`rbicopula`: Recursive bivariate copula estimation and decomposition of marginal effects

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Motivation

Effects of interest

1. What we assume
   - Effect of a binary or treatment variable on a binary outcome variable
   - Treatment variable itself is endogenous
   - Unobservables may correlate with treatment and outcome equation
   - Bivariate normal distribution may not fit our data
2. What we want
   - Use different bivariate distributions and compare results
   - Find the best-fitting bivariate distribution for our data
   - Compute treatment effect and marginal effect of independent variables
3. What doesn't work:
   - `bicop` doesn't allow `margins` as postestimation command
   - `rbiprobit` only allows bivariate normal distribution
   - `ivprobit` inappropriate; treatment variable is binary

```
ssc install rbiprobit
```

Contribution

A new Stata package

- rbicopula estimates RBMs like bicop or rbiprobit
  - allows different bivariate distributions or copulas
  - calculates Kendall's τ as a comparison criterion of estimation results
  - allows weights (pw,fw,iw)
  - provides various variance estimators (vce)
  - bootstrap, jackknife, and svy prefix are allowed
- rbicopula accounts for recursive nature in postestimation
- Postestimation commands enable
  - Correct predictions
  - Computation of different treatment effects
  - Decomposition of average marginal effects of independent variables
  - Standard errors using the delta method or bootstrapping

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Recursive bivariate model

The Model

A structural model with endogenous explanatory treatment variable y_2

$$y_1^\star = x'\beta + \alpha y_2 + \epsilon_1 \quad , y_1 = 1\left[y_1^\star > 0\right] \tag{1}$$

$$y_2^\star = z'\gamma + \epsilon_2 \quad , y_2 = 1\left[y_2^\star > 0\right] \tag{2}$$

$$\text{with } \begin{pmatrix} \epsilon_1 \\ \epsilon_2 \end{pmatrix} \sim F(\epsilon_1, \epsilon_2)$$

- dependence or correlation between ϵ_1 and ϵ_2 induces endogeneity
- flexible parametric distribution assumption for $F(\epsilon_1, \epsilon_2)$
- x' and z' can share some or all independent variables
- Greene (2018) notes that endogenous nature of y_2 can be ignored
- Han and Lee (2019): estimates are at best weakly identified if $\boldsymbol{x} = \boldsymbol{z}$

Recursive bivariate model

Treatment Effects: ATE, ATET, and ATEC

1. Average treatment effect (ATE)

$$\text{ATE} = \Pr(y_1 = 1|x')|_{y_2=1} - \Pr(y_1 = 1|x')|_{y_2=0}$$

   - Ceteris-paribus scenario over full sample
   - Difference between marginal probabilities of y_1
   - Effect of discrete change in treatment holding all other observed and unobserved variables constant

2. Average treatment effect on the treated (ATET) atet
3. Average treatment effect on conditional probability of outcome success (ATEC) atec

Decomposition of Marginal Effects

Joint and Conditional Probabilities

- Independent variable d appears in both x' and z'
- Decomposition of total marginal effects on the probabilities (except marginal probabilities) are then
  1. Continuous Variables (see Greene, 2018)

$$\text{ME} = \frac{\partial \Pr}{\partial \begin{pmatrix} x_d \\ z_d \end{pmatrix}} = \underbrace{\frac{\partial \Pr}{\partial x_d}}_{\text{direct effect}} + \underbrace{\frac{\partial \Pr}{\partial z_d}}_{\text{indirect effect}}$$

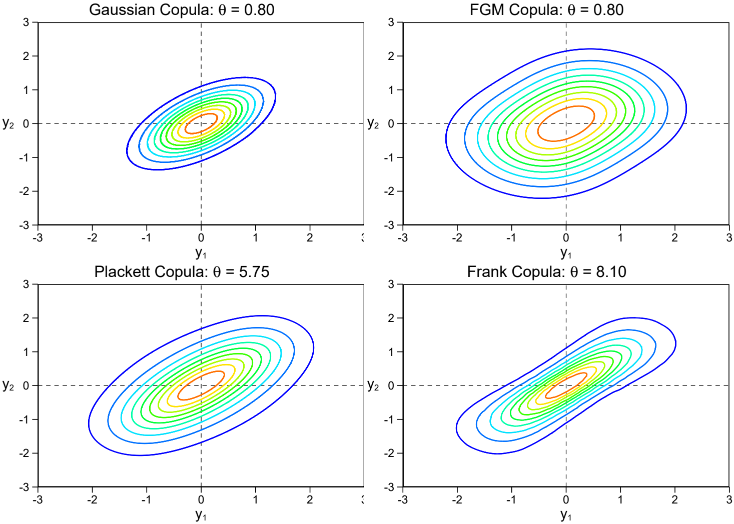
  2. Discrete Variables (see Hasebe, 2013; Edwards et al., 2019)

