THE PINHAS SAPIR CENTER FOR DEVELOPMENT
TEL AVIV UNIVERSITY

"Higher Inequality, Higher Education?
The Changing Role of Differential Fertility"

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Abstract

In this paper we propose and quantify a channel by which income inequality may yield a rise in growth through its effects on differential fertility. The conventional wisdom has been that, given the historically negative relationship between income and fertility, increasing inequality will tend to result in relatively more children being born to poorer household, and thus receive less education. However, since 1980 there has been a stark rise in inequality with a simultaneous flattening of the relationship between fertility and income. We reconcile standard models with the empirical reality by arguing that inequality leads to the cost of childcare and home good substitutes being relatively low for high income mothers. This results in an increased ability for high income mothers to marketize home production, and thus increases their fertility. The net result is the subsequent generation having, on average, higher human capital and thus more growth.

1 Introduction

Public discussion in recent years has focused on income inequality and its adverse effect on economic growth.[1] The rise in inequality has been dramatic.[2] Theoretical papers have proposed mechanisms by which inequality may be either good or bad for growth, while the empirical literature has yet to come to a consensus on the sign or magnitude of the effects of inequality.[3] Inequality has a variety of mechanisms in which it influences growth. In particular, one is through the effects on differential fertility, i.e. the gap in fertility between rich and poor people. The consensus in the literature has been that rising inequality would lead to more differential fertility, and thus lower accumulation of human capital (de la Croix and Doepke 2003, Moav 2005). However, from 1980 to 2010, just as inequality increased dramatically, there was a substantial flattening of the relationship between income and fertility, leading to relatively more children to be born to richer parents (Hazan and Zoabi 2014). We propose and quantify a channel by which inequality may yield a rise in growth through its effects on differential fertility.

One of the central determinants of fertility emphasized in the literature is the opportunity cost of women's time in raising the children, which is higher for higher income women.[4] The notion we are advancing in this paper is that when inequality increases wealthier women have an easier time purchasing substitutes in the marketplace for their home production (i.e. childcare). Inequality thus reduces the relative price of children to wealthier parents by negating the opportunity cost of women's time. While the idea of marketization of home production has been studied, such as in Greenwood, Seshadri, and Vandenbroucke

[1] Obama (2013), Krueger (2012), among others.

[2] Katz and Murphy (1992), Autor, Katz, and Kearney (2008), Heathcote, Perri, and Violante (2010).

[3] The literature on inequality and growth is too vast and diverse to survey here. For an excellent collection of articles on this topic, see Galor (2009).

[4] See Becker (1960), Ben-Porath (1973), Galor and Weil (1996) and Voigtländer and Voth (2013), among others.

(2005) and Greenwood, Seshadri, and Yorukoglu (2005), the influence of inequality through marketization has been overlooked.

To motivate our analysis, we first show the changing relationship between income and fertility, and then describe a back-of-the-envelope calculation as to the effects of changing differential fertility on human capital accumulation. The changing cross sectional profile of fertility can be seen in Figure 1. Note that the relationship has become much flatter over time. For the back-of-the-envelope calculation, hold constant the 1980 cross-sectional relationship between income and college graduation rates of children born in that year, and calculate how many children would have received a college education using the cross sectional fertility rates (i.e. differential fertility) of 2010. We find that the effects of changing fertility imply a 4.4% increase in college graduation. As discussed below, this rise is in contrast to the substantial decline predicted by the literature, leading a large potential effect of marketization.

The mechanism described above is in contrast to the conventional wisdom in the literature. The negative relationship between income and fertility that has prevailed at least since the 19th century until recently has been typically explained by either a quantity-quality trade off, an opportunity cost of parents time, or both.[5] This view of the world implies that rising inequality will lead to the rich having fewer children while the poor have more children. Given that rich people invest more in their children's education (quality), rising inequality, under the conventional wisdom, gives rise to falling educational attainment in the next generation.

