Do Highly Educated Women Choose Smaller Families?

Moshe Hazan and Hosny Zoabi

October 2013
Conventional Wisdom

Income (and education) and fertility are negatively correlated. This is true:

- In a cross-section of countries (Weil 2005)
- Over time within countries and regions (Galor 2005)
- In a cross-section of individuals in developing and developed countries (Kremer and Chen 2002)
- In a cross-section of cohorts of American women born between 1826 and 1960 (Jones and Tertilt 2008)
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Total Fertility Rate by Education in the U.S., 2001-11

<table>
<thead>
<tr>
<th>Years of Schooling</th>
<th>Total Fertility Rate</th>
</tr>
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<tbody>
<tr>
<td>&lt;12</td>
<td>2.24</td>
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<tr>
<td>12</td>
<td>2.09</td>
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<tr>
<td>13-15</td>
<td>1.78</td>
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<tr>
<td>16</td>
<td>1.88</td>
</tr>
<tr>
<td>&gt;16</td>
<td>1.96</td>
</tr>
</tbody>
</table>
TFR & Labor Supply by Education in the U.S., 2001-11

![Graph showing the relationship between years of schooling and total fertility rate, usual hours worked per week, and years of schooling for women 25-50, mothers to newborns 25-50, and TFR.](image)

- **Total Fertility Rate (TFR)**: The TFR is shown as a line with data points for different years of schooling. The TFR increases with higher years of schooling.
- **Usual Hours worked per Week**: The usual hours worked per week also increase with higher years of schooling.
- **Years of Schooling**:
  - Women 25-50: The usual hours worked per week decrease as years of schooling increase.
  - Mothers to newborns 25-50: The usual hours worked per week increase as years of schooling increase.
  - TFR: The TFR increases with higher years of schooling.

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Moshe Hazan and Hosny Zoabi

The Fertility of Highly Educated Women

October 2013
Outline of the Talk

- Patterns of American fertility by education
  - Theory: the Marketization Hypothesis
    - Explain the U-shaped fertility pattern
    - Explain the positive correlation between labor supply and fertility
  - What drives the change in cross-sectional relationship between fertility and education over time?
  - Supportive evidence and alternative hypotheses
  - Concluding remarks and future research
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U.S. Fertility Patterns by Education

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Age-Specific-Fertility-Rates by Education, 2001-11
Total Fertility Rate by Education in the U.S., 2001-11

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The Fertility of Highly Educated Women
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Potential problem: the assignment of women into educational groups is based on *current* rather than completed education.

Possible solution: “hybrid” fertility rate $HFR_t$:

$$HFR_t = n_{24} + \sum_{a=25}^{50} ASFR_{at},$$

where $n_{24}$ is the number of children at age 24.

This assumes that assignment to educational group is postponed to age 24.
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Hybrid Fertility Rate by Education in the U.S., 2001-11

Years of Schooling

Hybrid Fertility Rate

<12 12 13-15 16 >16
The partial association between fertility and education

Consider the following regression model:

\[ b_{ist} = \alpha + e'_{ist} \pi + \kappa N_{ist} + X'_{ist} \cdot \gamma + \delta_a + \delta_m + \delta_t + \delta_s + \epsilon_{ist} \]

- \( b_{ist} \) – dummy variable equals to 1 if woman \( i \) living in state \( s \) gave birth in year \( t \) and 0 otherwise
- \( e'_{ist} \) – a set of dummies that correspond to the five educational levels
- \( N_{ist} \) is the number of children woman \( i \) has, not including the current birth
- \( X'_{ist} \) includes dummies for female salary income (4 quartiles), spouse salary income and other income
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<td>-0.012***</td>
<td>-0.013***</td>
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<td>$R^2$</td>
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<td>0.071</td>
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The partial association between fertility and earnings

