Abortions, Inequality and Intergenerational Mobility: A Quantitative Evaluation

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Abstract

In the last three decades over a million abortions are performed annually in the United States. Empirical studies such as Donohue and Levitt (2001) and Gruber, Levine and Staiger (1999) assess the impact of legalization of abortions on crime and living conditions of children. They argue that legalization of abortions provides better living conditions and human capital endowments to surviving children. This paper takes seriously the hypothesis that the improved living conditions of children due to legalized abortion will alter their labor market outcomes. The main question of the paper is what are the aggregate implications of abortions for income inequality and intergenerational transmission of income? A model of fertility, human capital transmission, contraception and abortion decisions is built to answer this question quantitatively.

JEL Classifications: E24, D31, J13, J17, J62.
Key Words: Fertility, Abortions, Contraception, Income Inequality, Intergenerational Mobility.

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1 Introduction

Unintended pregnancies accounted for around half of the 6.4 million pregnancies in the United States in 2000. Half of these unintended pregnancies resulted in abortion (Finer and Henshaw, 2006).[1] Several recent papers have studied the consequences of abortion access empirically. Donohue and Levitt (2001) analyze the impact of legalized abortion on crime. The evidence they present suggests that legalized abortion reduced crime rates with a twenty-year lag and find that an increase of 100 abortions per 1000 live births reduces cohort's crime by 10%. When using the estimates to create a counterfactual, it turns out that crime was 15-25% lower in 1997 than it should be in the absence of legalized abortion. They claim that using this counterfactual and previously estimated cost of crime, the social benefit of reduced crime due to legalization is of order $30 billion annually. The explanations for this strong effect of abortion on crime are either due to reduced cohort size or lowered offending rates per capita. The intuitive explanation for lower average rates goes through two channels: (i) women who have abortions are those who are more likely to give birth to children who engage in crime or/and; (ii) women may use abortion to optimize the timing of childbearing and children can receive better living environment and consequently better human capital endowments.

In a similar study, Gruber, Levine and Staiger (1999) ask the following question: Would the children who were not born because of abortion access have lived in different circumstances than the average child in their cohort? The answer depends on the magnitude of two opposing effects, (i) positive selection: women use abortion to avoid bearing children in adverse circumstances and the marginal child has worse living conditions than the average child of the cohort or/and; (ii) negative selection: if the most disadvantaged women are constrained in their abortion access (geographically or financially), the marginal child has better living conditions than the average child of the cohort. They discover sizable positive selection:

[1]The debate on abortion legalization in the U.S. is dominated by two ideological positions. Pro-life supporters consider the fetus a living being and therefore view abortion as taking life. On the other extreme, the pro-choice stand views abotion as an essetial woman's right to control her own body. Although these two groups often use well-rehearsed arguments for the economic consequences of legalizing abortion, the discussion between them is of moral nature. This paper views abortion access as an economic policy, and its only goal is to gleam some light on the economic consequences of the legalization of abortion for the agrregates of the economy. For more details, see Levine (2004).

> "[...]the average living circumstances of cohorts of children born immediately after abortion became legalized improved substantially relative to preceding cohorts, and relative to places where the legal status of abortion was not changing. Our results suggest that the marginal children who were not born as a result of abortion legalization would have systematically been born into less favorable circumstances if the pregnancies had not been terminated: they would have been 60 percent more likely to live in a single-parent household, 50 percent more likely to live in poverty, 45 percent more likely to be in a household collecting welfare, and 40 percent more likely to die during the first year of life."

The empirical studies on abortion access are not able to give information on the long-run aggregate implications of the change in the average living standards of children due to abortion. The reduced form estimates of the cited works are inappropriate when computing aggregate changes due to abortions.[2] A more suitable framework would be that of a general equilibrium model of fertility and abortion decision which maps the level of abortion access into a particular intergenerational mobility pattern and ultimately, into a different labor market outcome. The main mechanism works through initial human capital endowments given to children by their parents. The amount of this endowment is determined by preferences, income levels, and availability of methods to reduce the risk due to the stochastic nature of the fertility choice. Models of children's quality-quantity tradeoffs relating intergenerational mobility and income inequality date back to Becker and Tomes (1979). Aiyagari, Greenwood and Guner (2000) and Greenwood, Guner and Knowles (2003) use this approach in a search equilibrium framework to analyze the marriage market. Restuccia and Urrutia (2004) build a model of this type to emphasize the role of early children's education in the intergenerational persistence of income.[3]

The goal of this paper is to examine the quantitative importance of access to abortion for the income inequality. A dynamic equilibrium model of matching, abortions, contraception and fertility choice is built using the U.S. earnings distribution for the late 1990s and early

[2] Another strand of the emprical literature utlizes structural dynamic models of dicrete choice with stochastic fetrility and contraception choice, to estimate key structural paramters of the models. See, for example, Hotz and Miller (1993) and Carro and Mira (2006).

[3] An alternative approach is taken by Huggett, Ventura and Yaron (2006). They use the human capital accumulation model of Ben-Porath (1967) to reproduce the dynamics of the U.S. earnings distribution. Huggett, Ventura and Yaron (2007) discuss the role of the initial conditions in explaining lifetime inequality.

2000s to match the fertility and abortions behavior in the economy. Then, a set of counterfactual earnings distributions is derived for the case in which legalization of abortion is not introduced. The resulting differences in terms of inequality are interpreted as evaluations of the policy of legalizing abortion.

In the model, female and male agents start their adult life with certain education level and a possible premarital teenage birth. They match and may form married households in an assortative fashion based on education. Alternative, they may choose to form single-headed households. The married derive disutility from the presence of a child from premarital teenage birth in the household. After households are formed they face a trade-off between quantity and quality of children they may have. Fertility is stochastic, i.e., the quantity of children they desire is not realized with probability of one. They can use contraception and abortion as instruments to mitigate the risk stemming from this uncertainty. Contraception is an instrument that reduces the fertility risk before the realization of the fertility process, while abortion is a tool that can correct the fertility outcome after the final realization of the process. Households use a particular mix of these two instruments depending on their costs and the preferences over quantity and quality of children. Human capital endowments given to children (quality), thus, depend on the cost of abortion. The future income of children is positively correlated with their human capital endowments, and therefore is conditional on the cost of abortion as well. Using this link, the model can assess changes in the cost of abortion and their influence on the future income distribution.[4]

The general equilibrium modeling approach is essential in this exercise because, any change of the cost of abortion will alter also the functional dependency of future income on this cost. This is so because households can reconsider the way they use contraception, the number of their children, or the way they invest in their children. Reduced form estimations relate the change in the cost of abortion to future income using the old functional dependency which is not valid.