In order to study our proposed channel, we build and quantify a model of fertility and child education that features marketization of home production. We then use the model to evaluate changes in both differential fertility and child quality by feeding in the changes in inequality documented from 1980 to 2010. We find that rising income inequality implies a 2.7% rise in college graduation

[5]Some of the many examples include Becker and Lewis (1973), Galor and Weil (1996), and Galor and Weil (2000), Doepke (2004)

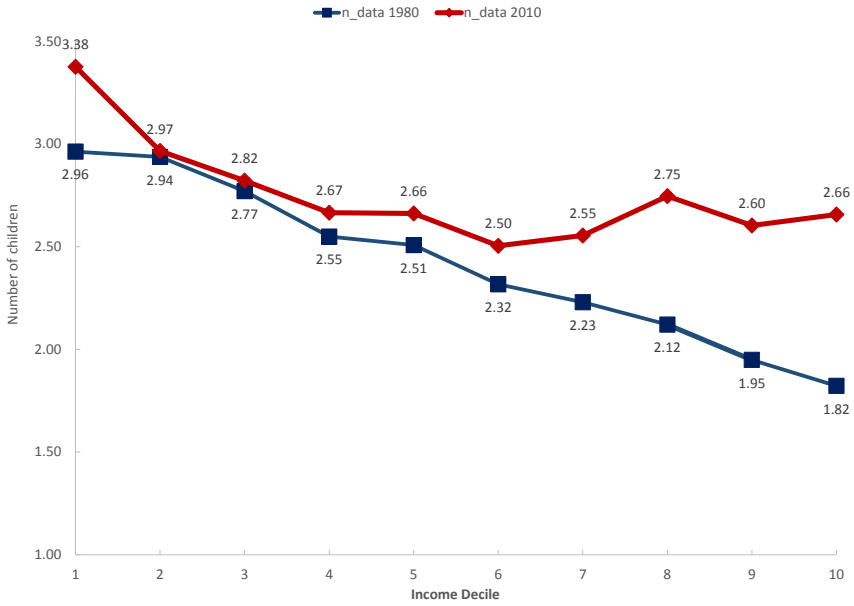

Figure 1: Fertility in the Cross Section. White, non-Hispanic, married couples. See Data section for full description.

rates and a flatter differential fertility profile.

Following de la Croix and Doepke (2003), we perform the same exercise *without* the marketization mechanism. That is, using the same model as in de la Croix and Doepke (2003), we calibrate and feed in the same rise in equality that we do for our model. We find a predicted decline in college graduation of 3.9%, in contrast to the modest rise in our model. The difference in results demonstrates the quantitative importance of the marketization mechanism.

We add to debate on the relationship between inequality and growth that inequality has an effect on differential fertility and thus on education. Education in turn affects growth in two ways. First, a more educated populace has a higher income level, implying growth has occurred. Second, as in Galor and Weil (2000), more human capital results in a higher rate of technological development, and

thus growth. Vogl (2014) shows that prior to the demographic transition, developing countries exhibited the opposite of conventional wisdom. That is, richer families had more children. This in turn contributed to growth, as the children of richer families received more education.

The paper proceeds as follows. In Section 2 we present the model. In Section 3 we describe the data. In Section 4 we detail the calibration strategy and model fit. Section 5 describes the results of the quantitative exercise. Finally, in Section 6, we discuss extensions to the exercise and conclude.

2 Model

2.1 Setup

There is a unit measure of married households that are heterogenous on the wage offers that the spouses receive, denoted w_h and w_w for the wage of the husband and wife, respectively.[6] Households derive utility from market consumption of the numeraire, c, quantity of their children, n, and the quality of their children, $\pi(e)$, where e is the expenditure level on child quality. We interpret π to be the fraction of children that complete a college education. Households preferences, as in Galor and Weil (2000), are represented by the utility function:

$$u = \ln(c) + \alpha \ln[n\pi(e)]. \tag{1}$$

Each spouse has a unit of time. The man is assumed to work full time while the woman makes an intensive margin decision between raising kids, t_w, and market production, $1 - t_w$. Kids require family resources combining t_w with the time of a baby sitter t_b and a market good m according to:

$$n = f(t_w, t_b, m), \tag{2}$$

[6] We use the term mother and wife interchangeably throughout the text.

where t_b and m will end up being a substitute for t_w.

Parents are required to spend the same amount of resources on the quality of each child. Thus, the budget constraint is given by:

$$c + q(n) + p_e e n = w_h + w_w, \tag{3}$$

where $q(n)$, defined below, represents the cost associated with goods, m, the babysitters time t_b, and the mother's time, t_w, of producing n kids, and p_e is the price of child quality investment.

