lpirf - Local-projection impulse-response functions

| Description | Quick start | Menu | Syntax |
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Description

lpirf estimates local-projection impulse-response functions (IRFs). Dynamic multipliers on exogenous variables can also be computed.

Quick start

Local-projection IRFs for dependent variable y1 with the default of 8 steps lpirf y1

Same as above, but for dependent variables y1 and y2 with 12 steps lpirf y1 y2, step(12)

Same as above, but use lags 1 through 4 instead of the default lags 1 and 2 lpirf y1 y2, step(12) lags(1/4)

Local-projection IRFs for y1 and y2 and dynamic multipliers for exogenous variable x lpirf y1 y2, exog(x)

Same as above, but use robust standard errors, and make a small-sample degrees-of-freedom adjustment lpirf y1 y2, exog(x) vce(robust) dfk

Menu

 $Statistics > {\sf Multivariate\ time\ series} > {\sf Local-projection\ IRFs}$

Syntax

Description options Model lags(*numlist*) include specified lags of dependent variables step(#) set forecast horizon to # steps; default is step(8) exog(varlist) include exogenous variables include small-sample degrees-of-freedom adjustment dfk report small-sample t statistics small SE/Robust vce(vcetype) vcetype may be ols, robust, or hac hacspec Reporting level(#) set confidence level; default is level(95) control columns and column formats and row spacing display_options display legend instead of statistics coeflegend You must tsset your data before using lpirf; see [TS] tsset. depvarlist and varlist may contain time-series operators; see [U] 11.4.4 Time-series varlists.

depvartist and *vartist* may contain time-series operators, see

collect is allowed; see [U] 11.1.10 Prefix commands.

lpirf *depvarlist* [*if*] [*in*] [, *options*]

coeflegend does not appear in the dialog box.

See [U] 20 Estimation and postestimation commands for more capabilities of estimation commands.

Options

Model

- lags (numlist) specifies the lags of the dependent variables to be included in the model. The default is lags (1 2). The first-lag coefficient is the local-projection coefficient and must be included. Additional lags may be included as controls. Lags may be skipped; for example, lags (1 3) would include lags 1 and 3 but not lag 2.
- step(#) specifies the step (forecast) horizon; the default is eight periods.
- exog(varlist) specifies a list of exogenous variables to be included in the local projections. Coefficients on contemporaneous exogenous variables are interpreted as dynamic multiplier coefficients. Other exogenous variables such as lags are included as controls.
- dfk specifies that a small-sample degrees-of-freedom adjustment be used when estimating the residual covariance matrix. Specifically, 1/(T-m) is used instead of the large-sample divisor 1/T, where m is the number of right-hand-side variables used in each local projection.

small causes lpirf to report small-sample t statistics instead of large-sample normal statistics.

SE/Robust

- vce(vcetype) specifies the type of standard error reported, which includes types that are derived from asymptotic theory (ols) and that are robust to some kinds of misspecification (robust); see [R] vce_option.
 - vce(ols), the default, uses the standard variance estimator for ordinary least-squares regression.
 - lpirf also allows the following:
 - vce(hac *hacspec*) requests a heteroskedasticity- and autocorrelation-consistent (HAC) variancecovariance matrix. The full syntax of *hacspec* is the following:
 - vce (hac kernel [#]) requests a HAC variance–covariance matrix using the specified kernel (see below) with optional # lags. The bandwidth of a kernel is equal to # + 1. If # is not specified, a kernel with N 2 lags is used, where N is the sample size.

kernel may be one of the following:

bartlett or nwest requests the Bartlett (Newey-West 1994) kernel.

parzen or gallant requests the Parzen (Gallant 1987) kernel.

Reporting

level(#); see [R] Estimation options.

```
display_options: noci, nopvalues, vsquish, cformat(%fmt), pformat(%fmt), sformat(%fmt), and nolstretch; see [R] Estimation options.
```

The following option is available with lpirf but is not shown in the dialog box:

coeflegend; see [R] Estimation options.

