

Family Size of Women and Children during the Demographic Transition

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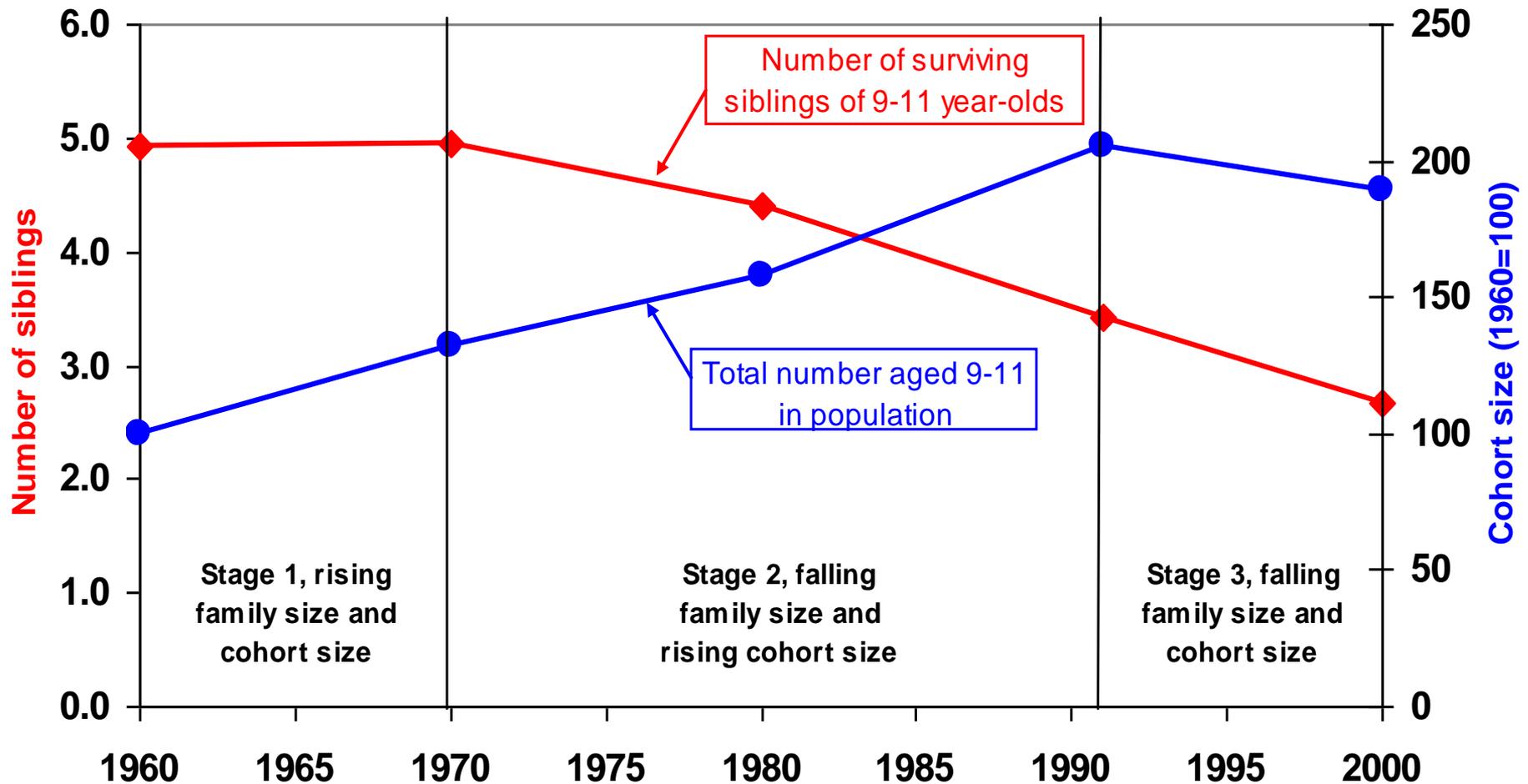
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Family size and cohort size

- This paper is a sequel to a number of papers looking at family size and cohort size during the demographic transition:
- David Lam and Letícia Marteleto, “Stages of the Demographic Transition from a Child’s Perspective: Family Size, Cohort Size, and Children’s Resources,” *Population and Development Review*, June 2008, 34(2): 225-252.
- David Lam, “Economics of Youth Demography in Developing Countries,” in Gudrun Kochendörfer-Lucius and Boris Pleskovic, editors, *Development and the Next Generation*, World Bank, Washington DC, 2007, pp. 27-38.
- David Lam and Letícia Marteleto, “Small Families and Large Cohorts: The Impact of the Demographic Transition on Schooling in Brazil,” in *The Changing Transitions to Adulthood in Developing Countries*, National Academies Press, Washington, DC, 2006, pp. 56-83.
- David Lam, “The Demography of Youth in Developing Countries and its Economic Implications,” World Bank Policy Research Working Paper #4022, October 2006 (background paper for the 2007 World Development Report).

Number of surviving siblings of 9-11-year-olds and total number of 9-11-year-olds in population, Brazilian censuses 1960-2000



David Lam and Letícia Marteleto, "Stages of the Demographic Transition from a Child's Perspective: Family Size, Cohort Size, and Children's Resources," *Population and Development Review*, June 2008.

Purpose of this paper

- How are changes in the family size of children related to changes in fertility during the demographic transition?
- This is important if children are competing for resources with siblings.
- While it may seem obvious that children's family size will fall when fertility declines, they do not need to fall at the same rate or even change in the same direction.
- We expand on Preston (1976) and study a large number of countries during the demographic transition.
- We also look at the inequality in family size, extending Preston's results.

Sam Preston, Family Sizes of Children and Family Sizes of Women," *Demography* 1976

\bar{s}_W = mean family size for women aged 45-49

σ_W = standard deviation of family size for women aged 45-49

\bar{s}_C = mean family size of their children

$$\bar{s}_W = \int_0^n s f_W(s) ds$$

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\bar{s}_W = mean family size for women aged 45-49

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\bar{s}_C = mean family size of their children

$$\bar{s}_C = \bar{s}_W + \left(\frac{\sigma_W^2}{\bar{s}_W} \right) \quad (1)$$

CV_W = coefficient of variation of women's family size (σ_W / \bar{s}_W)

$$\bar{s}_C = \bar{s}_W \left(1 + \frac{\sigma_W^2}{\bar{s}_W^2} \right) = \bar{s}_W (1 + CV_W^2) \quad (2)$$

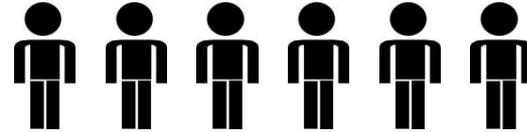
Fertility can decline without a decrease in mean family size for children

Case 1: Before fertility decline

50% of women have 2 children



50% of women have 6 children



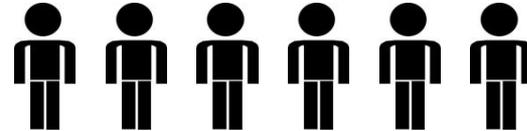
$$\text{Mean family size for women} = 1/2 * 2 + 1/2 * 6 = 4.0$$

$$\text{Mean family size for children} = 2/8 * 2 + 6/8 * 6 = 0.5 + 4.5 = 5.0$$

Case 2: After fertility decline

50% of women have no children

50% of women have 6 children



$$\text{Mean family size for women} = 1/2 * 0 + 1/2 * 6 = 3.0 \quad (\text{decrease of } 1)$$

$$\text{Mean family size for children} = 6.0 \quad (\text{increase of } 1)$$

Implications of Preston's result

$$\bar{s}_C = \bar{s}_W (1 + CV_W^2) \quad (2)$$

- Mean children's family size is always greater than mean women's family size, as long as there is any variance in fertility
- Fertility decline and family size:
 - If CV goes up while mean fertility declines, children's family size will decline more slowly than women's family size
- Comparing subgroups:
 - If a group with higher fertility also has a higher CV, then the difference in family size of children will be larger than the difference in family size of women.

Preston's analysis of U.S. data

- Preston found exactly these two patterns in historical U.S. data for women aged 45-49

Year	Women's mean family size	Children's mean family size	Ratio (2) / (1)	CV for women
	(1)	(2)	(3)	(4)
1890	4.99	7.78	1.56	0.75
1910	4.09	7.17	1.75	0.87
1940	2.66	5.36	2.02	1.01
1950	2.29	4.91	2.14	1.07
1960	2.25	4.41	1.96	0.98
1970	2.71	4.46	1.65	0.81

Women's family size fell 54% from 1890-1950, but children's family size fell only 37%

Due to rising CV

Year	Women's mean family size	Children's mean family size	Ratio (2) / (1)	CV for women
	(1)	(2)	(3)	(4)
1970 White	2.65	4.20	1.58	0.76
1970 Nonwhite	3.16	6.32	2.00	1.00

Nonwhite women had 19% higher family size than white women, but nonwhite children had 50% higher family size than white children

Due to larger CV for nonwhites

Implications for family size during demographic transition

- “These patterns are a disconcerting precedent for those concerned with issues of population quality in less developed countries; the pace of reductions in family size for children can be expected to lag behind that for women in the process of fertility transition” (Preston 1976: 108).
- One purpose of this paper is to test this prediction across a wide range of countries.

We extend Preston's results to look at the standard deviation of children's family size

σ_C = standard deviation of family size for children

σ_W = standard deviation of family size for women

CV_W = coefficient of variation of women's family size (σ_W / \bar{s}_W)

