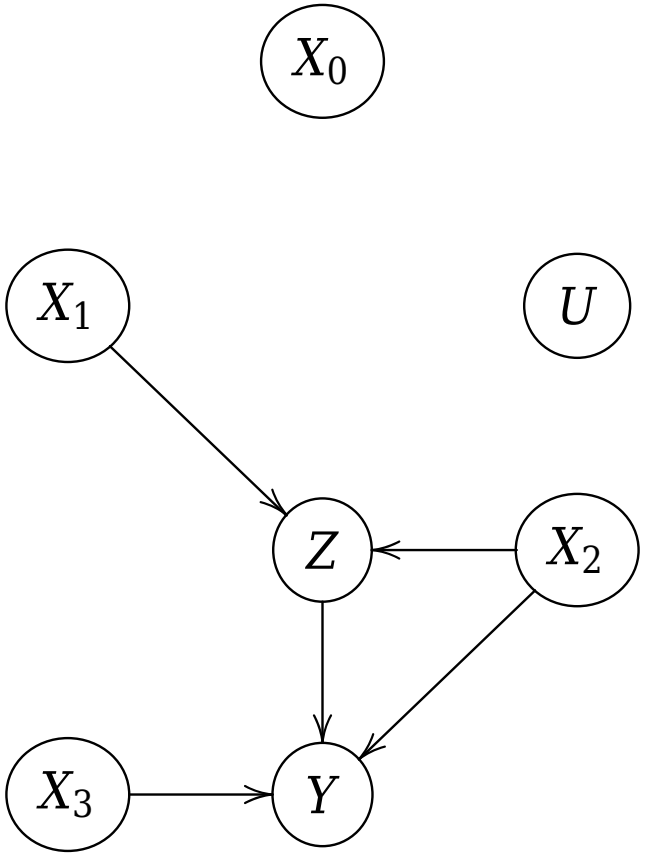
Comparing Adjustment Approaches: A simulation study

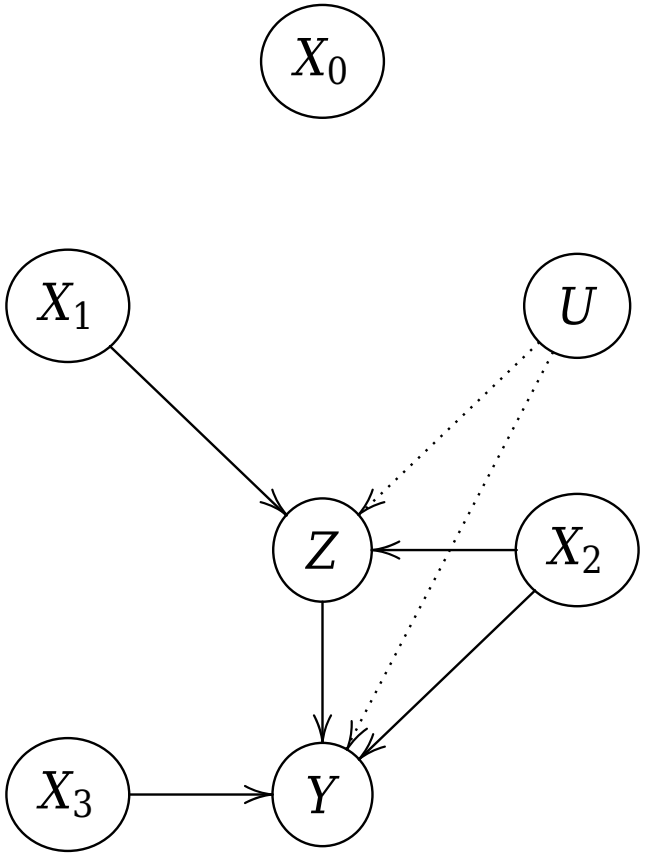
Variables for Adjustment

- spurious variables (X_0);
- instruments (X_1);
- confounders (X_2);
- predictors of outcome only (X_3);
- unmeasured confounders (U).

Variables for Adjustment



Variables for Adjustment



Simulation Study

We can study the pros and cons of the different approaches using simulation.

In the following study, we look at the sampling distribution of estimators of the ATE in a binary treatment setting. There are **four** simulation settings, with different patterns of confounding and exposure.

We use $p = 10$ predictors, with

- two spurious variables (X_0);
- two instruments (X_1);
- three confounders (X_2);
- three predictors of outcome only (X_3).

We use $n = 1000$ and perform 1000 replicate studies.

Simulation Study

We examine five types of estimator alongside ordinary regression:

1. Propensity score stratification;
2. Propensity score regression (PSR);
3. Inverse probability weighting (IPW);
4. Doubly robust (augmented) IPW (DR);
5. Propensity score matching.

Simulation Study

1. Propensity score stratification;

   Boxplots contain sampling distribution of estimators for:

   1.1 Regression using all predictors;
   1.2 Regression using only the predictors of outcome (including confounders);
   1.3 Regression on the exposure of interest (unadjusted);
   1.4 Regression using a misspecified model;
   1.5 Regression using the confounders only;
   1.6 Propensity score stratification using all predictors in the propensity score model;
   1.7 Propensity score stratification using predictors of treatment;
   1.8 Propensity score stratification using confounders.

Simulation Study

2. Propensity score regression (PSR);
   - 2.1 Regression using all predictors;
   - 2.2 Regression using only the predictors of outcome (including confounders);
   - 2.3 Regression on the exposure of interest (unadjusted);
   - 2.4 Regression using a misspecified model;
   - 2.5 Regression using the confounders only;
   - 2.6 Propensity score regression using all predictors in the propensity score model;
   - 2.7 Propensity score regression using predictors of treatment;
   - 2.8 Propensity score regression using confounders.

Here the PSR model is the simplest possible:

$$\beta_0 + \beta_1 e(X) + \theta Z$$

Simulation Study

3. Inverse probability weighting (IPW);

   Here we consider four pairs of estimators; the two elements in the pair use weights that are unstandardized (IPW0), and standardized (IPW), respectively. We consider

   3.1 IPW using all predictors in the propensity score model;
   3.2 IPW using predictors of treatment;
   3.3 IPW using confounders;
   3.4 IPW using all predictors of outcome.

Simulation Study

4. Doubly robust (augmented) IPW (DR);

   Again we consider four pairs of estimators; the two elements in the pair use weights that are unstandardized (AIPW0), and standardized (AIPW), respectively. We consider

   4.1 AIPW using all predictors in the propensity score model;
   4.2 AIPW using predictors of treatment;
   4.3 AIPW using confounders;
   4.4 AIPW using all predictors of outcome.

