



The Measure of Exogamous Marriage through Disagreement Scaling

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Abstract

In this paper we used the weighted kappa through disagreement scaling proposed by Cohen (1968) to measure the exogamous marriage. It is the interest of sociologist to investigate the trend of exogamous or mixed marriage between different ethnic groups, as the upward trend of mixed marriage can be view as degree of assimilation of particular ethnic groups. We are able to measure the strength of exogamous marriage directly. We found that the upward trend of mixed marriage among Americans of different ethnicity tend to increase from 1980 to 2000. We also used the estimated large sample variance of weighted kappa given by Fleiss *et al.* (1969) to build the Wald confidence interval and hence testing the null hypothesis of nonexistence of exogamous marriage.

Keywords: Weighted kappa, Exogamous marriage, Assimilation, Disagreement scaling

1. Introduction

In American society with multiethnic immigrants, the issue of exogamous marriage has been widely studied. The kappa statistics (Cohen, 1960) were introduced to measure the agreement between two raters for nominal scales. Strauss (1977) has applied the kappa statistics by Cohen to study the endogamous marriage, followed by Rust and Seed (1985) and further developed by Ahmad Mahir (1993). This issue refers to the intersection of race and class.

Lessard (2001) has used the definition given by Chang (1999) who stated that "Intermarriage refers to marriage between members of different groups, identified by one or more socially important dimensions of differentiation". In this paper, we studied the intermarriage data which have been arranged in the form of a square two-ways contingency table. This arrangement was originally introduced by Ahmad Mahir (1991) as shown in table 1. The ethnic groups for both men and women are given by $E_1, E_2, \dots, E_k$. The diagonal cells refers to the endogamy marriage that is the marriage between the brides and grooms of the same ethnic groups, whereas off diagonal cells give the couples of exogamous marriage that is the marriage between the brides and grooms of different ethnic groups. The main objectives of this paper are using the weighted kappa to measure marriage the strength of the exogamous marriage and to study the trend of the exogamous marriage.

For simplicity, we assigned the weight zero and one to the diagonal and off diagonal cells respectively. Then, weighted kappa was calculated followed by the construction of the 95% confidence interval with the estimated variance given by Fleiss *et al.* (1969).

We extracted the five percent of the 1980, 1990 and 1990 U.S. censuses, made available through the Integrated Public Use Microdata Sample (IPUMS, 2003). By using cross tabulation procedure of SPSS software, we obtained two-ways table shown in table 2, 3 and 4.

2. Theories and the calculation

Cohen (1968) proposed a basic formula for weighted kappa which is given by

$$\kappa_w = 1 - (q_o / q_e) \quad (2.1)$$

where

$$q_o = \sum_{i=1}^k \sum_{j=1}^k w_{ij} p_{oij} \quad (2.2)$$

and

$$q_e = \sum_{i=1}^k \sum_{j=1}^k w_{ij} p_{eij} \quad (2.3)$$

Let p_{oij} be the observed proportion of marriage placed in the (i,j) cells and p_{eij} be the expected proportion in the (i,j) cells. The investigator chose the disagreement weighted scale as follow:

$$w_{ij} = \begin{cases} 0 & \text{if } i = j \\ 1 & \text{otherwise} \end{cases} \quad (2.4)$$

Assume that we have x_{ij} which is the number of observation in the (i,j) cell with a total of n observations. Let x_{i+} and x_{+j} refer to the total sum of the i th row and j th column respectively. The estimates of p_{oij} and p_{eij} are given by

$$\hat{p}_{oij} = x_{ij} / n \quad (2.5)$$

and assuming that the column and the row variables are independent.

$$\hat{p}_{eij} = x_{i+} x_{+j} / n \quad (2.6)$$

By substituted Eq. (2.2) to Eq. (2.6) into Eq. (2.1), we obtained the estimated weighted kappa as below.

$$\hat{\kappa}_w = 1 - (n \sum_{i=1}^k \sum_{j=1}^k w_{ij} x_{ij} / \sum_{i=1}^k \sum_{j=1}^k w_{ij} x_{i+} x_{+j}) \quad (2.7)$$

Fleiss *et al.* (1969) has derived the formula for estimated large sample variance of $\hat{\kappa}_w$, useful in setting up confidence interval for comparing two independent values of $\hat{\kappa}_w$. This estimated large sample variance is

$$\text{var}(\hat{\kappa}_w) = \{ \sum_{i=1}^k \sum_{j=1}^k p_{ij} [w_{ij}(1-q_e) - (\bar{w}_{i+} + \bar{w}_{+j})(1-q_o)]^2 - (q_o q_e - 2q_e + q_o)^2 \} / (n(1-q_e)^4) \quad (2.8)$$

with weighted average of the weights in the i th row, $\bar{w}_{i+} = \sum_{j=1}^k w_{ij} p_{+j}$ and $\bar{w}_{+j} = \sum_{i=1}^k w_{ij} p_{i+}$

a weighted average of the weights in the j th column.