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Female earnings: Q1</td>
<td>-0.019*** (0.001)</td>
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<tr>
<td>Female earnings: Q2</td>
<td>-0.039*** (0.001)</td>
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<tr>
<td>Female earnings: Q3</td>
<td>-0.041*** (0.001)</td>
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<td>Female earnings: Q4</td>
<td>-0.029*** (0.001)</td>
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<tr>
<td>Spouse earnings</td>
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<tr>
<td>Other income</td>
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<tr>
<td>N</td>
<td>-0.018*** (0.000)</td>
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<tr>
<td>Age</td>
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<td>Year</td>
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<td>Obs.</td>
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<td>$R^2$</td>
<td>0.089</td>
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Hybrid Fertility Rate by Education 1980, 1990 & 2000

![Graph showing hybrid fertility rate by years of schooling for 1980, 1990, and 2000. The graph displays a downward trend as years of schooling increase, with the highest rates for the lowest years of schooling and the lowest rates for the highest years of schooling.]
Completed Fertility Rate by Education

Years of Schooling

- <12
- 12
- 13-15
- 16
- >16

Year Periods:
- 1946-50
- 1951-55
- 1956-60
- 1960-64
- 1964-68
Basic Assumptions

Similar setup to Doepke and de la Croix (2003) and Moav (2005):

- A continuum of individuals that differ in their human capital, $h_i$ (market productivity)
- Each Individual forms a household, works, chooses consumption, her number of children and their level of education
- To focus on the cross-sectional relationship assume for simplicity a one period model
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Preferences, Budget Constraint and H.C. Production Function

- utility function:

\[ u_i = \ln(c_i) + \ln(n_i h_i') \]

- budget constraint:

\[ h_i = p_{ci}c_i + p_{ni}n_i + n_i p_{ei}e_i \]

- human capital production function:

\[ h_i' = (e_i + \eta)^\theta, \quad \eta > 0, \quad \theta \in (0, 1) \]
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Education (Quality)

Similar to Doepke and de la Croix (2003) and Moav (2005):

- Education is provided in schools
- The average level of human capital among teachers is $\bar{h}$
- Thus, all parents face the same market price for education, $p_{ei} = p_e = \bar{h}$
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Raising Children (Quantity)

- In Doepke and de la Croix (2003) and Moav (2005), it’s the parent’s time that is needed to raise children.

- Hence, education is getting relatively cheaper as parent’s productivity increases.

- This generates a q-q tradeoff and therefore the cross-sectional relationship between parent’s human capital and fertility is negative.

- But in the real world, parents can substitute their time with others, e.g., a baby-sitter.
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Raising Children (Quantity)

- production function:

\[ n = (t_M^n)^\phi (t_B^n)^{1-\phi}, \quad \phi \in (0, 1) \]

- \( t_M^n \) is time of the mother
- \( t_B^n \) is the time bought in the market, e.g., a babysitter.
- Assumption: price of one unit of time bought in the market is some level of human capital denoted by \( h \).

\[ TC^n(n, h, h_i) = p_{ni} n = \varphi h^{1-\phi} h_i^\phi n; \quad \varphi \equiv (\phi^\phi (1 - \phi)^{1-\phi})^{-1} \]
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\[ TC^n(n, h, h^i) = p_{ni} n = \varphi h^{1-\phi} h^\phi_i n; \quad \varphi \equiv (\phi^\phi (1 - \phi)^{1-\phi})^{-1} \]
Consumption

- production function:

\[ c = m^{1-\alpha} \left[ (t^c_M)^\sigma + (t^c_H)^\sigma \right]^{\alpha/\sigma}, \quad \sigma \in (0, 1) \]

- \( m \) is the market good
- \( t^c_M \) is time of the mother
- \( t^c_H \) is the time bought in the market, e.g., a housekeeper.
- Assumption: price of one unit of time of a housekeeper is \( \hat{h} \).

\[ \Rightarrow \]

\[ TC^c(c, \hat{h}, h^i) = p_c c = \frac{h_i^\alpha}{\omega \left( 1 + \left( \frac{h_i}{\hat{h}} \right)^{\frac{\alpha}{1-\sigma}} \right)^{1+\alpha\left(\frac{1}{\sigma}-1\right)} c} \]
Consumption

