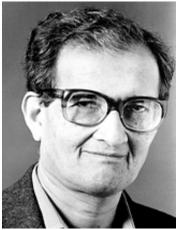
Hepatitis B and Missing Women

Ming-Ching Luoh



Amartya Sen

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1998

- Sen (1990), *New York Review of Books*, 100 million women are missing in China, India, and other Asian countries due to excess female mortality.

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FEBRUARY 28, 2005

ECONOMIC VIEWPOINT

By Robert J. Barro

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The Case Of Asia's "Missing Women"

The culprit may not be government policy, but hepatitis B virus

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In 1990 my Harvard colleague Amartya Sen caused a stir by observing in *The New York Review of Books* that excess female mortality in China, India, and other Asian countries meant that there were 100 million women fewer in the world than there should be. The presumption was that the excess mortality came from discrimination against women by men and governments. Although the estimate was lowered to 60 million by demographer Ansley Coale's more detailed analysis in the *1991 Population & Development Review*, this still shockingly large number became a symbol of discrimination against women in developing countries. Many people think the reason is abortion and the killing of newborn girls. But new research suggests another reason. Harvard economist Emily Oster, in her PhD thesis "Hepatitis B and the Case of the Missing Women," suggests that biology explains a good deal of the missing-women puzzle.

February 28, 2005, *Businessweek*, Robert Barro:

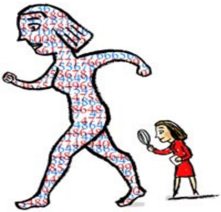
- Harvard economist Emily Oster, in her PhD thesis "Hepatitis B and the Case of Missing Women," suggests that biology (Hepatitis B Virus, HBV)explains a good deal of the missing-women puzzle.
- the HBV influence is greatest in China, explaining 75% of "missing women."

HOME / THE DISMAL SCIENCE : THE SEARCH FOR BETTER ECONOMIC POLICY.

The Search for 100 Million Missing Women

An economics detective story.

By Stephen J. Dubner and Steven D. Levitt
Posted Tuesday, May 24, 2005, at 6:42 AM ET

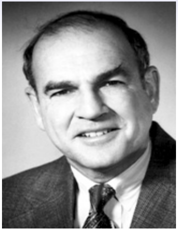


What is economics, anyway? It's not so much a subject matter as a sort of tool kit—one that, when set loose on a thicket of information, can determine the effect of any given factor. "The economy" is the thicket that concerns jobs and real estate and banking and investment. But the economist's tool kit can just as easily be put to more creative use.

Consider, for instance, an incendiary argument made by the economist Amartya Sen in 1990. In an essay in the *New York Review of Books,* Sen claimed that there were some 100 million "missing women" in Asia. While the ratio of men to women in the West was nearly even, in countries like China, India, and Pakistan, there were far more men than women. Sen charged these cultures with gravely mistreating their young girls—perhaps by starving their daughters at the expense of their sons or not taking the girls to doctors when they should have. Although Sen didn't say so, there were other sinister possibilities. Were the missing women a result of selective abortions? Female infanticide? A forced export of prostitutes?

May 24, 2005, *Slate*, Dubner and Levitt,

- Emily Oster is an economics graduate student at Harvard who started running regression analyses when she was 10 (both her parents are economists) and is particularly interested in studying disease.
- One day last summer, while doing some poolside reading in Las Vegas— the book was Baruch Blumberg's Hepatitis B: The Hunt for a Killer Virus— she discovered a strange fact. ··· researchers had found that a preganant women with hepatitis B is far more likely to have a baby boy than a baby girl.



Baruch S. Blumberg

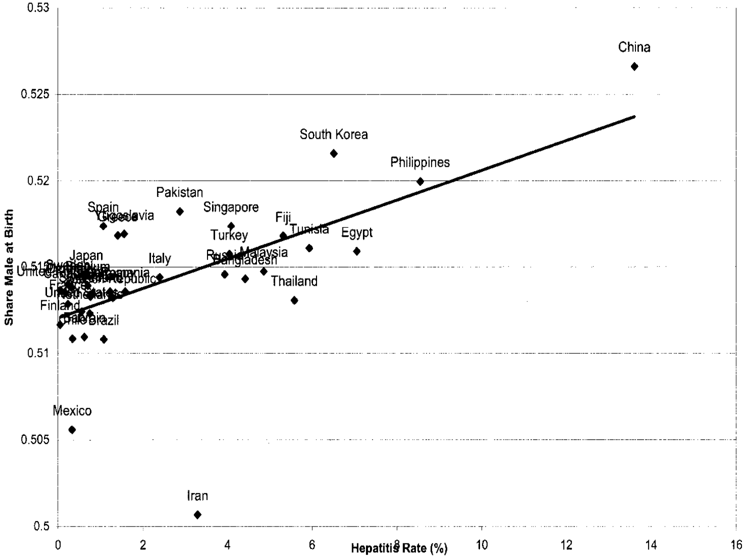
The Nobel Prize in Physiology or Medicine 1976

