The Driving Forces of Iran's Baby Boom*

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Abstract

Using the Census data 1976-2006 besides HIES in 1984, this paper establishes that the "Iran's Baby Boom" in the late 1970's and the early 1980's coincided with an increase in the number of marriages. In addition, the paper shows that different generations peaked their life cycle number of children over the same period, which increased their age specific fertilities and consequently TFR during the baby boom. Moreover, the paper documents that the female labor participation declined about 33% after the revolution. All these facts are consistent with our observation that in contrast to the US baby boom, the CEB has been decreasing throughout the baby boom. To assess, quantitatively, which fundamental factors derived these stylized facts, we develop a dynamic model that individuals decide endogenously about marriage, giving birth, asset holdings, and labor force. Then we use the Simulated Method of Moment (SMM) to estimate the structural model. Our preliminary estimations show that the baby boom after the revolution is mostly driven by getting more utility from children and marriage rather than a fall in child costs. We conduct two counterfactual experiments and conclude that the legal marriage amendment shows significant effects on the marriage rate.

1 Introduction

Why baby boom occurred in Iran? This question, though its significance as a unique demographic phenomenon in the Iranian Economy has not been explained by economic tools yet. Here, we are not concern in its implications and

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Table 1: The History of CEB for the Iranian women

birth year	CEB
1972-1980s	<3**
1967-1971	2.99*
1962-1966	3.81
1957-1961	4.66
1952-1956	5.42
1947-1951	5.93
1942-1946	6.65
1937-1941	7.05
1932-1936	7.10
1927-1931	6.96
1922-1926	6.68
1910s-1921	6.16
ref: Authors' calculation based on Census 1986 and 2006	
* fertility is not completed yet ** prediction	

consequences, but only we are facing the question from deriving forces of the Iranian short-run baby boom in late 70s and early 80s. Meanwhile, we do not regard our work as a comprehensive answer to this question but just hope to provide a quantitative explanation as the first steps in this field.

In this paper, we first illustrate the stylized facts of the Iranian baby boom. Investigating these facts would display questionable features of the baby boom. Based on the facts our hypothesises would arise. Then, in the context of a dynamic model we present an economy in which decisions on marriage and fertility is endogenous. And finally, by calibrating the model, we provide a quantitative explanation of the Iranian baby boom.

1.1 Stylized Facts

The history of Iranian women's fertility over the last century suggests two remarkable features: a long-run trend and a short-run baby boom.

First, there is a long-run trend in females' completed lifetime fertility. This feature can be observed well in time series of completed CEB (Children Ever Born) of old to young females' cohorts. Table 1 illustrates that CEB has been more than 6 and rather close to 7 for the Iranian women who have been born during 1910 to 1950; followed by a rather rapid decline to below 3 for the cohort who has been born in 1970s. Relevant predictions suggest that CEB would be close to 2 for even younger cohorts (Abbasi-Shavazi et al 2009). To sum up, the first feature is that females' completed lifetime fertility has been high for cohorts born up to middle century and declined with a fairly large delay but sharply for the subsequent cohorts in the second half of the century.

Second, there is a short-run baby boom which has occurred in late 1970s

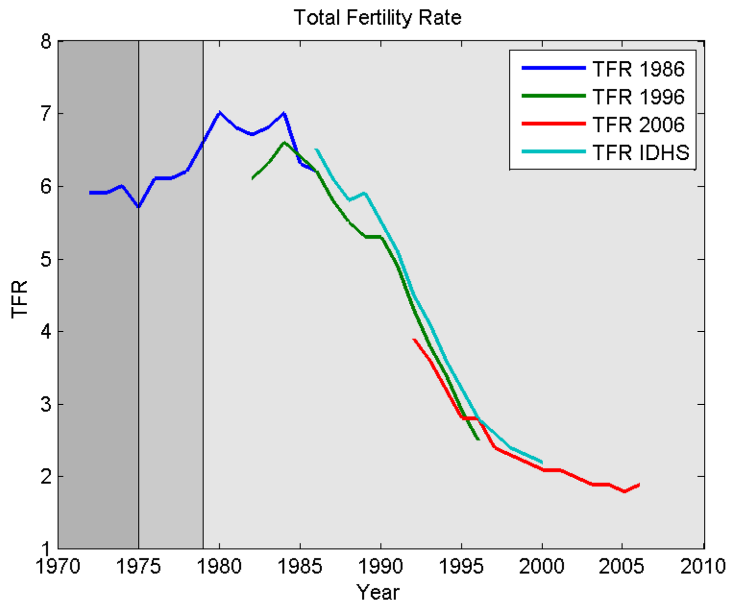

Figure 1: Total Fertility rate of the Iranian Women

and early 1980s. Interestingly, the Iranian baby boom could not been observed from the time series of CEB while it is noticeably observed in TFR (See figure 1 for TFR, figure 2 for age specific fertility rate, figure 3 for annual average birth per woman of different cohorts, and figure 4 for TFR versus CEB) and in birth (figure 5 for number of birth besides number of birth per married woman).

Qualitatively, TFR started to increase mildly before the revolution[1] but it accelerated after revolution and remained high up to 1984, and then it has been declining sharply over two decades. The peak of TFR and birth rate is in 1980 which is one year after revolution.

The size of baby boom depends on the index which one uses for defining fertility (as in US, see greenwood (2005)). As in figure 1, TFR increased mildly from 5.7 in 1975 (before revolution) to 7 in 1980 (one year after revolution) and close to 7 or again 7 up to 1984 followed by a continuous rapid decline to 1.9 in 2006. Meanwhile, as in figure 4 the number of registered birth increased from 1.40 million in 1975 to 2.45 million in 1980 (equivalently from 0.169 in 1975 to 0.281 birth per married woman in 1980). While TFR increased 10-20 percent during the baby boom, number of birth and birth per married woman increased 83 and 63 percent respectively.[2]

[1]The revolution occurred in Feb. 1979.

[2]It is more reasonable to regard birth per fecund woman instead of birth per married woman. We do not have access to that data but intend to search for it in the next stage of developing this paper.