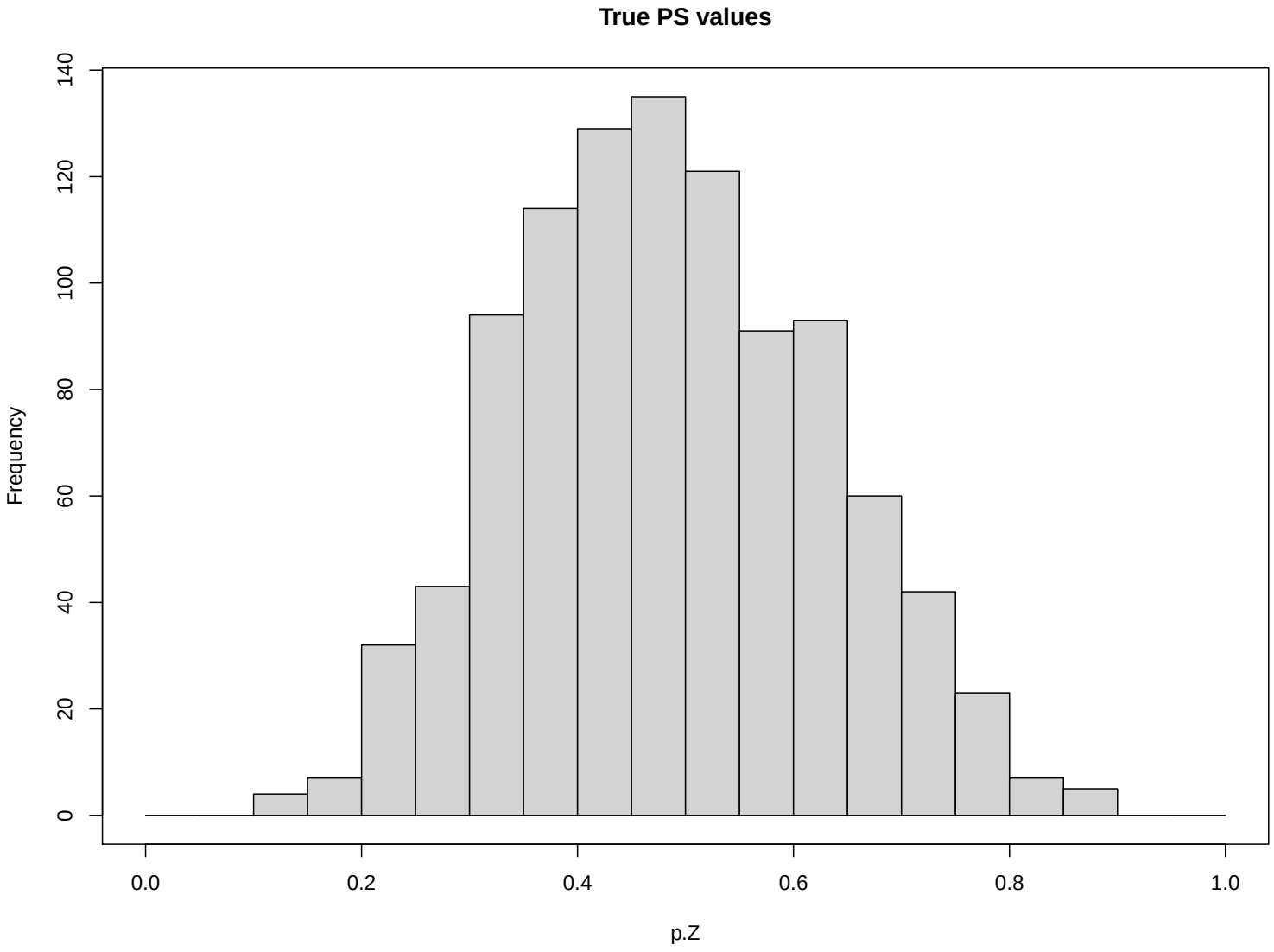
   The same predictors are used in the outcome regression model.

5. Propensity score matching.

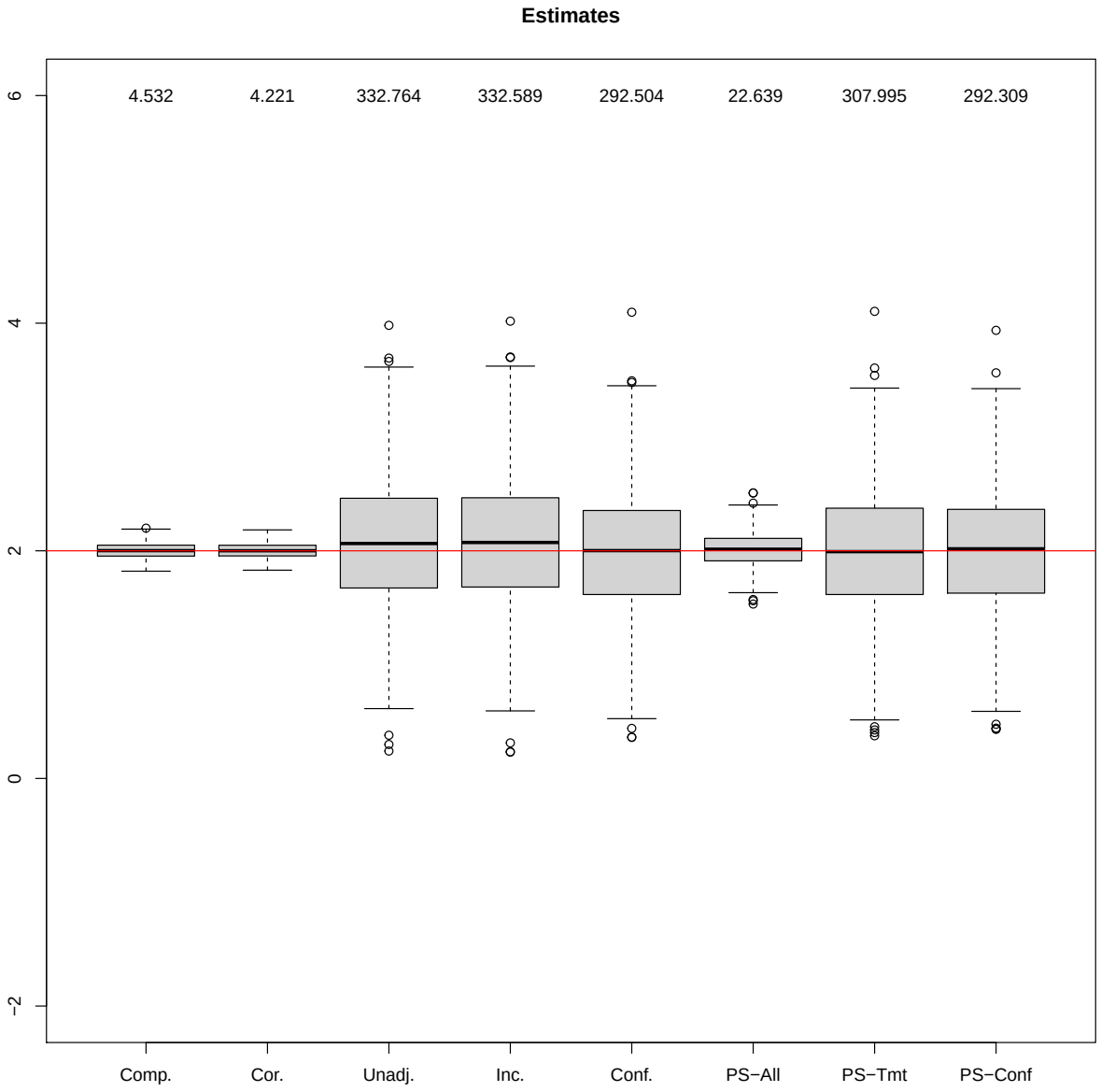
   We perform matching estimation using the `Matching` package in `R`. We consider

   5.1 1-1 matching ($M = 1$) with all predictors;
   5.2 1-1 PS matching ($M = 1$) using all predictors;
   5.3 2-1 PS matching ($M = 2$) using all predictors;
   5.4 5-1 PS matching ($M = 5$) using all predictors;
   5.5 10-1 PS matching ($M = 10$) using all predictors;
   5.6 1-1 matching ($M = 1$) using confounders;
   5.7 1-1 PS matching ($M = 1$) using confounders.