Remarks and examples

An IRF measures how an endogenous variable responds in the future to a present-day shock to itself or another endogenous variable in the model. In economics, for example, these functions are used to study how inflation shocks today affect the evolution of prices and GDP in the months to come. Localprojections estimate the IRF directly by running multistep regressions of response variables on impulse variables. lpirf estimates these regressions jointly, allowing for tests of hypotheses involving multiple impulse–response coefficients.

Local projections were introduced by Jordà (2005) as an alternative to traditional IRF estimation based on vector autoregressive (VAR) models (see var). Local-projection estimation is not constrained by a model and thus provides more flexible impulse–response coefficients. Local projections also greatly simplify IRF estimation for multiple endogenous variables and horizons, making inference and hypothesis testing easier. See example 3 in [TS] **lpirf postestimation** for an example. Moreover, confidence intervals provided by local projections can have better small-sample coverage than those based on the VAR model's asymptotic distribution and the delta method. The IRF coefficients are highly nonlinear functions of the parameters in the VAR model and thus the delta-method approximation can perform poorly. See Kilian and Kim (2011) and Montiel Olea and Plagborg-Møller (2021) for simulation evidence comparing the local-projection estimator against vector autoregression IRFs.

Because local projections are a direct multistep method, they have the disadvantage of having a reduced sample size compared with an equivalent VAR model. Both local projections and VAR models condition on p initial values. However, local projections also condition on H - 1 trailing values, where H-1 is the maximum desired impulse–response step (horizon). Conditioning on the trailing observations can severely reduce the sample size when attempting to estimate long horizon responses using a short sample size.

The local-projection estimator conditions on past lags of the model variables. A series of regressions is run for each dependent variable and each horizon h = 1, 2, ..., H

$$y_{i,t+h-1} = \theta_{ijh}y_{j,t-1} + \mathbf{z}_t \boldsymbol{\delta} + u_{t+h-1}$$

where y_i is the response variable and y_j is the impulse variable. The parameter of interest is the impulse– response coefficient θ_{ijh} . Additional controls \mathbf{z}_t dated t or earlier, such as further lags of the endogenous variables, may be included; their associated coefficients $\boldsymbol{\delta}$ are nuisance parameters.

Exogenous variables may also be included. The effect of the kth exogenous variable $x_{k,t}$ on the *i*th dependent variable h steps ahead $y_{i,t+h}$ is found by estimating the local projection

$$y_{i,t+h} = \phi_{ikh} x_{k,t} + \mathbf{z}_t \boldsymbol{\delta} + u_{t+h}$$

for h = 0, 1, 2, ..., H - 1. The coefficient of interest is the dynamic multiplier coefficient ϕ_{ikh} . Additional controls \mathbf{z}_t dated t or earlier, such as further lags of the endogenous variables, may be included; their associated coefficients $\boldsymbol{\delta}$ are nuisance parameters.

lpirf estimates all the impulse-response and dynamic multiplier coefficients simultaneously, allowing for joint inference across arbitrary combinations of impulse variables, response variables, and horizons.

Example 1: Univariate local-projection model

Consider a model with one endogenous variable, the interest rate, and no exogenous variables. In this univariate model, there is only one possible shock, so the IRF measures the effect of a shock to the interest rate on itself. We use data on the federal funds rate from 1955 to 2010 to estimate the local-projection IRF.

```
. use https://www.stata-press.com/data/r19/usmacro
(Federal Reserve Economic Data - St. Louis Fed)
. lpirf fedfunds
Local-projection impulse responses
Sample: 1955q1 thru 2009q1
                                                        Number of obs
                                                                             = 217
                                                        Number of impulses
                                                                                  1
                                                        Number of responses =
                                                                                  1
                                                        Number of controls
                                                                                  1
                    IRF
                coefficient Std. err.
                                                   P>|z|
                                                              [95% conf. interval]
                                             7.
    fedfunds
         F1.
                  1.221569
                              .0653797
                                          18.68
                                                   0.000
                                                              1.093427
                                                                           1.34971
         F2.
                  1.080856
                                          10.30
                                                   0.000
                                                                          1.286504
                              .1049245
                                                              .8752076
         F3.
                  1.118528
                              .1267763
                                           8.82
                                                   0.000
                                                              .8700512
                                                                          1.367005
         F4.
                  1.166434
                              .145672
                                           8.01
                                                   0.000
                                                              .8809218
                                                                          1.451945
         F5.
                  1.255471
                              .1620139
                                           7.75
                                                   0.000
                                                              .9379294
                                                                          1.573012
         F6.
                                           6.32
                                                   0.000
                                                                          1.492841
                  1.139327
                              .1803676
                                                              .7858127
         F7.
                  .8283938
                              .1959921
                                           4.23
                                                   0.000
                                                              .4442565
                                                                          1.212531
         F8.
                  .7639486
                             .2038356
                                           3.75
                                                   0.000
                                                              .3644381
                                                                          1.163459
```