2.2 Solution

We choose a functional form for $\pi(e)$ to be:

$$\pi(e) = b(e + \eta)^{\theta}, \tag{4}$$

where $b > 0$ is a scaling parameter, $\eta > 0$ is a baseline level of child quality, and $\theta \in (0, 1)$ is the curvature of the human capital production function. We choose this functional form for π as it exhibits a negative relationship between fertility and income through a quantity-quality tradeoff (de la Croix and Doepke 2003, Moav 2005, Jones, Schoonbroodt, and Tertilt 2010).

Given a level of fertility, n, $q(n)$ is the solution to the cost minimization problem given by:

$$\begin{aligned} q(n) &= \min_{t_w, t_b, m} t_w w_w + t_b w_b + m p_m \\ &\text{s.t.} \\ n &= f(t_w, t_b, m), \end{aligned} \tag{5}$$

where p_m is the relative price of good input m and w_b is the relative price of the babysitters time. We assume that f exhibits constant elasticity of substitution

between t_w and m, as given by:

$$n = \frac{1}{\kappa}\left[\phi\left(t_w^n\right)^{\rho} + (1-\phi)\left(t_b\right)^{\rho}\right]^{\frac{\zeta}{\rho}} m^{1-\zeta}, \tag{6}$$

where $\kappa > 0$ is a scaling parameter, $0 < \phi < 1$ controls the relative importance of mothers' time in the production of children, $\rho < 1$ controls the elasticity of substitution between the mother and baby sitters time, while ζ controls the relative importance of market goods.

Substituting (6) into (5), we can solve

$$q(n) = p_n n, \tag{7}$$

where

$$p_n = \left[\phi^{\frac{1}{1-\rho}} w_f^{\frac{\rho}{\rho-1}} + (1-\phi)^{\frac{1}{1-\rho}} w_b^{\frac{\rho}{\rho-1}}\right]^{\zeta\frac{\rho-1}{\rho}} p_m^{1-\zeta}\left[\left(\frac{\zeta}{1-\zeta}\right)^{1-\zeta} + \left(\frac{1-\zeta}{\zeta}\right)^{\zeta}\right]\kappa.$$

Solving the model for quality expenditures, e, and fertility rates, n, we get:

$$e^* = \max\left\{0, \frac{\theta\frac{p_n}{p_e} - \eta}{1-\theta}\right\} \tag{8}$$

and

$$n^* = \frac{\alpha}{1+\alpha}\left(\frac{w_w + w_h}{p_n + w_e e^*}\right). \tag{9}$$

3 Data

We use the 1980 Census and the American Community Survey (ACS) 2010 (Ruggles, Alexander, Genadek, Goeken, Schroeder, and Sobek 2010). Additionally, we use the National Longitudinal Study of Youth 1997 (NLSY 97). In this study we focus on the growth of inequality between 1980 and 2010. These years are chosen to allow us to follow the cohort from the NLSY 97 for their educational attainment by

their parental income, while still studying the period of rising income inequality as defined by Autor, Katz, and Kearney (2008).

We restrict the sample to white non-Hispanic married couples, aged 25-55. We further restrict the sample to couples where the husband works at least 35 hours a week and at least 40 weeks per year, following Autor, Katz, and Kearney (2008). We do not include those living in 'group quarters'.

We define income inequality by selecting points along the income distribution to feed into the model. For 1980 we use the Census while the ACS is used for 2010. Using family income levels, we drop the bottom and top 2% of the distribution. We create deciles at each age and then take the average over ages for each decile.

Next, we describe how we calculate wages in the data. For each decile, we take an average of the husbands total income and divide by his hours in order to deduce his wage.[7] For the women, we calculate their wages by dividing their earnings by their hours. If they do not work, or their hourly wages are less than $2 in 2010 dollars, we impute their wages using a Heckman model following closely the strategy implemented by Mulligan and Rubinstein (2008). To calculate hours worked by women in the marketplace, we average the hours by deciles. Normalizing the average amount men work to 1, we simply divide the average female hours by decile by the average of all male hours in order to come up with the target for the fraction of womens' time spent working by deciles.

We estimate the hybrid fertility rate (HFR), as in Shang and Weinberg (2013), by deciles. The hybrid fertility is the total fertility rate, adjusted for the fact that we begin at age 25, and not when women first become fecund or start to have children. In order to make this adjustment, we replace the summation of fertility rates until age 25 by the completed fertility by that age.