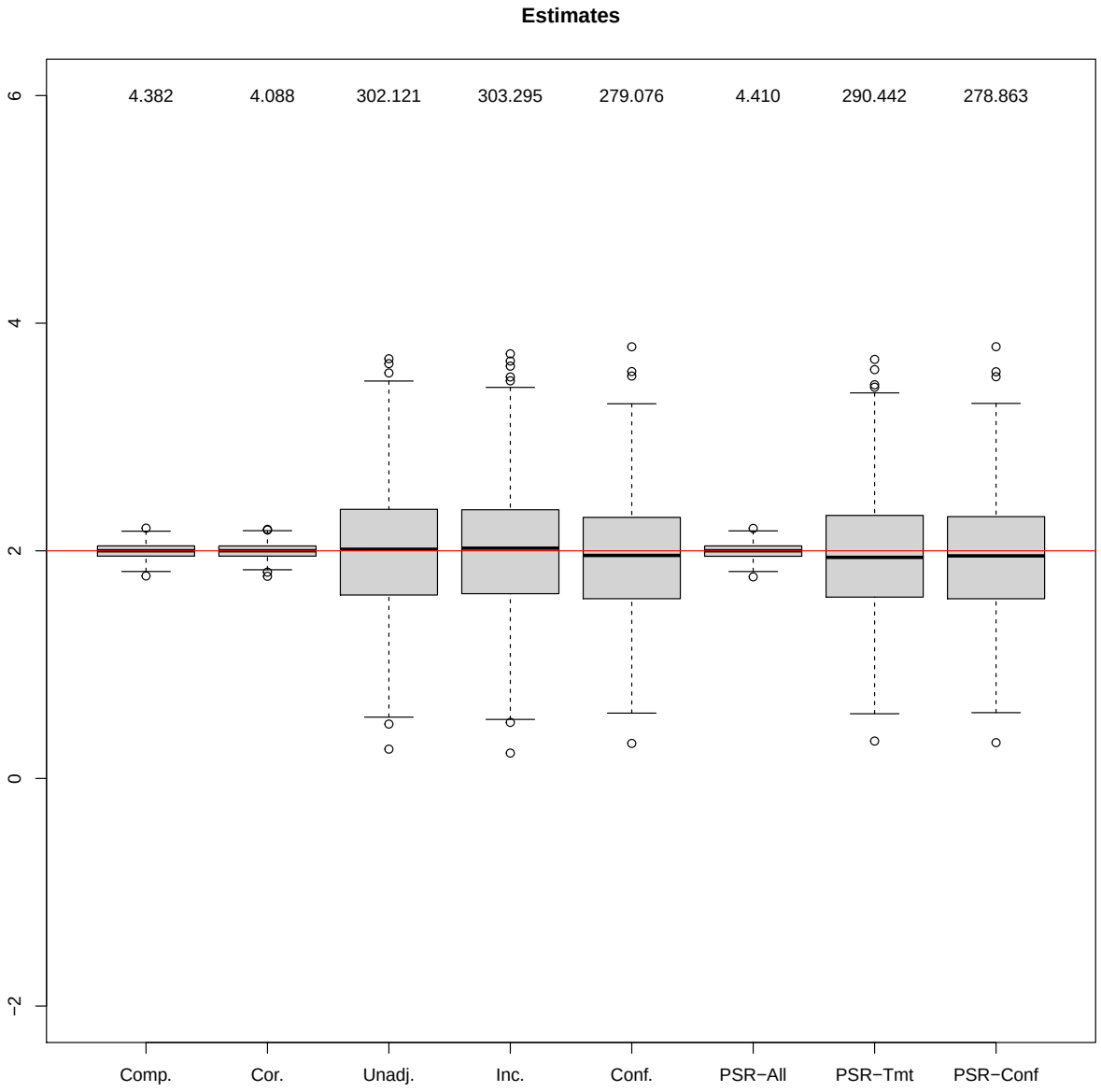
Setting 1: True PS values



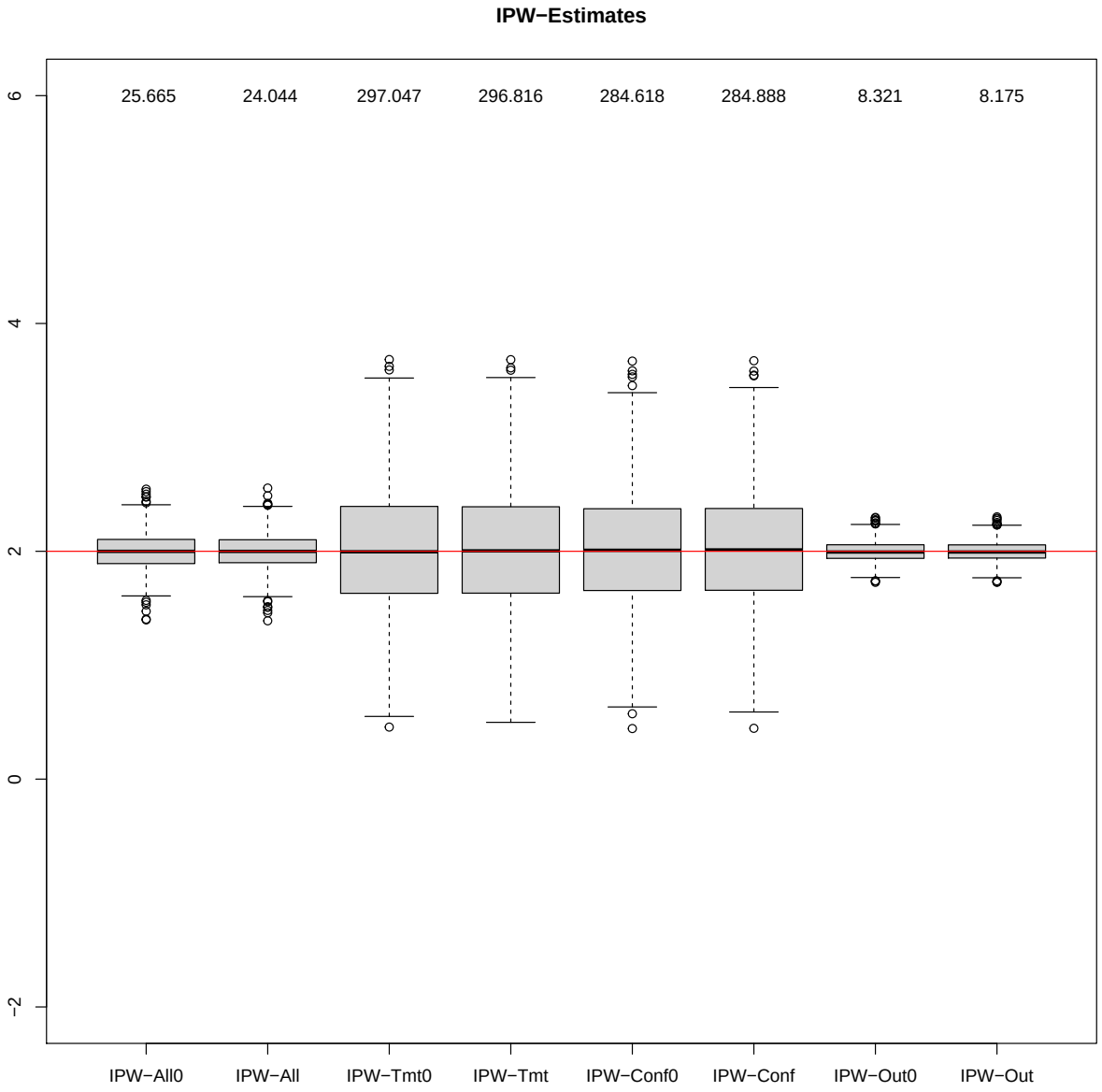
Setting 1: Stratification