Impulse: fedfunds Response: fedfunds Control: L2.fedfunds The header of the output reports the time span of the estimation sample and the numbers of observations, impulse and response variables, and controls. The estimation table provides the impulse–response coefficients, ordered by impulse, response, and step. In this example, there is only one impulse and one response variable. By default, impulse–response coefficients are reported up to horizon 8. The footer contains information on the impulse and response variables; it also provides a full list of controls used in each local projection.

The IRF coefficients in the table are interpreted as follows. For a 1 percentage point shock to the interest rate, we expect the interest rate rises by 1.22 percentage points in the following period. The interest rate remains elevated for all steps 1 through 8. Eight periods after the shock, the interest rate remains 0.76 percentage points above its long-run value. By convention, the response at time 0 is set to 1 and is not reported.

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Example 2: Model with two endogenous variables

Next we estimate the impulse-response coefficients of a model with two endogenous variables, the output gap and the federal funds rate. We use the lags() option to specify lags 1 through 4 of both endogenous variables. Lags 2 through 4 are controls, while coefficients on the first lags are the impulse-responses of interest.

.3176052

2

2

6

1.140536

. lpirf ogap fedfunds, lags(1/4) Local-projection impulse responses Sample: 1955q3 thru 2009q1 Number of obs = 215 Number of impulses = Number of responses = Number of controls = IRF coefficient Std. err. P>|z| [95% conf. interval] 7. ogap ogap F1. 1.195888 .0703241 17.01 0.000 1.058055 1.333721 F2. 1.357788 12.19 0.000 1.139535 1.576041 .1113556 F3. 1.258217 .1461423 8.61 0.000 .971783 1.54465 F4. 6.78 1.154532 .1703871 0.000 .8205797 1.488485 F5. 5.03 .9490696 0.000 1.318883 .1886837 .5792564 F6. 4.19 .8409692 .2005783 0.000 .447843 1.234095

3.47

0.001

.2099352

F8. .5371741 .2168984 2.48 0.013 .112061 .9622872 fedfunds 4.51 0.000 F1. .340385 .0755028 .1924023 .4883677 F2. .6155252 .1219423 5.05 0.000 .3765228 .8545277 F3. 4.51 0.000 .6645369 .1471894 .376051 .9530228 F4. .5518402 .1727784 3.19 0.001 .2132007 .8904797 F5. .6452311 3.31 0.001 .1949615 .2631136 1.027349 F6. .7062151 .2179209 3.24 0.001 1.133332 .279098 F7. .6356759 .2388224 2.66 0.008 .1675926 1.103759 F8. .3931728 .2502723 1.57 0.116 -.097352 .8836975 fedfunds ogap F1. .0706023 .0642572 1.10 0.272 -.0553395.196544 F2. -.1944006.1017489 -1.91 0.056 -.3938248 .0050235 F3. -.2381567 .1335345 -1.780.075 -.4998795 .0235661 F4. -.3092885 .1556876 -1.99 0.047 -.6144307 -.0041464 F5. -2.54 -.4381839.1724058 0.011 -.776093 -.1002748 F6. -2.790.005 -.5121501 .1832742 -.871361 -.1529392 F7. -.5796563.1918239 -3.02 0.003 -.9556242-.2036884 F8. -.6646151 .1981864 -3.35 0.001 -1.053053-.2761769 fedfunds F1. 1.170208 .0689891 16.96 0.000 1.034992 1.305424 F2. .9238313 .1114222 8.29 0.000 .7054478 1.142215 F3. 7.23 0.000 .9727738 .1344912 .7091758 1.236372 F4. 6.21 0.000 1.289055 .9796306 .1578727 .6702059 F5. 1.044107 .178142 5.86 0.000 .694955 1.393259 0.000 F6. 1.019702 .1991207 5.12 .6294331 1.409972 F7. .7324305 .218219 3.36 0.001 .3047292 1.160132 F8. .6598259 .2286811 2.89 0.004 1.108033 .2116192