This paper is concerned not with fertility per se, rather relative fertility among the various income deciles. To this end, we define *reproductive success*, denoted

[7] In this model, men's earnings are simply an income effect. We therefore want to include all of their income in our calculation of their wages.

rs_i, to be the relative fertility of decile i. Formally,

$$rs_i = \frac{n_i}{\sum_{j=1}^{j=10} n_j}. \tag{10}$$

Our empirical counterpart for child quality is college graduation rates. We calculate the graduation rates of children of various families following Bailey and Dynarski (2011). Using the NLSY, we divide parents into deciles as above. We then calculate the fraction of children from each decile that completes a college education.

4 Calibration

In this Section, we describe the process of calibrating the model. We aim to calibrate the model so it is consistent with cross-sectional observations in 1980. Thus, we do not target any of the changes in reproductive success between 1980 and 2010.

We discuss how we match the model to the data, followed by an illustration of the model fit.

4.1 Parameterization

This model has 11 parameters, $\Omega = \{\alpha, b, \theta, \eta, \phi, \kappa, \rho, p_e, p_m, w_b, \zeta\}$. While all parameters are jointly identified, what follows below is a heuristic strategy for identification of each parameter, as summarized in Table 1. Again, we are targeting data moments *only* from 1980. Nothing in 2010 is targeted.

α represents how much parents care about their children relative to other goods. We therefore identify this parameter by targeting the fraction of income spent on children. We follow Doepke (2004), who argues that this number is 40%. Next, we turn to b and θ. b scales the education profile, while θ helps determine it's slope, as it controls the relative payoff to investing in education for rich vs

poor households. These two parameters are inferred from the profile of college completion by decile. η represents the basic level of education that all children get free of cost, while ϕ represents how important the mother's time is for the production of children. Intuitively, these affect the level and slope of fertility, respectively, and thus are identified off of the reproductive success profile. κ scales the cost of children, which includes mother's time, while ρ controls the elasticity between mother's time input and purchased goods input into the production of children. They can thus be deduced by targeting the profile of women's hours worked. We set p_e to the median wage of women. p_m is set to match the average expenditures, as a fraction of expenditure, on home inputs. w_b and ζ control the cost of babysitters, and their importance relative to other home inputs, respectively. We therefore identify these parameters by targeting the profile of babysitter hours hired by income decile. As these are preliminary results, we have yet to calculate the baby sitter profile or the expenditures on home inputs.

Parameter	Meaning	Identification
α	weight on children	% expend. on kids
b	scaling	col. grad. prof.
θ	exponent π	col. grad. prof.
η	basic edu.	rs prof.
ϕ	prod. of kids	rs prof.
κ	scaling	wife hrs work
ρ	elast. wife/m	wife hrs work
p_e	cost of edu.	median wife wage
p_m	price of m	expen. on home inputs
w_b	price of babysitter	prof. babysitter hr
ζ	importance of m	prof. babysitter hr

Table 1: Identification

4.2 Model Fit

What follows is a numerical example rather than a full calibration. We successfully matched some of the moments we are targeting.