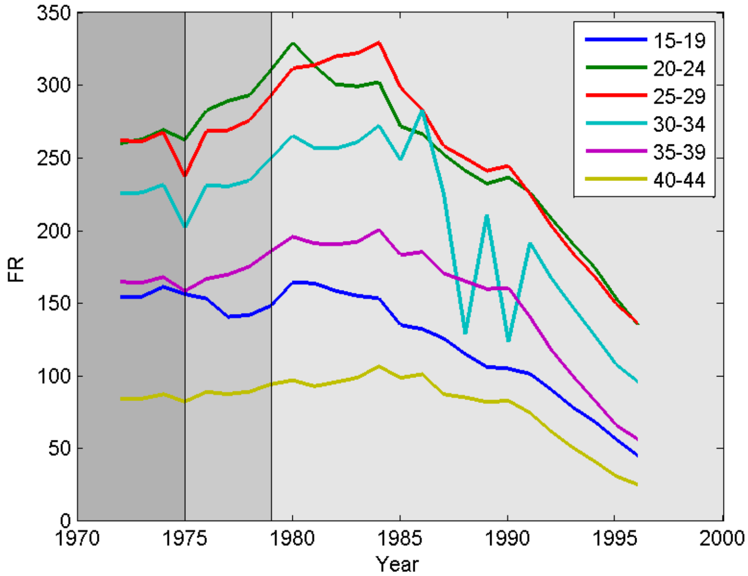

Figure 2: Age Specific Fertility rate of the Iranian Women

Figure 2 shows the age specific fertility rate (ASFR) for fecund women. During the baby boom, the probability of child-bearing has been higher in women aged 20-29 years old. ASFR has a peak in 1980 for women aged 20-24 and a peak in 1984 for women aged 25-29. This implies the significant high fertility of birth cohort of 1956-60 which have been the makers of both cited peaks.

To have a more clear observation of fertility during the baby boom, we can focus on annual birth per woman in different females' cohorts. On this basis, figure 3 shows the average annual birth per 1000 women for female cohorts born in 1950 to 1980. Cohorts of 1950, 1955, and 1960 were 30-35, 25-30 and 20-25 years old in 1980-85, and therefore were the most effective cohorts to change the TFR during the baby boom. As in figure 3, all of these three cohorts have one or two peak(s) in their fertility during 1980-84. Moreover, this figure suggests that the baby boom was mainly occurred due to female cohorts of 1955 and 1960 (who were 20-30 years old during the baby boom). The fertilities of these two cohorts have jumped after revolution up to 1984 and then it has fallen then. As it is expected, this pattern is the same as TFR pattern. So, it seems that women who have been born during 1950-1960, especially those who have been born in 1955-60 are those who caused the baby boom.

In following lines, since much of the literature on baby boom has studied the American baby boom, we illustrate particular features of the Iranian baby boom in comparison to the US baby boom.

