Office for National Statistics

An R implementation of a model-based estimator – a UK study

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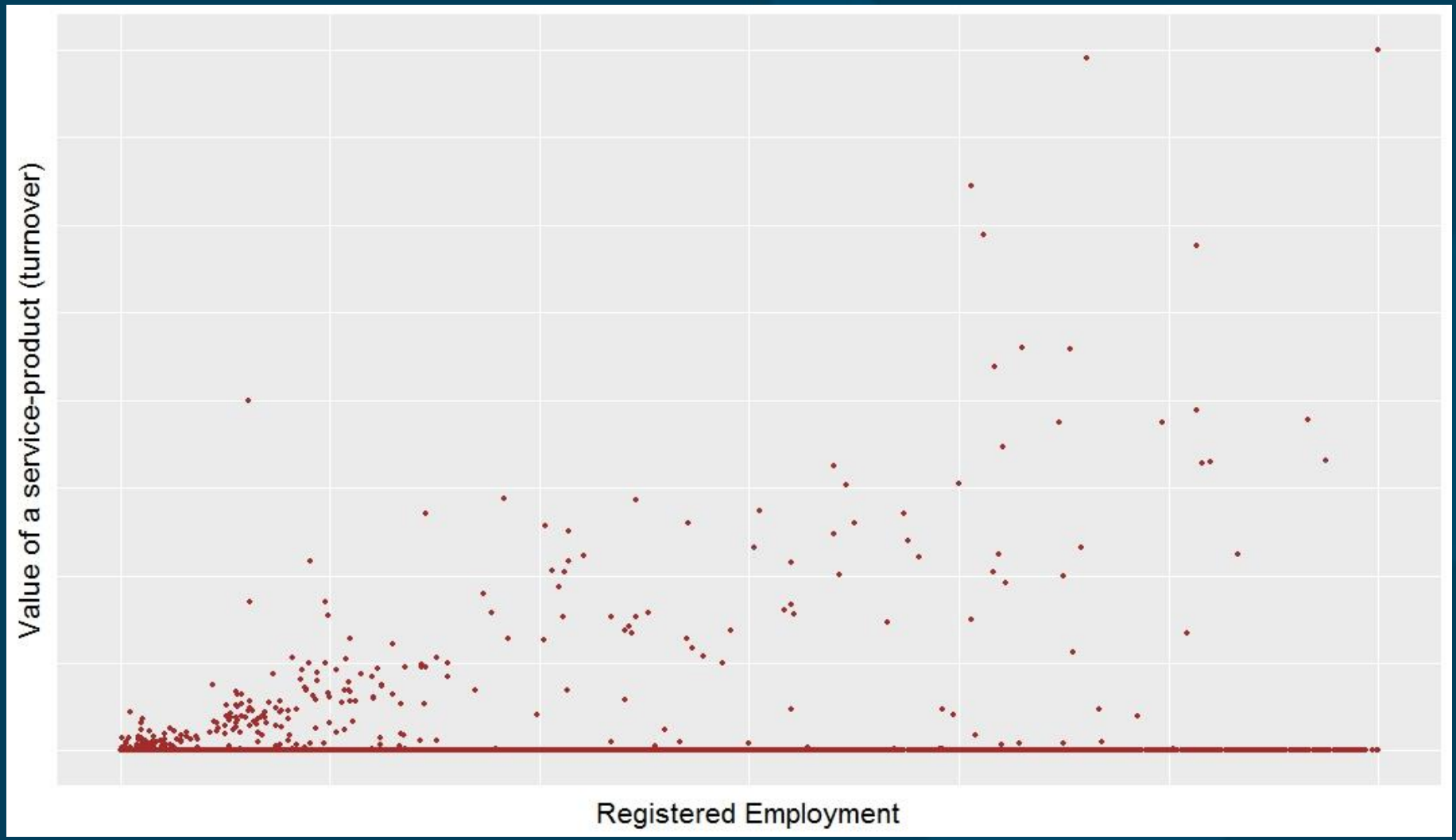
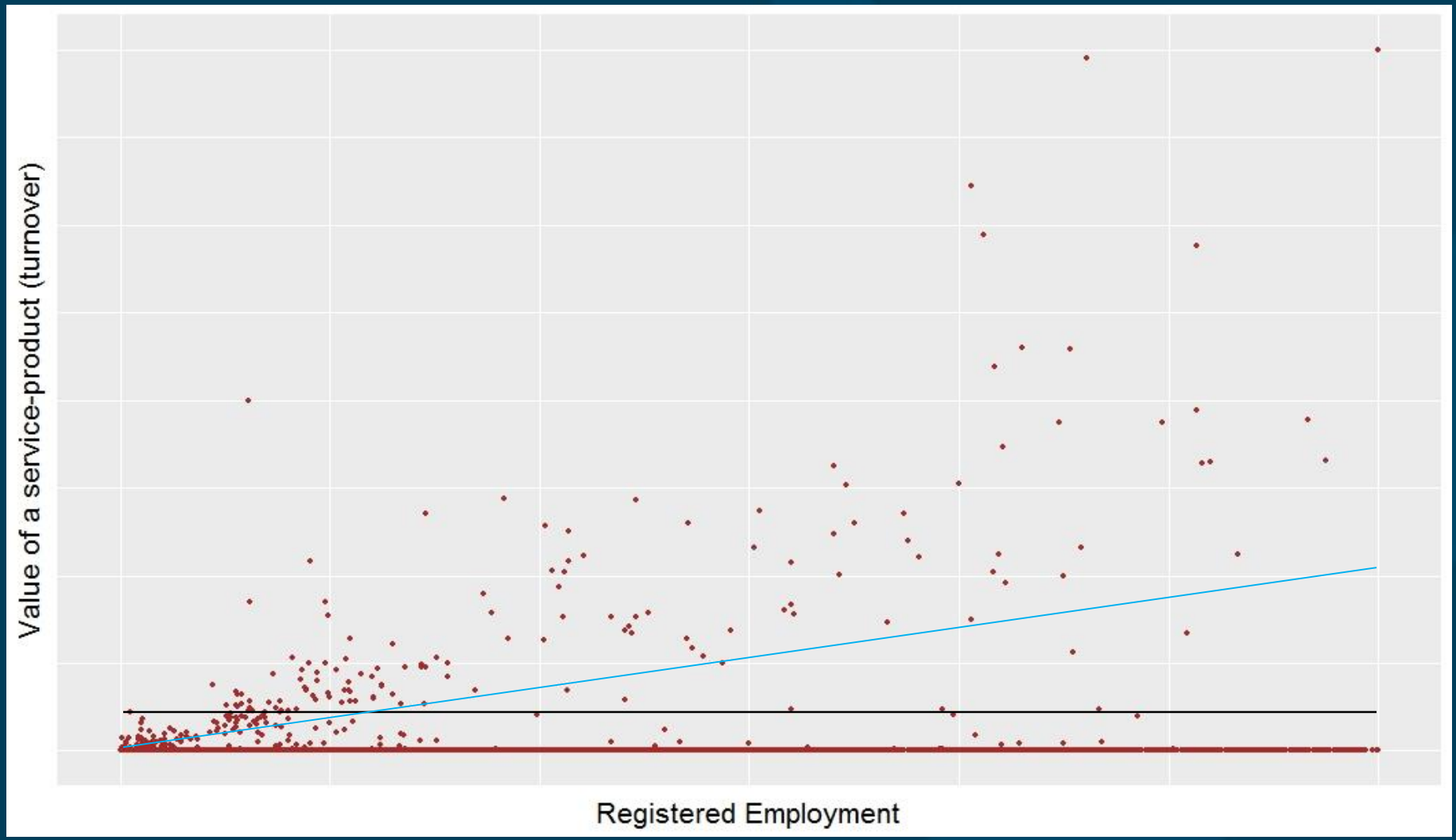
Traditional approaches to survey inference