[4] Abortion policies are interpreted within the model as changes in the cost of abortion. For instance, banning abortion in the model is equivalent to imposing a prohibitively high cost of abortion at which no one can afford this procedure.

2 Facts

The number of induced abortions has been high ever since the legalization of abortion under the Roe v. Wade decision of 1973 (Figure 1). This pattern suggests that abortion continues to be a major way of mitigating risk due to the stochastic nature of the fertility choice.

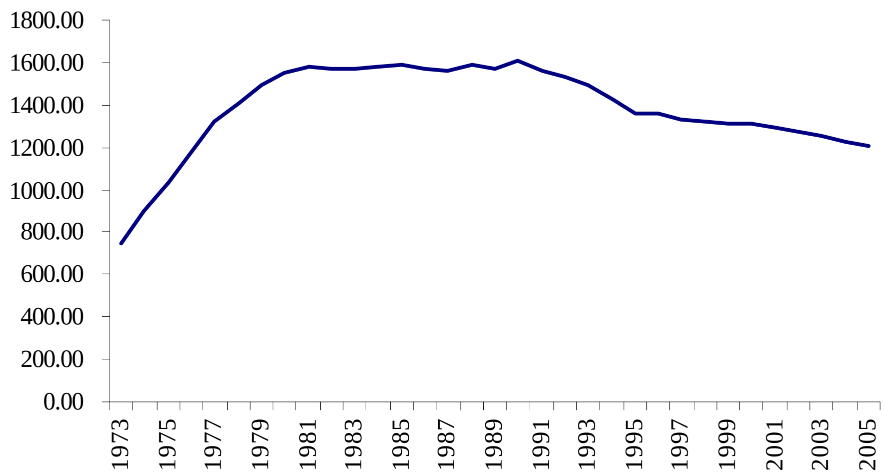

Figure 1: Number of reported abortions (in thousands), United States, 1973-2005

As emphasized in the previous section, a possible channel that links abortion numbers and income inequality can be the living environment and initial human capital endowments of children. In order to assess the feasibility of such a channel, one should look at the cross-section facts on women who abort:

- Around half of the abortions are performed before the age 25 and two-thirds before the age of 30. Abortion and unintended pregnancy rates are highest for groups 18-19 and 20-24 of age. Proportion of unintended pregnancies is highest for group $\leq$19. The percentage of unintended pregnancies ending in abortions varies across age groups but in general is around 50% and is higher for >35 women.

Table 1: Abortion and Unintended Pregnancy Rates by Age, 2001

	Abortions (%)	Abortion rate	Unintended birth rate
Age			
15-19	18.6	23	67
15-17	6.5	14	40
18-19	12	37	108
20-24	33	45	104
25-29	23.1	32	71
30-34	13.5	19	44
35-39	8.1	10	20
>40	3.1	3	6

Table 2: Unintended Pregnancies by Age, 2001

	Unintended pregnancies	
Age	As % of total	% ending in abortion
15-19	82	40
15-17	87	39
18-19	79	41
20-24	60	49
25-29	43	50
30-34	33	49
35-39	29	60
>40	38	56

- Most of the abortions are performed by never married women. Therefore,it is not surprising that rates of unintended pregnancies and abortions are higher among unmarried women.

Table 3: Abortion and Unintended Pregnancy Rates by Marital Status, 2001

	Abortions (%)	Abortion rate	Unintended pregnancy rate
Marital Status			
Married	17	8	32
Formerly married	15.6	29	52
Never married	67.3	35	70

Table 4: Unintended Pregnancy by Marital Status, 2001

	Unintended pregnancies	
Marital Status	As % of total	% ending in abortion
Married	27	27
Formerly married	63	67
Never married	77	57

- Majority of abortions are performed by women who do not have complete college education. Consequently the abortion and unintended pregnancy rates are higher for less educated women. The percentage of unintended pregnancies which end in abortion increases in education. This points out that although less educated women use abortions a lot, they still cannot insure enough against unintended pregnancies. This may occur because of higher relative costs of fertility control or poor literacy about contraception and abortion measures.

Table 5: Abortion and Unintended Pregnancy Rates by Education, 2001

	Abortions (%)	Abortion rate	Unintended pregnancy rate
Education			
<hs	12.7	22	76
hs	30.3	21	54
sc	40.6	25	47
col	16.4	12	26

Table 6: Unintended Pregnancies by Education, 2001

	Unintended pregnancies	
Education	As % of total	% ending in abortion
<hs	50	36
hs	47	46
sc	52	60
col	24	55

- Around 40% of the abortions are preformed by women who do not have children. This is consistent with the fact that the majority of abortions are performed by women who are not married and below 25.

Table 7: Abortion and Unintended Pregnancy Rates by Number of Live Births, 2001

	Abortions (%)	Abortion rate
No. of live births		
0	39.1	19
1	27.4	32
≥ 2	33.5	18

The unintended pregnancy rate can be interpreted as the severity of the error when making children. The percentage of unintended pregnancies ending in abortion is the efficacy with which this error is corrected. The resulting abortion rate is a mix between these two factors because it depends both on the severity of the error and the efficiency when correcting this error.

3 Economic Environment

Consider an overlapping generations economy with a continuum of individuals, each of which lives for five periods. Individuals are either males or females, and these groups are of equal size. In the first period of their lives agents are children. They inherit a level of learning ability from their parents. In the second period agents are teenagers. Parents invest in the human capital development of their children and teenagers. Female and male teenagers date each other and females face a probability of getting pregnant. They have the option to terminate the pregnancy through an abortion. If they do not terminate it, a premarital teenage birth is realized.

Teenagers acquire certain educational achievement which is determined by their learning abilities, their parents' spending, and in the case of the females, by the occurence of a premarital teenage birth. The educational achievements of teenagers, jointly with their learning ability, determine their starting positions in terms of human capital on the labor market.

Agents live as adults for the next three periods in which they are active workers. In the first and the second period of adult life agents are fertile, while in the third they are not. Workers have a unit time endowment per period which they supply inelastically to the labor market in exchange for a wage per human capital unit. Human capital evolves between periods at a constant rate. In the case of females the evolution of human capital is also influenced by the number of children present in the household.

