Too Many Men, Too-Short Lives:
The Effect of the Male-Biased Sex Ratio on Mortality

by

Simon Chang[1], Kamhon Kan[2], and Xiaobo Zhang[3]

Abstract

Using a natural experiment in Taiwan, this paper shows that, for men, exposure to male-biased sex ratios at a marriageable age is associated with a greater likelihood of death in later life. In the late 1940s, over half a million soldiers from mainland China retreated to Taiwan after a civil war and were initially subjected to a marriage ban. When the ban was lifted in 1959, the great influx of mostly male soldiers into the marriage market suddenly tipped the balance in favor of women. We have found that men subjected to this massive marriage market squeeze exhibited higher mortality rates at ages 50–64. We offer several possible explanations. Surprisingly, an elevated mortality rate, albeit of a much smaller magnitude, was also observed among the women of the relevant age groups. We show that this is likely driven by the widowhood effect—women's mortality rate increased after their husbands' deaths.

Keywords: Sex Ratio, Mortality, Marriage Market, Widowhood Effect

JEL Codes: I1, J1

[1] Simon Chang is a senior lecturer at the University of Western Australia, a research fellow at Institute of Labor Economics (IZA) and a fellow at Global Labor Organization (GLO).
[2] Kamhon Kan is a research fellow at the Institute of Economics, Academia Sinica.
[3] Corresponding author: Xiaobo Zhang is a chair professor at Peking University and senior research fellow at the International Food Policy Research Institute (IFPRI). x.zhang@gsm.pku.edu.cn

Appendix 1. Imputing the Sex Ratios

We followed the method proposed by Chang (2013) to impute the sex ratios in the marriage market. We briefly describe the method below. Readers interested in more details should reference Chang (2013) directly.

The main difficulty in calculating the sex ratios using the household registration data is that military personnel, mostly men, was excluded until an executive order was issued in November 1968 requiring all military personnel to be included in the household registration system. In other words, the soldiers who followed Chiang Kai-shek to Taiwan were not included in the data until 1969, leading to a downward bias in the sex ratios before 1969.

To correct the bias, we first calculated the increases in the male population in the household registration data between 1968 and 1970 for each age group and county, based on the assumption that all military personnel was registered in this period. The second step was adding the increases in men back to the corresponding age-county cells for the years before 1969 with an adjustment for age-sex-specific mortality rates.

Appendix 2. Tables and Figures

Table A1. Estimates of the Sex-Ratio Effect on Mortality Rates

	Ordinary Least Squares (OLS)				Two-Stage Least Squares (2SLS)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Men	Women	Men	Women	Men	Women	Men	Women
Sex Ratio at Age	Age 30	Age 30	Age 35	Age 35	Age 30	Age 30	Age 35	Age 35
	Panel A: Mortality Rate at Age 50–54							
Sex ratio	0.041***	0.012**	0.034***	0.012**	0.081***	0.049***	0.082***	0.054***
	(0.009)	(0.005)	(0.009)	(0.004)	(0.021)	(0.011)	(0.019)	(0.013)
	Panel B: Mortality Rate at Age 55–59							
Sex ratio	0.058***	0.017*	0.051***	0.015*	0.106***	0.055***	0.116***	0.058***
	(0.014)	(0.008)	(0.015)	(0.008)	(0.024)	(0.017)	(0.020)	(0.018)
	Panel C: Mortality Rate at Age 60–64							
Sex ratio	0.081***	0.021**	0.071***	0.022**	0.102**	0.062***	0.114***	0.072***
	(0.020)	(0.008)	(0.019)	(0.009)	(0.041)	(0.014)	(0.037)	(0.015)
	Panel D: Mortality Rate at Age 50–64							
Sex ratio	0.157***	0.047**	0.135***	0.046**	0.254***	0.156***	0.274***	0.175***
	(0.034)	(0.018)	(0.035)	(0.018)	(0.066)	(0.035)	(0.058)	(0.040)
Kleibergen-Paap F					49.62	50.57	53.28	55
Observations	400	400	400	400	400	400	400	400

