Social Change: The Sexual Revolution

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Why is there so much social change today, and why was there so little in ancient times? The most probable answer, the result of quite extensive study, is mechanical invention and scientific discovery. There is no doubt that useful inventions and researches cause social changes. Steam and steel were major forces in developing our extensive urban life. Gunpowder influenced the decline of feudalism. The discovery of seed-planting destroyed the hunting cultures and brought a radically new form of social life. The automobile is helping to create the metropolitan community. Small inventions, likewise, have far-reaching effects. The coin-in-the-slot device changes the range and nature of salesmanship, radically affects different businesses, and creates unemployment. The effects of the invention of contraceptives on population and social institutions is so vast as to defy human estimation. It is obvious, then, that social changes are caused by inventions.

*William F. Ogburn*, 1936
1 Facts

Rise in Premarital Sex, 1900-2002
More Permissive Attitudes toward Premarital Sex, 1963-1987
Increase in Number of Partners, 1933-1972
Increase in Out-of-Wedlock Births, 1920-1999
1.1 Question

- *Question*: What caused the rise in premarital sex?
  - Or, the increase in frequency of sex?

- *Answer*: Technological Progress in Contraception
  - Lowered the cost of premarital sex
    * 1900 – Odds of a safe sexual encounter, 0.961
    * 2002 – Odds of a safe sexual encounter, 0.996
1.2 **Ingredients**

- Purposive decision making by rational agents
  - Weight the costs and benefits of risky activity
    - Contraception and abortion

- Desire a mate who is similarly inclined
  - Bilateral matching structure

- Formation of social groups of similarly-minded people
  - Minimize search costs
1.3 Results

- *Theoretical*
  - Steady state displays clean sorting
    - Two social groups: those who want sex and those who don't
  - Transitional dynamics are rapid
  - Predictions from matching structure
    - Duration of relationships
    - Number of partners
    - Number of teenagers in a relationship in a period
* Number of teenagers who have had a relationship by age 19

* Number of pregnancies

* Frequency of sex—times per month

- **Quantitative**

  - Model explains the rise in premarital sex well

  - Explains *mean* duration of relationships, number of teens in a relationship, number of partners

  - Can’t explain huge *variation* in number of partners

  - Model can account for the observed increase in the frequency of sex
• *Extensions*

  – Modeling the AIDS/HIV epidemic

  – Modeling the socialization of children—endogenous culture
2 Environment

- Two social classes
  - Abstinent, $\mathcal{A}$
  - Promiscuous, $\mathcal{P}$

- Sex – costs and benefits
  - Idiosyncratic benefit $j \in \mathcal{J} = \{j_1, j_2, \ldots, j_n\}$
  - Cost, $c$
• Matching structure
  – Match with probability $\mu$
  – Breakup with probability $\delta$

• Two Decisions
  – Accept or reject your mate – matched agents only
  – Social class to join – matched and unmatched agents
    * Decisions inextricably linked
• Utility
  – Single, $w$
  – Abstinent relationship, $u > w$
  – Promiscuous relationship, $u + j - c$

• Social Change
  – Technological progress in contraception, $c$ declines
  – Social Change
    * $(\mathcal{A})$ shrinks and $(\mathcal{P})$ swells
Social Change

A
Abstinence

Social Divide

P
Promiscuity

penitence

Social Change
3 Decision Problems

3.1 Notation

*Abstinent relationships* – in $\mathcal{A}$

$A^m(j, \tilde{j})$ – expected lifetime utility for $j$ when matched with $\tilde{j}$

$A^s(j)$ – expected lifetime utility for $j$ when unmatched
Promiscuous relationships – in \( \mathcal{P} \)

\[ P^m(j, \tilde{j}) \] – expected lifetime utility for \( j \) when matched with \( \tilde{j} \)

\[ P^s(j) \] – expected lifetime utility for \( j \) when unmatched

Matching Probabilities – conditional on drawing mate

\[ a^m(j, \tilde{j}) \] – equilibrium probability that an abstinent match will occur

\[ p^m(j, \tilde{j}) \] – equilibrium probability that a promiscuous match will occur

\[ 1 - a^m(j, \tilde{j}) - p^m(j, \tilde{j}) \] – equilibrium probability that no match will occur
Type Distributions – unmatched agents