- Design-based approach (Horvitz-Thompson estimator)
- Model-assisted approach (ratio estimator)
- Well-understood properties
- Available in *survey* and *ReGenesees* libraries

Annual Survey of Goods and Services (ASGS)

- Sample size ~40,000 UK businesses
- Over 2000 service products (study variables)
- Estimates for each product produced for each service industry class (4-digit level of SIC)
- Outputs to be used for important economic indicators such as GDP


Value of a service-product (turnover)
Registered Employment


Value of a service-product (turnover)
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Model-based approach

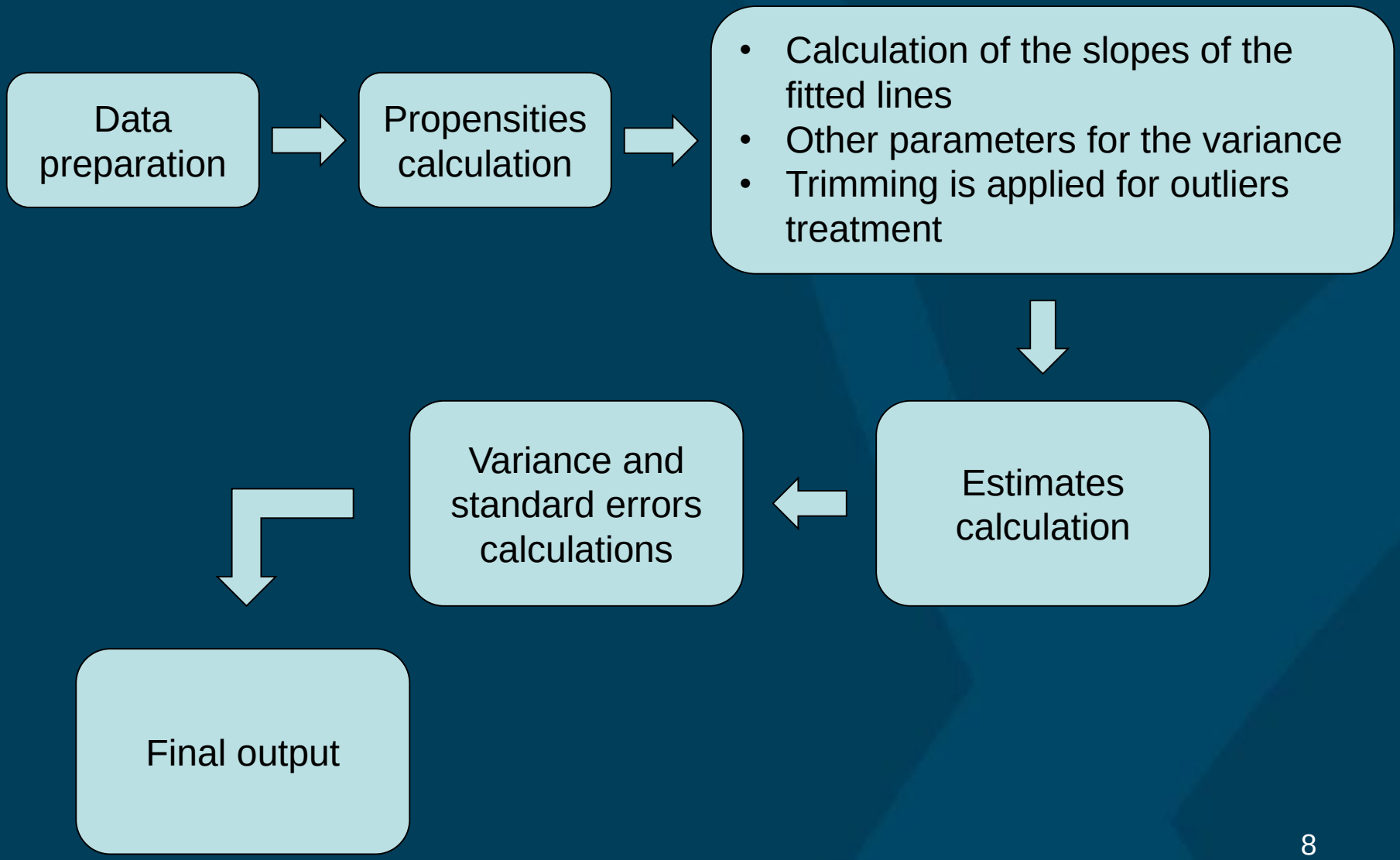
- Two-part conditional ratio, also called Chambers-Cruddas model (CC)
- Part 1: estimate the probability that a business provides a particular service
- Part 2: model the service turnover as proportional to register employment