Note: The dependent variables are mortality rates at the county-cohort level at ages 50–54 (panel A), 55–59 (panel B), 60–64 (panel C), and 50–64 (panel D). The instrumental variable is the log of mainland Chinese men interacted with the gender differential in the estimated global mortality rate at age 20 when each cohort turned 20. The sample includes birth cohorts between 1931 and 1950 across 20 counties. All estimates were obtained from separate regressions. The sex ratio at ages 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort reached age 30 and 35 respectively. All regressions control for the log of working-age (20–64) males, industry male ratio, share of risky jobs at the county level in each age group, and a full set of county and birth cohort dummy variables. Robust standard errors clustered at the county are in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% respectively. Mortality rates and sex ratios are the authors' own imputations. The data relating to mainland Chinese men were drawn from the 1956 Population and Housing Census. Estimated global mortality rates at age 20 for males and females were obtained from the Abridged Life Table for Males and Females, World Population Prospects 2019, United Nations, Population Division, Department of Economic and Social Affairs.

Table A2. First-Stage Estimates

Sex Ratio at Age	(1) Age 30	(2) Age 35
Log of MCM × gender diff in global mortality at age 20	59.107*** (12.996)	55.962*** (12.565)

Note: The dependent variables are the sex ratios at ages 30 (column 1) and 35 (column 2). They are measured as the ratios of men to women who respectively are 25–34 and 30–39 at the county level. The key explanatory variable is the log of MCM interacted with the gender differential in the estimated global mortality rate at age 20 when each cohort turned 20. All regressions control for the log of prime-age (20–64) men, industry male ratio, share of risky jobs at the county level in each age group, and a full set of county and birth cohort dummy variables. Robust standard errors clustered at the county are in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10%.

The sex ratios are the authors' own imputations. The data relating to mainland Chinese men were drawn from the 1956 Population and Housing Census. Estimated global mortality rates at age 20 for males and females were obtained from the Abridged Life Table for Males and Females, World Population Prospects 2019, United Nations, Population Division, Department of Economic and Social Affairs.

Table A3. Two-Stage Least Squares Estimates Using Worldwide Gender Difference in Mortality Rate at Age 30 as Instrument

	(1)	(2)	(3)	(4)
	Men	Women	Men	Women
Sex Ratio at Age	Age 30	Age 30	Age 35	Age 35
	Panel A: Mortality Rate at Age 50–54			
Sex ratio	0.054***	0.022***	0.055***	0.026***
	(0.014)	(0.008)	(0.014)	(0.009)
	Panel B: Mortality Rate at Age 55–59			
Sex ratio	0.074***	0.024*	0.081***	0.027*
	(0.019)	(0.014)	(0.017)	(0.014)
	Panel C: Mortality Rate at Age 60–64			
Sex ratio	0.077***	0.026**	0.084***	0.033**
	(0.030)	(0.013)	(0.028)	(0.013)
	Panel D: Mortality Rate at Age 50–64			
Sex ratio	0.181***	0.069**	0.193***	0.081***
	(0.049)	(0.030)	(0.047)	(0.031)
Observations	400	400	400	400
Kleibergen-Paap F	108.2	105.8	120.9	114.1

Notes: The dependent variables are mortality rates at the county-cohort level at ages 50–54 (panel A), 55–59 (panel B), 60–64 (panel C), and 50–64 (panel D). The sample includes birth cohorts between 1931 and 1950 across 20 counties. All estimates were obtained from separate regressions. The sex ratio at ages 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort turned 30 and 35 respectively. All regressions control for the log of working-age (20–64) men, industry male ratio, share of risky jobs at the county level in each age group, and a full set of county and birth cohort dummy variables. The instrumental variable is the log of mainland Chinese men interacted with the national gender differential in mortality at ages 0–14 in Taiwan when each cohort reached age 20. Robust standard errors clustered at the county are in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10%. Kleibergen-Paap F statistics for a weak instrument test are at the bottom.

Mortality rates and sex ratios are the authors' own imputations. The data relating to mainland Chinese men were drawn from the 1956 Population and Housing Census. Gender differentials in mortality were obtained from various abridged life tables published by the Ministry of the Interior in Taiwan.

