sociological science

Supplement to:

Aksoy, Ozan. 2017. "Motherhood, Sex of the Offspring, and Religious Signaling." Sociological Science 4: 511-527.

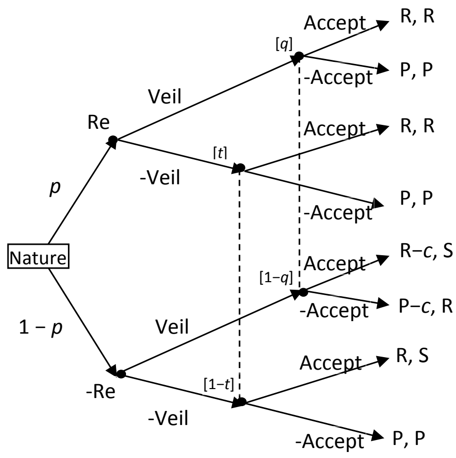
Online supplement for "Motherhood, Sex of the Offspring, and Religious Signaling"

A: A simple model of veiling as a signal of piety

Assume for the moment that there are two actors, a woman and the community. There are two types of women, pious and non-pious. Nature randomly draws the type of the woman with probabilities p and $1 - p$ corresponding to pious and non-pious types, respectively. The woman observes her type and decides to veil or to not veil. The community observes whether the woman veils but cannot observe her type. The community then decides to accept the woman and her family or to not accept. Acceptance by the community can be in various forms, including finding a suitable mate or a job for the woman or her offspring, trusting the woman's family members, and socially approving the family. The woman's and the community's outcomes are given in Fig. A1. The first and the second letter in the cells in the far-right side of the figure indicate the outcomes for the woman and the community, respectively. Both pious and non-pious types prefer to be accepted by the community (R > P). However, veiling is costly for the non-pious type and it is costless for the pious type.[1] This cost is indicated by $c > 0$ in Fig. A1. c can be a psychological cost of wearing a religious garb despite being non-pious, it could also be a physical cost as the veil constrains the woman's body. I assume that this cost is absent for the pious type: the psychological benefits of the veiling for the pious (fulfilling religious duties) offset its costs. The community prefers to accept the pious (R > P). The worst outcome for the community is accepting the non-pious (R > P > S). q (t) is the community's belief about the probability that a woman is of pious type given that she veils (she does not veil): q = Pr(Re|Veil), t = Pr(Re|-Veil).

[1] This model can be easily extended to make the veil also costly for the pious type, albeit less costly than it is for the non-pious type. The model can also be extended to include the possibility that the pious type derives additional positive utility from veiling. I leave such extensions for future work.

Fig. A1: Veiling as a signaling game between a woman and the community. Re = pious type, -Re = non-pious type.



R > P > S; $c > 0$; $0 \leq p, q, t \leq 1$

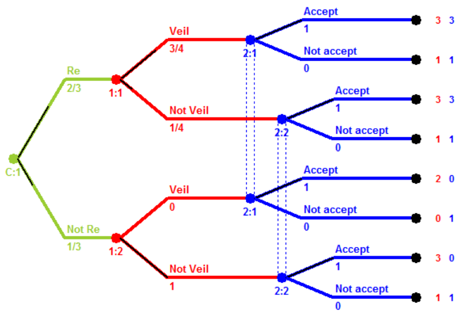
This game, as in most signaling games, has multiple equilibria. Both pooling in veiling (pious and non-pious types veil, the community accepts the veiled—provided that *p* is sufficiently high) and pooling in non-veiling (both types not veil and the community accepts the non-veiled—provided that *p* is sufficiently high) are equilibrium strategies. These equilibria are interesting, but not as interesting as a further equilibrium which is partially pooling: the pious type veils with probability *a* and does not veil with probability $1 - a$, the non-pious type does not veil, and the community accepts both veiled and non-veiled woman—provided that *p* is sufficiently high. Not all values of *a* satisfy this equilibrium. Firstly, $a > (P - S)(1 - p)/p(R - P)$. Secondly, if *a* is too high the community prefers to unilaterally deviate by not accepting the non-veiled. There is a maximum value of *a*, denoted by ā, which makes the community indifferent between accepting and not accepting the non-veiled. This value of ā is:

$$\bar{a} = [p(R - S) + S - p]/p(R - P)$$

The equilibrium which provides the maximum separation between the pious and non-pious types can be written formally as: {[V×(ā, 1 − ā), -V], [Accept, Accept], $q = \bar{a}p/(\bar{a}p + 1 - p)$, $t =$

$(1-\bar{a})p/[(1-\bar{a})p+1-p]\}$. Fig A2 presents a numerical example with R = 3, P = 1, S = 0, c = 1, p = 2/3 (hence 2/3 of all women are of pious type). In this example, in the maximally separating equilibrium the pious type veils with probability 3/4, the non-pious type does not veil. In the population the prevalence of veiling is then 2/3×3/4 = 0.5.

Fig. A2.

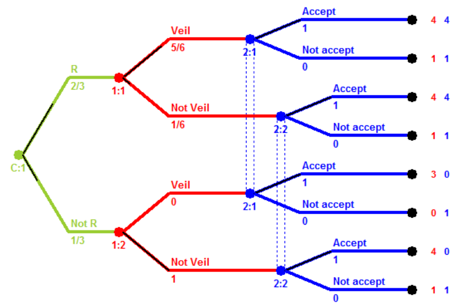


Now assume that R increases as the woman has a child and as this child grows up. This may be because the acceptance by the community now benefits both the woman and her child, and those benefits become particularly important when the child approaches to the marriage or job market. It can be easily shown that:

$$\frac{\partial \bar{a}}{\partial R} = \frac{P-S}{[p(R-P)]^2} > 0$$

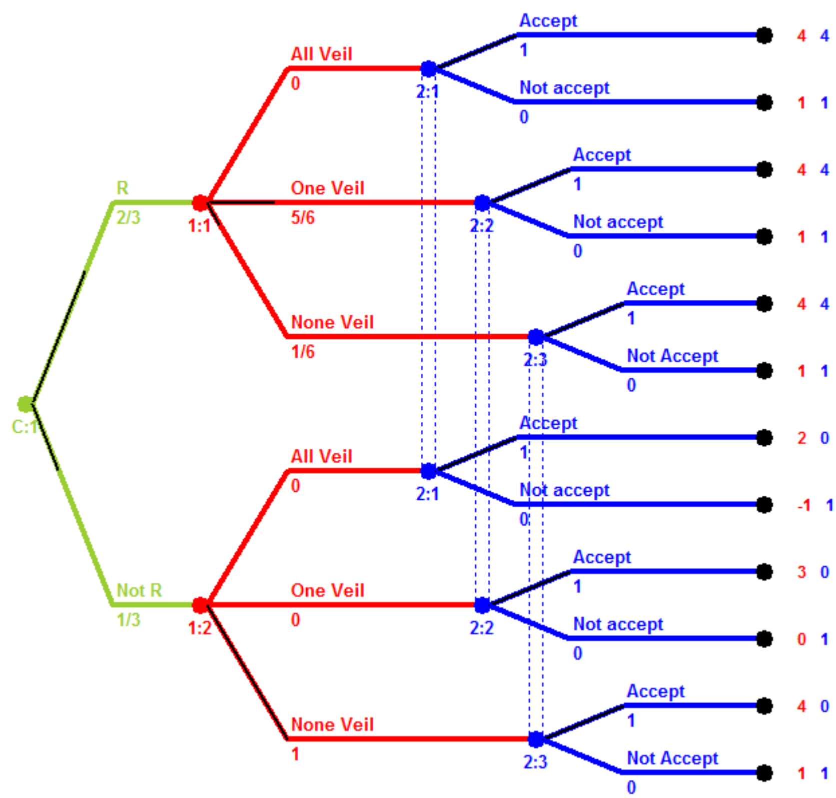
Because R increases as the woman has a child and the child grows up, so does ā. In Fig. A3 R is increased to 4. All other game parameters remain the same as in Fig. A2. In the maximally separating equilibrium the religious type now veils with probability 5/6 and the prevalence of veiling in the population increases to 2/3×5/6 = 0.56.