Adult females and males of the same age match in a marriage market before the start of their first period as adults and form household units for joint consumption, and making and raising children. These units can be married, single female, or single male households. Married and single female households can have children and make decisions about consumption, fertility, and resources spent on their children's development while male-headed households cannot have children and care only about their consumption. In the detailed description of the economic environment below, single male households are ignored because of their simplicity. Children stay for two periods with their parents, in the second of which they are teenagers.

Fertility decision of a household accounts for the number of desired children, contraception and abortion choice. Fertility is stochastic, i.e., the number of desired children is not realized with probability one. Contraception and abortion are instruments which households utilize in coping with the stochastic nature of fertility.

3.1 Children and Teenagers

3.1.1 Children

Learning ability. Children are endowed with a level of learning ability, π. Learning abilities are correlated across parents and children and follow continuous AR(1) process

$$\log(\pi') = \varphi \log(\pi^f) + \epsilon\ ,\ \ \epsilon \sim N(0, \sigma_\epsilon^2)$$

where π^f is the learning ability of the mother[5] and $0 < \varphi < 1$.

Human capital investment. Parents spend b^1 resources per child.

3.1.2 Teenagers

Teenage premarital fertility, contraception and abortion. Female teenagers match with partners from the opposite sex on a teenage dating market. The probability of getting pregnant in the process of dating is

$$p(z) = \frac{1}{1 + \mu_1(1 - e^{-z})},$$

[5] Subscripts ^{f} and ^{m} denote the gender specificity of a variable, i.e. female and male. The subscripts are omitted when gender does not matter for the particular realization of the variable.

with $p'(\cdot) < 0$, $p''(\cdot) < 0$, and $\mu_1 > 0$. The variable $z \in [0, \infty)$ denotes the effort that the female teenager puts into contraception. The cost of this effort is

$$k(z) = \mu_2 z^2,$$

with $k'(\cdot) > 0$, $k''(\cdot) > 0$, and $\mu_2 > 0$.

The female teenager has the option to abort the pregnancy at a utility cost κ. The indicator I_p takes the value of one if the female teenager gets pregnant, and zero otherwise. If she does not perform an abortion the resulting birth is called a teenage premarital birth. The indicator I_b takes the value of one if a female teenager has a teenage premarital birth, and zero otherwise.

Human capital investment. Parents spend b^2 resources per teenager.

Educational Achievements. Teenagers have a probability of attaining high educational degree and become skilled with probability q. For female teenagers, this probability function is

$$q^f(\pi^f, b^1, b^2, I_b) = 1 - \exp(\psi_1 I_b - \psi_2 \pi^f - \psi_3 b^1 - \psi_4 b^2),$$

and it is increasing in its first 3 arguments, but decreasing in the forth, with ψ_1, ψ_2, ψ_3, $\psi_4 > 0$. For females a realized teenage premarital birth lowers the likelihood of becoming skilled, and higher learning ability and human capital investments increase it.

For male teenagers the corresponding probability function is given by

$$q^m(\pi^m, b^1, b^2) = 1 - \exp(-\psi_5 \pi^m - \psi_6 b^1 - \psi_7 b^2),$$

and it is increasing in all its arguments, with $\psi_5 > 0$, $\psi_6 > 0, \psi_7 > 0$. This signifies that the odds of becoming skilled for males are positively influenced by the level of their learning ability and their parents' human capital investments b^1 and b^2.

Educational achievements of agents at the beginning of their adult life are summarized by

$$e = \begin{cases} e_1 \text{ if unskilled} \\ e_2 \text{ if skilled} \end{cases}.$$

3.2 Adults

Human Capital and its Evolution. The level of human capital at the beginning of the adult life of the agents is determined by their ability level and educational achievement. The starting values of human capital are given by

$$h_1^f = \varkappa \pi \chi_e$$

and

$$h_1^m = \pi \chi_e$$

where the parameter $0 < \varkappa < 1$ reflects the gender gap in income.

Human capital evolution for females over the life cycle is described by

$$h_{j+1}^f = \begin{cases} \xi_j h_j^f \text{ if } n^1 = 0 \\ \xi_j h_j^f \text{ w.p. } \lambda \text{ if } n^1 > 0 \\ h_j^f \text{ w.p. } 1-\lambda \text{ if } n^1 > 0 \end{cases}$$

where $j \in \{1, 2, 3\}$ is the age of the adult agents, and n^1 denotes the number of new born children to the female in the period. The above specification implies that the earnings potential of females with children grows with probability λ, and stays the same with probability $1-\lambda$. This reflects the fact that new born children may negatively influence the current human capital accumulation process for a female.[6] Human capital for males evolves according to

$$h_{j+1}^m = \xi_j h_j^m.$$

Income. Workers receive wage w per efficiency unit of human capital. Therefore a married household income equals $wh^f + wh^m$, while a single female household income is wh^f.

Household Formation. Adult agents form households in the beginning of their adult life in a marriage market where they meet adults of the opposite sex and of the same age as them. Agents match with probability θ randomly within their own educational group, and with probability $(1-\theta)$ randomly across all agents of the opposite sex. A potential match appears together with a match-specific quality parameter γ drawn from a distribution $\Gamma(\gamma)$. In addition, all things equal males prefer females without a teenage premarital birth (see

[6] Recent empirical studies of the effect of childbearing on female human capital accumulation are Neumark and Korenman (1992), Budig and England (2001), and Anderson, Binder and Krause (2002).

section on household preferences). Agents choose to marry or stay single in the marriage market. They compare the value of the married household they may enter and the value of forming a single household instead.