Table A4. Estimates of the Mortality Effect Using Sex Ratios with a Wide Age Range (15–49)

	Ordinary Least Squares				Two-Stage Least Squares			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Men	Women	Men	Women	Men	Women	Men	Women
Sex Ratio at Age	Age 30	Age 30	Age 35	Age 35	Age 30	Age 30	Age 35	Age 35
	Panel A: Mortality Rate at Age 50–54							
Sex ratio	0.066***	0.026***	0.078***	0.032***	0.070***	0.042***	0.098***	0.065***
	(0.013)	(0.006)	(0.014)	(0.007)	(0.019)	(0.009)	(0.026)	(0.014)
	Panel B: Mortality Rate at Age 55–59							
Sex ratio	0.089***	0.038***	0.114***	0.040***	0.092***	0.047***	0.139***	0.070***
	(0.018)	(0.011)	(0.020)	(0.013)	(0.024)	(0.016)	(0.030)	(0.024)
	Panel C: Mortality Rate at Age 60–64							
Sex ratio	0.113***	0.042***	0.145***	0.054***	0.088**	0.053***	0.137**	0.086***
	(0.031)	(0.012)	(0.036)	(0.013)	(0.041)	(0.013)	(0.053)	(0.020)
	Panel D: Mortality Rate at Age 50–64							
Sex ratio	0.233***	0.099***	0.293***	0.118***	0.219***	0.135***	0.329***	0.210***
	(0.051)	(0.025)	(0.056)	(0.028)	(0.066)	(0.033)	(0.087)	(0.050)
Kleibergen-Paap F					187.8	191.4	121.4	124.9
Observations	400	400	400	400	400	400	400	400

Notes: The dependent variables are mortality rates at the county-cohort level at ages 50–54 (panel A), 55–59 (panel B), 60–64 (panel C), and 50–64 (panel D). The instrumental variable is the log of mainland Chinese men interacted with the gender differential in the estimated global mortality rate at age 20 when each cohort turned 20. The sample includes birth cohorts born between 1931 and 1950 across 20 counties. All estimates were obtained from separate regressions. The sex ratio at ages 30 and 35 is the ratio of men to women who were 15–49 when each cohort turned 30 and 35 respectively. All regressions control for the log of working-age (20–64) men, industry male ratio, share of risky jobs at the county level in each age group, and a full set of county and birth cohort dummy variables. Robust standard errors clustered at the county are in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% respectively.

Mortality rates and sex ratios are the authors' own imputations. The data relating to mainland Chinese men were drawn from the 1956 Population and Housing Census. Estimated global mortality rates at age 20 for males and females were obtained from the Abridged Life Table for Males and Females, World Population Prospects 2019, United Nations, Population Division, Department of Economic and Social Affairs.

Table A5. OLS and 2SLS Estimates of the Sex-Ratio Effect on Other Health Outcomes