$$\text{ME} = \underbrace{[\Pr|_{x_d=1} - \Pr|_{x_d=0}]}_{\text{direct effect}} + \underbrace{[\Pr|_{z_d=1} - \Pr|_{z_d=0}]}_{\text{indirect effect}}$$

Copula Functions

Basics

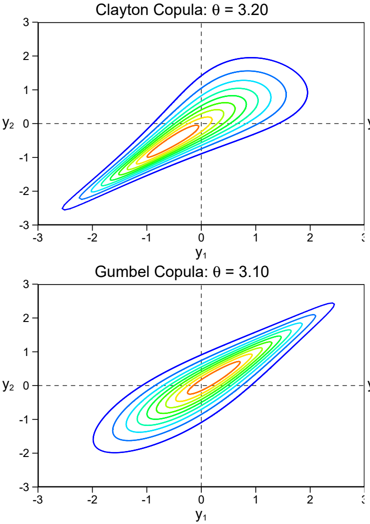
Bivariate Density of Copulas



Copula Functions

Copulas

Bivariate Density of Copulas (con't)



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Basic Syntax

rbicopula *depvar* [=] [*indepvars*] [*if*] [*in*] [*weight*]
, endogenous(*depvar_en* [=] [*indepvars_en*] [, *enopts*]) [*options*]

- depvar and depvar_en have to be 0/1 variables
- *depvar_en* automatically added to outcome equation as factor-variable
- copula() allows 9 different copula functions, e.g. gaussian, fgm,...
- Factor variables and time-series operators allowed
- bootstrap, jackknife, and svy prefix are allowed
- Variance estimators: robust, cluster robust, bootstrap, ...
- Linear constraints are applicable

Postestimation Commands

predict

Margins and Treatment Effects

rbicopula margdec [*if*] [*in*] [*weight*] [, *response_options options*]

rbicopula tmeffects [*if*] [*in*] [*weight*] [, tmeffect(*effecttype*) *options*]

rbiprobit margdec options

effect(*effecttype*)	specify type of effect; *effecttype* may be total, direct, or indirect; default is total
predict(*pred_opt*)	estimate margins for predict, *pred_opt* ; multiple predict not applicable
dydx(*varlist*)	estimate marginal effect of variables in *varlist*

...

rbiprobit tmeffects options

tmeffect(*effecttype*)	specify type of effect; *effecttype* may be ate, atet, or atec; default is ate

...

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rbicopula output table

empirical application

```
. use "https://cobanomics.github.io/rbicopula/data/ess7_uk.dta", clear
(Modified excerpt from European Social Survey Wave 7 for United Kingdom)

. global indeplist        c.age##c.age i.female i.urban educyrs rigleft i.lbf

. rbicopula redist = $indeplist hhincdec hhmemb ///
>                  , endog(imcult = $indeplist i.pareduc imcont) copula(frank) nolog

Recursive Bivariate Copula Regression (Copula: FRANK)

                                                Number of obs     =      1,256
                                                Wald chi2(19)     =     402.80
Log likelihood = -1118.4116                     Prob > chi2       =     0.0000

------------------------------------------------------------------------------------
                   |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------------+----------------------------------------------------------------
redist             |
            imcult |
Culture undermined |  -1.315288   .2477447    -5.31   0.000    -1.800859   -.8297176
               age |   .0387031   .0149494     2.59   0.010     .0094029    .0680033
                   |
       c.age#c.age |   -.000319   .0001386    -2.30   0.021    -.0005906   -.0000474
                   |
            female |
            Female |  -.0133382   .0828927    -0.16   0.872     -.175805    .1491286
                   |
             urban |
    [1] (Sub)Urban |   .0628647   .0908488     0.69   0.489    -.1151957    .2409252
           educyrs |   .0034365   .0112123     0.31   0.759    -.0185391    .0254122
           rigleft |   .1461538   .0261515     5.59   0.000     .0948977    .1974098
                   |
               lbf |
          Employed |  -.0534302   .1010681    -0.53   0.597    -.2515201    .1446597
          hhincdec |  -.0587576   .0162586    -3.61   0.000    -.0906238   -.0268913
            hhmemb |  -.0016695   .0383488    -0.04   0.965    -.0768317    .0734928
             _cons |  -1.369986   .6219236    -2.20   0.028    -2.588934   -.1510378
-------------------+----------------------------------------------------------------
```

