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The Great Transition: Kuznets Facts for Family-Economists

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Abstract

The 20th century beheld a dramatic transformation of the family. Some Kuznets style facts regarding structural change in the family are presented. Over the course of the 20th century in the United States fertility declined, educational attainment waxed, housework fell, leisure increased, jobs shifted from blue to white collar, and marriage waned. These trends are also observed in the cross-country data. A model is developed, and then calibrated, to address the trends in the US data. The calibration procedure is closely connected to the underlying economic logic. Three drivers of the great transition are considered: neutral technological progress, skilled-biased technological change, and drops in the price of labor-saving household durables.

JEL Codes: D10, E13, J10, O10.

Keywords: Average weekly hours, blue-collar jobs, calibration, college premium, education, family economics, fertility, housework, Kuznets, leisure, market work, marriage, neutral technological progress, price of labor-saving household durables, skilled-biased technological change, white-collar jobs.

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1 Beginning

In celebrated research Simon Kuznets (1957) documented the structural change that an economy goes through as it grows. In particular, he showed that as an economy evolves there is a shift in the distribution of output away from agriculture toward manufacturing and after that a reallocation favoring services. Likewise, with economic development there is initially a decline in the share of agriculture in aggregate employment with labor being redirected into manufacturing and then eventually moving into services. Kuznets (1957) examined both time trends within countries as well as how the distributions of output and employment varied across countries with their level of development.¹

The analysis here has two key objectives. First, it follows in the footsteps of Kuznets (1957) by examining the structural change that the family goes through as an economy develops. This is done both across time and countries. Facts are presented about: (1) the decline in work effort, (2) the drop in fertility, (3) the waning in marriage, (4) the descent in household size, (5) the rise in educational attainment, and (6) the shift from blue- to white-collar jobs.

Second, a macroeconomic model of the family is developed and calibrated to see if it can simultaneously explain the above set of facts. This is important because current models of the family tend to focus on some subset of these facts, while ignoring the complementary set. The calibration procedure shows how the parameters governing tastes and technology can be backed out to hit exactly certain Kuznets facts. Some causal impulses underlying the great transition are examined; namely, neutral technological progress, skilled-biased technological change, and process innovation in the production of labor-saving household durables. Both neutral and skilled-biased technological change are important for explaining the rise in living standards between 1880 and 2020. Skilled-biased technological progress is the primary driver of the decline in fertility and the rise in educational attainment. It induces a shift from having a large number of uneducated children toward a smaller number of educated ones. Process innovation in the production of household durables is the force underlying the decline in housework and the fall in marriage.

A brief literature review is provided at the end. Since other literature reviews are available, the review here is oriented toward providing references for the ingredients used in the modeling analysis.

¹Kuznets was instrumental in developing the US National Income and Product Accounts. In his early thirties he oversaw, for Bureau of Foreign and Domestic Commerce, the tallying of the first official estimates of GNP published in the report *National Income, 1929-32*.

2 Kuznets Facts for Family-Economists

Some key facts about the twentieth-century great transition are presented now. Data descriptions and sources are provided in the Data Appendix.

2.1 The Decline in Work Effort

There has been a dramatic decline in labor effort over the last two centuries, as Figure 2.1 shows. In 1830 the average full-time worker put in 69 hours of effort. This declined to 39 hours by 2000. Historically speaking, it was mostly men that participated in the labor market. They had a workweek of 63 hours in 1900 versus 44 hours in 2018. Over time the labor-force participation rate for men has fallen. It was 97 percent in 1860 compared with 88 percent in 2018. By contrast, almost no women worked in 1860 (7 percent) while the majority did in 2018 (74 percent). The average workweek for women was 40 hours in 1940 and declined slightly to 38 hours in 2018. While historically women did not participate in the labor market as much as men, women did work in the home. In particular, in 1900 they spent 58 hours a week on cleaning, cooking, and laundry. This tumbled to just 11 hours by 2019, as Figure 2.2 illustrates.

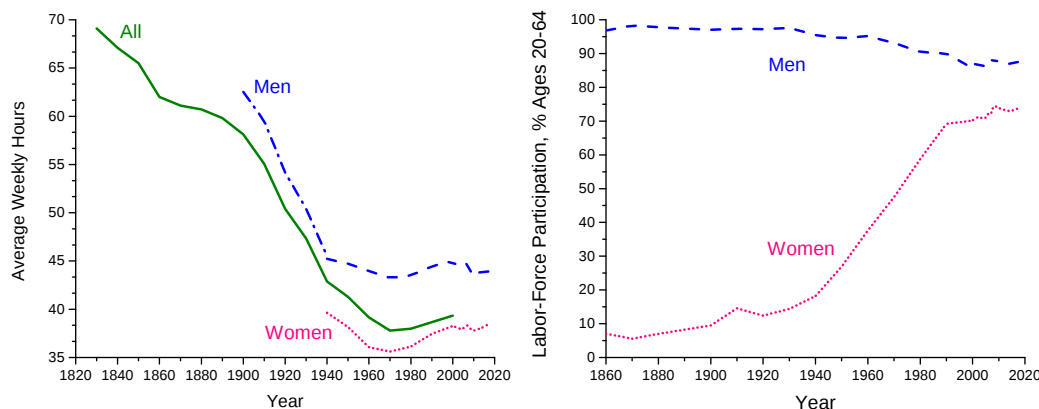


Figure 2.1: Average Weekly Hours and Labor-Force Participation in the United States.

Now, one might think that poor countries today might resemble the United States of the past. If so, then there should be a negative relationship in a cross-section of countries between per-capita income and average weekly market hours. Likewise, time spent in housework should decline with per-capita income. It might be a bit wide-eyed to expect that the cross-country relationship observed today would match up exactly with the US historical time series (where time is replaced with per-capita income); because, even

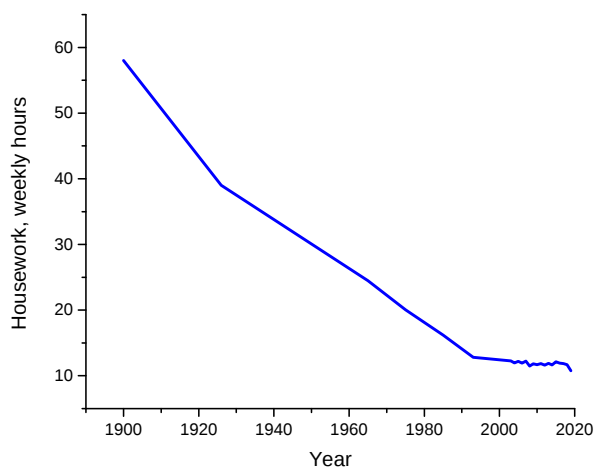


Figure 2.2: Housework in the United States.

the poorest countries today have appliances, computers, and machinery that were not available in the American past. As can be seen from Figure 2.3, though, there is indeed a negative relationship between (logged) per-capita GDP and average weekly hours. The correlation coefficient between these two variables is -0.64. There is also a negative correlation between cleaning and cooking, on the one hand, and per-capita GDP, on the other. The correlation coefficients are -0.31 and -0.78, respectively.

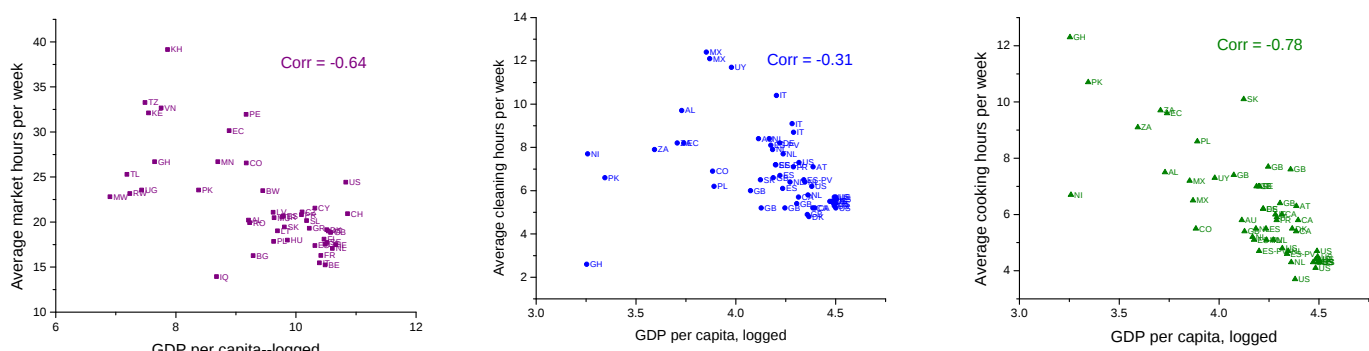


Figure 2.3: The Cross-Country Relationship between per-capita GDP and Hours Worked, both in the Market and at Home.

As the need for household labor declined, due to appliances in the home, and as the workplace became more favorable to women, caused by a shift from brain to brawn associated with computerization and mechanization, there was an upswing in female labor-force participation across the world. This can be gleaned from the left panel of

Figure 2.4. Per-capita GDP and female labor-force participation are positively related, with a correlation coefficient of 0.48 between the two series. The waxing of female labor-force participation is stronger than it appears in the scatter diagram. This is because technological innovation at home and in the workplace hit various countries at differing levels of GDP per capita, thereby muddying per-capita GDP's relationship with female labor-force participation. Additionally, one would expect female labor-force participation to peak and level off at some point in time. After that its relationship with per-capita GDP would be flat. The right panel of Figure 2.4 shows the rise in female labor-force participation over time for seven representative countries. As can be seen, the trends follow the US pattern.

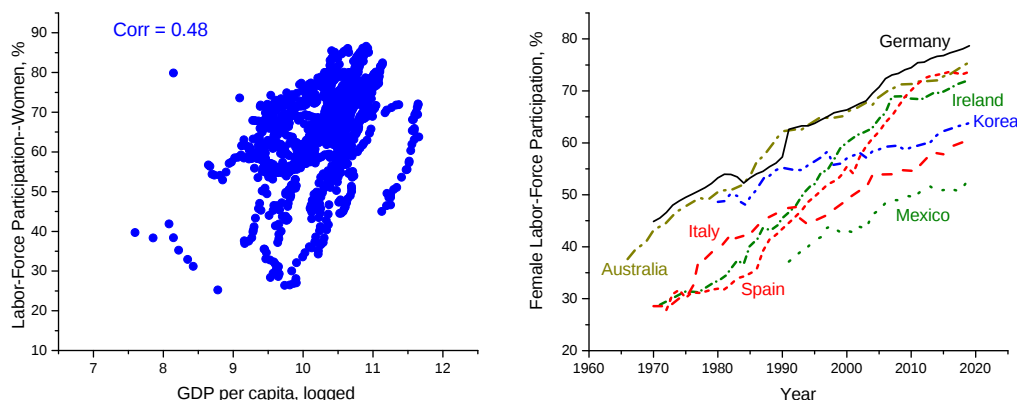


Figure 2.4: The Cross-Country Rise in Female Labor-Force Participation, Ages 20-64.

Another manifestation of the decline in hours worked is the trend over the last century toward retiring at an earlier age. Sixty percent of 80-year-old men in the United States still worked in 1850! This had fallen to just 6 percent by 2018, as Figure 2.5, left panel, illustrates. Over the course of the last century there was a dramatic increase in the fraction of men in retirement for every age group over 60. This stylized fact is also true across the world. In the cross-country data (right panel) the fraction of men retired after age 65 is positively related with GDP, as can be seen. A caveat is in order. As life spans increase in the modern era people may choose to delay retirement. Some evidence of this is seen in the US time series for the 60-to-65 and 65-to-70 age groups.

2.2 The Drop in Fertility

The track followed by fertility descended from 7.4 children per white woman in 1800, to 4.2 in 1880, and then to 1.6 kids in 2018. The trend in the total fertility rate (TFR),

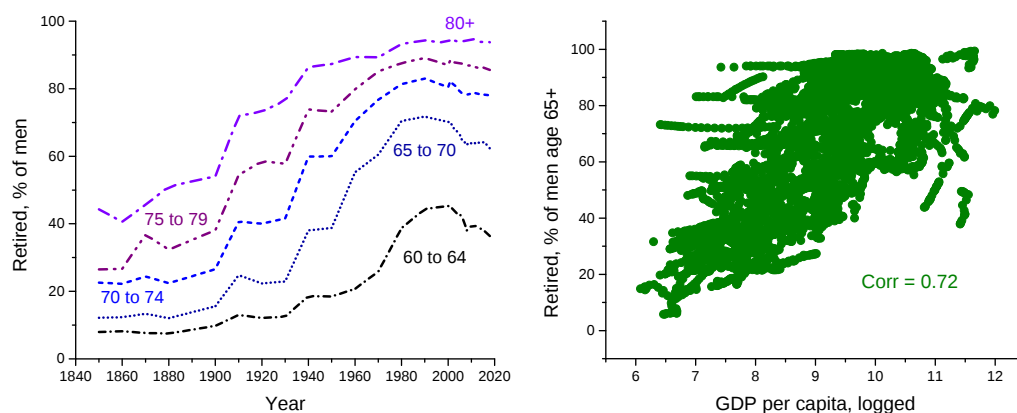


Figure 2.5: The Trend Toward Earlier Retirement.

shown in Figure 2.6, was interrupted once by the baby boom, which occurred roughly between 1940 and 1971, with a peak of 3.6 kids in 1957. As can be seen, the secular decline in fertility swamps the rise during the baby boom years. Fertility decreases as a country becomes richer, as can be seen in Figure 2.7. The correlation coefficient between (the log of) per-capita GDP and the total fertility rate and is -0.75. The downward time trend in the crude birth rate (CBR) for seven representative countries is also shown. Mexico displays the classic $\cap$ -shaped demographic transition, where fertility first rises and then falls. At its peak in 1930 there were 49 births per 1,000 population. By 2016 this had dropped to 18. While the mid-twentieth century baby boom for the United Kingdom is noticeable, it is swamped by the secular decline.