Fig. A3.



Furthermore, when the woman has a daughter the strategy space of the woman's family will be expanded. Now either the woman or her daughter or both can veil. When the woman has a son, instead, only the woman can veil. In other words, the game remains as in Fig A3 when the woman has a son, but becomes like the one in Fig. A4 when the woman has a daughter. The number of equilibria in the game in Fig. A4 explodes. However, there remains a maximally separating equilibrium in which only one (either the woman or her daughter) person in the pious family veils with probability ā, and no one veils in the non-pious family. If at least in some cases the daughter veils alone in the pious family, in this maximally separating strategy the probability that the mother veils decreases compared to the game in Fig. A3.

Fig. A4.


Accept
1
Not accept
0
4 4
1 1
All Veil
0
2:1
Accept
1
Not accept
0
4 4
1 1
R
2/3
1:1
One Veil
5/6
2:2
None Veil
1/6
2:3
Accept
1
Not Accept
0
4 4
1 1
C:1
All Veil
0
2:1
Accept
1
Not accept
0
2 0
-1 1
Not R
1/3
1:2
One Veil
0
2:2
Accept
1
Not accept
0
3 0
0 1
None Veil
1
2:3
Accept
1
Not Accept
0
4 0
1 1

B: Coefficients of logistic regression models that predict the likelihood of veiling in Turkey

Table B1: Coefficients of logistic regression models that predict the likelihood of veiling among married women. Data source: Turkey's 2013 demographic and health survey.