Contrary to the US baby boom, during the Iranian baby boom, TFR is

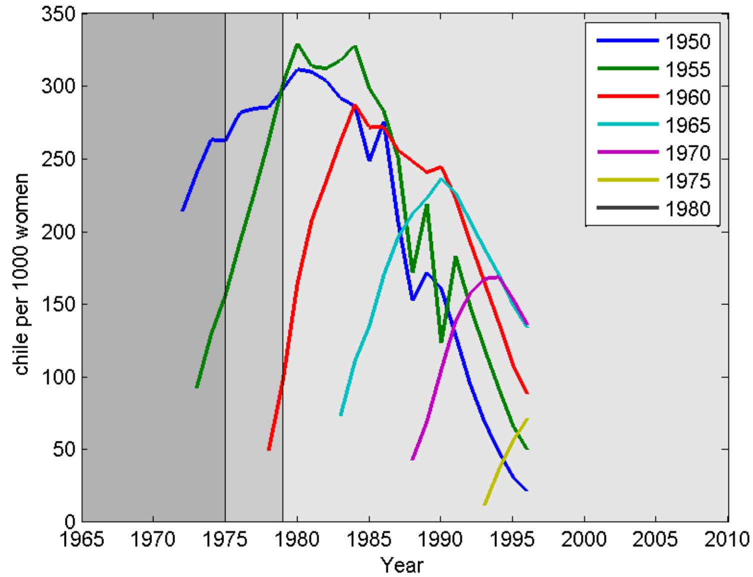

Figure 3: Average Annual Birth per 1000 Women for Different Female Cohorts

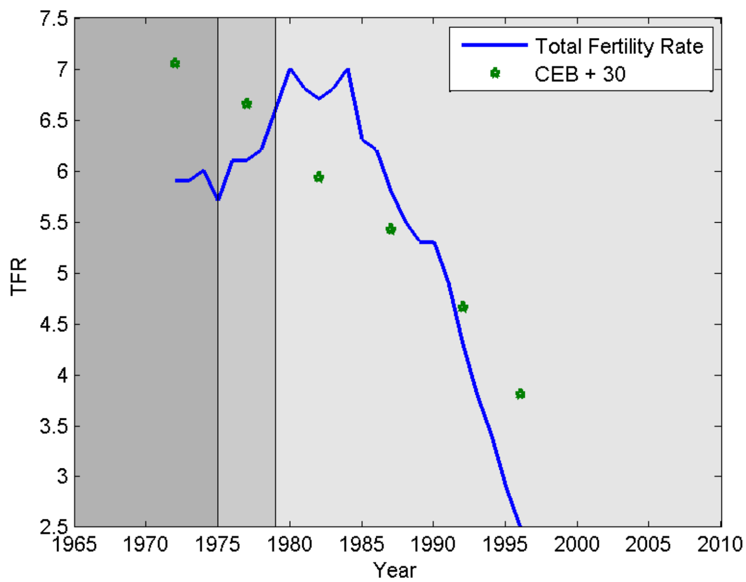

Figure 4: CEB+30 years versus TFR

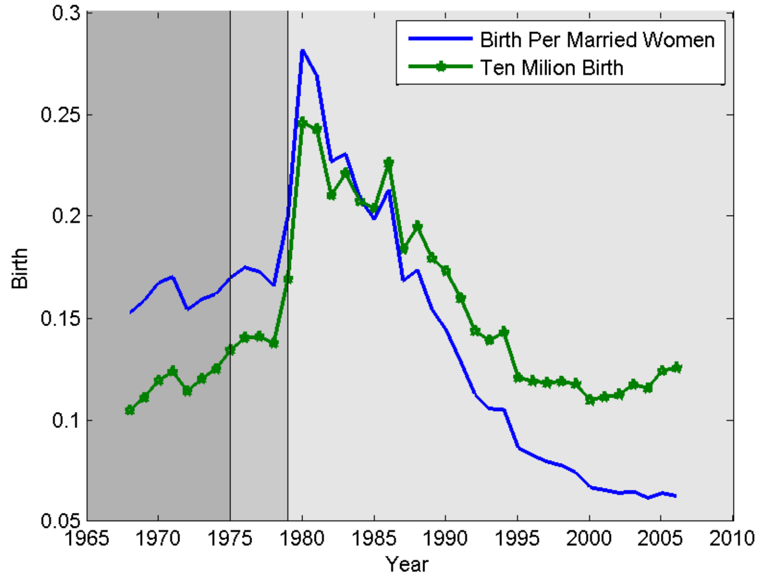

Figure 5: Number of Birth and Birth per Married Woman

increasing while CEB is decreasing (figure 3: TFR versus CEB shifted by 30 years)[3]. This fact indicates that the cohorts who caused the baby boom, after completed their fertility plan, made fewer children rather than the cohorts who were older. Consequently, this idea arises that the Iranian baby boom might be occurred due to a squeezing in timing of child-bearing and especially in timing of marriage. Figure 5 shows the Annual number of marriage of Iranian women. Number of marriage grows 83 percent from 1978 to 1980 indicating a large squeezing in marriage timing. With everything being equal especially documented high frequent first child occurrence in the first years after marriage[4], very higher rate of marriage occurrence in late 1970s might lead to a higher fertility in both late 1970s and early 1980s. Therefore, change in timing of marriage especially in late 1970s could partly account for the Iranian baby boom. If we concern only in completed lifetime fertility regardless of fertility timing, then the baby boom is not observable. This implies that we should take marriage as endogenous variables in our model.

[3] TFR_t indicates the expected number of a woman's children in her fecund period of life (15-44 or 15-49) conditioned to the assumption that in her life, she had and will have the fertility the same as the women at younger and older age in year t. Therefore, TFR is a synthetic rate and shows a conditioned probability instead of the determined fertility of any real group of women. This is why its pattern is not necessarily the same as CEB's pattern.

[4] In 1981-90, approximately 40 percent of women had had their first birth in first year after marriage and approximately 90 percent of women had had their first birth during four years after marriage (Abbasi-Shavazi et al (2005), P. 70).

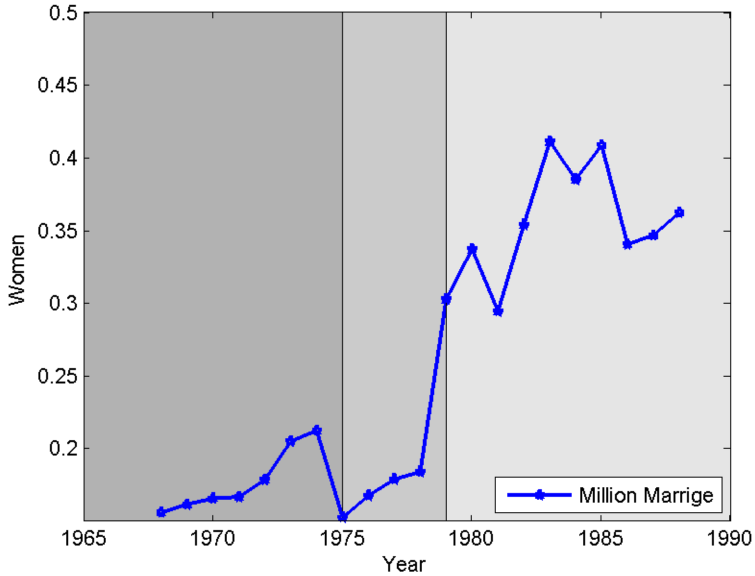

Figure 6: Annual Number of Marriage of Iranian Women

Again contrary to US baby boom, we observe no baby bust before or after the Iranian baby boom. Short-run Iranian baby boom lasted only for less than a decade. From middle of 1980s to 2000s both TFR and CEB shifted by 30 years have been decreasing steadily. The fact that during the baby boom CEB has been decreasing suggests that after the baby boom, TFR is expected to decrease steeper than CEB because considerable percent of parents have already made most of the children that they desired. This expectation is consistent to the stylized facts: from 1980 to 1996 TFR has fallen from 7 to 2.5 while CEB shifted by 30 years has decreases from approximately 6 to 3.5.

Finally we should mention the facts on infant mortality. The infant mortality rate has decreased from 9.96 percent in 1975-80 to 8.84 percent in 1980-85[5]. Since the baby boom is short-run enough to let the infant mortality rate not change considerably, we abstract from "infant mortality rate" as a significant factor for accounting for the baby boom.

1.2 Pre- and Post-Revolutionary Government's Policies and Socio-Economic Environment

The Islamic Revolution occurred in February 1979. It brought about a radical unexpected shift in government's policies and significant changes in socio-economic environment. Following lines of this subsection contains a review on

[5]United Nation Divisions Data

pre- and post-revolutionary changes in government's policies on population issues, wealth distribution on households, labor participation, and other social and economic relevant factors.

- **Review on government's policies**
  After regarding population issues in Third Development Plan (1963-67) the first pre-revolutionary family planning program started officially in 1968 in the Forth Development Plan (1968-72) aiming at reducing Crude Birth Rate. The Fifth Development Plan (1973-77) reinforced this target besides expansion of health and education services. In 1974 by an amendment of law the minimum age of marriage increased for girls from 13 to 18 and for boys from 15 to 20. The changes in fertility during late 1960s and early 1970s appear to have been small. TFR decreased from above 7.0 in 1966 to around 6.5 in 1976.[6]

  Soon after the revolution the comprehensive family planning program of Sixth Development Plan was suspended. Moreover, the legal minimum age at marriage was again reduced for girls to 13 and for boys to 15. However, since the degree of enforcement of implementation of pre-revolutionary amendment is not clear, the effect of post-revolutionary change in law of the minimum age at marriage on baby boom yet has remained an open question.

- **Wealth**
  The unchallenged common belief is that after the revolution government's (re)distribution policy changed to benefit poor households at the cost of some wealthy households.

  In the Iranian Economy the government's expenditure historically has been financed by not only tax revenues but also exogenous oil revenues. During 1970-90 the average share of oil revenue as a percentage of total government's revenue has been 59.7.[7] Regarding this fact, what the government policies do in the Iranian Economy is not only a wealth redistribution but also a wealth distribution. Therefore, independent of possible channels of aggregate effect of a zero-sum wealth redistribution, there have been aggregate wealth effects in this economy. Post-revolutionary government took more redistributive policies aiming at equalizing incomes and wealth between pre-poor and rich households. One of the main channel of implementing these policies was intensifying some forms of subsidies especially subsidies on essential goods.