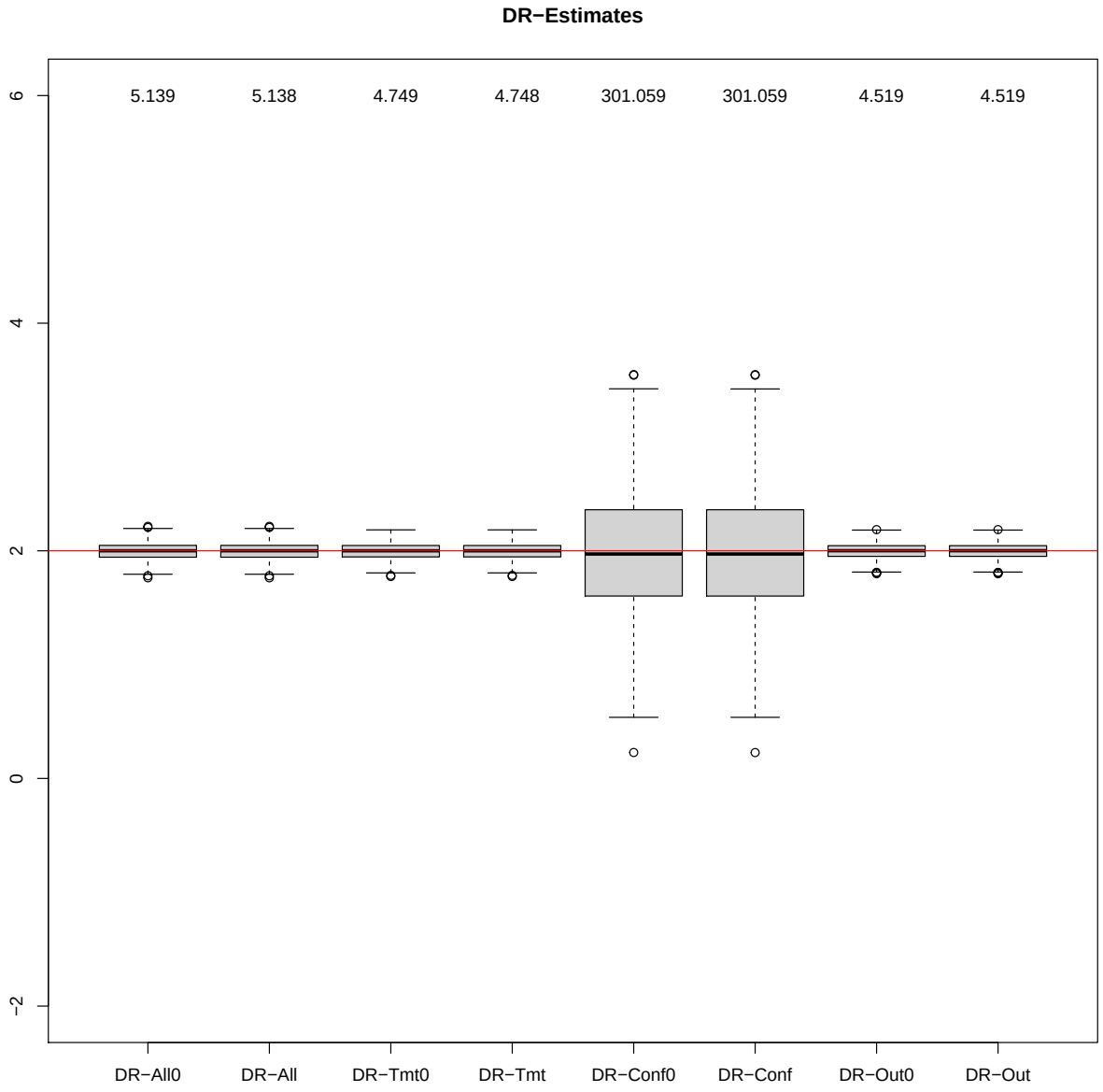
Setting 1: PS Regression



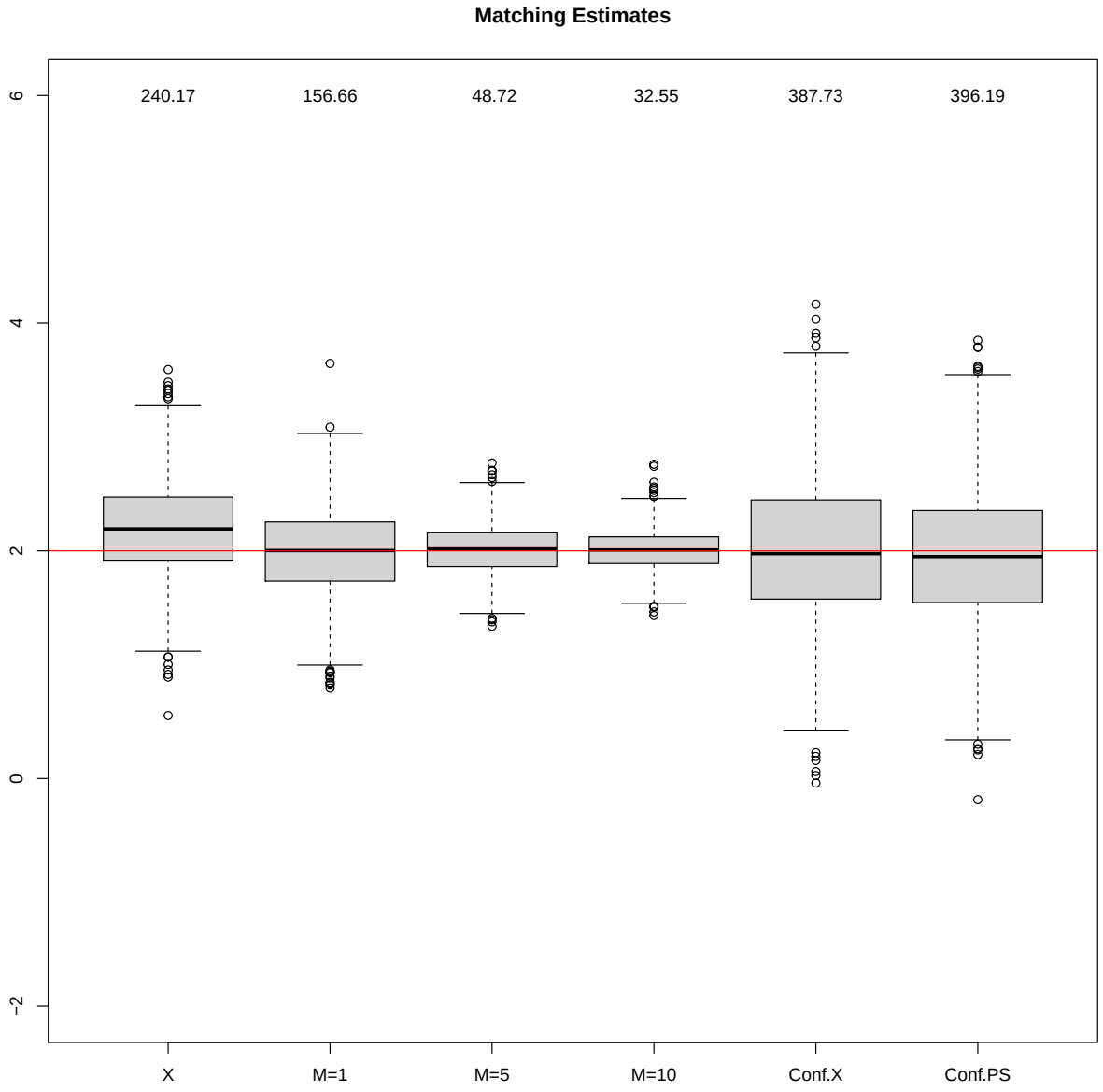
Setting 1: IPW