$$\hat{t}_y = \sum_{i \in s} y_i + \sum_{i \notin s} y_i$$

Using R: custom functions

- Successive functions estimate the model parameters, and then the totals, with variances and standard errors
- Outputs of certain functions are used as inputs to other ones
- Tracking of calculations, debugging, convenient in outliers treatment

Pipeline flow chart



Code Examples – Data preparation

```
finaldata <- finaldata %>% left_join(popcounts, by = "cell_no") %>%
                           select(RUReference:sizeband, ncount, bign, everything()) %>%
                           mutate_at(vars(RUReference,FormType,cell_no, sic2007, sic_group),
                                     funs(as.numeric(.))) %>%
                          mutate(sic4 = as.numeric(substr(sic2007,1,4)))
                          select(RUReference:sic2007, sic4, everything())
```

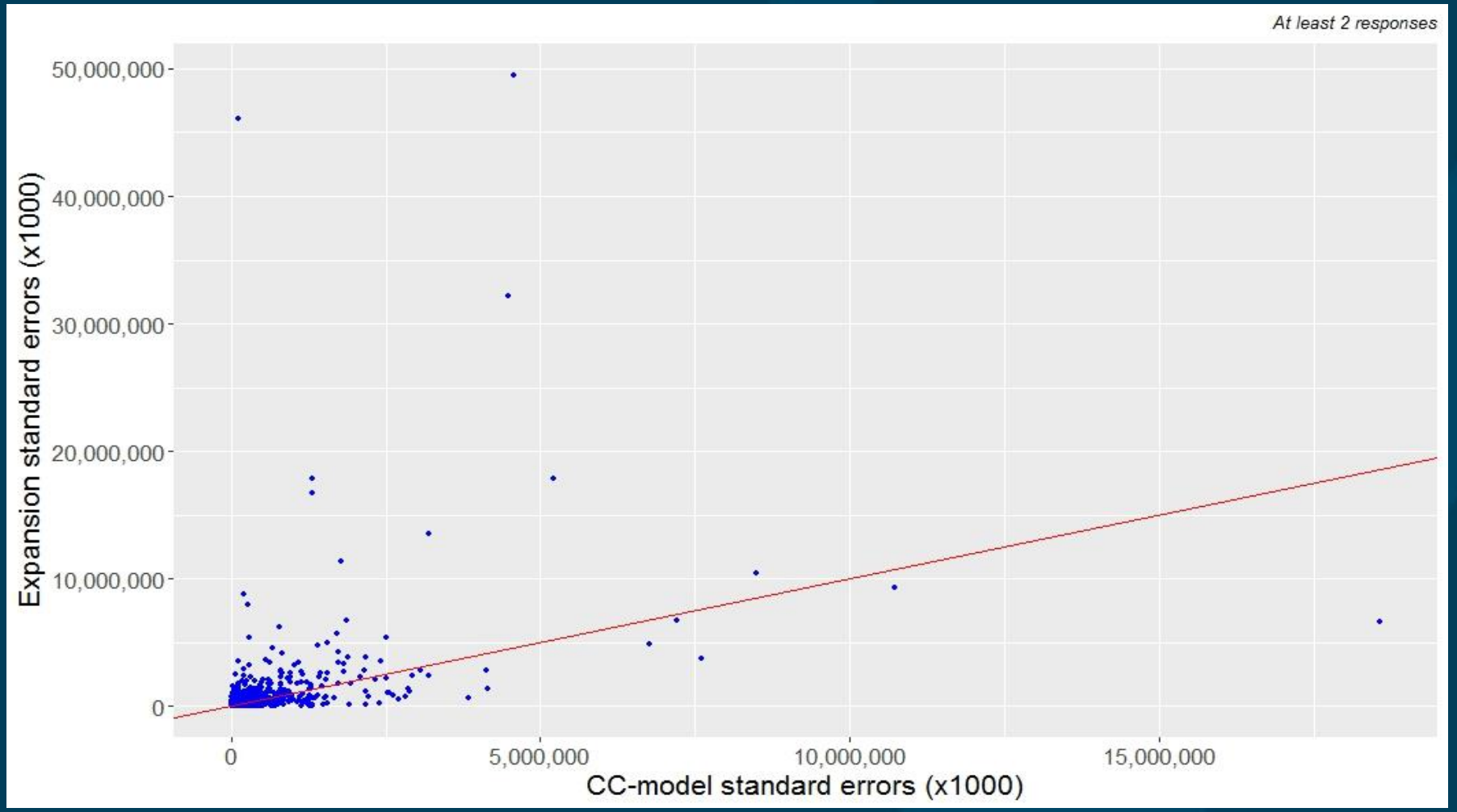
```
finaldata_prep <- finaldata %>%
                        mutate_at(vars(-RUReference:-bign),
                                  funs("DELTA" = ifelse(.>0, 1, 0),
                                       "YxD_X" = ifelse(Emptfro > 0, .^2/Emptfro, 0))) %>%
                        mutate_at(vars(contains("DELTA")), funs("X"=.*Emptfro))
```

```
responses_sic4 <- finaldata_mod %>% group_by(sic4) %>%
                                    summarise_at(vars(starts_with("UK"),starts_with("OS")),
                                                 funs(sum(.!=0))) %>%
                                    gather(question, responses, -sic4) %>%
                                    filter(responses!=0)
```

