Comparing coefficients of nested nonlinear probability models using `khb`

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Outline

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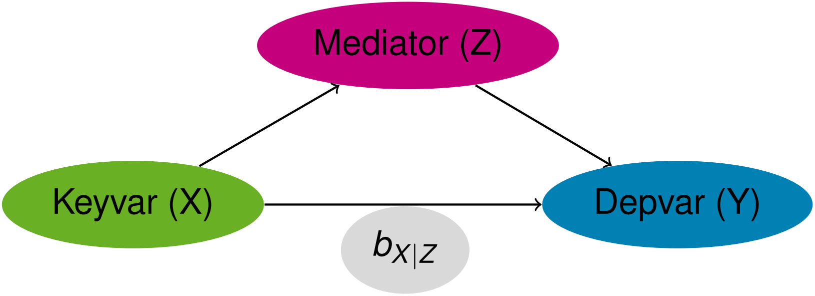
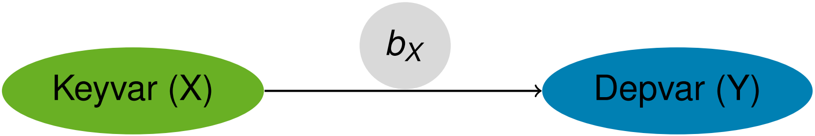
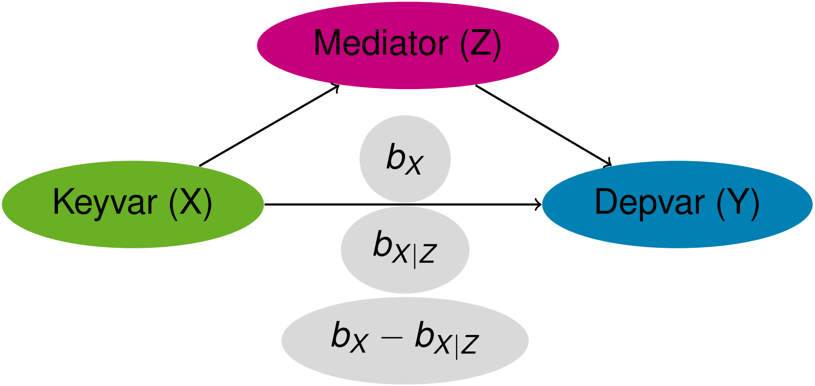
Reasons to compare



Reasons to compare



Reasons to compare



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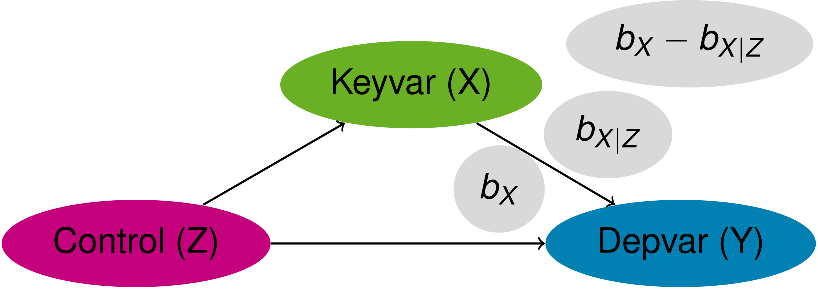
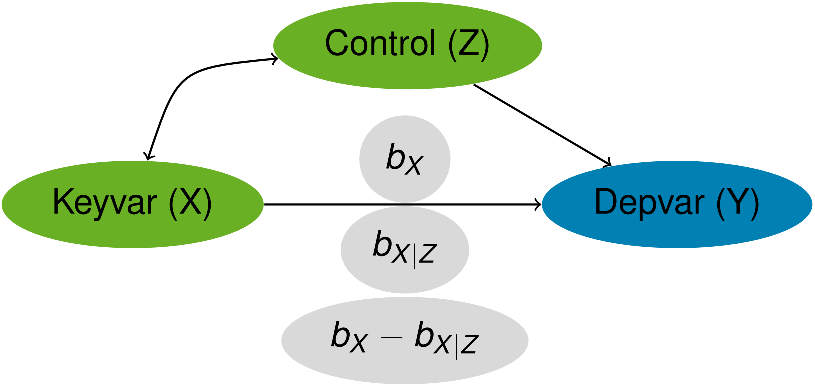


Reasons to compare



The problem

We are interested in obtaining $\beta_R - \beta_F$ from the following models for latent Y^*:

$$Y^* = \alpha_F + \beta_F X + \gamma_F Z + \delta_F C + \epsilon \quad (1)$$

$$Y^* = \alpha_R + \beta_R X + \delta_R C + \varepsilon \quad (2)$$

Having ovserved Y with value 0 if $Y^* < \tau$ and 1 if $Y^* \geq \tau$ we can obtain the logit/probit estimates with

$$b_F = \frac{\beta_F}{\sigma_F} \quad \text{and} \quad b_R = \frac{\beta_R}{\sigma_R} \quad (3)$$

Note: We identify the underlying coefficients of interest relative to a scale unknown to us.