\( a_i^s \) – unmatched types in \( A \)

\( p_i^s \) – unmatched types in \( P \)
3.2 Abstinent Class

- Matched

\[
A^m(j, \tilde{j}) = u + \beta(1 - \delta) \left[ a^m(j, \tilde{j}) A^m(j, \tilde{j}) + p^m(j, \tilde{j}) P^m(j, \tilde{j}) \right] \]

\[
+ \beta \left\{ \frac{\delta}{\text{exg}} + (1 - \delta) \left[ 1 - a^m(j, \tilde{j}) - p^m(j, \tilde{j}) \right] \right\} \]

\[
\times \max\{ A^{s'}(j), A^{s'}(\tilde{j}) \},
\]

abstinent \hspace{1cm} promiscuous
\[ A^s(j) = w + \beta \mu \sum_{i=1}^{n} a_i^{st} \left[ a^m(j, \tilde{j}_i) A^m(j, \tilde{j}_i) + p^m(j, \tilde{j}_i) P^m(j, \tilde{j}_i) \right] \]

\[ + \beta \{1 - \mu\} + \mu \sum_{i=1}^{n} a_i^{st} [1 - a^m(j, \tilde{j}_i) - p^m(j, \tilde{j}_i)] \]

\[ \times \max\{A^s(s), P^s(s)\} \]
3.3 Promiscuous Class

- **Matched**

\[
P^m(j, \tilde{j}) = u + j - c + \beta (1 - \delta) [a^{ml}(j, \tilde{j}) A^{ml}(j, \tilde{j}) + p^{ml}(j, \tilde{j}) P^{ml}(j, \tilde{j})] \\
+ \beta \{ \delta + (1 - \delta) [1 - a^{ml}(j, \tilde{j}) - p^{ml}(j, \tilde{j})] \} \\
\times \max \{ A^{sl}(j), P^{sl}(j) \}.
\]

- **Unmatched**

\[
P^s(j) = w + \beta \mu \sum_{i=1}^{n} p_i^{sl} [a^{ml}(j, \tilde{j}_i) A^{ml}(j, \tilde{j}_i) + p^{ml}(j, \tilde{j}_i) P^{ml}(j, \tilde{j}_i)] \\
+ \beta \{(1 - \mu) + \mu \sum_{i=1}^{n} p_i^{sl} [1 - a^{ml}(j, \tilde{j}_i) - p^{ml}(j, \tilde{j}_i)] \} \\
\times \max \{ A^{sl}(j), P^{sl}(j) \}.
\]
3.4 Social Class Membership Decision

- **Decision Rules**

  - Abstinent match is first choice

\[ 1^a(j, \tilde{j}) = \begin{cases} 
  1, & \text{if } A(s, \tilde{s}) > A^m(j, \tilde{j}) > \max\{P^m(j, \tilde{j}), A^s(j), P^s(j)\} \\
  0, & \text{otherwise.} 
\end{cases} \]

  - Abstinent match preferred to single life, at least 2nd choice

\[ 2^{a,s}(j, \tilde{j}) = \begin{cases} 
  1, & \text{if } A^m(j, \tilde{j}) > \max\{A^s(j), P^s(j)\} \\
  0, & \text{otherwise.} 
\end{cases} \]

  - Promiscuous match is first choice

\[ 1^p(j, \tilde{j}) = \begin{cases} 
  1, & \text{if } P^m(j, \tilde{j}) > \max\{A^m(j, \tilde{j}), A^s(j), P^s(j)\} \\
  0, & \text{otherwise.} 
\end{cases} \]
– Promiscuous match preferred to single life, at least 2nd choice

\[ 2^{p,s}(j, \tilde{j}) = \begin{cases} 
1, & \text{if } P^m(j, \tilde{j}) > \max\{A^s(j), P^s(j)\}, \\
0, & \text{otherwise.} 
\end{cases} \]

– Transposed matrices give partner’s choices.
Matching Probabilities – conditional on drawing mate

