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Risk Attitude in Couples

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Abstract

The determinants of risk attitude in couples are explored using data from the German Socio-Economic Panel over the period 2004 to 2009. The focus of the analysis is the repeated responses to the survey question about general willingness to take risk. Responses to this question are provided on a 0-10 Likert scale. We focus on couples in the data set, and we apply the bivariate panel ordered probit model to the analysis of the simultaneous determination of the male's and the female's risk attitude. A number of individual characteristics, including age, height, education and household income, are found to have strong effects on risk attitude, in some cases differing markedly between the male and the female. Both the individual-specific effects and the observation-specific error terms are assumed to have non-zero correlations between the two equations. These correlations are estimated to be +0.27 and +0.28 respectively. We consider the former to be a key parameter, since its positive sign may be interpreted as a form of *homophily*: individuals tend to form partnerships with others having a similar risk attitude.

Keywords: Multiple Equation Models; Panel Data; Risk Attitude.

JEL: C33, D81.

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1 Introduction

Economists are very interested in the determinants of risk attitude. Due to data constraints, research that seeks to determine risk attitude has often been in the laboratory setting, and consequently restricted to small numbers of contrived risk questions and relatively small numbers of respondents at a given point in time. Investigation of risk attitude outside the laboratory overcomes some of the restrictions, allowing for larger numbers of respondents to be examined, and moreover allowing repeated observations over time. One setting in which such advantages are fully realized is that of the longitudinal survey with self-reported risk attitude questions. One such survey is the German Social and Economic Panel Survey (SOEP), which has already been analysed for the purpose of determining factors affecting risk attitude by Dohmen et al. (2011).

In this paper, we use this self-reported data on risk attitude to investigate risk-attitude in couples. It is common for household decisions to be made jointly by two (or more) household members. It is therefore of interest to know in what ways, if any, joint decision-making differs from individual decision-making. Previous research on risky choices in couples: Bateman and Munro (2005) and Masclet et al. (2009) find that joint decisions made by mixed-gender couples show more risk-aversion than those made by members of couples operating individually.

Unlike the aforementioned literature, we are more interested in the risk attitude of the members of couples, than in decisions actually made. We are also interested in estimating the determinants of these risk attitudes. Furthermore, we are interested in how individual-specific risk-attitude enters the matching process leading to couple formation. These issues may all be addressed by estimating a bivariate model in which one equation represents the risk-attitude of the male partner, and the other represents that of the female. The two dependent variables representing risk attitude are both ordinal variables with 11 outcomes. The model we construct may be described as the bivariate panel ordered probit model (BPOP). Underlying each outcome is a continuous variable representing the propensity-to-take-risk, which is assumed to depend linearly on the characteristics of the relevant individual, and also on certain characteristics of the spouse. Note that it is a panel data model, since each couple

is typically observed in more than one wave.

The panel structure of the data enables us to estimate separately two different correlation parameters, which may be interpreted in the context of Becker's (1974) theory of marriage. The first (ρ_u) represents the correlation between individual-specific terms for the two partners and may be interpreted in terms of the extent of 'assortive mating'; the second (ρ_ϵ) represents the correlation between the two within-individual errors and may be interpreted in terms of 'shared social environment'. We consider the first of these (ρ_u) to be of particular interest, since it conveys information on the matching process; specifically, it reveals whether risk seeking individuals match with other risk-seeking individuals (if $\rho_u > 0$), or with risk-averse individuals (if $\rho_u < 0$). If $\rho_u = 0$, we may conclude that risk attitude is irrelevant in the matching process. Di Cagno et al. (2012) have pursued similar goals in an experimental setting. They find that when subjects are allowed to choose a gambling partner, they tend to team up with other agents displaying similar degrees of risk aversion. In terms of our modelling framework, they are finding evidence that $\rho_u > 0$. This may be interpreted as a form of *homophily* (McPherson et al. (2001)): the tendency of individuals to form partnerships with others having similar personality traits.

Spousal correlations have been estimated using survey or lingitudinal data in other contexts, for example:labour force participation, Kooreman (1994); health, Wilson (2002); smoking behaviour, Clark and Etilé (2006); obesity, Kano (2008) and wellbeing, Powdthavee (2009). To our knowledge, spousal correlations in risk attitude have not been previously estimated.