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General idea

The KHB-method extracts from Z the information that is not contained in X. This is done by calculating the residuals of a linear regression of Z on X, i.e,

$$R = Z - (a + bX) \quad , \tag{4}$$

where a and b are the estimated regression parameters of a linear regression.

Instead of using equation (2) we then use

$$Y^* = \widetilde{\alpha}_R + \widetilde{\beta}_R X + \widetilde{\gamma}_R R + \widetilde{\delta}_R C + \epsilon \quad . \tag{5}$$

Difference of coefficients

As R and Z differ only in the component in Z that is correlated with X, model (1) is no more predictive than model (5), and consequently the residuals have the same standard deviation so that

$$\widetilde{\sigma}_R = \sigma_F \tag{6}$$

As $\widetilde{\beta}_R = \beta_R$ we can write

$$\widetilde{b}_R - b_F = \frac{\widetilde{\beta}_R}{\widetilde{\sigma}_R} - \frac{\beta_F}{\sigma_F} = \frac{\beta_R - \beta_F}{\sigma_F} \quad . \tag{7}$$

Hence, the difference obtained reflects the difference searched divided by some common scale.

Derived statistics

Confounding ratio

$$\frac{\widetilde{b}_R}{b_F} = \frac{\frac{\beta_R}{\sigma_F}}{\frac{\beta_F}{\sigma_F}} = \frac{\beta_R}{\beta_F} \quad , \tag{8}$$

Counfounding percentage

$$100 \cdot \frac{\widetilde{b}_R - b_F}{\widetilde{b}_R} = 100 \cdot \frac{\frac{\beta_R}{\sigma_F} - \frac{\beta_F}{\sigma_F}}{\frac{\beta_R}{\sigma_F}} = 100 \cdot \frac{\beta_R - \beta_F}{\beta_R} \quad , \tag{9}$$

Significance test for the difference in effects

- Analyitcally derived standard errors for the difference in effects exist.
- Based on the delta method (Sobel, 1982).
- Simple for one X and ond Z but fairly complicated for situations with more than one X, Z.
- Karlson et al. (2010) has more details; also see our Stata Journal publications (in Press)

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Syntax

`khb` *model-type depvar key-vars* || *mediator-vars* [*if*] [*in*] [, *options*]

model-type can be any of `regress`, `logit`, `ologit`, `probit`, `oprobit`, `cloglog`, `slogit`, `scobit`, `rologit`, `clogit`, and `mlogit`.

key-vars may contain factor variables

`aweights`, `fweights`, `iweights`, and `pweights` are allowed if they are allowed for the specified model type.

Options (most important ones)

options	description
`concomitant(`*varlist*`)`	concomitants
`disentangle`	disentangle difference of effects
`summary`	summary of decomposition
`vce(`*vcetype*`)`	robust or cluster clustvar
`ape`	decomposition using avg. partial effects
`verbose`	show restricted and full model
`keep`	keep residuals of mediators

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Preliminaries

- Examples from educational sociology
- Subset of Danish National Longitudinal Survey (DLSY).
- Reproduce analysis presented by Karlson and Holm (2011).

```
. use dlsy_khb, clear
. describe
Contains data from dlsy_khb.dta
  obs:         1,896
 vars:             8                          17 Jan 2011 10:26
 size:        49,296 (99.9% of memory free)
------------------------------------------------------------------------------
              storage  display     value
variable name   type   format      label      variable label
------------------------------------------------------------------------------
edu             byte   %20.0g      edu        Educational attainment
upsec           byte   %10.0g      yesno      Complete upper secondary
                                                education (Gymnasium)
univ            byte   %13.0g      yesno      Complete University education
fgroup          byte   %9.0g       fgroup     Father´s social group/class
fses            float  %9.0g                  Father´s SES, standardized with
                                                mean 0 and sd 1
abil            double %10.0g                 Standardized ability measure,
                                                with mean 0 and sd 1
intact          byte   %9.0g       yesno      Intact family
boy             byte   %9.0g       yesno      Boy
------------------------------------------------------------------------------
Sorted by:
```

Basic use

```
. khb logit univ fses || abil, c(intact boy)
Decomposition using the KHB-Method
Model-Type:  logit                                  Number of obs     =    1896
Variables of Interest: fses                         Pseudo R2         =    0.19
Z-variable(s): abil
Concomitant: intact boy
------------------------------------------------------------------------------
        univ |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
fses         |
     Reduced |   .5459815   .0779806     7.00   0.000     .3931424    .6988206
        Full |   .3817324   .0778061     4.91   0.000     .2292353    .5342295
        Diff |   .1642491   .0293249     5.60   0.000     .1067734    .2217247
------------------------------------------------------------------------------
```

Confounding ratio/percentage

```
. khb logit univ fses || abil, c(intact boy) summary notable
Decomposition using the KHB-Method
Model-Type:  logit                                 Number of obs     =    1896
Variables of Interest: fses                        Pseudo R2         =    0.19
Z-variable(s): abil
Concomitant: intact boy
Summary of confounding
```