rbicopula output table (con't)

```
-------------------+----------------------------------------------------------------
imcult             |
               age |   .0048037     .01644     0.29   0.770    -.0274181    .0370254
                   |
       c.age#c.age |  -.0000514   .0001572    -0.33   0.744    -.0003596    .0002568
                   |
            female |
           Female  |   .3517705   .0882759     3.98   0.000     .1787528    .5247881
                   |
             urban |
     [1] (Sub)Urban |  -.1568613   .1011722    -1.55   0.121    -.3551552    .0414326
           educyrs |  -.0594006   .0114453    -5.19   0.000     -.081833   -.0369682
           rigleft |  -.1364683    .021957    -6.22   0.000    -.1795033   -.0934333
                   |
               lbf |
         Employed  |  -.1580659   .1134969    -1.39   0.164    -.3805157    .0643839
                   |
           pareduc |
   Academic parent  |  -.1861031   .0952308    -1.95   0.051    -.3727521    .0005459
            imcont |  -.0807959   .0254167    -3.18   0.001    -.1306116   -.0309801
             _cons |   2.931108   .4854207     6.04   0.000     1.979701    3.882516
-------------------+----------------------------------------------------------------
            /delta |   5.312024   1.937433     2.74   0.006     1.514725    9.109323
-------------------+----------------------------------------------------------------
             theta |   5.312024   1.937433                       1.514725    9.109323
-------------------+----------------------------------------------------------------
               tau |   .4757469
------------------------------------------------------------------------------------
Wald test of theta=0: chi2(1) = 7.51738                  Prob > chi2 = 0.0061
```

- In ML estimation dependence parameter θ is not directly estimated, but the ancillary parameter δ
- estimated dependence between error terms is positive and significantly different from zero
- Kendall's τ denoted by `tau`; there is no τ for Plackett copula

Copula Choice

Kendall's τ

Comparison of Measures of Fit

Copula	θ	τ	Wald-test p-value	log-likelihood	AIC
Gaussian	0.540	0.363	0.001	-1120.12	2284.24
FGM	1.000	0.222	0.000	-1120.17	2284.35
Plackett	11.314	—	0.175	-1118.34	2280.68
Clayton	0.441	0.181	0.123	-1121.55	2287.10
Frank	5.312	0.476	0.006	-1118.41	2280.82
Gumbel	1.957	0.489	0.015	-1118.65	2281.30
Joe	3.840	0.601	0.026	-1117.84	**2279.69**
AMH	0.826	0.245	0.000	-1120.37	2284.75

Postestimation: Treatment effects

atet and atec

rbicopula tmeffects: Average treatment effects (ATE)

```
. rbicopula tmeffects, tmeffect(ate)

Treatment effect                                        Number of obs     =      1,256
Model VCE    : OIM

Expression   : Pr(redist=1), predict(pmarg1)
Effect       : Average treatment effect
dydx w.r.t.  : 1.imcult

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         ate |  -.4385982   .0902992    -4.86   0.000    -.6155814   -.2616151
------------------------------------------------------------------------------
```

Postestimation: Marginal effects

rbicopula margdec: Average marginal effects (continuous independent variable)

```
. rbicopula margdec, dydx(rigleft) predict(p11) effect(direct)

Average marginal effects                      Number of obs     =      1,256
Model VCE    : OIM

Expression   : Pr(redist=1,imcult=1), predict(p11)
dy/dx w.r.t. : rigleft

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     rigleft |   .0327624   .0053263     6.15   0.000     .0223231    .0432017
------------------------------------------------------------------------------

. rbicopula margdec, dydx(rigleft) predict(p11) effect(indirect)

Average marginal effects                      Number of obs     =      1,256
Model VCE    : OIM

Expression   : Pr(redist=1,imcult=1), predict(p11)
dy/dx w.r.t. : rigleft

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     rigleft |  -.0015215   .0010085    -1.51   0.131     -.003498    .0004551
------------------------------------------------------------------------------
```