Given the importance of the correlation parameters, it is desirable to estimate them as precisely as possible. Smith and Moffatt (1999) have drawn attention to the problems arising in the estimation of correlation parameters in limited dependent variable settings. In particular, they find that it is very hard to obtain a precise estimate when only bivariate binary data is available. This underlines the usefulness of the ordinal data that is available on self-reported risk attitude, and it is important to exploit the full range of this ordinal response. It is furthermore important to make maximal use of the repeated responses. It is for these reasons that we develop and estimate the Bivariate Panel Ordered Probit model (BPOP).

The paper is organised as follows. Section 2 describes the data. Section 3 outlines the theory underlying the BPOP model which is used for estimation. Section 4 presents and interprets the estimation results. Section 5 concludes.

2 The Data

We draw on data from the German (SOEP) for the four years 2004, 2006, 2008 and 2009. There are approximately 21,000 individuals, surveyed on average 3.2 times in the four survey years. For the purposes of this research, a subset of 'household couples' is extracted from the panel, comprising 6,380 couples, observed on average 2.9 times over the four years.

In constructing the couples dataset a number of items were taken into account. From the variable 'relationship to head' we determine the 'head' and 'spouse' for each household for each survey year. We are careful to check that they both report having a partner or being married (referring to the variable denoting marital status). This filtering rule excludes: elderly parent 'heads' who have older children living with them; households headed by single 'heads'; and 'non-head' households, in which the 'spouse' remains following separation, divorce or bereavement. The variable denoting gender is then used to identify couples with male heads, and couples with female heads. We do not find any same sex couples.

The main focus of our analysis is on a risk attitude question asked in each of the survey years. This question is reproduced as follows:

How do you see yourself? Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?" Please tick a box on the scale, where 0 means "risk averse" and the value 10 means "fully prepared to take risks"



0 1 2 3 4 5 6 7 8 9 10

Whilst it is hugely beneficial to be working with such a large sample that is representative of the population, there is clearly a potential problem with self-reported data on risk attitude: the responses may not be incentive compatible. This factor has hitherto hindered the use of survey question responses in research into risk attitude. This is evidenced by the discussion of this dilemma given in Camerer and Hogarth (1999), relating to the controversy/validity of self-reported survey responses where no incentive mechanisms are used: indeed, this is one of the reasons for the growing popularity of experimental economics in recent decades.

There is clearly an issue of internal consistency when working with any type of survey data. The debate centres around motivation and truthfulness. Motivation to participate in a survey is largely unknown, since compensation is likely to be nominal and unrelated to outcomes. Hence, case responses rely on altruism, but may be biased, so it is hard to imagine how one might introduce "task-related incentives" that induce truthful responses to individual survey questions. This problem is of special concern here, because we wish to use survey data to make inferences that are more usually made through the channel of risky choice experiments, in which subjects choices *are* incentive compatible.

Dohmen et al. (2011) have to a certain extent bridged this gap for us already, by validating the 2004 survey responses with an economically motivated experiment carried out in 2005. They report that 450 subjects were drawn randomly from the same German population from which the national SOEP is drawn and asked the identical questions from the SOEP survey with respect to the risk attitude questions. To elicit 'true' risk preferences, this survey was augmented by responses from a paid lottery experiment with a simple structure. This experiment consisted of presenting subjects with a table containing 20 rows, each depicting a choice problem. The risky option was always a 50:50 lottery with outcomes €300 and €0; the safe option was a certain outcome which increased between tasks, from €0 to €190 in increments of €10. After a participant had made a decision for each row, one of the rows was selected at random, and the choice made for that row was played out for real.[1] In this type of experiment subjects tend to switch from the safe to the risky alternative at a particular row of the table,

[1] This is essentially the random lottery incentive (RLI) scheme, which is a means of ensuring (notwithstanding the Holt (1986), critique) that subjects treat each choice task as if it is the only task, and therefore that each task is incentive-compatible.

and the safe outcome in that row may be interpreted as the subjects' certainty-equivalent (CE) of the risky lottery. This certainty-equivalent may in turn be interpreted as a measure of the subjects' willingness to take risks.