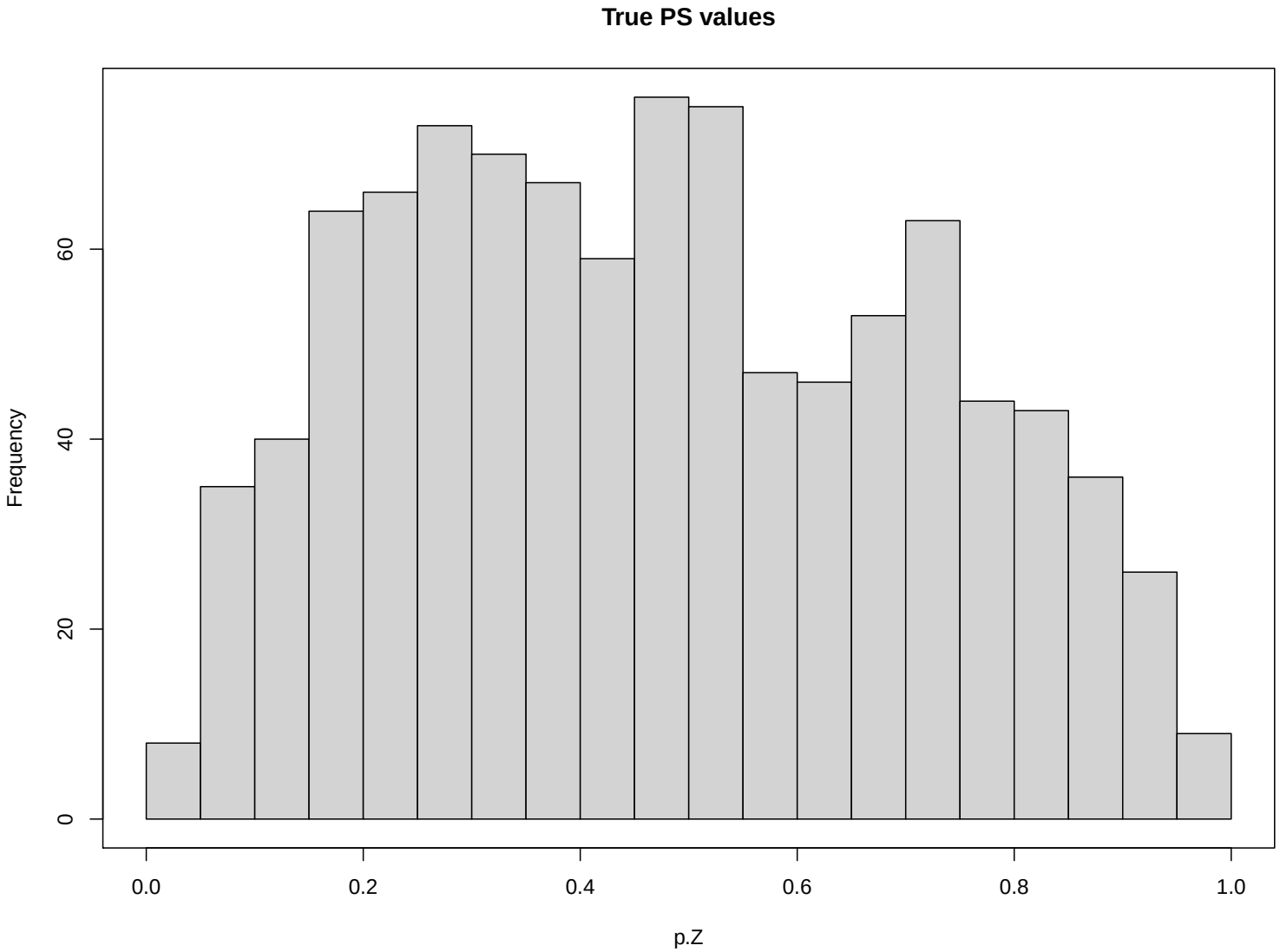
Setting 1: DR AIPW



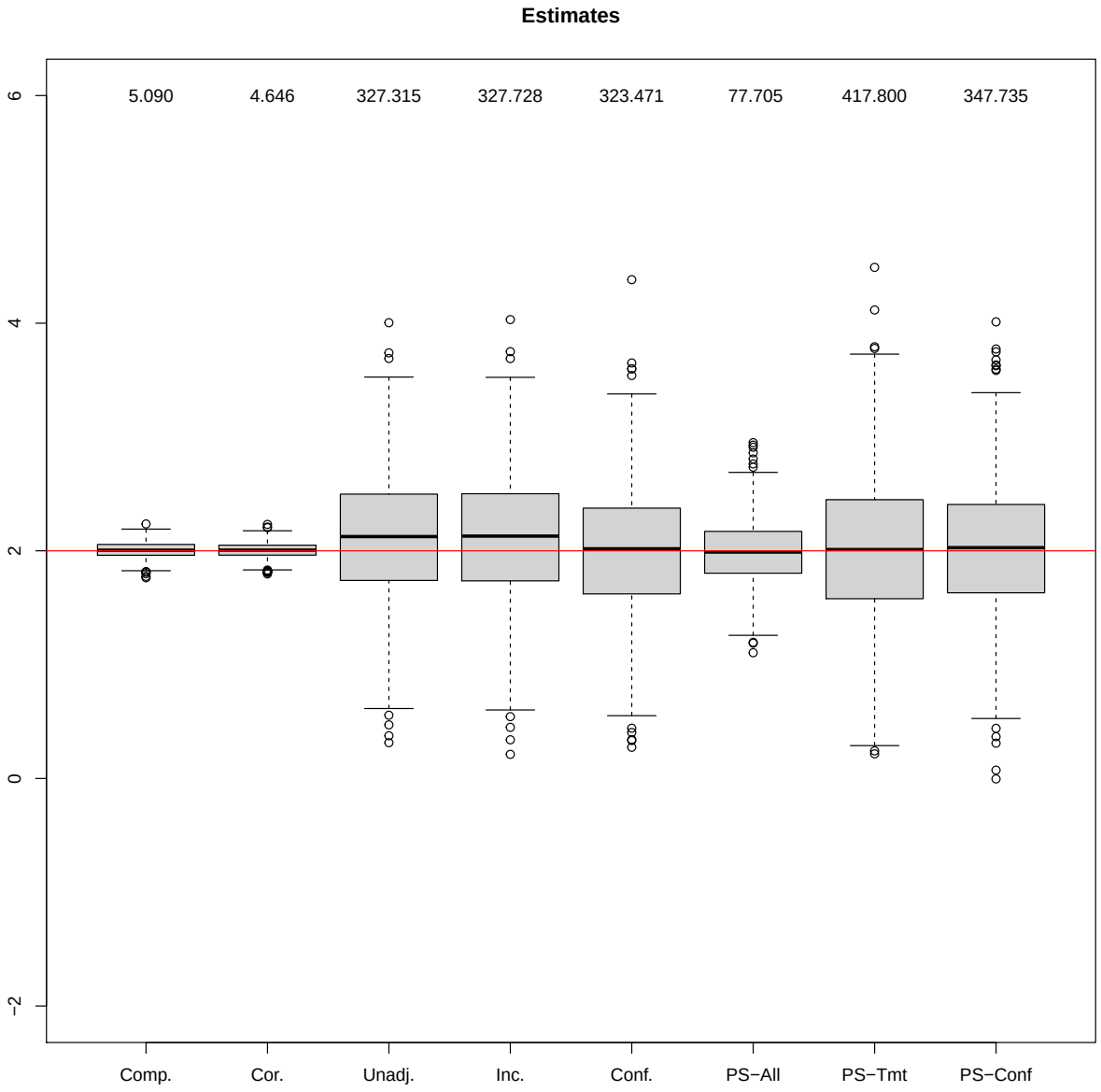
Setting 1: Matching