Postestimation: Marginal effects

don't use margins

rbicopula margdec: Average marginal effects (continuous independent variable)

```
. rbicopula margdec, dydx(rigleft) predict(p11) effect(total)

Average marginal effects                        Number of obs     =      1,256
Model VCE    : OIM

Expression   : Pr(redist=1,imcult=1), predict(p11)
dy/dx w.r.t. : rigleft

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     rigleft |   .0312409   .0049005     6.38   0.000     .0216362    .0408457
------------------------------------------------------------------------------
```

- Direct effect of `rigleft` is positive
- Indirect effect of `rigleft` is negative
- Indirect effect doesn't offset direct effect entirely

Postestimation: Plots

rbicopula margdec and rbicopula tmeffects: Marginsplots

- Marginsplot of total average marginal effects

```
. rbicopula margdec, dydx(rigleft hhincdec lbf) pr(p11) eff(total)
. marginsplot
```

- Marginsplot of indirect average marginal effects

```
. rbicopula margdec, dydx(female pareduc) pr(p10) eff(indirect)
. marginsplot
```

- Marginsplot of average treatment effect

```
. rbicopula tmeffects, tmeffect(ate)
. marginsplot
```

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Conclusion and Future Work

1. Conclusion
   - `rbicopula` identified even without IV (theoretically)
   - Without IV: identification of `rbicopula` decisively based on parametric distribution assumption
   - Three different treatment effects computable
   - Decomposition of marginal effects gives insight about insignificant total marginal effects
2. Future Work
   - 2.1 More copula functions for postestimation commands
     - Gaussian, Gumbel, Joe, AMH, and Galambos
   - 2.2 More Measures of Dependence
     - Blomqvist's β and Spearman's ρ
   - 2.3 Goodness-of-fit-tests
     - Vuong test, Clarke test, and further model selection methods

Thank you

Version 1.0.0 available

```
net install rbicopula, from("https://cobanomics.github.io/rbicopula/")
```

For Frank copula you have to additionally install `integrate`

```
ssc install integrate, replace
```

github.com/cobanomics
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References

Alrasheed, D. S. (2019). The relationship between neighborhood design and social capital as measured by carpooling. *Journal of Regional Science*, 59(5):962–987.

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Formula of Treatment Effects: ATET

Following Chiburis et al. (2012) the average treatment effect on the treated is defined by

$$
\begin{aligned}
\text{ATET} &= \Pr(y_1 = 1, y2 = 1 | x', z')|_{y_2=1} - \Pr(y_1 = 1, y2 = 1 | x', z')|_{y_2=0} \\
&= \Big\{ 1 - \Phi(-x`\beta - \alpha) - \Phi(-z'\gamma) + C\Big[\Phi(-x`\beta - \alpha), \Phi(-z'\gamma); \theta\Big]\Big\} \\
&- \Big\{ 1 - \Phi(-x`\beta) - \Phi(-z'\gamma) + C\Big[\Phi(-x`\beta), \Phi(-z'\gamma); \theta\Big]\Big\} \quad \forall\ y_{2i} = 1
\end{aligned}
$$

- Ceteris-paribus scenario over sub-sample of treated
- Effect of discrete change in treatment on the adjusted joint probability

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Formula of Treatment Effects: ATEC

Following Alrasheed (2019) the average treatment effect on conditional probability of outcome success (ATEC) is defined by

$$\text{ATEC} = \frac{\Pr(y_1 = 1, y_2 = 1 | x', z')}{\Pr(y_2 = 1 | z')} - \frac{\Pr(y_1 = 1, y_2 = 0 | x', z')}{\Pr(y_2 = 0 | z')}$$

- Accounts for selection on unobservables
- Utilizes conditional probabilities of the outcome $\Pr(y_{1i} = 1 | y_{2i} = s)$ for $s = 0, 1$ over full sample.
- Effect of a discrete change in treatment, holding only the observed variables constant
- Imposing no constraint on dependence between equations to account for changes in unobserved variables as a consequence of the treatment
- ATEC collapses to ATE if equations are independent

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Basics of Copula Functions

$$F(\epsilon_1, \epsilon_2) = C\left[F_1(\epsilon_1), F_2(\epsilon_2); \theta\right] = C\left[u, v; \theta\right]$$

