psi \sum_{i=0}^{g} \alpha^i \binom{g}{i} (1-\alpha)^{g-i}\, v\left(b\,(e_b)^{\gamma}\, w + i\,(e_g)^{\gamma}\, w\right) \end{aligned} \tag{13}$$

$$\begin{aligned} U_{II} = {} & u\left(\left(y_m - (b+g)\,p - be_b - ge_g\right)\right) + \\ & +\psi \sum_{i=0}^{g} \alpha^i \binom{g}{i} (1-\alpha)^{g-i}\, v\left(b\,(e_b)^{\gamma}\, w + i\,(e_g)^{\gamma}\, w\right) \end{aligned} \tag{14}$$

The $u(.)$ and $v(.)$ functions are of CRRA type with coefficient of relative risk aversion equal to 0.5. The $y_m$ and $y_f$ are male and female lifetime earnings. The cost of child $p$, investment in human capital $e_b$ and $e_g$ are all in terms of goods which are paid either from from the total income of the households. Note that I assume fixed cost of a child in terms of goods. This is done due to the fact that now we make a distinction between male and female adult members of the household. If the household is Type II, than the female adult is not in the labor market, so that having a child does not reduce supply work-time of the male, but children still require some fixed costs in terms of goods, so even Type II household faces some costs from childbearing. In addition to the fixed cost of $p$ in Type I household each child comes with an additional cost of $z$ which is a fraction of the female's lifetime income forgone due to having a child. Echevarria and Merlo (1999) estimate that in Canada raising a child costs women a 0.05 of her lifetime income, while in de la Croix and Doepke (2003) cost of a child is estimated to be 0.075 of the lifetime income and gender wage gap is 0.8 for US. I stay close to these numbers and assume $p = 0.05$ and the rest being expenses on education. The opportunity cost of having a child is assumed to be $z = 0.05$, that is if we assume that a women works for 40 years, with every child she loses approximately 2 years of earnings. Lifetime earnings of a male are normalized to 1 and given that there was always a wage gender gap, female lifetime income is assumed to be 70% ($y_f$) of male income. The $\gamma$ of the human capital accumulation function is assumed to be 0.5 as in Hazan and Zoabi (2015). The altruism parameter $\psi$ is set to be equal to 0.25 to get an average fertility rate around 2 which was TFR observed in 1930s when FLFP rate was around 0.2.

### 5.2 Fertility stopping rules and resulting distribution of women by number of children

**Figure 3** and **Figure 4** depict the fertility stopping rules for Type I (13) and Type II (14) households. At very low FLFP fertility stopping rule of both types is the extreme case of the SP-DSB and is described quite simply as: "have children until the first boy". The desire to have a boy is expected as at FLFP return from having a girl is minimal thus parents with only girls desperately want to have the boy. What is less expected is that households stop having children as soon as they have a boy. However in this model that behavior is reasonable, as if a household has a boy, it is "lucky" and does not want to risk to have another child which may turn to be a girl. The existence of this phenomenon is mentioned in McClelland (1979) who state that the fear of having an additional child of an undesired gender may force women to abstain from having another child even if the current gender composition of children is not desirable. This is because such household has equal chances of getting desired gender composition of children or further worsening it by having a child of undesired gender.

As FLFP increases a bit, household with large number of children start to disappear. At higher FLFP girls become more desirable, or rather more "acceptable". Not so much "acceptable" to make a parent with a boy to risk having another child, but "acceptable" enough for a household with 7 or 8 or 9, etc. girls to stop attempting to have a boy. At FLFP equal to 0.6 "lucky" Type I household whose first child is a boy will risk having another child while "lucky" Type II household will risk having another child at $\alpha = 0.4$. On other hand those with girls, who previously desperately wanted to have at least one boy, will get more satisfaction from having girls and will not engage in "child gamble" accumulating many girls. This is consistent with the conjecture of subsection 4.6 that the marginal benefit from an additional child increases if the household has few girls and decreases if opposite is true, which is stipulated by interaction of the "flow" and the "stock" effects. Note that at $\alpha = 1$ all households have the same number of children, this is because at $\alpha = 1$ boys and girls become completely identical so that fertility stopping rule stops to be fertility history dependent. The model is developed in a way that it does not generate childless households, however it was shown that increase in FLFP will induce childless households to have at least one child (extensive margin).

**Figure 6** depicts the economy-wide distribution of women by number of children resulting from the fertility stopping rules for Type I and Type II households. Although each generation of households in the model are ex-ante identical, the model generates heterogeneous childbearing histories resulting in fertility differentials. Distributions presented in **Figure 6** are for FLFP of 0.2 and 0.5 which are approximately the values of FLFP recorded during the reproductive lifetime of the cohorts of **Figure 4**. As in its empirical counterpart, early cohorts in **Figure 6** have larger fertility differentials. For the later cohort, differentials are smaller, the distribution lost mass on the left and right tails and became more concentrated around 2 children which is also observed in the **Figure 4**. The model transition from one distribution to another is depicted in the **Figure 8** and follows the general pattern observed empirically in the **Figure 7**.

### 5.3 Robustness of the results

For curvature parameter (coefficient of relative risk aversion) close to 1, that is closer to the logarithmic utility function, the household behavior is consistent with the baseline results, however they are sharper. At low FLFP, the SP-DSB is observed as in the baseline case, generating dispersed distribution. At higher FLFP, the SP-DSB virtually disappears: due to "flow" effect all-boy households increase their completed fertility, and all-girl households reduce it due to "stock" effect. These results are well predicted by the model where most of the results are derived for logarithmic case. However, for curvature parameter close to 0, the behavior changes. At lower FLFP the SP-DSB is still observed as households are risk averse and given the high levels of uncertainty are ready to "accumulate" girls. Unlike more concave cases, at higher FLFP the "stock" effect does not necessary dominates the "flow" effect so for some values of parameters all-girl household may decrease than increase, increase or keep unchanged fertility. However, as expected all-boy households increase fertility as they are affected only by the "flow" effect. The variation of the effect of increased FLFP on all-girls households is due to the fact that income and substitution effects coming from increased FLFP do not cancel each other as in the logarithmic case and there is a complex interaction between them. This interaction is further complicated by the presence of the opportunity to invest in the human capital of children. This opportunity certainly plays a role as for example in the exogenous human capital case—the "flow" effect dominates "stock" effect at any level of FLFP. Note that, in case of almost flat utility function, the distribution of women by number of children instead of becoming more concentrated moves towards the right extreme and the average fertility increases.

### 5.4 Results on education

Although it is shown that in the presence of endogenous human capital does not change the main results, it is still interesting to note what happens to the investment into human capital of children in the model. As expected at extremely low FLFP average investment in girl's human capital is minimal, while boys get much more (almost 33 times more investment). This is true for both Type I and Type II households. The majority of girls are born with many siblings, thus in addition to small investment due to low expected return from girl's human capital, households with girls also have more children and spread available resources over more children. As FLFP increases the average investment in boys human capital decreases while investment in girls' human capital increases. This continues until $\alpha = 1$ where the average investment in human capital is identical for both genders. **Figure 9** depicts the evolution of children's human capital investment in the society consisting of Type I and Type II households.

## 6 Conclusion

This study is a contribution to a growing literature in demographic economics which focuses on alternative measures of human fertility behavior. In this paper I study the changes of household behavior which are expressed in reduction of variation in completed fertility and intensity of son-preference that took place in the US between 1930s and 1970s. Note that in 1930s and 1970s despite change in variance, the mean of the fertility distribution was almost the same, thus models built with a focus on average number of children per women (TFR) can not capture these changes. To explain these facts, I suggest to allow the model to make a distinction between boys and girls. In an environment where probability of becoming adult is much lower for girls than for boys, I show that households demonstrate son-preferring bias. Due to that bias, even ex-ante identical households will end up with different number of children, hence we will observe significant variation in completed fertility. Increases in chances of the girls to be an employed adult weaken the son-preference which results in reduced variation in completed fertility.