- production function:

\[ c = m^{1-\alpha}\left[(t_{MC}\sigma) + (t_{CH}\sigma)\right]^{\alpha/\sigma}, \quad \sigma \in (0, 1) \]

- \( m \) is the market good
- \( t_{MC} \) is time of the mother
- \( t_{CH} \) is the time bought in the market, e.g., a housekeeper.
- Assumption: price of one unit of time of a housekeeper is \( \hat{h} \).

\[ TC^c(c, \hat{h}, h^i) = p_c c = \frac{h_i^\alpha}{\omega \left(1 + \left(\frac{h_i}{\hat{h}}\right)^{\frac{\sigma}{1-\sigma}}\right)^{1+\alpha\left(\frac{1}{\sigma}-1\right)}}c \]
Consumption

- production function:

\[
c = m^{1-\alpha} \left[ (t_M^c)^\sigma + (t_H^c)^\sigma \right]^{\alpha/\sigma}, \quad \sigma \in (0, 1)
\]

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\[
\Rightarrow T C^c(c, \hat{h}, h^i) = p_c c = \frac{h_i^\alpha}{\omega \left( 1 + \left( \frac{h_i}{\hat{h}} \right)^{\frac{\sigma}{1-\sigma}} \right)^{1+\alpha(\frac{1}{\sigma}-1)}}
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\[ TC^c(c, \hat{h}, h_i) = p_cc = \frac{h_i^\alpha}{\omega \left( 1 + \left( \frac{h_i}{\hat{h}} \right)^{\sigma/(1-\sigma)} \right)^{1+\alpha(\frac{1}{\sigma}-1)}c} \]
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Equilibrium

Education:

\[ e_i = \frac{\theta \varphi h^{1-\phi} h_i^\phi - \eta \bar{h}}{\bar{h}(1 - \theta)} \]

**Proposition 1:** The educational choice, \( e^* \), strictly increases with \( h_i \)

Evidence: Bailey and Dynarski (2012)
Equilibrium

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Equilibrium

Fertility:

\[ n_i = \frac{h_i(1 - \theta)}{2(\varphi h_i {h_i}^{1-\phi} - \bar{\eta} \bar{h})} \]

**Proposition 2:** The fertility choice, \( n^* \) is U-shaped as a function of \( h_i \).
**Equilibrium**

Fertility:

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n_i = \frac{h_i(1 - \theta)}{2(\varphi h_i^{1-\phi} h_i^\phi - \eta \bar{h})}
\]

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Equilibrium

Mother’s time spent in child raising:

\[ t^n_M = \left( \frac{\phi \frac{h}{1 - \phi}}{\phi h_i} \right)^{1-\phi} \frac{h_i(1 - \theta)}{2(\varphi h^{1-\phi} h_i^\phi - \eta h)} \]

**Proposition 3:** Mother’s time spent on raising children, \( t^n_M \), strictly decreases with \( h_i \)
Equilibrium

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Mother’s time spent in home production:

\[ t^c_M = \frac{\alpha}{2 \left( 1 + \left( \frac{h_i}{\hat{h}} \right)^{\frac{\sigma}{1-\sigma}} \right)} \]

**Proposition 4:** Mother’s time spent in home production, \( t^c_M \), strictly decreases with \( h_i \)

Evidence: Immigration wave of the 1980s and 1990s reduced by a city-average of 138 minutes the time very skilled American women spent weekly on household chores (Cortes and Tessada 2011)
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Equilibrium

Mother’s labor supply:

\[ l^* \equiv 1 - t^n_M - t^c_M \]

**Proposition 5:** The labor supply strictly increases with \( h_i \)

Evidence: see below
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**Proposition 5:** The labor supply strictly increases with \( h_i \)

**Evidence:** see below
Equilibrium

Babysitting services purchased in the market:

\[ t_B^n = \left( \frac{1 - \phi h_i}{\phi h} \right)^\phi \frac{h_i(1 - \theta)}{2(\varphi h^{1-\phi} h_i^\phi - \eta \bar{h})} \]