Fertility. Married and single female households can have children in period 1 or/and in period 2 of their adult lives. They choose the number of children which they desire to have $k \in \{0, 1, 2, \ldots, N\}$ in a period. In the first adult period of her life, the female of the household might already have had a birth as a teenager. This potential child is considered to be delivered in the first period of adulthood and is taken into consideration when k is chosen by the household. The probability of having male or female children is the same for all pregnancies. Due to the stochastic nature of human fertility, the number of realized children $\widetilde{n} \in \{0, 1, 2, \ldots, N\}$ is described by a $N+1$-by-$N+1$ matrix $\Pi^{j,s,r}$, each of which rows represents the probabilities that $\widetilde{n}$ children will be realized given the choice k, which is the number of the row. Therefore,

$$\Pi^{j,s,r} = \begin{bmatrix} \Pr(\widetilde{n} = 0|k = 0) & \cdots & \Pr(\widetilde{n} = N|k = 0) \\ \vdots & \ddots & \vdots \\ \Pr(\widetilde{n} = 0|k = N) & \cdots & \Pr(\widetilde{n} = N|k = N) \end{bmatrix}$$

where $j \in \{1, 2\}$ is the age of the fertile household, and $s \in \{0, 1\}$ is an indicator whether the household has purchased contraception treatment or not (discussed shortly), and $r \in \{f, t\}$ indexes whether the household is single female (f) or married (t). Note that $\sum_{i=0}^{N} \Pr(\widetilde{n} = i|k = i') = 1$, for every $i' \in \{0, 1, 2, \ldots, N\}$.

Contraception and abortion. If contraception treatment is purchased by a household ($s = 1$), then the $N+1$-by-$N+1$ transition matrix from k to $\widetilde{n}$ is $\Pi^{j,1,r}$, otherwise ($s = 0$) it is $\Pi^{j,1,r}$. The purchase of contraception treatment strengthens the diagonal of the transition matrix. In the first fertile period the fertility matrices $\Pi^{1,s,r}$ assign relatively higher probabilities to fertility outcomes higher than the desired, while in the second period, probabilities are relatively higher for lower fertility outcomes than the desired. This reflects the fact that human ability of reproduction decreases with age. The fertility matrices are also contingent on the household type. This reflects the fact that single females experience higher unintended pregnancy rates than married females.

Abortion within the household, on the other hand is defined as a medical procedure that can be performed after the realization of stochastic fertility process. It can bring back the realization of the number of children to the original choice k or to $k+1,\ldots,\widetilde{n}$ if $\widetilde{n}>k$ with $\widetilde{n}-k$ or $\widetilde{n}-k-1,\ldots,0$ abortions performed. If $\widetilde{n}\leq k$, no abortions are performed. The final number of children born in a household per period is $n^1=\widetilde{n}-a$, where a is the number of performed abortions per period ($\widetilde{n}\geq a\geq 0$).

Parents' spending on children. Once the final number of children born in a household per period, n^1, is realized, parents spend b^1 on the human capital formation of each of their new born children. In the subsequent period they spend b^2 on each of these children who then are teenagers.

Sequence of events. In each fertile period, the sequence of events goes like this:

1. Households choose k and whether to purchase contraception treatment ($s=1$ or $s=0$).

2. k is realized as $\widetilde{n}$ and households decide whether to perform abortions (if $\widetilde{n}>k$) and how many to perform (a). n^1 is determined.

3. Households choose the human capital spendings per child and teenager, b^1,b^2, and household consumption, c.

Preferences. Households have the following period utility functions:

- Married households

$$\begin{aligned} u^t(c,b^1,b^2,n^1,n^2,I_b,\gamma) &= \log\left(\frac{c}{1+\zeta_1+\zeta_2 n^1+\zeta_3 n^2}\right) \\ &\quad +\alpha_1\log(1+b^1n^1)+\alpha_2\log(1+b^2n^2)-\alpha_3 I_b-\gamma \end{aligned}$$

- Single female households

$$u^f(c,b^1,b^2,n^1,n^2)=\log\left(\frac{c}{1+\zeta_2 n^1+\zeta_3 n^2}\right)+\alpha_1\log(b^1n^1)+\alpha_2\log(b^2n^2)$$

- Single male households

$$u^m(c)=\log c.$$

  The parameters $\zeta_1>0$, $\zeta_2>0$, and $\zeta_3>0$ reflect the existence of economies of scale in household consumption. In particular, adding a second member to a household has a weight $\zeta_1<1$ in calculating per capita household consumption, and similarly adding an additional child or teenager has a weight of $\zeta_2<1$ or $\zeta_3<1$.

4 Decision Making

4.1 Households' Problems

4.1.1 Married Household's Problems

Consider the problem of a married household in period one of their adult life after the fertility and contraception choices are made, and fertility outcome $\widetilde{n}$ is realized. The household is about to decide how many abortions to perform given the realization $\widetilde{n}$ and the contraception decision s. The value of this problem is denoted by $\widetilde{V}_1^t(h^f, I_b, h^m, \gamma, \widetilde{n}, s)$.[7] Denote by $V_1^t(h^f, I_b, h^m, \gamma)$, the value of the problem that a household faces before fertility and contraception choices are made, and the realization of the fertility outcome $\widetilde{n}$ is not yet known. The problem after the fertility outcome is realized is

$$\begin{aligned}\widetilde{V}_1^t(h^f, I_b, h^m, \gamma, \widetilde{n}, s) \quad = \quad & \max_{a,c,b^1}\{u^t(c, b^1, 0, n^1, 0, I_b, \gamma) + \beta I_{n^1}[\lambda V_2^t(\xi h^f, n^{2\prime}, I_b, \xi h^m, \gamma) \\ & +(1-\lambda)V_2^t(h^f, n^{2\prime}, I_b, \xi h^m, \gamma)] \\ & +\beta(1 - I_{n^1})V_2^t(\xi h^f, n^{2\prime}, I_b, \xi h^m, \gamma)\} \end{aligned} \tag{1a}$$

$$\begin{aligned} \text{s.t. } c + (b^1 + \delta^1)n^1 + \eta a &\leq wh^f + wh^m - \rho s \\ n^1 &= I_b + \widetilde{n} - a \\ n^{2\prime} &= n^1 \end{aligned}$$

where δ^1 is the fixed costs of bearing a child, ρ is the cost of contraception treatment, η is the cost of abortion, s is a decision whether to purchase contraception ($s = 1$) or not ($s = 0$), a is the number of performed abortions. The indicator function I_{n^1} take the value of one if the number of new born children to the household is larger than zero ($n^1 > 0$), and zero otherwise.

Married household in period one of their adult life do not have any teenagers present in the household, however, the female might have had a teenage premarital birth, which is reflected in the final number of children born to the household.

The problem before the realization of the fertility process is given by

$$V_1^t(h^f, I_b, h^m, \gamma) = \max_{k,s}\{\sum_{\widetilde{n}=0}^{N} \Pi_{k\widetilde{n}}^{1,s} \widetilde{V}_1^t(h^f, I_b, h^m, \gamma, \widetilde{n}, s)\}. \tag{2}$$

[7] The age or type subscripts on variables are suppresed in the cases in which they are not essential.