The intuition behind those results is based on the fact that change in the likelihood of daughter's employment produces two effects. The "flow" effect comes from the fact that the next child has a higher expected return inducing increases in fertility of the "prudent" parents. The "stock " effect comes from the fact that each girl becomes more "valuable" and less risky and this reduces fertility of the "prudent" parents. The relative strength of each effect depends on the gender composition in the household. For households with few girls the "flow" effect is stronger while for households with many girls the "stock" effect is stronger. As a result, large households, which due to the son-preference at low FLFP were more likely to be all-girl, at higher FLFP would reduce their completed fertility while small households, which at low FLFP were more likely to be all-boy, would increase it. Thus, at higher FLFP the distribution becomes more concentrated. Note that presence of the "flow" and the "stock" effects can either increase or decrease the TFR during transition to more concentrated distribution. For the US these effects seemed to cancel each other leaving TFR around 2 children.

This study demonstrates that allowing the model to make a distinction between boys and girl, alone can help to explain existence of differentials in completed fertility and replicate main features of evolution of those differentials even if we do not use other important factors such as narrowing of the gender wage gap, the improvements in contraceptive techniques and their proliferation, urbanization, etc. In future, however, it is important to incorporate the above-mentioned factors to have more general model of fertility which can effectively capture human reproductive behavior across wider variety of measures. This means the policy makers will have with more reliable model(s) at their service.

# 7 Reference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# 8 Figures and Tables

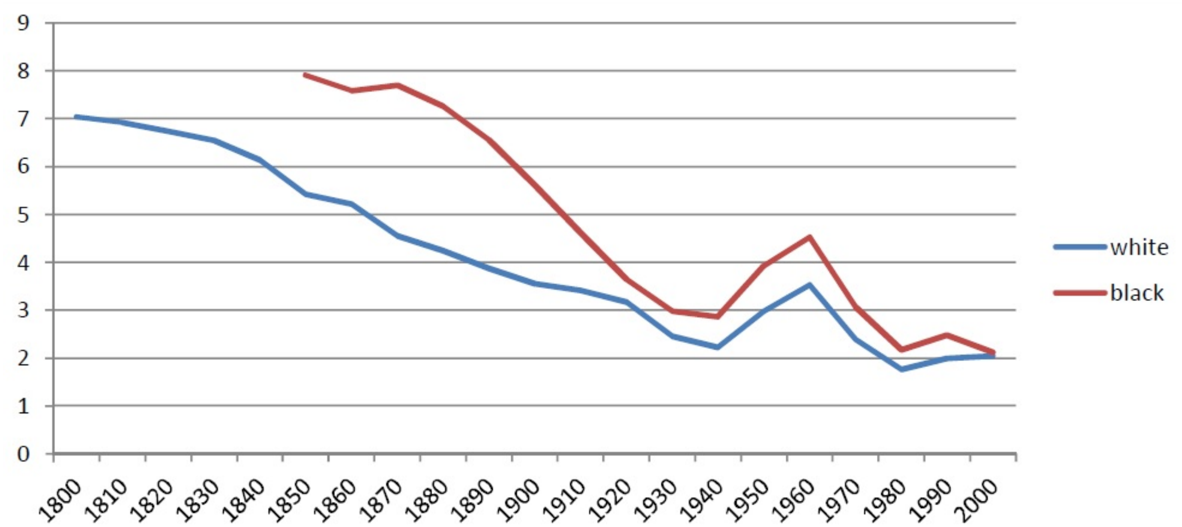


**Figure 1**: Total Fertility Rate, US from 1800-2000 for white and black women.

Source: M.R. Haines and J.D. Hacker.

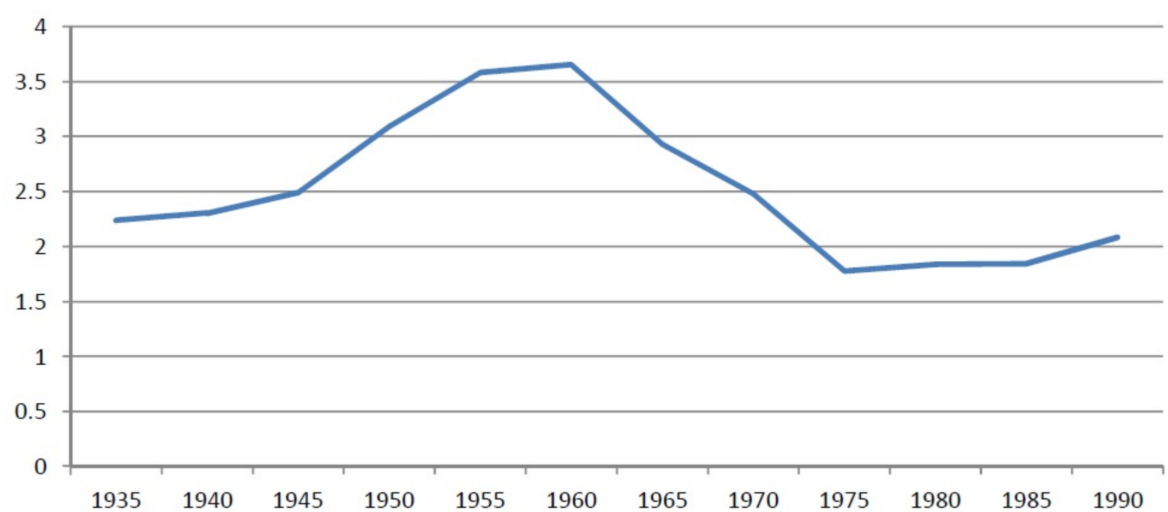


**Figure 2**: Total Fertility Rate, US from 1935 to 1990, all races.

Source: US Census.

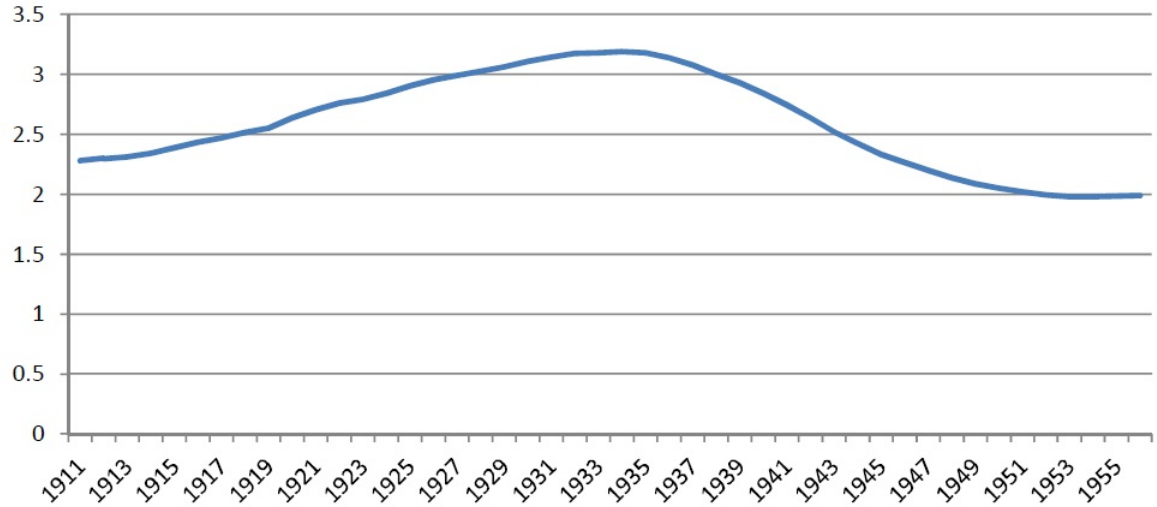


**Figure 3**: Average fertility of women aged 50, US birth cohorts from 1911 to 1955, all races.

Source: Cumulative birth rates, by live-birth order, exact age, and race of women in each cohort from 1911 through 1991: United States, 1961-2006 (CDC/NCHS, National Vital Statistics System).