**Proposition 6:** Purchase of babysitter services:

- Strictly increases with \( h_i \) if \( \theta < \frac{1}{1 + \phi} \)
- Strictly increases with \( h_i \) when \( n \) increases
- Evidence: see below
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Housekeeping services purchased in the market:

\[
\frac{\left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha} h_i^{\alpha+\frac{\sigma}{1-\sigma}}}{\hat{h}^{1-\sigma} \left(1 + \left(\frac{h_i}{\hat{h}}\right)^{\frac{\sigma}{1-\sigma}}\right)^{1+\alpha\left(\frac{1}{\sigma}-1\right)}} \omega h_i^{1-\alpha} \left(1 + \left(\frac{h_i}{\hat{h}}\right)^{\frac{\sigma}{1-\sigma}}\right)^{\alpha\left(\frac{1}{\sigma}-1\right)}
\]

**Proposition 7:** Purchase of housekeeping services strictly increases with \( h_i \)

Evidence: Expenditures on household services increased, despite a reduction in the prices of these services (Cortes 2008, Cortes and Tessada 2011)
Equilibrium

Housekeeping services purchased in the market:

\[
\frac{(\frac{\alpha}{1-\alpha})^{1-\alpha} h_i^{\alpha+\frac{\sigma}{1-\sigma}}}{\hat{h}^{\frac{1}{1-\sigma}} \left(1 + \left(\frac{h_i}{\hat{h}}\right)^{\frac{\sigma}{1-\sigma}}\right)^{1+\alpha(\frac{1}{\sigma}-1)} \frac{\omega}{2} h_i^{1-\alpha} \left(1 + \left(\frac{h_i}{\hat{h}}\right)^{\frac{\sigma}{1-\sigma}}\right)^{\alpha(\frac{1}{\sigma}-1)} }.
\]

**Proposition 7:** Purchase of housekeeping services strictly increases with \(h_i\)

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Summing up

Highly educated women:

1. Provide each of their children with more education
2. Have larger families than women with intermediate level of education
3. Allocate less time to child raising (and to home production)
4. Work more in the labor market
5. This is possible because they buy more babysitting (and housekeeping) services
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What drives the change in the cross-sectional relationship?

- Why haven’t we seen a U-shaped fertility pattern before the 2000s?
- Clearly, baby-sitting and housekeeping services were available before the 2000s and women did purchase them.
- So what have changed over time?
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Relative Cost of Child-Care

![Graph showing the relative cost of child-care over years from 1983 to 2011. The x-axis represents the years, and the y-axis represents the log wage ratio. The graph includes lines for different education levels: <12, 12, 13-15, and >16 years of education. The 95% confidence intervals are also indicated.]
What drives the change in the cross-sectional relationship?

The partial association between fertility and child-care cost

Consider the following regression model:

\[ b_{ist} = \alpha + \beta \ln \left( \frac{w_{st}^{cc}}{w_{ist}} \right) + \kappa N_{ist} + X'_{ist} \cdot \gamma + \delta_a + \delta_m + \delta_t + \delta_s + \epsilon_{ist}, \]

- \( \ln \left( \frac{w_{st}^{cc}}{w_{ist}} \right) \) is the log of the ratio between the average wage paid to workers in the child-care industry in state \( s \) in year \( t \) and the wage of woman \( i \), living in state \( s \) in year \( t \)

- Data: March CPS for 1983-2012

- White non-Hispanic women aged 25-50
What drives the change in the cross-sectional relationship?

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Data: March CPS for 1983-2012

White non-Hispanic women aged 25-50
What drives the change in the cross-sectional relationship?