Impulses: ogap fedfunds

F7.

.7290706

Responses: ogap fedfunds

Controls: L2.fedfunds L2.ogap L3.fedfunds L3.ogap L4.fedfunds L4.ogap

The estimation table has two blocks, one for each impulse variable. Responses are grouped by impulse and then by response.

The coefficients of the table are interpreted as follows. The effect of an impulse to ogap on ogap itself is 1.196 at horizon 1, rises to 1.358 at horizon 2, and declines to 0.537 at horizon 8. The effect of an impulse to ogap on fedfunds is 0.340 at horizon 1, rises to 0.706 at horizon 6, and declines to 0.393 at horizon 8. A shock to fedfunds is associated with a rise in ogap of 0.071 at horizon 1, and the response at every other horizon is negative. The response of ogap at horizon 8 is -0.665.

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Example 3: Estimating dynamic multipliers

The local-projection estimator allows for the inclusion of exogenous variables. The responses of endogenous variables to shocks to exogenous variables are called dynamic multipliers. In this example, we fit a three-equation model of inflation, the output gap, and the interest rate, treating the interest rate as exogenous.

We include the step() option to compute the responses for four steps, instead of the default eight. We use the exog() option to specify fedfunds as the exogenous variable.

| Sample: 1956q | 3 thru 2010q1 | | | | Number of obs Number of impul Number of respo Number of contr | = 215 ses = 3 nses = 2 ols = 6 |
|---------------|--------------------|-----------|-------|-------|--|---|
| | IRF coefficient | Std. err. | z | P> z | [95% conf. | interval] |
| ogap | | | | | | |
| ogap | | | | | | |
| F1. | 1.183248 | .0696613 | 16.99 | 0.000 | 1.046714 | 1.319782 |
| F2. | 1.298995 | .1084817 | 11.97 | 0.000 | 1.086374 | 1.511615 |
| F3. | 1.240221 | .1408233 | 8.81 | 0.000 | .9642124 | 1.51623 |
| F4. | 1.163917 | .1641595 | 7.09 | 0.000 | .8421708 | 1.485664 |
| inflation | | | | | | |
| F1. | .065811 | .0546801 | 1.20 | 0.229 | 04136 | .172982 |
| F2. | .1562728 | .0875892 | 1.78 | 0.074 | 0153988 | .3279444 |
| F3. | .2659506 | .1150475 | 2.31 | 0.021 | .0404616 | .4914396 |
| F4. | .4547818 | .1445588 | 3.15 | 0.002 | .1714517 | .7381119 |
| inflation | | | | | | |
| ogap | | | | | | |
| F1. | 1348397 | .0849333 | -1.59 | 0.112 | 301306 | .0316265 |
| F2. | 2116188 | .1322643 | -1.60 | 0.110 | 4708521 | .0476145 |
| F3. | 2891468 | .1716962 | -1.68 | 0.092 | 6256653 | .0473716 |
| F4. | 4686839 | .2001485 | -2.34 | 0.019 | 8609677 | 0764001 |
| inflation | | | | | | |
| F1. | 1.205986 | .0666677 | 18.09 | 0.000 | 1.075319 | 1.336652 |
| F2. | 1.209659 | .1067915 | 11.33 | 0.000 | 1.000351 | 1.418966 |
| F3. | 1.396595 | .1402696 | 9.96 | 0.000 | 1.121671 | 1.671518 |
| F4. | .9968414 | .1762507 | 5.66 | 0.000 | .6513963 | 1.342286 |
| fedfunds | | | | | | |
| ogap | | | | | | |
| | .0289642 | .0270094 | 1.07 | 0.284 | 0239732 | .0819016 |
| F1. | 0017852 | .0420609 | -0.04 | 0.966 | 0842231 | .0806527 |
| F2. | 0506758 | .0546005 | -0.93 | 0.353 | 1576909 | .0563393 |
| F3. | 0776979 | .0636485 | -1.22 | 0.222 | 2024467 | .0470509 |
| inflation | | | | | | |
| | .073647 | .0212008 | 3.47 | 0.001 | .0320943 | .1151997 |
| F1. | .115983 | .0339604 | 3.42 | 0.001 | .0494218 | .1825442 |
| F2. | .120239 | .0446067 | 2.70 | 0.007 | .0328115 | .2076664 |
| F3. | .1092225 | .0560489 | 1.95 | 0.051 | 0006313 | .2190763 |