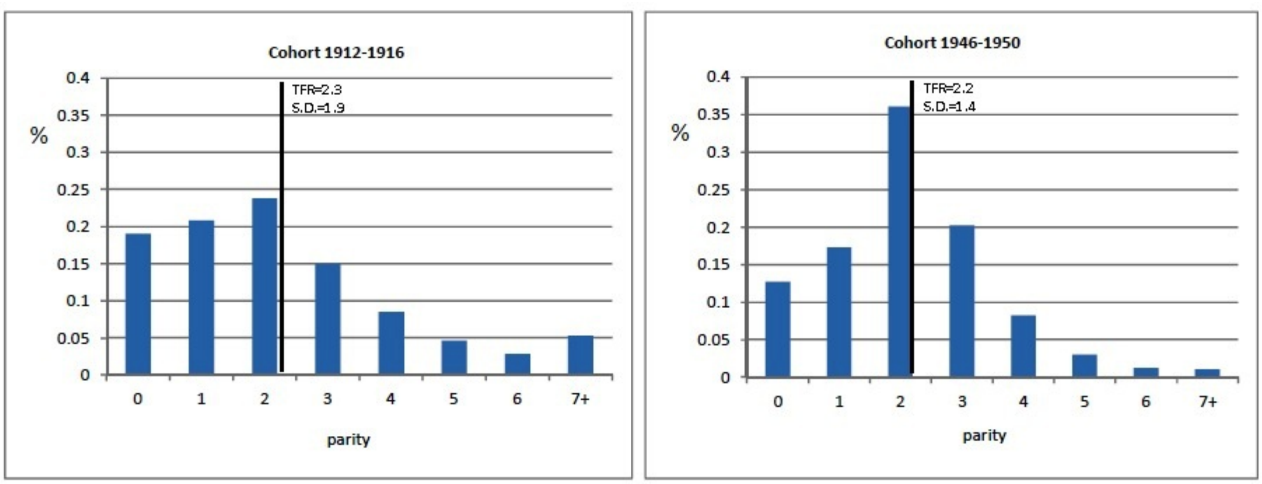


**Figure 4**: Distribution of women by number of children ever born, US women aged 45-49 of all races born in 1912-1916 and 1946-1950.

Source: CDC/NCHS, National Vital Statistics System.

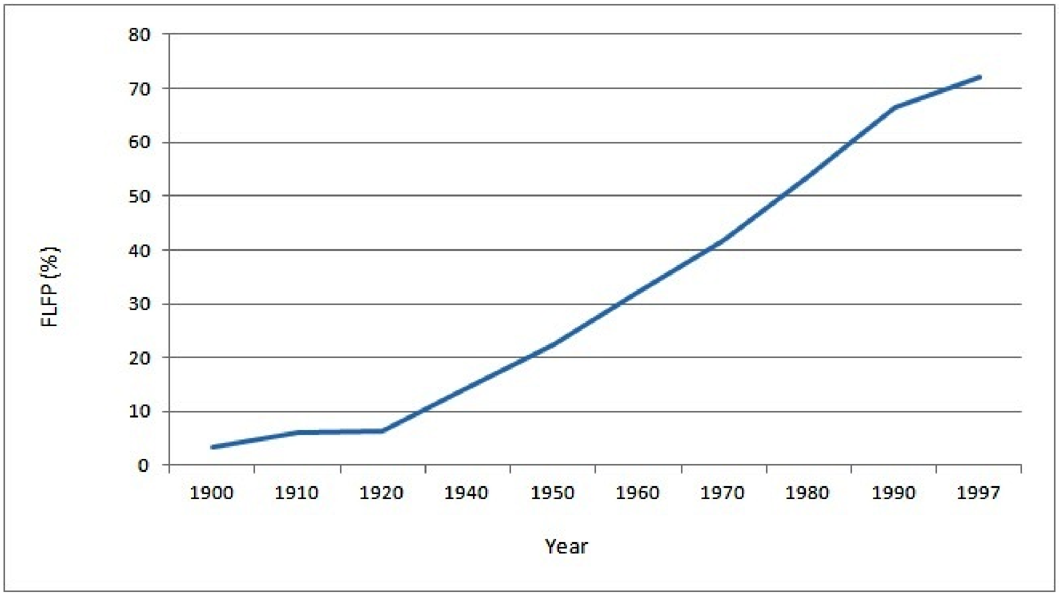


**Figure 5**: Percentage of married women in labor force.

Source: US Census.

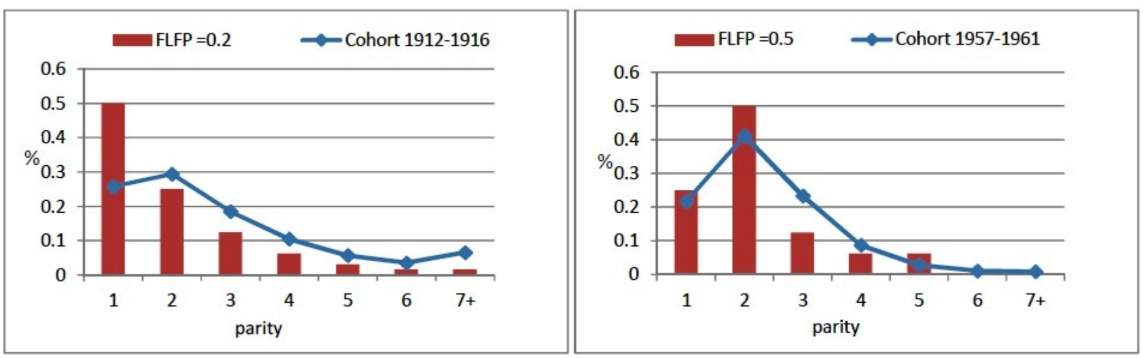


**Figure 6**: Distribution of women by number of children, model results.

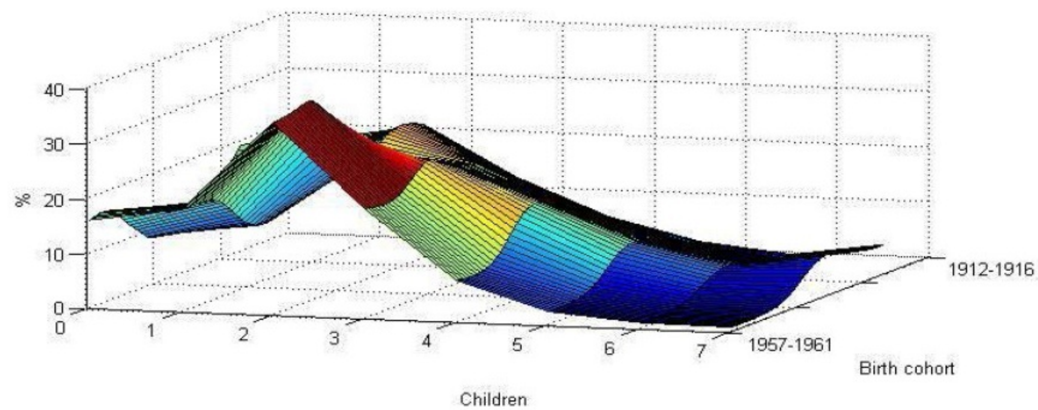


**Figure 7**: Distribution of women by number of children ever born, US women aged 45-49 of all races born from 1912 to 1961.

Source: CDC/NCHS, National Vital Statistics System.