	OLS	OLS	OLS	OLS	2SLS	2SLS	2SLS	2SLS
	Men	Women	Men	Women	Men	Women	Men	Women
Sex Ratio at Age	Age 30	Age 30	Age 35	Age 35	Age 30	Age 30	Age 35	Age 35
				Panel A: CES-D				
Sex ratio	-1.780	1.130	-2.164*	1.819	-5.979	6.183	-10.401	10.673
	(1.448)	(1.649)	(1.248)	(1.860)	(6.206)	(7.210)	(8.213)	(10.412)
Observations	1,990	1,899	1,990	1,899	1,990	1,899	1,990	1,899
Kleibergen-Paap F					25.94	24.20	14.99	13.33
				Panel B: Cancers				
Sex ratio	0.141**	-0.028	0.018	-0.028	0.307**	-0.062	0.171	-0.138
	(0.059)	(0.037)	(0.041)	(0.036)	(0.142)	(0.148)	(0.184)	(0.161)
Observations	2,081	1,980	2,081	1,980	2,081	1,980	2,081	1,980
Kleibergen-Paap F					23.81	24.67	12.89	15.06
				Panel C: Heart Diseases				
Sex ratio	0.112	0.185	0.026	0.187	-0.269	-0.028	-0.448	-0.051
	(0.110)	(0.116)	(0.108)	(0.156)	(0.328)	(0.408)	(0.454)	(0.423)
Observations	2,081	1,980	2,081	1,980	2,081	1,980	2,081	1,980
					23.81	24.67	12.89	15.06
Kleibergen-Paap F				Panel D: High Blood Pressure				
Sex ratio	0.147	-0.174	-0.042	-0.037	0.715*	1.095*	0.494	1.735
	(0.159)	(0.184)	(0.171)	(0.174)	(0.430)	(0.642)	(0.678)	(1.063)
Observations	2,081	1,980	2,081	1,980	2,081	1,980	2,081	1,980
Kleibergen-Paap F					23.81	24.67	12.89	15.06
				Panel E: Stroke				
Sex ratio	0.035	-0.021	0.018	0.013	0.104	-0.062	0.006	-0.075
	(0.084)	(0.063)	(0.050)	(0.058)	(0.168)	(0.170)	(0.162)	(0.194)
Observations	2,081	1,976	2,081	1,976	2,081	1,976	2,081	1,976
Kleibergen-Paap F					23.81	24.48	12.89	14.59
				Panel F: Diabetes				
Sex ratio	0.106	0.289***	0.209	0.074	-0.270	0.453	-0.275	0.213
	(0.117)	(0.088)	(0.152)	(0.126)	(0.235)	(0.356)	(0.318)	(0.434)
Observations	2,081	1,980	2,081	1,980	2,081	1,980	2,081	1,980
Kleibergen-Paap F					23.81	24.67	12.89	15.06

Notes: CES-D measures depression with a score ranging from 0 (low depression) to 30 (high depression). All other dependent variables are dummy variables indicating whether a person has the respective medical condition. All estimates were obtained from separate regressions. The sex ratio at ages 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort turned 30 and 35 respectively. All regressions additionally control for age, age squared, the log of prime-age (20–64) men, industry male ratio, share of risky jobs at the county at the corresponding age, a full set of county and birth cohort dummy variables, and a dummy variable indicating the sample drawn in 2003. The sample includes birth cohorts between 1929 and 1953 across 20 counties. Robust standard errors clustered at the county have been used to construct the confidence intervals. ***, **, and * indicate significance at 1%, 5%, and 10%.

Health outcome data were drawn from the Health and Living Status of the Middle-Aged and Elderly Survey done in Taiwan in 1996 and 2003. Sex ratios are the authors' own imputations.