lnirf ogen inflation lags(1/4) sten(4) ever(fodfunds)

Note: IRF coefficients for exogenous variables are dynamic multipliers. Impulses: ogap inflation fedfunds Responses: ogap inflation Controls: L2.inflation L2.ogap L3.inflation L3.ogap L4.inflation L4.ogap

The estimation table has three blocks, one for each impulse. The first block reports the responses of the output gap and inflation to an impulse to the output gap. The second block reports the responses of the output gap and inflation to an impulse to inflation. The third block reports the dynamic multipliers of the output gap and inflation to an impulse to the interest rate.

The contemporaneous effect of the exogenous variable is not constrained to be 1. These effects are displayed in the third block of the table. The contemporaneous effect, also known as the impact effect, of a shock to the interest rate on the output gap is 0.029 with a standard error of 0.027. The responses of the output gap at horizons 1, 2, and 3 are all negative. The effect of a shock to the interest rate on inflation is 0.074 on impact. Inflation continues to rise in the first three periods after a shock, reaching a value of 0.109 in the third period after the shock.

4

Example 4: Robust inference

Several options control how standard errors are calculated and reported. The dfk option provides a small-sample degrees-of-freedom adjustment for estimating the residual covariance matrix. The small option requests that small-sample t statistics be reported instead of large-sample z statistics.

We revisit the simple univariate model of the interest rate, but this time we specify the dfk and small options.

| . lpirf fedfu | nds, dfk small | | | | | |
|---|---|-------------------------|-----------|-------------------|--|--|
| Local-project | ion impulse re | sponses | | | | |
| Sample: 1955q | 1 thru 2009q1 | | | Nur Nur Nur | nber of obs nber of impul nber of respo nber of contr | = 217 ses = 1 nses = 1 rols = 1 |
| | IRF coefficient | Std. err. | t | P> t | [95% conf. | interval] |
| fedfunds | | | | | | |
| F1. | 1.221569 | .0658364 | 18.55 | 0.000 | 1.091798 | 1.351339 |
| F2. | 1.080856 | .1056574 | 10.23 | 0.000 | .8725934 | 1.289118 |
| F3. | 1.118528 | .1276618 | 8.76 | 0.000 | .8668925 | 1.370164 |
| F4. | 1.166434 | .1466895 | 7.95 | 0.000 | .8772924 | 1.455575 |
| F5. | 1.255471 | .1631456 | 7.70 | 0.000 | .9338928 | 1.577049 |
| F6. | 1.139327 | .1816275 | 6.27 | 0.000 | .7813188 | 1.497335 |
| F7. | .8283938 | .1973611 | 4.20 | 0.000 | .4393732 | 1.217414 |
| F8. | .7639486 | .2052594 | 3.72 | 0.000 | .3593595 | 1.168538 |
| Note: Small-s covaria Impulse: fed: Besponse: fed: | ample degrees- nce matrix of funds funds | of-freedom a residuals. | adjustmen | nt applied | d when estima | ting |

Control: L2.fedfunds

Confidence intervals here are somewhat wider than in example 1.