The key issue is then the closeness with which this experimentally induced risk measure corresponds to the self-reported measure from the survey. Dohmen et al. (2011) address this issue by performing linear regressions with the experimental measure as the dependent variable, and the self-reported measure of risk attitude as one of the explanatory variables. In all of the regressions they perform, the self-reported risk attitude measure has a strongly positive effect on the experimental risk measure, with the certainty equivalent appearing to increase by around €5 with each unit increase in the self-reported measure. The important outcome here is that the self-reported risk-attitude data, in spite of its reputation as a non-incentive compatible method, is found to be eminently reliable and therefore can be trusted to reflect true risk attitudes in the same way as we unquestioningly trust data from risky choice experiments.

Figure 1 depicts the distribution of risk attitude from the risk question reproduced above over the four survey years, by gender. The two important features of Figure 1 are that females appear to be more risk averse than males, and that respondents appear to become more risk averse over time. We also see that in general the distribution of risk attitude is multi-modal, with modes at 0, 3 and 5. However, the mode at 5 is conjectured to be partly the result of a tendency for respondents to be drawn to this 'focal point', being the mid-point of the scale. This conjecture is confirmed by observing that the frequencies at the neighbouring values, 4 and 6, appear to be too low relative to the surrounding frequencies. It therefore appears that the focality of 5 attracts respondents who would otherwise have selected 4 or 6. This focality is likely to be reflected in the positions of the estimated cut-points in the BPOP model (see Section 3). The mode at zero may be interpreted as a manifestation of zero censoring, where a sizable proportion of the sample appears to be attempting to signal that they are highly risk averse, and they therefore accumulate at the lowest possible score of zero.

A number of explanatory variables are used. Age (in years) and age-squared are used in order to allow for a non-monotonic age effect. The variable representing educational at-

tainment contains four levels: none recorded (0); less than high school (1); high school (2); more than high school (3). From this we extract a dummy variable to denote whether the individual has a higher education level than their spouse. The occupation variable is converted into four dummy variables: unemployed; self-employed; retired; and other occupation (being the base case). For each of these we include the status of both in each equation for example: 'female is self-employed' and 'male is self-employed'. The variable 'Presence of of children in the HH' denotes the presence of children aged 17 or under in the household. Log of household income is derived from the income of all family members reported for the survey year, including benefits. This income figure is applied to both members of the couple. The time variable indicates the month number in which the interview takes place, taking values between 1 (January 2004) and 72 (December 2009).

3 Bivariate Panel Ordered Probit (BPOP) Model

The ordered probit model was introduced by Aitchison and Silvey (1957) and extended to repeated outcomes by Frechette (2001*a*,*b*). In this paper we make the further extension that is necessary when repeated ordered outcomes are observed simultaneously for two different agents, we refer to this extended model as the Bivariate Panel Ordered Probit (BPOP) model. The main purpose of this section is to derive the log-likelihood function for the BPOP model. For this purpose we shall focus on the empirical example considered in the paper: the simultaneous modelling of the risk-attitude of male and female partners.

Let i index couples i, $i = 1,\cdots n$, and let t index time period, t=1,...,T. Let $y_{m,it}$ be the response (to the risk question) of the male in couple i in period t, and let $y^*_{m,it}(-\infty < y^*_{m,it} < +\infty)$ be that male's underlying latent propensity to risk-taking. Let $y_{f,it}$ and $y^*_{f,it}$ be similarly defined for the female in couple i in period t. Let $x_{m,it}$ and $x_{f,it}$ be vectors of explanatory variables pertaining to the male and the female respectively at time t.

We then specify two equations:

$$
\begin{aligned}
y^*_{m,it} &= x'_{m,it}\beta_m + u_{m,i} + \epsilon_{m,it} \\
y^*_{f,it} &= x'_{f,it}\beta_f + u_{f,i} + \epsilon_{f,it} \\
\begin{pmatrix} u_{m,i} \\ u_{f,i} \end{pmatrix} &\sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2_{m,u} & \rho_u\sigma_{m,u}\sigma_{f,u} \\ & \sigma^2_{f,u} \end{pmatrix}\right] \\
\begin{pmatrix} \epsilon_{m,it} \\ \epsilon_{f,it} \end{pmatrix} &\sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho_\epsilon \\ & 1 \end{pmatrix}\right]
\end{aligned}
\tag{1}
$$

Note that both the between-subject error 'u' and the within-subject error 'ϵ' are assumed to be bivariate normal. ρ_u and ρ_ϵ are crucial parameters, respectively representing the correlation between the individual-specific effects, and between the within-errors, for the two members of the same couple. ρ_u reveals the manner in which risk-attitude enters the matching process leading to couple formation. ρ_ϵ reveals the manner in which the two individuals are jointly influenced by unobserved 'shocks' occurring in the time period leading up to the survey date.