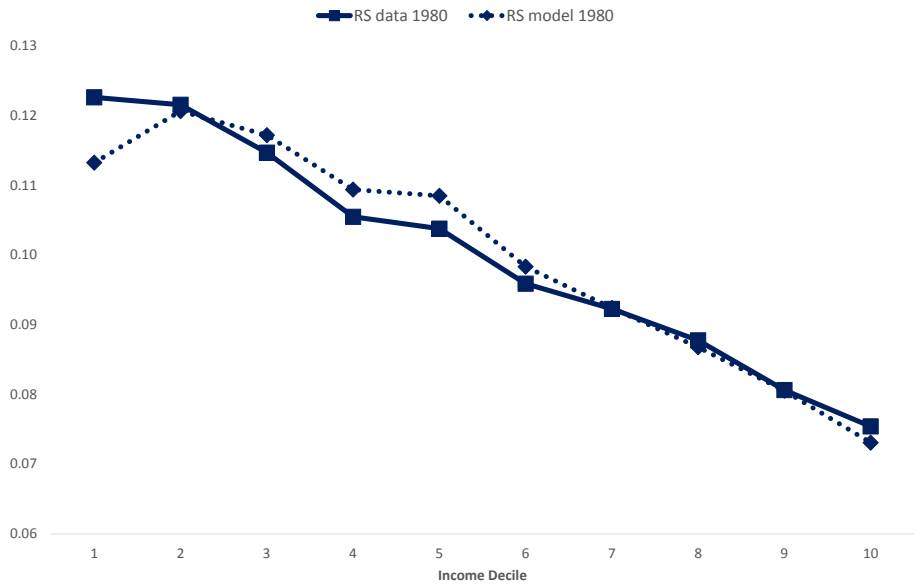

Figure 2: Model Fit, Reproductive Success

As can be seen in Figures 2, 3, and 4, the model fits well the moments related to reproductive success, college graduation rates, and the mothers' time allocations.

5 Results

We then solve the model with the 2010 income distribution. We find that reproductive success in the model became flatter, as represented in Figure 5.

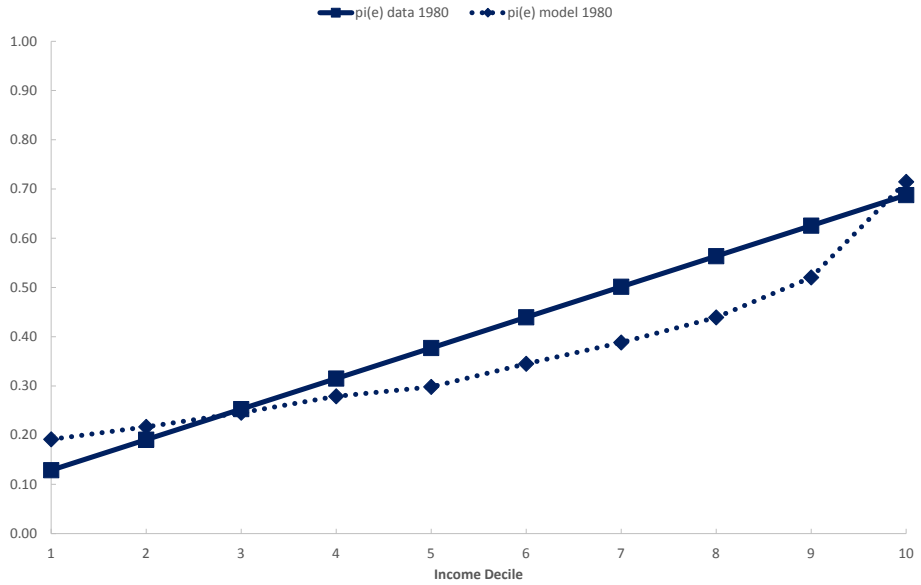

Figure 3: Model Fit, College Graduation Rates

In order to compare with the back-of-the-envelope calculation from the introduction, which implied a two percentage point rise in education, we use the model's prediction for reproductive success in 2010 and the model's 1980 college attainment profile to calculate how education changes *just as a response to differential fertility*. We find that education rose by 2.7%, or about 60% of the potential amount to be explained.

We now compare the results we found with those implied by a model without marketization.

5.1 The Importance of Marketization

The premise of this paper is that growing inequality leads to a change in reproductive success through the marketization of child care and home production.