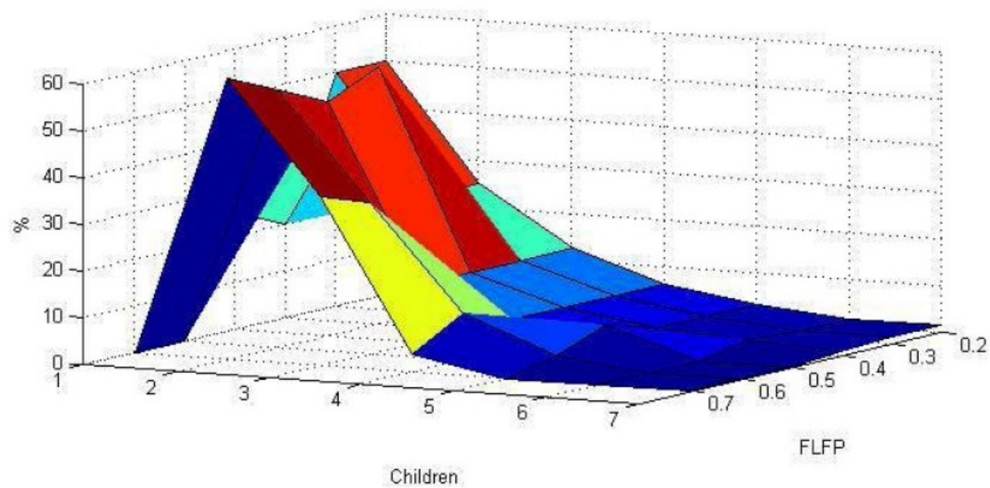


**Figure 8**: Distribution of women by number of children, model results.

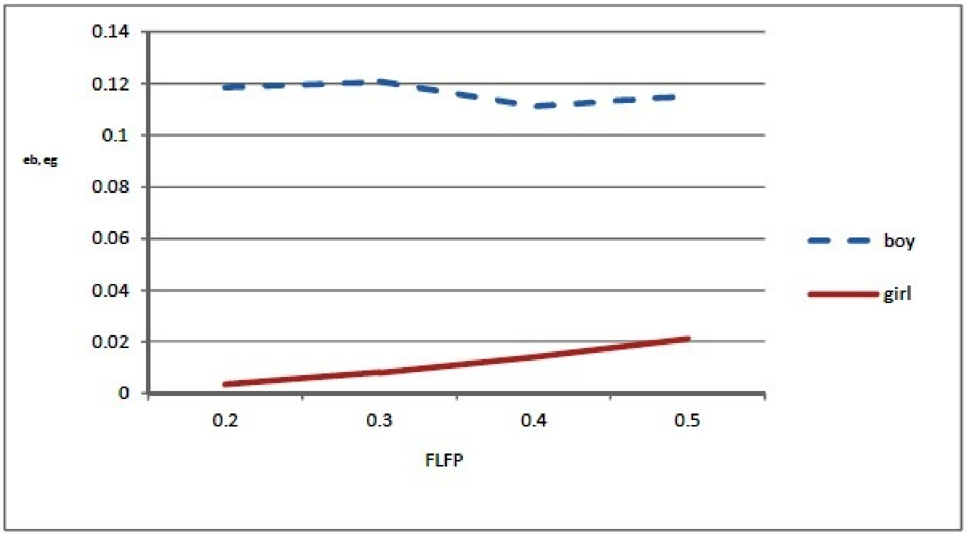


**Figure 9**: Investment in Human capital of children, model results.

| | 1925-1930 Cohort | | | 1945-1950 Cohort | | |
|---|---|---|---|---|---|---|
| Sample weights | Basic monthly weight | Supplement weight | Final basic weight | Basic monthly weight | Supplement weight | Final basic weight |
| First child is boy $\tau$ | -0.201** | -0.201** | -0.201** | -0.00729 | -0.00903 | -0.00903 |
| | (0.078) | (0.079) | (0.079) | (0.048) | (0.048) | (0.048) |
| Age at first birth | -0.102*** | -0.102*** | -0.102*** | -0.0751*** | -0.0752*** | -0.0752*** |
| | (0.01) | (0.01) | (0.01) | (0.005) | (0.005) | (0.005) |
| In labor market | -0.00286 | -0.00274 | -0.00274 | -0.289*** | -0.291*** | -0.291*** |
| | (0.085) | (0.085) | (0.085) | (0.062) | (0.062) | (0.062) |
| White | -0.568*** | -0.569*** | -0.569*** | -0.292*** | -0.294*** | -0.294*** |
| | (0.188) | (0.188) | (0.188) | (0.098) | (0.098) | (0.098) |
| Constant | 6.348*** | 6.359*** | 6.359*** | 4.791*** | 4.798*** | 4.798*** |
| | (0.277) | (0.277) | (0.277) | (0.178) | (0.178) | (0.178) |
| $\bar{y} \mid Z = 0$ | 3.415 | 3.415 | 3.415 | 2.527 | 2.529 | 2.529 |
| Observations | 2,382 | 2,382 | 2,382 | 3,581 | 3,580 | 3,580 |
| R-squared | 0.076 | 0.076 | 0.076 | 0.102 | 0.102 | 0.102 |

**Table 1**: Estimation of gender stipulated fertility stopping behavior: OLS.

Notes: The sample consist of married women who had at least one live birth and at the moment of the survey has completed fertility (testified by being in the age of menopause as well as directly stating absence of intention to have more children). Independent variable is the number of live births a women ever had. Data comes from CPS Fertility Supplements 1990 and 1995 (obtained from IPUMS-CPS). *** significant at less than 1%; ** significant at 5%; * significant at 10%

| Regression | 1925-1930 Cohort<br>Poisson | <br>Zero-truncated Poisson | 1945-1950 Cohort<br>Poisson | <br>Zero-truncated Poisson |
|---|---|---|---|---|
| First child is boy $\tau$ | -0.047** | -0.054** | -0.004 | -0.006 |
| | (0.022) | (0.024) | (0.021) | (0.024) |
| Age at first birth | -0.033*** | -0.040*** | -0.032*** | -0.046*** |
| | (0.003) | (0.003) | (0.002) | (0.003) |
| In labor market | 0.019 | 0.022 | -0.095*** | -0.123*** |
| | (0.025) | (0.026) | (0.023) | (0.027) |
| White | -0.154*** | -0.170*** | -0.101*** | -0.126*** |
| | (0.038) | (0.040) | (0.030) | (0.034) |
| Constant | 2.152*** | 2.273*** | 1.857*** | 2.104*** |
| | (0.071) | (0.077) | (0.060) | (0.070) |
| Pseudo $R^2$ | 0.02 | 0.025 | 0.022 | 0.038 |
| Observations | 2,382 | 2,382 | 3,581 | 3,581 |

**Table 2**: Estimation of gender stipulated fertility stopping behavior: Poisson regressions.

Notes: The sample consist of married women who had at least one live birth and at the moment of the survey has completed fertility (testified by being in the age of menopause as well as directly stating absence of intention to have more children). Independent variable is the number of live births a women ever had. Data comes from CPS Fertility Supplements 1990 and 1995 (obtained from IPUMS-CPS). The $e^{\tau}$ is the average ratio of number of children of women with male first born to the number of children of a women with female first born. *** significant at less than 1%; ** significant at 5%; * significant at 10%

| Number of boys and girls in the household (b, g) | FLFP<br>0.1 | <br>0.2 | <br>0.3 | <br>0.4 | <br>0.5 | <br>0.6 | <br>0.7 | <br>0.8 | <br>0.9 | <br>1.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| **0,0** | x | x | x | x | x | x | x | x | x | x |
| **0,1** | x | x | x | x | x | x | x | x | x | x |
| **0,2** | x | x | x | x | x | x | x | x | x | |
| **0,3** | x | x | x | x | x | x | | | | |
| **0,4** | x | x | x | x | x | | | | | |
| **0,5** | x | x | x | x | | | | | | |
| **0,6** | x | x | x | | | | | | | |
| **0,7** | x | x | | | | | | | | |
| **0,8** | x | x | | | | | | | | |
| **0,9** | x | x | | | | | | | | |
| **0,10** | x | | | | | | | | | |
| **0,11** | x | | | | | | | | | |
| **0,12** | x | | | | | | | | | |
| **0,13** | | | | | | | | | | |
| **1,0** | | | | | | x | x | x | x | x |
| **1,1** | | | | | | | | | | |
| **2,0** | | | | | | | | | | |

**Table 3**, Fertility stopping rules of Type I households.

Notes: the "x" indicates that household with (b,g) children will have another child.

| Number of boys and girls in the household (b, g) | FLFP | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **0.1** | **0.2** | **0.3** | **0.4** | **0.5** | **0.6** | **0.7** | **0.8** | **0.9** | **1.0** |
| **0,0** | x | x | x | x | x | x | x | x | x | x |
| **0,1** | x | x | x | x | x | x | x | x | x | x |
| **0,2** | x | x | x | x | x | x | x | x | x | x |
| **0,3** | x | x | x | x | x | x | x | x | | |
| **0,4** | x | x | x | x | x | x | | | | |
| **0,5** | x | x | x | x | | | | | | |
| **0,6** | x | x | x | x | | | | | | |
| **0,7** | x | x | x | | | | | | | |
| **0,8** | x | x | | | | | | | | |
| **0,9** | x | x | | | | | | | | |
| **0,10** | x | x | | | | | | | | |
| **0,11** | x | | | | | | | | | |
| **0,12** | x | | | | | | | | | |
| **0,13** | x | | | | | | | | | |
| **1,0** | | | | x | x | x | x | x | x | x |
| **1,1** | | | | | | x | x | x | x | x |
| **2,0** | | | | | | | | | x | x |

**Table 4**, Fertility stopping rules of Type II households.

Notes: the "x" indicates that household with (b,g) children will have another child.