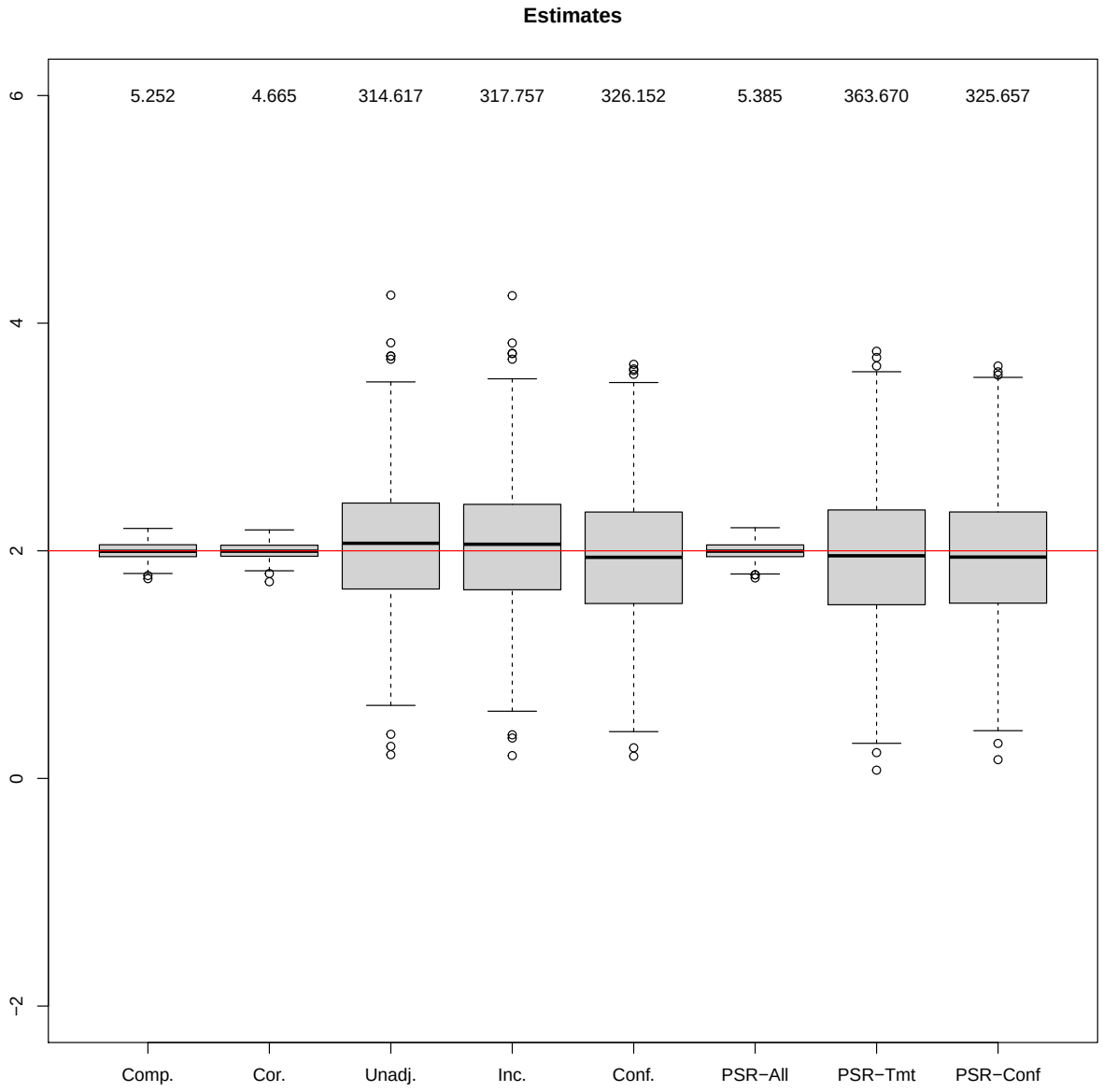
Setting 2: True PS values



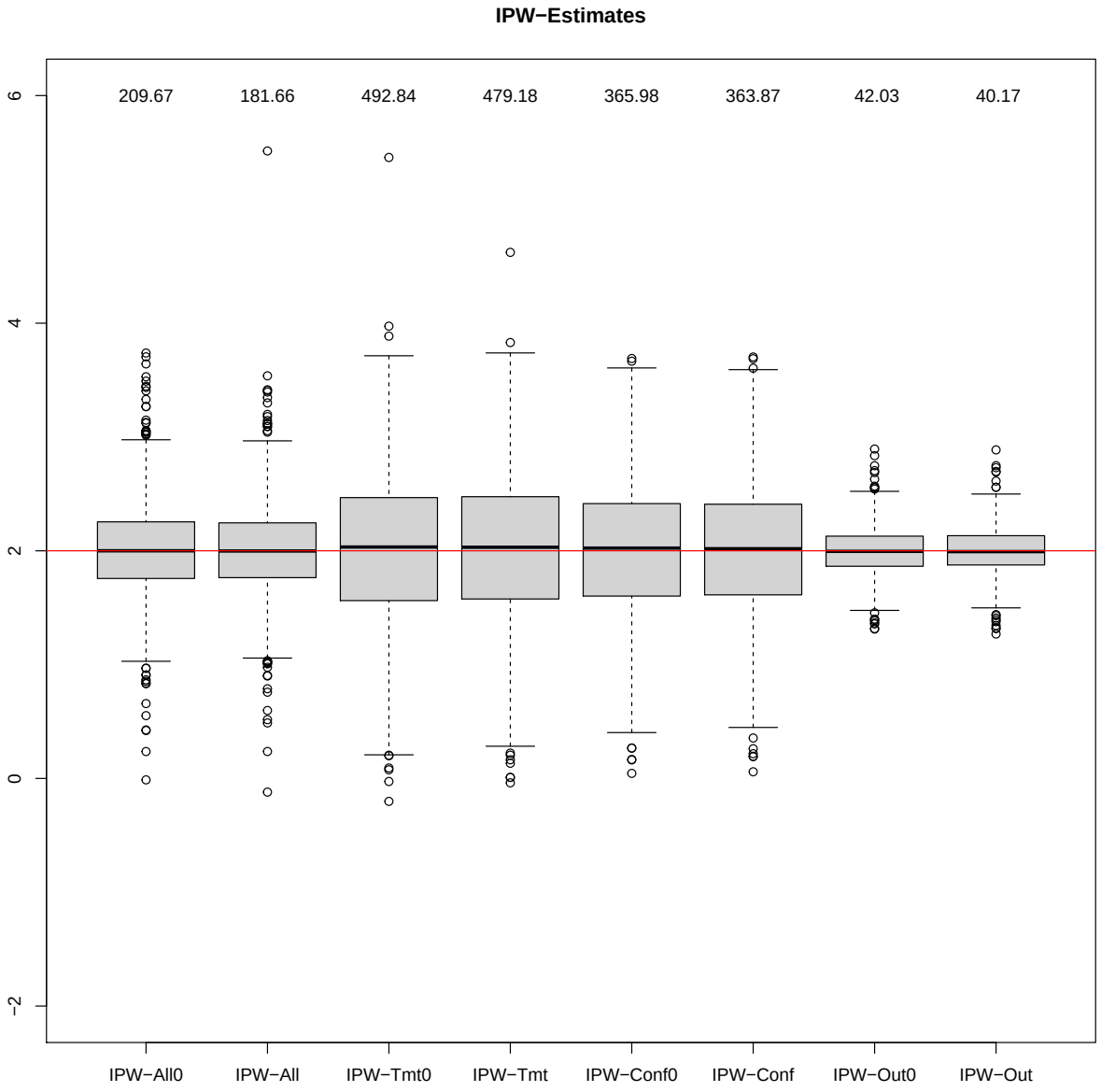
Setting 2: Stratification



