**2.1. Informative sampling with the povmap package**

The povmap package offers, in addition to the methodology of Guadarrama *et al.* (2018),

the possibility to consider the informative sampling via the weights argument in the nlme

package (Pinheiro *et al.* 2015). The well-known nlme package allows the estimation of linear

mixed models via the function lme and is used in both the emdi and povmap package for

the estimation of Empirical Best Predictor (EBP) models, which are special cases of a linear

mixed model. The weights argument in the lme command provides an alternative method to

adjust for informative sampling.. The povmap package now allows users to include weights via the lme function. There are two different possibilities to use the nlme package in this context:

(1) to include the informative sampling for the estimation of the model for the EBP (cf. step 2

in Kreutzmann *et al.* (2019) on page 7) or (2) when using data-driven transformations, using

the weights both to select the optimal transformation parameter and for estimating the model

(cf. step 1 in Kreutzmann *et al.* (2019) on page 7). This selection is now enabled with the

argument weights\_type in the povmap package. The default are the inclusion of informative

sampling following Guadarrama *et al.* (2018) ("Guadarrama"). If "nlme" is selected, weights

are included within the lme function for estimating the linear-mixed model for the EBP. If

"nlme\_lambda" is selected, weights are also included within the estimation of the

data-driven parameter for the transformation. In both cases, each residual is assumed to have variance equal to the inverse of the weight for that observation, so that each observation is weighted using its specified weight.

For all three weight options, the estimated shrinkage factor takes the weights into account, using the formula:

where and are the estimated variances of the area effect and idiosyncratic error term, and is the weight assigned to unit j located in target area i. When there are no weights specified, =1 for all j, and this reduces to:

Where is the number of units in target area i. The main advantage of specifying weights through the nmle or nmle\_lambda options, as implemented in the povmap package, is that this is compatible with all transformations. The version with the "Guadarrama"-weights is only compatible with no transformation or the log transformation. A second difference between the methods is that when using nlme weights, the variance component estimates of and from the linear mixed model are derived from a weighted model.