- allows non-normal dependence between error terms
- binds univariate marginal distributions u and v to generate a bivariate distribution
- Depending on copula, the dependence parameter θ has different intervals
- Implementation in `rbicopula`
  - univariate marginal distribution functions are identical
  - univariate marginal distributions are normal

$$F_j(\epsilon_j) = \Phi(\epsilon_j)$$

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Available Copulas in `rbicopula`

Copula	Function $C(u, v)$	Range of θ	Independence
Product	$u \cdot v$	N/A	N/A
Gaussian	$\Phi_2\left[\Phi^{-1}(u), \Phi^{-2}(v); \theta\right]$	$-1 < \theta < +1$	$\theta = 0$
FGM	$uv \cdot [1 + \theta \cdot (1 - u) \cdot (1 - v)]$	$-1 \leq \theta \leq +1$	$\theta = 0$
Plackett	$\frac{r - \sqrt{r^2 - 4uv\theta \cdot (\theta - 1)}}{2(\theta - 1)}$	$\theta \in (0, +\infty)$	$\theta = 1$
Clayton	$(u^{-\theta} + v^{-\theta} - 1)^{-1/\theta}$	$\theta \in (0, +\infty)$	$\theta = 0$
Frank	$-\frac{1}{\theta} \cdot \ln\left[1 + \frac{(e^{-\theta u} - 1) \cdot (e^{-\theta v} - 1)}{e^{-\theta} - 1}\right]$	$\theta \in (-\infty, +\infty) \backslash \{0\}$	$\theta = 0$
Gumbel	$\exp\left\{-\left[(-\ln(u))^\theta + (-\ln(v))^\theta\right]^{1/\theta}\right\}$	$1 \leq \theta < \infty$	$\theta = 1$
Joe	$1 - \left[(\widetilde{u})^\theta + (\widetilde{v})^\theta - (\widetilde{u}\widetilde{v})^\theta\right]^{1/\theta}$	$1 \leq \theta < \infty$	$\theta = 1$
AMH	$uv \cdot [1 - \theta \cdot (1 - u) \cdot (1 - v)]^{-1}$	$-1 \leq \theta \leq +1$	$\theta = 0$

where $r = 1 + (\theta - 1)(u + v)$ for Plackett copula and $\widetilde{u} = 1 - u$, $\widetilde{v} = 1 - v$ for Joe copula

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Predictions

`predict` [*type*] *newvar* [*if*] [*in*] [, *statistic*]

statistic

`p11`	Pr(depvar = 1, depvar_en = 1); the default
`p10`	Pr(depvar = 1, depvar_en = 0)
`p01`	Pr(depvar = 0, depvar_en = 1)
`p00`	Pr(depvar = 0, depvar_en = 0)
`pmarg1`	Pr(depvar = 1); marginal success probability for outcome eq.
`pmarg2`	Pr(depvar_en = 1); marginal success probability for treatment eq.
`pcond1`	Pr(depvar = 1 | depvar_en = 1)
`pcond2`	Pr(depvar_en = 1 | depvar = 1)
`xb1`	linear prediction for outcome eq.
`xb2`	linear prediction for treatment eq.
...	

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Predictions of Interest

1. Joint Probabilities

   For $s = 0, 1$ and $t = 0, 1$ joint probabilities are given by

$$\Pr(y_1 = s, y_2 = t | x, z) = st - tq_1 \cdot u - sq_2 \cdot v + q_1 q_2 \cdot C(u, v; \theta)$$

   where

$$q_1 = 2s - 1$$
$$q_2 = 2t - 1$$
$$v = \Phi(-z'\gamma)$$
$$u = \begin{cases} \Phi(-x'\beta - \alpha) & \text{if } t = 1 \\ \Phi(-x'\beta) & \text{if } t = 0 \end{cases}$$

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Predictions of Interest

2. Conditional Probabilities

$$\Pr(y_1 = 1 | y_2 = 1, x, z) = \frac{\Pr(y_1 = 1, y_2 = 1 | x, z)}{\Phi(z'\gamma)}$$

$$\Pr(y_2 = 1 | y_1 = 1, x, z) = \frac{\Pr(y_1 = 1, y_2 = 1 | x, z)}{\Phi(x'\beta + \alpha)}$$