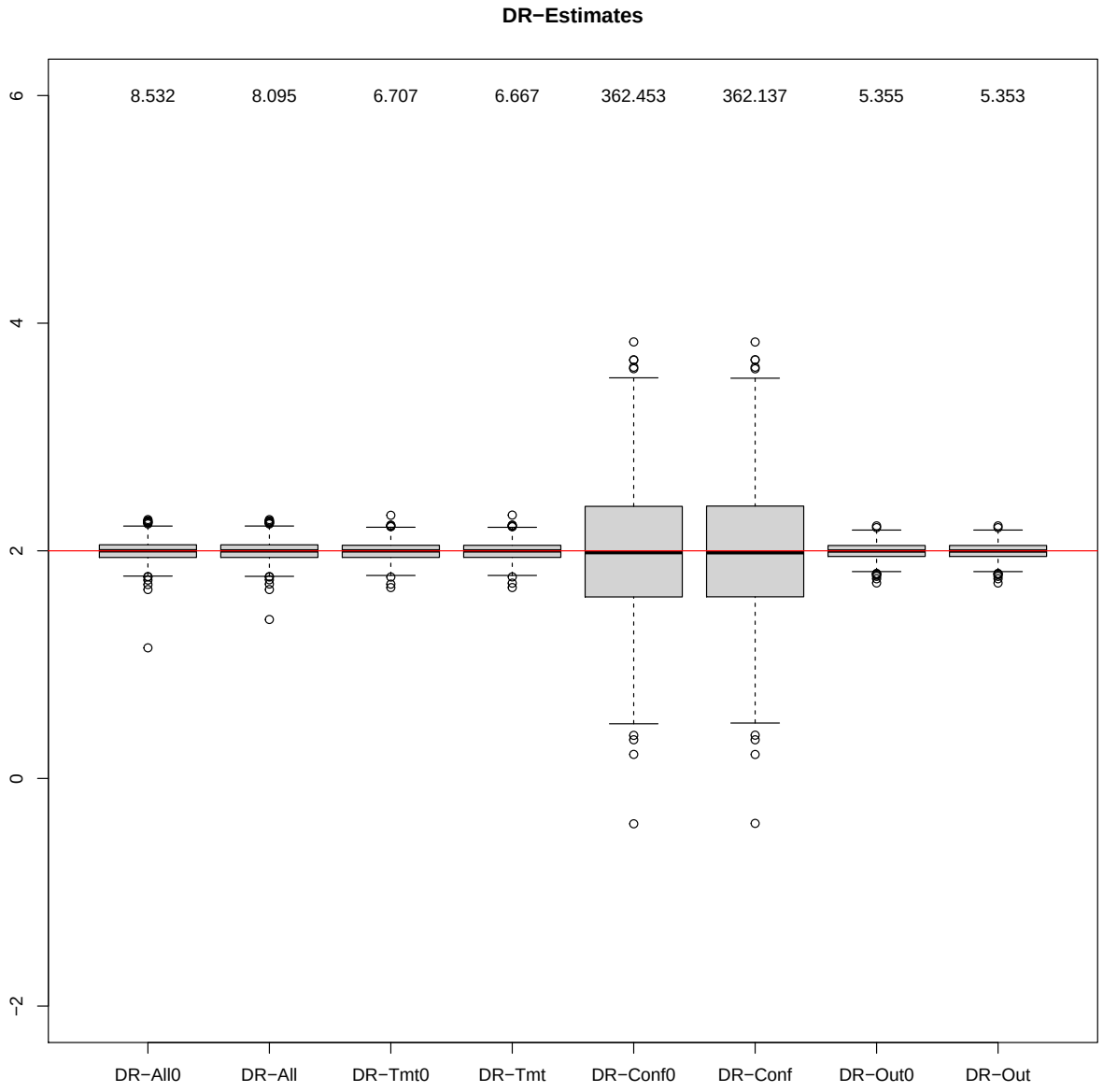
Setting 2: PS Regression



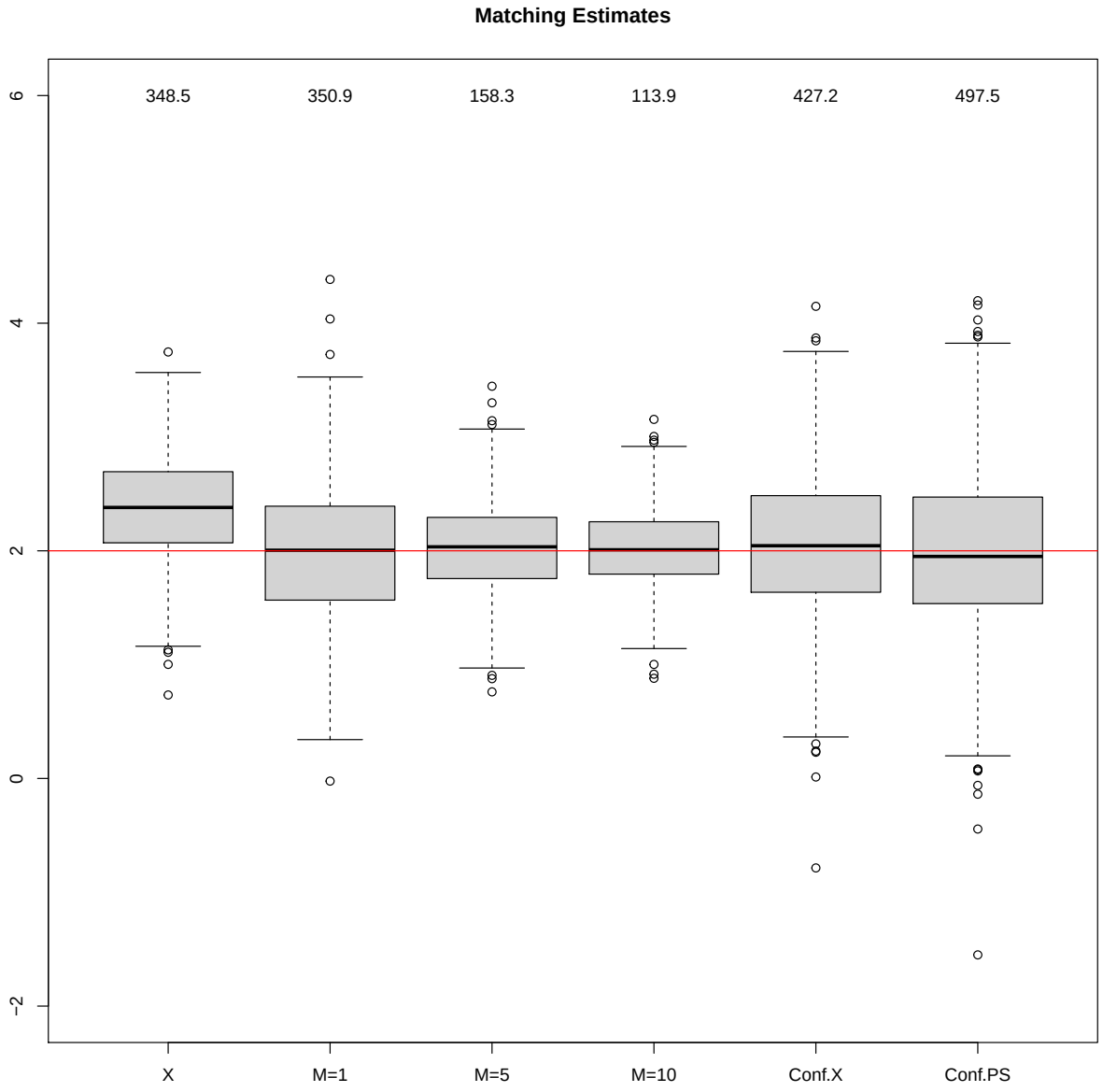
Setting 2: IPW