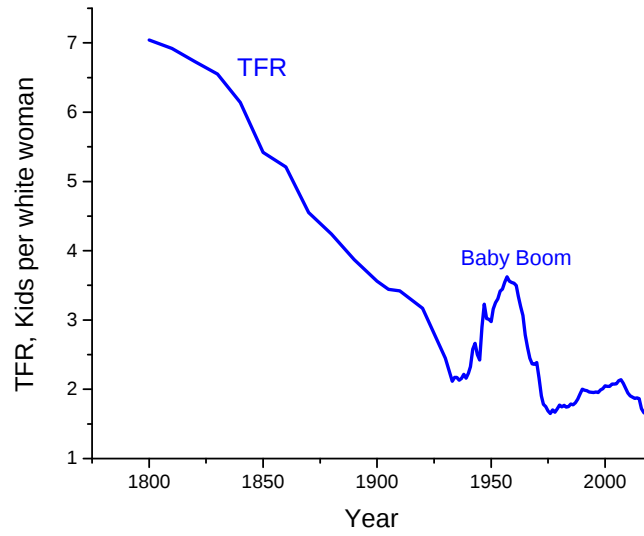


Figure 2.6: Fertility in the United States.

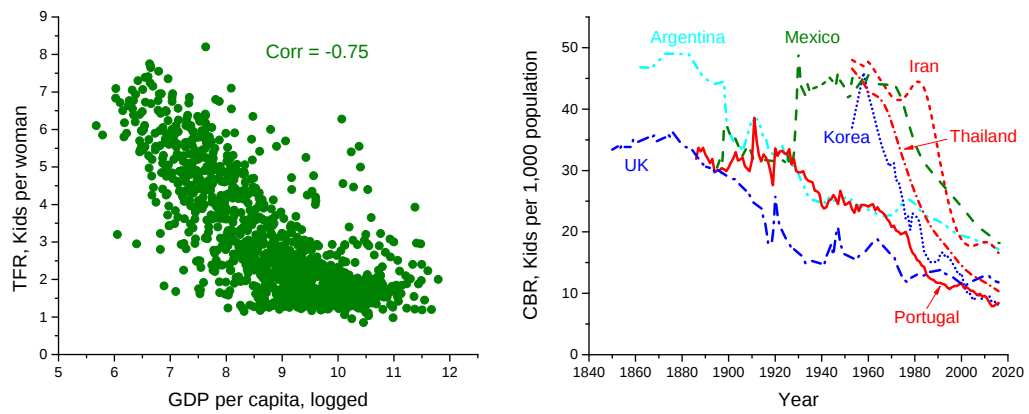


Figure 2.7: The Cross-Country Decline in Fertility.

2.3 The Waning in Marriage

In 1880 only 39 percent of women in the 20-to-29 age group had never been married; direct attention to the left panel of Figure 2.8. This had jumped up to 76 percent by 2019. This was linked to an increase in the median age of marriage from 22 years in 1890 to 28 in 2019. As can be seen, around the baby boom years there was a burst in marriage with an associated drop in the median age of marriage. The figure, right panel, also tracks the composition of US households over time. The fraction of US households that were married contracted continuously, especially married households with children. Correspondingly, the fraction of households made up by singles grew significantly, with a distinct rise in single households with children. The same patterns show up in the cross-country data as well. The fraction of women ages 20 to 24 that are never married rises with (the log of) real per-capita income. The correlation between the two series is 0.83—see Figure 2.9, left panel. So, does the mean age of marriage (right panel), with a correlation coefficient of 0.80.

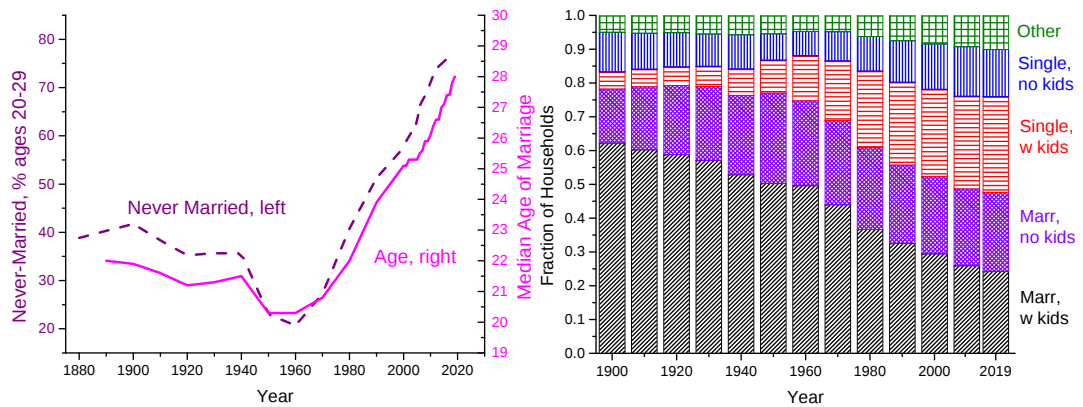


Figure 2.8: Marriage in the United States.

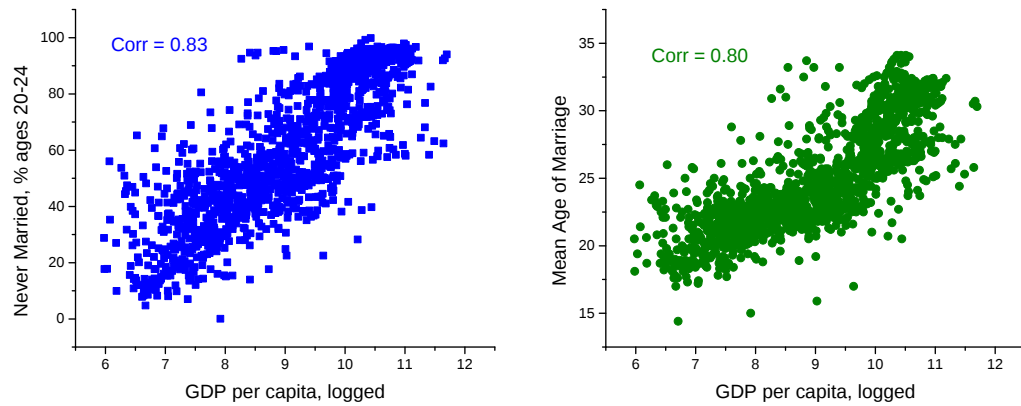


Figure 2.9: The Cross-Country Relationship between per-capita GDP and Marriage.

2.4 The Descent in Household Size

Associated with the drop in fertility and a rise in the number of singles has been a descent in household size, both in the United States and across countries. In 1850 there were roughly 5.4 people living in the average American household, compared with 2.5 in 2019. Across countries there is a negative association between per-capita GDP and household size, with a correlation of -0.70—see Figure 2.10.

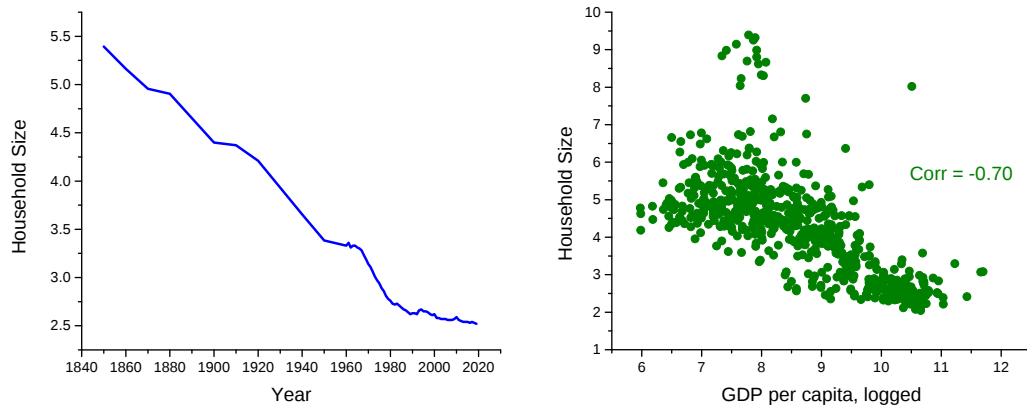


Figure 2.10: Household Size in the United States and Across Countries.

2.5 The Waxing in Educational Attainment

A child born in 1876 would have had 7.7 years of schooling by age 35, while one born in 1975 would have had 14.2; see Figure 2.11. So, years of schooling roughly doubled over

the last century. In 1869 only 1.3 percent of individuals, ages 18 to 24, were enrolled in an institution of higher education, while 57 percent were in 1995. Move on now to the cross-country data and direct attention to Figure 2.12. Years of schooling rise with a country's level of per-capita GDP; the correlation coefficient is 0.85. Likewise, the percentage of the population who completed a tertiary education moves up with per-capita GDP, with a correlation of 0.71. So, the cross-country evidence is simpatico with the US time-series evidence.

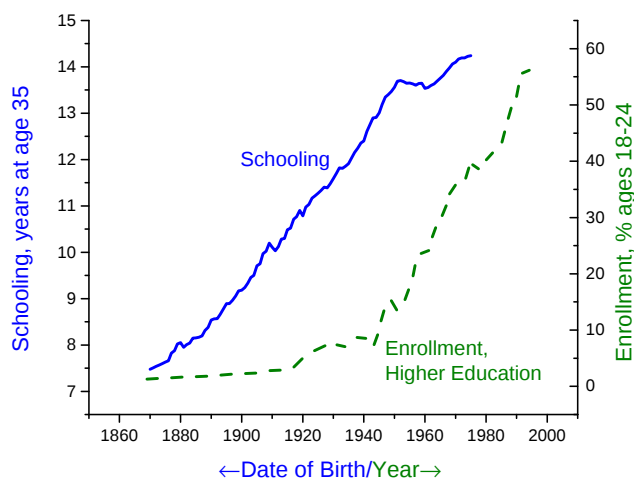


Figure 2.11: Educational Attainment in the United States.

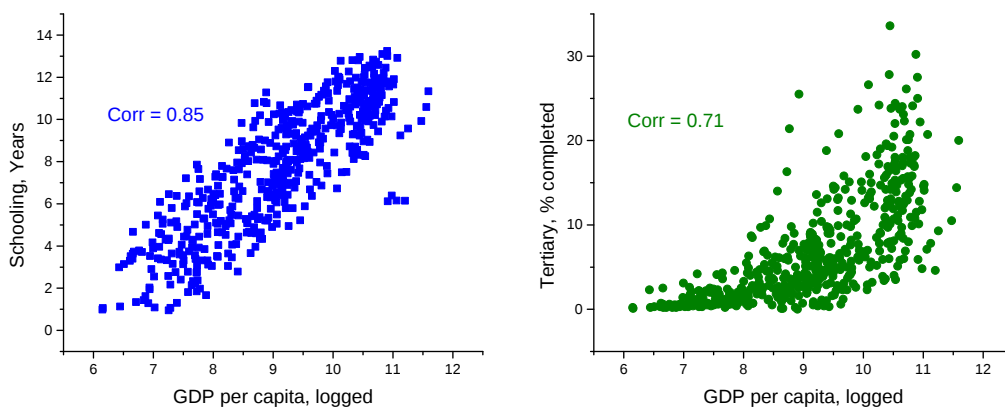


Figure 2.12: The Cross-Country Relationship between per-capita GDP and Educational Attainment.

2.6 The Shift from Blue- to White-Collar Jobs

With the introduction of electricity and the internal combustion engine, the need for physical labor declined. This led to a dramatic shift in labor force away from blue-collar jobs toward white-collar ones for both men and women. This shift is displayed in Figure 2.13. As can be seen, 88 percent of the male labor force labored in blue-collar jobs in 1860. By 2018 this had dropped to 37 percent. The shift was even stronger for women. Today only 10 percent of working women are in blue-collar jobs compared with 87 percent in 1860. Not surprisingly, over the entire period there is a proclivity of women relative to men to favor white-collar jobs over blue-collar ones. The same trend is true in the cross-country data. As a country's per-capita GDP rises so does the fraction of the labor-force working in white-collar jobs. This is true for both men and women; see Figure 2.14. Women are more likely to work in white-collar jobs than men.