Similarly in the period two of the life of the married household, the problem after the fertility outcome is realized is represented recursively by

$$\begin{aligned}\widetilde{V}_2^t(h^f, n^2, I_b, h^m, \gamma, \widetilde{n}, s) &= \max_{a,c,b^1,b^2}\{u^t(c, b^1, b^2, n^1, n^2, I_b, \gamma) + \beta I_{n^1}[\lambda V_3^t(\xi h^f, n^{2\prime}, I_b, \xi h^m, \gamma) \\ &\quad +(1-\lambda)V_3^t(h^f, n^{2\prime}, I_b, \xi h^m, \gamma)] \\ &\quad +\beta(1-I_{n^1})V_3^t(\xi h^f, n^{2\prime}, I_b, \xi h^m, \gamma) \qquad (3)\end{aligned}$$

$$\begin{gathered}\text{s.t. } c + (b^1+\delta^1)n^1 + (b^2+\delta^2)n^2 + \eta a \leq wh^f + wh^m - \rho s \\ n^1 = \widetilde{n} - a \\ n^{2\prime} = n^1\end{gathered}$$

where δ^2 is the fixed cost of having a teenager in the household. For period two married households, the problem before the realization of the fertility process is

$$V_2^t(h^f, n^2, I_b, h^m, \gamma) = \max_{k,s}\{\sum_{\widetilde{n}=0}^{N} \Pi_{k\widetilde{n}}^{2,s}\widetilde{V}_2^t(h^f, n^2, I_b, h^m, \gamma, \widetilde{n}, s)\}. \qquad (4)$$

Married households of age 3 are not fertile and face the deterministic problem

$$\begin{gathered}V_3^t(h^f, n^2, I_b, h^m, \gamma) = \max_{c,b^2}\{u^t(c, 0, b^2, 0, n^2, I_b, \gamma)\} \qquad (5) \\ \text{s.t. } c + (b^2+\delta^2)n^2 \leq wh^f + wh^m.\end{gathered}$$

4.1.2 Single Female Household's Problems

Let the value of the problem for a single female household in period one of the adult life be $\widetilde{V}_1^f(h^f, I_b, \widetilde{n}, s)$, and the value after the realization of the fertility choice be $V_1^f(h^f, I_b)$. Then the problems faced by the single female household are

$$\begin{aligned}\widetilde{V}_1^f(h^f, I_b, \widetilde{n}, s) &= \max_{a,c,b^1}\{u^f(c, b^1, 0, n^1, 0) + \beta I_{n^1}[\lambda V_2^f(\xi h^f, n^{2\prime}) \\ &\quad +(1-\lambda)V_2^f(h^f, n^{2\prime})] + \beta(1-I_{n^1})V_2^f(\xi h^f, n^{2\prime})\} \qquad (6)\end{aligned}$$

$$\begin{gathered}\text{s.t. } c + (b^1+\delta^1)n^1 + \eta a \leq wh^f - \rho s \\ n^1 = I_b + \widetilde{n} - a \\ n^{2\prime} = n^1\end{gathered}$$

before the realization of the fertility choice, and

$$V_1^f(h^f, I_b) = \max_{k,s}\{\sum_{\widetilde{n}=0}^{N} \Pi_{k\widetilde{n}}^{1,s} \widetilde{V}_1^f(h^f, I_b, \widetilde{n}, s)\} \tag{7}$$

after the fertility uncertainty is resolved.

In period 2 of the life of the single female household, the corresponding problems are

$$\begin{aligned} \widetilde{V}_2^f(h^f, n^2, \widetilde{n}, s) &= \max_{a,c,b^1,b^2}\{u^f(c, b^1, b^2, n^1, n^2) + \beta I_{n^1}[\lambda V_3^f(\xi h^f, n^{2\prime}) \\ &\quad +(1-\lambda)V_3^f(h^f, n^{2\prime})] + \beta(1 - I_{n^1})V_3^f(\xi h^f, n^{2\prime})\} \end{aligned} \tag{8}$$

$$\begin{aligned} \text{s.t. } c + (b^1 + \delta^1)n^1 + (b^2 + \delta^2)n^2 + \eta a &\leq wh^f - \rho s \\ n^1 &= \widetilde{n} - a \\ n^{2\prime} &= n^1 \end{aligned}$$

and

$$V_2^f(h^f, n^2) = \max_{k,s}\{\sum_{\widetilde{n}=0}^{N} \Pi_{k\widetilde{n}}^{2,s} \widetilde{V}_2^f(h^f, n^2, \widetilde{n}, s)\}. \tag{9}$$

Finally, in period 3, the single female household is not fertile and the deterministic problem is given by

$$\begin{aligned} V_3^f(h^f, n^2) &= \max_{c,b^2}\{u^f(c, 0, b^2, 0, n^2)\} \\ \text{s.t. } c + (b^2 + \delta^2)n^2 &\leq wh^f. \end{aligned} \tag{10}$$

4.2 Matching Problem

When matched with a partner in the marriage market in period 1 of their adult lives, agents choose whether to accept or reject the match comparing the values of the potential married household they may form if they accept and the single agent household they may form if they reject the match. This decision is summarized by the indicator functions I^f for female agents and I^m males, which take the value of one if the agent accepts the match, and zero otherwise. Formally,

$$I^f(h^f, I_b, h^m, \gamma) = \begin{cases} 1 \text{ if } V_1^t(h^f, I_b, h^m, \gamma) \geq V_1^f(h^f, I_b) \\ 0 \text{ if } V_1^f(h^f, I_b) \geq V_1^t(h^f, I_b, h^m, \gamma) \end{cases}$$

and

$$I^m(h^f, I_b, h^m, \gamma) = \begin{cases} 1 \text{ if } V_1^t(h^f, I_b, h^m, \gamma) \geq V_1^m(h^m) \\ 0 \text{ if } V_1^m(h^m) \geq V_1^t(h^f, I_b, h^m, \gamma) \end{cases}.$$

Single female households arise in the model for three reasons: first, because of unfavorable match specific shocks, second because there is negative preference over teenage births, and third, because marrying a female with a teenage premarital birth constrains the fertility choice of the household.