	--No child vs. 1 child--		--No child vs. 2 children--		--No child vs. 3-or-more-	
	Model 1[b]	Model 2[a]	Model 3[b]	Model 4[a]	Model 5[b]	Model 6[a]
(Intercept)	1.22 *	2.41 ***	1.23 **	0.87	0.55	0.47
	(0.51)	(0.68)	(0.41)	(0.65)	(0.49)	(0.68)
factor(Child)	0.31 *	0.47 **	0.59 ***	0.87 ***	1.07 ***	1.09 ***
	(0.15)	(0.18)	(0.15)	(0.18)	(0.18)	(0.20)
performs salah	1.92 ***	2.05 ***	1.74 ***	1.79 ***	1.85 ***	1.99 ***
	(0.15)	(0.21)	(0.12)	(0.20)	(0.15)	(0.21)
fasts	1.66 ***	1.38 ***	1.70 ***	1.77 ***	1.73 ***	1.67 ***
	(0.21)	(0.27)	(0.16)	(0.26)	(0.19)	(0.28)
education (z-score)	-0.69 ***	-0.98 ***	-0.82 ***	-0.87 ***	-0.78 ***	-0.65 ***
	(0.10)	(0.13)	(0.08)	(0.13)	(0.10)	(0.13)
age (z-score)	-0.47 ***	-0.63 ***	-0.29 ***	-0.37 ***	-0.26 **	-0.35 **
	(0.08)	(0.11)	(0.06)	(0.10)	(0.08)	(0.11)
wealth (z-score)	-0.80 ***	-0.79 ***	-0.69 ***	-0.83 ***	-0.56 ***	-0.96 ***
	(0.11)	(0.15)	(0.09)	(0.15)	(0.10)	(0.15)
employed (vs not)	-0.67 ***	-0.85 ***	-0.58 ***	-0.88 ***	-0.37 **	-0.61 **
	(0.15)	(0.20)	(0.12)	(0.19)	(0.14)	(0.21)
urban (vs rural)	-0.04	0.36	-0.38 *	0.49	0.16	0.48
	(0.20)	(0.27)	(0.16)	(0.26)	(0.18)	(0.28)
Kurd (vs. Turk)	0.34	0.28	-0.06	-0.43	-0.27	-0.09
	(0.28)	(0.34)	(0.23)	(0.31)	(0.22)	(0.34)
Arab (vs. Turk)	-0.48	-0.59	-1.47 **	-0.98	-1.04 **	-0.47
	(0.60)	(0.63)	(0.46)	(0.56)	(0.34)	(0.55)
Other ethn (vs. Turk)	-0.32	-0.65	-0.83	0.62	-0.57	0.66
	(0.59)	(0.78)	(0.52)	(0.99)	(0.52)	(0.89)
South (vs. West)	-0.74 **	-0.80 **	-0.65 ***	-1.32 ***	-0.94 ***	-1.08 ***
	(0.23)	(0.31)	(0.17)	(0.31)	(0.21)	(0.32)
Central (vs. West)	0.09	0.14	0.37 *	0.08	0.22	0.32
	(0.19)	(0.25)	(0.15)	(0.25)	(0.20)	(0.27)
North (vs. West)	0.14	-0.04	0.49 **	-0.04	0.08	-0.14
	(0.20)	(0.28)	(0.16)	(0.29)	(0.23)	(0.29)
East (vs. West)	0.32	0.21	0.71 ***	0.32	0.22	0.24
	(0.21)	(0.26)	(0.18)	(0.26)	(0.21)	(0.28)
ideal N children	0.26 ***	0.28 **	0.16 **	0.36 ***	0.18 **	0.22 *
	(0.07)	(0.09)	(0.05)	(0.09)	(0.06)	(0.09)
Traditional values (z)	1.38 ***	0.98 *	1.45 ***	1.35 **	2.03 ***	1.64 ***
	(0.33)	(0.43)	(0.28)	(0.45)	(0.34)	(0.47)
AIC	1460.59	868.41	2245.24	886.36	1612.22	810.96
BIC	1560.12	959.88	2353.03	977.83	1720.93	902.43
Log Likelihood	-712.30	-416.20	-1104.62	-425.18	-788.11	-387.48
Deviance	1424.59	832.41	2209.24	850.36	1576.22	774.96
Num. obs.	1862	1190	2946	1190	3102	1190

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$
[a] Estimates based on matching women with no children with those who have child or children with propensity scores
[b] Estimates based on conventional logistic regressions.

C: The PEW World Muslim's survey and the results of the models that predict veiling.

In the PEW dataset veiling is measured in four categories: no-veil, hijab, niqab, and burqa. This variable is dichotomized in the analysis below as the proportion of women who wear the niqab and the burqa is too low. Education is measured in six to 12 categories, depending on the country, where higher categories represent increasing years of education. Those education scores are converted to country specific z-scores. Income is measured in six to 17 categories with increasing increments of income. Those income categories are converted into country specific z-scores. Age is measured in years. Urbanity is a dummy indicator of whether the respondent lives in an urban area as opposed to a rural area. Religiosity is measured by six likert-type items. Those items recode whether the respondent thinks if it is necessary to believe in God in order to be moral and have good values (*moral*) frequency of Mosque visit (*mosque*), self-reported importance of religion in one's life (*self*), frequency of praying (*pray*), the extent to which the way the respondent lives their life reflect the Hadith and Sunna, that is, the sayings and actions of the Prophet (*sunna*), and the frequency of listening to or reading Quran (*Quran*). The PEW survey has fewer covariates of veiling compared to the TDHS. To control for unobserved heterogeneity, I also control for the prevalence of veiling in one's district, that is, the mean of the original veiling variable calculated per respondent's district. When calculating this veiling prevalence measure, I exclude the subject herself.

