LocalProjection package for gretl
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This package estimates the impulse response functions (IRF) following Jordà (2005) methodology for a multivariate linear local projection, and Auerbach and Gorodnichenko (2012), for a multivariate regime-switching local projection.¹

**Linear local projection:**
First, a reduced VAR is estimated to get the covariance matrix and, then, the Cholesky decomposition is applied to obtain the shock matrix $P$.
For the endogenous variables, $Y_t$, the linear local projection model is estimated such that:
$$ Y_{t+h} = \beta_0 + \sum_i \beta_i Y_{t-i} + \epsilon_t $$
for the horizons $h = 1, ..., H$
The set of parameters $\beta_i$ are estimated based on an OLS model for each horizon $h$. The IRFs are then estimated as:
$$ \hat{IRF}_{j,h} = \beta_{1,R1}^h P^j; \text{ for endogenous variable } j \text{ and the horizon } h = 1, ..., H. $$

The linear model estimation can be executed using the command:
```python
lin_local_projection(endogenous, exogenous, length, constant, nlags, exog_nlags, contemporaneous, ConInterv, shocksize, PositionShock, PositionResponse)
```

Inputs:
- **endogenous** – List including the endogenous variables in the model.
- **exogenous** – List including the exogenous variables, if any. Optional (default = null).
- **length** – Integer. Number of periods ahead to be estimated in the local projection IRF. Valid values 1 to 60 periods. (default = 12).
- **constant** – Boolean. 1.- Constant; 0.- No constant (default = 1).
- **nlags** – Integer. Number of lags of the endogenous variables to be included in the estimation. Valid values 1 to 12 periods. (default = 4).
- **exog_nlags** – Integer. Number of lags of the exogenous variables to be included in the estimation. Valid values 1 to 12 periods. Not required if exogenous is null. (default = 1).
- **contemporaneous** – Boolean. Contemporaneous effect (t=0) of exogenous variables, if any (1.- Yes, 0.- No). (default = 1).
- **ConInterv** – Scalar. Confidence interval in the IRF. Valid values between 0 and 1. (default = 0.95).
- **shocksize** - Boolean. 1.- One-unit shock; 0.- One standard deviation shock. (default = 0).
- **PositionShock** – Integer. Position of the shock variable (number of variable) in the list of endogenous variables. (default = 2).
- **PositionResponse** – Integer. Position of the response variable (number of variable) in the list of endogenous variables. (default = 1).

¹ This package was first inspired by the R package “lpirfs” developed by Philipp Adämmer.
The `lin_local_projection` function returns a bundle. It includes multiple objects described below concerning the characteristics and the results of the linear local projection model:

- **Model** – String. “Linear Local Projection”
- **EndogVariables** – List. Endogenous variables.
- **ExogVariables** – List. Exogenous variables
- **Horizon** – Scalar. Number of periods ahead estimated in the IRF.
- **IRF** – Matrix. Impulse response function values with columns in the order of upper limit, estimation value, lower limit, and periods ahead.
- **ShockVar** – String. Shock Variable
- **ResponseVar** – String. Response Variable
**Regime switching local projection**

First, a reduced VAR is estimated to get the covariance matrix. Then, the Cholesky decomposition is applied to obtain the shock matrix $P$.

To differentiate between regimes, the endogenous variables ($Y_t$) are transformed using a transition function $F(Z_{t-1})$ such that:

- Regime 1: $(1 - F(Z_{t-1}))Y_{t-i}$; for the lags $i = 1, ..., T$
- Regime 2: $F(Z_{t-1})Y_{t-i}$; for the lags $i = 1, ..., T$

where $Z_{t-1}$ is a switching/trigger variable that can be decomposed with a Hodrick-Prescott filter or plugged directly into a logistic function $F(Z_{t-1})$.

Consequently, the model is estimated as

$$Y_{t+h} = \beta_{1,R1}^h \left( (1 - F(Z_{t-1}))Y_{t-1} \right) + \cdots + \beta_{1,R1}^h \left( (1 - F(Z_{t-i}))Y_{t-i} \right)$$

$$+ \beta_{1,R2}^h (F(Z_{t-1})Y_{t-1}) + \cdots + \beta_{1,R2}^h (F(Z_{t-i})Y_{t-i}) + \epsilon_t;$$

for the horizons $h = 1, ..., H$; with $\beta_{1,R1}^0 = 1$ and $\beta_{1,R2}^0 = 1$;

The set of parameters $\beta_i$ is estimated based on an OLS model for each horizon $h$.

The IRFs for each regime are then estimated as:

- IRF in regime 1: $IRF_{R1,i}^{R1} = \beta_{1,R1}^h P_j$; for endogenous variable $j$ and the horizon $h = 1, ..., H$.
- IRF in regime 2: $IRF_{R1,i}^{R2} = \beta_{1,R2}^h P_j$; for endogenous variable $j$ for the horizons $h = 1, ..., H$.

The regime switching model estimation can be executed using the command:

```
rs_local_projection(endogenous, exogenous, length, constant, nlags, exog_nlags, contemp, ConfInterv, shocksize, PositionShock, PositionResponse, trigger, logisticfun, lagswitching, dummy, thresh, hpfilter, lambda, gamma)
```

In addition to the parameters of the linear projection previously described, specific parameters of the regime-switching format are required. The most relevant is a switching or transition variable that can either be decomposed with the Hodrick-Prescott filter, directly plugged in a logistic function or transformed into an indicator variable. The latter allows to determine the periods in which the model is in the Regime 1 (high regime) or in Regime 2 (low regime). Switching/trigger variable is set in $t - 1$ to avoid contemporaneous feedback (Auerbach and Gorodnichenko, 2012). The user can deactivate this feature setting the input `lagswitching = 0`.

