How can I perform exact logistic regression using Stata for my data analysis?

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June 29, 2024

Exact logistic regression is a statistical method used to analyze categorical data and determine the relationship between a binary dependent variable and one or more independent variables. This method is particularly useful when the assumptions of traditional logistic regression cannot be met. To perform exact logistic regression using Stata, one must first ensure that the data is in the appropriate format, with the dependent variable coded as 0 or 1 and the independent variables as categorical or dichotomous. Then, the user can use the "exlogistic" command in Stata, which will perform the exact logistic regression using maximum likelihood estimation. This method provides more accurate results compared to traditional logistic regression, making it a valuable tool in data analysis. Additionally, Stata offers various options for model diagnostics and interpretation of results, making it a user-friendly and robust platform for conducting exact logistic regression.

Exact Logistic Regression | Stata Data Analysis Examples

Version info: Code for this page was tested in Stata 12.

Exact logistic regression is used to model binary outcome variables in which the log odds of the outcome is modeled as a linear combination of the predictor variables. It is used when the sample size is too small for a regular logistic regression (which uses the standard maximum-likelihood-based estimator) and/or when some of the cells formed by the outcome and categorical predictor variable have no observations. The estimates given by exact logistic regression do not depend on

asymptotic results.

Please note: The purpose of this page is to show how to use various data
analysis commands. It does not cover all aspects of the research process which
researchers are expected to do. In particular, it does not cover data
cleaning and checking, verification of assumptions, model diagnostics or
potential follow-up analyses.

Example of exact logistic regression

Suppose that we are interested in the factors
that influence whether or not a high school senior is admitted into a very competitive
engineering school. The
outcome variable is binary (0/1): admit or not admit.
The predictor variables of interest include student gender and whether or not the
student took Advanced Placement calculus in high school. Because the response variable is binary, we need

to use a model that handles 0/1 outcome variables correctly. Also, because of the number of students involved is small, we will need a procedure that can perform the estimation with
a small sample size.

Description of the data

The data for this exact logistic data analysis include the number of students admitted, the total
number of applicants broken down by gender (the variable female), and whether or not
they had taken AP calculus (the variable apcalc). Since the dataset
is so small, we will read it in directly.

```
clear
input female apcalc admit num
0 0 0 7
0 0 1 1
0 1 0 3
0 1 1 7
1 0 0 5
1 0 1 1
1 1 0 0
```

1 1 1 6
end

Let's look at some frequency tables. We will specify the variable num
as the frequency weight.

tabulate female apcalc

| apcalc
female | 0 1 | Total
-----------+----------------------+----------
0 | 8 10 | 18
1 | 6 6 | 12
-----------+----------------------+----------
Total | 14 16 | 30

tabulate female admit

| admit
female | 0 1 | Total
-----------+----------------------+----------
0 | 10 8 | 18
1 | 5 7 | 12
-----------+----------------------+----------

Total | 15 15 | 30

tabulate apcalc admit

| admit
apcalc | 0 1 | Total
----------+----------------------+----------
0 | 12 2 | 14
1 | 3 13 | 16
----------+----------------------+----------
Total | 15 15 | 30

table female apcalc admit, content(sum num)

| admit and apcalc
| ---- 0 --- ---- 1 ---
female | 0 1 0 1
----------+-----------------------
0 | 7 3 1 7
1 | 5 0 1 6

The tables reveal that 30 students applied for the Engineering program. Of

those, 15 were admitted and 15 were denied admission. There were 18 male and 12
female applicants. Sixteen of the applicants had taken AP calculus and 14 had
not. Note that all of the females who took AP calculus were admitted, versus only
about half the males.

Analysis methods you might consider

Below is a list of some analysis methods you may have encountered. Some of the methods listed are quite reasonable, while others have
either fallen out of favor or have limitations.

Exact logistic regression

Let's run the exact logistic analysis using the exlogistic command.
We will use the coef option to have the results displayed as logistic
regression coefficients (in the log odds metric), rather than the default of
odds ratios. As before, we will use num as the frequency weight.

exlogistic admit female apcalc , coef

Enumerating sample-space combinations:
observation 1: enumerations = 2
observation 2: enumerations = 4
observation 3: enumerations = 16
observation 4: enumerations = 56
observation 5: enumerations = 282
observation 6: enumerations = 536
observation 7: enumerations = 123

Exact logistic regression Number of obs = 30
Model score = 13.81227
Pr >= score = 0.0005
--
admit | Coef. Suff. 2*Pr(Suff.)
-------------+--
female | 1.360521 7 0.4557 -1.128988 5.367999
apcalc | 3.3387 13 0.0006 1.10166 7.265928
--

We can issue the exlogistic command without the coef option to
see the results displayed as odds ratios.

exlogistic

Exact logistic regression Number of obs = 30
Model score = 13.81227
Pr >= score = 0.0005

--
admit | Odds Ratio Suff. 2*Pr(Suff.)
------------+---
female | 3.898225 7 0.4557 .3233604 214.4334
apcalc | 28.18247 13 0.0006 3.009156 1430.713
--

The odds for an applicant who had taken AP calculus was about 28.2 times greater
than for one who had not taken the course.