We introduced the overall exogamy measure as lambda, $\hat{\lambda}$ where the estimate is given by

$$\hat{\lambda} = 1 - \hat{\kappa}_w \quad (2.9)$$

We can show that the variance of $\hat{\lambda}$ is approximately equals to the variance of $\hat{\kappa}_w$ since 1 is a constant. We have

$$\text{var}(\hat{\lambda}) = \text{var}(1 - \hat{\kappa}_w) \approx \text{var}(\hat{\kappa}_w) \quad (2.10)$$

3. Result and Finding

We computed the strength of exogamy estimate $\hat{\lambda}$ and $\text{var}(\hat{\lambda})$ using marriage data sets given in table 2, 3, and 4. The 95 % confidence limit also been constructed to test the hypothesis $\hat{\lambda} = 0$. The results are shown in the table 5.

According to Cohen (1968) both measures are chance corrected proportion. Weighted kappa is a special case of kappa. The value of weighted kappa κ_w is smaller than the κ as it gives weight to the disagreement cells. Normally the value of weighted kappa falls the in the range (0,1), so we can deduce overall exogamy measure is $0 < \hat{\lambda} < 1$. If $\hat{\lambda} = 1$, it said to be perfect exogamy. Where as $\hat{\lambda} = 0$ implied that exogamy does not happen.

By comparing data set 1, 2 and 3 we can conclude that the exogamous marriage in the U.S society has increased over the past two decades as the value of $\hat{\lambda}$ has increased from 0.0967 to 0.1764. The increase of $\hat{\lambda}$ for year 1980 to 1990

is 0.0335 compare to the year 1990 to 2000 is 0.0462. From Figure 1 indicate the upward exogamous marriage trend of American society.

For testing the null hypothesis $\hat{\lambda} = 0$, we can reject the null hypothesis for the two decades that we chosen.

References

- Ahmad Mahir R. 1991. Statistical Issues in Interracial Marriages. PhD.Thesis. Medical University of South Carolina.
- Bishop Y.M.M.,Feinberg S.E. & Holland P.W. 1975. *Discrete Multivariate Analysis: Theory and Practice*. Cambridge: MIT Press.
- Chang Y.C. 1999. Models for Intergroup Association: An Examination of Inter-marriage in the United States, 1980-1990. Department of Sociology, University of South Carolina.
- Cohen J.1960. A coefficient of agreement for nominal scales. *Psychological Measurement* 20: 37-46.
- Cohen J. 1968. Weighted kappa: Nominal scale agreement with provision for scaled disagreement or partial credits. *Psychological Bulletin* 70: 213-220.
- Fleiss J. L., Cohen J. & Everitt B.S. 1969: Large sample standard errors of kappa. *Psychological Bulletin* 72: 323-327.
- IPUMS. 2003. *IPUMS User's Guide*. Minneapolis, MN: Minnesota Population Center. [Online] Available: <http://www.ipums.org/usa/doc.html>
- Lessard C. 2001.*Ethnic Exogamy in Canada in 1996: With a special focus on Toronto and Vancouver*.SRA 569. Ottawa : Strategic Research and Analysis, Department of Canadian Heritage.
- Rust P. F. & Seed P.1985. Equality Endogamy: Statistical Approaches. *Social Science Research* 14:57-59.
- Strauss D.J. 1977. Measuring endogamy. *Social Science Research* 6:225-245.

Table 1. Data Format

		Women								Total
		E_1	E_2	.	.	E_j	.	.	E_k	
Men	E_1	x_{11}	x_{12}	.	.	x_{1j}	.	.	x_{1k}	x_{1+}
	E_2	x_{21}	x_{22}	.	.	x_{2j}	.	.	x_{2k}	x_{2+}
	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.
	E_i	x_{i1}	x_{i2}	.	.	.	.	.	x_{ik}	x_{i+}
	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.
	E_k	x_{k1}	x_{k2}	.	.	.	.	.	x_{kk}	x_{k+}
Total		x_{+1}	x_{+2}	.	.	x_{+j}	.	.	x_{+k}	n

Source : Ahmad Mahir(1991)