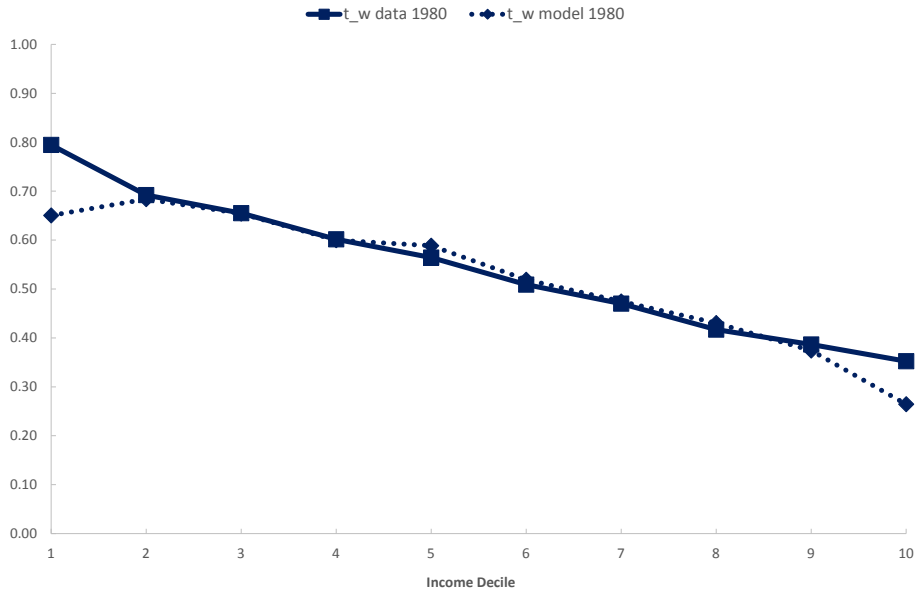

Figure 4: Model Fit, Mothers' Time

To illustrate the importance of this mechanism, we now perform the same exercise as before, but requiring that all childcare be done by the mother. That is, the production of children, formerly equation (2), is now entirely performed by the mother. The equation for production of children is now given by:

$$n = \frac{1}{\kappa} t_w. \tag{11}$$

Thus the cost of producing children, as given by Equation (7), is now $q(n) = \kappa w_w n$. Accordingly, now $p_n = \kappa w_w$. Equations (8) and (9) solve the new model, using the updated definitions of $q(n)$ and p_n.

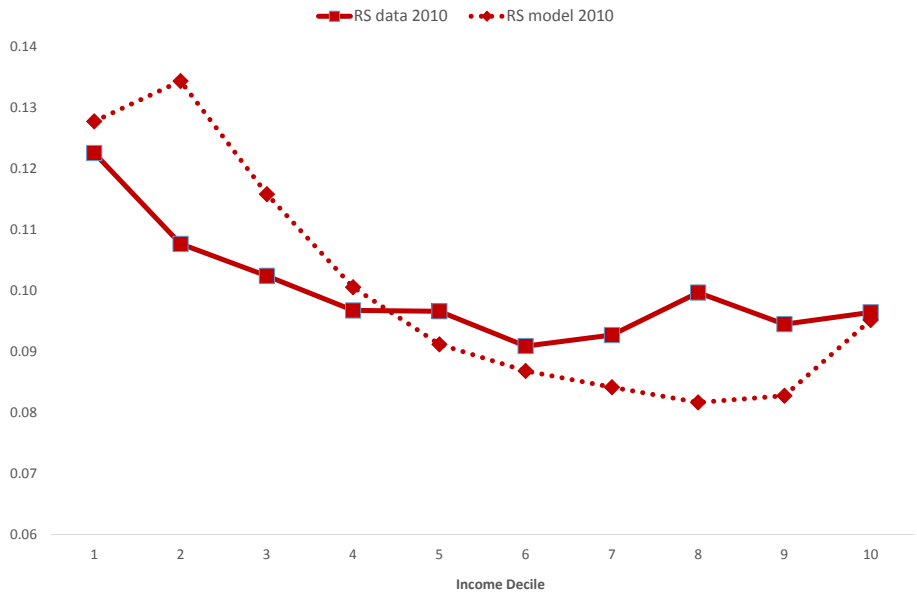

Figure 5: Reproductive Success, 2010

5.1.1 No Marketization Model Fit & Results

In this version of the model we do not target any aspect of marketization, neither babysitters nor home inputs, as they do not appear in the model. The model is still able to fit the data well, as seen in Figures 6, 7, and 8.

We then ask the model to predict reproductive success in 2010, as seen in Figure 9. Unlike both the data and the version of this model with marketization, the relationship between income decile and fertility becomes even steeper here.

When inequality increases under this model specification, college attainment drops by 3.9% , as opposed to the 2.7% rise in the main model.

This illustrates the importance of the mechanism.