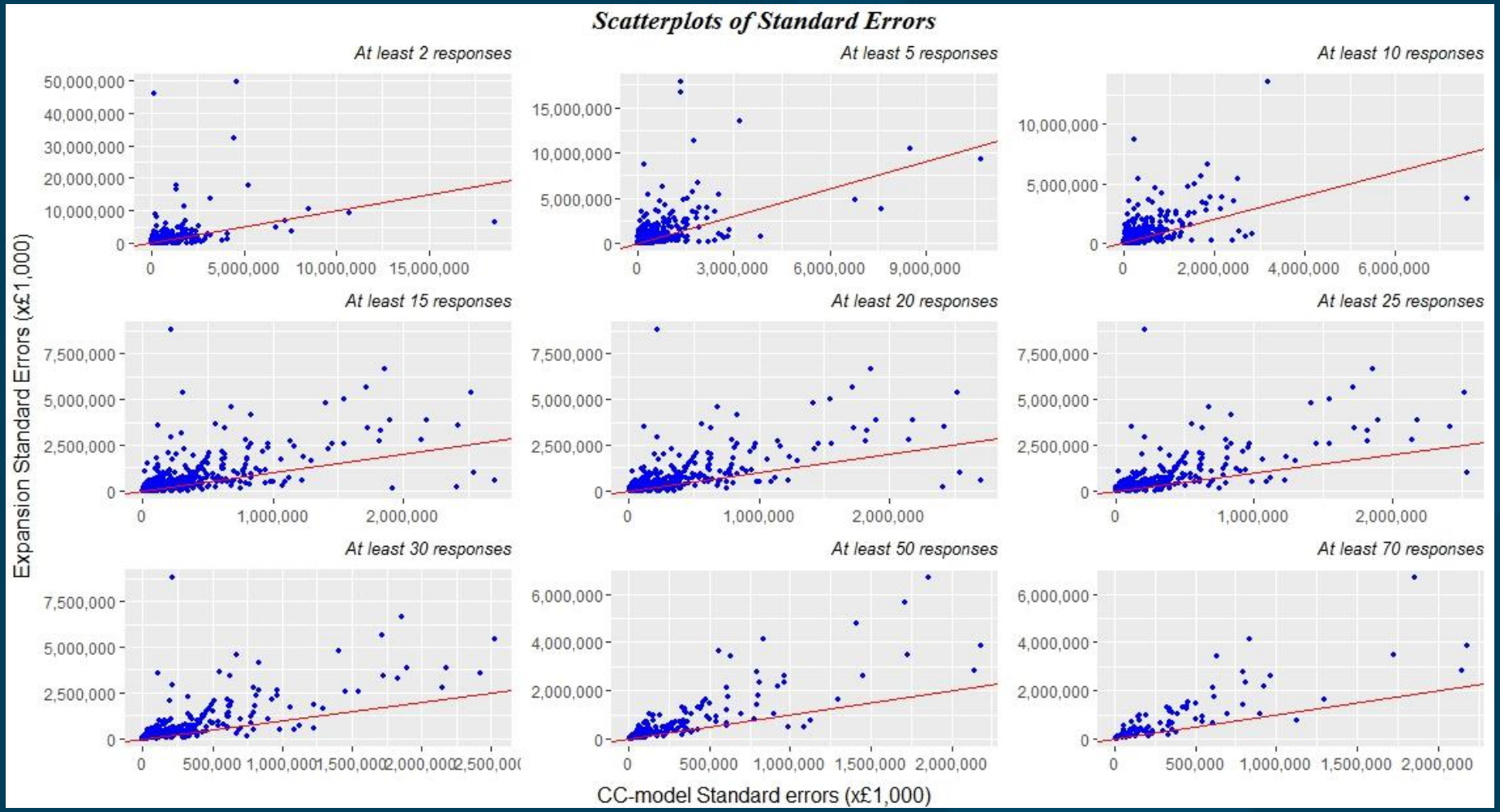
Code Example - custom functions

```
calc_betas <- function(df, grp.var){

  grp.var <- enquo(grp.var)

  ## Betas formula: [ b = Sumof(D*Y) / Sumof(D*X) ]:

  # numerator:
  betas.num <- df %>% group_by(cell_no, !!grp.var) %>%
                      summarise_at(vars(-RUReference:-bign,
                                        -contains("DELTA"),
                                        -contains("YxD_X")),sum) %>%
                      group_by(!!grp.var) %>%
                      summarise_at(vars(-cell_no),sum) %>%
                      arrange(!!grp.var)

  # denominator:
  betas.denom <- df %>% group_by(cell_no, !!grp.var) %>%
                        summarise_at(vars(contains("DELTA_X")),sum) %>%
                        group_by(!!grp.var) %>%
                        summarise_at(vars(-cell_no),sum) %>%
                        arrange(!!grp.var)

  # betas final:
  BETAS <- cbind(betas.num[1], betas.num[-1] / betas.denom[-1])

  return(BETAS)

}
```