<table>
<thead>
<tr>
<th>Dependant Variable: Birth in the past 12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
</tr>
<tr>
<td>log_wage &amp; -0.008*** &amp; -0.012*** &amp; -0.011*** &amp; -0.010*** &amp; -0.011*** &amp; -0.023*** &amp; -0.032***</td>
</tr>
<tr>
<td>N &amp; -0.008*** &amp; -0.003*** &amp; -0.014*** &amp; -0.014*** &amp; -0.015*** &amp; -0.015*** &amp; -0.020***</td>
</tr>
<tr>
<td>Tot. Personal Inc. &amp; -0.075*** &amp; -0.108***</td>
</tr>
<tr>
<td>Tot. Personal Inc.(^2) &amp; 0.025*** &amp; 0.030**</td>
</tr>
<tr>
<td>Spouse’s Wage &amp; 0.402***</td>
</tr>
<tr>
<td>Age Dummies &amp; No &amp; Yes &amp; Yes &amp; Yes &amp; Yes &amp; Yes &amp; Yes</td>
</tr>
<tr>
<td>Martial Status &amp; No &amp; No &amp; Yes &amp; Yes &amp; Yes &amp; Yes &amp; –</td>
</tr>
<tr>
<td>Year Dummies &amp; No &amp; No &amp; No &amp; Yes &amp; Yes &amp; Yes &amp; Yes</td>
</tr>
<tr>
<td>State Dummies &amp; No &amp; No &amp; No &amp; No &amp; Yes &amp; Yes &amp; Yes</td>
</tr>
<tr>
<td>Obs. &amp; 514,829 &amp; 514,829 &amp; 514,829 &amp; 514,829 &amp; 514,829 &amp; 514,829 &amp; 305,847</td>
</tr>
<tr>
<td>(R^2) &amp; 0.003 &amp; 0.038 &amp; 0.064 &amp; 0.065 &amp; 0.066 &amp; 0.068 &amp; 0.079</td>
</tr>
</tbody>
</table>

Linear probability models. Robust standard errors adjusted for heteroscedasticity are reported in parentheses.
What drives the change in the cross-sectional relationship?

Dependant Variable: Birth in the past 12 months

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>log_wage_r</td>
<td>-0.035***</td>
<td>-0.024***</td>
<td>-0.023***</td>
<td>-0.020***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>N</td>
<td>-0.018***</td>
<td>-0.019***</td>
<td>-0.018***</td>
<td>-0.018***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Total Personal Income</td>
<td>-0.061***</td>
<td>-0.089***</td>
<td>-0.095***</td>
<td>-0.063***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Total Personal Income$^2$</td>
<td>0.016***</td>
<td>0.020***</td>
<td>0.022***</td>
<td>0.017***</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Spouse’s Wage</td>
<td>0.519***</td>
<td>0.499***</td>
<td>0.543***</td>
<td>0.627***</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.035)</td>
<td>(0.035)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>Obs.</td>
<td>418,347</td>
<td>418,347</td>
<td>418,347</td>
<td>418,347</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.079</td>
<td>0.080</td>
<td>0.079</td>
<td>0.078</td>
</tr>
</tbody>
</table>

Linear probability models. Robust standard errors adjusted for heteroscedasticity are reported in parentheses. Column (1) uses imputed wages for all women. Column (2) uses own wages for women who reported positive wage and imputed for those who do not. Column (3) uses own wages for women who reported positive wage and imputed from a quantile regression for the 25$^{th}$ percentile for those who do not. Column (4) uses imputed wages from a median regression for working women and from a quantile regression for the 25$^{th}$ percentile for those who do not. All models include age year and state dummies.
What drives the change in the cross-sectional relationship?

