Package: u5mr (via r-universe)

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Type Package

Title Under-Five Child Mortality Estimation

Version 0.1.2

Date 2021-09-09

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Description Contains functions for calculating under-five child mortality estimates using the Trussell version of the Brass method (United Nations (1990) <https://www.un.org/en/development/desa/population/publications/pdf/mortality/stepguide_childmort.pdf> and United Nations (1983) <https://www.un.org/en/development/desa/population/publications/pdf/mortality/stepguide_childmort.pdf>) as well as applying the cohort-derived methods by Rajaratnam and colleagues (Rajaratnam JK, Tran LN, Lopez AD, Murray CJL (2010) ``Measuring Under-Five Mortality: Validation of New Low-Cost Methods" <doi:10.1371/journal.pmed.1000253>).

License GPL (>= 2)

Encoding UTF-8

LazyData true

LazyDataCompression bzip2

Depends R(>= 4.0.0)

URL https://github.com/myominnoo/u5mr

BugReports https://github.com/myominnoo/u5mr/issues

Suggests knitr, rmarkdown

RoxygenNote 7.1.1

Roxygen list(markdown = TRUE)

Language en-US

Imports lifecycle

Repository https://myominnoo.r-universe.dev

RemoteUrl https://github.com/myominnoo/u5mr

RemoteRef HEAD

RemoteSha 61003741a87abb9efaec01f307e01188ee8c6cf6

Contents

`agegroup_as_map` *Categorize age into two yearly intervals, needed to apply MAP method*

Description

[Stable]

`agegroup_as_map()` converts `age` variable into a character vector named `agegroup` with two yearly intervals between 14 and 50.

Usage

```
agegroup_as_map(data, age = "age")
```

Arguments

`data`	processed data
`age`	age of women

Value

data.frame

Examples

```
## demonstrating using microdata
data("microdata")
## get only female
md <- subset(microdata, sex == 2)
## get those aged between 14 and 50
md <- subset(md, age >= 15 & age < 50)
## create age group into 2-yearly intervals
md <- agegroup_as_map(md, age = "age")

summary(md$agegroup)
table(md$agegroup)
```

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bangladesh *Bangladesh 1974*

Description

The data gathered by the 1974 Bangladesh Retrospective Survey of Fertility and Mortality can be used to demonstrate the estimation of child mortality from summary birth histories using the Trussell version of the BRASS method and the Coale-Demeny model life tables coale_demeny_ltm.

Usage

```
data(bangladesh)
```

Format

A data frame

Details

- extracted from Display 6 on page 28 and Display 7 on page 29.

References

United Nations Population Studies (1990) Step-by-Step Guide to the Estimation of Child Mortality No.107:1-83 (United Nations)

birthdays_distribution

Distribution of birthdays for calculating maternal age period-derived U5MR estimates

Description

The data of distribution of birthdays for different regions.

Usage

```
data(birthdays_distribution)
```

Format

A data frame

Details

- ASIA
- LATC (Latin America and the Caribbean)
- NAME (North Africa and Middle East)
- SASE (Sub-Saharan Africa, South/East)
- SAWC (Sub-Saharan Africa, West/Central)

Source

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References

Rajaratnam JK, Tran LN, Lopez AD, Murray CJL (2010) Measuring Under-Five Mortality: Validation of New Low-Cost Methods. PLOS Medicine 7(4): e1000253. (doi:10.1371/journal.pmed.100025310.1371/journal.pmed

cambodia

Aggregated summary birth histories derived from microdata

Description

Fake summary data used to demonstrate the application of Cohort-derived and Period-derived methods developed by Rajaratnam et al in 2010.

Usage

```
data(cambodia)
```

Format

A data frame

Details

```
## codes used to derive the dataset `cambodia`

## install.packages("tidyverse", dependencies = TRUE)
## install.packages("devtools", dependencies = TRUE)
## devtools::install_github("myominnoo/mStats")

library(tidyverse)
library(mStats)
data(microdata)
cambodia <- microdata %>%
  filter(sex == 2) %>%
  filter(age >= 15 & age < 50) %>%
  egen(age, seq(15, 45, 5), new_var = "agegroup") %>%
  generate(n, 1 * wtper) %>%
  replace(ceb, ceb * wtper) %>%
  replace(cd, cd * wtper) %>%
  group_by(iso3, svdate, agegroup) %>%
  summarise(women = sum(n),
            child_born = sum(ceb),
            child_dead = sum(cd)) %>%
  rename(agegrp = agegroup) %>%
  data.frame()
```