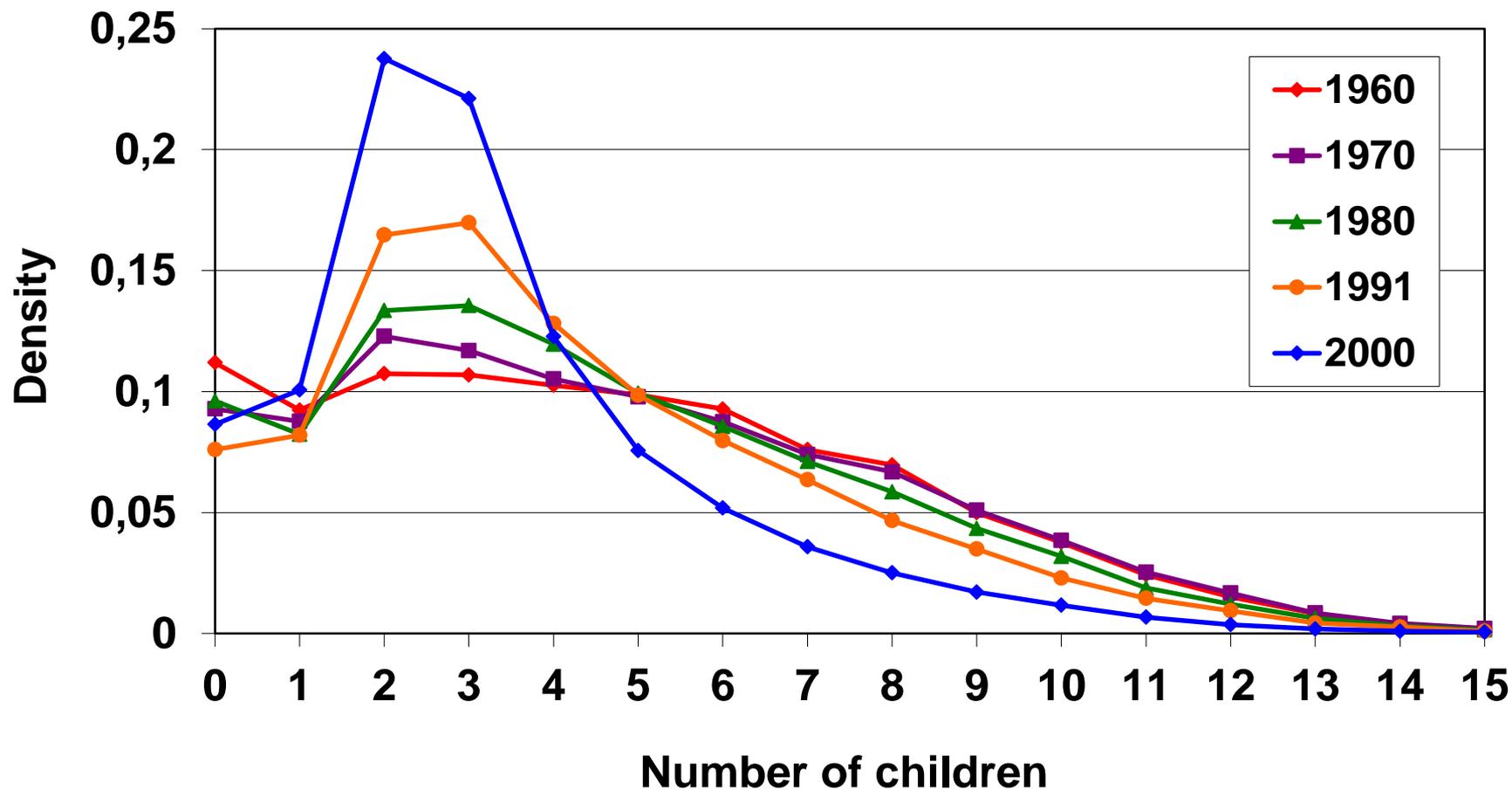
S_W = skewness of family size for women

$$\sigma_C^2 = \sigma_W^2 [1 + CV_W (S_W - CV_W)] \quad (3)$$

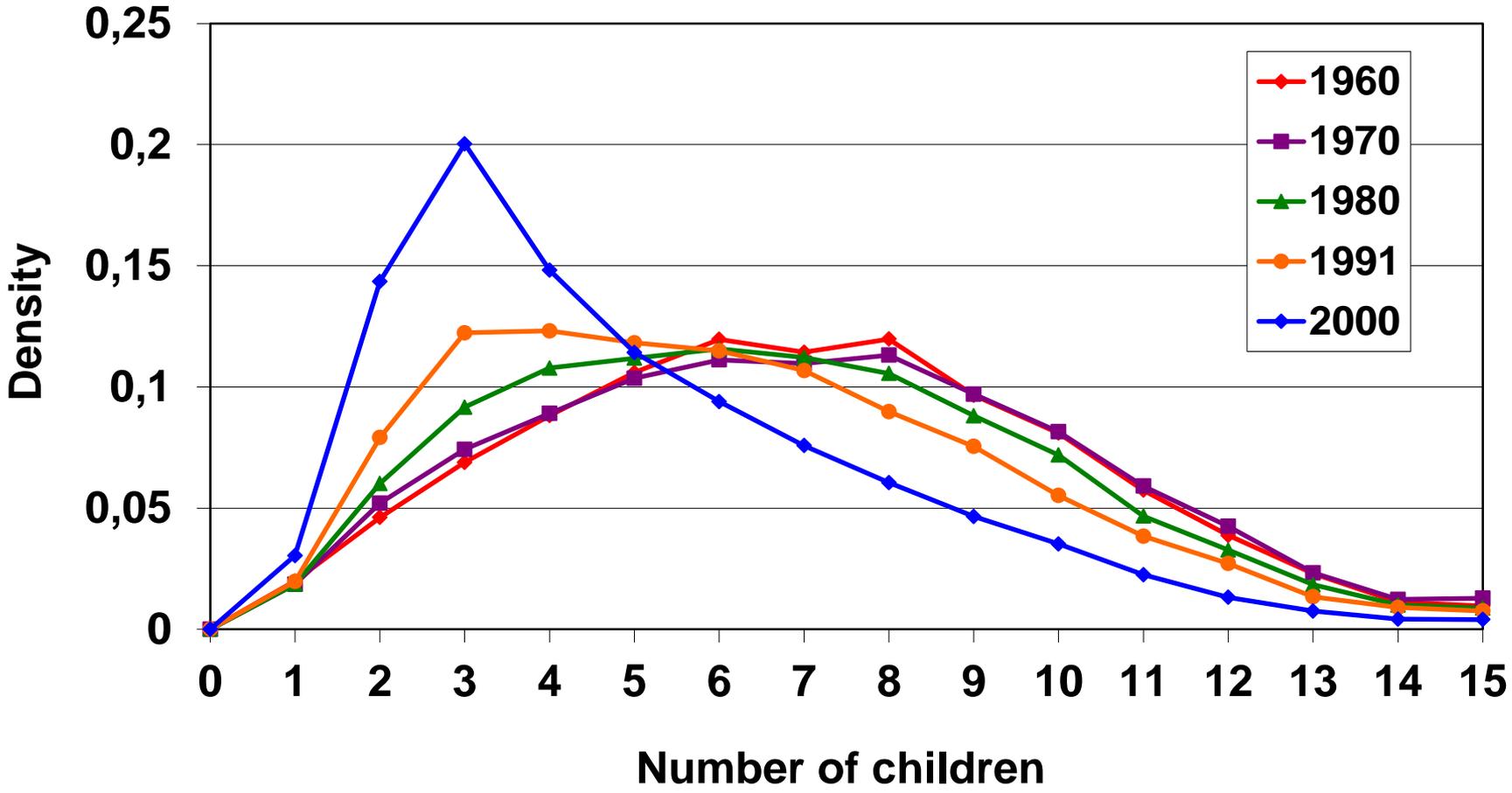
Empirically, skewness is always positive for family size. It is low at high levels of fertility and increases as fertility declines. The term in brackets tends to be less than 1 at high levels of fertility and greater than 1 at low levels of fertility.

Increasing skewness causes children's standard deviation to fall more slowly than women's standard deviation as fertility declines.

Number of children surviving to women aged 45-49, Brazil 1960-2000

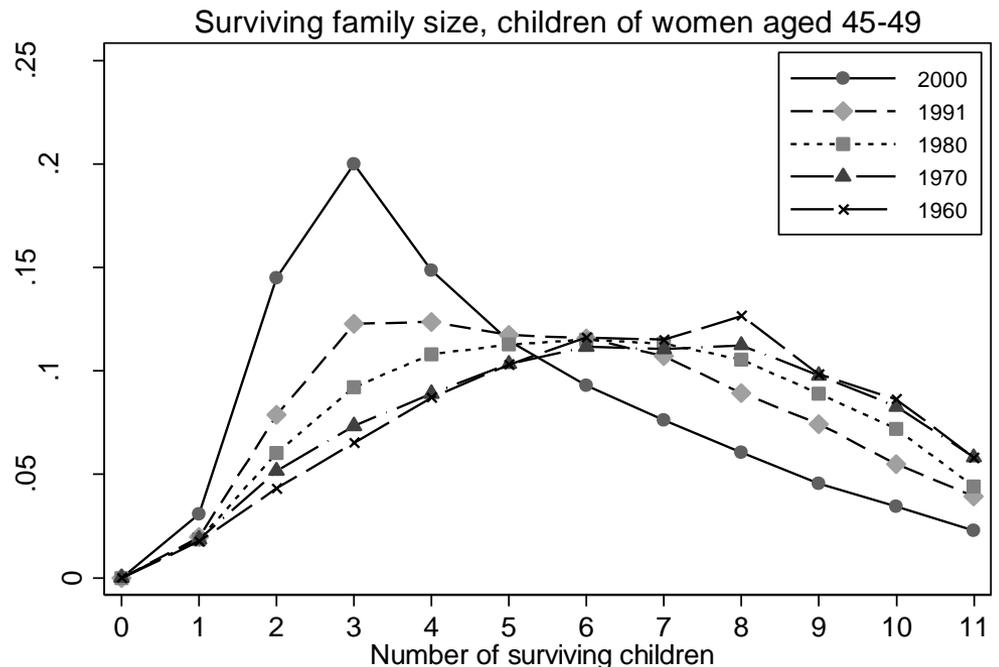
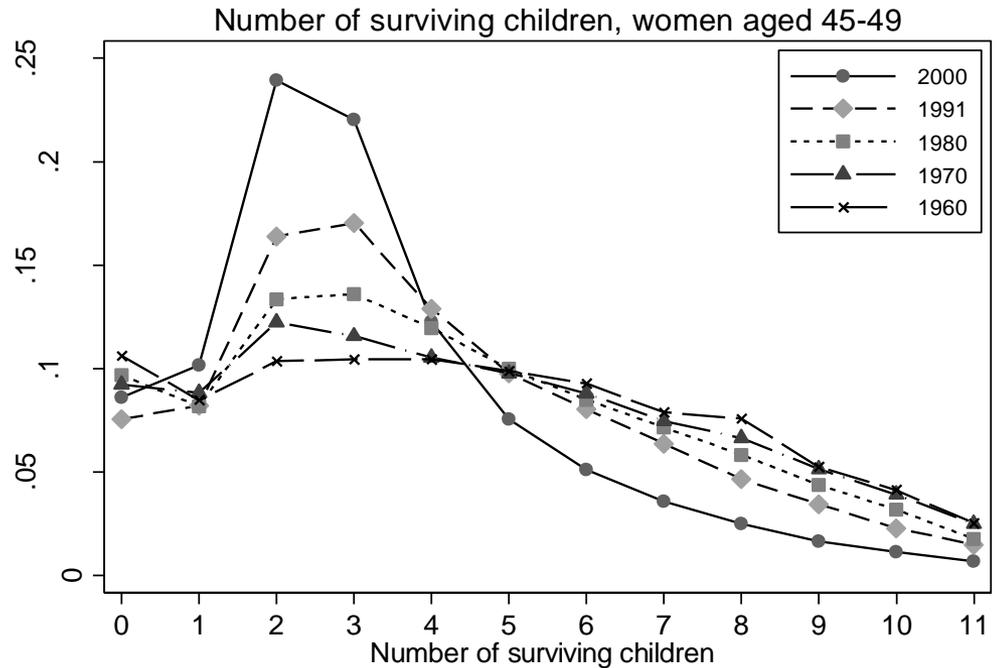


Distribution of family size for children of women aged 45-49, Brazil 1960-2000



Distribution of family size for women aged 45-49 and children of women aged 45-49, Brazil 1960-2000

Note that bottom figure is a reweighted version of the top figure



Family size of school-aged children

- Preston's result applies to women of a given age, say 45-49 – these children will span a broad age range, say 5-30.
- What if we are interested in the family size of school-aged children (say children age 10), tracking how it changes as fertility declines.
- This is a harder problem, since we need to map into a broad age range of potential mothers of 10-year old children
- Note that women with more children are more likely to be represented among the mothers of children of any single age

Family size of school-aged children

- We show empirically that the following is a good approximation for describing the mean family size of ten-year old children:

$$\bar{s}_{C(10)} \approx \bar{s}_{W(25-49)} \left[1 + CV_{W(25-49)}^2 \right] \quad (4)$$

- Women aged 25-49 represent roughly fertility behavior lagged ten years
- As in Preston's result, the family size of school-aged children might fall faster or slower than the family size of women aged 25-49.

Empirical Analysis

- We need micro census or survey data with information on children ever born for a large number of countries over the demographic transition.
- We use IPUMS-International census data and Demographic and Health Surveys (DHS)
- We begin with Brazil, where we have census data from 1960 to 2000.
- We use 94 countries, 273 total data sets.

Table 1. Family size of women aged 45-49 and family size of their children, Brazil 1960-2000

Measure	1960	1970	1980	1991	2000
<i>All Brazil - Children ever born</i>					
Mean children ever born, women 45-49	6.05	5.58	5.23	4.45	3.38
Standard deviation, women's family size	4.57	4.25	3.89	3.41	2.64
Coefficient of variation, women's family size	0.76	0.76	0.74	0.76	0.78
Mean family size for children of women 45-49	9.51	8.81	8.14	7.06	5.44
Ratio, children's family size/women's family size	1.57	1.58	1.55	1.58	1.61

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- Standard deviation of women's family size falls at roughly the same rate as the mean
- Coefficient of variation stays between 0.74 and 0.78 from 1960 to 2000

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- Mean family size for children is equal to mean family size for women times $1+CV^2$

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- Since CV stays around 0.75, mean family size of children is about 1.6 times the mean family size of women in every year.
- Mean family size for children falls at about the same rate as mean family size for women – we do not see the pattern Preston found in the U.S.