The partial association between fertility and child-care cost

1. Assume that women care about pursuing a career and that this aspiration increases with women’s education.
2. Assume that there are two types of women: uneducated women who do not care about pursuing a career and educated women who do.
3. For the first type, the reduction in the relative cost of child care has a pure price (substitution) effect.
4. For the second type there is an additional effect that stems from a reduction in the rivalry between children and career.
5. Thus, a reduction in the child care cost should have a larger effect on the probability of giving a birth for more educated women.
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The partial association between fertility and child-care cost

Consider then a more flexible regression model:

\[ b_{ist} = \alpha + \sum_{j=2}^{5} \pi_j e_{ist}^j + \beta \ln \left( \frac{w_{st}^{cc}}{w_{ist}} \right) + \sum_{j=2}^{5} \gamma_j e_{ist}^j \ln \left( \frac{w_{st}^{cc}}{w_{ist}} \right) + \delta_a + \delta_m + \delta_t + \delta_s + \epsilon_{ist}, \]

This specification allows for differential association between child-care cost on fertility for each educational group: \( \beta + \gamma_j \)
The partial association between fertility and child-care cost

Consider then a more flexible regression model:

\[ b_{ist} = \alpha + \sum_{j=2}^{5} \pi_j e^j_{ist} + \beta \ln \left( \frac{w_{st}^{cc}}{w_{ist}} \right) + \sum_{j=2}^{5} \gamma_j e^j_{ist} \ln \left( \frac{w_{st}^{cc}}{w_{ist}} \right) + \]

\[ + \delta_A + \delta_m + \delta_t + \delta_s + \epsilon_{ist}, \]

This specification allows for differential association between child-care cost on fertility for each educational group: \( \beta + \gamma_j \)
What drives the change in the cross-sectional relationship?

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Moshe Hazan and Hosny Zoabi

The Fertility of Highly Educated Women

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What drives the change in the cross-sectional relationship?

Counterfactual Hybrid Fertility

\[ \Delta F_j = \beta \left[ \ln \left( \frac{w^{cc}}{w} \right)_{jt_1} - \ln \left( \frac{w^{cc}}{w} \right)_{jt_0} \right] \cdot 26 \]

\[ \Delta F_j = (\beta + \gamma_j) \left[ \ln \left( \frac{w^{cc}}{w} \right)_{jt_1} - \ln \left( \frac{w^{cc}}{w} \right)_{jt_0} \right] \cdot 26 \]
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What drives the change in the cross-sectional relationship?

Counterfactual Hybrid Fertility

![Graph showing the relationship between years of schooling and hybrid fertility rate.](image)
What drives the change in the cross-sectional relationship?

Paid Child-Care Weekly Hours per Woman aged 25-50

Moshe Hazan and Hosny Zoabi
The Fertility of Highly Educated Women
Usual hours worked by women aged 25-50 and women with newborns, 2001-2011
Minutes per day spent on child-care activity 2003-2011: Married Men by the Educational group of their Wives
Fraction of currently married women by age and education, 2001-2011
Usual hours worked of women with newborns by marital status, 2001-2011
Number of Births per 1,000 White Women in the U.S.: Women with Advanced Degrees 2001-2011 and Historical Rates
Future Research

- Study the implications for the relationship between income inequality and growth

  - de la Croix and Doepke (2003): poorer parents have more children, each with lower education $\Rightarrow$ income inequality adversely affects growth through fertility.

  - With a U-shaped fertility pattern and “marketization”, inequality may spur growth.
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Mother’s time spent on children

- Guryan et al (2008): Mother’s time allocated to childcare increases with mother’s education

  - Guryan et al define “childcare” as the sum of four primary time use components: “basic”, “educational”, “recreational” and “travel”

- Ramey and Ramey (2010): as slots in elite postsecondary institutions have become scarcer, parents responded by investing more in their children’s quality

- Since more educated parents spend more of their own time and on market goods and services related to child’s quality, it implies that parental time and market goods and services are strong complements in the production of children’s quality.
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Mother’s time spent on children

\[ e_i = \left( (t_{SC}^e)^\zeta + (t_M^e)^\zeta \right)^{1/\zeta} , \]

with \( \zeta \in (-\infty, 0) \)

- \( t_{SC}^e \) time invested in education provided by the school
- \( t_M^e \) time invested in education provided by the mother
Mother’s time spent on children

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- \( t_{SC}^e \) time invested in education provided by the school
- \( t_M^e \) time invested in education provided by the mother
Numerical Example

Proposition 3

Summing up

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