Suppressing i and t subscripts for a moment, it is noted that y^*_m and y^*_f are unobserved, but the relationships between these and the observed variables y_m and y_f are:

$$
\begin{array}{llll}
y_m = 1 \text{ if} & -\infty < y^*_m < \kappa_{1,m} & y_f = 1 \text{ if} & -\infty < y^*_f < \kappa_{1,f} \\
y_m = 2 \text{ if} & \kappa_{1,m} < y^*_m < \kappa_{2,m} & y_f = 2 \text{ if} & \kappa_{1,f} < y^*_f < \kappa_{2,f} \\
y_m = 3 \text{ if} & \kappa_{2,m} < y^*_m < \kappa_{3,m} & y_f = 3 \text{ if} & \kappa_{2,f} < y^*_f < \kappa_{3,f} \\
 & \vdots & & \vdots \\
y_m = J \text{ if} & \kappa_{J-1,m} < y^*_m < \infty & y_f = J \text{ if} & \kappa_{J-1,f} < y^*_f < \infty
\end{array}
$$

The parameters $\kappa_{1,m},\cdots,\kappa_{J-1,m}$ and $\kappa_{1,f},\cdots,\kappa_{J-1,f}$, j=1,...,$J-1$, are known as "cut-points". The absence of intercepts in the first two lines of (1) is a consequence of the cut-points all being free parameters.

The log-likelihood function for this model is constructed as follows. Let $P_{it}(y_f, y_m|u_{f,i}, u_{m,i})$ be the joint probability (conditional on $u_{m,i}$ and $u_{f,i}$) that the responses of the male and female in the i-th couple in period t are respectively y_m and y_f. This conditional joint probability is given by:

$$\begin{aligned} P_{it}(y_f, y_m|u_{f,i}, u_{m,i}) &= P(\{\kappa_{y_m-1,m} < y^*_{m,it} < \kappa_{y_m,m}\} \cap \{\kappa_{y_f-1,f} < y^*_{f,it} < \kappa_{y_f,f}\}|u_{f,i}, u_{m,i}) \\ &= \Phi_2(\kappa_{y_m,m} - x'_{m,it}\beta_m - u_{m,i}, \kappa_{y_f,f} - x'_{f,it}\beta_m - u_{f,i}, \rho_\epsilon) \\ &-\Phi_2(\kappa_{y_m,m} - x'_{m,it}\beta_m - u_{m,i}, \kappa_{y_f-1,f} - x'_{f,it}\beta_m - u_{f,i}, \rho_\epsilon) \\ &-\Phi_2(\kappa_{y_m-1,m} - x'_{m,it}\beta_m - u_{m,i}, \kappa_{y_f,f} - x'_{f,it}\beta_m - u_{f,i}, \rho_\epsilon) \\ &+\Phi_2(\kappa_{y_m-1,m} - x'_{m,it}\beta_m - u_{m,i}, \kappa_{y_f-1,f} - x'_{f,it}\beta_m - u_{f,i}, \rho_\epsilon) \end{aligned} \tag{2}$$

where $\Phi_2(z_1, z_2, \rho)$ is the bivariate normal cdf. The probability (conditional on $u_{m,i}$ and $u_{f,i}$) of the complete set of responses $(y_{m,i1} \cdots y_{m,iT};\ y_{f,i1} \cdots y_{f,iT})$ for couple i is:

$$\prod_{t=1}^{T} P_{it}(y_f, y_m|u_{f,i}, u_{m,i}) \tag{3}$$

The likelihood contribution for couple i, that is, the unconditional joint probability of y_m and y_f, is obtained by integrating both u_m and u_f out of (3):

$$L_i = \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \left[\prod_{t=1}^{T} P_{it}(y_f, y_m|u_{f,i}, u_{m,i})\right] f(u_m, u_f; \sigma_m, \sigma_f, \rho_u) du_m du_f \tag{4}$$

where: $f(u_m, u_f, \sigma_m, \sigma_f, \rho_u)$ is the bivariate normal density function with mean vector zero, and covariance matrix as specified in the third line of (1).

