An Introduction to **APCI**: An R Package for Implementing the Three-Step Procedure of the Age-Period-Cohort-Interaction Model

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# **1. Overview**

This document is a brief introduction of **APCI** package, in which the core function is **apci**. It is designed to implement the age-period-cohort-interaction (APC-I) model proposed by Luo and Hodge (Forthcoming). Different from previous APC methods that assume the effects of age, period, and cohort to be additive and independent of each other, the APC-I model is informed by Ryder's (1965) theory and accordingly characterizes cohort effects as the interaction terms between age and period main effects. It quantifies inter-cohort deviations from the age and period main effects and also permits hypothesis testing about intra-cohort life-course dynamics. ~~This package also includes functions like~~ **~~CohortDeviation~~** ~~and~~ **~~MainEffect~~**~~. They two functions aim to extract the slope and interaction of cohort effects, age-effects, as well as period-effects directly.~~

Specifically, in its simplest form (users can add other covariates), the APC-I model can be written as a generalized linear model:

for age groups , periods , and cohorts , where . denotes the expected value of the outcome for the th age group in the th time period; is the "link function"; denotes the mean difference from the global mean associated with the *i*th age category; denotes the mean difference from associated with the th period; denotes the interaction of the th age group and th period group, corresponding to the effect of the th cohort. Note that the effect of one cohort includes multiple age-by-period interaction terms that lie on the same diagonal in a table with ages in rows and periods in columns.

[a word about constraint] The usual ANOVA constraint applies where the sum of coefficients for each effect is set to zero. [categorical varaibles]

The APCI package's apci function can be used to implement the three-step procedure described in Luo and Hodges (Forthcoming). Briefly, step 1 is a global deviance test about the interaction terms . Step 2, cohort deviation magnitude tests, concerns the magnitude of cohort-specific deviations from age and period main effects. Step 3.1, average deviation tests, examines for each cohort that significantly deviates from age and period main effects based on Step 2, is a set of *t* tests of cohort-specific deviations. These averages and associated *t* tests can be used to assess differences between cohorts in terms of their deviation from the age and period main effects. Step 3.2, life-course dynamics tests, involves a series of *t* test of the linear (and quadratic if desirable) orthogonal polynomial contrast of the cohort's age-by-period interaction terms to inform whether the average (dis)advantages of members of that cohort accumulate, remain stable, or diminish in their life course.

# **2. Functions in the Package**

## **apci**

Fit the APC-I model and return the coefficient estimates for age main effects, period main effects, inter-cohort average deviations, and intra-cohort life-course trends.

Usage

apci(data, outcome, age, period, cohort, weight, covariate, family, F.test=TRUE, …)

Arguments

outcome the outcome variable

age age group index in the data

period time period index in the data

cohort cohort membership index in the data

weight optional sample weights

covariate a list of optional user-specified covariates

data an optional data frame that contains variables named in acc, pcc, ccc, weights, and covs

F.test logical, if run the series of tests and return their results

family xxx

Details

**apci** is the core function in APCI package. It provides xxx.

Value

The estimation results are returned as a list with the following components:

model summary of the fitted generalized linear regression

f\_global results of the global F test

f\_local results of the local F test

intercept the ovearal intercept

age\_effect estimated age effect

period\_effect estimated period effect

cohort\_average cohort averages for comparing inter-cohort differences

cohort\_slope intra-cohort life-course changes

References

Luo and Hodge Forthcoming

Examples

library("APCI")

#Associating **APCI** package, the data of 1990-2014 Current Population Survey containing #1,071,234 white women aged 20 to 64 is automatically loaded, which is then used in this #example.

# fit model

test.result <- apci(outcome = "inlfc",

age = "acc",

period = "pcc",

cohort = "ccc",

weight = "wt",

covariate = c("age", "year", "educr", "educc"),

data = data,

F.test=FALSE)

# check results

summary(testresult)

test.result$model

test.result$f\_global

test.result$f\_ocal

test.result$intercept

test.result$age\_effect

test.result$period\_effect

test.result$cohort\_avearage

test.result$cohort\_slope

## **cohortdeviation**

internal function, only used by the package APCI

Usage

cohortdeviation(A, P, C, model, weights, covs,…)

Argument

A the dimension of age, i.e., the number of age groups

P the dimension of period, i.e., the number of period groups

C the dimension of cohort, i.e., the number of period groups

model a model fitted in temp\_model

weights optional case weights

covariate a list of optional covariances that control details of the model

Values

cohort\_average cohort averages used for comparing inter-cohort differences

cohort\_slope intra-cohort life-course changes

## **maineffect**

internal function, only used by the package APCI

Usage

maineffect(A, P, C, model, data,…)

Arguments

A the dimension of age, i.e., the number of age groups

P the dimension of period, i.e., the number of period groups

C the dimension of cohort, i.e., the number of cohort groups

model a model fitted in temp\_model

data an optional data frame supplied by the user

Value

intercept the overall intercept

age\_effect the estimated age effect

period\_effect the estimated period effect

## **temp\_model**

An internal function, only used by the package APCI. Fit the APC-I model.

Usage

temp\_model(data, outcome, age, period, cohort, weight, covariate, …)

Arguments

outcome the outcome variable

age age group index in the data

period time period index in the data

cohort cohort membership index in the data

weight optional sample weights

covariate a list of optional user-specified covariates

data an optional data frame that contains variables used in the model

F.test logical, if run the series of tests and return their results

family xxx

Value

A the dimension of age, i.e., the number of age groups

P the dimension of period, i.e., the number of period groups

C the dimension of cohort, i.e., the number of cohort groups

model model fitted

## **tests**

An internal function, only used by the package APCI. Implement the sets of statistical tests.

Usage

tests(model, A, P, C, cohort\_index, data, weight, …)

Argument

A the dimension of age, i.e., the number of age groups

P the dimension of period, i.e., the number of period groups

C the dimension of cohort, i.e., the number of cohort groups

model a model fitted in temp\_model

data an optional data frame supplied by the user

cohort\_index the list of names for all the cohorts

weight optional case weights

Value

f\_global results of the global F test

f\_local results of the local F test