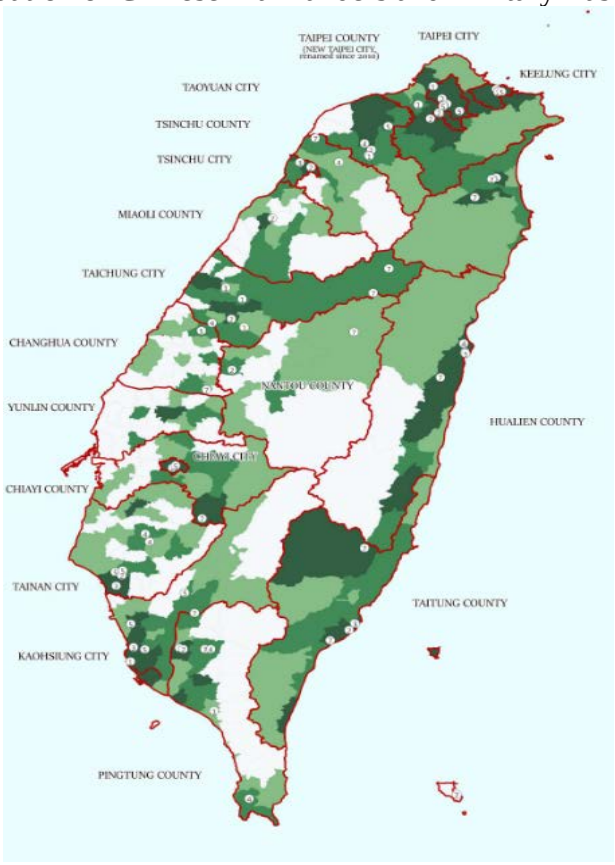
Table A6. Widowhood Effect Test

	(1)	(2)	(3)	(4)
Sex Ratio at Age	Age 30	Age 30	Age 35	Age 35
	Panel A: Women's Mortality: OLS			
Sex ratio	0.005	0.005	0.006	0.004
	(0.005)	(0.007)	(0.004)	(0.006)
Men's mortality	0.118***	0.151***	0.127***	0.155***
	(0.041)	(0.029)	(0.040)	(0.029)
	Panel B: Women's Mortality: 2SLS			
Sex ratio	-0.039**	-0.070	-0.037**	-0.063*
	(0.017)	(0.045)	(0.016)	(0.033)
Men's mortality	0.825***	1.222	0.785***	1.061**
	(0.263)	(0.781)	(0.216)	(0.525)
Outcome: Women's Mortality	Age 50–54	Age 55–59	Age 50–54	Age 55–59
Control: Men's Mortality	Age 55–59	Age 60–64	Age 55–59	Age 60–64
Observations	400	400	400	400
Kleibergen-Paap F	7.892	2.052	9.390	3.369
	Panel C: Men's Mortality: OLS			
Sex ratio	0.052***	0.072***	0.044***	0.062***
	(0.012)	(0.016)	(0.013)	(0.016)
Women's mortality	0.447***	0.547***	0.499***	0.587***
	(0.147)	(0.147)	(0.155)	(0.146)
	Panel D: Men's Mortality: 2SLS			
Sex ratio	0.047***	0.057***	0.047***	0.059***
	(0.014)	(0.015)	(0.013)	(0.014)
Women's mortality	1.213***	0.818	1.274***	0.943**
	(0.387)	(0.523)	(0.350)	(0.467)
Outcome: Men's Mortality	Age 55–59	Age 60–64	Age 55–59	Age 60–64
Control: Women's Mortality	Age 50–54	Age 55–59	Age 50–54	Age 55–59
Observations	400	400	400	400
Kleibergen-Paap F	17.08	12.32	18.20	12.13

Notes: The dependent variables in panels (A) and (B) are women's mortality rates at ages 50–54 and 55–59. The dependent variables in panels (C) and (D) are men's mortality rates at ages 55–59 and 60–64. In regressions of women's mortality at ages 50–54 and 50–59, men's mortality at ages 55–59 and 60–64 respectively is further controlled to test the widowhood effect. In regressions of men's mortality at ages 55–59 and 60–64, women's mortality at ages 50–54 and 55–59 is respectively further controlled to test the widowerhood effect. All estimates have been obtained from separate regressions. The sex ratio at ages 30 and 35 is the ratio of men to women who were 25–34 and 30–39 when each cohort turned 30 and 35 respectively. All regressions additionally control for the log of prime-age (20–64) men, industry male ratio, share of risky jobs at the county at the corresponding age, and a full set of county and birth cohort dummy variables. In panels (B) and (D), the instrumental variables are the log of mainland Chinese men interacted with the gender differential in the estimated global mortality rate at age 20 when each cohort turned 20 and the log of mainland Chinese men interacted with the gender differential in the estimated global mortality rate at age 30 when each cohort turned 30. Robust standard errors clustered at the county have been used to construct the confidence interval. The sample includes birth cohorts born between 1931 and 1950 across 20 counties. ***, **, and * indicate significance at 1%, 5%, and 10%.

Mortality rates and sex ratios are the authors' own imputations. The data relating to mainland Chinese men were drawn from the 1956 Population and Housing Census. Estimated global mortality rates at age 20 for males and females were obtained from the Abridged Life Table for Males and Females, World Population Prospects 2019, United Nations, Population Division, Department of Economic and Social Affairs.

(A) Distribution of Chinese Mainlanders and Military Bases in 1956.