- Abstinent match, \( a^m(j, \tilde{j}) \in \{0, 1/2, 1\} \)

\[
 a^m(j, \tilde{j}) =
\begin{align*}
&\underbrace{1^a(j, \tilde{j})1^a_T(j, \tilde{j})}_{1st, 1st} \\
&\underbrace{1^a(j, \tilde{j})2^{p,s}(j, \tilde{j})1^p_T(j, \tilde{j})2^{a,s}_T(j, \tilde{j})}_{1st, 2nd - mixing} / 2 \\
&\underbrace{1^a_T(j, \tilde{j})2^{p,s}_T(j, \tilde{j})1^p(j, \tilde{j})2^{a,s}(j, \tilde{j})}_{2nd, 1st - mixing} / 2 \\
&\underbrace{1^a(j, \tilde{j})[1 - 2^{p,s}(j, \tilde{j})][1 - 1^a_T(j, \tilde{j})]2^{a,s}_T(j, \tilde{j})}_{1st, 2nd - pure} \\
&\underbrace{1^a_T(j, \tilde{j})[1 - 2^{p,s}_T(j, \tilde{j})][1 - 1^a(j, \tilde{j})]2^{a,s}(j, \tilde{j})}_{2nd, 1st - pure}.
\end{align*}
\]

- Promiscuous Match, \( p^m(j, \tilde{j}) \in \{0, 1/2, 1\} \)
– No Match, $1 - a^m(j, \tilde{j}) - p^m(j, \tilde{j}) \in \{0, 1\}$
4 Equilibrium

- Calculate value functions, $A^m(j, \tilde{j})$, $A^s(j)$, $P^m(j, \tilde{j})$, $P^s(j)$
  - use matching probabilities and type distributions

- Calculate matching probabilities – $a^m(j, \tilde{j})$, and $p^m(j, \tilde{j})$
  - use Bellman equations

- Calculate type distributions – $a^s_i$ and $p^s_i$ in $\mathcal{A}$ and $\mathcal{P}$
  - use matching probabilities

- Equilibrium: compute fixed-point problem
5 Steady State

- Threshold type, $j_b$, defined by

$$j_b < c \leq j_{b+1}.$$ 

such that

$$j_i \in \mathcal{A} \text{ for } j_i < j_b, \quad \text{(abstinent)}.$$ 

and

$$j_i \in \mathcal{P} \text{ for } j_i \geq j_b \quad \text{(promiscuous)}.$$ 

Lemma 1 The steady-state number of people engaging in premarital sex (weakly) increases with a fall in the cost of premarital sex.
6 Dynamics: Once-and-for-all Decline in $c$

Threshold drops from $j_b$ to $j_d$

- Unmatched agents
  
  $j \in [j_d, j_b]$ move immediately to $\mathcal{P}'$
  now promiscuous

- Matched agents
  
  $j, \tilde{j} \in [j_d, j_b]$ move immediately to $\mathcal{P}'$
  now promiscuous
\[ j \leq \tilde{j}_d \quad \text{and} \quad \tilde{j} \geq \tilde{j}_d + 1 \]

\begin{itemize}
  \item \text{abstinent}
  \item \text{promiscuous}
\end{itemize}

* Breakup

* Stay in \( A' \)
  \begin{itemize}
    \item mixing relationship
    \item pure – \( j \) is low
  \end{itemize}

* Move to \( P' \)
  \begin{itemize}
    \item mixing relationship
    \item pure – \( \tilde{j} \) is high
  \end{itemize}
Equilibrium Matching Sets

Once-and-for-all change in $c$
7 Technological Progress in Contraception

History

- Coitus Interruptus – Bible

- Condoms – 18th century

To guard yourself from shame or fear,
Votaries to Venus, haften here;
None in my wares ever found a flaw,
Self preservation's nature's law.
1850, vulcanized rubber,
  – expensive – $5 a dozen ($34 today)
  – 1930, Latex condom

Diaphragm
  – 18th century – Casanova, lemon
  – 1890, rubber diaphragm

Pill, 1960
- Knowledge

  - 1833, Dr. Charles Knowlton – *Fruits of Philosophy*
    * Douching

  - 1853, Newport
    * Fertility cycle in frogs

  - 1914, Margaret Sanger – *Family Limitation*
    * Condoms, douching, suppositories