# 9 Appendix

### A-1. Proposition 1

The $MH$ $(0, 0, \alpha_0)$ is indifferent between having and not having a child as utility from having a child and in case it is a boy investing $e_b$ in his education and in case of a girl investing $e_g$ in her education is equal to utility from staying childless, that is $MU$ (15) is zero.

$$0.5(u(e_b) + v(e_b)) + 0.5(u(e_g) + \alpha v(e_g)) - u(y). \tag{15}$$

Now let us see how parents decision will change if FLFP increases. The FOC for the parents problem of choosing optimal educational investment for a boy $e_b$ is $u'(e_b)+v'(e_b) = 0$. As this problem does not involve $\alpha$, the changes in FLFP will not affect decision on boy's schooling. However for girls that FOC is $u'(e_g(\alpha)) + \alpha v'(e_g(\alpha)) = 0$ where $e_b(\alpha)$ is the optimal level of educational investment in girl's human capital, which depends on $\alpha$. To find how optimal investment in education changes in response of change in FLFP (instead of initial $\alpha_0$ it increases and becomes $\alpha_1$) I will take the full derivative of the FOC with respect to $\alpha$, $(u''(e_g(\alpha)) + \alpha v''(e_g(\alpha)))\frac{\partial e_g}{\partial \alpha} + v'(e_g(\alpha)) = 0$,

$$\frac{\partial e_g(\alpha)}{\partial \alpha} = -\frac{v'(e_g(\alpha))}{u''(e_g) + \alpha v''(e_g(\alpha))} > 0. \tag{16}$$

Thus the $e_g(\alpha_1) > e_g(\alpha_0)$. Note that the household's decision on whether to have a child or not depends on the sign of

$0.5(u(e_b) + v(e_b)) + 0.5(u(e_g(\alpha_1)) + \alpha_1 v(e_g(\alpha_1))) - u(y)$ and if $(u(e_g(\alpha_1)) + \alpha_1 v(e_g(\alpha_1))$ is bigger than $(u(e_g(\alpha_0)) + \alpha v(e_g(\alpha_0))$ the $MU$ (15) will be positive and the household will have its first child.

Note that $(u(e_g(\alpha_1)) + \alpha_1 v(e_g(\alpha_1)) >(u(e_g(\alpha)) + \alpha_1 v(e_g(\alpha))$

as $e_g(\alpha_1)$ is optimal (utility maximizing) at $\alpha_1$.

Note that $(u(e_g(\alpha)) + \alpha_1 v(e_g(\alpha))>(u(e_g(\alpha)) + \alpha v(e_g(\alpha))$.

So $(u(e_g(\alpha_1)) + \alpha_1 v(e_g(\alpha_1)) >(u(e_g(\alpha)) + \alpha v(e_g(\alpha))$.

## A-2. Proposition 2

Assume a household with arbitrary number of boys and girls $(b,\ g)$.

Substituting

$$c = y\,(1-(b+g)\,p) - be_b - ge_g$$

FOC for education are

$$e_g:\ u_{e_g}(e_b, e_g, b, g) + E\left[v_{e_g}(e_b, e_g, b, g)\right] = 0 \tag{17}$$

$$e_b:\ u_{e_b}(e_b, e_g, b, g) + E\left[v_{e_b}(e_b, e_g, b, g)\right] = 0. \tag{18}$$

To know how the investment in children's human capital changes when FLFP changes I take the full derivative of (17) and (18) with respect to $\alpha$ and get

$$\begin{pmatrix} A & B \\ C & D \end{pmatrix} \begin{pmatrix} \frac{\partial e_g}{\partial \alpha} \\ \frac{\partial e_b}{\partial \alpha} \end{pmatrix} = \begin{pmatrix} -a \\ -b \end{pmatrix}, \tag{19}$$

where given the logarithmic assumption for $u\,(.)$ and $v\,(.)$ functions:

$A = u_{e_g e_g}(e_b, e_g, b, g) + E\left[v_{e_g e_g}(e_b, e_g, b, g)\right] < 0$

$B = u_{e_g e_b}(e_b, e_g, b, g) + E\left[v_{e_g e_b}(e_b, e_g, b, g)\right] < 0$

$C = u_{e_b e_g}(e_b, e_g, b, g) + E\left[v_{e_b e_g}(e_b, e_g, b, g)\right] < 0$

$D = u_{e_b e_b}(e_b, e_g, b, g) + E\left[v_{e_b e_b}(e_b, e_g, b, g)\right] < 0$

$a = u_{e_g \alpha}(e_b, e_g, b, g) + E\left[v_{e_g \alpha}(e_b, e_g, b, g)\right]$

$b = u_{e_b \alpha}(e_b, e_g, b, g) + E\left[v_{e_b \alpha}(e_b, e_g, b, g)\right].$

Utility from consumption is not affected by the changes in FLFP thus

$u_{e_g \alpha}(e_b, e_g, b, g) = 0$

$u_{e_b \alpha}(e_b, e_g, b, g) = 0.$

Utilizing expressions (4) and (7) From Sah (1991)

$$b = E\left[v_{e_b\alpha}\left(e_b, e_g, b, g\right)\right] = g\sum_{i=0}^{g-1}\alpha^i \begin{pmatrix} g-1 \\ i \end{pmatrix} (1-\alpha)^{g-1-i}(v_{e_b}(be_b^{\gamma}w+(i+1)e_g^{\gamma}w)-v_{e_b}(be_b^{\gamma}w+ie_g^{\gamma}w)) < 0$$

and[5]

$$E\left[v_{e_g\alpha}\left(e_b, e_g, b, g\right)\right] = g\sum_{i=0}^{g-1}\alpha^i\left(1-\alpha\right)^{g-1-i} \begin{pmatrix} g-1 \\ i \end{pmatrix} \left(v_{e_g}\left(be_b^{\gamma}w + \left(i+1\right)e_g^{\gamma}w\right) - v_{e_g}\left(be_b^{\gamma}w + ie_g^{\gamma}w\right)\right).$$

If utility function $v\left(.\right)$ is restricted to a logarithmic form

$$v_{e_g}\left(be_b^{\gamma}w + \left(i+1\right)e_g^{\gamma}w\right) - v_{e_g}\left(be_b^{\gamma}w + ie_g^{\gamma}w\right) = \frac{\gamma e_g^{\gamma-1}be_b^{\gamma}}{\left(be_b^{\gamma} + \left(i+1\right)e_g^{\gamma}\right)\left(be_b^{\gamma} + ie_g^{\gamma}\right)}$$

which is positive for any value of $i$. Thus $a > 0$.

If $\begin{pmatrix} A & B \\ C & D \end{pmatrix}$ is a negative definite matrix then its determinant is positive and in this case $\frac{\partial e_b}{\partial\alpha} < 0$ and $\frac{\partial e_g}{\partial\alpha} > 0$. The condition required for negative definite matrix is concavity of the objective function in both $e_b$ and $e_g$ which must be satisfied as it is also required for maximizing the utility function. So if optimal (utility maximizing) $e_b$ and $e_g$ exist, the matrix is negative definite.