Table 1. Family size of women aged 45-49 and family size of their children, Brazil 1960-2000

Measure	1960	1970	1980	1991	2000
<i>All Brazil - Children surviving</i>					
Mean number surviving children, women 45-49	4.48	4.45	4.44	3.89	3.43
Standard deviation, women's family size	3.41	3.36	3.22	2.82	2.16
Coefficient of variation, women's family size	0.76	0.76	0.72	0.73	0.63
Mean family size for children of women 45-49	7.08	6.98	6.77	5.94	4.79
Ratio, children's mean/women's mean	1.58	1.57	1.52	1.53	1.39

- Using surviving children instead of children born, the mean family size of children is still about 1.5-1.6 times the mean family size of women in every year.
- Family size of children falls more between 1991 and 2000 than does family size of women

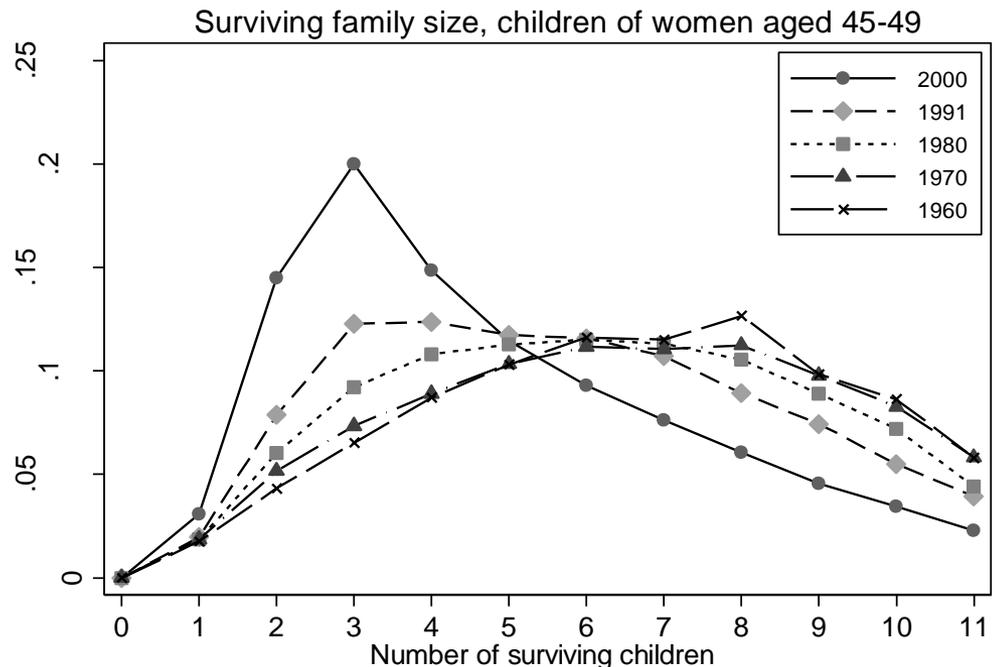
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Standard deviation, women's family size	3.41	3.36	3.22	2.82	2.16
Coefficient of variation, women's family size	0.76	0.76	0.72	0.73	0.63
Skewness, women's family size	0.52	0.62	0.62	0.91	1.56
Mean family size, children of women 45-49	7.08	6.98	6.77	5.94	4.79
Ratio, children's mean/women's mean	1.58	1.57	1.52	1.53	1.39
Standard deviation of children's family size	2.78	3.01	2.98	3.20	3.42
Coefficient of variation of children's family size	0.39	0.43	0.44	0.54	0.71

- While the standard deviation of women's family size falls, the standard deviation of children's family size increases. This is due to increase in skewness in women's family size.

Distribution of family size for women aged 45-49 and children of women aged 45-49, Brazil 1960-2000

Note that bottom figure is a reweighted version of the top figure



Analysis of other countries

- Children ever born: 94 countries, 273 data points
 - 66 countries with at least 2 periods
- Children surviving: 83 countries, 235 data points
 - 56 countries with at least 2 periods
- We focus on surviving family size, since this is most relevant for children's resource allocation
- We generate mean family size for women aged 45-49 and their children

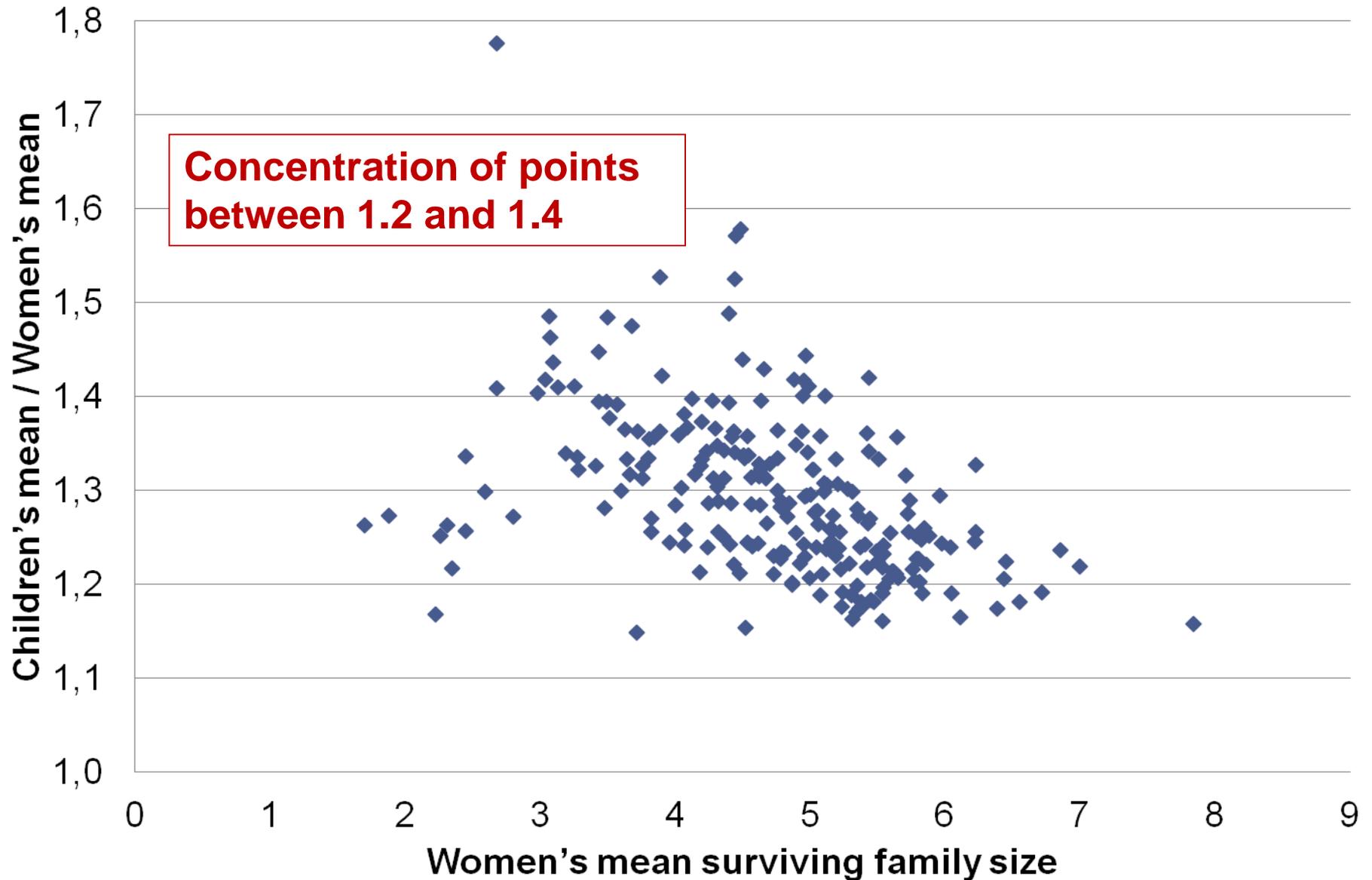
Table 3. Mean and standard deviation of surviving family size for women aged 45-49 and their children

			Mean Family Size			Standard Deviation		
			Women	Children	Ratio	Women	Children	Ratio
Country	Year	Source	(1)	(2)	(3)	(4)	(5)	(6)
Cambodia	1998	IPUMS	4.50	6.02	1.34	2.62	1.91	0.73
Chile	1970	IPUMS	4.40	6.13	1.39	2.76	2.64	0.96
Chile	1982	IPUMS	4.30	5.87	1.37	2.60	3.01	1.16
Chile	1992	IPUMS	3.09	4.44	1.44	2.04	2.48	1.22
Chile	2002	IPUMS	3.80	3.56	1.27	1.46	1.81	1.24
China	1982				1.15	1.77	1.46	0.83
China	1992				1.15	1.43	1.37	0.96
Ecuador	1972				1.27	3.00	2.65	0.88
Ecuador	1982	IPUMS	5.73	7.19	1.26	2.89	2.67	0.92
Ecuador	1987	DHS	5.02	6.63	1.32	2.85	2.36	0.83
Ecuador	1990	IPUMS	5.17	6.58	1.27	2.70	2.65	0.98
Ecuador	2000				1.32	2.34	2.88	1.23
Lesotho	2000				1.24	2.17	1.88	0.87
Liberia	1992				1.31	2.61	1.80	0.69
Liberia	2000				1.22	2.32	1.89	0.81
Madagascar	1992				1.36	3.37	1.81	0.54
Madagascar	1997				1.34	3.18	2.36	0.74
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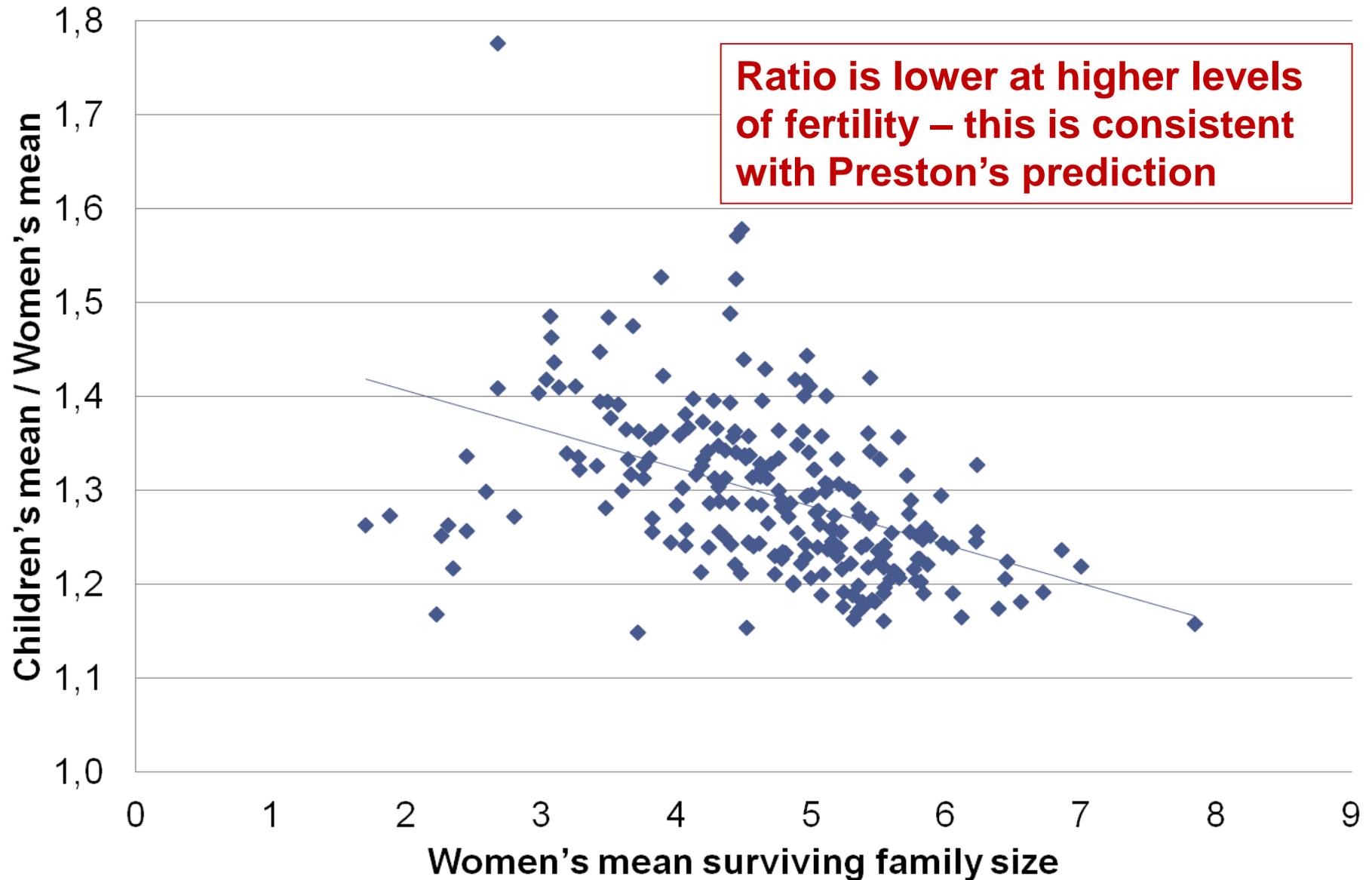
Note narrow range of ratio