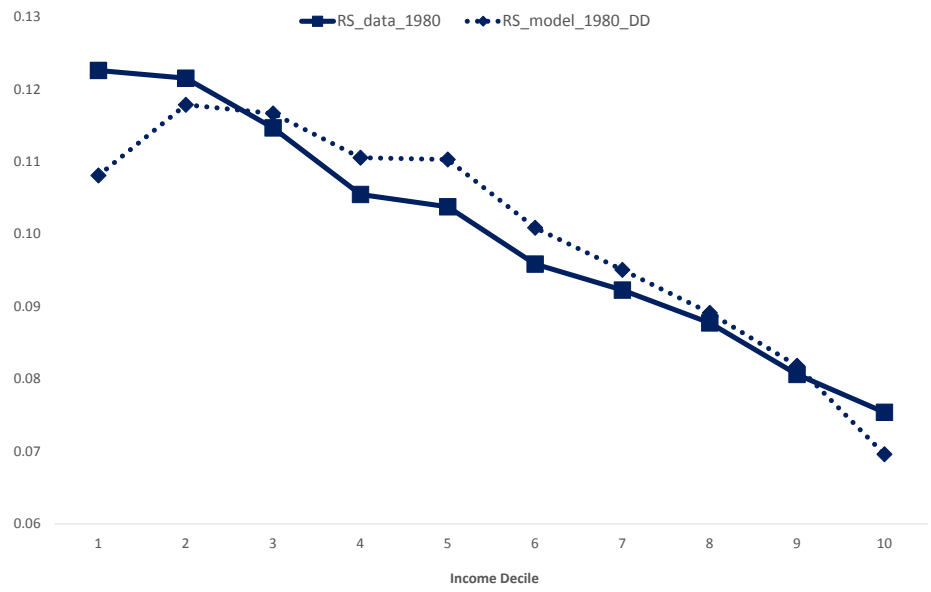

Figure 6: Model Fit, Reproductive Success

6 Discussion and Conclusions

Our data is of pretax income with no government transfers. It is logical to assume that including taxes and transfers would increase the potency of our results. This may seem counterintuitive: the government, in general, acts to reduce inequality, and thus is against our mechanism. However, the story presented here is one of *changing* inequality. The time period of 1980 to 2010 included many changes in the tax code that were regressive, in the sense of helping the highest income Americans, further exasperating after tax inequality. Furthermore, since it is the rich that drive the results in our model, it is this change in the taxes that matters, rather than transfers.

Over this time period, the college premium rose dramatically (Krusell, Ohanian, Rios-Rull, and Violante 2000). The relevance to our story of this change is

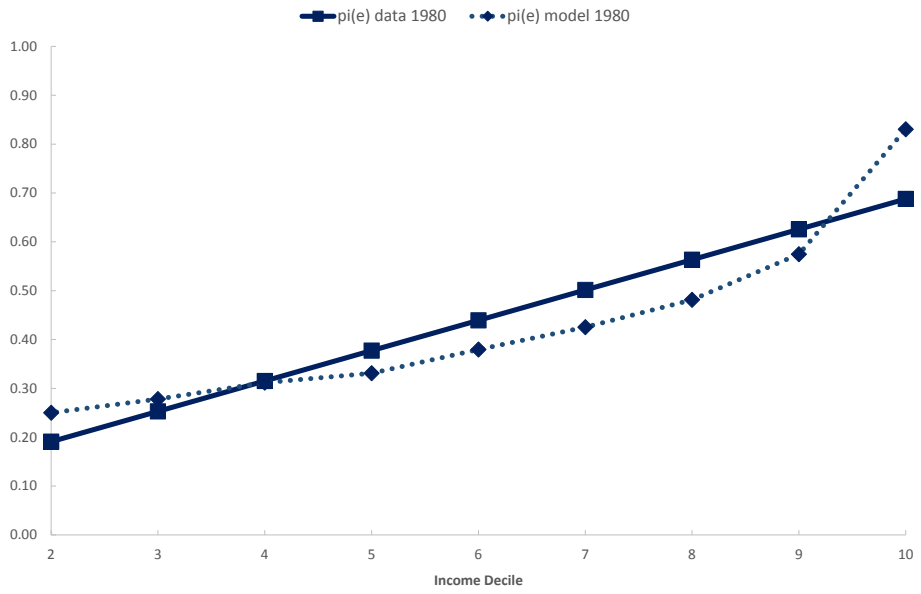

Figure 7: Model Fit, College Graduation Rates

how it interacts with inequality. That is, to the extent that inequality is associated with the rising college premium we should consider it in our model. Notice that a rising premium tends to cause people to be more likely to go to college. Thus, if inequality is associated with a rising college premium, then we are understating the effects of inequality on college attendance.

Another widely discussed phenomenon is that of rising tuition rates. At first glance, this may not be a necessary item for us to include in our analysis, since it is unclear the connection to inequality. However, it is possible to tell a story in which rising inequality led to higher tuition rates as the rich compete over limited spots at high-prestige institutions, or that workers at the university saw their wages increase due to the college premium. We must balance out this concern with the fact that, while tuition rose, financial aid grew dramatically as well.