### A-3. Derivative of marginal utility from another child with respect to FLFP

For the ease of exposition I denote $e_b\left(b+1, g, \alpha_0\right) \equiv e_b^b$ ,$e_g\left(b+1, g, \alpha_0\right) \equiv e_g^b$, $e_b\left(b, g+1, \alpha_0\right) \equiv e_b^g$, $e_g\left(b, g+1, \alpha_0\right) \equiv e_g^g$, $e_b\left(b, g, \alpha_0\right) \equiv e_b$ and $e_g\left(b, g, \alpha_0\right) \equiv e_g$. Using expressions (4) and (7) from Sah (1991) the derivative of marginal utility from having another child with respect to FLFP is

[5] Because the derivative of $v_{e_g}$due to chain rule is multiplied by $(i+1)$(i+1) and $i$, which makes it difficult to predict the sign.

$$
\begin{aligned}
&g\sum_{i=0}^{g-1}\alpha^{i}\begin{pmatrix} g-1 \\ i \end{pmatrix}(1-\alpha)^{g-1-i}\left(v\left(w\left(b+1\right)\left(e_{b}^{b}\right)^{\gamma}+w\left(i+1\right)\left(e_{g}^{b}\right)^{\gamma}\right)-v\left(w\left(b+1\right)\left(e_{b}^{b}\right)^{\gamma}+wi\left(e_{g}^{b}\right)^{\gamma}\right)\right)- \\
&\quad -g\sum_{i=0}^{g-1}\alpha^{i}\begin{pmatrix} g-1 \\ i \end{pmatrix}(1-\alpha)^{g-1-i}\left(v\left(wb\left(e_{b}\right)^{\gamma}+w\left(i+1\right)\left(e_{g}\right)^{\gamma}\right)-v\left(wb\left(e_{b}\right)^{\gamma}+wi\left(e_{g}\right)^{\gamma}\right)\right)+ \\
&\quad +\left(g+1\right)\sum_{i=0}^{g}\alpha^{i}\begin{pmatrix} g \\ i \end{pmatrix}(1-\alpha)^{g-i}\left(v\left(wb\left(e_{b}^{g}\right)^{\gamma}\right)+w\left(i+1\right)\left(e_{g}^{g}\right)^{\gamma}-v\left(wb\left(e_{b}^{g}\right)^{\gamma}+wi\left(e_{g}^{g}\right)^{\gamma}\right)\right)- \\
&\quad -g\sum_{i=0}^{g-1}\alpha^{i}\begin{pmatrix} g-1 \\ i \end{pmatrix}(1-\alpha)^{g-1-i}\left(v\left(wb\left(e_{b}\right)^{\gamma}+w\left(i+1\right)\left(e_{g}\right)^{\gamma}\right)-v\left(wb\left(e_{b}\right)^{\gamma}+wi\left(e_{g}\right)^{\gamma}\right)\right).
\end{aligned}
$$

### A-4. Derivative of marginal utility from another child with respect to FLFP (exogenous human capital of children)

Household with $b$ boys and $g$ girls consider having a child. Each child irrespective of gender is endowed with 1 unit of human capital. The wage per unit of human capital is assumed to be 1. Parents make decision on having another child after observing the gender outcome of the previous birth. The expected utility function (2) and budget constraint (3) simplify to

$$U\left(c,b,g\right)=u\left(c\right)+\psi E\left[v\left(b,g\right)\right] \tag{20}$$

and

$$c=y\left(1-\left(b+g\right)p\right).$$

In details the expected utility function is

$$U\left(c,b,g\right)=u\left(y\left(1-\left(b+g\right)p\right)\right)+\psi\sum_{i=0}^{g}\alpha^{i}\begin{pmatrix} g \\ i \end{pmatrix}(1-\alpha)^{g-i}\,v\left(b+i\right). \tag{21}$$

The decision of parents to have another child is positive if the marginal benefit from another child is positive

$$0.5V(b+1,g)+0.5V(b,g+1)-V(b,g)>0. \tag{22}$$

To know how decision of parents changes when FLFP rate increases I need to calculate the derivative of the marginal utility (22) with respect to $\alpha$.

$$0.5\left(\frac{\partial V(b+1,g)}{\partial\alpha}+\frac{\partial V(b,g+1)}{\partial\alpha}\right)-\frac{\partial V(b,g)}{\partial\alpha}=$$

$$0.5\left(\frac{\partial E\left[v(b+1,g)\right]}{\partial\alpha}-\frac{\partial E\left[v(b,g)\right]}{\partial\alpha}\right)+0.5\left(\frac{\partial E\left[v(b,g+1)\right]}{\partial\alpha}-\frac{\partial E\left[v(b,g)\right]}{\partial\alpha}\right). \tag{23}$$

Using derivations (4) and (7) from Sah (1991) the first part of (23) is

$$0.5\left(g\sum_{i=0}^{g-1}\alpha^i\binom{g-1}{i}(1-a)^{g-1-i}\left(v\left((b+1)+(i+1)\right)-v\left((b+1)+i\right)\right)\right)-$$

$$-0.5\left(g\sum_{i=0}^{g-1}\alpha^i\binom{g-1}{i}(1-\alpha)^{g-1-i}\left(v\left(b+(i+1)\right)-v\left(b+i\right)\right)\right)<0, \tag{24}$$

as $v(.)$ is a concave function. The second part is (25) and it sign is hard to identify.

$$0.5\left((g+1)\sum_{i=0}^{g}\alpha^i\binom{g}{i}(1-a)^{g-i}\left(v\left((b+1)+(i+1)\right)-v\left((b+1)+i\right)\right)\right)-$$

$$-0.5\left(g\sum_{i=0}^{g-1}\alpha^i\binom{g-1}{i}(1-\alpha)^{g-1-i}\left(v\left(b+(i+1)\right)-v\left(b+i\right)\right)\right)\lesseqgtr 0. \tag{25}$$

### A-5. Intermediate result 1

The extreme case of a household which has $b$ boys and considers having another child. It is known that the next child will be a girl. The household will decide to have an additional child if marginal utility (26) is positive.

$$MU = u\left(e_{b1}, e_{g1}, b, 1\right) + \alpha v\left(e_{b1}, e_{g1}, b, 1\right) + (1-\alpha)\, v\left(e_{b1}, 0, b, 1\right) - u\left(e_{b0}, 0, b, 0\right) - v\left(e_{b0}, 0, b, 0\right), \tag{26}$$

where $e_{b1}$ and $e_{g1}$ are investment in education of boys and a girl if household decides to have a girl, $e_{b0}$ is the investment in education of boys if the household abstains from having that girl and $v\left(e_{b1}, 0, b, 1\right)$ means a household has $b$ boys and a girl, the boys work, so the household derives utility from their $e_{b1}$ while a girl does not work, hence instead of $e_{g1}$ we have 0.

The full derivative of the $MU$ (26) with respect to $\alpha$ is expression (27) (note that utility with $b$ boys does not depend on $\alpha$ so its derivative with respect to $\alpha$ is zero)

$$\begin{aligned} MU_\alpha = & \left(u_{e_b}\left(e_{b1}, e_{g1}, b, 1\right) + \alpha v_{e_b}\left(e_{b1}, e_{g1}, b, 1\right) + (1-\alpha)\, v_{e_b}\left(e_{b1}, 0, b, 1\right)\right) \tfrac{\partial e_b}{\partial \alpha} + \\ & + \left(u_{e_g}\left(e_{b1}, e_{g1}, b, 1\right) + \alpha v_{e_g}\left(e_{b1}, e_{g1}, b, 1\right) + (1-\alpha)\, v_{e_g}\left(e_{g1}, 0, b, 1\right)\right) \tfrac{\partial e_g}{\partial \alpha} + \\ & + \left(u_\alpha\left(e_{b1}, e_{g1}, b, 1\right) + v\left(e_{b1}, e_{g1}, b, 1\right) - v\left(e_{b1}, 0, b, 1\right)\right). \end{aligned} \tag{27}$$

Note that first two lines of derivative of marginal utility with respect to $\alpha$ (27) are FOC for the optimal education choice in case of $b$ boys and 1 girl which is a result from from the Envelope Theorem stating that the first two lines of (27) are zero and only direct effect of $\alpha$ matters. The $u_\alpha\left(e_{b1}, e_{g1}, b, 1\right)$ is zero too as consumption part of the utility function does not directly depend on $\alpha$. Thus the full derivative of the marginal utility with respect to $\alpha$ (28) is positive.

$$v\left(e_{b1}, e_{g1}, b, 1\right) - v\left(e_{b1}, 0, b, 1\right). \tag{28}$$

When the next child is known to be a boy the utility does not depend on $\alpha$, so marginal utility from having another child is not affected by FLFP.