- **Labor Market**
  Table 2 shows the participation rate[8] of male and female in 1976 and 1986. [9] The participation rate has decreased from 1976 to 1986 for both

[6] Abbasi-Shavazi et al, p47
[7] Authors' calculation based on TSD CB data
[8] Participation Rate is defined as the share of the labor force expressed as a percentage of

Table 2: Labor participation for male and female

male and female			
	1976	1986	$-\%\Delta$
10-14	14.80	8.10	45.27
15-24	41.80	38.80	7.18
25-54	55.90	52.60	5.90
55-64	48.00	45.70	4.79
15-more	49.00	45.80	6.53
male			
	1976	1986	$-\%\Delta$
10-14	18.40	11.40	38.04
15-24	67.40	66.30	1.63
25-54	96.40	94.50	1.97
55-64	82.30	80.40	2.13
15-more	83.20	81.00	2.64
female			
	1976	1986	$-\%\Delta$
10-14	10.70	4.50	5.79
15-24	16.70	10.60	36.53
25-54	13.00	11.90	8.46
55-64	4.70	4.60	2.13
15-more	13.40	8.90	33.58

male and female and for all age-intervals. But the change in female labor participation is more significant.

In aggregate level, the percentage of decline is 6.5 for the population aged 15 and more. In general, while the participation rate of male aged 15 and more decreased moderately from 83.2 to 81.0 (2.6 percent decline), the participation rate of female aged 15 and more decreased from 13.4 to 8.9 (33.6 percent decline). By disaggregation in age, we observe that the participation rate of age 15-24 and 25-54 has decreased 1.63 and 1.97 percent for male and 36.53 and 8.46 for female.

For men, in both 1976 and 1986 the participation rate of age 25-54 is dominant with respect to older and younger age-interval. But for women, in 1976 the participation of age 15-24 (16.7) is greater than age 25-54 (13) while in 1986 the participation of age 15-24 (10.6) is lower than age 25-54 (11.9). This fact indicates that while baby boom, early young women contributed much less in labor market in comparison to a decade ago.

- **Social change**
  One noticeable social change caused by the revolution is the change in marriage cost. Although we do not access to the data on financial cost of marriage, relevant declarations emphasize that marriage cost has fallen in post-revolutionary years.

- **War**
  Two years after the revolution on September 1981, Iraq started a war with Iran which lasted for 8 years. We mention two points about the war. First, it could change the mortality rate of men. Second, during the war, to provide equal access to basic goods, the government set up a rationing system. The rationing system, including the distribution of basic food, TV set, refrigerator, carpet, etc. was based on per capita. This fact implies that larger families could have benefited more from the rationing. These policies which aimed at reducing inequality during the war could have had an increasing effect on fertility (Abbasi-Shavazi et al (2002)).

1.3 Literature Review

In this section, since much of the literature focuses on the American baby boom, we first review main recent works on explaining it. Then, in a wider view, we mention those fertility determinants that we think they could be relevant for explaining the Iranian baby boom.

In recent literature, there are at least three types of explanations for US baby boom which has occurred in the middle-century after World War Two. These explanations can be classified based on the sources which causes the baby boom:

the population for specific age intervals

[9]For the labor force data we have access to only Census 1976 and 1986 but do not have access to the data interior of the interval 1976-86.

1. Technology shock in home-production;
2. Female labor demand shock; and
3. Improving maternal mortality.

First, Greenwood (2005) raised the hypothesis that significant burst of technological progress of home-production has decreased the child cost and therefore caused the baby boom. When the home-production technology shock removed, the secular decreasing trend of fertility -derived by increasing trend of real wage- became the dominant effect again.

Second, Doepke et al (2007) explained the US baby boom by the long-run implications of female labor demand shock in World War Two. The shock first increased female labor participation and therefore decreased fertility (baby bust). They argue that a significant part of subsequent young female could not enter the labor market since female labor demand had decreased after the war and the war generation female labor had become experienced and remained the dominant female labor supply. Third, Albanesi and Olivetti (2009) suggest that significant drop in maternal mortality brought about more fertility in specific female cohorts and caused the baby boom.

In a wider view, the fertility determinants can be classified to those factors that have wealth effects and those that have substitution effects. Becker and Lewis (1973) analyse parents' quantity-quality trade-off in their decision on children, given the parents' income and relative prices. The child cost originates from two sources: first, the financial cost of child-rearing and second, the opportunity time-cost of parenting (this idea has been taken in following works like Doepke and de la Croix (2003), etc.). The latter cost would be determined coincidently with parents' decision for working hours.

The fertility economics literature suggests that the qualitative effects of parents' labor income and wealth on fertility are different (Veloso (1999), Becker in "A treatise on the family P274, Edition 1993", etc.). Labor income and wealth originates from two different resources. While the parents' labor income depends on working decision in the labor market, the households' wealth originates from possessing physical capital like estate.

The economic explanation of labor income effect on fertility states that the more income parents earn, the higher opportunity cost of time they bear, the higher opportunity cost of raising children they face, and consequently the fewer children they make. Therefore, labor income has a dominant substitution effect on fertility (Becker and Lewis (1973)). On the contrary, physical capital has only a wealth effect, i.e. everything being equal, more physical capital parents own brings about more family size they desire (Benhabib and Nishimura (1993), Alvarez (1994), Veloso (1999), etc.)

Zero-sum wealth redistribution could affect the aggregate fertility through at least two channels. Aggregate effects originate in the asymmetries of winners' and losers' reaction to changes in wealth (Doepke and Schneider (2006)). At least two sources of asymmetries could be relevant for our research: different levels of income/wealth and different ages of winners and losers. Firstly, given a certain wealth transfer from wealthy to poor households, the fertility increase in poor households is greater than the fertility decrease in rich households since the marginal wealth effect on fertility is greater at the lower level of wealth/income. Secondly, similar to Doepke and Schneider (2006) a certain un-anticipated wealth transfer from old-age parents who have completed their fertility to young-age parents who are in the period of child-making increases the fertility in the latter households and therefore brings about more total fertility rate. Both two cited channels might contribute as an aggregate wealth redistribution effect on the Iranian baby boom.

The paper is organized as follows. In section 2 the model economy is presented. In section 3 the model is calibrated. Then in section 4 the model is simulated to get the quantitative results. Further discussion and remarks in section 5 concludes.