We will plot Column 3 against Column 1

Ratio of children's mean family size to women's mean family size, 83 countries using surviving family size



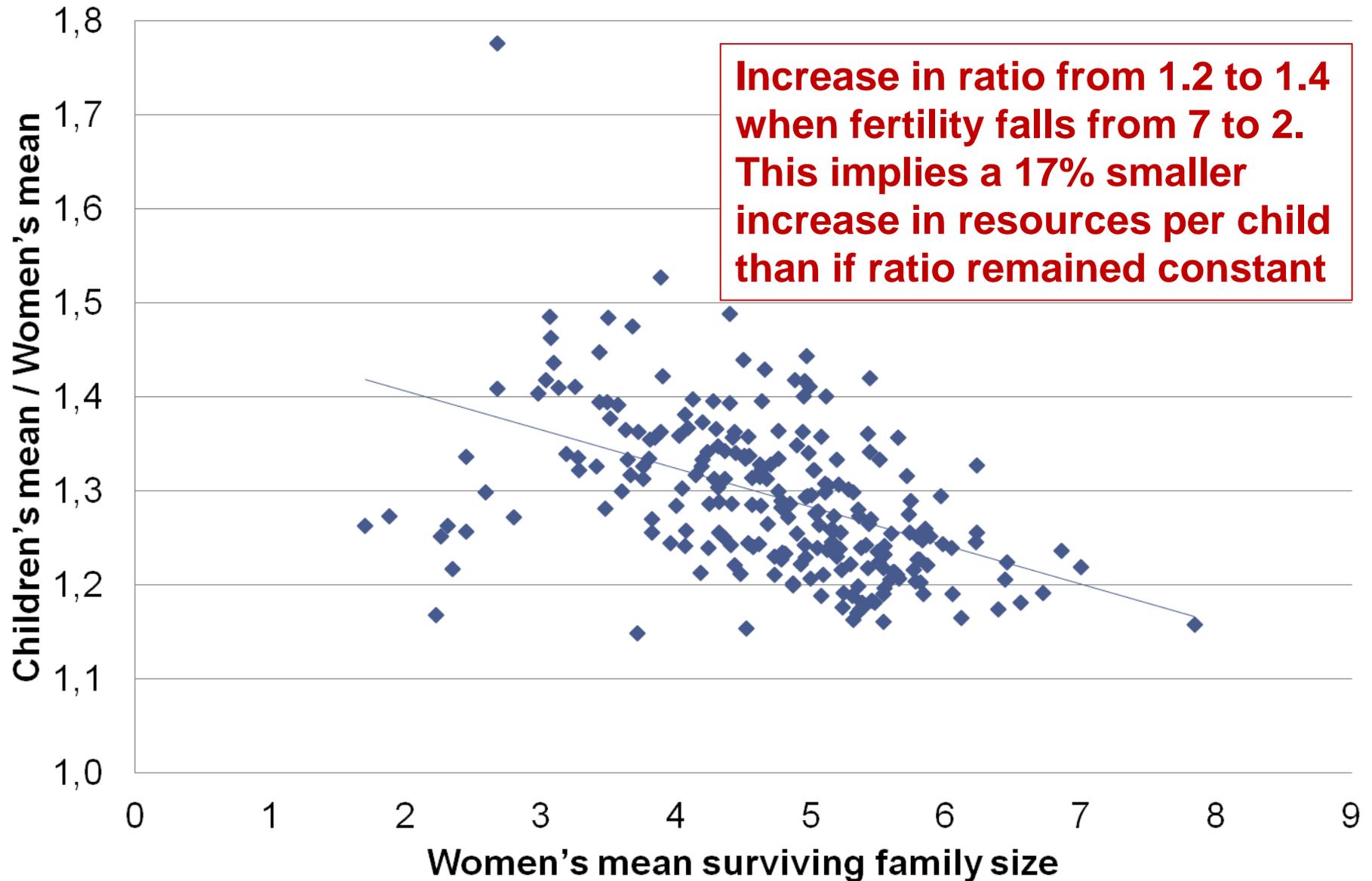
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Implications

- Suppose some fixed resource, like mother's time, is divided by the number of children.
- Suppose women's family size falls from 8 to 2.
- If children's family size also fell to $1/4$ its original size, then resources per child would go up 4 times.
- Alternatively, suppose the ratio of children's family size to women's size increases from 1.2 to 1.5 (children's family size falls from 9.6 to 3.0).
- Resources per child increase by 3.2 times instead of 4 times. The increase is 20% smaller than it would have been if children's family size had fallen as fast as women's family size.

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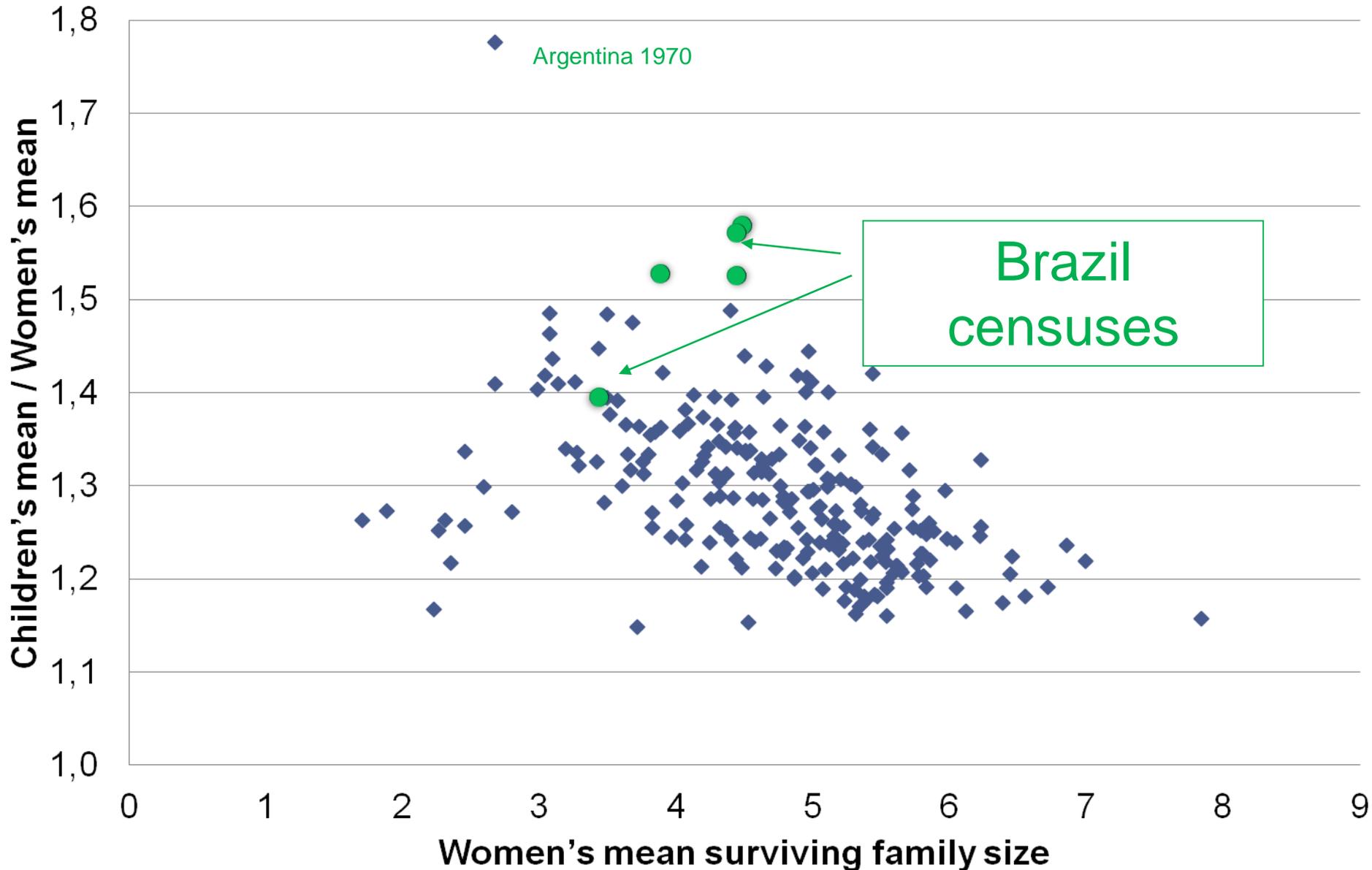


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Look at standard deviations

Table 3. Mean and standard deviation of surviving family size for women aged 45-49 and their children

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Ecuador	1987	DHS	5.02	6.63	1.32	2.85	2.36	0.83
Ecuador	1990	IPUMS	5.17	6.58	1.27	2.70	2.65	0.98
Ecuador	2001	IPUMS	4.15	5.47	1.32	2.34	2.88	1.23
Lesotho	2004	DHS	4.40	5.47	1.24	2.17	1.88	0.87
Liberia	1986	DHS	4.67	6.14	1.31	2.61	1.80	0.69
Liberia	2007	DHS	4.93	6.02	1.22	2.32	1.89	0.81
Madagascar	1992	DHS	5.65	7.66	1.36	3.37	1.81	0.54
Madagascar	1997	DHS	5.44	7.29	1.34	3.18	2.36	0.74
Madagascar	2003	DHS	4.64	6.47	1.40	2.92	2.26	0.77
Malawi	1992	DHS	4.81	5.93	1.23	2.32	1.82	0.78
Malawi	2000	DHS	4.89	6.14	1.25	2.47	1.72	0.70

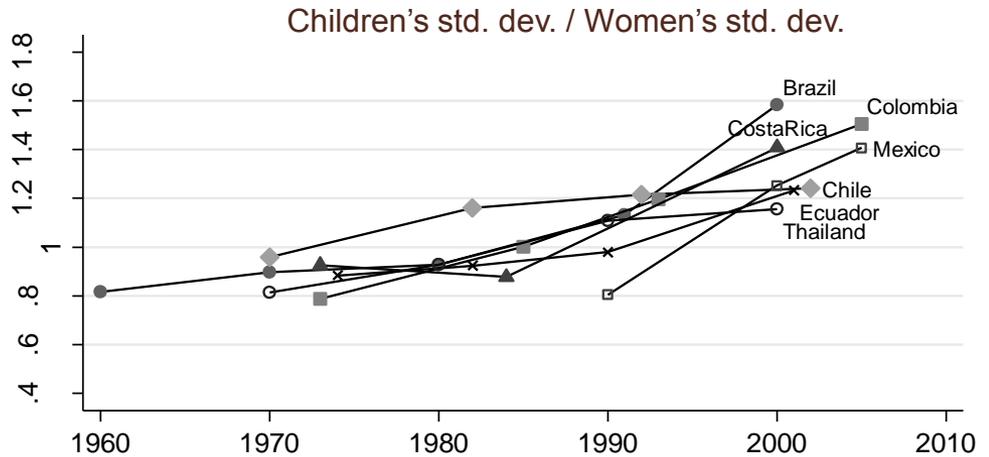
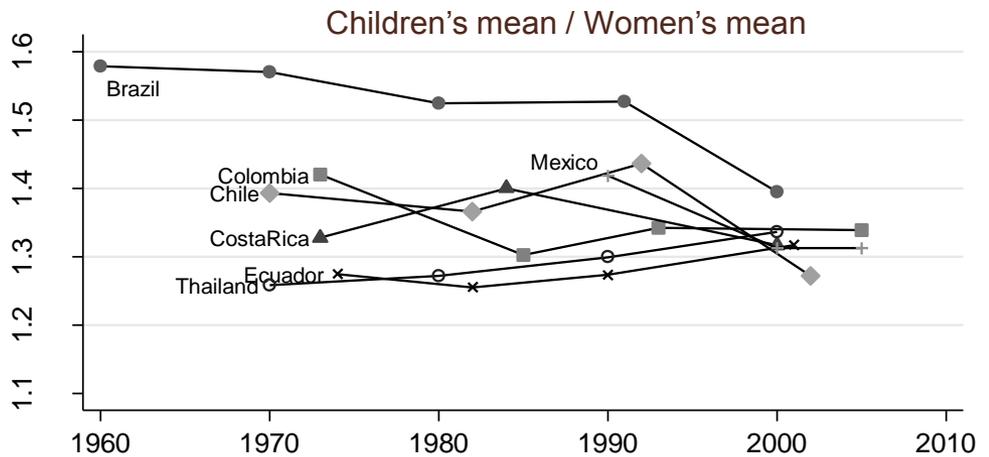
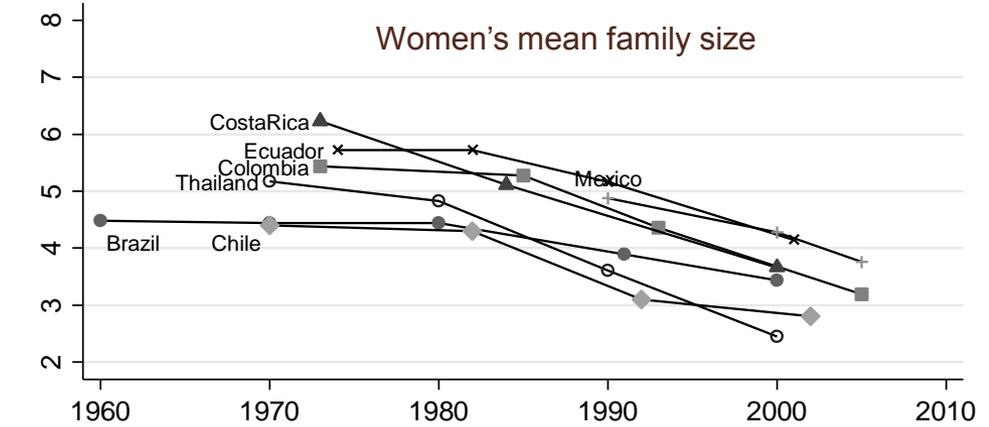
**We will graph
Column 6 against
Column 1**