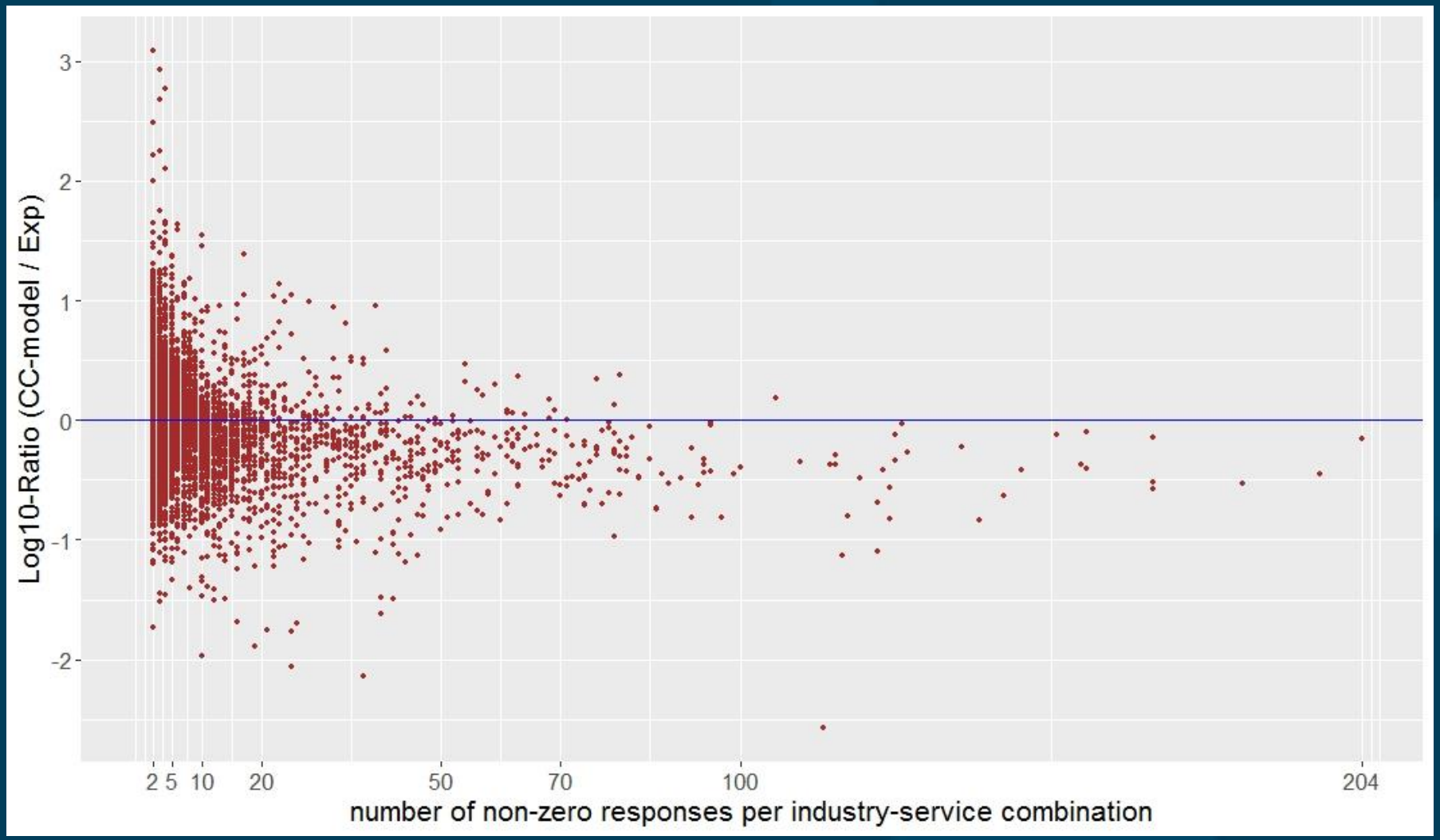
Scatterplots of Standard Errors



Scatterplots of Standard Errors



Ratio of Standard Errors



Conclusions / Future work

- CC estimator is more efficient than traditional expansion estimator
- R offered the versatility and speed to handle large amount of data and calculations
- Several functions and procedures were created, contributing to the Office's transition towards open software
- The code will continue to be tested, improved and finally packaged to be made generally available
- Further work for improved sampling and sample allocation

Thank you!

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