- It wasn't clear why— it may be that a female fetus is more likely to be miscarried when exposed to the virus.
- If you believe Oster's number— and as they are presented in a soon-to-be-published paper, they are extremely compelling— then her detective work has established the fate of roughly 50 million of Amartya Sen's missing women.

Hepatitis B and the Case of Missing Women, Emily Oster, December 2005, 1165-1216, *Journal of Political Economy*,

- I present new evidence, consistent with an existing scientific literature, that carriers of the Hepatitis B virus have offspring sex ratios around 1.50 boys for each girl.
- Using data on prevalence of the virus by country and estimates of the effect of hepatitis on the sex ratio, I argue that hepatitis B can account for about 45 percent of the "missing women": around 75 percent in China, between 20 and 50 percent in Egypt and western Asia, and under 20 percent in India, Bangladesh, Parkistan, and Nepal.

Oster(2005), Figure 5.- Share Male at birth and HBV prevalence.



Oster(2005), Figure 6.- Share Male at birth and HBV prevalence, OECD.

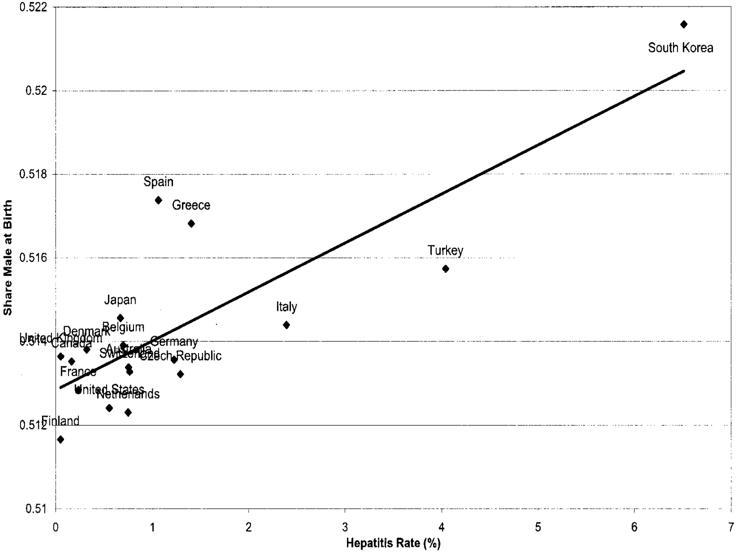


TABLE 6
CROSS-COUNTRY HEPATITIS B PREVALENCE AND SHARE MALE AT BIRTH
Dependent Variable: Share of Births That Are Male

Explanatory Variable	All (1)	All (2)	OECD (3)	All (4)	All, Complete (5)
Hepatitis B prevalence	.0009***	.0010***	.0014***	.0011***	.0012***
(%)	(4.63)	(4.88)	(4.03)	(3.91)	(9.87)
Log GDP per capita,		−.0020	−.0027	−.0017	−.0016**
1995		(−1.46)	(−1.32)	(−1.14)	(−2.54)
Total fertility rate		−.0008	.0005	−.0002	−.0006
		(−1.04)	(.14)	(−.28)	(−1.52)
Life expectancy		.0010*	.0003	.0006*	.0004***
		(1.9)	(1.04)	(1.84)	(2.76)
Infant mortality		.0000	.0000	.0000	.0001*
		(.43)	(−.92)	(.5)	(−1.71)
Constant	.512***	.492***	.511***	.486***	.502***
	(717.08)	(29.1)	(23.26)	(26.01)	(63.15)
Region fixed effects	no	no	no	yes	no
Observations	38	38	18	38	30
R^2	.37	.51	.73	.54	.86

- Let sex ratio at birth be s boys for each girl, then the relationship betwenn estimated coefficient $\hat{\beta}$ and s is $\hat{\beta} + \frac{1.05}{1.05+1} = \frac{s}{s+1}$.
- With $\hat{\beta} = 0.11$ in column(4), $\frac{s}{s+1} = 0.11 + 0.5122 = 0.6222$, $s = \frac{0.6222}{1-0.6222} = \frac{0.6222}{0.3778} \doteq 1.65$.
- With $\hat{\beta} = 0.09$ in column (1), $s = \frac{0.6022}{1-0.6022} \doteq 1.51$.

