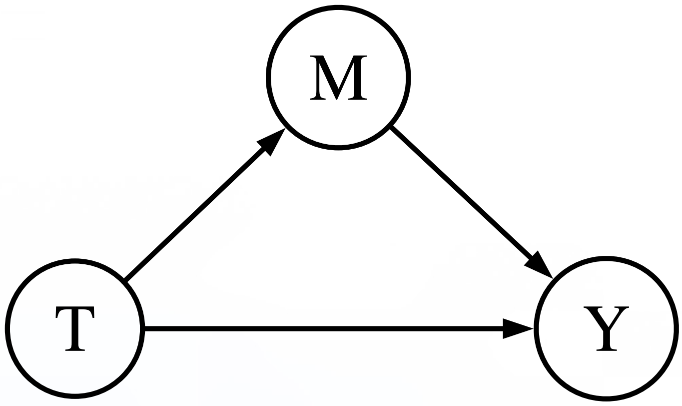
New in STATA 18

Causal mediation analysis

Want to better understand a causal relationship? Causal mediation analysis explains these relationships by decomposing a treatment effect into a direct effect of the treatment on the outcome and an indirect effect through another variable, the mediator.

With Stata's new **mediate** command, you can fit causal mediation models for a variety of outcome and mediator model combinations.



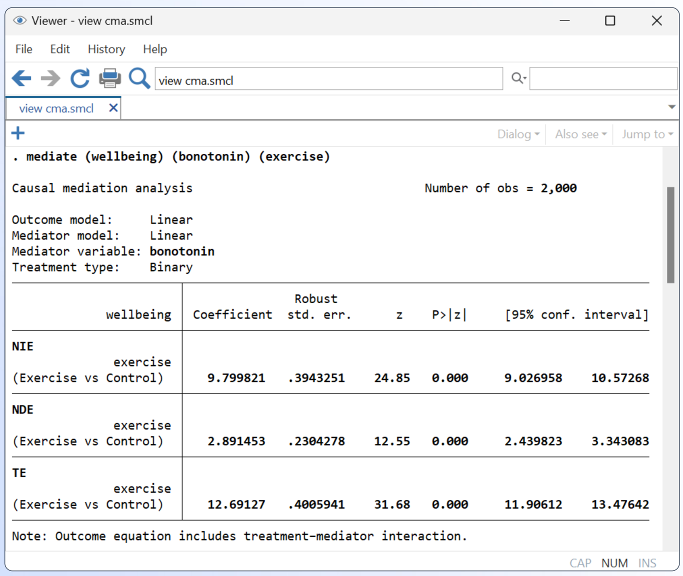
- Linear, logit, probit, Poisson, and exponential-mean models
- Direct effects, indirect effects, total effects, proportion mediated, and potential-outcome means
- Continuous, binary, and count outcomes
- Continuous, binary, and count mediators
- Binary, multivalued, and continuous treatments

Fit the model

Suppose we wish to evaluate the effect of physical exercise on self-perceived well-being and investigate potential causal mechanisms. Perhaps exercising causes an increase in certain hormones in the human body, which in turn affect perceptions of well-being. To explore these relationships, we use a causal mediation model.

We specify the outcome, the mediator, and the treatment variable.

```
. mediate (wellbeing) (bonotonin) (exercise)
```



```
. mediate (wellbeing) (bonotonin) (exercise)

Causal mediation analysis                          Number of obs = 2,000

Outcome model:     Linear
Mediator model:    Linear
Mediator variable: bonotonin
Treatment type:    Binary
```

wellbeing	Coefficient	Robust std. err.	z	P>|z|	[95% conf.	interval]
NIE						
exercise (Exercise vs Control)	9.799821	.3943251	24.85	0.000	9.026958	10.57268
NDE						
exercise (Exercise vs Control)	2.891453	.2304278	12.55	0.000	2.439823	3.343083
TE						
exercise (Exercise vs Control)	12.69127	.4005941	31.68	0.000	11.90612	13.47642

Note: Outcome equation includes treatment-mediator interaction.

The natural indirect effect (NIE) of 9.8 is an estimate of the effect of exercise on well-being through production of the fictional hormone bonotonin. The natural direct effect (NDE) of 2.9 is an estimate of the effect of exercise on well-being through mechanisms other than bonotonin. Together, they sum to a total effect (TE) of exercise on well-being.