Surviving family size of women age 45-49 and their children over time

Tracking countries over time

Low-income countries

IPUMS-I

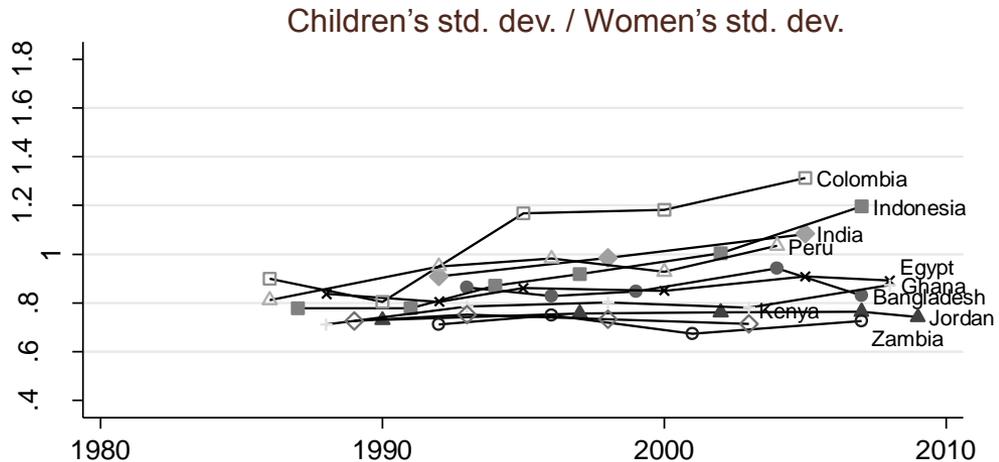
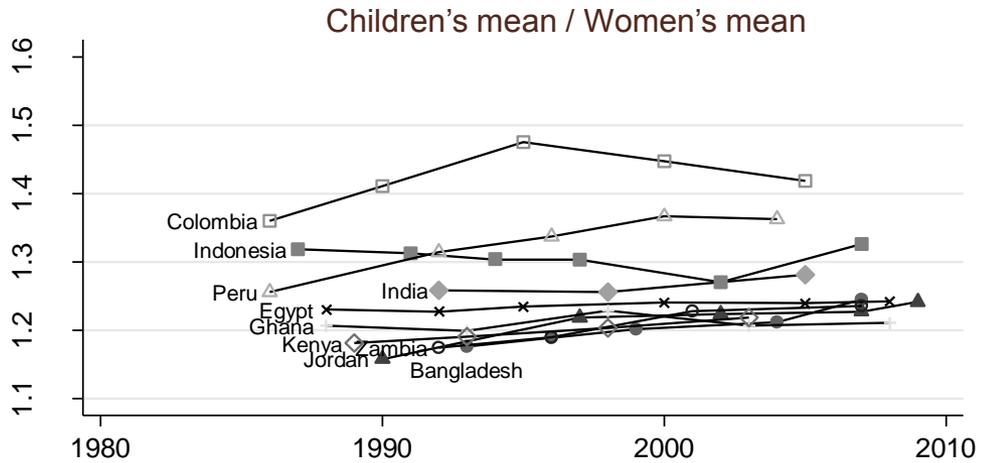
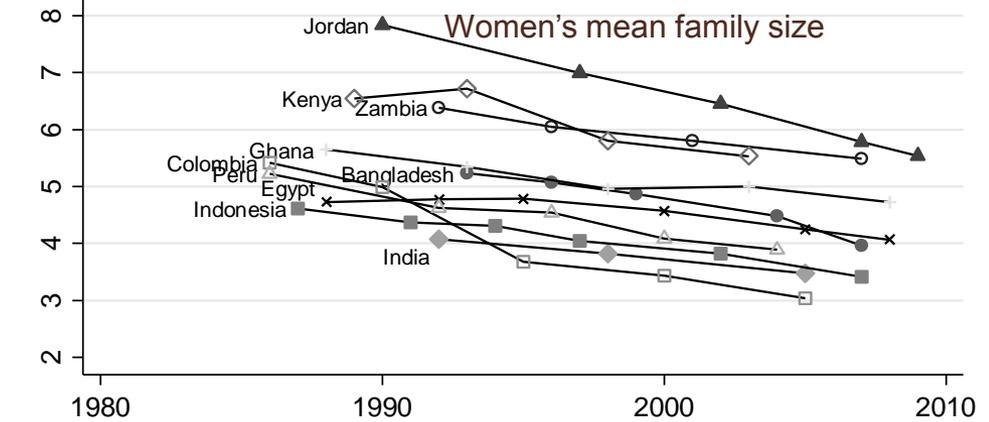


Surviving family size of women age 45-49 and their children over time

Tracking countries over time

Low-income countries

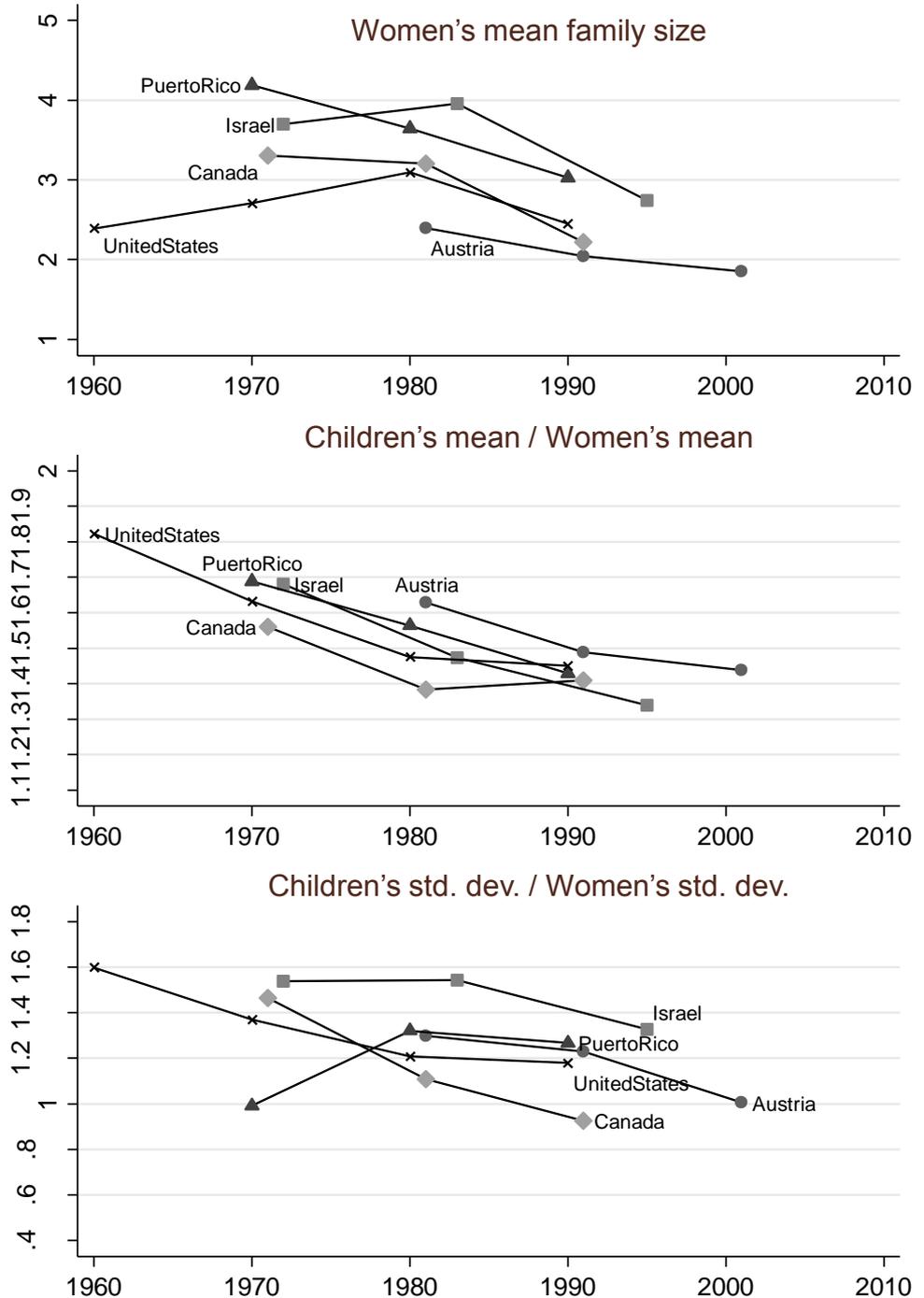
DHS



Family size of women age 45-49 and their children over time using CEB

High-income countries

IPUMS-I



Analysis from perspective of children age 9-11

- Mean family size of children of women aged 25-49 is very similar to mean family size of children aged 9-11
- Standard deviation is also similar (not shown)
- Children aged 9-11 are representative of all children born to women aged 25-49
- Equation 4 is good approximation

Table 3. Mean and standard deviation of surviving family size for women aged 25-49 and children aged 9-11