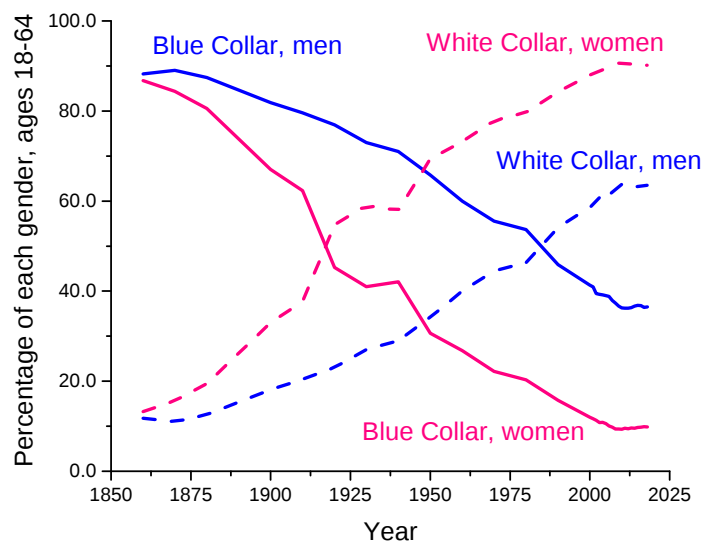


Figure 2.13: Occupations in the United States for Men and Women.

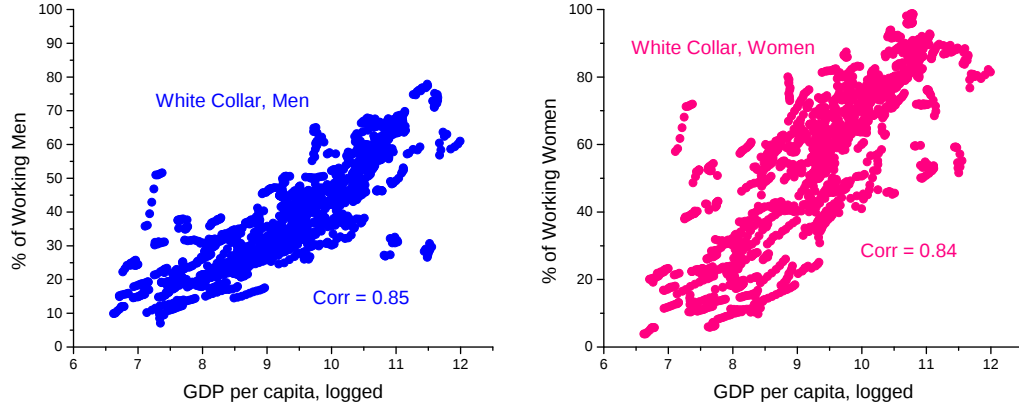


Figure 2.14: The Cross-Country Relationship between per-capita GDP and White-Collar Jobs.

3 Setup

There are two types of households in the economy; namely, married and single. An adult in a household lives for one period and has one unit of time. A single household can split their unit of time between three uses: household production, h , leisure, l , and toiling in the market, $t \equiv 1 - l - h$. A married couple has two units of time. They must devote some of this time to raising children, both for basic childcare and educating their kids. In terms of time, a child costs b in basic childcare and e in education. So, a married couple have five uses for their time: basic childcare for $k \geq 0$ kids, or bk ; educating k children, ek ; household production, h ; leisure, l ; and toiling in the market, $t \equiv 2 - bk - ek - h - l$. An adult has one unit of raw talent that is divided between brain and brawn. This split, $s \in [0, 1]$, was decided earlier in life by the adult's parents. A unit of brain is paid v while a unit of brawn receives u . Brain is paid more than brawn so that $v > u$. The market wage for a unit of labor, $w = sv + (1 - s)u$, depends on how a person's skill endowment is split between brain and brawn.

Labor income is used to purchase market consumption, c , and household durables, d . Market consumption is the numeraire good with a price of one. Durable goods, d , are mixed with household labor, $\mathbf{h}$, to produce nonmarket goods, n .² The per-unit price of a household durable is p .

At the beginning of adult life a single is matched with another single. At that point in time, they draw a common joy shock for the relationship, j . The couple then decides

²Note that $\mathbf{h}$ can be different from h above.

immediately whether to marry or not. In addition to marital joy, j , marriage offers the possibility of children, k , as well as some scale economies from pooling resources. The extent of the scale economies from pooling resources is regulated by a household equivalence scale, $\varepsilon \in [0.5, 1.0]$. Specifically, the household equivalence scale converts total consumption into consumption per adult, so in a married household the per-adult consumptions of market and nonmarket goods are εc and εn .

3.1 Household Production

Nonmarket goods, n , are produced in accordance with the following household production function

$$n = [\theta d^\sigma + (1 - \theta) \mathbf{h}^\sigma]^{1/\sigma}, \text{ with } \sigma \leq 1, \quad (3.1)$$

where d represents the input of household durables in production and $\mathbf{h}$ denotes the amount of household labor. For a single household their labor is just the time spent on housework; i.e., $\mathbf{h} = h$. For a married household $\mathbf{h}$ might include the physical labor of children. Specifically, for a married household with k children let $\mathbf{h} = h + \chi k$, where χ represents the productivity of a child in housework. Historically, children did some work in the home. As an economy develops the need for child labor diminishes. This could transpire because better appliances lower the burden of housework. Additionally, increased schooling reduced the time that a child could devote to housework. This is represented here by a drop in the value for χ ; i.e., χ is allowed to change over time. Child labor operates to reduce the cost of children, which has implications for fertility.

The parameter σ plays an important role in the analysis. It controls the degree of substitutability between durables and labor in household production. A high value for σ implies that durables and labor can easily be substituted. In this situation household durables are labor saving. So, a decline in the price of durables, p , will create a substitution of capital, d , for labor, $\mathbf{h}$, in the home. The parameter θ denotes the share of durables in household production; it plays a much lesser role in the analysis.

3.2 Cost of Children

Only married households have children. There are two costs of raising children, basic childcare and education. The time cost per kid for basic childcare is b . So, the cost of basic childcare for k children is just bk . Each child has one unit of undeveloped talent. Parents can choose how to split their child's talent endowment between brain

and brawn. This determines a child's future wage. Let $s \in [0, 1]$ be the fraction that is allocated to brain. The time cost of educating a child, or e , is given by

$$e = \gamma s. \quad (3.2)$$

3.3 Tastes

Tastes for a single are distributed over their consumption of market goods, c , nonmarket goods, n , and leisure, l . Their utility function reads

$$\alpha \frac{c^{1-\rho} - 1}{1 - \rho} + \beta \frac{n^{1-\nu} - 1}{1 - \nu} + (1 - \alpha - \beta) \frac{l^{1-\lambda} - 1}{1 - \lambda}. \quad (3.3)$$

Here α , β , and $1 - \alpha - \beta$ are the weights attached to the utilities from consumption, nonmarket goods, and leisure. The exponents on these utility terms, or ρ , ν , and λ , control the concavity of the utility terms. As will be seen, these exponents (or inverse elasticities) are important for governing the rate of change over time in an utility function's arguments. The weights can be thought of as determining the level of an argument for some baseline period.

For a married household tastes are defined over their consumption of market goods, c , nonmarket goods, n , leisure, l , the number of children, k , and their children's future wage rate, $sv + (1 - s)u$. As can be seen, the future wage for a child depends on the their skill level, s . The utility function for a married household is specified as

$$\alpha \frac{(\varepsilon c)^{1-\rho} - 1}{1 - \rho} + \beta \frac{(\varepsilon n)^{1-\nu} - 1}{1 - \nu} + \delta \frac{l^{1-\lambda} - 1}{1 - \lambda} + \psi \frac{k^{1-\kappa} - 1}{1 - \kappa} + \xi \frac{[sv + (1 - s)u]^{1-\zeta} - 1}{1 - \zeta}, \quad (3.4)$$

where again $\varepsilon \in (0.5, 1.0)$ is a household equivalence scale. When $\varepsilon = 0.5$ there are no economies of scale in consumption. Alternatively, if $\varepsilon = 1.0$, then consumption is a full public good. The weight on the utility from leisure for a married household, δ , differs from a single one, $1 - \alpha - \beta$; it's hard to know how the utility of husband and wife should be aggregated in a household. When the utility terms for the number of children, $\psi(k^{1-\kappa} - 1)/(1 - \kappa)$, and their skill level, $\xi\{[sv + (1 - s)u]^{1-\zeta} - 1\}/(1 - \zeta)$, are positive, this adds to the value of married life over single life.

4 Decision Problems

The decision problems for married and single households are now cast. The choice to either marry or remain single is then addressed.

4.1 Singles

The budget constraint for singles is

$$c + pd = w(1 - h - l), \quad (4.1)$$

where the lefthand side represents the person's expenditure on market consumption and durables while the righthand side specifies their labor income. In the utility function for a single (3.3) substitute out for market consumption, c , using the budget constraint (4.1), and for nonmarket goods, n , using the household production function (3.1) while noting that $h = h$. The maximization problem for singles then formulates as

$$S = \max_{d,h,l} \left\{ \alpha \frac{[w(1 - h - l) - pd]^{1-\rho} - 1}{1 - \rho} + \beta \frac{[\theta d^\sigma + (1 - \theta)h^\sigma]^{(1-\nu)/\sigma} - 1}{1 - \nu} + (1 - \alpha - \beta) \frac{l^{1-\lambda} - 1}{1 - \lambda} \right\}. \quad (4.2)$$

The variable S gives the maximal level of utility that a single can attain.

4.2 Married Couples

The budget constraint for married households reads

$$c + pd = w(2 - bk - \gamma sk - h - l). \quad (4.3)$$

Their budget constraint is similar to the one for singles except that a married couple has two units of time that now must also be used for basic childcare, bk , and educating children, $ek = \gamma sk$. A married couple's maximization problem is

$$M = \max_{d,h,l,k,s} \left\{ \alpha \frac{\varepsilon^{1-\rho} \{w[2 - bk - \gamma sk - h - l] - pd\}^{1-\rho} - 1}{1 - \rho} + \beta \frac{\varepsilon^{1-\nu} [\theta d^\sigma + (1 - \theta)(h + \chi k)^\sigma]^{(1-\nu)/\sigma} - 1}{1 - \nu} + \delta \frac{l^{1-\lambda} - 1}{1 - \lambda} + \psi \frac{k^{1-\kappa} - 1}{1 - \kappa} + \xi \frac{[sv + (1 - s)u]^{1-\zeta} - 1}{1 - \zeta} \right\}. \quad (4.4)$$

In formulating this problem c and n have been eliminated from (3.4) by using (4.3) and (3.1) while noting that $\mathbf{h} = h + \chi k$. The variable M gives the economic value of marriage. The economic values of married and single lives, M and S , play important roles in the marriage decision, as is discussed next.

4.3 Married versus Single Life

A single is matched with another single at the beginning of adult life. Upon meeting they draw a common joy shock, j . The value of married life is then given by $M + j$, where the economic value of marriage, M , is defined by (4.4). The value of single life is provided by S in (4.2). The joy shock, $j \in \mathbb{R}$, is drawn from a Gumbel distribution, $G(j)$:

$$G(j) = Pr(\tilde{j} \leq j) = \exp \left\{ -\exp \left[-\frac{(j - \mathbf{a})}{\mathbf{d}} \right] \right\}, \text{ with } \mathbf{d} > 0,$$

where $\mathbf{a}$ and $\mathbf{d}$ are the location and scale parameters and $\tilde{j}$ denotes a random draw for j .

The decision to marry formulates as

$$\begin{aligned} &\text{Marry,} && \text{if } M + j \geq S; \\ &\text{Single,} && \text{if } M + j < S. \end{aligned}$$

The threshold level of joy, j^* , at which a person is indifferent between marriage and single life is given by $j^* = S - M$. Let $\mathbf{m}$ denote the fraction of the population who is married. The fraction of the population who is single (or unmarried), $1 - \mathbf{m}$, is

$$1 - \mathbf{m} = G(j^*) = \exp \left\{ -\exp \left[-\frac{(j^* - \mathbf{a})}{\mathbf{d}} \right] \right\} = \exp \left\{ -\exp \left[-\frac{(S - M - \mathbf{a})}{\mathbf{d}} \right] \right\}. \quad (4.5)$$

Now, if the economic value of marriage exceeds the value of single life, so that $M > S$ and $S - M < 0$, then the threshold value for marriage, j^* , is negative. This implies that some people marry purely for economic reasons.

5 Calibrating the Model to US Data

Can the above model match the Kuznets facts discussed in Section 2? To address this question, the analysis focuses on two periods; namely, 1880 and 2020. The set of targeted facts is fertility, schooling, housework, market work, and the fraction of

the population that is single (or equivalently married). In order to match the set of data targets values must be assigned to the model's various parameters. Some parameters values can be directly imposed from information that is available while others are selected to maximize the fit of the model with respect to the data targets.