Perhaps we want to know the effect of exercise on well-being if we could control the bonotonin level. To estimate the controlled direct effect with bonotonin set to 10, we type

```
. estat cde, mvalue(10)
```

Include covariates

We can control for confounders by including them in the model for the outcome, mediator, or both.

```
. mediate (wellbeing basewell age i.hstatus)
          (bonotonin i.gender i.hstatus)
          (exercise)

Causal mediation analysis                         Number of obs = 2,000

Outcome model:      Linear
Mediator model:     Linear
Mediator variable:  bonotonin
Treatment type:     Binary

------------------------------------------------------------------------------------
                     |               Robust
           wellbeing | Coefficient  std. err.      z    P>|z|    [95% conf. interval]
---------------------+--------------------------------------------------------------
NIE                  |
            exercise |
(Exercise vs Control)|   9.718811   .369158    26.33   0.000    8.995274    10.44235
---------------------+--------------------------------------------------------------
NDE                  |
            exercise |
(Exercise vs Control)|   3.092069   .1676971   18.44   0.000    2.763389     3.42075
---------------------+--------------------------------------------------------------
TE                   |
            exercise |
(Exercise vs Control)|   12.81088   .3723542   34.41   0.000    12.08108    13.54068
------------------------------------------------------------------------------------
Note: Outcome equation includes treatment-mediator interaction.
```

When controlling for covariates, the estimated total effect is 12.8. If everyone in the population exercised, well-being would be, on average, 12.8 points higher than if no one exercised. Of this, a 9.7-point increase is due to the mediating effect via bonotonin, and a 3.1-point increase is due to other mechanisms. We could type **estat proportion** to learn that the effect via bonotonin is 76% of the total effect.

Alternative statistics

Add the **all** option to report alternative direct effects, indirect effects, and potential-outcome means.

```
. mediate (wellbeing) (bonotonin) (exercise), all

Causal mediation analysis                         Number of obs = 2,000

------------------------------------------------------------------------------------
                     |               Robust
           wellbeing | Coefficient  std. err.      z    P>|z|    [95% conf. interval]
---------------------+--------------------------------------------------------------
POmeans              |
                Y0M0 |   57.11317   .2753201   207.44  0.000    56.57355    57.65278
                Y1M0 |   60.00462   .3157888   190.02  0.000    59.38569    60.62356
                Y0M1 |   66.68199   .3258477   204.64  0.000    66.04334    67.32064
                Y1M1 |   69.80444   .2898927   240.79  0.000    69.23626    70.37262
---------------------+--------------------------------------------------------------
NIE                  |
            exercise |
(Exercise vs Control)|   9.799821   .3943251    24.85  0.000    9.026958    10.57268
---------------------+--------------------------------------------------------------
NDE                  |
            exercise |
(Exercise vs Control)|   2.891453   .2304278    12.55  0.000    2.439823    3.343083
---------------------+--------------------------------------------------------------
PNIE                 |
            exercise |
(Exercise vs Control)|   9.568827   .3884522    24.63  0.000    8.807475    10.33018
---------------------+--------------------------------------------------------------
TNDE                 |
            exercise |
(Exercise vs Control)|   3.122447   .2418591    12.91  0.000    2.648412    3.596482
---------------------+--------------------------------------------------------------
TE                   |
            exercise |
(Exercise vs Control)|   12.69127   .4005941    31.68  0.000    11.90612    13.47642
------------------------------------------------------------------------------------
```

The pure natural indirect effect (PNIE) and total natural direct effect (TNDE) are alternative decompositions of the total effect. Potential-outcome means are the expected values of the outcome under specific conditions. For example, the Y0M0 of 57.1 is the expected well-being if no one exercises.

Alternative models

By default, **mediate** assumes a linear model for the outcome and mediator and a categorical treatment variable.

For a binary outcome or mediator, add the **logit** or **probit** option.

```
. mediate (y1 x1 x2, logit)
          (m1 x1 x3, logit)
          (treat)
```

Then, type **estat or** or **estat rr** to calculate effects on the odds-ratio or risk-ratio scale.

For count variables, use the **poisson** option.

```
. mediate (y2 x1 x2, poisson)
          (m2 x1 x3, logit)
          (treat)
```

Then type **estat irr** to calculate effects on the incidence-rate–ratio scale.

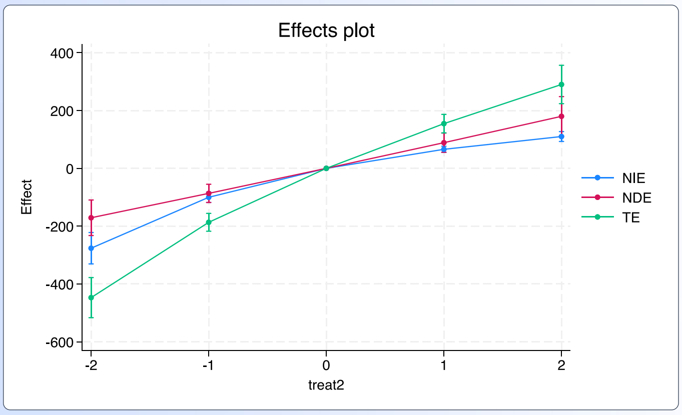
For exponential-mean models, use the **expmean** option.

```
. mediate (y3 x1 x2, expmean)
          (m1 x1 x3, probit)
          (treat)
```

When the treatment is continuous, we specify the **continuous()** suboption to indicate control and treatment levels of interest

```
. mediate (y x1 x2)
          (m x1 x3)
          (treat2, continuous(0 -2 -1 1 2))
```

We can visualize the treatment effects at each value of the treatment variable we specified with **estat effectsplot**.



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