2 Model

Despite seminal paper on fertility and baby boom causes (mentioned in Literature Review) few studies have focused on an empirical measurement of these factors. This section aims to fill this gap and evaluate the main causes for the Iranian Baby Boom. To do that we develop a dynamic model and estimate its parameters as our benchmark model. Then, we conduct appropriate counterfactual experiments to assess the significance of each factor. In particular, we are interested in following causes: a change in income and a wealth distribution before and after the revolution, government's regulations on the legal minimum age of marriage, costs of an extra child in either monetary or time expenses, and finally marriage cost. Hence, we need a rich model to capture qualitatively the basic facts about marriage and fertility trends and at the same time to reconcile these facts with the short period baby boom in Iran.

2.1 Modelling

Agents in each period are male who are single or married (i.e. have family). We start this section by describing the problem faced by a family. At the beginning of each period, a family is characterized by an age t, an asset position a_t, a level of education e, and a current number of children n. Notice that e is a given endowment and does not change through time. We assume that all men work, but each family chooses that the mother works or stays at home and doesn't participate in the labor force. Moreover, each family observes its wage shocks denoted by y^m for the male parent and y^f for the mother. Since the mother may stay at home, wage shocks are not necessarily interpreted as the family income. Given the above state variables, a family decides to have a birth or to keep the same number of children.

$$V_F(y^m, y^f, e, n, a_t, t) = \max\left\{ \begin{array}{l} \widehat{V}(y^m, y^f, e, n+1, a_t, t), \\ \widehat{V}(y^m, y^f, e, n, a_t, t) \end{array} \right\} \tag{1}$$

Where V_F is the value function of the family with a state variable y^m, y^f, e, n, a_t, t. In this formulation we have made some assumptions. First, we abstract from the probability of infant mortality because, as previously mentioned in section 1.2, in the short period of 1976-1986 there was no structural changes in the infant mortality. In other words, if parents decide to give birth to a baby, their number of children will certainly increase by one. Second, we assume that parents decide on their number of children at the beginning of period for each period. We think this might be a realistic assumption because parents start enjoying and spending time and money for a new child during the pregnancy period. In contrast, we include one-year's delay for a marriage decision as the fiance period. Moreover, we assume that a decision on birth is a family decision, i.e. we don't distinguish between the mother and the father or their bargaining or unaligned utility. In the same way, we assume one utility function for each family rather than a utility for each members of the family. In this context, in addition to decision on fertility, the family decides about the mother's labor force participation and the family's next period asset position.

$$\widehat{V}(y^m, y^f, e, n, a_t, t) = \max_{h_i^f, a_{i,t+1}} (\mu + n^\eta)\frac{(c_i)^{1-\theta}}{1-\theta} + \lambda\frac{(l_i^f)^{1-\alpha}}{1-\alpha} + \frac{(l_i^m)^{1-\alpha}}{1-\alpha}$$
$$+\beta\left\{\rho_t V_F(y^m, y^f, e, n, a_{t+1}, t+1) + (1-\rho_t)V_F^D(y^m, y^f, e, n, a_{t+1}, t+1)\right\} \tag{2}$$

We assume that families get utility from both per capita consumption and quantity of children. According to Jones, Hosseini, Shourideh (2010) we assume the utility from children is a multiplication of n^η cross the consumption utility. In addition, we consider the leisure utility both from the women's and men's labor force, although based on our assumption men supply their labor inelastically $l^m = 1 - \hat{n}$. Moreover, for simplification the women's labor force is assumed to be indivisible, hence they choose to work $\hat{n}$ hours or to stay unemployed. Furthermore, for robustness to consider the impact of the mortality during the war, the model contains the probability of death as a function of ages. Hence, the ρ_t is the survival probability and the V_F^D, the death utility, is defined as:

$$V_F^D(y^m, y^f, e, n, a_t, t) = (2+n)\frac{(\frac{a_t}{n+2})^{1-\theta}}{1-\theta} \qquad \forall t \in \{15, \cdots, 44\} \tag{3}$$

Equation 3 states that the death utility is only a function of families' asset position and the number of children.

We define the value functions for the fertility period, i.e. we take families older than 14^{th} and younger than 45^{th}. The reason we choose the youngest fertility age as low as 15^{th} is that after the revolution the new government decreased the legal minimum age of marriage from 20^{th} to 15^{th}. Meanwhile, we define the value function at age 45^{th} as a constant $\overline{V_F}$ calibrated from data. In the next section we will explain the assumption regarding its calibration.

The family maximizes its life time utility subject to regular budget constraint. One noticeable exception is effects of child on family's budget constraint, which is the focus of this paper. On one hand, we assume the marginal monetary cost of each child is equal to ϑ, that is each child consumes ϑc rather than c. On the other hand, as stressed by Doepke et. al. (2007) in addition to the time that mothers spend for child care, each new birth takes some time for giving birth a baby. Hence, the family's monetary and time budget constraint can be proposed as:

$$\begin{aligned} &(\vartheta n + 2)c_{i,t} = y^m_{i,t} + y^f_{i,t} + Ra_t - a_{t+1} \quad a_\tau \geq 0 \quad \forall \tau \\ &1 = h^f_i + l^f_i + \delta n^\phi \end{aligned} \tag{4}$$

Importantly, the δ is constant in Deopke et al.(2009) but because we are interested on effects of child expenses on baby boom we will let the post-revolution δ departs from its pre-revolution level. In addition, notice that we impose the assumption that agents only can do saving, which is consistent with many paper in empirical literature.[10] Our interpretation for a is the total value of wealth and we assume all agents start the fertility period at age 15^{th} by initial wealth a_{15}.

In the next stage we study the unmarried individuals to provide a framework for the marriage decision. As it is mentioned in section one, one hypothesis is that the after revolution baby boom might be caused by a surge in marriage. Although many authors have focused on marriage decisions from different points of view[11], we abstract the model from unnecessary complexities. In other words, to explain effects of the marriage shock on the Iranian baby boom, it is enough that the model captures main marriage causes before and after the revolution including wealth distribution, income shocks, and marriage costs. In contrast, one could take the surge in marriage as an exogenous shock and measure its impact on baby boom but this exercise is unable to address why baby boom happened. As a matter of fact, if it has a significant effect on the baby boom then a similar question arises that why the marriage rate rose just after the revolution. For simplicity, we assume only men decide on marriage[12] thus we abstract model to just study the single males.

A man at an age t, with an asset position a, an education e, and income y at the beginning of each period decides to stay single or marry. By construction, the marriage decision take one period to be implemented. This one year gap could be interpreted as the fiance period.

$$V_s(y, e, a, t) = \max\{\overline{v}(y, e, a, t), \tilde{v}(y, e, a, t)\} \tag{5}$$

If the individual decides to stay single $\overline{v}$ then he chooses his next period asset position and with the survival rates for families survives with probability

[10] For example look at Hubbar, ... (1995)

[11] TBA papers on search and matching, Becker paper on supermodularity, ...