- But, is this correlation between hepatitis B prevalence and sex ratio at birth causal?
- Are there omitted variables?
- Why does hepatitis B work only on high-parity births?

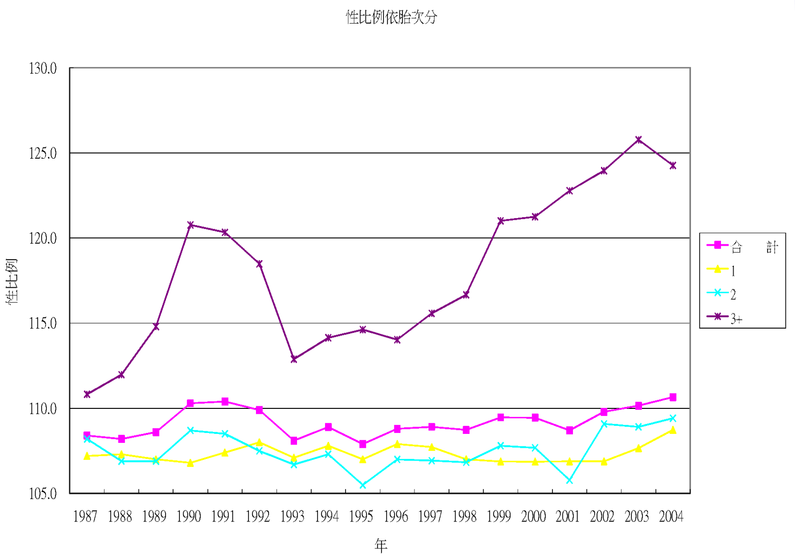

性比例依胎次分
130.0
125.0
120.0
115.0
110.0
105.0
性比例
1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
年
合 計
1
2
3+

Table 3b. Fraction of Having 3rd birth and the sex of 3rd birth by sex composition of first 2 births

	1980 census			1990 census			2000 census		
sex of 1st 2 child in fami with two or more childre	Fraction of sample	Fraction that had another child	% boy in 3rd birth	Fraction of sample	Fraction that had another child	% boy in 3rd birth	Fraction of sample	Fraction that had another child	% boy in 3rd birth
boy, boy	0.261	0.552	0.5099	0.272	0.376	0.5164	0.265	0.259	0.5175
boy, girl	0.247	0.620	0.5110	0.242	0.419	0.5115	0.247	0.281	0.5048
girl, boy	0.252	0.618	0.5228	0.246	0.416	0.5268	0.252	0.285	0.5257
girl, girl	0.240	0.727	0.5167	0.240	0.597	0.5317	0.237	0.422	0.5577
Total	1.000	0.627	0.515	1.000	0.450	0.523	1.000	0.310	0.530

Ming-Jen Lin and Ming-Ching Luoh (2008),
"Can Hepatitis B Mothers Account for the Number of Missing Women? Evidence from Three Million Newborns in Taiwan," American Economic Review, 98:5, December, 2259-2273.

- A mass immunization proram was launched in Taiwan in 1984 for all infants born to HBsAg(+) mothers, the first program of its kind in the world.
- By 1986, all newborn babies in Taiwan were receiving the Hepatitis B vaccine.
- Three million newborns in the period of 1988-1999 are used for analyses.