5.1 Data Targets

The data targets are enumerated now. Unless mentioned, all definitions and sources for the data targets are provided in the Data Appendix.

1. *Fertility*: The targets here are the total fertility rates for white women in 1880 and 2018. So the objective is to attain $k_{1880} = 4.24$ and $k_{2020} = 1.64$.
2. *Market work*: The average market workweek for a married household in 1880 is taken to be 68.82 hours, while for 2020 it was 66.91 hours. The number for 2020 corresponds to total market work by a husband and wife ages 20 to 64, conditional on one person being employed, as recorded in the American Community Survey in 2019. While hours worked in the market declined over time for married men they rose for married women resulting in the average workweek across both men and women being stable. There are 112 non-sleeping hours per adult in a week so a married household will have $2 \times 112 = 224$ hours. Thus, for a married household the goal is to match $t_{m,1880} = 2 \times 68.82/224$ and $t_{m,2020} = 2 \times 66.91/224$ —recall that a married household has two units of time, whereas a single household has one. The 1880 and 2020 targets for the average market workweek for a single household are 40.26 and 33.83 hours. For 2020 the number is taken from the American Community Survey and is the average over all singles ages 20 to 64 in 2019. Therefore, for a single household the targets are $t_{s,1880} = 40.26/112$ and $t_{s,2020} = 33.83/112$. To obtain the numbers for 1880 an inference is made. Specifically, Vandenbroucke (2009) reports that the average workweek (across both working married and single individuals) in 1880 was 60.7 hours. Therefore, $m_{1880} \times \text{hrs}_{m,1880} + (1 - m_{1880}) \times \text{hrs}_{s,1880} = 60.7$. Now, boldly assume that the married-to-single ratio of market time was the same in 1880 as is documented for 1940 by the Census. (The earliest Census year for which hours-worked data is available.) Then, one can write

$$\text{hrs}_{s,1880} = 60.7 \div [m_{1880}(\text{hrs}_{m,1940}/\text{hrs}_{s,1940}) + (1 - m_{1880})],$$

and

$$\text{hrs}_{\text{m},1880} = [60.7 - (1 - m_{1880})\text{hrs}_{\text{s},1880}]/m_{1880},$$

where $\text{hrs}_{\text{m},1940}/\text{hrs}_{\text{s},1940} = 41.94/24.53$. This calculation results in $\text{hrs}_{\text{m},1880} = 68.82$ and $\text{hrs}_{\text{s},1880} = 40.26$.

3. *Housework*: Lebergott (1993) estimated that 58 hours a week was spent on housework—cleaning, laundry, and meals—in 1900. Assume that this number represents total housework in 1900 by both husband and wife. This number is somewhat speculative but only 3 percent of households had electricity at this time. No one had refrigerators, vacuum cleaners, washing machines, and the like. According to Lebergott (1993), scrub boards were used to clean clothes by 98 percent of households with only 1 percent using a commercial laundry. By 2019 the total amount spent on housework, by both husband and wife ages 20 to 64, had declined to 17.45 hours, according to the data recorded in the American Time Use Survey. Given these facts set the targets for a married household to $h_{\text{m},1880} = 2 \times 58/224$ and $h_{\text{m},2020} = 2 \times 17.45/224$. Data from the American Time Use Survey suggests that a single household (ages 20 to 64) spent 6.41 hours per week on housework in 2019. For 1880 a fearless assumption is made: suppose that the married-to-single housework ratio was the same in 1880 as the average ratio between 1965 and 2019 as computed from the American Heritage Time Use Study and American Time Use Survey.³ Consequently, $\text{hrs}_{\text{s},1880} = 58 \div 2.80$. Thus, the goal for singles is $h_{\text{s},1880} = 20.73/112$ and $h_{\text{s},2020} = 6.41/112$.
4. *Marriage*: In 1880 the percentage of never-married women, ages 20 to 29, was 38.8, while by 2019 this number was 76.2 percent. Therefore, ideally $1 - m_{1880} = 0.388$ and $1 - m_{2020} = 0.762$.
5. *Schooling*: The level of schooling is identified as the fraction of the population that was working in white collar jobs. In 1880 the percentage of the ages 25-to-54 population in white-collar jobs was 16.82. This percentage was 76.54 in 2018. So the schooling targets are $s_{1880} = 0.1682$ and $s_{2020} = 0.7654$.

5.2 Fitting Parameter Values

To see if the set of Kuznets facts can be matched, values must be assigned to the model's various parameters. This is done in three ways. First, some parameters are exogenously

³This time-use data only goes back as far as 1965.

imposed. Second, other parameters can be backed out from the first-order conditions so that the model hits certain data targets for married households exactly. Third, the remaining parameters are chosen to maximize the fit of the model with respect to some remaining data targets for singles.

Assigning parameter values using direct information

Begin with the parameters that are exogenously imposed. These fall into 7 broad categories that are discussed now.

1. *Prices*: Prices for the two periods need to be specified; namely the wage rates, w_{1880} and w_{2020} , the college premiums defined as the ratios of the college to non-college wage rates, $q_{1880} \equiv v_{1880}/u_{1880}$ and $q_{2020} \equiv v_{2020}/u_{2020}$, and the prices of durables, p_{1880} and p_{2020} . In the analysis, the wage rate for 1880 is normalized to one; i.e., set $w_{1880} = 1$. Over the period in question wages grew eleven fold, or an average increase of about 1.7 percent per year. Therefore $w_{2020} = 11.3w_{1880}$.⁴ The college premium in 2020 is taken to be $q_{2020} = 1.81$. This value corresponds to the income earned from graduating with a four-year college degree relative to the income earned from graduating just from high school—median incomes for males are used, taken from the Census’s Current Population Survey in 2018. In the model’s steady-state equilibrium the aggregate real wage, w , is related to the skilled and unskilled wage rates, v and u , as follows:

$$w = sv + (1 - s)u. \quad (5.1)$$

Therefore, given data on the average wage rate, w_{2020} , the college premium, q_{2020} , and the level of schooling, s_{2020} , values can be backed out for the non-college and college wage rates:

$$u_{2020} = \frac{w_{2020}}{s_{2020}q_{2020} + 1 - s_{2020}} \quad \text{and} \quad v_{2020} = \frac{w_{2020}}{s_{2020} + (1 - s_{2020})/q_{2020}}.$$

Little is known about the value of the college premium in 1880, q_{1880} , so this will be a free parameter in the calibration exercise. A calibrated value for q_{1880} implies values for u_{1880} and v_{1880} , given w_{1880} and s_{1880} . The price of durables is assumed to fall at about 5 percent a year, the number used by Greenwood et al

⁴For the period 1880 to 1988, the real wage data in Williamson (1995) is used, while for 1989 to 2019 real wages are defined to be the real compensation of employees divided by aggregate hours worked as reported in FRED.

(2016). So, $p_{2020} = 1.05^{-(2020-1880)}p_{1880}$. The price for household durables in 1880 is normalized so that $p_{1880} = 100$.

2. *Household production function*: The following values are assigned to the parameters governing household production: $\theta = 0.206$ and $\sigma = 0.276$. The number for θ comes from McGrattan, Rogerson, and Wright (1997). The value for σ lies between the numbers in Greenwood, Seshadri, and Yorukoglu (2005) and McGrattan, Rogerson, and Wright (1997). A discussion on the selection of σ is deferred to Section 6.4. The fact that $\sigma > 0$ implies that durables and housework are quite substitutable in household production. Therefore, process innovation in the production of household durables, which lowers their price, will be labor saving. To see this, note that durables, d , are chosen to satisfy

$$\frac{\theta}{1 - \theta} \left(\frac{d}{h} \right)^{\sigma-1} = \frac{p}{w}. \quad (5.2)$$

This equation states that the marginal rate of substitution of durables for time in household production, as given by the lefthand side, must equal the time price of durable, or the righthand side. The parameter σ regulates the response of the durables/housework ratio in the home to a change in the time price of durables. The elasticity of substitution between durables and housework is $-1/(1 - \sigma)$, which in absolute value is increasing in σ . So when $0 < \sigma < 1$ there will be a larger increase in the durables/housework ratio (or equivalently a decrease in the housework/durables ratio) in response to a *drop* in the time price relative to a Cobb-Douglas production function ($\sigma = 0$).

3. *Coefficient of relative risk aversion*: A standard value of 1.25 is chosen for the coefficient of relative risk aversion, ρ .
4. *Household equivalence scale*: The household equivalence scale is set to $\varepsilon = 0.6667$, in line with the OECD's modified scale. The scale assigns a value of 1 to the first adult in family and a value of 0.5 to second one, which implies $\varepsilon = 1/(1 + 0.5)$.
5. *Basic childcare*: The American Time Use Survey and Gershuny and Harms (2016) are used to pin down the time cost of basic childcare. Women spent on average 4.96 hours per week per child in basic childcare in 2019, 3.93 hours in 1965, and 1.22 in 1919. The average of these three values is selected for b ; i.e., set $b = 2 \times 3.37/224$. Here it is assumed that only women provide basic childcare. The 1965 and 2019 numbers are for all married women with and without children

and are taken from the American Heritage Time Use Study and American Time Use Survey. The 1920 number is based on Gershuny and Harms (2016) who report that women spent 35 minutes per day on child and adult care in the 1920s. This is about 4.08 hours per week. To calculate hours per child, divide this by 2.81, the average of the total fertility rates in 1920 and 1930. In the 1965 American Heritage Time Use Study, 84 percent of total care time per child by mothers was for the basic care. It is assumed that women allocated their time between basic and educational childcare in the same way in the 1920s.

6. *Educating children:* Given data on schooling, s , and the time spent educating children by parents, e , an estimate can be obtained for γ . Specifically, $\gamma = e/s$. As a measure of schooling the fraction of the labor force in white-collar jobs is used. Now, 76.54 percent of the labor force was in white collar jobs in 2020. According to the American Time Use survey a household spent 4.41 hours a week educating a child in 2020. Thus, $\gamma_{2020} = 2 \times (4.41/224)/0.77$. Between 1960 and 1970, 57 percent of the labor force was in white-collar jobs. Data from the American Heritage Time Use Study suggests that in 1965 the time spent on educational activities per child was 1.31 hours per week. Therefore, $\gamma_{1965} = (1.31/224)/0.57$. Last, the data in Gershuny and Harms (2016) suggests that 0.24 hours per week was spent educating a child in the 1920s.⁵ The fraction of white-collar workers was 33.33 percent (an average between 1920 and 1930). So, $\gamma_{1920} = (0.24/224)/0.33$. An average of these three values is taken for γ . This results in $\gamma = 0.0261$.
7. *Child labor in home production:* A child is not as productive as an adult in household production. Wages can be used to gauge the productivity of children vis à vis adults. The evidence suggests that the productivity of a child is much less than that of an adult. For example, anecdotal evidence from Abbott (1908, p. 28) is presented in Table 5.1. Lebergott (1964, pp. 49–50) relates that a ten-year-old in 1798 could earn the equivalent of \$22 a year working as a farm laborer, as compared with \$96 for an adult. So, how much housework did children do? To answer this question, suppose that poorer countries today resemble the United States in 1880. Webbink, Smits, and De Jong (2012) document children's housework across low-income countries (mostly African and Asian). The average number of hours worked per week for boys and girls ages 8 to 13 was 6 and 9 hours. For 2020, the findings in Hofferth and Sandberg (2001) for the United

⁵The 0.24 hours per week corresponds to the total amount of child and adult care provided by women multiplied by the fraction of the time women spent per child on educational child care (16 percent according to the 1965 American Heritage Time Use Study).

States are used. They document that children ages 0 to 12 spent 5.48 hours per week in housework. Hence, $\chi_{1880} = (22/96) \times 2 \times (7.5/224)$ and $\chi_{2020} = (22/96) \times 2 \times (5.48/224)$.

Table 5.1: Weekly wages in 1815

Age	\$
Adult man	5.00
Adult woman	2.33
16-year-old boy	2.00
13-year-old boy	1.50
12-year-old girl	1.25
10-year-old boy	0.83
8-year-old girl	0.75

Assigning parameter values using the first-order conditions—Inner loop

The rest of the parameters are fit with respect to a set of data targets. The calibration procedure here has two loops: inner and outer. The inner loop picks the utility parameters governing a married household’s tastes over leisure, δ and λ , fertility, ψ and κ , their children’s future wages, ξ and ζ , and home goods, β and ν . This is done based on observations for a married household’s leisure, fertility, educational choice for children, and housework. When doing this the parameter values for the weight term on a married household’s utility from consumption, α , and the 1880 college premium, q_{1880} , are taken as given. Note that a single household’s utility functions for consumption, home goods, and leisure share the parameters α, ρ, β, ν , and λ .