Finally the indicator function I^t summarizes whether a match becomes a married household, i.e.,

$$I^t(h^f, I_b, h^m, \gamma) = I^f(h^f, I_b, h^m, \gamma) I^m(h^f, I_b, h^m, \gamma).$$

4.3 Teenagers' Problem

Consider the problem of a female teenager at the end of the teenage period when she knows her educational achievement and whether or not a teenage birth occurred while dating. Let the distribution functions of female and male agents in the beginning of period 1 of their adult lives before the matching stage be $P^f(h^f, e^f, I_b)$ and $P^m(h^m, e^m)$. In addition denote by $P^m_{h|e}(h^m|e^m)$.[8] Then, the expected value to a female teenager of the household she forms in period 1 is given by

$$\begin{aligned} W(\pi^f, e_i^f, I_b, P^m) &= \theta \int \int [I^t(h^f, I_b, h^m, \gamma) V_1^t(h^f, I_b, h^m, \gamma) \\ &\quad + (1 - I^t(h^f, I_b, h^m, \gamma)) V_1^f(h^f, I_b)] dP^m_{h|e}(h^m|e_i^m) d\Gamma(\gamma) \\ &\quad + (1-\theta) \int \int [I^t(h^f, I_b, h^m, \gamma) V_1^t(h^f, I_b, h^m, \gamma) \\ &\quad + (1 - I^t(h^f, I_b, h^m, \gamma)) V_1^f(h^f, I_b)] dP^m(h^m, e^m) d\Gamma(\gamma) \end{aligned}$$

$$\text{s.t. } h^f = \pi^f \chi_{e_i}.$$

The indicator function I_p summarizes the information about the pregnancy status of the female teenagers. Consider the problem of a female teenager after it is known whether a teenage pregnancy occurs or not, but before the abortion decision and the resolution of the educational achievement. The value of this problem for the female teenager is denoted by

[8] The conditional distribution function $P^m_{h|e}(h^m|e^m) = \frac{P^m(h^m, e^m)}{P^m_e(e^m)}$, where $P^m_e(e^m) = \int P^m(h^m, e^m) dh^m$ is the marginal distribution function of e^m.

$\widetilde{V}_{-1}(\pi^f, b^1, b^2, I_p, P^m)$. In the case of realized pregnancy the problem is

$$\begin{aligned}
\widetilde{V}_{-1}(\pi^f, b^1, b^2, 1, P^m) &= \max_{a\in\{0,1\}}\{(1-q^f(\pi^f, b^1, b^2, I_b))W(\pi^f, e_1^f, I_b, P^m) \\
&\quad + q^f(\pi^f, b^1, b^2, I_b)W(\pi^f, e_2^f, I_b, P^m) - \kappa a\} \qquad (11) \\
&\quad \text{s.t. } I_b = 1-a.
\end{aligned}$$

When no pregnancy is realized, the corresponding value is given by

$$\begin{aligned}
\widetilde{V}_{-1}(\pi^f, b^1, b^2, 0, P^m) &= (1-q^f(\pi^f, b^1, b^2, 0))W(\pi^f, e_1^f, 0, P^m) \\
&\quad + q^f(\pi^f, b^1, b^2, 0)W(\pi^f, e_2^f, 0, P^m).
\end{aligned}$$

Denote by $V_{-1}(\pi^f, b^1, b^2, P^m)$, the value of the problem that a female teenager faces before it is known whether she becomes pregnant or not. This problem is described by

$$\begin{aligned}
V_{-1}(\pi^f, b^1, b^2, P^m) &= \max_z\{p(z)\widetilde{V}_{-1}(\pi^f, b^1, b^2, 1, P^m) \qquad (12) \\
&\quad + (1-p(z))\widetilde{V}_{-1}(\pi^f, b^1, b^2, 0, P^m) - k(z)\}
\end{aligned}$$

and the solution z gives the level of contraception employed by the female teenager.

4.4 Firm's Problem

There is a representative firm that operates a linear constant returns to scale production technology

$$Y(H) = AH,$$

where H is the total stock of human capital.

The firm takes wage rate, w, as given and solves

$$\max_{H\geq 0}\left[Y(H) - wH\right]. \qquad (13)$$

The firm's human capital demand is denoted by H^d. The market clearing condition implies that

$$\begin{aligned}
H^d &= H = \int (h_1^f + h_1^m)dT_1(h_1^f, h_1^m) + \int h_1^f dF_1(h_1^f) + \int h_1^m dM_1(h_1^m) \\
&\quad + \int (h_2^f + h_2^m)dT_2(h_2^f, h_2^m) + \int h_2^f dF_2(h_2^f) + \int h_2^m dM_2(h_2^m) \\
&\quad + \int (h_3^f + h_3^m)dT_3(h_3^f, h_3^m) + \int h_3^f dF_3(h_3^f) + \int h_3^m dM_3(h_3^m),
\end{aligned}$$

where $T_j(h_j^f, h_j^m)$, $F_j(h_j^f)$, $M_j(h_j^m)$ are the distributions over human capital levels for married, single female and male households, respectively, of age j.

5 Equilibrium

The households in the economy at hand make an explicit fertility choice, therefore the economy can grow or shrink in terms of population size. In such an environment, a steady-state equilibrium requires the distributions of households of different ages, children and teenagers, normalized to the measure of each generation, to be identical over time. This is true if and only if the normalized distributions of female and male agents entering adulthood are constant over time. Denote these normalized distributions as

$$\widehat{P}^f(h^f, e^f, I_b) = \frac{P^f(h^f, e^f, I_b)}{\int P^f(h^f, e^f, I_b)}, \ \widehat{P}^m(h^m, e^m) = \frac{P^m(h^m, e^m)}{\int P^m(h^m, e^m)}.$$

Then we are ready to define the equilibrium.