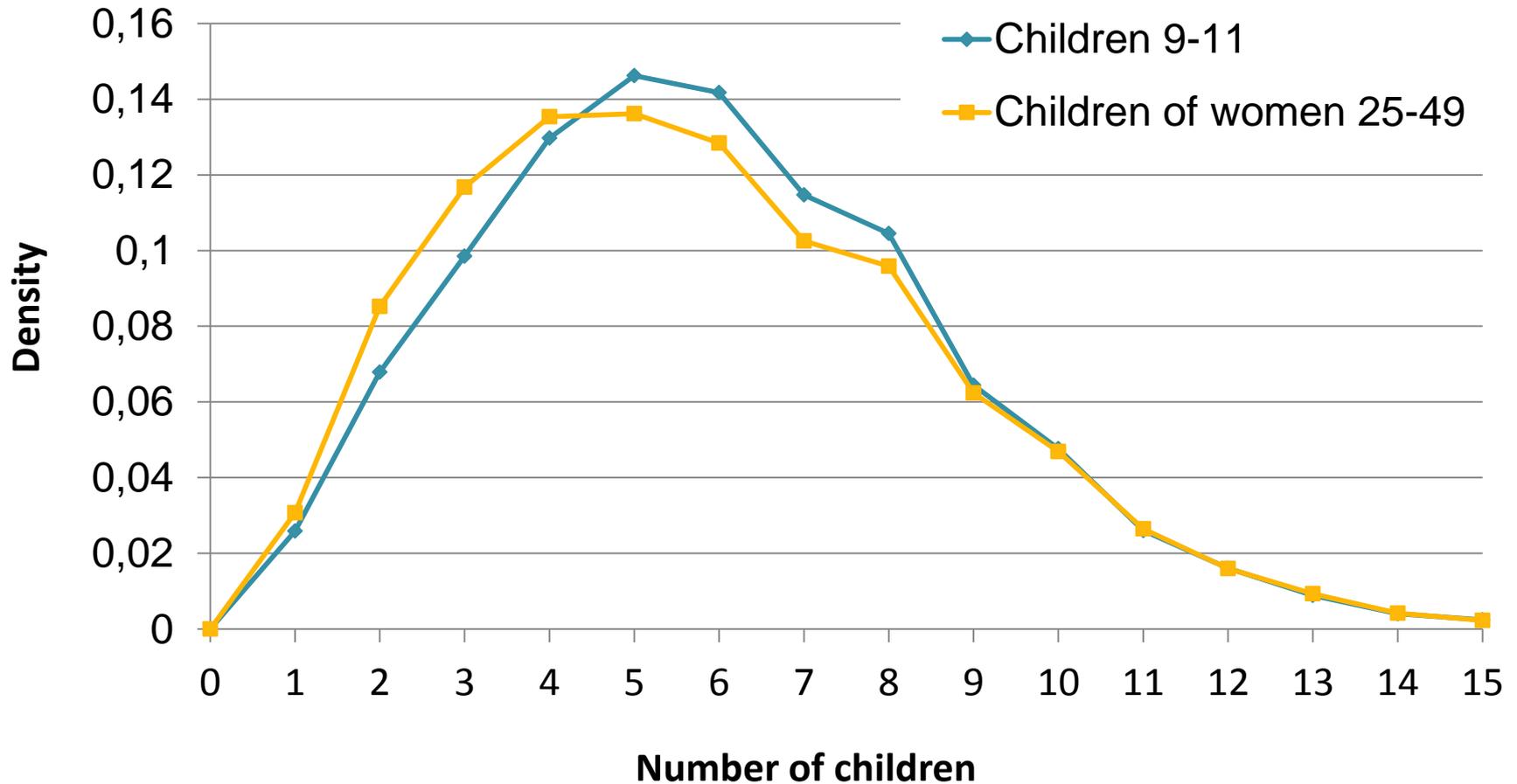
		Mean Family Size			
		Women age 25-49	Children age 9-11	Children of women 25-49	Ratio (3)/(1)
Country	Year	(1)	(2)	(3)	(4)
Brazil	1960	3.37	5.90	5.80	1.72
Brazil	1970	3.51	5.94	5.87	1.67
Brazil	1980	3.16	5.52	5.47	1.73
Brazil	1991	3.45	4.32	5.52	1.60
Brazil	2000	2.70	3.63	3.77	1.40
CostaRica	1973	4.80	6.72	6.72	1.40
CostaRica	1984	3.23	4.82	5.09	1.58
CostaRica	2000	2.95	3.77	3.93	1.33
Kenya	1989	4.65	6.15	6.29	1.35
Kenya	1999	3.95	5.43	5.74	1.45
Mexico	1990	3.23	4.89	5.23	1.62
Mexico	2000	3.17	4.17	4.32	1.36
SouthAfrica	1996	2.55	3.81	3.92	1.54
SouthAfrica	2001	2.36	3.50	3.70	1.57
SouthAfrica	2007	2.20	3.32	3.72	1.69
Thailand	1970	4.23	5.62	5.47	1.29
Thailand	1980	3.57	4.89	4.94	1.38
Thailand	1990	2.51	3.31	3.53	1.41
Thailand	2000	1.93	2.44	2.64	1.36
Uganda	1991	4.35	5.64	5.70	1.31
Uganda	2002	4.42	5.64	5.95	1.35
Venezuela	1990	3.01	4.59	4.87	1.62
Venezuela	2001	3.04	3.87	4.23	1.39

Family size of school-aged children

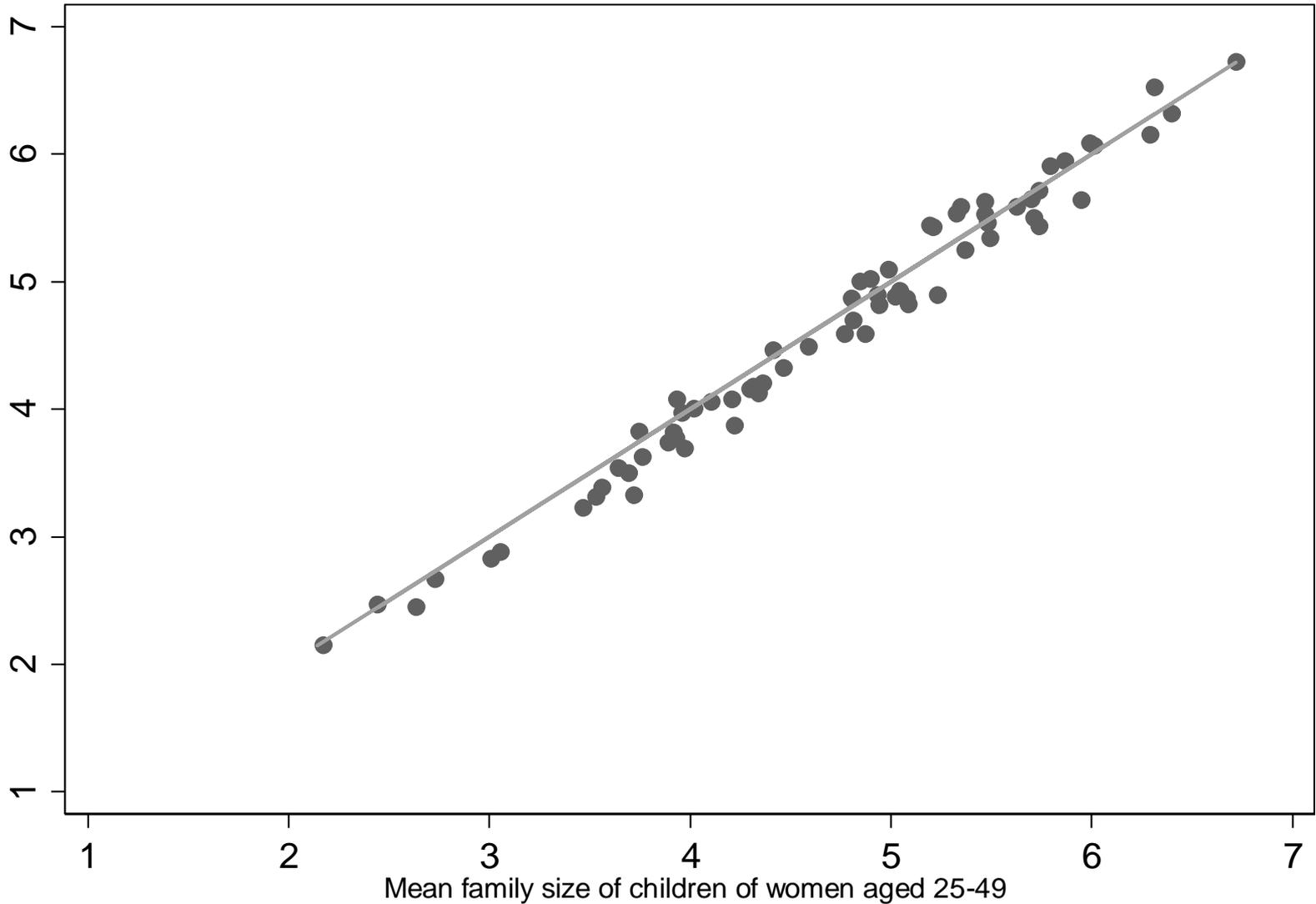
- We show empirically that the following is a good approximation for describing the mean family size of ten-year old children:

$$\bar{s}_{C(10)} \approx \bar{s}_{W(25-49)} \left[1 + CV_{W(25-49)}^2 \right] \quad (4)$$

Family size of children aged 9-11 and children of women aged 25-49, Brazil 1960



Family size of children aged 9-11 and children of women aged 25-49



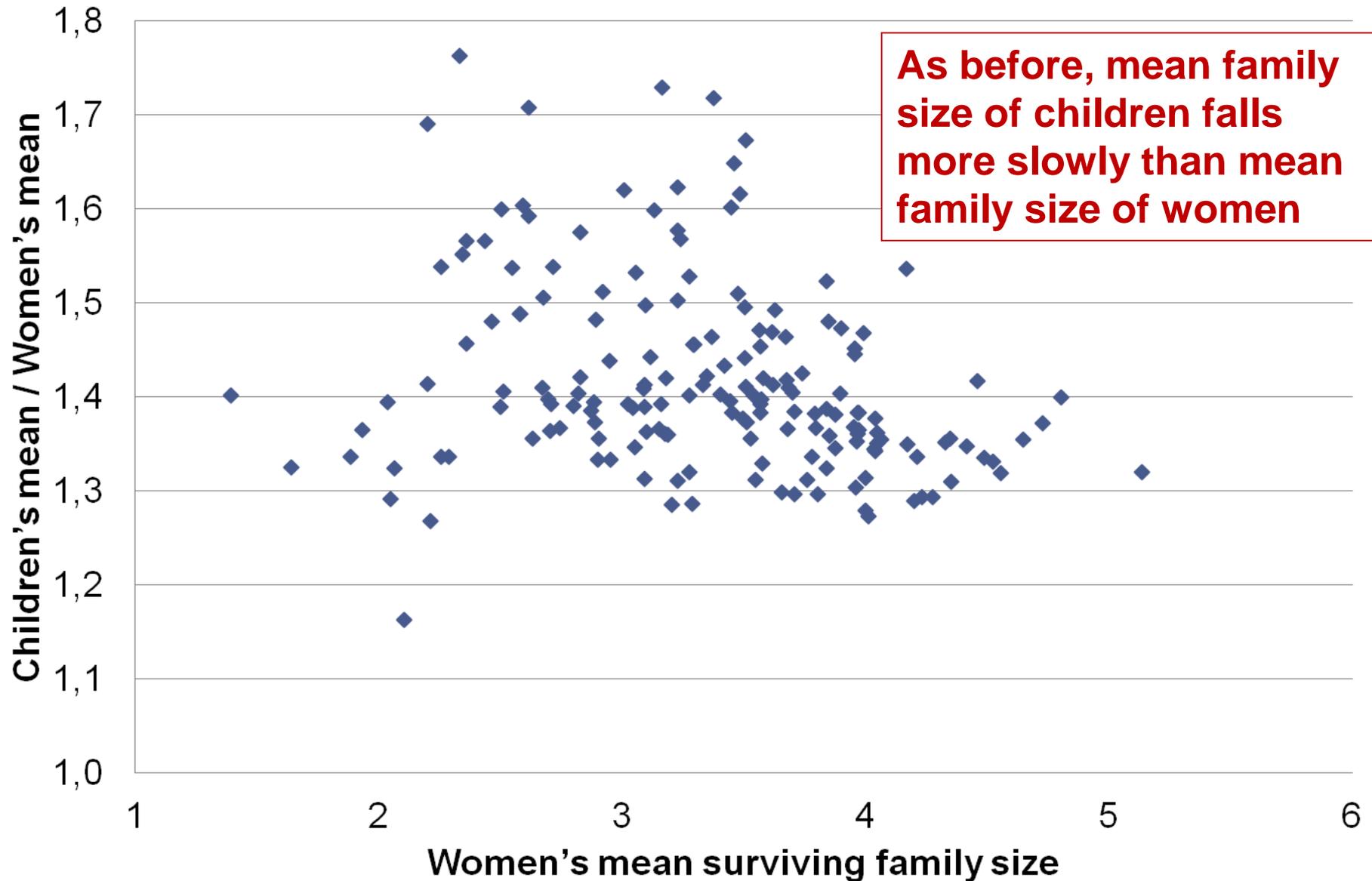
Analysis from perspective of children aged 9-11

- Given approximation in Equation 4, we look at ratio of family size of children aged 9-11 to family size of women aged 25-49
- Once again, the ratio is in range of 1.3-1.7