The inner loop uses the first-order conditions for the married household to back out parameter values so that the model fits exactly a married household’s data targets for leisure, fertility, schooling, and housework. The exponents on the various utility functions, λ, κ, ζ , and ν , are identified from the observed rates of change in the function’s argument. The weights on the utility functions, δ, ψ, ξ , and β , are selected so that the model fits the data for some particular year. The outer loop then picks the two remaining parameters, α and q_{1880} , to maximize the fit of the model over the time-allocation data targets for singles. The choice of these two parameters influences the determination of the inner loop’s parameter values. Last, the parameters governing the Gumbel distribution are chosen to meet the targets concerning marriage.

Start now with the inner loop. To begin with, consider the married household’s choice

for leisure, l . The leisure first-order condition can be expressed as

$$\delta l^{-\lambda} = \alpha \varepsilon^{1-\rho} \underbrace{[w(2 - bk - \gamma sk - h - l) - pd]}_{=c}^{-\rho} w. \quad (5.3)$$

The lefthand side is utility gain from an extra unit of leisure. The righthand side gives the loss in utility from taking a unit of time away from market work. This results in a loss of wages, and hence in consumption, of w . The loss in utility from a unit reduction in consumption is just the marginal utility of consumption or $\alpha \varepsilon^{1-\rho} c^{-\rho}$. When evaluated at the data targets, this equation implies

$$\left(\frac{l_{2020}}{l_{1880}} \right)^{-\lambda} = \left[\frac{w_{2020} (2 - bk_{2020} - \gamma s_{2020} k_{2020} - h_{2020} - l_{2020}) - p_{2020} d_{2020}}{w_{1880} (2 - bk_{1880} - \gamma s_{1880} k_{1880} - h_{1880} - l_{1880}) - p_{1880} d_{1880}} \right]^{-\rho} \frac{w_{2020}}{w_{1880}}.$$

It is clear that the change in leisure, l_{2020}/l_{1880} , is governed by the exponent on the utility function for leisure, λ . So, conditional on values for the variables on the righthand side, λ can be selected to match the desired change in leisure.⁶ The solution for λ is dependent on the value for ρ that is set exogenously based on direct information. The weight on the leisure utility function of married households, δ , can be obtained by using the first-order condition for leisure to hit the leisure target for 2020 or to solve the equation

$$\delta l_{2020}^{-\lambda} = \alpha \varepsilon^{1-\rho} [w_{2020} (2 - bk_{2020} - \gamma s_{2020} k_{2020} - h_{2020} - l_{2020}) - p_{2020} d_{2020}]^{-\rho} w_{2020}.$$

Next, move onto fertility, k , which has the efficiency condition

$$\psi k^{-\kappa} = \delta l^{-\lambda} (b + \gamma s - \chi). \quad (5.4)$$

The lefthand side is the marginal utility of a child. The righthand side is the marginal cost in terms of the forgone leisure. An extra child costs b units of time in terms of basic childcare and γs in time spent on education. This time cost is offset by the effective time the child spends in home production, χ . The net time cost is multiplied by marginal utility of leisure. From this it transpires that

$$\left(\frac{k_{2020}}{k_{1880}} \right)^{-\kappa} = \left(\frac{l_{2020}}{l_{1880}} \right)^{-\lambda} \frac{b + \gamma s_{2020} - \chi_{2020}}{b + \gamma s_{1880} - \chi_{1880}}.$$

⁶By taking logs of the above equation an explicit solution for λ in terms of the other variables obtains.

As can be seen, κ is central for controlling the change in fertility, k_{2020}/k_{1880} . It can be selected to match the targeted decline in fertility.⁷ The constant term on the utility function for fertility is chosen so that the following equation is met

$$\psi k_{2020}^{-\kappa} = \delta l_{2020}^{-\lambda} [b + \gamma s_{2020} - \chi_{2020}].$$

Turn to schooling, s . The first-order condition for schooling can be written as

$$\xi [sv + (1 - s)u]^{-\zeta} (v - u) = \delta l^{-\lambda} \gamma k. \quad (5.5)$$

The lefthand side gives the benefit to parents from investing in an extra unit of brain for their children. This increases the adult child's wages by $v - u$, where the marginal utility to the parents of an extra unit of earnings is $\xi [sv + (1 - s)u]^{-\zeta}$. The righthand side is the cost from an extra unit of brain. The time cost of the extra unit of brain for k kids is γk , which could have been used for leisure. The marginal utility of leisure is $\delta l^{-\lambda}$. In this equation $w = sv + (1 - s)u$ is the average wage in the economy, while $v - u$ can be thought of as representing the college premium. So, equation (5.5) can be equivalently expressed in terms of the average wage, w , and the college premium, $q = v/u$.⁸ When it holds at the data targets,

$$\left[\frac{s_{2020}v_{2020} + (1 - s_{2020})u_{2020}}{s_{1880}v_{1880} + (1 - s_{1880})u_{1880}} \right]^{-\zeta} \frac{v_{2020} - u_{2020}}{v_{1880} - u_{1880}} = \left(\frac{l_{2020}}{l_{1880}} \right)^{-\lambda} \frac{k_{2020}}{k_{1880}}.$$

Contingent upon a value for λ , it's clear that ζ , or the exponent in the utility function for a child's future wage, regulates the change in schooling over time. So, the value of ζ that solves this equation is chosen. Recall that the college premium for 1880, q_{1880} , is determined in the outer loop. This implies a value for $v_{1880} - u_{1880}$. The weight term in the utility function for a child's future wage, ξ , can be nailed down from

$$\xi [s_{2020}v_{2020} + (1 - s_{2020})u_{2020}]^{-\zeta} (v_{2020} - u_{2020}) = \delta l_{2020}^{-\lambda} \gamma k_{2020},$$

when assuming values for λ , δ , and ζ .

Finally, the first-order condition for a married household's housework, h , reads

$$\beta \epsilon^{1-\rho} (1 - \theta) [\theta d^\sigma + (1 - \theta)(h + \chi k)^\sigma]^{(1-\nu-\sigma)/\sigma} (h + \chi k)^{\sigma-1} = \delta l^{-\lambda}. \quad (5.6)$$

⁷Again, by taking logs of the above equation an explicit solution for κ results in terms of the other variables.

⁸Specifically, it is easy to calculate that $v - u = w(q - 1)/(sq + 1 - s)$.

The lefthand side gives the benefit of an extra unit of labor in the home, while the righthand side is the cost in terms of forgone leisure. It should be apparent by now that the exponent on the utility term for home goods, ν , can be tied down by the change in nonmarket goods,

$$\left[\frac{\theta d_{2020}^\sigma + (1 - \theta) (h_{2020} + \chi_{2020} k_{2020})^\sigma}{\theta d_{1880}^\sigma + (1 - \theta) (h_{1880} + \chi_{1880} k_{1880})^\sigma} \right]^{(1-\nu-\sigma)/\sigma} \left[\frac{h_{1880} + \chi_{1880} k_{1880}}{h_{2020} + \chi_{2020} k_{2020}} \right]^{\sigma-1} = \left(\frac{l_{2020}}{l_{1880}} \right)^{-\lambda},$$

while β can be determined by fitting the equation to some baseline year, specifically 1880, so that

$$\beta \epsilon^{1-\rho} (1-\theta) [\theta d_{1880}^\sigma + (1 - \theta) (h_{1880} + \chi_{1880} k_{1880})^\sigma]^{(1-\nu-\sigma)/\sigma} (h_{1880} + \chi_{1880} k_{1880})^{\sigma-1} = \delta l_{1880}^{-\lambda}.$$

Assigning parameter values to maximize model fit—Outer loop

Turn now to the outer loop. The inner loop matches exactly the married household's data targets for fertility, schooling, housework, and market hours (hence leisure). The outer loop helps the model match the targets for single households, in particular their housework and market hours. The parameters α and q_{1880} are selected to get the best fit possible for the model's predictions about singles. Specifically, denote the i 'th data target by $\mathbf{D}_i$ and the model's solution for this target by $\mathbf{M}_i(\alpha, q_{1880})$. The parameters α and q_{1880} solve

$$\min_{\alpha, q_{1880}} \sum_i \left[\frac{\mathbf{D}_i - \mathbf{M}_i(\alpha, q_{1880})}{\mathbf{D}_i} \right]^2, \quad (5.7)$$

where each observation for singles is weighted uniformly. This minimization routine takes into account how the choice of α and q_{1880} affects $\delta, \lambda, \psi, \kappa, \xi, \zeta, \beta$, and ν as described above.

Finally, to match the marriage facts, recall that the maximization problems (4.2) and (4.4) give values for single and married lives, S and M . Now, using equation (4.5), for the fraction of the population that is unmarried, $1 - \mathbf{m}$, it follows that

$$\ln[-\ln(1 - \mathbf{m})] = -(S - M - \mathbf{a})/d.$$

If the above equation holds at the data targets, then

$$\frac{\ln[-\ln(1 - \mathbf{m}_{2020})]}{\ln[-\ln(1 - \mathbf{m}_{1880})]} = \frac{S_{2020} - M_{2020} - \mathbf{a}}{S_{1880} - M_{1880} - \mathbf{a}}. \quad (5.8)$$

So, the location parameter for the Gumbel distribution, $\mathbf{a}$, can be selected to hit the change in the fraction of the population that is single. Given $\mathbf{a}$, the scale parameter, $\mathbf{d}$, can be used to match the fraction of the population that is single in 2020 by employing the equation

$$\mathbf{d} = -\frac{S_{2020} - M_{2020} - \mathbf{a}}{\ln[-\ln(1 - \mathbf{m}_{2020})]}. \quad (5.9)$$

Values for the location and scale parameters are chosen after values for all the other parameters have been selected. The procedure here is akin to the matching strategy employed in the inner loop.

5.3 Results

The parameter values resulting from the calibration procedure are displayed in Table 5.2. Table 5.3 presents the match between the data and model. The results are very good. The above calibration procedure ensures that the model will match exactly the time allocations for a married household. Fertility and schooling are matched precisely too. It also guarantees the model's fit for the marriage statistics is perfect. The framework captures the fact that over time singles do less housework, cut back on their market work, and enjoy more leisure. While the trends are correct, the levels for these three variables are off a bit.

6 Propelling the Great Transition

Direct attention now to the driving forces behind the great transition. These are the growth in the general level of wages, w , the fall in the price of household durables, p , and the rise in the college premium, q . The driving forces underlying these endogenous shifts in prices are various forms of technological progress; viz, neutral technological advance, skill-biased technological change, and process innovation in the production of labor-saving household durables. These three underlying exogenous forces are examined in turn, which serves to illustrate the mechanisms at work.

To model this a production sector is appended onto the framework. To this end, suppose that output, $\mathbf{o}$, is produced according to a CES production function using unskilled and skilled labor, $\mathbf{u}$ and $\mathbf{v}$:

$$\mathbf{o} = \mathbf{z}[(1 - \omega)\mathbf{u}^\iota + \omega\mathbf{x}\mathbf{v}^\iota]^{1/\iota}, \text{ with } \iota \leq 1. \quad (6.1)$$

Table 5.2: Parameter Values

Parameter	Description	Value	Identification
<i>Market consumption</i>			
α, ρ	Weight, exponent	0.157, 1.250	Eq (5.7), literature
<i>Home goods consumption</i>			
β, ν	Weight, exponent	0.054, 1.77	Eq (5.6)
<i>Leisure</i>			
δ	Weight, married	0.285	Eq (5.3)
$1 - \alpha - \beta$	Weight, single	0.789	Implied
λ	Exponent	0.454	Eq (5.3)
<i>Fertility</i>			
ψ, κ	Weight, exponent	0.013, 0.517	Eq (5.4)
<i>Schooling</i>			
ξ, ζ	Weight, exponent	0.106, 1.635	Eq (5.5)
<i>Home production technology</i>			
θ, σ	Durables weight, exponent	0.206, 0.276	Literature, Sec 6.4
χ_{1880}, χ_{2020}	Child labor-productivity: 1880, 2020	0.015, 0.011	Data
<i>Cost of Children</i>			
b, γ	basic, education	0.030, 0.026	Data
<i>Marriage, Gumbel</i>			
$\mathbf{a}, \mathbf{d}$	location, shape	-0.606, 0.032	Eqs (5.8) and (5.9)
<i>Prices</i>			
$p_{1880}, p_{2020}, \% \Delta p$	Durables: 1880 and 2020 levels, growth	100.000, 0.108, -5.000%	Normalization, literature
$w_{1880}, w_{2020}, \% \Delta w$	Wages: 1880 and 2020 levels, growth	1.000, 11.300, 1.747%	Normalization, data for $\% \Delta$
$q_{1880}, q_{2020}, \% \Delta q$	Skill premium: 1880 and 2020 levels, growth	1.366, 1.810, 0.201%	Eq (5.7), 2020 Data
<i>Equivalence scale</i>			
ε	Equivalence scale	0.667	OECD

Table 5.3: Results, Data and Model

Variable	Description	Data	Model
		1880, 2020	1880, 2020
<i>Fertility</i>			
k	Fertility rate	4.240, 1.640	4.240, 1.640
<i>Schooling</i>			
s	Schooling	0.168, 0.765	0.168, 0.765
<i>Time</i>			
h	Housework (<i>married</i>)	0.518, 0.156	0.518, 0.156
	Housework (<i>single</i>)	0.185, 0.057	0.253, 0.072
t	Market work (<i>married</i>)	0.614, 0.597	0.614, 0.597
	Market work (<i>single</i>)	0.360, 0.302	0.224, 0.216
l	Leisure (<i>married</i>), <i>implied</i>	0.722, 1.165	0.722, 1.165
	Leisure (<i>single</i>), <i>implied</i>	0.455, 0.641	0.523, 0.712
bk	Childcare	0.128, 0.049	0.128, 0.049
ek	Educational care	0.019, 0.033	0.019, 0.033
<i>Marriage</i>			
m	Fraction married	0.612, 0.238	0.612, 0.238
$1 - m$	Fraction single (unmarried)	0.388, 0.762	0.388, 0.762

Here increases in $\mathbf{z}$ reflect neutral technological progress while shifts in $\mathbf{x}$ govern skilled-biased technological change. Labor-saving household durables are produced according to a linear production function where one unit of final output produces $1/p$ units of durable goods. Thus, upward movements in $1/p$, or equivalently drops in p , stand in for process innovation in the production of household durables.