Inputs:

- `trigger` – List. Switching or trigger variable that define the high/low regime in the estimation. Only one variable is allowed. (default = null).
- `logisticfun` – Boolean. Plug the switching variable into the transition function? (1. Yes, 0. No). (default = 1).
- `lagswitching` – Boolean. Plug the switching variable in $t - 1$ to avoid contemporaneous feedback. (1. Yes, 0. No). (default = 1).

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2 Switching/trigger variable is set in $t - 1$ in order to avoid contemporaneous feedback (Auerbach and Gorodnichenko, 2012).
- **dummy** – Boolean. 1.- Switching/trigger variable is a dummy that determines the periods that belong to the high/low regime; 0.- Switching/trigger variable is not a dummy. (default = 0)
- **thresh** – Scalar. This parameter indicates the threshold (as a percentile value) that separates the high and the low regime. (default = 0.75).
  - If the user previously created an indicator variable and dummy = 1, this input can be disregarded.
  - If dummy = 1 and the trigger variable is not a dummy, thresh creates a dummy variable that takes value of 1 if the trigger variable exceeds the indicated percentile value and 0 otherwise. Valid values between 0 and 1.
- **hpfilter** – Boolean. 1.- The switching/trigger variable will be decomposed with the Hodrick-Prescott filter; 0.- the variable will be directly plugged in the logistic function. (default = 1).
  - If dummy = 1, hpfilter is not required.
- **gamma** – Sensitivity parameter (>0) of the logistic function. (default = 1).

Similarly, the *rs_local_projection* function returns a bundle including multiple objects with the characteristics and the results obtained of the nonlinear model:
- **Model** – String. “Regime Switching Local Projection”
- **EndogVariables** – List. Endogenous variables.
- **ExogVariables** – List. Exogenous variables
- **SwitchingTriggerVar** – List. Switching variable
- **Horizon** – Scalar. Number of periods ahead estimated in the IRF.
- **HPLambda** – Lambda parameter of the HP filter.
- **TransitionFunction** – Matrix. Transition function values to differentiate between regimes.
- **Gamma** – Scalar. Logistic function’s gamma parameter.
- **ShockVar** – String. Shock Variable
- **ResponseVar** – String. Response Variable
- **HighIRF** – Matrix. High-regime impulse response function values with columns in the order of upper limit, estimation value, lower limit and periods ahead.
- **LowIRF** – Matrix. Low-regime impulse response function values with columns in the order of upper limit, estimation value, lower limit and periods ahead.
Optimal lag selection function
The LocalProjection package includes a function that selects the optimal number of lags based on a specified information criterion. The optimal number of lags is valid for both the linear and the regime switching local projection models. The command to identify the optimal number of lags, following the procedure of proposed by Brugnolini (2018), is:

`lag_select(endogenous, exogenous, constant, infocr, lagselection, nlags, maxlags, exog_lagselection, exog_nlags, exog_maxlags, contemp, verbose)`

Inputs:
- **endogenous** – List including the endogenous variables in the model.
- **exogenous** – List including the exogenous variables, if any. Optional. (default = null).
- **constant** – Boolean. 1. - Constant; 0. - No constant. (default = 1).
- **infocr** – Integer. The information criterion (1. AIC, 2. BIC, 3. HQC) considered for the optimal lag selection. Required when `lagselection = 1` or `exog_lagselection = 1`. (default = 2).
- **lagselection** – Boolean. 1. - Lag selection of the endogenous variables, based on an information criterion; 0. - no selection. (default = 0).
- **nlags** – Integer. Number of lags of the endogenous variables considered in the estimation. Required when `lagselection = 0`. Valid values 1 to 12 periods. (default = 4).
- **maxlags** – Integer. Maximum number of lags of the endogenous variables to be tested in the selection of lags, based on the information criterion selected. Required when `lagselection = 1`. Valid values 1 to 12 periods. (default = 12).

When exogenous variables are included in the estimation,
- **exog_lagselection** – Boolean. 1. - Lag selection of the exogenous variables, based on an information criterion; 0. - No selection (number of lags predefined). Not required if `exogenous` is null. (default = 0).
- **exog_nlags** – Integer. Number of lags of the exogenous variables to be considered in the estimation. Valid values 0 to 12 periods. Required when `exog_lagselection = 1`. Not required if exogenous is null. When: (1) `exog_nlags = 0`, and, (2) `exog_lagselection = 0`, please activate the feature `contemp`. (default = 1).
- **exog_maxlags** – Integer. Maximum number of lags for the exogenous variables to be tested in the selection of lags, based on the information criterion selected. Valid values 0 to 12 periods. required if `exog_lagselection = 1`. Not required if `exogenous` is null. When (1) `exog_maxlags = 0`, and (2) `exog_lagselection = 1`, please activate the feature `contemp`. (default = 2).
- **contemp** – Boolean. Contemporaneous effect (t=0) of exogenous variables, if any (1. - Yes, 0. - No). (default = 1).

This function returns a bundle with two elements:
- **InfoCrit** – String. Information criterion selected
- **OptimalLags** – Matrix. Optimal lags selected for each equation in the VAR.
Any doubts, comments or suggestions are welcome.
I thank Lorenzo Menna, Andrea Sánchez Urbina and Daniel Ventosa-Santaulària for their valuable reviews and comments.
Coming soon, instrumental variable local projection and three regimes switching local projection.

Enjoy,
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References