Table C1 and C2 below show the results of multilevel models with random effects for the 25 countries. E1 shows the results after imputing missing values with Multiple Imputation. E2 presents results after list-wise deletion of those missing values. Results in E1 and E2 are rather similar.

Table C1: Coefficients of multilevel logistic regression models that predict the likelihood of veiling among married women in the Muslim World after imputing the missing values by Multiple Imputation. Data source: PEW World Muslims survey.

```
Multiple-imputation estimates                  Imputations       =        10
Random-effects logistic regression             Number of obs     =     11035
Group variable: country                        Number of groups  =        25
Random effects u_i ~ Gaussian                  Obs per group: min =      206
                                                              avg =     441.4
Integration points = 12                                       max =       807

                              (Within VCE adjusted for 25 clusters in country)
------------------------------------------------------------------------------
          v2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
# children (0 = reference)
          1  |   .2211335   .1152067     1.92   0.055    -.0046674    .4469345
          2  |   .2269148    .112088     2.02   0.043     .0072263    .4466033
  3-or-more  |    .447566   .1180548     3.79   0.000     .2161827    .6789492
             |
    urbanity |  -.3319694   .0980135    -3.39   0.001    -.5240723   -.1398665
  income (z) |  -.0203252   .0384589    -0.53   0.597    -.0957418    .0550914
education (z)|  -.1967879    .061186    -3.22   0.001    -.3167105   -.0768652
  mean(veil) |   4.127539    .611729     6.75   0.000     2.928573    5.326506
         age |   .1973621   .0579497     3.41   0.001     .0837814    .3109429
 Religiosity |   .3763399   .0593027     6.35   0.000     .2601087    .4925711
       _cons |  -3.260676   .6203645    -5.26   0.000    -4.476569   -2.044784
-------------+----------------------------------------------------------------
    /lnsig2u |   .6296226    .366262                     -.0882378    1.347483
-------------+----------------------------------------------------------------
     sigma_u |   1.370001   .2508896                      .9568402    1.961563
         rho |   .3632641   .0847176                       .217706     .539079
------------------------------------------------------------------------------
```

Table C2: Coefficients of multilevel logistic regression models that predict the likelihood of veiling among married women in the Muslim World after list-wise deletion of missing values. Data source: PEW World Muslims survey.

```
Random-effects logistic regression              Number of obs      =     10098
Group variable: country                         Number of groups   =        25

Random effects u_i ~ Gaussian                   Obs per group: min =       199
                                                               avg =     403.9
                                                               max =       789

Integration method: mvaghermite                 Integration points =        12

                                                Wald chi2(9)       =    127.97
Log pseudolikelihood  = -4577.3378              Prob > chi2        =    0.0000

                               (Std. Err. adjusted for 25 clusters in country)
```

v2	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
# children (0 = reference)						
1	.19038	.1114958	1.71	0.088	-.0281479	.4089078
2	.2498429	.11041	2.26	0.024	.0334433	.4662426
3-or-more	.424164	.1170206	3.62	0.000	.194808	.6535201
urbanity	-.3614454	.1056008	-3.42	0.001	-.5684191	-.1544717
income (z)	-.0354877	.0384425	-0.92	0.356	-.1108336	.0398582
education (z)	-.1769176	.0662475	-2.67	0.008	-.3067603	-.0470749
mean(veil)	3.878427	.5951459	6.52	0.000	2.711963	5.044892
age	.0148918	.0039667	3.75	0.000	.0071171	.0226664
Religiosity	.3702974	.053959	6.86	0.000	.2645398	.4760551
_cons	-3.578632	.5966402	-6.00	0.000	-4.748025	-2.409238
/lnsig2u	.6943286	.3573944			-.0061515	1.394809
sigma_u	1.415049	.2528653			.996929	2.008532
rho	.3783591	.0840604			.2320095	.5508143