Table 2. Data set 1 of marriage by race of U.S. Women 1980 census

		Women							Total
		White	Black/ Negro	America n Indian /Alaska Native	Chines e	Japanese	Other Asian / Pacific Islander	Other races	
Men	White	2 228 918	1 639	6 485	1 106	3 266	6 534	1603	2 249 551
	Black/Negro	5 193	171 500	271	53	181	608	166	177 972
	American Indian /Alaska Native	6 355	148	5 993	8	19	79	55	12 657
	Chinese	654	21	9	7 635	223	186	16	8 744
	Japanese	891	23	7	152	5 984	235	17	7 309
	Other Asian or Pacific Islander	2 982	111	66	152	261	16 809	61	20 442
	Other races	1 906	120	59	21	28	75	4131	6 340
	Total	2 246 899	173 562	12 890	9 127	9 962	24 526	6049	2 483 015

Source: 5 % Sample of 1980 U.S.Census IPUMS

Table 3. Data set 2 of marriage by race of U.S. Women 1990 census

		Women							Total
		White	Black/ Negro	America n Indian /Alaska Native	Chinese	Japane se	Other Asian / Pacific Islander	Other races	
Men	White	2 355 248	2 541	9 361	2117	4 058	10 083	8 372	2 391 780
	Black/Negro	6 990	150 587	409	72	188	854	870	159 970
	American Indian /Alaska Native	8 973	220	7 769	15	46	147	275	17 445
	Chinese	1 056	36	8	14 994	324	461	79	16 958
	Japanese	1 382	13	23	260	6 707	355	96	8 836
	Other Asian or Pacific Islander	3 977	158	110	308	382	34501	439	3 9875
	Other races	9 753	516	469	65	77	498	61 674	7 3052
	Total	2 387 379	154 071	18 149	17 831	11 782	46 899	71 805	2 707 916

Source: 5 % Sample of 1990 U.S.Census IPUMS

Table 4. Data set 3 of marriage by race of U.S. Women 2000 census

		Women							Total
		White	Black/ Negro	America Indian /Alaska Native	Chinese	Japanese	Other Asian / Pacific Islander	Other races	
Men	White	2 348 792	4 433	9 453	3212	3999	13 266	33 909	2 417 064
	Black/Negro	11 471	165 134	412	77	180	1 190	3 929	182 393
	American Indian /Alaska Native	8 820	214	9 429	16	19	131	1 153	19 782
	Chinese	1 238	26	5	22 448	277	750	265	25 009
	Japanese	1 360	22	16	292	5642	440	301	8 073
	Other Asian or Pacific Islander	4 887	198	98	572	377	58 005	1 695	65 832
	Other races	31 795	2 115	1 410	350	459	2 176	121 530	159 835
	Total	2 408 363	1 72 142	20 823	26 967	10953	75 958	162 782	2 877 988

Source: 5 % Sample of 2000 U.S.Census IPUMS

Table 5 .Parameters estimate, standard errors and 95% confident limit for $\hat{\lambda}$

Data Set	Weighted Kappa, $\hat{\kappa}_w$	Exogamy estimate $\hat{\lambda} = 1 - \hat{\kappa}_w$	Standard Errors ($\hat{\lambda}$)	95% Confidence Limit $\hat{\lambda}$
1	0.9033	0.0967	0.000777	(0.0952, 0.0982)
2	0.8698	0.1302	0.0008381	(0.1286, 0.1318)
3	0.8236	0.1764	0.0009779	(0.1745, 0.1783)

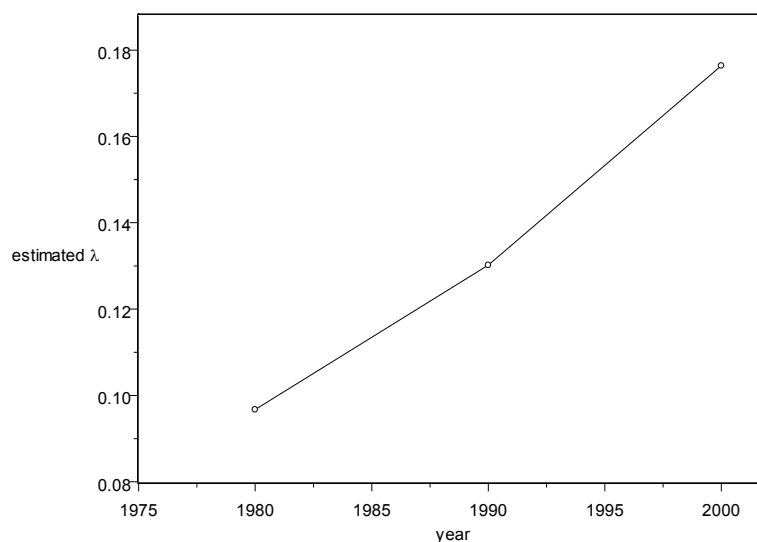


Figure 1. The trend of exogamous marriage in United States for the year 1980, 1990 and 2000 census.