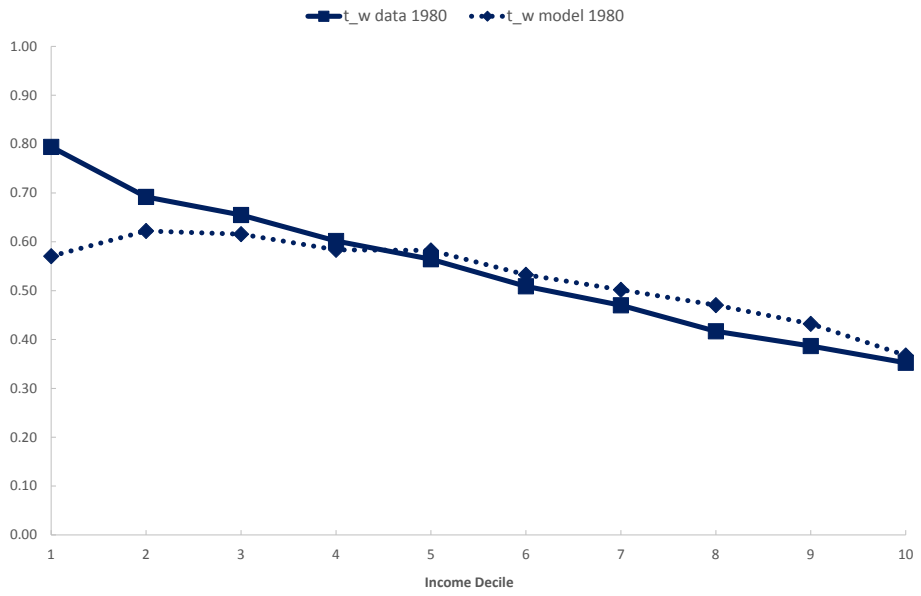

Figure 8: Model Fit, Mothers' Time

Furthermore, non-inequality related causes may well have driven much of the rise in tuition. For instance, there was a substantial drop in government subsidies to state schools. Additionally, the rise in financial aid increased demand for college, resulting in higher tuition rates. Since we cannot accurately assess how much the change in the cost of education over this time period may have been due to rising inequality (or offset by rising aid), we leave it out of our analysis.

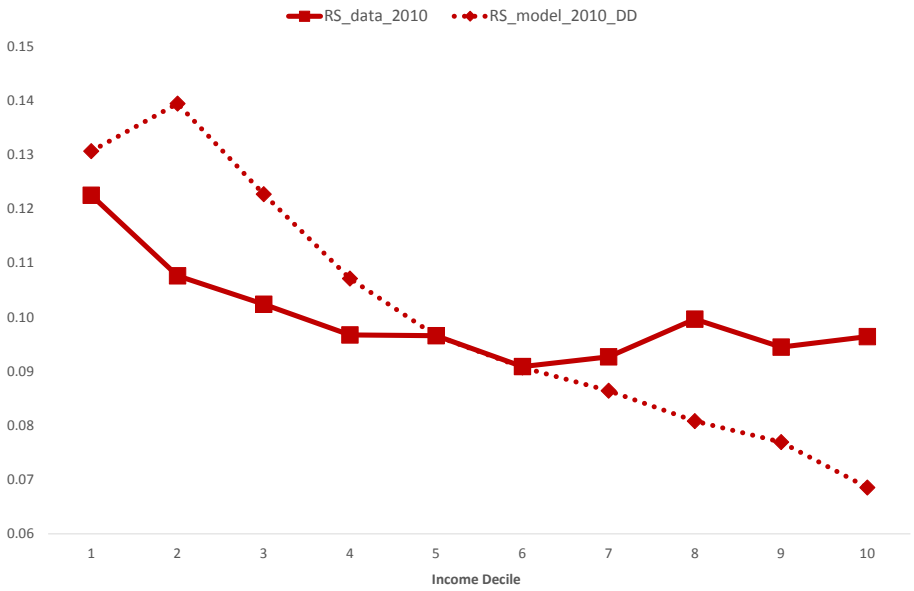

Figure 9: Reproductive Success without Marketization, 2010

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