Montiel Olea and Plagborg-Møller (2021) provide a thorough discussion of inference in localprojection models. They suggest two additional adjustments. First, if the true model is believed to be a VAR model of order p, then p+1 lags should be included in the local projections. Second, White-corrected standard errors should be reported. We use the lags(1/3) option to add one further lag to the controls. Additionally, we specify the vce(robust) option to provide White-corrected standard errors. With all of these options, the output of lpirf changes to the following:

| . lpirf fedfur | nds, lags(1/3) | dfk small | vce(robus | st) | | | |
|---|---|-------------------------------------|-----------|----------------|--|--------------------------------|---|
| Local-projecti | ion impulse re | sponses | | | | | |
| Sample: 1955q2 | 2 thru 2009q1 | | | Νυ Νυ Νυ | umber of umber of umber of umber of | obs impul respo contr | = 216 ses = 1 nses = 1 ols = 2 |
| | IRF coefficient | Robust std. err. | t | P> t | [95% | conf. | interval] |
| fedfunds | | | | | | | |
| F1. | 1.264674 | .1123728 | 11.25 | 0.000 | 1.043 | 3163 | 1.486185 |
| F2. | 1.087209 | .1681724 | 6.46 | 0.000 | .75 | 5705 | 1.418714 |
| F3. | 1.098138 | .1927819 | 5.70 | 0.000 | .718: | 1227 | 1.478153 |
| F4. | 1.105892 | .2030137 | 5.45 | 0.000 | .70 | 5708 | 1.506076 |
| F5. | 1.216923 | .2099187 | 5.80 | 0.000 | .803 | 1281 | 1.630719 |
| F6. | 1.168236 | .2192774 | 5.33 | 0.000 | .7359 | 9926 | 1.600479 |
| F7. | .8415941 | .2382936 | 3.53 | 0.001 | .3718 | 3657 | 1.311323 |
| F8. | .7565939 | .2355971 | 3.21 | 0.002 | .292 | 1808 | 1.221007 |
| Note: Small-sa covarian Impulse: fedi Response: fedi Controls: L2.1 | ample degrees- nce matrix of funds funds fedfunds L3.fe | of-freedom residuals. edfunds | adjustmen | nt applie | ed when e | estima | ting |

The use of three lags indicates a belief that the the underlying VAR model is of order two. Thus, three lags provide the appropriate adjustment. We also adjust for the possibility of heteroskedasticity by specifying vce(robust), which is equivalent to the standard errors that would be obtained with regress, vce(robust).

For comparison, the results of sureg for the first two response horizons would be given by the following:

. sureg (f(0/1).fedfunds = l(1/3).fedfunds) if e(sample), vce(robust) dfk small Seemingly unrelated regression

| Equation | Obs | Params | RMSE | "R-squ | ared" | | F P>F |
|----------------|-------------|-----------|----------|--------|-------|-------|-----------|
| fedfunds | 216 | 3 | .8940584 | 0. | 9278 | 412.5 | 8 0.0000 |
| F_fedfunds | 216 | 3 | 1.453377 | 0.3 | 8102 | 129.5 | 6 0.0000 |
| | | Robust | | | | | |
| | Coefficient | std. err. | t | P> t | [95% | conf. | interval] |
| fedfunds | | | | | | | |
| Ieurunus L1 | 1 264674 | 1113275 | 11 36 | 0 000 | 1 04 | 5852 | 1 483497 |
| L1. | - 4670027 | 1513732 | -3.09 | 0.002 | - 764 | 5381 | - 1694674 |
| L3. | .1604177 | .121733 | 1.32 | 0.188 | 078 | 8575 | .3996929 |
| _cons | .2333601 | .1568402 | 1.49 | 0.138 | 074 | 9211 | .5416413 |
| F_fedfunds | | | | | | | |
| fedfunds | | | | | | | |
| L1. | 1.087209 | .166608 | 6.53 | 0.000 | .759 | 7289 | 1.41469 |
| L2. | 2141638 | .242216 | -0.88 | 0.377 | 690 | 2574 | .2619298 |
| L3. | .023556 | .1679403 | 0.14 | 0.889 | 306 | 5431 | .3536551 |
| _cons | .5746647 | .2276758 | 2.52 | 0.012 | .127 | 1509 | 1.022178 |