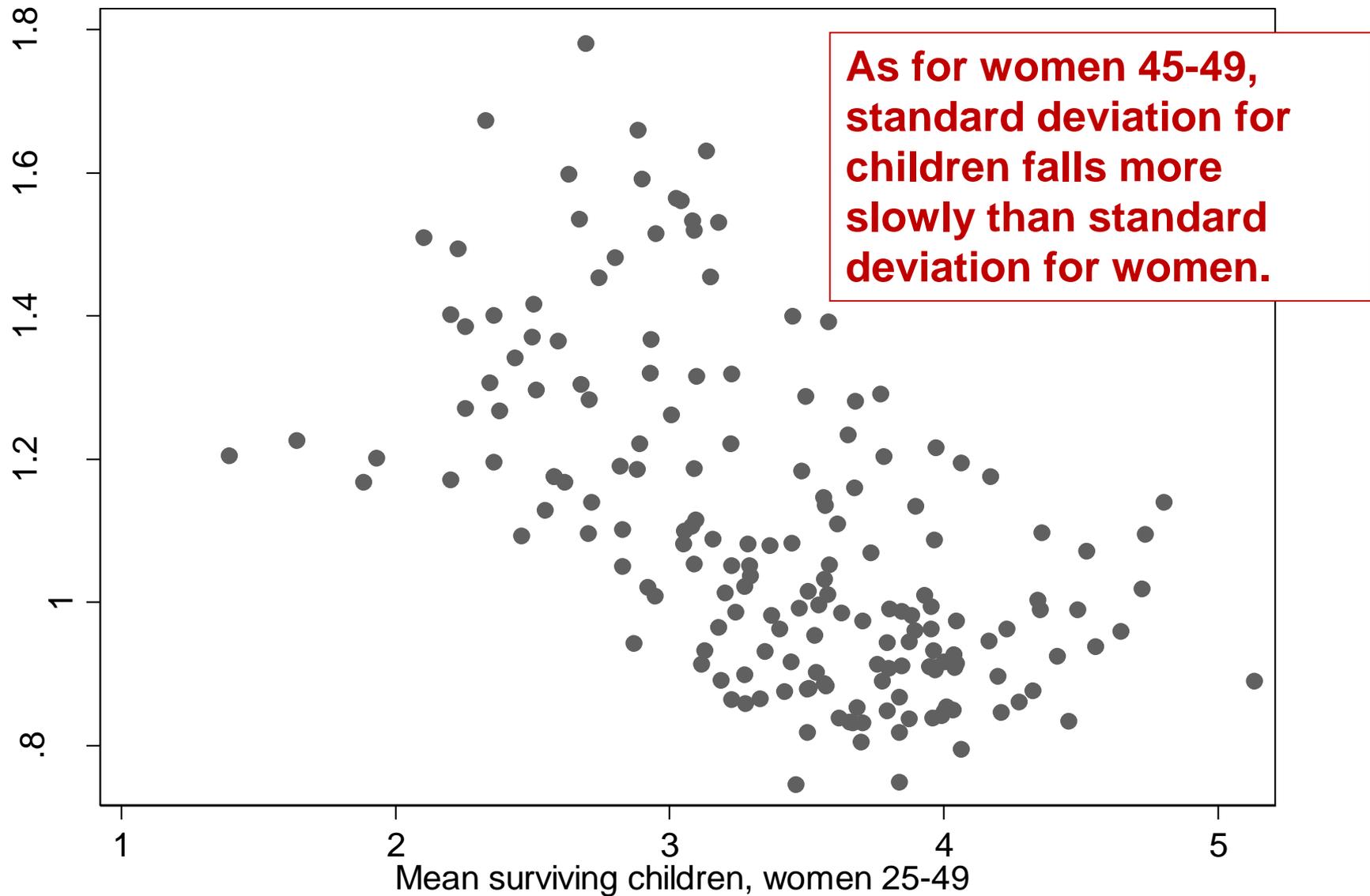
Table 3. Mean and standard deviation of surviving family size for women aged 25-49 and children aged 9-11

		Mean Family Size			
		Women age 25-49	Children age 9-11	Children of women 25-49	Ratio (3)/(1)
Country	Year	(1)	(2)	(3)	(4)
Brazil	1960	3.37	5.90	5.80	1.72
Brazil	1970	3.51	5.94	5.87	1.67
Brazil	1980	3.16	5.52	5.47	1.73
Brazil	1991	3.45	4.32	5.52	1.60
Brazil	2000	2.70	3.63	3.77	1.40
CostaRica	1973	4.80	6.72	6.72	1.40
CostaRica	1984	3.23	4.82	5.09	1.58
CostaRica	2000	2.95	3.77	3.93	1.33
Kenya	1989	4.65	6.15	6.29	1.35
Kenya	1999	3.95	5.43	5.74	1.45
Mexico	1990	3.23	4.89	5.23	1.62
Mexico	2000	3.17	4.17	4.32	1.36
SouthAfrica	1996	2.55	3.81	3.92	1.54
SouthAfrica	2001	2.36	3.50	3.70	1.57
SouthAfrica	2007	2.20	3.32	3.72	1.69
Thailand	1970	4.23	5.62	5.47	1.29
Thailand	1980	3.57	4.89	4.94	1.38
Thailand	1990	2.51	3.31	3.53	1.41
Thailand	2000	1.93	2.44	2.64	1.36
Uganda	1991	4.35	5.64	5.70	1.31
Uganda	2002	4.42	5.64	5.95	1.35
Venezuela	1990	3.01	4.59	4.87	1.62
Venezuela	2001	3.04	3.87	4.23	1.39

Ratio of children's mean family size to women's mean family size, women age 25-49 and their children



Ratio of children's standard deviation to women's standard deviation, women age 25-49



Inequality in children's family size

- Women's standard deviation falls at roughly the same rate as the mean
- Children's mean falls almost as fast as women's mean
- But children's standard deviation falls much more slowly – it tends to stay roughly constant due to increase in skewness in women's family size
- These imply that the coefficient of variation in children's family size must increase as mean family size declines
- In general there is a substantial increase in inequality in children's family size as mean family size declines

Cumulative distribution of family size for women aged 25-49 and children aged 9-11, Brazil, Ecuador, and Costa Rica

Large families are much more common for children than for women.

Figure 3. Distribution of family size, women 25-49 and children 9-11

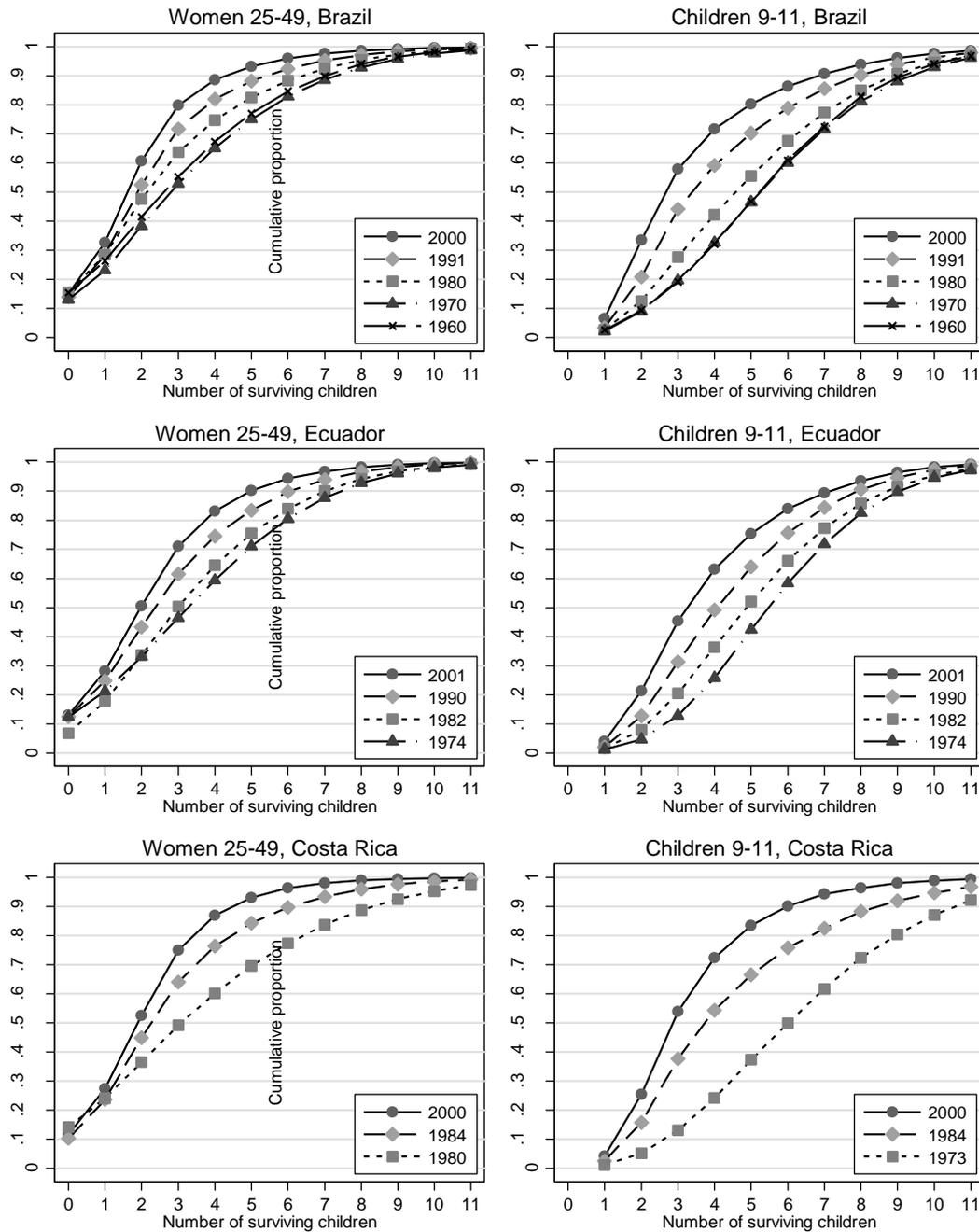
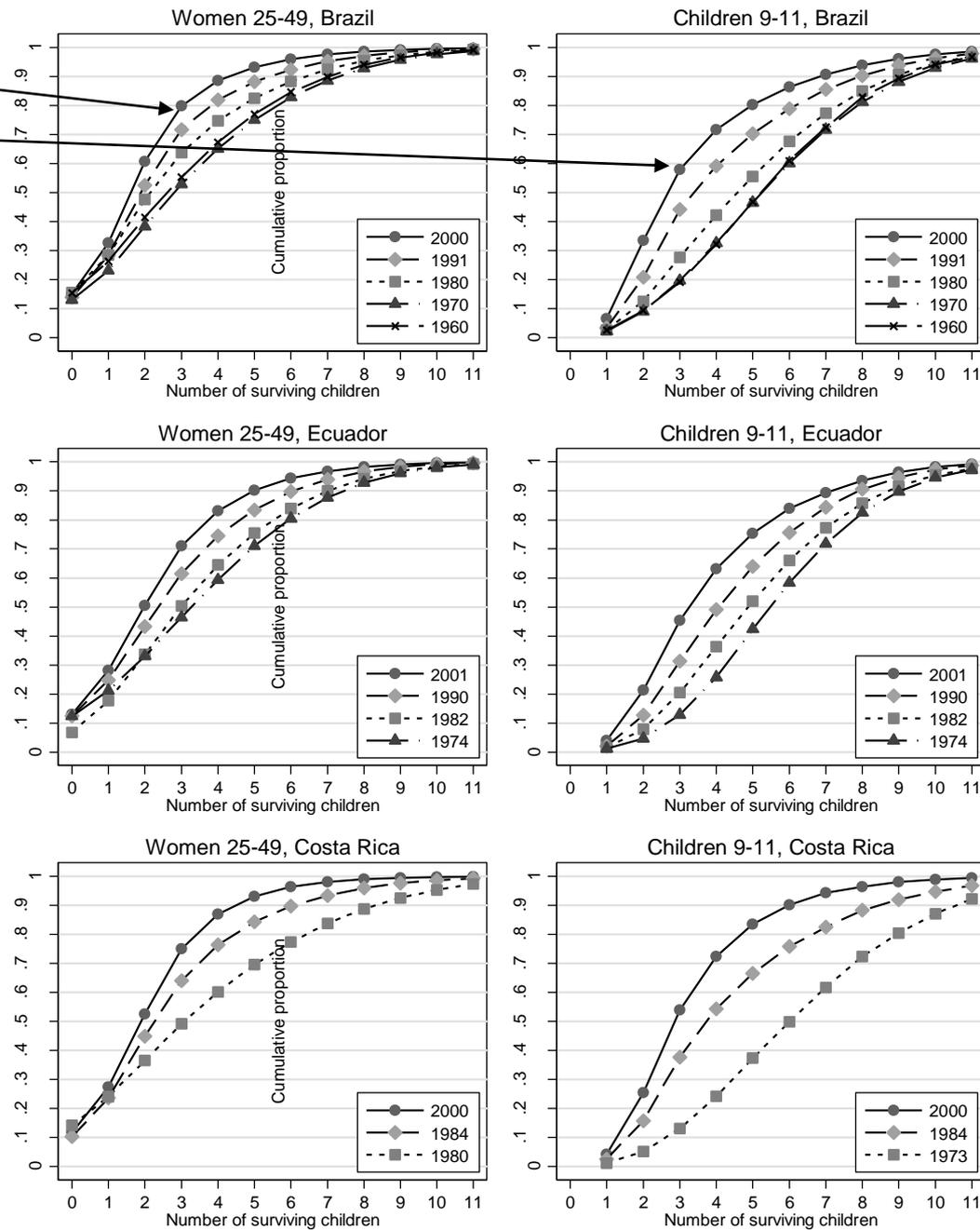
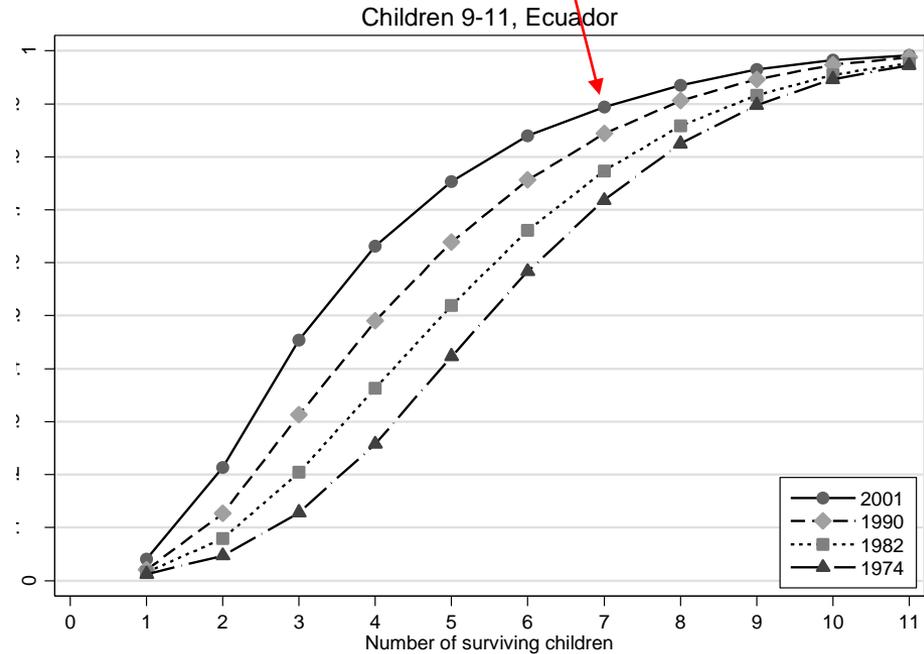
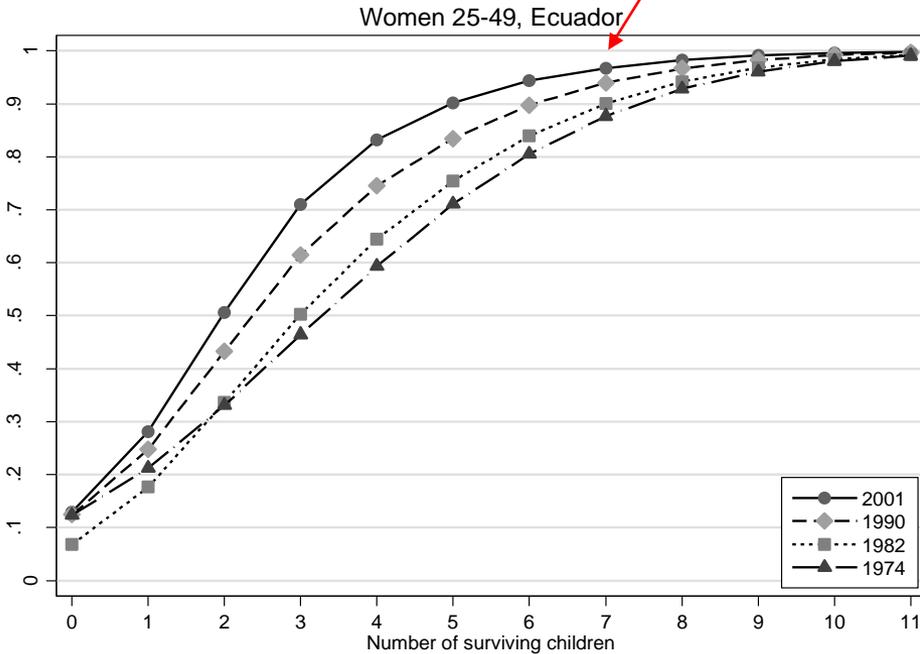