A firm hires unskilled and skilled labor to maximize its profits or to solve the problem

$$\max_{\mathbf{u}, \mathbf{v}} \{ \mathbf{z}[(1 - \omega)\mathbf{u}^\iota + \omega\mathbf{x}\mathbf{v}^\iota]^{1/\iota} - u\mathbf{u} - v\mathbf{v} \}.$$

The first-order conditions from this problem state that the marginal products of unskilled and skilled labor equal the wages rates, u and v , for the two types of labor. Thus,

$$\mathbf{z}[(1 - \omega)\mathbf{u}^\iota + \omega\mathbf{x}\mathbf{v}^\iota]^{1/\iota-1}(1 - \omega)\mathbf{u}^{\iota-1} = u,$$

and

$$\mathbf{z}[(1 - \omega)\mathbf{u}^\iota + \omega\mathbf{x}\mathbf{v}^\iota]^{1/\iota-1}\omega\mathbf{x}\mathbf{v}^{\iota-1} = v.$$

The college premium, $q = v/u$, then reads

$$\frac{v}{u} = \frac{\omega\mathbf{x}}{1 - \omega} \left(\frac{\mathbf{v}}{\mathbf{u}} \right)^{\iota-1}.$$

So the college premium is a function of the skilled-biased technology shift factor, $\mathbf{x}$, and the aggregate supplies of unskilled and skilled labors, $\mathbf{u}$ and $\mathbf{v}$. It is not a function of the neutral technology shift factor, $\mathbf{z}$. Aggregate market hours worked, $\mathbf{t}$, is

$$\mathbf{t} = mt_m + (1 - m)t_s,$$

where m is the fraction of households that are married, t_m is market hours worked by a married household, and t_s is hours worked by a single one. Accordingly, aggregate hours of unskilled and skilled labor, $\mathbf{u}$ and $\mathbf{v}$, are

$$\mathbf{u} = (1 - s)\mathbf{t}$$

and

$$\mathbf{v} = s\mathbf{t}.$$

These two relationships allow the college premium to be rewritten as

$$\frac{v}{u} = \frac{\omega \mathbf{x}}{1 - \omega} \left(\frac{s}{1 - s} \right)^{\iota - 1}. \quad (6.2)$$

To proceed estimates are needed for the skilled-biased and neutral technology factors, $\mathbf{x}$ and $\mathbf{z}$. From the above equation it is apparent that

$$\frac{v_{2020}/u_{2020}}{v_{1880}/u_{1880}} = \frac{\mathbf{x}_{2020}}{\mathbf{x}_{1880}} \left[\frac{s_{2020}/(1 - s_{2020})}{s_{1880}/(1 - s_{1880})} \right]^{\iota - 1}.$$

From the baseline simulation values are known for m, s, t_m, t_s, u , and v for 1880 and 2020. This implies that values for $\mathbf{t}$ are also known for these two years. Given numbers for ω and ι , the change in the college premium can be used to calibrate skilled-biased technological change or $\mathbf{x}_{2020}/\mathbf{x}_{1880}$. Then, by using the college premium for one year, a value for $\mathbf{x}$ for that year can be assigned from (6.2). Last, $\mathbf{z}_{1880}$ and $\mathbf{z}_{2020}$ can be backed out by using (6.1). Values for ι and ω are needed to implement the procedure. Acemoglu and Autor (2011, Table 8) estimate the elasticity of substitution between skilled and unskilled labor for the 1963-2008 period. Their estimates suggest that ι lies in the range [0.444, 0.661]. A value of 0.552, the average of their estimates, is selected here. This implies an elasticity of substitution between skilled and unskilled labor of -2.23.⁹ Additionally, from the constant terms in their regressions a range of values for

⁹In interesting work, Bills, Kaymak, and Wu (2020) allow firms to choose their production function depending upon the wages for skilled and unskilled labor. They find that this results in a higher elasticity of substitution between the two types of labor.

ω can be recovered. The average value of 0.439 is selected.

The upshot of the above procedure is presented in Table 6.1. The rise in $\mathbf{x}$ can be thought of as reflecting a shift from brawn to brain as mechanization reduced the need for physical labor. By tacking on a production sector in the above manner the baseline equilibria for 1880 and 2020 can be retained untouched. The general equilibrium analysis kicks in when perturbations from the baseline 2020 equilibrium are studied. Specifically, neutral technological progress, skilled biased technological change, and process innovation in the production of labor-saving household durables are each switched off in isolation. The results are shown in Table 6.2.

Table 6.1: Technology Parameter Values

Parameter	Description	Value	Identification
<i>Market Production Function</i>			
ω, ι	Weight on skilled labor, exponent	0.439, 0.552	Literature
<i>Technology Factors</i>			
$\mathbf{x}_{1880}, \mathbf{x}_{2020}, \% \Delta \mathbf{x}$	Skill biased: 1880 and 2020 levels, growth	0.852, 3.920, 1.096%	Eq (6.2)
$\mathbf{z}_{1880}, \mathbf{z}_{2020}, \% \Delta \mathbf{z}$	Neutral: 1880 and 2020 levels, growth	2.204, 4.157, 0.454%	Eq (6.1)
$p_{1880}, p_{2020}, \% \Delta p$	Process Innovation: 1880 and 2020 levels, growth	100.000, 0.108, -5.000%	Literature

6.1 Neutral Technological Progress, $\mathbf{z}$

Neutral technological progress is shut down in the first experiment. To do this, let $\Delta \mathbf{z} = 0$, while keeping $\mathbf{x}$ and p at the values specified in the baseline calibration. Thus, $\Delta \mathbf{x} > 0$ and $\Delta p < 0$. The college premium, $q = v/u$, can still change due to shifts in factor supplies. The results of this experiment are reported in column 3 of Table 6.2. The salient feature of this experiment is that things don't change dramatically from the baseline 2020 calibration, except for living standards. Households are much poorer in 2020 relative to the baseline calibration, a fact reflected by the lower average real wage, w , in 2020. This causes a large drop in market consumption, c , for both married and single households. As a consequence the marginal benefit from working in the market moves up due to an income effect—as can be gleaned from the righthand side of (5.3). All households work more as a result so that t rises. Additionally, household purchase a smaller quantity of durables, d . This leads to a drop in the consumption of home goods, n , which motivates an increase in housework, h —the marginal benefit of housework or the lefthand side of (5.6) rises. To compensate for the extra time spent on housework and in the market, households cut back on leisure, l . Leisure is still considerably higher

than its 1880 value, because of the stock of labor-saving durables is still much larger than in 1880.

For married households the drop in leisure raises the marginal cost of children relative to the 2020 baseline—the righthand side of (5.4). This induces a drop in fertility, k , compared with the baseline 2020 calibration. So the drop in fertility from 1880 is more pronounced now. Consequently, time spent on basic childcare, bk , is less now. Since married households are having less kids it pays to educate them more so s rises—the righthand side of (5.5) falls. That is, there is a substitution away from the quantity of children toward the quality of children. Still, due to the drop in fertility, time spent on educating kids, ek , falls from the baseline. The college premium, $q = v/u$, comes down as a result of the increase in the level of skill.

Last, the benefit of marriage is larger relative to the 2020 baseline calibration as a result of the declines in home goods, market goods, and leisure. So, m rises and s falls. Hence, the drop in marriage from 1880 is smaller than in the 2020 baseline. The impact on marriage relative to the 2020 baseline is relatively small because on the one hand people are poorer, which is reflected in less consumption and leisure. This promotes marriage. On the other hand, married couples have less kids and this raises the value of single life vis à vis married life. Overall by comparing the results of this exercise with the baseline calibration, it is apparent in this setup that neutral technological progress is not the primary driver of the rise in leisure, the drop in fertility, the increase in educational attainment, and the waning in marriage. It is an important force, however, in the rise of living standards.

6.2 Skilled-Biased Technological Change, $\mathbf{x}$

Skilled-biased technological progress is unplugged in the second experiment, so that $\Delta \mathbf{x} = 0$. Neutral technological progress and the price of durables behave as in the baseline model; i.e., $\Delta \mathbf{z} > 0$ and $\Delta p < 0$. The big change here compared with the 2020 baseline calibration is that fertility, k , is much higher, and the fraction of the population that is schooled, s , is significantly lower—see column 4 of Table 6.2. When skilled-biased technological change is turned off, the reward from educating a child in 2020 drops—the lefthand side of (5.5) falls because the college premium is lower. The freed-up time from schooling kids goes into having more of them. As in the previous experiment, households are much poorer now so they consume less, work more, reduce spending on durables, do more housework, and have less leisure. The benefit of marriage rises relative to the 2020 baseline model. The fact that people are poorer once again

encourages marriage. Fertility is higher but this positive effect on marriage is offset by a decline in children's educational attainment. By comparing the results of this experiment with the baseline calibration, the upshot is that skilled-biased technological progress is an important driver of the decline in fertility and the rise in educational attainment. Other than a large fall in living standards, the effect on the other variables is more moderate.

6.3 The Fall in the Price of Household Durables, p

To execute the third experiment process innovation in the production of labor-saving household durables is turned off so that $\Delta p = 0$, implying $p_{2020} = p_{1880}$. The other technology drivers, $\mathbf{z}$ and $\mathbf{x}$, operate as in the baseline model; that is, $\Delta \mathbf{x} > 0$ and $\Delta \mathbf{z} > 0$. Again, wages, u , v , and w , may react in response to movements in labor supplies. The main takeaway from this experiment is that the drop in the price of labor-saving household durables is important for explaining the decline in housework and the waning in marriage—Table 6.2, column 5. Household durables are now much more expensive so people purchase less of them. This raises the benefit of working at home—the lefthand side of (5.6). As consequence of the need to devote more time to housework, time in 2020 is scarcer. There is a large drop in market work, t , relative to the 2020 baseline, as well as a noticeable decline in leisure, l . The scarcity of time also encourages a switch toward having fewer better educated kids. The benefit of marriage jumps up because the difference in the utilities between marrieds and singles deriving from leisure and the consumption of home goods widens. As a result the fraction of households who decide to marry rises considerably—even higher than in 1880 due to boost in utility from having better educated children.

6.4 The Great Transition's Transitions

The above results can be made even sharper by examining some quasi-transitions for the model. Suppose that $\mathbf{z}$, $\mathbf{x}$, and p move along the following transition paths from 1880 to 2020:

$$\mathbf{z}_t = \mathbf{z}_{1880} e^{\Delta \mathbf{z}(t-1880)}, \quad \mathbf{x}_t = \mathbf{x}_{1880} e^{\Delta \mathbf{x}(t-1880)}, \quad \text{and} \quad p_t = p_{1880} e^{\Delta p(t-1880)},$$

Table 6.2: Results, Experiments

Variable	Description	Data	Baseline Model		Fixed z	Fixed x	Fixed p
		1	2		3	4	5
		1880, 2020	1880	2020	2020	2020	2020
<i>Fertility</i>							
k	Fertility rate	4.240, 1.640	4.240	1.640	1.388	3.683	1.302
<i>Schooling</i>							
s	Schooling	0.168, 0.765	0.168	0.765	0.853	0.155	0.793
<i>Time</i>							
h	Housework (<i>married</i>)	0.518, 0.156	0.518	0.156	0.198	0.250	0.558
	Housework (<i>single</i>)	0.185, 0.057	0.253	0.072	0.089	0.124	0.241
t	Market work (<i>married</i>)	0.614, 0.597	0.614	0.597	0.638	0.710	0.443
	Market work (<i>single</i>)	0.360, 0.302	0.224	0.216	0.231	0.261	0.157
l	Leisure (<i>married</i>)	0.722, 1.165	0.722	1.165	1.092	0.915	0.933
	Leisure (<i>single</i>)	0.455, 0.641	0.523	0.712	0.680	0.615	0.602
bk	Childcare	0.128, 0.049	0.128	0.049	0.042	0.111	0.039
ek	Educational care	0.019, 0.033	0.019	0.033	0.031	0.015	0.027
<i>Marriage</i>							
m	Fraction married	0.612, 0.238	0.612	0.238	0.287	0.324	0.978
$1 - m$	Fraction single (unmarried)	0.388, 0.762	0.388	0.762	0.713	0.676	0.022
<i>Prices</i>							
w	Average wage		1.000	11.300	6.207	1.877	11.450
q	College premium, v/u		1.366	1.810	1.399	1.424	1.683
<i>Goods</i>							
c	Market goods (<i>married</i>)		0.599	4.957	2.999	1.080	4.623
	Market goods (<i>single</i>)		0.217	1.692	1.031	0.382	1.609
d	Stock of durables (<i>married</i>)		0.000	16.602	8.890	2.330	0.005
	Stock of durables (<i>single</i>)		0.000	6.897	3.712	0.992	0.002
n	Home goods (<i>married</i>)		0.278	0.791	0.668	0.498	0.315
	Home goods (<i>single</i>)		0.121	0.329	0.279	0.212	0.133

for $t = 1880, \dots, 2020$. Here $\Delta \mathbf{z} > \mathbf{0}$, $\Delta \mathbf{x} > \mathbf{0}$, and $\Delta p < 0$ are the net rates of change in these variables as reported in Table 6.1.¹⁰ For each period from 1880 to 2020 the model is run under four scenarios: (1) A baseline scenario where all technology factors are operational, (2) an experiment where just changes in $\mathbf{z}$ are shut down, (3) a situation where $\mathbf{x}$ alone is unplugged, and (4) a case where p is held fixed in isolation. The word “quasi” is used because in each period parents neglect to take into account that prices will be different in the subsequent period; i.e., they are myopic. Think about the experiments as running a series of steady states.