Source

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References

Rajaratnam JK, Tran LN, Lopez AD, Murray CJL (2010) Measuring Under-Five Mortality: Validation of New Low-Cost Methods. PLOS Medicine 7(4): e1000253. (doi:10.1371/journal.pmed.100025310.1371/journal.pmed

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coale_demeny_ltm *Coale-Demeny Model Life Tables*

Description

The Coale-Demeny life tables consist of four sets of models, each representing a distinct mortality pattern. Each model is arranged in terms of 25 mortality levels, associated with different expectations of life at birth for females in such a way that `e0` of 20 years corresponds to level 1 and `e0` of 80 years corresponds to level 25.

Usage

```
data(coale_demeny_ltm)
```

Format

An object of class `"list"`; consist of four `data.frame` for `male`, `female` and `both sexes`.

Details

The four underlying mortality patterns of the Coale-Demeny models are called "North", "South", "East" and "West". They were identified through statistical and graphical analysis of a large number of life tables of acceptable quality, mainly for European countries.

Reference: United Nations (1990) "Step-by-step guide to the estimation of the child mortality" https://www.un.org/en/development/desa/population/publications/pdf/mortality/stepguide_childmort.pdf

References

United Nations Population Studies (1990) Step-by-Step Guide to the Estimation of Child Mortality No.107:1-83 (United Nations)

`coeff_trussell_ki` *Coefficients for the estimation of child mortality multipliers*

Description

This is a dataset of coefficients used to estimate multipliers `k(i)` in the TRUSSELL version of the BRASS method, using Coale-Demeny mortality models.

Usage

```
data(coeff_trussell_ki)
```

Format

A data frame

Details

The basic estimation equation for the Trussell method (equation 4.3) is

$$k(i) = a(i) + b(i)P(1)/P(2) + c(i)P(2)/P(3)$$

- extracted from page 26, Table 4.

References

United Nations Population Studies (1990) Step-by-Step Guide to the Estimation of Child Mortality No.107:1-83 (United Nations)

coeff_trussell_ti *Coefficients for the estimation of the time reference*

Description

This is a dataset of coefficients used to derive the time reference `t(i)`, for values of `q(x)` in the TRUSSELL version of the BRASS method, using Coale-Demeny mortality models.

Usage

```
data(coeff_trussell_ti)
```

Format

A data frame

Details

The basic estimation equation for the Trussell method (equation 4.3) is

$$t(i) = a(i) + b(i)P(1)/P(2) + c(i)P(2)/P(3)$$

The names of coefficients were changed from `e`, `f`, and `g` to `a`, `b`, and `c`.

- extracted from page 27, Table 5.

References

United Nations Population Studies (1990) Step-by-Step Guide to the Estimation of Child Mortality No.107:1-83 (United Nations)

coef_mac_5q0 *Model coefficients for the Maternal Age Cohort-derived method*

Description

Coefficients provided by Rajaratnam et al for estimation of under-five child mortality data from the maternal age cohort-derived method (MAC).

Usage

```
data(coef_mac_5q0)
```

Format

A data frame

Source

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References

Rajaratnam JK, Tran LN, Lopez AD, Murray CJL (2010) Measuring Under-Five Mortality: Validation of New Low-Cost Methods. PLOS Medicine 7(4): e1000253. (doi:10.1371/journal.pmed.100025310.1371/journal.pmed

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`coef_mac_re` *Random effect coefficients for the Maternal Age Cohort-derived method*

Description

Random effect coefficients provided by Rajaratnam et al for estimation of under-five child mortality data from the maternal age Cohort-derived method (MAC).

Usage

```
data(coef_mac_re)
```

Format

A data frame

Source

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References

Rajaratnam JK, Tran LN, Lopez AD, Murray CJL (2010) Measuring Under-Five Mortality: Validation of New Low-Cost Methods. PLOS Medicine 7(4): e1000253. (doi:10.1371/journal.pmed.100025310.1371/journal.pmed

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`coef_mac_ti` *Coefficients for calculating time reference in the Maternal Age Cohort-derived method*

Description

Coefficients provided by Rajaratnam et al for estimation of under-five child mortality data from the maternal age cohort-derived method (MAC).