## A-6. Exogenous human capital case all-boy households.

The marginal utility from having another child is

$$\alpha\left(u\left(y\left(1-\left(b+1\right)p\right)\right)+v\left(b+1\right)\right)+\left(1-\alpha\right)\left(u\left(y\left(1-\left(b+1\right)p\right)\right)+v\left(b\right)\right)-u\left(y\left(1-bp\right)\right)-v\left(b\right)= \\ =u\left(y\left(1-\left(b+1\right)p\right)\right)-u\left(y\left(1-bp\right)\right)+\alpha\left(v\left(b+1\right)-v\left(b\right)\right). \tag{29}$$

When $\alpha$ increases, it is obvious that marginal benefit (third term of the expression (29)) will increase while marginal cost (first two terms of the equation) will not change.

## A-7. Intermediate result 2

The extreme case of household which has $g$ girls and considers to have another child who is known to be a boy. The household will decide to have that child if marginal utility from having that child is positive.

The marginal utility is

$$MU=u\left(c_1\right)+E\left[v\left(e_{b1},e_{g1},1,b\right)\right]-u\left(c_0\right)-E\left[v\left(0,e_{g0},0,g\right)\right]. \tag{30}$$

where $e_{b1}$, $e_{g1}$ and $c_1$ are investment in human capital of a boy and girls and household consumption if the household decides to have another child while $e_{g0}$ and $c_0$ are the investment in human capital of girls and household consumption if the household abstains from having another child.

The full derivative of the $MU$ (30) with respect to $\alpha$ is

$$\begin{aligned} MU_\alpha=&\left(u_{e_b}\left(c_1\right)+E\left[v_{e_{b1}}\left(e_{b1},e_{g1},1,g\right)\right]\right)\tfrac{\partial e_{b1}}{\partial\alpha}+\\ &+\left(u_{e_g}\left(c_1\right)+E\left[v_{e_{g1}}\left(e_{b1},e_{g1},1,g\right)\right]\right)\tfrac{\partial e_{g1}}{\partial\alpha}+\\ &+\left(u_\alpha\left(c_1\right)+E\left[v_\alpha\left(e_{b1},e_{g1},1,g\right)\right]\right)-\\ &-\left(u_{e_b}\left(c_0\right)+E\left[v_{e_b}\left(0,e_{g0},0,g\right)\right]\right)\tfrac{\partial e_b}{\partial\alpha}-\\ &-\left(u_{e_g}\left(c_0\right)+E\left[v_{e_{g0}}\left(0,e_{g0},0,g\right)\right]\right)\tfrac{\partial e_{g0}}{\partial\alpha}-\\ &-\left(u_\alpha\left(c_0\right)+E\left[v_\alpha\left(0,e_{g0},0,g\right)\right]\right). \end{aligned} \tag{31}$$

The first, second, fourth and the fifth lines of derivative (31) are zero as they are First Order Conditions for the optimal choice of education and consistent with the Envelope Theorem stating that we must consider only direct effect of $\alpha$ . Thus,

$$MU_{\alpha}=u_{\alpha}\left(c_{1}\right)+E\left[v_{\alpha}\left(e_{b1},e_{g1},1,g\right)\right]-u_{\alpha}\left(c_{0}\right)-E\left[v_{\alpha}\left(0,e_{g0},0,g\right)\right]. \tag{32}$$

Using expressions (4) and (7) from Sah (1991) and the fact that $u\left(.\right)$ does not depend on $\alpha$, the expressions (32) is

$$MU_{\alpha}=g\sum_{i=0}^{g-1}\alpha\left(1-\alpha\right)^{g-1-i}\begin{pmatrix}g-1\\ i\end{pmatrix}\left(v\left(e_{b1}^{\gamma}w+\left(i+1\right)e_{g1}^{\gamma}w\right)-v\left(e_{b1}^{\gamma}w+ie_{g1}^{\gamma}w\right)\right)-$$
$$-g\sum_{i=0}^{g-1}\alpha\left(1-\alpha\right)^{g-1-i}\begin{pmatrix}g-1\\ i\end{pmatrix}\left(v\left(\left(i+1\right)e_{g0}^{\gamma}w\right)-v\left(ie_{g0}^{\gamma}w\right)\right).$$

If the utility function $v\left(.\right)$ is restricted to be logarithmic then

$$MU_{\alpha}=g\sum_{i=0}^{g-1}\begin{pmatrix}g-1\\ i\end{pmatrix}ln\left(\frac{e_{b1}^{\gamma}ie_{g0}^{\gamma}+i^{2}e_{g1}^{\gamma}e_{g0}^{\gamma}+e_{g1}^{\gamma}ie_{g0}^{\gamma}}{e_{b1}^{\gamma}ie_{g0}^{\gamma}+e_{b1}^{\gamma}e_{g0}^{\gamma}+i^{2}e_{g1}^{\gamma}e_{g0}^{\gamma}+e_{g1}^{\gamma}ie_{g0}^{\gamma}}\right), \tag{33}$$

the argument in the logarithm in the marginal utility (33) less than 1 for any $i>0$ which means that derivative of marginal utility with respect to $\alpha$ (32) is negative. Note that if $v\left(.\right)$ is of CRRA type, then we have $MU_{\alpha}=g\sum\limits_{i=0}^{g-1}\begin{pmatrix}g-1\\ i\end{pmatrix}\alpha^{i}\left(1-\alpha\right)^{g-1-i}\frac{\left(e_{g1}^{\gamma}-e_{g0}^{\gamma}\right)^{1-\sigma}}{\left(1-\sigma\right)}<0$ for $\sigma>1$ as $e_{g1}$ which is negative as $e_{g1}^{\gamma}-e_{g0}^{\gamma}<0$.[6]

## A-8. Intermediate result 3

The extreme case is when a household with $g$ girls consider having another child, when that

[6]The FOC when household has only girl is $\frac{g}{y-ge_{g0}-pg}=\sum\limits_{i=0}^{g}\begin{pmatrix}g\\ i\end{pmatrix}\alpha^{i}\left(1-\alpha\right)^{g-i}\frac{i\gamma e_{g0}^{\gamma-1}}{ie_{g0}^{\gamma}}$. If the household has an additional son, then even with an infinitely small investment in $e_{b}$ (not investing anything in the son is not optimal) the derivative of the utility function w.r.t. $e_{g}$ is $\frac{-g}{y-ge_{g0}-pg}+\sum\limits_{i=0}^{g}\begin{pmatrix}g\\ i\end{pmatrix}\alpha^{i}\left(1-\alpha\right)^{g-i}\frac{i\gamma e_{g0}^{\gamma-1}}{e_{b}^{\gamma}+ie_{g0}^{\gamma}}$. Note that $e_{g0}$ is not optimal when there is a son as LFS of the derivative will be larger than in no-son case while RHS will be smaller. The derivative can be zero if $e_{g0}$ is decreased. It follows that $e_{g1}<e_{g0}$.