Figure 6.1 shows the transitional dynamics for fertility and schooling. It is immediately obvious that without skilled-biased technological change (the Fixed $\mathbf{x}$ lines) fertility would rise and schooling fall. When either $\mathbf{z}$ or p are shutdown fertility still drops and educational attainment picks up. For these two cases the deviations from the baseline time path are modest.

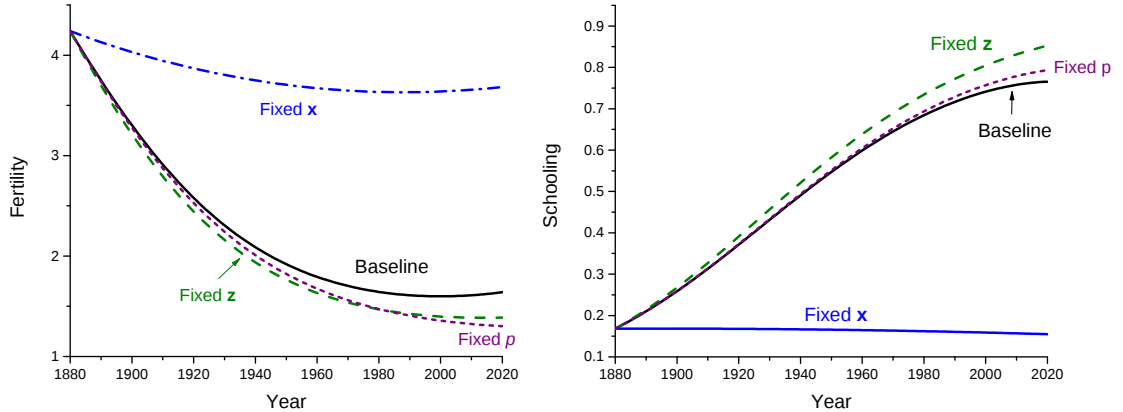


Figure 6.1: Transitional Dynamics—Fertility and Schooling.

The transitional dynamics for a married household’s time allocations are displayed in Figure 6.2. The time paths for single households (not shown) tell the same story. Focus on the lefthand panel. Clearly, process innovation in the production of labor-saving household durables is responsible for the decline in housework (the Fixed p line). Without this, housework actually rises a little. As a married household becomes richer they would like to consume more nonmarket goods, which requires either working more in the home or buying more labor-saving durables. The latter are still very expensive though. The impact of neutral technological progress, $\mathbf{z}$, or skilled-biased

¹⁰The productivity of child labor in the home also changes according to $\chi_t = \chi_{1880} e^{\Delta \chi(t-1880)}$, where $\Delta \chi\% = -0.223\%$ —recall from Table 5.2 that $\chi_{1880} = 0.011$ and $\chi_{1880} = 0.15$.

technological change, $\mathbf{x}$, on housework is slight. The middle panel demonstrates that process innovation in the production of labor-saving household durables is also very important for market work. Without this there is a dramatic decline in market work. As living standards improve due to increases in $\mathbf{z}$ and $\mathbf{x}$ households demand more leisure—see the right panel. But, without technological progress in the home this requires cutting back on market work. When either the neutral or skilled-biased technology factors are switched off households are much poorer. To make up for this, they must work more in the market relative to the baseline picture, as the middle panel illustrates—the Fixed $\mathbf{z}$ and $\mathbf{x}$ lines. As a consequence, the rise in leisure falls short of the baseline scenario—right panel.

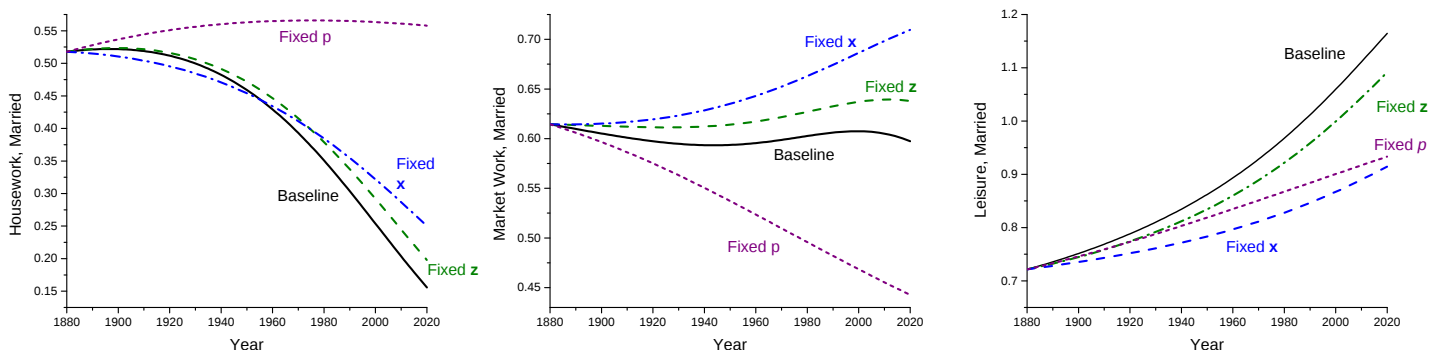


Figure 6.2: Transitional Dynamics—Housework, Market Work, and Leisure.

The next two plots are for marriage, which are presented in Figure 6.3. Start with the left panel. The primary driver of the decline in marriage is process innovation in the production of labor-saving household durables—as the Fixed p line demonstrates. The impact of $\mathbf{z}$ and $\mathbf{x}$ on marriage is negligible. When there is no decline in the price of durables married households fare better relative to single ones because their consumption of home goods and leisure isn't squeezed as much. Move to the right panel. In the US data marriage shows a $\cap$ -shaped pattern over time. To replicate this pattern, the parameter σ , governing the degree of substitutability between durables and housework in the home production function, is chosen so that the model matches as close as possible the fraction of the US population that was married in 1960.¹¹ As reported in Table 5.2, the resulting value for σ is 0.276. What explains the $\cap$ shape?

¹¹To compute σ another loop is added outside of the previous two loops in the calibration strategy described in Section 5. This outer loop minimizes the difference between the model's implied married population in 1960 and its data counterpart. The parameters values that are not assigned on the basis of direct information are functions of σ . So too are the sequences for $\mathbf{x}_t$ and $\mathbf{z}_t$. The sequences for χ_t and p_t are exogenous.

The utility benefit of marriage derived from the increased schooling for children climbs over time. So, early on there are gains from marriage. But this utility benefit from schooling children is eventually eroded away as the hike in labor-saving durables implies that the utility in single life derived from home goods, leisure, and market goods rises relative to married life and comes to dominate in the later years.¹²

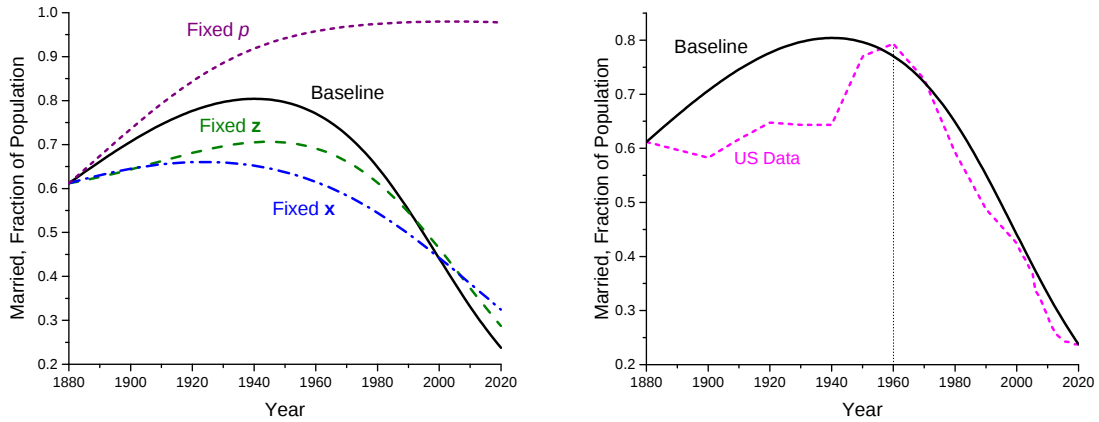


Figure 6.3: Transitional Dynamics–Marriage.

Finally, Figure 6.4 illustrates how the model’s prediction for fertility and schooling fare. Take fertility first, which is shown in the left panel. Abstracting from the baby boom, the model does well matching the secular decline in fertility displayed in the US data. The model also goes a good job matching the rise in schooling.

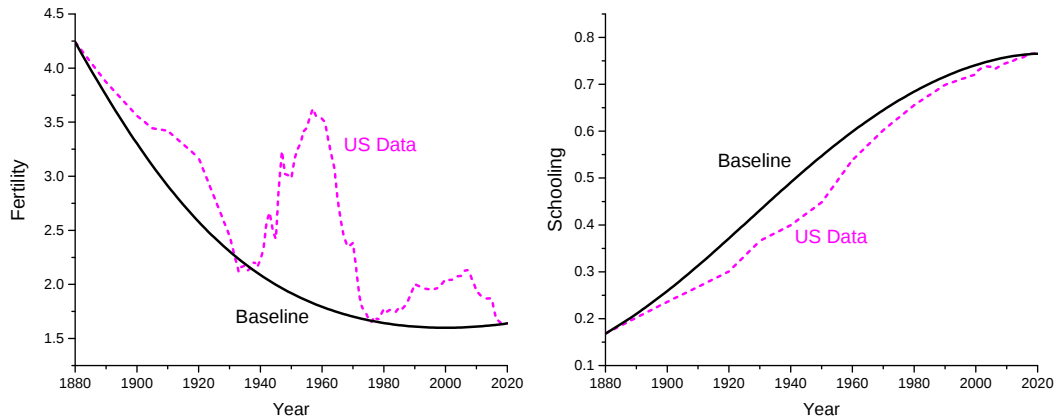


Figure 6.4: Fertility and Schooling, again–US Data and Model.

¹²The word *relative* is important as the utility from home goods, leisure, and market goods rises over the course of the century for both types of households.

7 Ending

A great transition in family structure occurred during the last century, both in the United States and the rest of the world. Family size became smaller as fertility dropped and marriage declined. Educational attainment rose. The burden of housework eased tremendously. People enjoyed much more leisure than in past. A macroeconomic model is advanced and calibrated to see if it can explain this set of facts for the United States. It can. The calibration strategy employed is closely linked with the economic intuition arising from the model. In particular, the exponents on the utility functions for leisure, nonmarket goods, the number of kids, and their children's wages, govern the rates of change in leisure, housework, fertility, and education, whereas the weights determine the levels for these variables in some baseline year. There may of course be other frameworks, and calibrations, that can explain the same set of facts. A virtue of the current setup is that it is parsimonious, yet rich enough to explain the great transition. Only time will reveal the best modeling strategy.

What forces propelled the great transition? Three candidates are considered here; namely, neutral technological progress, skilled-biased technological change, and process innovation that lowered the price of labor-saving household durables. Quantitative analysis suggests that skilled-biased technological change, reflecting a shift from brawn to brain, was instrumental in explaining the decline in fertility and the rise in educational attainment. This encouraged married households to have fewer, but more educated, kids. Process innovation that lowered the price of labor-saving household durables was key for deciphering both the decline in housework and marriage. Last, while neutral technological progress was important for rising living standards, it had a benign impact on family structure.