Figure 3. Distribution of family size, women 25-49 and children 9-11

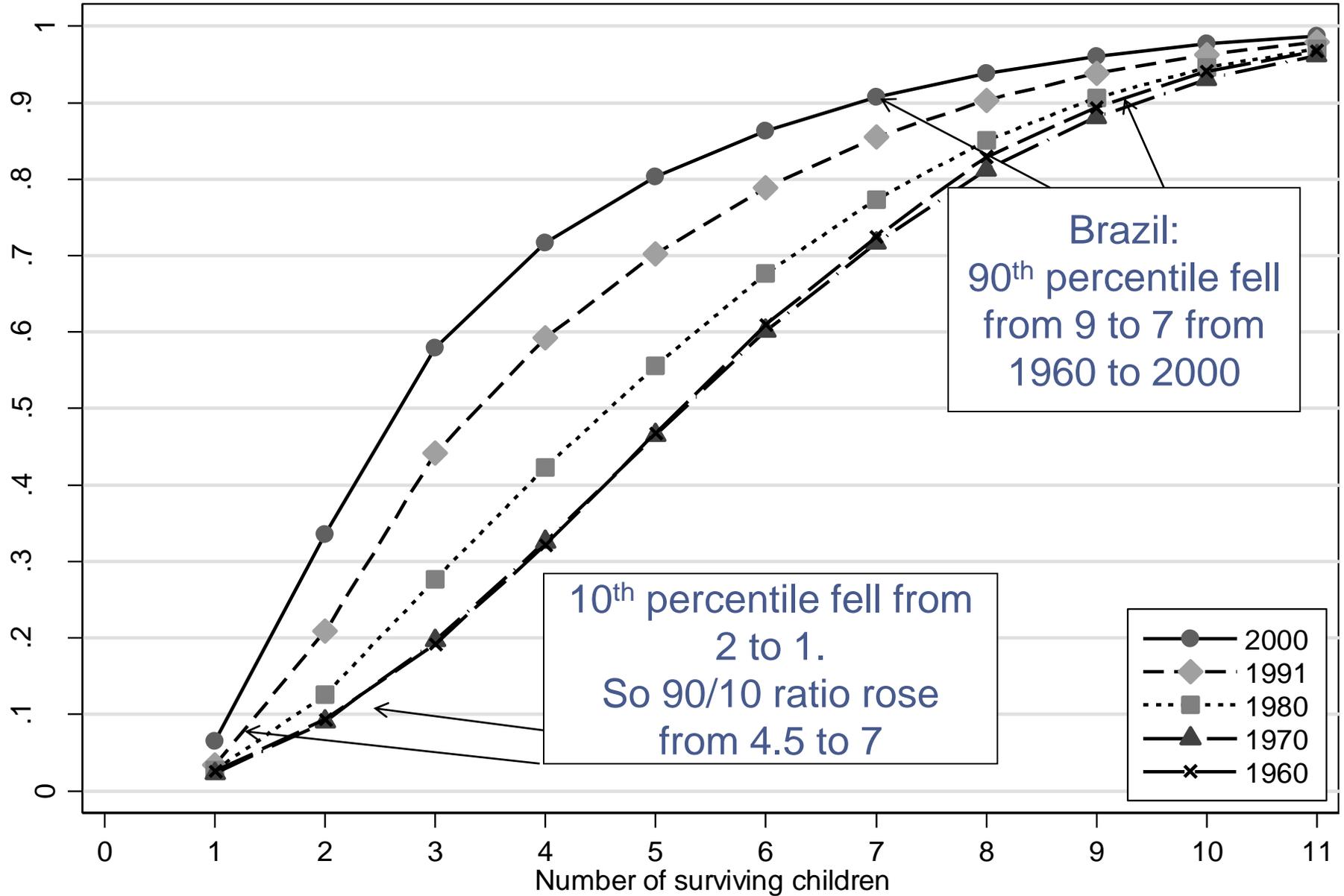
In Brazil 80% of women aged 25-49 had less than four surviving children in 2000;
 Only 58% of children were in families with less than four surviving children in 2000, similar to the proportion for women in 1960.



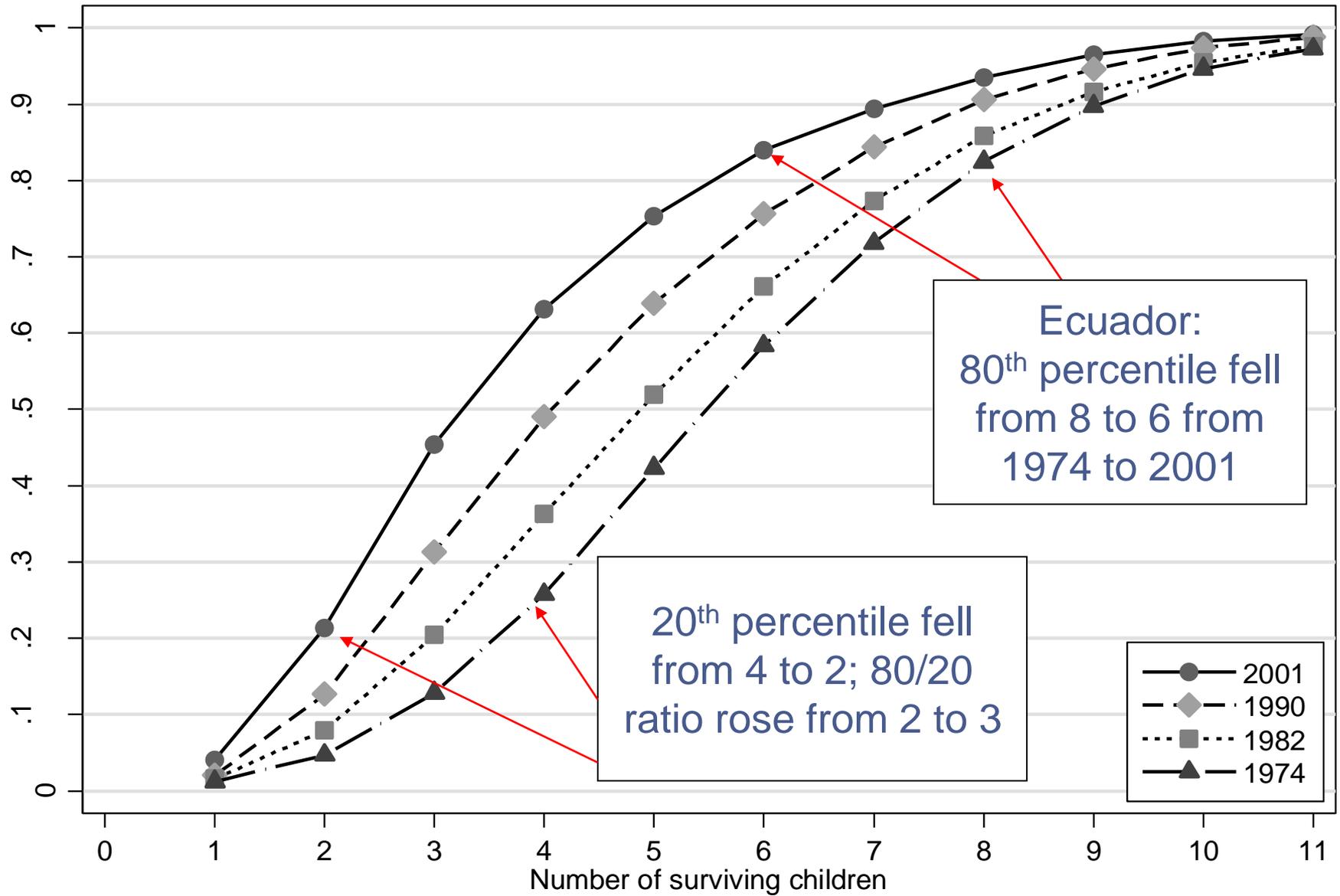
In Ecuador in 2001 only 3.2% of women were in a family with 8 or more children, but 10.6% of children were in a family with 8 or more surviving children.



Children 9-11, Brazil



Children 9-11, Ecuador



Conclusions

- Mean family size of children tends to fall more slowly than mean family size of women for the cases we analyze (with exceptions)
- Standard deviation in children's family size is lower than standard deviation in women's family size at high levels of fertility, even though children have a higher mean.
- Standard deviation in children's family size falls more slowly than standard deviation in women's family size, and may even increase.
- There is roughly a 20% smaller increase in resources per child during the demographic transition than would be implied by fertility decline alone.
- Inequality in children's family size tends to increase with the decline in mean family size.