Usage

```
data(coef_mac_ti)
```

Format

A data frame

Source

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References

Rajaratnam JK, Tran LN, Lopez AD, Murray CJL (2010) Measuring Under-Five Mortality: Validation of New Low-Cost Methods. PLOS Medicine 7(4): e1000253. (doi:10.1371/journal.pmed.100025310.1371/journal.pmed

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`coef_map_5q0` *Model coefficients for the Maternal Age Period-derived method*

Description

Coefficients provided by Rajaratnam et al for estimation of under-five child mortality data from the maternal age period-derived method (MAP).

Usage

```
data(coef_map_5q0)
```

Format

A data frame

Source

PLoS MEDICINE

References

Rajaratnam JK, Tran LN, Lopez AD, Murray CJL (2010) Measuring Under-Five Mortality: Validation of New Low-Cost Methods. PLOS Medicine 7(4): e1000253. (doi:10.1371/journal.pmed.100025310.1371/journal.pmed

coef_map_re

Random effect coefficients at country level for the Maternal Age Period-derived method

Description

Random effect coefficients provided by Rajaratnam et al for estimation of under-five child mortality data from the maternal age period-derived method (MAP).

Usage

```
data(coef_map_re)
```

Format

A data frame

Source

PLoS MEDICINE

References

Rajaratnam JK, Tran LN, Lopez AD, Murray CJL (2010) Measuring Under-Five Mortality: Validation of New Low-Cost Methods. PLOS Medicine 7(4): e1000253. (doi:10.1371/journal.pmed.100025310.1371/journal.pmed

deathdays_distribution

Distribution of death days for calculating maternal age period-derived U5MR estimates

Description

The data of distribution of birthdays for different regions.

Usage

```
data(deathdays_distribution)
```

Format

A data frame

Details

- ASIA
- LATC (Latin America and the Caribbean)
- NAME (North Africa and Middle East)
- SASE (Sub-Saharan Africa, South/East)
- SAWC (Sub-Saharan Africa, West/Central)

Source

PLoS MEDICINE

References

Rajaratnam JK, Tran LN, Lopez AD, Murray CJL (2010) Measuring Under-Five Mortality: Validation of New Low-Cost Methods. PLOS Medicine 7(4): e1000253. (doi:10.1371/journal.pmed.100025310.1371/journal.pmed

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microdata *Fake data for Cambodia*

Description

Fake data used to demonstrate the application of Cohort-derived and Period-derived methods developed by Rajaratnam et al in 2010.

Usage

```
data(microdata)
```

Format

A data frame

Details

iso3 - the iso3 code of the country from which your microdata come region - the region that the country belongs in country - name of the country svy_wt - sample weight given to the respondent. If no sample weights are provided, then generate this variable with a value of 1 for each respondent age - age of the respondent in years: or time since first birth of the respondent in years sex - sex of the respondent where 1 indicates male and 2 is female. ceb - number of children ever born cd - number of children that died

Source

PLoS MEDICINE

References

Rajaratnam JK, Tran LN, Lopez AD, Murray CJL (2010) Measuring Under-Five Mortality: Validation of New Low-Cost Methods. PLOS Medicine 7(4): e1000253. (doi:10.1371/journal.pmed.100025310.1371/journal.pmed

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`panama` *Panama 1976*

Description

The data gathered by a survey in Panama between August and October 1976 can be used to demonstrate the estimation of child mortality from summary birth histories using the Trussell version of the BRASS method and the Coale-Demeny model life tables `coale_demeny_ltm`.

Usage

```
data(panama)
```

Format

A data frame

Details

- extracted from Table49 on page 78.

Source

United Nations Population Division

References

United Nations (1983) Manual X: indirect techniques for demographic estimation. Population studies No. 81. New York: United Nations Department of International Economic and Social Affairs (United Nations)

`u5mr_cohort` *Estimating under-five mortality using Maternal Age Cohort-derived method (MAC)*

Description

[Stable]

`u5mr_cohort()` uses the maternal age cohort-derived methods (MAC) through summary birth history information and maternal age (or time since first birth) to calculate the under-five mortality estimates.