8 Literature Review

The father of family economics was Gary S. Becker. A compilation of his work is contained in Becker (1991). For an elementary introduction to family economics see Greenwood (2019). This book emphasizes how technological progress has affected the family. It follows in the footsteps of a prescient monograph in sociology by Ogburn and Nimkoff (1955). Two surveys on family economics from a macroeconomic perspective are Doepke and Tertilt (2016) and Greenwood, Guner, and Vandenbroucke (2017). Time use is discussed in Aguiar and Hurst (2016). Chiappori (2020) and Chi-

appori and Salanie (2021) review the empirical and theoretical literature on marriage. Currently there are no surveys of the macroeconomics literature on education. Goldin and Katz (2006) provide a twentieth century history on education and wages in the United States. Some references to the macro literature on education are provided below. Taken together these sources provide extensive literature reviews. So only research that is directly related to the analysis here is discussed.

As wages rose the average workweek in the market declined, as Figures 2.1 and 2.3 exhibit. An elementary discussion of the long-run trend in hours worked is contained in Greenwood and Vandenbroucke (2008). They emphasize three mechanisms that have an effect on hours worked: real wages, leisure goods, and time-saving appliances. Quantitative explorations of the first two forces are Vandenbroucke (2009) and Kopytov, Roussanov, and Taschereau-Dumouchel (2020). The trend toward earlier retirement, presented in Figure 2.5, is analyzed in Kopecky (2011) who models the impact of rising real wages and falling prices of leisure goods. The rise in female labor-force participation and the decline in housework is the subject of Greenwood, Seshadri, and Yorukoglu (2005); see Figures 2.1, 2.2, 2.3, and 2.4. Their analysis builds on the household production frameworks of Becker (1965) and Reid (1934). The idea is that household appliances liberated women from the home and allowed them to enter the workforce.

The mechanism adopted here for fertility has its roots in Razin and Ben-Zion (1975). In their analysis children are a good that enters the utility function. Their device is modified along the lines of Greenwood, Seshadri, and Vandenbroucke (2005, Section IV) to incorporate parental investment in children. This has the flavor of the famous Becker and Lewis (1973) tradeoff between the quality and quantity of children, but the brain-versus-brawn interpretation follows Galor and Weil (1996). Galor and Weil (1996) discuss how capital accumulation leads to a shift away from brawn toward brain in the labor market, which raises women's wages more than men's. Fertility declines as a consequence. Greenwood, Seshadri, and Vandenbroucke (2005) model the secular decline in fertility as well as the baby boom; recall Figure 2.6. The notion is that the long-run decline in fertility resulted from an increase in wages, which escalated the cost of having children. The baby boom resulted from technological progress in household sector that reduced the cost of kids. Delventhal, Fernandez-Villaverde and Guner (2021) study demographic transitions across the world since the middle of the 18th century. The rise in skill premium is the key driver of decline in fertility in their analysis.

The framework for marriage is adopted from Greenwood and Guner (2009), which was preceded by Mortensen's (1988) prototype model of marriage. The Greenwood and Guner (2009) framework again incorporates the notion of household production à la Becker (1965) and Reid (1934). The hypothesis is that technological progress in the home and rising living standards reduced the need for household labor. This raised the value of single life relative to marriage. Their analysis also addresses the transient decline in the fraction of the never-married population around World War II; i.e., the U-shaped pattern shown in Figure 2.8. This is done by incorporating a decision for young adults to leave home. At first rising incomes and technological advance in the household sector allowed young adults to leave their parent's home through marriage. As economic development continued they could afford to leave home and live alone before getting married. The framework predicts that household size should decline with economic development, a fact displayed in Figure 2.10. The decline in household size is also modelled in Salcedo, Schoellman, and Tertilt (2012).

The modern theory of education starts with Ben-Porath (1967). Often people interpret the full time spent on training at the beginning of life in his model as schooling. An important antecedent of Ben-Porath (1967) is Mincer (1958). The brain-versus-brawn framework adopted here, which can be used to explain the trends in occupational choice illustrated by Figures 2.13 and 2.14, can be thought of as a descendant of Ben-Porath (1967). The brain-versus-brawn framework is operationalized in the current work via skilled-biased technological change. A modern quantitative model of schooling in the United States is provided in Restuccia and Vandenbroucke (2014), which contains references to the literature—see also the work by Castro and Coen-Pirani (2016) that is similar in some ways. Restuccia and Vandenbroucke (2014) is in the spirit of Kuznets (1957). They try to explain both the cross-sectional and time-series facts regarding educational attainment shown in Figures 2.11 and 2.12, as well as the patterns of average hours worked displayed in Figures 2.1 and 2.3. In their analysis schooling enters the utility function, as it does here. As incomes rise so do the demands for education and leisure. Erosa, Koreshkova, and Restuccia (2010) and Manuelli and Seshadri (2014) focus on trying to explain cross-country facts surrounding education, especially differences in country's incomes.

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Data Appendix

- Figure 2.1 (average weekly hours and labor-force participation in the United States): The source for average weekly hours, “All”, is Vandemboucke (2009, Figure 1). This series covers the period 1830 to 2000. Prior to 1940, the data covers all workers and after that it refers to workers ages 15 and above. The series for men between 1900 and 1930 is also from Vandemboucke (2009, Figure 1) and is spliced together with US Census data for the subsequent years. The numbers for men and women from 1940 to 2018 correspond to the 20-64 age group (conditional on being employed and reporting positive hours) and are taken from the US Decennial Censuses, 1940–2000, and the American Community Survey (ACS) after that. The labor-force participation numbers derive from the US Decennial Censuses, 1860–2000, and the ACS thereafter. They refer to individuals ages 20 to 64. Both series are taken from the Integrated Public Use Microdata Series (IPUMS) and exclude households with institutionalized individuals. Only household heads and spouses are considered. The series are weighted means.
- Figure 2.2 (housework in the United States): The source for the data on housework (cleaning, cooking, and laundry) from 1900 to 1926 is Lebergott (1993, Table 8.1). Lebergott’s number of 58 hours per of housework in 1900 is somewhat speculative. Articles in women’s magazines, such as *Ladies Home Journal* in 1920, suggested a similar number—see Greenwood (2019, p. 51). Lebergott’s figure of 36 hours for 1925-1927 is close to the Gershuny and Harms (2017, Figure 1) estimate of 37 hours. In fact, if one adds in time spent knitting, mending, and sewing the Gershuny and Harms (2016) number rises to 43 hours. The numbers for 1965 to 2019 represent core nonmarket work (cleaning, cooking, laundry, and maintenance) for women ages 20 to 64. The data is taken from the American Heritage Time Use Survey (up to 1993) and from the American Time Use Survey (since 2003), available through the US Bureau of Labor Statistics. It excludes students and retirees, and all individuals who do not report their gender, age, or education level, as well as those whose total weekly hours are different than 168 hours per week (or 24 hours per day).
- Figure 2.3 (the cross-country relationship between per-capita GDP and hours worked, both in the market and at home): The hours worked data for 46 countries is taken from Bick et al. (2018, Figure 1), where each country has a single observation within a few years from 2005. The source for the data on hours

spent cleaning and cooking is Bridgman et al. (2018, Figure 9). They focused on 54 countries; different countries had a different set of years for the observations spanning from 1974 to 2012. Bick et al. (2018) use real GDP per capita for the same years as hours worked. GDP per capita is measured in US\$2011 (expenditure side PPP terms from the Penn World Tables). Bridgman et al. (2018) utilize real GDP per capita measured in US\$1990 for various years (in PPP terms from the Conference Board). This explains the difference in the horizontal axes.

- Figure 2.4 (the cross-country rise in female labor-force participation): The data pertains to women in the 20-to-64 age group. The numbers for female labor-force participation are taken from the OECD's Labor Force Statistics while those for per-capita GDP, measured in purchasing power parity (PPP) international \$2017, come from The World Bank. The scatter diagram shows the relationship between per-capita GDP and female labor-force participation for 50 countries for the years 1990 to 2019; some early years are missing for some countries. The time-series graph plots the data for Australia (1966-2019), Germany (1970-2019), Ireland (1971, 1975, 1977, 1981, 1983-2019), Italy (1970-2019), South Korea (1980-2019), Mexico (1991-2019), and Spain (1972-2019).
- Figure 2.5 (the trend toward earlier retirement): All numbers pertain to men. For the United States retirement for each age group is defined as not being in the labor force. The American data spans the years 1850 to 2018. The source for the 1850-2000 period is the US Decennial Censuses and the source for the 2001-2018 period is the ACS, all taken from IPUMS. The cross-country retirement data is for men ages 65+ across 186 countries and comes from the International Labor Organization (ILO), Labor Force Participation by Sex and Age. GDP per capita is taken from The World Bank and is measured in PPP terms in international \$2017. The range of years plotted for each country differs but lies somewhere between 1990 and 2020.
- Figure 2.6 (fertility in the United States): The numbers refer to the total fertility rate for white women. For 1800 to 1990 the data are from the *Historical Statistics of the United States: Millennial Addition*, Series Ab63. For the years 1991 to 2015, the data come from Martin et al. (2017, Table 4, p.21; and 2019, Table 2, p. 13).
- Figure 2.7 (the cross-country decline in fertility): Here the relationship between real per-capita GDP (logged) and the total fertility rate is shown for 185 countries for the years 1990, 1995, 2000, 2005, 2010, and 2015. The set of years varies across

countries. The source for the data on the total fertility rate is the United Nations, World Fertility Data 2019. Real per-capita GDP is taken from The World Bank, and is measured in PPP terms in international \$2011. The times series decline in the crude birth rate is plotted for Argentina (1862-2016), Iran (1953-2016), South Korea (1953-2016), Mexico (1895-2016), Portugal (1886-2016), Thailand (1953-2016), and the United Kingdom (1850-2016). The data was collected by Delventhal, Fernandez-Villaverde, and Guner (2021), who report the underlying sources.

- Figure 2.8 (marriage in the United States): The source for the data on the fraction of the female population, ages 20 to 29, that was never married is the U.S. Decennial Census for the years 1880 to 2000. The data for 2001-2019 is based on the ACS. The calculation excludes individuals who are separated, divorced, or widowed. The median age at first marriage, for the period 1880 to 2019, is harvested from the United States Census Bureau’s Historical Marital Status Tables, Table MS-2. The source for the data on living arrangements is the US Decennial Censuses, 1900–2000, and from the ACS, for 2010 and 2019. The “Other” category refers to households with unrelated individuals living together.
- Figure 2.9 (the cross-country relationship between GDP and marriage): The facts for marriage are plotted for 196 countries from 1990 to 2019; the set of years varies across countries. The fraction of women ages 20 to 24 that were never married and the mean age at marriage at first marriage are taken from the United Nations, World Marriage Data (2019). The source for the real GDP per capita is The World Bank, measured in PPP terms in international \$2011.
- Figure 2.10 (household size in the United States and across countries): The US data spanning 1850 to 1950 is sourced from the *Historical Statistics of the United States: Millennial Edition* (Series Ae79 and Ae85). From 1960 to 2019 the data is contained in the U.S. Census Bureau’s Historical Household Tables (Table HH-4). The cross-country data is for 151 countries, where each country has a set of observations for some years between 1990 and 2018. It comes from the United Nations, Household Size and Composition Database. Real per-capita GDP is taken from The World Bank, measured in PPP terms in international \$2011.
- Figure 2.11 (educational attainment in the United States): The data on years of schooling for whites at age 35, by birth cohorts from 1876 to 1975, is from Goldin and Katz (2008, Figure 1.4). Enrollment in institutions of higher education as a

percentage of the 18-to-24 year old population, for the years 1869-1995, is provided in *Historical Statistics of the United States: Millennial Edition* (Series Bc524).

- Figure 2.12 (the cross-country relationship between GDP and educational attainment): The data is for 112 countries, where a country reports some subset of years in the set {1990, 1995, 2000, 2005, 2010}. The source for the data on years of schooling and completed tertiary education is Lee and Lee (2016). Real GDP per capita, measured in PPP terms in international \$2017, comes from The World Bank.
- Figure 2.13 (occupations in the United States): The data spans the period 1860 to 2018. It shows the percentage of the labor force for each gender, ages 18 to 64, working in blue- and white-collar jobs. The source for the 1850-2000 period is the U.S. Decennial Censuses and the source for the 2001-2018 period is the ACS, all taken from IPUMS. White-collar jobs comprise the managerial and professional specialty occupations as well as the technical, sales, and administrative support occupations. Blue-collar jobs comprise the services occupations, the farming, forestry, and fishing occupations, the precision production, craft, and repair occupations, and the operators, fabricators, and laborers occupations. This classification follows the ILO's ISCO categories.
- Figure 2.14 (the cross-country relationship between per-capita GDP and white-collar jobs): The data covers 186 countries for years 2010 to 2018. Not all countries had the data for all years. The data on white-collar jobs as a percentage of all jobs for a given gender is reaped from the ILO, Employment by Sex and Occupation. GDP per capita is measured in PPP terms in international \$2017 is taken from The World Bank.