Table A2—Sex Ratio at Birth by Birth Order in Taiwan and South Korea: 1980–2000

	Taiwan				South Korea			
	Total	First child	2nd child	3rd child+	Total	First child	2nd child	3rd child+
1980	106.5				103.9	105.7	104.2	101.5
1981	107.1				107.2	106.3	106.7	109.4
1982	106.9				106.8	105.4	106.0	110.9
1983	107.1				107.4	105.8	106.2	114.7
1984	107.4				108.3	106.1	107.2	120.7
1985	106.7				109.4	106.0	107.8	134.3
1986	107.3				111.7	107.3	111.2	141.5
1987	108.4	107.2	108.2	110.8	108.8	104.7	109.1	137.9
1988	108.2	107.3	106.9	112.0	113.3	107.2	113.2	168.3
1989	108.6	107.0	106.9	114.8	111.7	104.1	112.4	185.0
1990	110.3	106.8	108.7	120.8	116.5	108.5	117.0	192.7
1991	110.4	107.4	108.5	120.3	112.4	105.7	112.4	182.1
1992	109.9	108.0	107.5	118.5	113.6	106.2	112.4	194.4
1993	108.1	107.1	106.7	112.9	115.3	106.4	114.7	206.6
1994	108.9	107.8	107.3	114.1	115.2	105.9	114.1	205.1
1995	107.9	107.0	105.5	114.6	113.2	105.8	111.7	180.2
1996	108.8	107.9	107.0	114.0	111.6	105.3	109.8	166.2
1997	108.9	107.7	106.9	115.6	108.2	105.1	106.3	135.5
1998	108.7	107.0	106.8	116.7	110.1	105.9	108.0	145.6
1999	109.5	106.9	107.8	121.0	109.6	105.6	107.6	143.1
2000	109.4	106.9	107.7	121.2	110.1	106.2	107.4	143.9

Source: Taiwan National Statistical Office and South Korea National Statistical Office.

Table A1—Summary Statistics: Sex Ratio at Birth, by Birth Order and HBsAg Status: The Three Million Sample

	Observations		HBsAg (+) prevalence		Proportion of male births (sex ratio, total men/100 women)		
Birth order	Total	Percent	Total	Percent	HBsAg (−)	HBsAg (+)	Difference
First	1,767,657	56.5	288,461	16.3	0.51680 (107.0)	0.51900 (107.9)	0.00220 (0.9)
Second	1,037,902	33.2	170,508	16.4	0.51825 (107.6)	0.52081 (108.7)	0.00256 (1.1)
Third (or subsequent)	320,443	10.3	55,073	17.2	0.53484 (115.0)	0.53703 (116.0)	0.00219 (1.0)
Totals	3,126,002	100.0	514,042	16.4	0.51911 (107.9)	0.52154 (109.0)	0.00243 (1.1)

TABLE A4—EFFECT OF HBSAG, BIRTH ORDER, AND THEIR INTERACTION ON MALE PROBABILITY: OLS RESULTS FOR FULL SAMPLE

	(1)	(2)	(3)	(4)	(5)
HBsAg (+)	0.00242	0.00232	0.00255	0.00249	0.00234
	(0.00076)**	(0.00076)**	(0.00076)**	(0.00076)**	(0.00102)*
Second birth		0.00151	0.00046	0.00051	0.00044
		(0.00062)*	(0.00065)	(0.00066)	(0.00071)
Third (or subsequent) birth		0.01804	0.0164	0.01659	0.01658
		(0.00096)**	(0.00101)**	(0.00102)**	(0.00111)**
HBsAg(+) × second birth					0.00044
					(0.00167)
HBsAg(+) × third (or subsequent) birth					0.00006
					(0.00255)
Other controls					
Age of mother	No	No	Yes	Yes	Yes
Year of birth	No	No	Yes	Yes	Yes
Township	No	No	No	Yes	Yes
Constant	0.51911	0.51678	0.50860	0.52531	0.52534
	(0.00031)**	(0.00040)**	(0.01023)**	(0.01053)**	(0.01053)**
Observations	3,126,002	3,126,002	3,126,002	3,126,002	3,126,002
Pseudo R^2	0.0000	0.0001	0.0002	0.0004	0.0004

Note: Figures in parentheses are robust standard errors.
* Significant at, or below, 5 percent.
** Significant at, or below, 1 percent.

- For the estimate of 0.00249 in column(4),
  $\frac{s}{s+1} = 0.0025 + 0.5122 = 0.5147,$
  $s = \frac{0.5147}{1-0.5147} = \frac{0.5147}{0.4853} \doteq 1.06.$

Further Development

March 10,2007, “Hepatitis B and Sex Ratios at Birth: Fathers or Mothers?", Baruch Blumberg and Emily Oster, working paper.

- Both argument could be correct if it was paternal, not maternal, hepatitis carrier status that drives higher offspring sex ratios.
- We present three pieces of evidence that this may be the case.

April 16, 2008, “Hepatitis B Does Not Explain Male-Biased Sex Ratios in China," Emily Oster, Gang Chen, Xinsen Yu and Wenyao Lin.

- We collected data on the offspring gender for a cohort of 67,000 people in China who are being observed in a prospective cohort study of liver cancer; approximately 15% of these individuals are hepatitis B carriers.
- In this sample, we find no effect of either maternal or paternal hepatitis B carrier status on offspring sex.
- This finding leads us to conclude that hepatitis B cannot explain skewed sex ratios in China.