    * 1919, birthcontrol clinic opened – diaphragm
– 1930, human fertility cycle

* Human ovum seen

* Safe Period – Ogino and Knaus
## Effectiveness and Use of Contraception

<table>
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<tr>
<th>Method</th>
<th>1900</th>
<th>60-64</th>
<th>65-69</th>
<th>70-74</th>
<th>75-79</th>
<th>83-88</th>
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<th>90-94</th>
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<td>61.4</td>
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<td>20.5</td>
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<td>20.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

- Technology series, shown in right panel of transitional dynamics diagram
8 Calibration

Period = one quarter

\[ \beta = 0.99 \]

\[ 1 - \zeta = 1/20 \] – probability of exiting teenage life

- Matching Parameters, \( \mu \) and \( \delta \)
  - Teen’s first sexual relationship last 13 months
    - \[ 1/\delta = 13/3 \]
- On average 34.4 percent of teenagers had sex within the last quarter.

* $\mu = 0.22$ – tuned from Markov Chain
• *Two Type Distribution Parameters, $\bar{j}$ and $\varsigma_j$

  – Cost of Sex – Quarterly
    * $c_{1900} = 0.2729$
    * $c_{2002} = 0.0802$

  – Two Data Targets
    * $\Pr(\text{match over ages 15 to 19}) \times \#P_{1900} = 0.06$
    * $\Pr(\text{match over ages 15 to 19}) \times \#P_{2002} = 0.75$

  – Backed-out Solution: $\bar{j} = 0.1450$ and $\varsigma_j = 0.0857$
9 Computational Experiment: Social Change

- Experiment
  
  - Start off in 1900 steady state
  
  - Feed in technological progress for contraception, $\{c_t\}_{t=1900}^{2002}$
    
    * The analysis is done with and without abortion in the model
Matching set, 2002 steady state
9.1 Abortion

- 1972, Abortion Legalized–series shown below

- Modify setup to allow for Abortion

  - $\psi_a = \text{cost of abortion (relative to pregnancy)}$ – estimated
  
  - $\xi = \text{Pr(abortion|pregnancy)}$ – data on abortions
  
  - $\pi = \text{Pr(pregnancy|sex)}$ – data on failure rates

- Cost of Premartial Sex

\[
\text{cost of sex} = (1 - \xi)\pi + \phi_a \xi \pi
\]
• Estimation Criteria – minimize distance between model and data
  \[ \phi_a = 0.0853 \]
Transitional dynamics (with and without abortion), 1900-2002
Abortion and Teenage Pregnancies, 1960-2002
9.2 Power of the Pill

- Run *no-pill* counterfactual experiment
  - Allocate pill users across other contraceptive methods
  - Construct new risk-of-pregnancy series

- 2002 – # of sexually experienced girls by age 19
  - with pill, 74.6%
  - without pill, 73.6%
The power of the pill
9.3 Number of Partners

- Mean **Number of Partners**
  - Data, 3.0
  - Model, 2.5

<table>
<thead>
<tr>
<th># of Partners</th>
<th>1</th>
<th>2 to 3</th>
<th>4 to 6</th>
<th>7+</th>
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<tr>
<td>Data</td>
<td>0.390</td>
<td>0.306</td>
<td>0.171</td>
<td>0.133</td>
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<tr>
<td>Model</td>
<td>0.1343</td>
<td>0.7205</td>
<td>0.1451</td>
<td>0.0001</td>
</tr>
</tbody>
</table>
10 Frequency of Sex–extension

- Increase in Frequency of Sex
  - 1935 – 7.92 times per quarter
  - 2002 – 12.71 times per quarter
### TABLE 4: Monthly Frequency of Sex

(Active females, ages 15 to 19)

<table>
<thead>
<tr>
<th># of times</th>
<th>distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.3890</td>
</tr>
<tr>
<td>1</td>
<td>0.0945</td>
</tr>
<tr>
<td>2 to 3 (= 2.5)</td>
<td>0.1604</td>
</tr>
<tr>
<td>4 to 7 (= 5.5)</td>
<td>0.1495</td>
</tr>
<tr>
<td>8+ (= 9)</td>
<td>0.2066</td>
</tr>
</tbody>
</table>