child is known to be a girl. This is a bit complicated as both the "flow" and the "stock" effects are operational in this case. To simplify derivations and see how marginal utility changes imagine parents must make a one-time decision on number of children (all of whom are girls) they want to have and amount investment in their human capital formation. When we have all-girl household who will have a girl one time decision making on number of children who are all girls is an accurate depiction of reality. This is true as one may imagine that before making final one-time decision, a household, as standard utility maximizer, weights the costs and the benefits of an additional child, so in its calculations, one-time decision making household follows a sequential decision making. The $u(.)$ and $v(.)$ functions are logarithmic. The FLFP rate they observe is $\alpha$. So the household problem is

$$max_{g,e} \sum_{i=0}^{g} \begin{pmatrix} g \\ 0 \end{pmatrix} \alpha^{i} (1-\alpha)^{g-i} \left( ln \left( y \left( 1 - (p+e) g \right) \right) + ln \left( iwe^{\gamma} \right) \right). \quad (34)$$

Following Kalemli-Ozcan (2003) the utility can be approximated around expected number of surviving children using Delta method:

$$max_{g,e} ln \left( y \left( 1 - (p+e) g \right) \right) + ln \left( g\alpha we^{\gamma} \right) - \frac{(1-\gamma)(1-\alpha)}{2g\alpha}$$

or for simplicity I will denote the total utility as one part coming from consumption and another part coming from children

$$max_{g,e} \{u+v\}.$$

The FOC are:

$e: \ u_e + v_e = 0$ and $g: \ u_g + v_g = 0$

If I totally differentiate the FOC with respect to FLFP rate ($\alpha$) I will have

$$\begin{pmatrix} A & B \\ C & D \end{pmatrix} \begin{pmatrix} \frac{\partial e}{\partial \alpha} \\ \frac{\partial g}{\partial \alpha} \end{pmatrix} = \begin{pmatrix} -a \\ -b \end{pmatrix}, \quad (35)$$

where $A = u_{ee} + v_{ee}$, $B = u_{eg} + v_{eg}$, $C = u_{ge} + v_{ge}$, $D = u_{gg} + v_{gg}$, $a = u_{e\alpha} + v_{e\alpha}$, $b = u_{g\alpha} + v_{g\alpha}$.

Note that $a = 0$ as $e_{e\alpha} = 0$ and $v_{e\alpha} = 0$, as well as $u_{g\alpha} = 0$, $v_{eg} = 0$, $u_{eg} < 0$, $u_{ee} < 0$, $v_{ee} < 0$,

and

$$v_{g\alpha} = -\frac{1}{2}\frac{(1-\gamma)}{g^2\alpha} - \frac{1}{2}\frac{(1-\gamma)(1-\alpha)}{g^2\alpha^2} < 0.$$

Keeping in mind that in order to have a local maximum the Hessian should be negative definite, for 2x2 case the determinant of Hessian should be positive. Thus

$$\frac{\partial g}{\partial \alpha} < 0 \tag{36}$$

$$\frac{\partial e}{\partial \alpha} > 0. \tag{37}$$

Thus, the marginal utility from an additional child decreases in FLFP (36).

**A-9. Exogenous human capital case.**

I assume for simplicity that human capital and wage per unit of human capital are equal to 1. Imagine a household with $g$ girls which is considering having another child, who is known to be a boy. Note that in this setup, changes in FLFP rate does not affect return from the additional child, it affects only already existing girls. The marginal utility from having another child is

$$(u(y(1-(g+1)p)) + v(g+1)) - (u(y(1-gp)) - v(g)). \tag{38}$$

The derivative of expression (38) with respect to FLFP is expression (24) if $b = 1$. So independent on number of girls, at any level of FLFP rate the derivative is negative.

In the case when the next child is known to be a girl the cross derivative of the utility function (approximated by Delta method as in A-8) with respect to $g$ and $\alpha$ is:

in case of logarithmic utility

$$\frac{\partial^2 U}{\partial g \partial \alpha} = -\frac{1}{2g^2}\left(\alpha^{-1} + \alpha^{-2}(1-\alpha)\right) < 0, \quad (39)$$

in case of CRRA function

$$\frac{\partial^2 U}{\partial g \partial \alpha} = \left((1-\beta)(g\alpha)^{-\beta} - \frac{\beta^2}{2g^{\beta+1}}\left(\alpha^{-\beta} + \beta\alpha^{-\beta-1}(1-\alpha)\right)\right). \quad (40)$$

Here as well as in Kalemli-Ozcan (2003) logarithmic function (39) is such that substitution and income effects coming from increase in expected return are canceling each other leaving only the variance effect (precautionary saving reduction). For other utility functions (for example CRRA function with Coefficient of Relative Risk Aversion $\beta$) the income and substitution effects may not cancel and actually fertility may increase like if $\beta < 1$ while at $\beta > 1$ (40) this derivative is always negative .

Given the results for $\frac{\partial^2 U}{\partial g \partial \alpha}$ it is clear that in logarithmic case the change in marginal benefit is negative (in case of CRRA utility function when $\beta < 1$ it can be positive as mean effect can outweigh the variance effect). Thus, for fairly concave utility function, marginal benefit from having additional child decreases while marginal cost associated with that child does not change. This means that household who at lower FLFP rate found it optimal to have another child, at higher FLFP rate may find it non-optimal.

## Conclusion

This thesis is composed of three research papers intended for publication. They investigate such important economic and social phenomena as relative consumption concerns, income inequality and existence of fertility differentials. The motivation comes from the fact that households which indeed have relative consumption concerns try to achieve the "normal" living standards which are formed by the consumption levels of those who are higher ranked in the local and national income distributions. The recent 30 years saw significant increase in income inequality both on local and national levels in the US and other developed nations. However the median earnings did not change much. Those who are at the right tail of distribution enjoyed great three decades and increase significantly their wealth and consumption levels. Due to desire of households to "keep up with the Joneses," these increased consumption levels changed the perception of desired living standards and introduced new concepts of "normal". In light of these phenomena the study of household behavior whose perceptions of "normal" have shifted, but income did not, helps to understand the household reaction and its consequences for the society. I study the possible outcomes of "keeping up with the Joneses" on household consumption/borrowing and fertility decisions. Each of these decisions are important as they affect household's financial leverage, potentially affecting the effectiveness of monetary policy as well as fertility differentials between households which potentially can affect economic growth and future of the public finance.

The first two papers study implications for borrowing and fertility. In the first paper, motivated by simultaneous growth of income inequality and household indebtedness as well the fact that increase income inequality did not translate into increased consumption inequality, it is proposed that household try to "keep up with the Joneses" and coinciding relaxation of credit constraints allowed them to do it. An OLG model is developed and its implication are tested using SCF data. Finding support for the model in the data it is shown the model predicts that easing of the credit constrained for the low-income household allowed them to increase consumption which did hurt their welfare as most of this increased consumption was channeled to keep up consumption to the "new standards." This hints that policy makers should take into consideration welfare implications of policy actions which are aimed at increasing access to credit in an environment where households may exhibit relative consumption concerns.

In the second paper I endogenize the fertility decisions of the households which exhibit relative consumption concerns. The cross sectional variation of local income inequality implies also variation in the reference consumption or consumption "norms." This variation allows to use econometric techniques to test the implication of the model that areas with higher income inequality should have less average fertility rate, an implication which is confirmed for the US.

The third paper is motivated by the fact that fertility models which are focused on average fertility rate can not capture the concentration of the distribution of completed fertilities and existence of son-preference in early 20-th century in the US. A model is developed which makes explicit distinction between boys and girl. In this model, at low level of female labor force participation, household exhibit son-preference: household whose first-born children are girls continue childbearing and end up with many children. When participation rate increases household with first-born daughters stop having many children in pursuit of having a boy. Interesting is that households whose first-born children are boys tend to have additional child at higher participation rate, potentially offsetting the reduction in total fertility rate caused by household with first-born girls.

The finding of the third paper have implications for the gender equality promotion programs, indicating that promoting gender equality may actually lead to increased fertility. I argue that gender equality polices should not be tied to the fertility results and the potential increase in fertility must be clearly explained to authorities to avoid backlash and wrapping up of the gender equality promotion programs, which are important independent of their effect on fertility. On the contrary, the introduction of new social norms, including norms for the education and well-being of children, can be complementary to the advance of gender equality and can help avoid increases in fertility rates, especially among low-income households. The advancement of such policies can be done by means of easing the credit constraints for borrowing with the purpose of investment into the "child quality".