Note: Small-sample degrees-of-freedom adjustment applied when estimating covariance matrix of residuals.

The regression of the current interest rate on its first three lags is identical to the underlying projection for the first horizon. The coefficient estimate on L.fedfunds is 1.265, identical to the coefficient on F1.fedfunds in the local-projection estimation table. The standard errors are also identical, 0.111.

The regression of the one-period-ahead interest rate on the first three lags of the interest rate in the sureg output is identical to the underlying projection for the second horizon of lpirf. The coefficient estimate on L.fedfunds is 1.087, identical to the coefficient on F2.fedfunds in the local-projection estimation table. The standard errors are also identical, 0.167.

Newey-West standard errors may be requested by specifying vce (hac nwest #), where # represents the maximum lag order of autocorrelation. If a number is not specified, the number of lags used is equal to the maximum step.

| . lpirf fedfur | nds, lags(1/3) | dfk small | vce(hac | nwest) | | | | | | |
|---|---|--------------------------|----------|----------|------------------|----------|-----------------|-------------|-----------|---------|
| Local-projecti | ion impulse re | sponses | | | | | | | | |
| Sample: 1955q2 | 2 thru 2009q1 | - | | | Number Number | of of | obs impul | ses | = 21 = | 16 1 |
| HAC kernel: Ne | ewey-West with | 8 lags | | | Number Number | of of | respo: contr | nses ols | = | 1 2 |
| | IRF coefficient | HAC std. err. | t | P> t | [9 | 95% | conf. | int | erval | 1] |
| fedfunds | | | | | | | | | | |
| F1. | 1.264674 | .1367966 | 9.24 | 0.000 |) .9 | 9950 | 0182 | 1 | .5343 | 33 |
| F2. | 1.087209 | .1731642 | 6.28 | 0.000 |) .7 | 7458 | 3652 | 1. | 42855 | 54 |
| F3. | 1.098138 | .1677261 | 6.55 | 0.000 |) | .76 | 7513 | 1. | 42876 | 32 |
| F4. | 1.105892 | .2446402 | 4.52 | 0.000 |).(| 623 | 3531 | 1. | 58813 | 31 |
| F5. | 1.216923 | .2595175 | 4.69 | 0.000 |) . | 705 | 3581 | 1. | 72848 | 39 |
| F6. | 1.168236 | .2757997 | 4.24 | 0.000 |).(| 624 | 5749 | 1. | 71189 | 97 |
| F7. | .8415941 | .2968191 | 2.84 | 0.005 | 55 | 2564 | 1993 | 1. | 42668 | 39 |
| F8. | .7565939 | .3054195 | 2.48 | 0.014 | . .: | 154 | 5458 | 1. | 35864 | 12 |
| Note: Small-sa covariar Impulse: fedf Response: fedf | ample degrees- nce matrix of funds funds | of-freedom residuals. | adjustme | ent app] | ied whe | en (| estima | ting | | |

Controls: L2.fedfunds L3.fedfunds

The Newey–West standard errors reported here correct for both heteroskedasticity and autocorrelation and are often recommended for local-projection IRFs.