Usage

```
u5mr_cohort(
  data,
  women = "women",
  child_born = "child_born",
  child_dead = "child_dead",
  agegrp = "agegrp",
  iso3 = "KHM",
  svy_year = 2010
)
```

Arguments

`data`	preprocessed data
`women`	total number of women
`child_born`	children ever born
`child_dead`	children dead
`agegrp`	age grouping or time since first birth
`iso3`	the `iso3` code of the country from which the survey data come
`svy_year`	end of the survey

Details

In this cohort-derived method, under-five mortality and reference time are estimated through summary birth history information from the mothers and her age or time since her first birth.

In case sample weights are available for the mothers, final variables should be multiplied by these weights before summarizing.

Computational Procedure

Two formulas were used to quantify MAC method:

$5q0$ **component**

logit(5q0_{ijk}) = β_{0i} + U_{ij} + β_{1i} x logit(CD_{ijk} / CEB_{ijk}) + β_{2i} x CEB_{ijk} + β_{3i} x PR1 + β_{4i} x PR2 + ϵ_{ijk}

where

i = 5-year maternal age group ϵ (15-19, 20-24, ... , 45-49) j = country k = survey CD_i = total dead children from maternal age group `i` CEB_i = total children ever born from maternal age group `i` PR1 = ratio of parity among maternal age group 15-19 and parity among maternal age group 20-24 PR2 = ratio of parity among maternal age group 20-24 and parity among maternal age group 25-29 U_{ij} = country-specific random effects

All coefficients vary by maternal age group, as indicated by `i` and the random effects also vary by country, as indicated by `j`.

Reference time component

reftime_{ijk} = β_{0i} + β_{1i} x (CD_{ijk} / CEB_{ijk}) + β_{2i} x CEB_{ijk} + β_{3i} x PR1 + β_{4i} x PR2 + ϵ_{ijk}

Value

`data.frame`

- `iso3` - total number of women
- `svy_year` - total number of children ever born
- `agegrp` - five-year age groups
- `ref_time` - time between survey year and interpolated year
- `year` - reference year
- `q5` - under-five mortality

References

Rajaratnam JK, Tran LN, Lopez AD, Murray CJL (2010) Measuring Under-Five Mortality: Validation of New Low-Cost Methods. PLOS Medicine 7(4): e1000253. (doi:10.1371/journal.pmed.100025310.1371/journal.pmed

Examples

```
## Example using fake survey data from Cambodia
data(cambodia)
camb <- u5mr_cohort(cambodia, women = "women", child_born = "child_born",
child_dead = "child_dead", agegrp = "agegrp", iso3 = "KHM", svy_year = 1234)

with(camb,
     plot(year, q5 * 1000, type = "b", pch = 19,
          col = "black", xlab = "Year", ylab = "U5MR per 1000 live births",
          main = paste0("Under-five mortality, q(5) in Bangladesh, estimated\n",
                        "using the maternal age cohort-derived method")))
```

`u5mr_period` *Estimating under-five mortality using Maternal Age Period-derived method (MAP)*

Description

[Stable]

`u5mr_period()` uses the maternal age period-derived method (MAP) through summary birth history information and maternal age (or time since first birth) to calculate the under-five mortality estimates.

Usage

```
u5mr_period(
  data,
  child_born = "child_born",
  child_dead = "child_dead",
  agegrp = "agegrp",
  svy_wt = "svy_wt",
  iso3 = "KHM",
  svy_region = "ASIA",
  svy_year = 1234
)
```

Arguments

`data`	preprocessed data
`child_born`	children ever born
`child_dead`	children dead
`agegrp`	age grouping or time since first birth
`svy_wt`	sample weights: if not available, use 1.
`iso3`	the `iso3` code of the country from which the survey data come
`svy_region`	region of the country from which the survey data come • `ASIA` • `LATC` (Latin America and the Caribbean) • `NAME` (North Africa and Middle East) • `SASE` (Sub-Saharan Africa, South/East) • `SAWC` (Sub-Saharan Africa, West/Central)
`svy_year`	end of the survey

Details

In this period-derived method, under-five mortality and reference time are estimated through distributions of child birthdays and death days for different categories of mothers, stratified by maternal information such as region, age, and number of child ever born or dead. These distributions are used to find the expected number of children ever born and dead in every year prior to the survey (up to 25 years) for a mother in each particular strata.