Variable	Conf_ratio	Conf_Pct	Resc_Fact
fses	1.4302727	30.08	1.0602422

Option ape

```
. khb logit univ fses || abil, c(intact boy) ape summary
Decomposition using the APE-Method
Model-Type:  logit                                 Number of obs     =    1896
Variables of Interest: fses                        Pseudo R2         =    0.19
Z-variable(s): abil
Concomitant: intact boy
------------------------------------------------------------------------------
        univ |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
fses         |
     Reduced |   .0384906   .0054429     7.07   0.000     .0278226    .0491585
        Full |   .0269113   .0054476     4.94   0.000     .0162343    .0375884
        Diff |   .0115792   .0020667     5.60   0.000     .0075286    .0156298
------------------------------------------------------------------------------
 Note: Standard errors of difference not known for APE method
Summary of confounding
    Variable | Conf_ratio    Conf_Pct   Dist_Sens
-------------+------------------------------------
        fses |  1.4302727       30.08   .95931864
--------------------------------------------------
```

Disentangle contributions of mediators

```
. khb logit univ fses || abil intact boy, s d not
Decomposition using the KHB-Method
Model-Type:  logit                                  Number of obs     =     1896
Variables of Interest: fses                         Pseudo R2         =     0.19
Z-variable(s): abil intact boy
Summary of confounding

    Variable | Conf_ratio    Conf_Pct   Resc_Fact
-------------+--------------------------------------
        fses |  1.5207722       34.24   1.1317064
----------------------------------------------------

Components of Difference

  Z-Variable |      Coef    Std_Err      P_Diff  P_Reduced
-------------+-----------------------------------------------
fses         |
        abil |  .1661177   .0301003       83.56      28.61
      intact |   .020142   .0144611       10.13       3.47
         boy |  .0125359    .011524        6.31       2.16
-------------------------------------------------------------
```

More than one key variable

```
. khb logit univ boy intact || abil, c(fses) s
Decomposition using the KHB-Method
Model-Type:  logit                                 Number of obs     =     1896
Variables of Interest: boy intact                  Pseudo R2         =     0.19
Z-variable(s): abil
Concomitant: fses
```

univ	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
boy						
Reduced	1.06178	.1848087	5.75	0.000	.6995613	1.423998
Full	.9821406	.1848351	5.31	0.000	.6198704	1.344411
Diff	.0796391	.133004	0.60	0.549	-.1810438	.3403221
intact						
Reduced	1.129767	.7386976	1.53	0.126	-.3180536	2.577588
Full	1.08391	.7386558	1.47	0.142	-.3638292	2.531648
Diff	.0458575	.1328438	0.35	0.730	-.2145116	.3062266

Summary of confounding

Variable	Conf_ratio	Conf_Pct	Resc_Fact
boy	1.0810873	7.50	1.0033213
intact	1.0423075	4.06	1.03542

Categorical variables

```
. xtile catabil = abil, n(4)
. tab catabil, gen(catabil)
. khb logit univ i.fgroup || catabil2-catabil4, c(intact boy) s d
```

Ordered outcome

```
. forv i = 1/3 {
  2.          quietly eststo: khb ologit edu fses || abil, out(`i´) ape s
  3. }

. esttab, scalars("ratio_fses Conf.-Ratio" "pct_fses Conf.-Perc.")
------------------------------------------------------------
                      (1)             (2)             (3)
                      edu             edu             edu
------------------------------------------------------------
fses
Reduced            -0.103***       0.0643***       0.0385***
                 (-11.33)         (10.72)          (9.27)

Full              -0.0755***       0.0472***       0.0283***
                  (-8.02)          (7.76)          (7.23)

Diff              -0.0272***       0.0170***       0.0102***
                  (-6.50)          (6.44)          (5.95)
------------------------------------------------------------
N                    1896            1896            1896
Conf.-Ratio         1.360           1.360           1.360
Conf.-Perc.         26.48           26.48           26.48
------------------------------------------------------------
t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001
```

Multinomial outcome

```
. forv i = 2/3 {
  2.          quietly eststo: khb mlogit edu fses || abil,  out(`i´) base(1) s
  3. }

. esttab, scalars("ratio_fses Conf.-Ratio" "pct_fses Conf.-Perc.")
```

	(1) edu	(2) edu
fses		
Reduced	0.423***	0.779***
	(7.63)	(9.30)
Full	0.313***	0.552***
	(5.70)	(6.68)
Diff	0.109***	0.227***
	(5.93)	(6.04)
N	1896	1896
Conf.-Ratio	1.349	1.411
Conf.-Perc.	25.88	29.15

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Outline

References

Karlson, K. B. and A. Holm. 2011. Decomposing primary and secondary effects: A new decomposition method. *Research in Stratification and Social Mobility* 29: XXXX.

Karlson, K. B., A. Holm, and R. Breen. 2010. Comparing regression coefficients between models using logit and probit: a new method. Unpublished paper (currently under review).

Sobel, M. E. 1982. Asymptotic confidence intervals for indirect effects in structural equation models. In *Sociological Methodology 1982*, ed. L. S., 290–312. Washington D.C.: American Sociological Association.