[12] This assumption is consistent with cultural behavior of youth in Iran

ρ_t.

$$\overline{v}(y,e,a,t) = \max_{a_{t+1}} \frac{(c_i)^{1-\theta}}{1-\theta} + \frac{(l_i^m)^{1-\alpha}}{1-\alpha} + \beta\left\{\rho_t\left[V_s(y,e,a,t+1)\right] + (1-\rho_t)V^D(y,e,a_{t+1},t+1)\right\}$$
$$c_t = y_t + Ra_t - a_{t+1} \tag{6}$$

In contrast, if the individual prefers to marry then his next period utility function will be the value of a family with no child and asset position a_{t+1}. Notice that here the marriage cost ξ is a constant fixed cost and appears in his budget constraint at period t. Hence, an individual decides to marry if he owns high amount of wealth. In addition, an individual with higher income or at older age is more likely to marry.

$$\tilde{v}(y,e,a,t) = \max_{a_{t+1}} \frac{(c_i)^{1-\theta}}{1-\theta} + \frac{(l_i^m)^{1-\alpha}}{1-\alpha} + \beta\left\{\rho_t\left[\frac{V_M(y^m,y^f,e,0,a_{t+1}),t+1)}{2}\right] + (1-\rho_t)V^D(y,e,a_{t+1},t+1)\right\}$$
$$c = y + Ra_t - a_{t+1} - \xi \tag{7}$$

Equation 7 shows the difference between the individual's value function and the family's value function. The family's value function is the summation of the all members' value functions. Therefore, we assume the value of a head in a family with no child is the half of the total value of the family. Moreover, we assume that the single pays the cost of marriage one period before the occurrence of marriage.

2.2 Calibration and Simulation

This section describes methods that are employed to determine the numerical values of parameters. It is divided into three parts based on how their values are pined down. The first set of parameters are determined from the relevant literature and we will argue briefly their possible values. The second set addresses parameters and variables that are specifies directly from data without solving the model. Unlike the first set, these parameters are more specific for Iran's economy. The last set of parameters are identified by the Simulated Method of Moment. The details are noted below.

Standard Parameters

Standard parameters are called constants that are conventional in the literature and hard to estimate by SMM.As stressed by Arellano (2007) the discount factor in developing counties is much lower than developed countries, however here we rely on the calculation by Rahmati (2007), which calibrates the discount factor as $\beta = 0.95$ in a study on Iran's business cycle. Likewise, many studies including Lucas (1990) emphasizes that the interest rate is higher in developing countries. Unfortunately, there is no official reports on Iran's Interest rates either before or after the revolution. We test for different levels of the interest rate in our model and conclude that the central moments are not sensitive to the

Table 3: The Standard Parameters

Parameter	Value	Source
β	0.95	Rahmati (2007)
R	1.08	Khiabani et. al.
$\hat{n}$	0.3	

choice of the interest rate. Notice that although the level of the interest rate is inconsequential, different values for pre- and post-revolution interest rate, affects fertility decisions by making capital investment more/less attractive. We assume, thus, the same interest rate before and after the revolution to rule out the change in the intertemporal effect of the interest rate, particularly we assume the interest rate equals to $R = 1.08$.

Constant Variables

In addition to the model's parameters that are constant by assumption even during the revolution, some other coefficients are taken as given in the simulation. For example, the wage of individuals are defined as a function of other state variables. In particular, we define $w_{ij} = f(age_i, sex_i, education_i, numberofchild_j)$ where w_{ij} is the wage of individual i in family j. In other words, wages of male and female are defined separately in the model . As previously mentioned, we assume all men work and earn their specific wage [13], however women might choose to quit working or not to participate in the labor force at all. Importantly, in the wage function, the wage depends on the number of children in the family. This specification is of special interest because after the revolution the wage of workers explicitly increased by the number of child. In addition, large families are heavily subsidized monetarily by the government through the higher share of coupons. At the beginning of the revolution each family receives coupons proportional to the family size.[14] Therefore, many studies argue that the government policy after the revolution was pro large family size.[15] In sum, we expect the wage increased by the size of a family and we will check these thoughts in our estimation. Similarly, one can define a wage function for singles as $w_i = \hat{f}(age_i, sex_i, education_i)$.

Before any further step, one should specify the wage function f, $\hat{f}$ for workers after and before the revolution. The lack of data for the pre-revolution prevents us to fully identify the wage function, we will explain how we deal with this issue below. In contrast to the pre-revolution, we have access to "Households' Expenditure and Income Survey 1984" (HEIS) that is the earliest post-revolutionary's micro data set. This data reports incomes based on types, detail expenditures,[16] the number of children, and parents' education. To do the estimation, we need

[13] As defined by functions f and $\hat{f}$

[14] This rationing system is described in section 1.2

[15] TBA, Conference on Demographic Policy, Mashad, 1989

[16] The data description and what we used in regression is explained in the appendix

Table 4: The wage function for male and female based on HEIS 1984

Dependent: Log (Income)				
	Male		Female	
	(1)	(2)	(3)	(4)
Age	0.0519***	0.0508***	0.0331***	0.0328***
	(0.00281)	(0.00284)	(0.00603)	(0.00608)
Age^2	-0.000634***	-0.000627***	-0.000527***	-0.000538***
	(3.15e-05)	(3.19e-05)	(8.34e-05)	(8.41e-05)
Education	-0.543***	-0.550***	-1.083***	-1.064***
	(0.0801)	(0.0810)	(0.186)	(0.188)
Age $\times$ Educ	0.0670***	0.0669***	0.112***	0.109***
	(0.00451)	(0.00457)	(0.0143)	(0.0145)
$Age^2 \times$ Educ	-0.000760***	-0.000761***	-0.00119***	-0.00114***
	(5.99e-05)	(6.08e-05)	(0.000258)	(0.000260)
Family Size	0.0512***		0.0700***	
	(0.00264)		(0.00603)	
Number of Child		0.0438***		0.0589***
		(0.00307)		(0.00676)
Constant	11.14***	11.33***	11.22***	11.47***
	(0.0605)	(0.0594)	(0.105)	(0.101)
Observations	30,020	30,020	7,277	7,277
R-squared	0.128	0.123	0.143	0.136
*** p<0.01, ** p<0.05, * p<0.1				

to make assumptions about the wage functional form; we assume the wage is a function of age, square age, age cross education, and numbers of children. Results of estimations are shown in Table 4 4.