Definition 1 *A steady-state equilibrium is*

1. *A set of decision rules* $A_1^t(h^f, I_b, h^m, \gamma, \widetilde{n}, s)$, $C_1^t(h^f, I_b, h^m, \gamma, \widetilde{n}, s)$, $B_1^{1t}(h^f, I_b, h^m, \gamma, \widetilde{n}, s)$, $K_1^t(h^f, I_b, h^m, \gamma)$, $S_1^t(h^f, I_b, h^m, \gamma)$, $A_2^t(h^f, n^2, I_b, h^m, \gamma, \widetilde{n}, s)$, $C_2^t(h^f, n^2, I_b, h^m, \gamma, \widetilde{n}, s)$, $B_2^{1t}(h^f, n^2, I_b, h^m, \gamma, \widetilde{n}, s)$, $B_2^{2t}(h^f, n^2, I_b, h^m, \gamma, \widetilde{n}, s)$, $K_2^t(h^f, n^2, I_b, h^m, \gamma)$, $S_2^t(h^f, n^2, I_b, h^m, \gamma)$, $C_3^t(h^f, n^2, I_b, h^m, \gamma)$, $B_3^{2t}(h^f, n^2, I_b, h^m, \gamma)$, $A_1^f(h^f, I_b, \widetilde{n}, s)$, $C_1^f(h^f, I_b, \widetilde{n}, s)$, $B_1^{1f}(h^f, I_b, \widetilde{n}, s)$, $K_1^f(h^f, I_b)$, $S_1^f(h^f, I_b)$, $A_2^f(h^f, n^2, \widetilde{n}, s)$, $C_2^f(h^f, n^2, \widetilde{n}, s)$, $B_2^{1f}(h^f, n^2, \widetilde{n}, s)$, $B_2^{2f}(h^f, n^2, \widetilde{n}, s)$, $K_2^f(h^f, n^2)$, $S_2^{s,f}(h^f, n^2)$, $C_3^f(h^f, n^2)$, *and* $B_3^{2f}(h^f, n^2)$, $I^f(h^f, I_b, h^m, \gamma)$, $I^m(h^f, I_b, h^m, \gamma)$, $A_{-1}(\pi^f, b^1, b^2, 1, P^m)$, $Z_{-1}(\pi^f, b^1, b^2, P^m)$;

2. *A set of distributions* $\widehat{P}^f(h^f, e^f, I_b)$, $\widehat{P}^m(h^m, e^m)$ *such that:*

(a) *Given* w, *the decision rules in 1. solve problems (1)-(12)*

(b) *Given* w, H^d *solves (13).*

(c) *Markets for human capital and output clear.*

(d) *The distributions in 2. are constant in time.*

6 Calibration

The economic environment cannot be solved analytically. Therefore, the AR(1) process for abilities and the distribution for marital match quality are discretized and the model is simulated numerically. The model period is set to 10 years. Agents are considered to be children till the age of 10, while teenagehood ends at around 20. They obtain their education before they enter into adulthood at 21 years. This might sound a bit unrealistic since the university education continues till mid 20s, however, the period labor income in the model is equivalent to pooled income of individuals between their twenty-first year and their thirtieth year and it accounts for the fact that educated agents (university graduates) spent some time in their 20s at school instead of working.

Table 8: Life Cycle Structure of the Economy

Life period (Adult period)	1	2	3(1)	4(2)	5(3)
Age in years	(1-10)	(11-20)	(21-30)	(31-40)	(41-50)
Agent's type	Children	Teenagers	Adults	Adults	Adults

The benchmark economy is calibrated to represent closely certain features of the United States at around the year of 2000. (One sentence on the main dimensions in which the benchmark represents the US economy).

A few parameters are set directly to their empirical counterparts. Several assumptions are made to facilitate this process. First, the maximum number of children a household can have within a period is set to 2 ($N = 2$). The fertility matrices are assumed to take the following form,

$$\Pi^{j,s,r} = \begin{bmatrix} 1 - \upsilon_{j,s,r} - \upsilon_{j,s,r}^2 & \upsilon_{j,s,r} & \upsilon_{j,s,r}^2 \\ \omega_j & 1 - \omega_j - \upsilon_{j,s,r} & \upsilon_{j,s,r} \\ \omega_j^2 & \omega_j & 1 - \omega_j - \omega_j^2 \end{bmatrix}$$

where $j \in \{1, 2\}$ is the index for the age of the households, $s \in \{0, 1\}$ signifies whether contraception is used, and $r \in \{f, t\}$ indexes whether the household is single or married. Suppose that the probability of making a fertility mistake upwards, i.e. having one more child than desired is $\upsilon_{j,s}$, and in addition assume that the fertility mistakes are independent of each other. Therefore, the probability of making two consecutive mistakes upwards is $\upsilon_{j,s}^2$. Similarly, assume that, the probability of having one less child than desired is ω_j. Note that this probability does not depend on whether or not the households use contraception. This is so because here the source of uncertainty is the possibility of miscarriage, ectopic pregnancy, or sterility. It is additionally assumed that two consecutive mistakes downwards are independent of each other, therefore the probability of having two children less than what is desired is ω_j^2.

The parameters $\upsilon_{j,s}$ and ω_j are estimated using data from the National Survey of Family Growth (NSFG), Cycle VI , which was conducted by the National Center for Health Statistics (NCHS) in 2002. The survey consists of interviews conducted with females 15-44 years of age. A female pregnancy file is also compiled, containing a record for each pregnancy for all female respondents. This pregnancy file is used to divide the pregnancies according to the age of the females (21-30 and 31-40), whether they use contraception (including condoms) or not, and whether they are single or married. For each of these groups of pregnancies, the probability of having an unintended pregnancy ($\upsilon_{j,s,r}$) is estimated is the ratio of unintended pregnancies to all pregnancies within the group. The parameter ω_j is set to the ratio of female respondents who report sterility to all female respondents within the appropriate age group.

Table 9: Exogenous Paramters I: Fertility Matrices

Parameter	Value
$\upsilon_{1,0,t}$	0.172
$\upsilon_{2,0,t}$	0.127
$\upsilon_{1,1,t}$	0.121
$\upsilon_{2,1,t}$	0.118
$\upsilon_{1,0,f}$	0.328
$\upsilon_{2,0,f}$	0.288
$\upsilon_{1,1,f}$	0.271
$\upsilon_{2,1,f}$	0.266
ω_1	0.089
ω_2	0.307

The ratio $\frac{\chi_{e_2}}{\chi_{e_1}}$ represents the educational premium in terms of income for agents with identical ability levels in the first period of their adult life. The parameter χ_{e_1} is normalized to 1, while χ_{e_2} takes the value of of the average educational premium for male workers of age 21-30 in the 2000 1% census data sample of the Integrated Public Use Microdata Series (IPUMS).[9] (Note: The selection of higher ability agents into higher educational achievements should be accounted for, maybe run a 2SLS of income on education with IV being ?). The gender gap parameter $\varkappa$ is set to the average gender difference in income among agents of