Mean = 3.177

### 10.1 Model

\[
f = \text{frequency of sex}
\]

\[
p = \text{prob of safe sexual encounter}
\]
• Tastes

\[ \ln \tilde{j} + \chi f^\iota / \iota - \chi / \iota, \text{ with } \iota < 0 \text{ and } \chi > 0, \]

• Cost, \( \tilde{c} \)

\[ \tilde{c} = \frac{1 - p_f}{\Pr \text{ of pregnancy}} \]

• Frequency Problem

\[ \max_f \{ \ln \tilde{j} + \chi f^\iota / \iota - \chi / \iota - 1 + p_f \} \]

• Efficiency Condition

\[ \chi f^{\iota-1} = \frac{-(\ln p)p_f}{\text{M.C.}} \]
10.2 Calibration

- Probability of safe sex, $p$
  
  - $p_{1900} = 0.9606$

  $$(p_{1900})^{7.92} = \frac{1 - 0.2729}{\text{failure}}$$

  - $p_{2002} = 0.9956$  
    $$[(p_{2002})^{12.71} = (1 - 0.0543)]$$

- Data Targets
  
  - $f_{1900} = 7.92$
  
  - $f_{2002} = 12.71$
• Parameters – backed out using first-order condition
  
  – \( \nu = -3.13 \)
  
  – \( \chi = 149.39 \)

• Embed into model
  
  – \( j = \ln \tilde{j} \)
  
  – \( c = \tilde{c} - \chi F(\tilde{c})^\nu / \nu + \chi / \nu \)
  
  – \( f = F(\tilde{c}) \), optimal frequency decision
11 Conclusions

11.1 Facts

- Rise in Premarital Sex
- More Permissive Attitude Toward Sex
- Increase in Frequency of Sex
11.2 Hypothesis

- Result of Technological Improvement in Contraception

- Ingredients into Analysis
  - Individuals weight the cost and benefits of risky activity
  - Bilateral search model – want similarly inclined mate
  - Formation of social classes – economize on search costs
11.3 Extensions

* AIDS/HIV epidemic

  - Markets for safe and risky sex
  - Individuals decide on which markets to participate in
  - Decision will be based upon:
    * Prevalence rates in each market
    * Individual’s health status
      - updated via Bayesian learning, given sexual history
    * Price for sex in each market
• *Transmission of Culture*

  – Parent’s socialize children about perils of premarital sex.
    * Children’s well-being enters parent’s utility functions
    * Can influence children’s tastes, at a cost.
  
  – Children decide whether or not to engage in premarital sex.
    * Benefit–joy of sex
    * Cost–out-of-wedlock birth
      • lower income
      • worse mate on marriage market
- stigma effect inculcated by parents

- Over time as contraception improves.

  * Parents socialize children less
Markov Chain

• $\pi_j =$ odds of teenage being matched $j$ periods away

\[
\begin{bmatrix}
\pi_j \\
1 - \pi_j
\end{bmatrix}
= 
\begin{bmatrix}
1 - \delta & \mu \\
\delta & 1 - \mu
\end{bmatrix}^j
\begin{bmatrix}
0 \\
1
\end{bmatrix}, \text{ for } j = 1, \ldots, 20.
\]

• $\mu$ solves

\[
0.75 \times \sum_{j=1}^{20} \frac{\pi_j}{20} = 0.344
\]

% life active

% pop active

Return from MC
Markov Chain Over Number of Sexual Encounters

- $m_t^j = \#$ matched agents with $j$ sexual encounters by time $t$

- $u_t^j = \#$ unmatched agents with $j$ sexual encounters

\[
\begin{align*}
  m_{t+1}^j &= (1 - \delta)m_t^j + \mu u_t^{j-1}.
  \\
  u_{t+1}^j &= (1 - \mu)u_t^j + \delta m_t^j.
\end{align*}
\]

- Markov Chain over $\{m_t^0, u_t^0, \ldots, m_t^N, u_t^N\}$

- Use Initial distribution $\{0, 1, \ldots, 0, 0\}$ and Run for 20=4*5 periods Return from mcpar