Table 4 shows our estimations for the wage function. The column (1) and (2) report the wage function for a male whereas column (3) and (4) represent the female wage function. All coefficients in the Table 4 are highly significant and of the expected sign. For instance, the larger the family size, the higher is the wage for both male and female. Notice that , as mentioned before, the estimations are based on post revolutionary data and as we postulated the family size has a positive sign on the wage of parents. We also include the number of child in column (2) and (4), instead of the family size, which gives us the same results as before. In addition to the family size, other coefficients have conventional magnitudes and signs. For example, the age increases the wage for an uneducated man faster than the wage for an uneducated women; whereas this conclusion in comparison between an educated men and women is opposite. In other words, education increases women's wages more than men's wages. Notice that although the coefficient of *Education* is negative, however the marginal effect of education is $\gamma_{Education} + \gamma_{Age \times Educ} Age + \gamma_{Age^2 \times Educ} Age^2$

[17] which is positive for all adults and all estimations.

It is worth mentioning that all regressors show up in the state variables introduced in section 3.1. That is, given the state variables (i.e. education, number of children, age, sex) and the individual's specific wage error ϵ_w^i [18], we can calculate wages for all individuals. As a result, we can redefine the state variables in section 2.1. In section 2.1 we define $S = (y^m, y^f, e, n, a_t, t)$ as the state variables, but we know that wages y^m, y^f can be obtained by other state variables and errors $\epsilon_w^m, \epsilon_w^f$. Hence, we define the new state variables as $S' = (\epsilon_w^m, \epsilon_w^f, e, n, a_t, t)$ that $\epsilon_w^m, \epsilon_w^f$ can take the high value ϵ^h with probability 0.5 and the low value ϵ^l with the same probability. Importantly, the new set of state variables on the one hand reduces the dimension of state variables and on the other hand defines wages more accurately. In particular, in addition to e, n, a_t, t, if one knows the individual's specific error wage $\epsilon \in \{\epsilon^h, \epsilon^l\}$ the state variables are completely specified. Finally, the last element to be calibrated is values of ϵ^h, ϵ^l. Remember that these values are error terms in the estimations of Table 4, therefore we calculate error terms for all the samples and take the mean of error terms for those individuals with error terms above the median as $\epsilon^h = 0.52$ and similarly the mean of less than median for $\epsilon^l = -0.42$. This calculation completes the calibration and the estimation and the rest of parameters are specified by SMM which is called fertility parameters.

Fertility Parameters

The main contribution of this paper is to estimate the fertility parameters to determine leading driving forces of baby boom in Iran. Here ,in particular, we focus on monetary and time costs and study their effects on the baby boom. Remember that in Equation 4 the ϑ is called the *monetary cost* and similarly in the mother's leisure constraint, the δ denotes the *time cost*. Nevertheless, the higher the ϑ, the higher will be the monetary cost of each child in the family's budget constraint, likewise the higher the δ, the mother should spend more time for an additional child. Based on our assumption, potential changes in the ϑ and the δ during the revolution can contribute to the baby boom. In other words, by estimation these parameters after and before the revolution, we can assess which factor is the main driving force in the Iranian baby boom.

In addition to monetary and time costs, we assume that η and μ can be varied from the pre to the post revolution. That is, we let the marginal utility of marriage and the concavity of the child utility be different for pre and post revolution. If the value of μ be higher for the post-revolution, we interpret this as a more utility from marriage. Similary, higher η means agents derive more utility from children and therefore more likely to have a new child and to marry.

To do that, we use the Simulated Method of Moment (SMM) to estimate four parameters $\Theta_b \equiv \{\vartheta_b, \delta_b, \mu_b, \eta_b\}$ and $\Theta_a \equiv \{\vartheta_a, \delta_a, \mu_a, \eta_a\}$ for the pre- and the post-revolution respectively. Moreover, we estimate the same value of $\Theta \equiv \{\theta, \alpha, \xi, \phi, \lambda\}$ for all periods. We keep the other parameters as noted in

[17] The γs are corresponding coefficient parameters

[18] The ϵ_w^i is equal to the error term in the regression of Table 4

Table 3. The computational method is as following. First, for a given set of parameters $\{\Theta_b, \Theta_a, \Theta\}$, we find optimal policy functions by using the value function iterations on Equations $1 \cdots 5$. We solve backward from the age 45 and assume that $v_{45} = \overline{V_F}(2 + n^{\eta})$. Because the life expectancy was equal to 75 years in 1980s, consequently individuals live on average for 30 years after the age 45. As a result, The expected continuation value at the age 45 is equal to $\overline{V_F} = \frac{(Mean \quad Consumption)^{1-\theta}}{1-\theta} \times \frac{1-\beta^{30}}{1-\beta}$. Secons, given the value function at the age 45 by backward induction we can find all the value functions as defined in Equations $1 \cdots 5$. Likewise, By solving these equations we can find all policy functions corresponds to parameters $\{\Theta_b, \Theta_a, \Theta\}$, in particular we derive the asset policy function $g^k_{family,asset}(\epsilon^m_w, \epsilon^f_w, e, n, a_t, t)$ and $g^k_{single,asset}(\epsilon^m_w, e, a_t, t)$ $(k \in \{b, a\})$. In addition, one can derive the marriage decision and the new child policy function as follows $g^k_{family,birth}(\epsilon^m_w, \epsilon^f_w, e, n, a_t, t)$ and $g^k_{single,marriage}(\epsilon^m_w, e, a_t, t)$, as well as the women's labor choice decision $g^k_{female,labor}(\epsilon^m_w, \epsilon^f_w, e, n, a_t, t)$. Notice that these policy functions differ for the pre- and the post- revolution because the parameters Θ have been changed during the revolution.

After solving for the policy function, next we need to compute the transitional fertility in the late 70s and early 80s. As explained in the introduction, the fertility depends highly on the individual's distribution and especially on past shocks.[19] One way to capture this idea is to measure the individual's distribution non-parametrically and directly from data. Interestingly, our rich data set enables us to find the exact population's distribution. Census 1976 reports the age, the family size, the education, and the sex. In addition, Census 1976 provides data on agent's consumption and housing characteristics, which are used as an index for income and wealth. [20]. Finally, we simulate the model forward by using the optimal policy functions derived at second stage and the initial distribution comes from Census 1976. At each step of the simulation, first we find the distribution of the next period and then we calculate the sample moments for that period.