We can also obtain the standard errors of the odds ratios using the estat
se command.

estat se

----
admit | Odds Ratio Std. Err.
------------+----------------------

female | 3.898225 4.560112
apcalc | 28.18247 31.70723

You can use the test(score) or test(prob) option to have either
the score test or probabilities test displayed. Below we show the
probabilities test.

exlogistic, coef test(prob)

Exact logistic regression Number of obs = 30
Model prob. = .0000632
Pr <= prob. = 0.0005
---
admit | Coef. Prob. Pr<=Prob.
---+---
female | 1.360521 .1925039 0.3401 -1.128988 5.367999
apcalc | 3.3387 .0002831 0.0003 1.10166 7.265928

We can also graph the predicted probabilities. To do this, we will

create a new variable called yhat and set it equal to missing. Then
we will replace the missing values for each combination of female and
apcalc. Finally, we will use the twoway command to create the
graph.

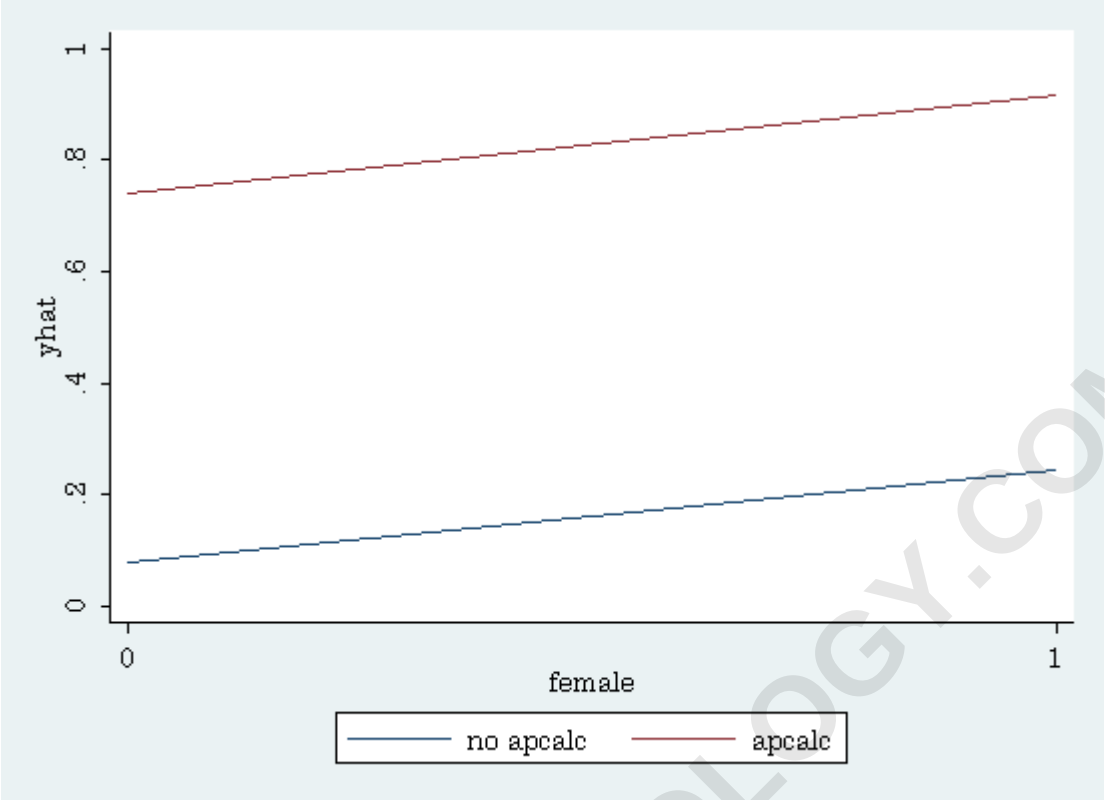
```
gen yhat = .
estat predict, at(female=1 apcalc=1)
replace yhat= r(pred) if female ==1 & apcalc==1

estat predict, at(female=0 apcalc=1)
replace yhat= r(pred) if female ==0 & apcalc==1

estat predict, at(female=1 apcalc=0)
replace yhat= r(pred) if female ==1 & apcalc==0

estat predict, at(female=0 apcalc=0)
replace yhat= r(pred) if female ==0 & apcalc==0

twoway (line yhat female if apcalc==0) (line yhat female if apcalc==1), ///
xlabel(0 1) ylabel(0(.2)1, nogrid) legend(label(1 "no apcalc") label(2 "apcalc"))
```



Things to consider

See also

References