[9] The 2000 1% census data sample of the IPUMS is used for all parameters unless specified otherwise.

age 21-30, while ξ_1 and ξ_2 are set to the average growth rate of income for men between age periods 21-30 and 31-40, and age periods 31-40 and 31-40, respectively. The probability of income growth while having children for females, λ, is set to match the average income premium for women of age 21-30 with no children to women of the same age group with children.[10]

The probability that agents date in the marriage market only within their own educational group, θ, is set to the value used in Fernández and Rogerson (2001). The equivalence scale parameters are in accord with the OECD scale which assigns a value of 1 to the first adult household member, 0.7 to the second, and 0.5 to each child. The fixed costs of having children (δ_1) and teenagers (δ_2) are assumed to be equal. Lino (2001) provides estimates for expenditures on children from birth to the age of 17. The expenses for housing, food, transportation, clothing, and health care provided to a child are presented for 3 categories of before-tax family income, <\$38000, \$38000-\$64000, and >\$64000.

[10] Assume that average income premium for a female with no children compared to a female with children in period 1 of their lives in the model is ξ_{n^1}. Then,

$$\xi_{n^1} = \frac{\xi_1}{\lambda \xi_1 + (1-\lambda)},$$

which implies that

$$\lambda = \frac{\xi_1 - \xi_{n^1}}{\xi_{n^1}(\xi_1 - 1)}.$$

Table 10: Exogenous Parameters II

Parameter	Value	Explanations/Source
$\chi_{e_1}, \mu_2, \psi_2, \psi_5$	1	Normalized to 1
χ_{e_2}	1.742	$\frac{\chi_{e_2}}{\chi_{e_1}}$, premium of education for males 21-30
$\varkappa$	0.776	Gender gap for workers 21-30
ξ_1	1.675	Income growth for men from 21-30 to 31-40
ξ_2	1.159	Income growth for men from 31-40 to 41-50
λ	0.557	Set to match premium for women 21-30 with no children below 5
θ	0.6	Fernández and Rogerson (2001)
ζ_1	0.7	OECD equivalence scale for a second adult
ζ_2	0.5	OECD equivalence scale for a child
ζ_3	0.5	OECD equivalence scale for a teenager
δ_1	0.133	30% out of the lowest female per period income
δ_2	0.133	30% out of the lowest female per period income
η	0	Cost of abortion
ρ	0.1	Cost of contraception
β	0.66	Annual discount rate of 0.96

The parameter on the cost of abortions is set to 0 in the baseline economy.

The endogenous parameters are set to match a number of targets. For the time being, calibration is not yet implemented and the values below are initial guesses. The results are presented for these values.

Table 11: Endogenous Parameters

Parameter	Value	Targets	Data
φ	0.2	Intergenerational persistence of family earnings (Mulligan 1997)	0.52
σ_ϵ	0.22	Std dev of log earnings (Restuccia&Urrutia 2004)	0.6
κ	1.35	Abortion rate among teenagers (Guttmacher Institute 2006)	24
μ_1	1.5	Pregnancy rate among teenagers (Guttmacher Institute 2006)	83.6
ψ_1	0.0367	Ratio of skilled/unskilled women with teenage premarital birth	0.113
ψ_2	0.1295	Ratio of std dev of log earnings for skilled/unskilled women	0.989
ψ_5	0.0834	Ratio of std dev of log earnings for skilled/unskilled men	1.034
$\psi_3 = \psi_6$	0.0937	Ratio of skilled/unskilled women	0.379
$\psi_4 = \psi_7$	0.0869	Ratio of skilled/unskilled men	0.369
α_1	1.5	Expenditures on early education/GDP (Restuccia&Urrutia 2004)	0.044
α_2	1.5	Expenditures on college/GDP (Restuccia&Urrutia 2004)	0.028
α_3	0.9	Ratio of single females with teen birth/single females to married females with teen birth/maried females	1.81
σ_γ	2.2	Ratio of single female households/married households	0.399

7 Results

The economy is simulated in the case in which abortions are allowed. Even though calbiration is not carried out completely, preliminary results are presented to access the ability of the model to match the general facts about abortions in the United States.

The proportions of abortions generated in the economy match the general patterns in the data. Teenagers perform a large fraction of abortions in the data and this is captured in the model economy. In addition, the fact that largest proportion of abortions is performed by females in their 20s is also present in the model.

Table 12: Proportions of Abortions by Age, Data and Model

Age	Proportions of Abortions	
	Data	Model
Teen (15-19)	0.186	0.292
Young (20-29)	0.561	0.378
Old (30-39)	0.247	0.331

Abortions performed by single females are well beyond 50%. This is captured by the model economy.

Table 13: Proportions of Abortions by Marital Status, Data and Model

Marital Status	Proportions of Abortions	
	Data	Model
Married	0.337	0.477
Single	0.673	0.523

7.1 Simulations

The model economy is simulated in the case in which abortions are not legal. This is done by setting the cost of abortions for teenagers and adults prohibitively high so that no abortions occur in the model economy.

The standard deviations of individual and family income in the baseline and "No Abortions" economies are of similar magnitude. However, under the counterfactual policy the whole distribution of wages shifts and therefore, the appropriate statistics to compare is the coefficient of variations.

Table 14: Baseline and No Abortions Economies

	Baseline	No Abortions
Std dev of log individual income	0.6090	0.6260
Std dev of log family income	0.4333	0.4315

The coefficients of variation of individual and family income increase under the alternative policy of illegal abortions. This points the effects of banning abortions on the income dispersion in the economy.

Table 15: Baseline and No Abortions Economies

	Baseline	No Abortions
Coefficient of variation of log individual income	1.234	1.732
Coefficient of variation of log family income	0.726	0.952
Intergenerational persistence of family income	0.625	0.162
Proportion of single families	0.471	0.645

At the same time the coefficient of intergenerational persistence of family income goes down under the alternative policy.[11] This points out that not having abortions around cause higher intergenerational mobility. Finally, in the case of no abortions there is larger proportion of single families.

The channels through which the effects of banning abortions occur will be clarified in the future versions of the paper.

8 Conclusions

[to be completed]

[11] The intergenerational persistence of family income is the coefficient β_1 in the regression

$$\log(H') = \beta_0 + \beta_1 \log(H) + \varepsilon,$$

where H' is the family income of individuals and H is the family income of their parents.

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