3. Marginal Probabilities

$$\Pr(y_1 = 1 | x) = \Phi(x'\beta + \alpha y_2)$$

$$\Pr(y_2 = 1 | z) = \Phi(z'\gamma)$$

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Predictions of Interest

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4. Unconditional Mean Function (see Blasch et al., 2019; Alrasheed, 2019)

$$
\begin{aligned}
E[y_1|x,z] &= \Pr(y_2 = 1|z) \cdot E[y_1|y_2 = 1, x, z] \\
&\quad + \Pr(y_2 = 0|z) \cdot E[y_1|y_2 = 0, x, z] \\
&= \Pr(y_1 = 1, y_2 = 1|x, z) + \Pr(y_1 = 1, y_2 = 0|x, z) \\
&= \Phi_2(x'\beta + \alpha, z'\gamma, \rho) + \Phi_2(x'\beta, -z'\gamma, -\rho)
\end{aligned}
$$

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An empirical application

1. Research question
   Does the perception of immigrants as a hazard of national culture effect natives' preference for redistribution?
2. Data
   - European Social Survey (Wave 7, 2014)
   - Individual Data from the United Kingdom
   - Data adjusted for demonstration purposes
   - Sample restricted to respondents with no migration background
3. The Model
   - Binary outcome variable: `redist`
     Should the government reduce difference in income levels?
     (Agree = 1, Disagree = 0)
   - Binary treatment variable: `imcult`
     Do immigrants undermine or enrich country's cultural life?
     (Undermine = 1, Enrich = 0)

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Varlist of independent variables

- Independent variables common to both equations
  - Age (`age`)
  - Gender (`female`)
  - Place of residence (`urban`)
  - Years of education (`educyrs`)
  - Main activity, last 7 days (`lbf`)
  - Self-placement on political left-right scale (`rigleft`)
- Independent Variables only in treatment equation
  - At least one parent is academic (`pareduc`)
  - Frequency of contact with immigrants beyond workplace and friendships (`imcont`)
- Independent Variables only in outcome equation
  - Household income (`hhincdec`)
  - Number of household members (`hhmemb`)

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Kendall's Rank Correlation or Kendall's τ

$$\tau = \Pr\left[(X_1 - X_2)(Y_1 - Y_2) > 0\right] - \Pr\left[(X_1 - X_2)(Y_1 - Y_2) < 0\right]$$

where (X_1, Y_1) and (X_2, Y_2) are independent pairs of random variables from C

- Measure of degree of dependence
- Allows comparison of dependence pattern between different copulas
- Limited to a range of $[-1, 1]$
- Negative (positive) values indicate negative (positive) dependence
- $\tau = 0$ indicates independence

Important: For Frank copula you must additionally install `integrate`

```
ssc install integrate, replace
```

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rbicopula tmeffects: ATET and ATEC

```
. rbicopula tmeffects, tmeffect(atet)

Treatment effect                                  Number of obs     =      1,026
Model VCE     : OIM

Expression    : Pr(redist=1,imcult=1|imcult=1) - Pr(redist=1,imcult=1|imcult=0)
Effect        : Average treatment effect on the treated
dydx w.r.t.   : 1.imcult

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        atet |  -.3977149   .0867208    -4.59   0.000    -.5676845   -.2277453
------------------------------------------------------------------------------

. rbicopula tmeffects, tmeffect(atec)

Treatment effect                                  Number of obs     =      1,256
Model VCE     : OIM

Expression    : Pr(redist=1|imcult=1)-Pr(redist=1|imcult=0), predict(pcond1)-predict(pc
> ond10)
Effect        : Average treatment effect on conditional probability
dydx w.r.t.   : 1.imcult

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        atec |  -.0184466   .0302367    -0.61   0.542    -.0777095    .0408163
------------------------------------------------------------------------------
```

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Incorrect standard errors using `margins`

```
. margins, dydx(rigleft) predict(p11)

Average marginal effects                        Number of obs     =      1,256
Model VCE    : OIM

Expression   : Pr(redist=1,imcult=1), predict(p11)
dy/dx w.r.t. : rigleft

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     rigleft |   .0312409    .004587     6.81   0.000     .0222505    .0402314
------------------------------------------------------------------------------

. rbicopula margdec, dydx(rigleft) predict(p11) effect(total)

Average marginal effects                        Number of obs     =      1,256
Model VCE    : OIM

Expression   : Pr(redist=1,imcult=1), predict(p11)
dy/dx w.r.t. : rigleft

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     rigleft |   .0312409   .0049005     6.38   0.000     .0216362    .0408457
------------------------------------------------------------------------------
```