(B) Distribution of Chinese Mainlanders and Veterans

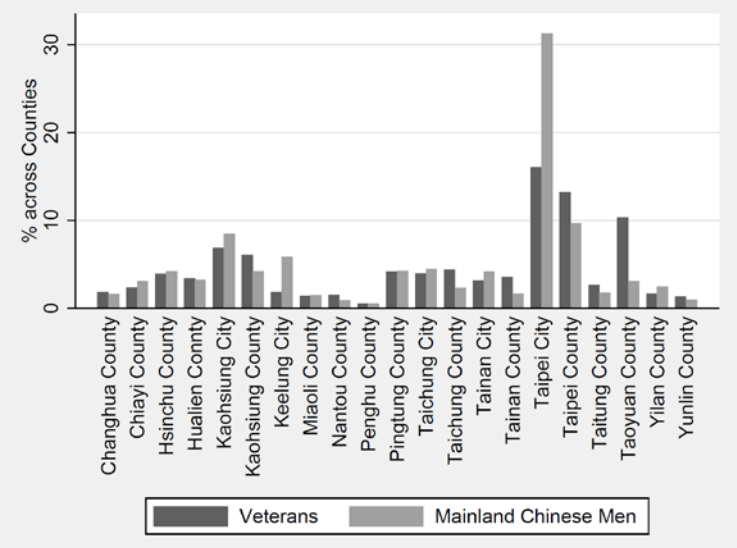


Figure A1. Distribution of Mainlanders, Military Bases, and Veterans.

Note: In (A), the green color indicates the percentage of Chinese mainlanders at the township level in 1956, with darker green indicating a higher percentage. The white circles indicate the following: 1. military camp, 2. military police, 3. military base, 4. recruit training center, 5. command, 6. headquarters, and 7. state farm. Image (B) shows the distribution of veterans across counties in 1996. The correlation coefficient between the two variables is as high as 0.802. Data were drawn from the Housing and Population Census of 1956 and Veteran Affairs Council, Taiwan.

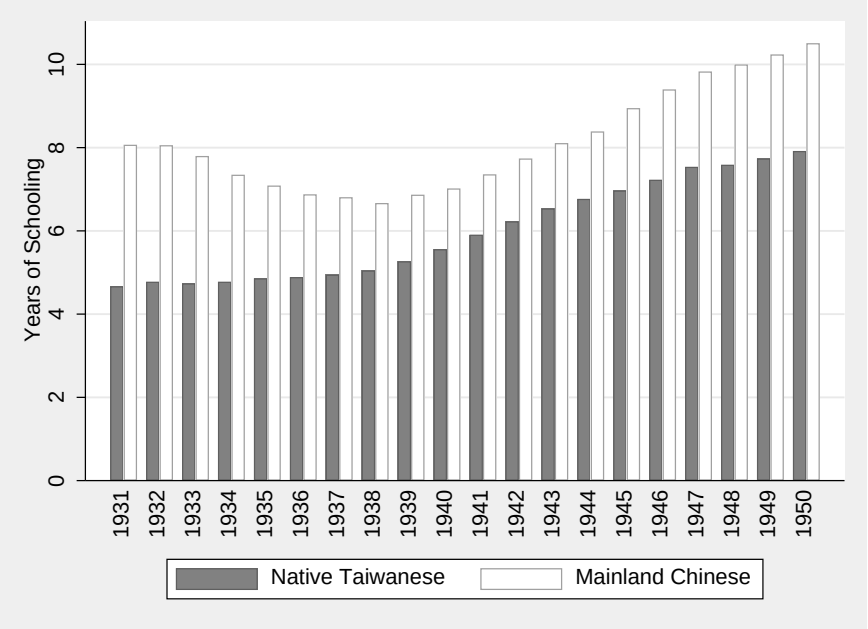


Figure A2. Schooling Years of Mainland Chinese Migrants vs. Native Taiwanese by Birth Years.

Note: Computed by the authors using the 1980 Taiwan Population Census.

Panel A: no local characteristics

Panel B: control for local characteristics

Figure A3. Reduced Form Estimates with and without Local Characteristics

Notes: All estimates are obtained from separate regressions of age-specific mortality rates on the instrumental variable controlling for the log of prime-age (20–64) men and a full set of county and birth cohort dummy variables. Estimates in Panel B further control for the local characteristics, including industry male ratio and risky job share at the county level.