Based on a sample $(y_{m,it}, x_{m,it}, y_{f,it}, x_{f,it}; i = 1 \cdots n, t = 1 \cdots T)$, the log-likelihood is given

by:

$$(5) \qquad LogL(\beta_m, \beta_f, \sigma_m, \sigma_f, \rho_u, \rho_\epsilon, \kappa_{1,m}, \cdots, \kappa_{J-1,m}, \kappa_{1,f}, \cdots, \kappa_{J-1,f}) = \sum_{i=1}^{n} lnL_i$$

(5) is maximised using the method of maximum simulated likelihood (MSL) to give maximum likelihood estimates of all parameters. The use of MSL in this case requires two sets of Halton draws: one to simulate each of u_m and u_f. The STATA code is available from the authors.

Note that the BPOP model could also be used to model two different responses made by the same respondent. This would be required where the respondent has been asked for their willingness to take risks in two different domains (financial and health, say). The only difference from the analysis above is that the same vector of explanatory variables would apply to both responses. Once again the key parameters would be ρ_u and ρ_ϵ: this time they would capture the degree of consistency of risk attitude over domains.

4 Results

Table 1 contains results from the BPOP model, constructed in Section 3, which simultaneously models the risk attitude of males and females in couples. A number of explanatory variables are used, and these were introduced in Section 2. Some of the variables have a similar effect for both members of the couple; in other cases the effects differ between them.

Age appears to be important for females, for whom there is a decline in willingness to take risk with age. A dummy indicating whether the individual has more years of eduction than the spouse is included; this has a significant positive effect on risk-taking for males but not for females. Self-employment has the expected positive effect on risk-taking, as is well-documented (e.g. see Elkelund et al. (2005)). Retirement appears to have a significant positive effect for females. The effect of unemployment is interesting. Although males' risk attitude appears to be unaffected by unemployment, females' risk attitude is negatively affected by *both* female and male unemployment. The presence of children has a significant negative effect on female

risk taking, but no effect on males. Dohmen et al. (2011) found a strongly significant effect of height on risk taking, and suggested explanations of this phenomenon. Here, we find that male height has a positive effect on risk taking for both partners, and that female height has a negative effect for both partners. The effect of income is positive for both partners, and greater in magnitude for females. Both males and females show a strongly significant decline in risk taking over the time period covered by the sample. This might be attributed to the changing economic climate over the period 2004-2009.

As previously discussed, the key parameter in the model is ρ_u, the correlation between the individual-specific terms for males and females. This is estimated to be +0.268 with a standard error of 0.020. The overwhelmingly strong significance of this coefficient, confirms the homophily hypothesis for which Di Cagno et al. (2012) have already found experimental evidence: that individuals tend to form partnerships with others with similar risk attitude. The other correlation coefficient is ρ_ϵ and this represents the association between the within-error terms for the male and the female at the same point in time. This is estimated to be +0.279 with a standard error of 0.0093. This is also of overwhelming significance, and indicates that the two members of the couple respond in similar ways to shocks that have an impact on risk attitude. Obvious examples of this type of shock include instances where both members experience an event simultaneously such as watching a TV broadcast showing a lottery winner, or reading a newspaper article reporting a gloomy economic outlook.

Turning finally to the estimates of the cut-points, we note only that the differences between κ_5 and κ_6 is, for both equations, considerably larger than differences between other pairs of adjacent cut-points. This is a consequence of the focality at 5: as seen in Figure 2 and discussed in Section 2, there is an apparent over-incidence of observations at this middle value of the Likert scale. A greater distance between consecutive cut-points is the model's way of dealing with an abnormally high frequency of a particular response. Hence the structure of the model is able to incorporate this rather awkward feature of the data; this is another important reason for using the BPOP.

5 Conclusion

In this research we have combined the data sets from four cohort years of a statistically representative sample of the German population, in order to obtain a panel of couples. We have used this data to analyse the determinants of risk attitude for each member of the couple, and we have also considered the association between the two members' risk attitudes. In analysing the data set we have been careful to exploit the longitudinal nature of the data, and also to respect the ordinality of the dependent variable.

The most important result relates to the significantly positive estimate of the parameter ρ_u, which has been interpreted in terms of 'assortive mating' in the context of Becker's (1974) theory of marriage. This result corroborates recent experimental findings regarding team-formation in decision tasks, where individuals appear to seek out similarly minded team mates. Here, of course, we are interested in the formation of unions that are expected to last somewhat longer than the duration of an experiment. A further point is that it is by no means obvious that a positive value of ρ_u is expected. Risk-sharing arguments would lead to the hypothesis that $\rho_u < 0$ and to the prediction that an increase in the marriage rate would bring about a fall in aggregate risk taking. However, our data is telling us that this is not the case.