By applying these distributions to each mother in each strata, and summing across all strata, expected numbers of children ever born (CEB) and child dead (CD) are generated for each year prior to the survey. The ratio of CD and CEB for each year can then be calculated.

Computational Procedure

The formulas used to quantify MAP method is as follows:

logit(5q0_{tjk}) = β⁰_t + U_{tj} + β¹_t x logit(CD_{tjk} / CEB_{tjk}) + ϵ_{tjk}

where

t = index of calendar time ϵ (0, 24) j = country k = survey CD_i = total dead children in time bin `t` CEB_i = total children ever born in time bin `t`

Value

`data.frame`

- `ref_time` - time between survey year and interpolated year
- `year` - reference year
- `q5` - under-five mortality

References

Rajaratnam JK, Tran LN, Lopez AD, Murray CJL (2010) Measuring Under-Five Mortality: Validation of New Low-Cost Methods. PLOS Medicine 7(4): e1000253. (doi:10.1371/journal.pmed.100025310.1371/journal.pmed

Examples

```
data("microdata")
## get only female
md <- subset(microdata, sex == 2)
## get those aged between 14 and 50
md <- subset(md, age >= 15 & age < 50)
## create age group into 2-yearly intervals
md <- agegroup_as_map(md, age = "age")
u5mr_period(md, child_born = "ceb", child_dead = "cd", agegrp = "agegroup",
            svy_wt = "svy_wt", iso3 = "KHM",
            svy_region = "ASIA", svy_year = 1234)
```

u5mr_trussell *Estimating under-five mortality using Coale-Demeny life table models*

Description

[Stable]

`u5mr_trussell()` uses the Trussell version of the BRASS method and calculates under-five mortality estimates.

Usage

```
u5mr_trussell(
  data,
  women = "women",
  child_born = "child_born",
  child_dead = "child_dead",
  agegrp = "agegrp",
  model = "west",
  svy_year = 1976.5,
  sex
)
```

Arguments

`data`	processed data
`women`	total number of women
`child_born`	children ever born
`child_dead`	children dead
`agegrp`	age grouping
`model`	Coale-Demeny life table model: `north`, `south`, `east`, and `west`
`svy_year`	end of the survey
`sex`	indicates sex-specific estimates: `both`, `male`, and `female`

Details

T. J. Trussell developed the Trussell version of the Brass method to estimate child mortality using summary birth history (United Nations, 1983b, Chapter III). It is based on the Coale-Demeny life table models of either North, South, East, or West.

Computational Procedure

Step 1. Preparing the dataset

The function needs four variables from the input data:

a) `agegrp`: age groups representing `15-19`, `20-24`, `25-29`, `30-34`, `35-39`, `40-44`, and `45-49`.

b) `women`: the total number of women in the age group irrespective of their marital or reporting status

c) `child_born`: the total number of children ever borne by these women

d) `child_dead`: the number of children dead reported by these women

Step 1.1. Calculation of average parity per woman `P(i)`

$$P(i) = CEB(i)/FP(i)$$

- `CEB(i)` is the total number of children ever borne by these women
- `FP(i)` is the total number of women in the age group irrespective of their marital or reporting status.

Step 1.2. Calculation of the proportions dead among children ever borne `D(i)`

$$D(i) = CD(i)/CEB(i)$$

- `CD(i)` is the number of children dead for women of age group i

Step 2. Calculating the multipliers `k(i)` and probabilities of dying by age x `q(x)`

$$k(i) = a(i) + b(i)P(1)/P(2) + c(i)P(2)/P(3)$$

where `a(i)`, `b(i)`, and `c(i)` are coefficients estimated by regression analysis of simulated model cases, and `P(1)/P(2)` and `P(2)/P(3)` are parity ratios.

$$q(x) = k(i)xD(i)$$

Step 3. Calculating the reference dates for `q(x)` and interpolating `q5`

Under conditions of steady mortality change over time, a reference time `t(i)` can be estimated for each `q(x)`.

$$t(i) = a(i) + b(i)P(1)/P(2) + c(i)P(2)/P(3)$$

Actual dates can be obtained by subtracting `t(i)` from the reference date of the survey or census, expressed in decimal terms.