Stored results

lpirf stores the following in e():

| Scalars | |
|----------------|---|
| e(N) | number of observations |
| e(k) | number of parameters |
| e(k_endog) | number of dependent variables |
| e(k_exog) | number of exogenous variables |
| e(k_impulses) | number of impulse variables |
| e(k_responses) | number of response variables |
| e(k_controls) | number of control variables |
| e(df_r) | residual degrees of freedom (small only) |
| e(tmin) | minimum time in sample |
| e(tmax) | maximum time in sample |
| e(step) | maximum step |
| e(rank) | rank of e(V) |
| Macros | |
| e(cmd) | lpirf |
| e(cmdline) | command as typed |
| e(depvar) | names of dependent variables |
| e(title) | title in estimation output |
| e(allcontrols) | list of control variables used in each projection |
| e(tsfmt) | format of the time variable |
| e(tvar) | variable denoting time within groups |
| e(tmins) | formatted minimum time |
| e(tmaxs) | formatted maximum time |
| e(lags) | lags used in controls |
| e(dfk) | dfk, if specified |
| e(small) | small, if specified |
| e(endog) | names of endogenous variables |
| e(exog) | names of exogenous variables |
| e(vce) | vcetype specified in vce() |
| e(vcetype) | title used to label Std. err. |
| e(properties) | b V |
| Matrices | |
| e(b) | coefficient vector |
| e(V) | variance-covariance matrix of the estimators |
| Functions | |
| e(sample) | marks estimation sample |

In addition to the above, the following is stored in r():

Matrices

```
r(table) matrix containing the coefficients with their standard errors, test statistics, p-values, and confidence intervals
```

Note that results stored in r() are updated when the command is replayed and will be replaced when any r-class command is run after the estimation command.

Methods and formulas

lpirf is equivalent to running regress, equation by equation, for each possible combination of impulse variable, response variable, and horizon (step). lpirf performs these regressions jointly to allow for tests of hypotheses that involve multiple impulse–response coefficients.

Let \mathbf{y}_t be the $k \times 1$ vector of endogenous variables in the model. For a given horizon h, consider the regression of response variables at time t + h - 1 on lags 1 through p of the dependent variables. Hence, for horizon 1, we use the current values of \mathbf{y} on the left-hand side; for horizon 2, we use the values of \mathbf{y} one period ahead; for horizon 3, we use the values of \mathbf{y} two periods ahead; and so on. In each regression, the right-hand-side variables remain the same, lags 1 through p of the dependent variables.

When the model does not include any exogenous variables, the system of regressions is

$$\mathbf{y}_{t+h-1} = \mathbf{B}_1^h \mathbf{y}_{t-1} + \mathbf{B}_2^h \mathbf{y}_{t-2} + \dots + \mathbf{B}_p^h \mathbf{y}_{t-p} + \mathbf{u}_{t+h-1}$$

for h = 1, ..., H, where H is the desired maximum horizon. In the system of regressions, \mathbf{B}_1^h is the $k \times k$ matrix of impulse–response coefficients at horizon h. The lags () option specifies which additional lags to use as controls in the local projections. Missing lags are allowed.

Contemporaneous exogenous variables are used to estimate dynamic multipliers. Here the timing convention is simpler: a regression of the endogenous variables at time t + h, \mathbf{y}_{t+h} , on the exogenous variable today, \mathbf{x}_t , gives the dynamic multiplier at horizon h:

$$\mathbf{y}_{t+h} = \mathbf{D}^h \mathbf{x}_t + \mathbf{\Gamma} \mathbf{z}_t + \mathbf{u}_{t+h}$$

Matrix \mathbf{D}^h contains the dynamic multipliers at horizon h. Additional controls dated t or earlier, \mathbf{z} , can be specified using the exog() option.

OLS and robust sandard errors are calculated as in sureg. The dfk, small, and vce(robust) options perform in lpirf exactly as they do in sureg; see [R] sureg. The vce(hac nwest #) and vce(hac gallant #) options perform exactly as they do in [R] gmm.

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Also see

- [TS] lpirf postestimation Postestimation tools for lpirf
- [TS] ivlpirf Instrumental-variables local-projection impulse-response functions
- [TS] tsset Declare data to be time-series data
- [TS] **var** Vector autoregressive models
- [R] regress Linear regression
- [U] 20 Estimation and postestimation commands

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