A final point is that the two strongly significant estimates of the correlation coefficients ρ_u and ρ_ϵ, underline the importance of adjusting for clustering when working with individual level data that is grouped into household clusters.

Table 1: Bivariate Panel Ordered Probit Model

Couples Bivariate	Male	Female		Cut Points Male	Cut Points Female
Age	-0.00163	0.00836	κ_1	-2.320	-1.458
	(0.00762)	(0.00711)		(0.242)	(0.221)
Age squared	-0.000121	-0.000197**	κ_2	-0.723	-0.745
	(0.0000688)	(0.0000669)		(0.0357)	(0.0269)
Individual has higher education	0.0687*	0.0451	κ_3	-0.441	-0.432
	(0.0293)	(0.0404)		(0.0221)	(0.0188)
Male is self employed	0.477***	0.0665	κ_4	-0.552	-0.545
	(0.0425)	(0.0483)		(0.0194)	(0.0177)
Female is self employed	-0.0131	0.341***	κ_5	-0.977	-0.896
	(0.0543)	(0.0532)		(0.0225)	(0.0208)
Male is retired	-0.0821	0.0119	κ_6	-0.297	-0.223
	(0.0470)	(0.0442)		(0.0155)	(0.0156)
Female is retired	0.0710	0.0895*	κ_7	-0.709	-0.810
	(0.0415)	(0.0419)		(0.0209)	(0.0253)
Male is unemployed	-0.0255	-0.0928*	κ_8	-0.398	-0.525
	(0.0388)	(0.0381)		(0.0207)	(0.0276)
Female is unemployed	-0.0295	-0.0852**	κ_9	-0.114	-0.332
	(0.0276)	(0.0273)		(0.0258)	(0.0390)
Presence of children in HH	-0.00750	-0.0800*	κ_{10}	-0.596	-0.808
	(0.0358)	(0.0347)		(0.0550)	(0.0828)
Male height	0.00210***	0.00184***			
	(0.000111)	(0.000110)			
Female height	-0.000316*	-0.000765***			
	(0.000123)	(0.000121)			
Log HH Total Income	0.0570*	0.0823***			
	(0.0160)	(0.0157)			
Time	-0.00612***	-0.00585***			
	(0.000380)	(0.000378)			
σ_u	0.878***	0.813***			
	(0.0158)	(0.0157)			
ρ_u	0.268***				
	(0.0198)				
ρ_ϵ	0.279***				
	(0.00933)				
Observations	17,503				
#Couples (n)	6,380				
T (mean of)	2.9				
Log − Likelihood	-70254.4				

Dependent variable is 'willingness to take risk', on a Likert scale 0-10, where 0 denotes extreme risk aversion, and 10 denotes 'fully prepared to take risks'. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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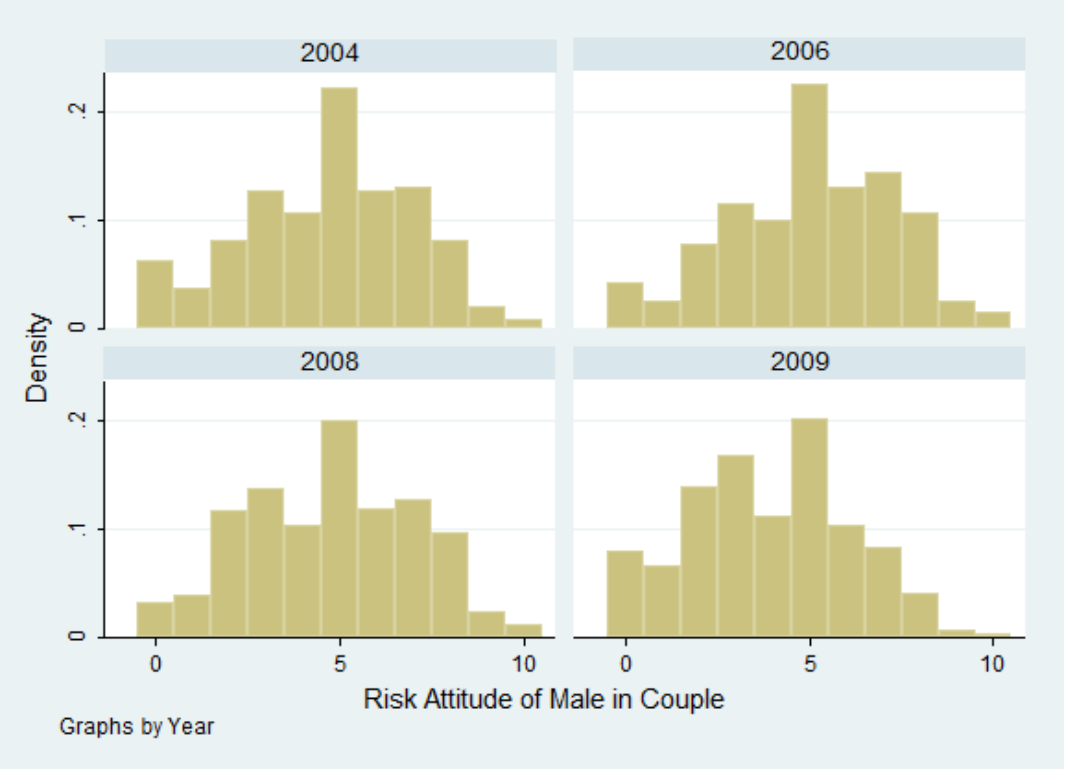