Step 4. Interpolating between `q(x)` and model life table

A common index, in this case, under-five mortality `q(5)` can be obtained by conversions of corresponding `q(x)` values to the specified family of the Coale-Demeny life table models. In a given life table family and sex, the first step is to identify the mortality levels with q(x) values that enclose the estimated value $q^e(x)$.

$$q^j(x) > q^e(x) > q^j + 1(x)$$

where $q^j(x)$ and $q^j + 1(x)$ are the model values of `q(x)` for levels `j` and `j+1`, and $q^e(x)$ is the estimated value.

The desired common index $q^c(5)$, or `q5` is given by

$$q^c(5) = (1.0 - h)xq^j(5) + hxq^e(5)$$

where h is the interpolation factor calculated in the following way:

$$h = q^e(x) - q^j(x)/q^j + 1(x) - q^j(x)$$

Step 5. Finalizing the calculation

The final output is combined into a `data.frame`, which contains original dataset as well as statistics produced during the computational procedure.

Value

`data.frame`

- `agegrp` - five-year age groups
- `women` - total number of women
- `child_born` - total number of children ever born
- `child_dead` - number of children dead
- `pi` - average parity
- `di` - proportion of dead among children ever born
- `ki` - multipliers
- `qx` - probabilities of dying at age x
- `ti` - time between survey year and interpolated year
- `year` - reference year
- `h` - interpolation factor
- `q5` - under-five mortality

References

1. United Nations (1990) "Step-by-step guide to the estimation of the child mortality" https://www.un.org/en/development/desa/population/publications/pdf/mortality/stepguide_childmort.pdf
2. United Nations (1983) "Manual X indirect techniques for demographic estimation" https://www.un.org/en/development/desa/population/publications/pdf/mortality/stepguide_childmort.pdf

Examples

```
## Using Bangladesh survey data to estimate child mortality
data("bangladesh")
bang_both <- u5mr_trussell(bangladesh, sex = "both", model = "south", svy_year = 1974.3)
bang_male <- u5mr_trussell(bangladesh, child_born = "male_born",
                 child_dead = "male_dead", sex = "male",
                 model = "south", svy_year = 1974.3)
bang_female <- u5mr_trussell(bangladesh, child_born = "female_born",
```

```
                child_dead = "female_dead", sex = "female",
                model = "south", svy_year = 1974.3)

## plotting all data points
with(bang_both,
    plot(year, q5, type = "b", pch = 19,
         ylim = c(0, .45),
         col = "black", xlab = "Reference date", ylab = "u5MR",
         main = paste0("Under-five mortality, q(5) in Bangladesh, estimated\n",
                     "using model South and the Trussell version of the Brass method")))
with(bang_both, text(year, q5, agegrp, cex=0.65, pos=3,col="purple"))
with(bang_male,
    lines(year, q5, pch = 18, col = "red", type = "b", lty = 2))
with(bang_female,
    lines(year, q5, pch = 18, col = "blue", type = "b", lty = 3))
legend("bottomright", legend=c("Both sexes", "Male", "Female"),
      col = c("Black", "red", "blue"), lty = 1:3, cex=0.8)


## Using panama survey data to estimate child mortality
data("panama")
pnm_both <- u5mr_trussell(panama, sex = "both", model = "west", svy_year = 1976.5)
pnm_male <- u5mr_trussell(panama, child_born = "male_born",
                child_dead = "male_dead", sex = "male",
                model = "west", svy_year = 1976.5)
pnm_female <- u5mr_trussell(panama, child_born = "female_born",
                child_dead = "female_dead", sex = "female",
                model = "west", svy_year = 1976.5)

## plotting all data points
with(pnm_both,
    plot(year, q5, type = "b", pch = 19,
        ylim = c(0, .2), col = "black", xlab = "Reference date", ylab = "u5MR",
         main = paste0("Under-five mortality, q(5) in Panama, estimated\n",
                      "using model West and the Trussell version of the Brass method")))
with(pnm_both, text(year, q5, agegrp, cex=0.65, pos=3,col="purple"))
with(pnm_male,
    lines(year, q5, pch = 18, col = "red", type = "b", lty = 2))
with(pnm_female,
    lines(year, q5, pch = 18, col = "blue", type = "b", lty = 3))
legend("bottomleft", legend=c("Both sexes", "Male", "Female"),
      col = c("Black", "red", "blue"), lty = 1:3, cex=0.8)
```

Index