For this study, we simulate the model for 9 periods and calculate various moments including the "Total Fertility Rate" at each period. Hence, in case of just TFR, for each iteration we have 9 TFR moments from data (TFR from 1977-1985) and likewise 9 TFR moments from model. As explained before, the TFR data can be calculated from Census data, however we used the official reports for TFR. In addition, for the same years, we use the 9 moments for the birth rate and the 9 moments for the marrige rate. All these aggregate data moments are reported from "National Organization for Civil Registration" at each year. Thus, so far, for each year of the data and the simulation we used 3 moments associated with the TFR, the birth rate and the marriage rate. Importantly the above moments represent the mean value of the distribution and we need more cross-sectional moments to estimate the parameters. Therefore, we use the "1986 Census data" to determine the marriage rate and the birth rate for

[19] One can call this cohort effects

[20] In appendix, we explain exactly how we find the distribution

Table 5: The parameters found the the SMM

Before revolution			After revolution		
Parameters	Coeff.	Std	Parameters	Coeff.	Std
ϑ_b	0.21	0.11	ϑ_a	0.60	1.08
η_b	0.73	0.97	η_a	1.24	0.67
μ_b	2.48	0.90	μ_a	2.93	2.64
δ_b	0.48	0.08	δ_a	0.41	0.50
Parameters	Coeff.	Std	Parameters	Coeff.	Std
θ	0.09	0.27	α	0.67	0.16
ξ	0.33	3.23	ϕ	0.52	0.13
λ	0.005	0.06			

each cohort. Notice that the 1986 is the last year of the simulation and hence the best captures the prediction of the model.

3 Results

In this section, we explain the result of the estimation and we then run two important counterfactual experiments. For estimation, we use the procedure of *Simulated Annealing* to seek for the global minimum of the squared error terms and the corresponding parameters $\{\Theta_b, \Theta_a, \Theta\}$. The optimal parameters are shown in Table 5. Based on the estimation, the monetary cost of childes increased after the revolution, but based on the standard errors their differences are not significant. Moreover, Table 5 shows that the time cost decreased slightly during the revolution. In fact, we don't expect a huge difference for time costs, because this parameter changes usually due to some technology progresses (Greenwood et. al. (2005)). On the other hand, the parameter of the child utility η increased considerably during the revolution. In the same direction, the marginal utility of marriage also raised after the revolution. In sum, the main deriving forces of the baby boom come from the taste changes during the revolution and as a matter of fact the aggregate effect of monetary and time cost doesn't significantly contribute to the baby boom. The results of the SMM characterise all the remaining parameters and provides a fully-identified structural model for policy analyses.

To verify results of the SMM estimation the Table 6 shows the moments from the data and the model. As previously mentioned, we used the 36 moments to estimate the 13 parameters $\{\Theta_b, \Theta_a, \Theta\}$. The comparison between these moments shows that the model fits very well to the data. In particular, the model explains very well the cross-cesional moment at year 1986. One noticeable exception is the child per mother ratio at age 40-44, the model predicts much lower ratio respect to data. This moment shows that the impact of the revolution on the agent's utility varies among cohorts and, consequently, indicates the necessity for heterogeneous variations in the utility function for the

Table 6: The Moments from Data and SMM Estimation. The BR and the MR stand for Birth Rate and Marriage Rate, respectively.

Moments	Data	Model	Moments	Data	Model	Moments	Data	Model
BR 1977	0.254	0.295	BR 78	0.245	0.321	BR 79	0.298	0.275
BR 1980	0.420	0.314	BR 81	0.400	0.363	BR 82	0.339	0.320
BR 1983	0.344	0.340	BR 84	0.311	0.317	BR 85	0.297	0.302
MR 1977	0.133	0.140	MR 78	0.120	0.140	MR 79	0.172	0.271
MR 1980	0.180	0.183	MR 81	0.150	0.168	MR 82	0.166	0.173
MR 1983	0.182	0.165	MR 84	0.164	0.168	MR 85	0.165	0.164
TFR 1977	6.1	5.9	TFR 78	6.2	6.2	TFR 79	6.6	6.1
TFR 1980	7.0	6.8	TFR 81	6.8	7.4	TFR 82	6.7	6.7
TFR 1983	6.8	6.7	TFR 84	7.0	6.2	TFR 85	6.3	6.1

	Data	Model	Data	Model	Data	Model
	Age 14-19		Age 20-24		Age 25-29	
$\%Married$	0.335	0.306	0.735	0.775	0.902	0.880
$\frac{Child}{Mother}$	0.958	0.977	1.977	2.280	3.228	3.420
	Age 30-34		Age 35-39		Age 40-44	
$\frac{Child}{Mother}$	4.418	4.394	5.346	5.675	5.888	7.330

future research.

This structural model enables us to run interesting counterfactual analyses. In particular, we are interested to estimate the impact of new legal minimum-age of marrige. As explained in the data section, the legal minimum-age before the revolution was 18 for women. However, after the revolution the legal minimum-age of marriage decreased to 15. Especially, we are interested to know if the government keeps the same legal minimum-age as before the revolution what happens to the marriage rate and the birth rate. To study this, we run the benchmark model but keep the same legal minimum-age of marriage to 18. In other words, agents are not allowed to marry for the age lower than 18 for the entire simulation periods, we will call this counterfactual $\underline{age} = 18$. In Table 7 we report the average "birth Rate" and "Marriage Rate" for each policy.

Table 7: The Counterfactual Experiments

	Data	Benchmark	$\underline{age} = 18$	Constant Production
Birth Rate	0.323	0.316	0.304	0.339
Marriage Rate	0.159	0.175	0.139	0.264

The results show that if we keep the legal minimum-age as high as 18 for the post revolution, the birth rate decreases slightly by 4%, whereas the marriage rate declines by 20%. Therefore, we can interpret this fact as the case that due to legal amendment the marriage jumped but the baby boom doesn't caused by the marriage.

During the estimation of the wage process, we mentioned that we haven't access to the pre-revolution income data, as a result we simply assumed that the post revolution income is 15% lower than pre revolution income. We conclude this number by assuming that the each person's income dropped the same amount as the aggregate amount. However , as a counterfactual analysis, we can relax this assumption and conduct an experiment to see the impact of the income on baby boom. Thus in the last column of Table 7 we increased the post revolution income by 15% to remain in the same aggregate level as the before the revolution. Interesting, we see that the marriage rate booms by 50% and reaches to the level of 0.269. As a result of this boom in marriage, the birth rate increased by 7%. In fact, this analysis shows that the marriage monetary cost was a major factor in the marriage decision.

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