Figure 1: Risk Attitude of Male in the Couple by Year

Source: SOEP 2004-2009

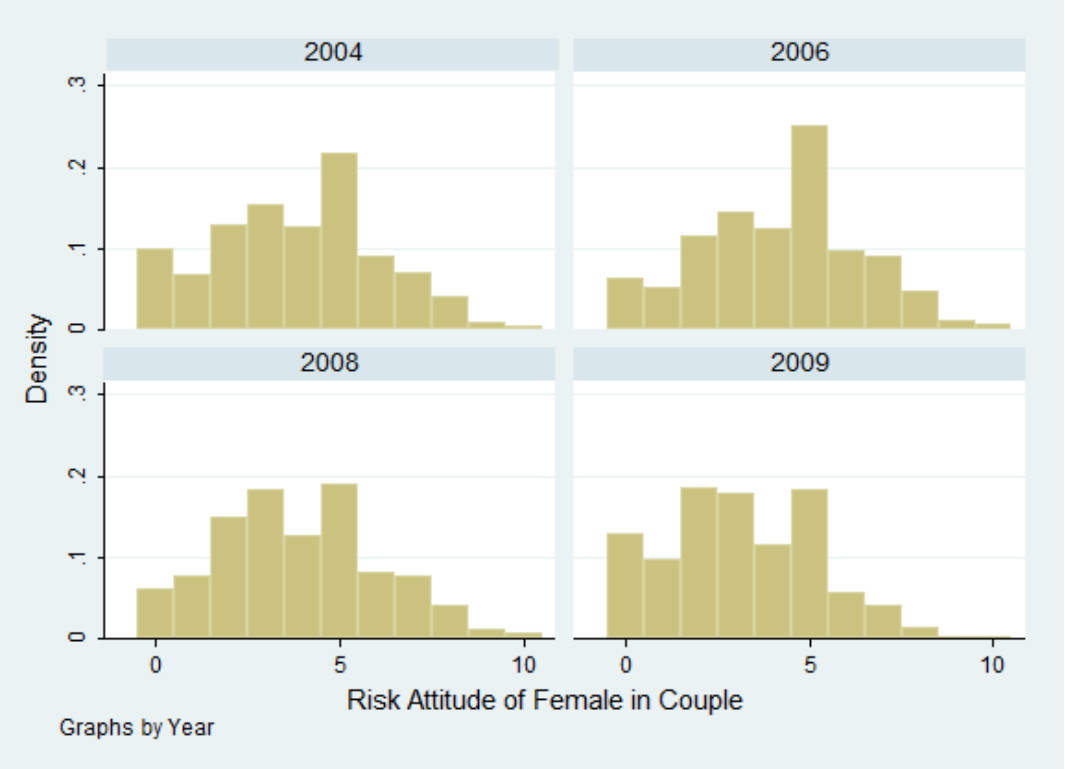


Figure 2: Risk Attitude of Female in the Couple by Year

Source: SOEP 2004-2009