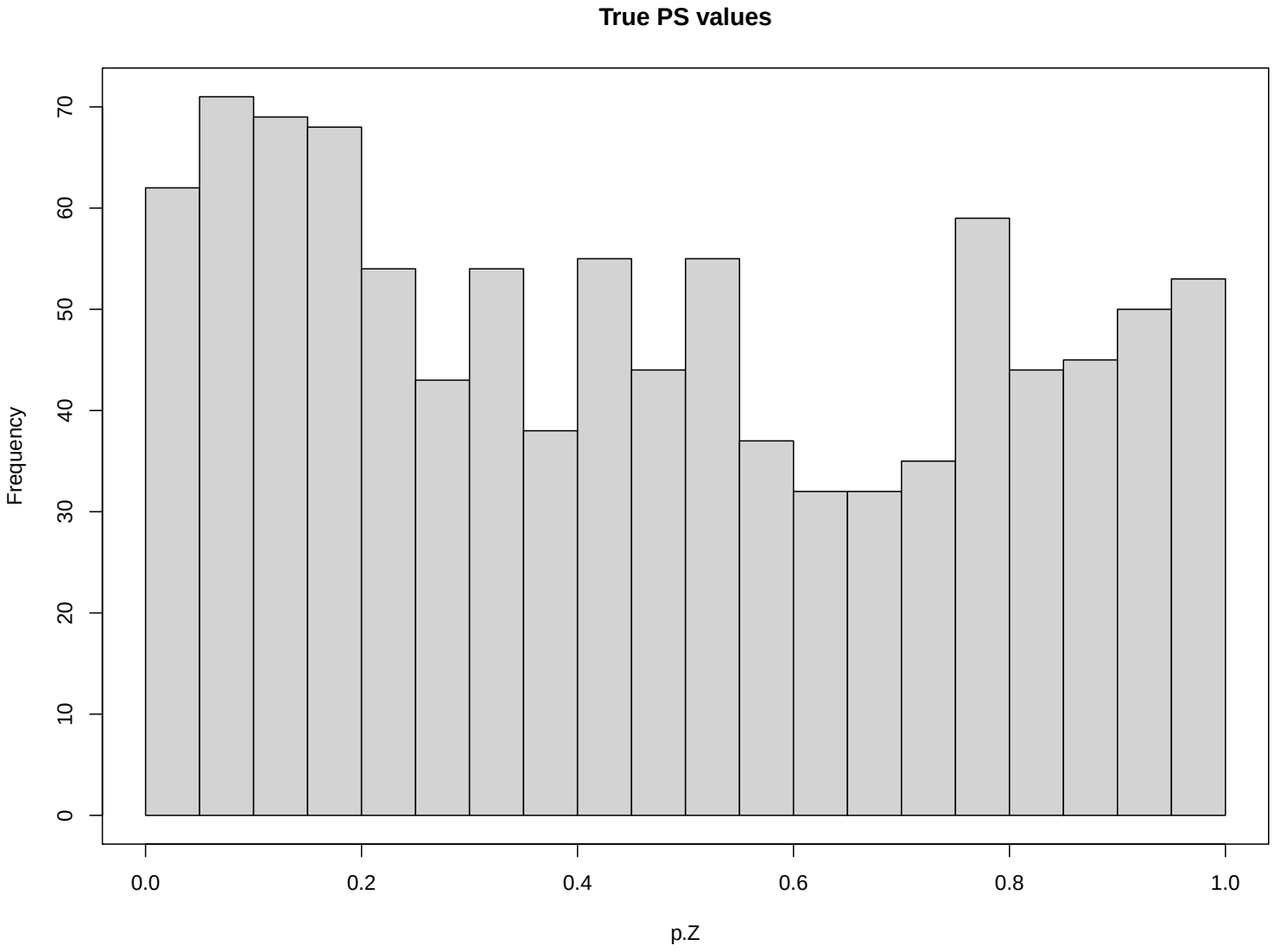
Setting 2: DR AIPW



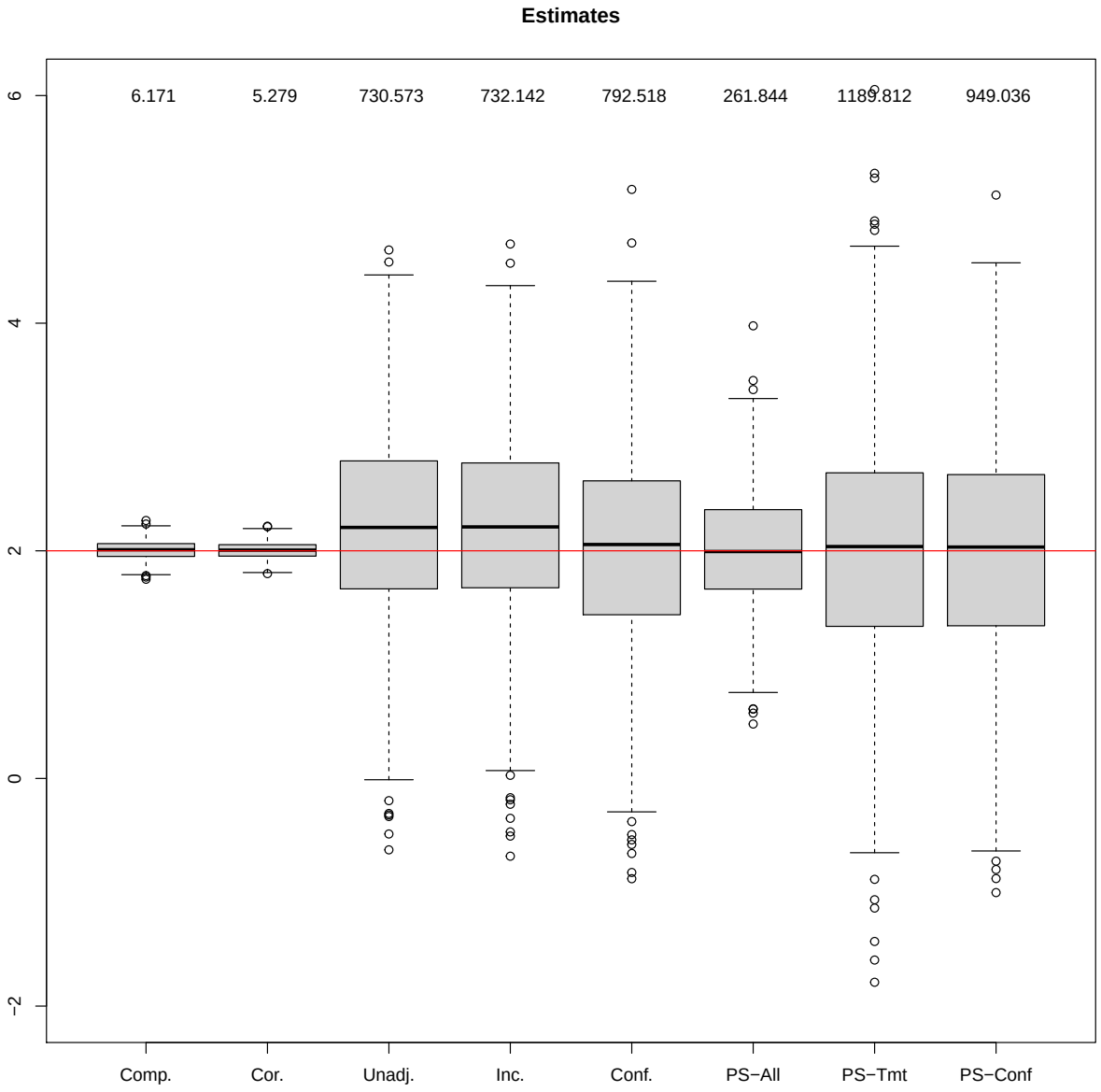
Setting 2: Matching



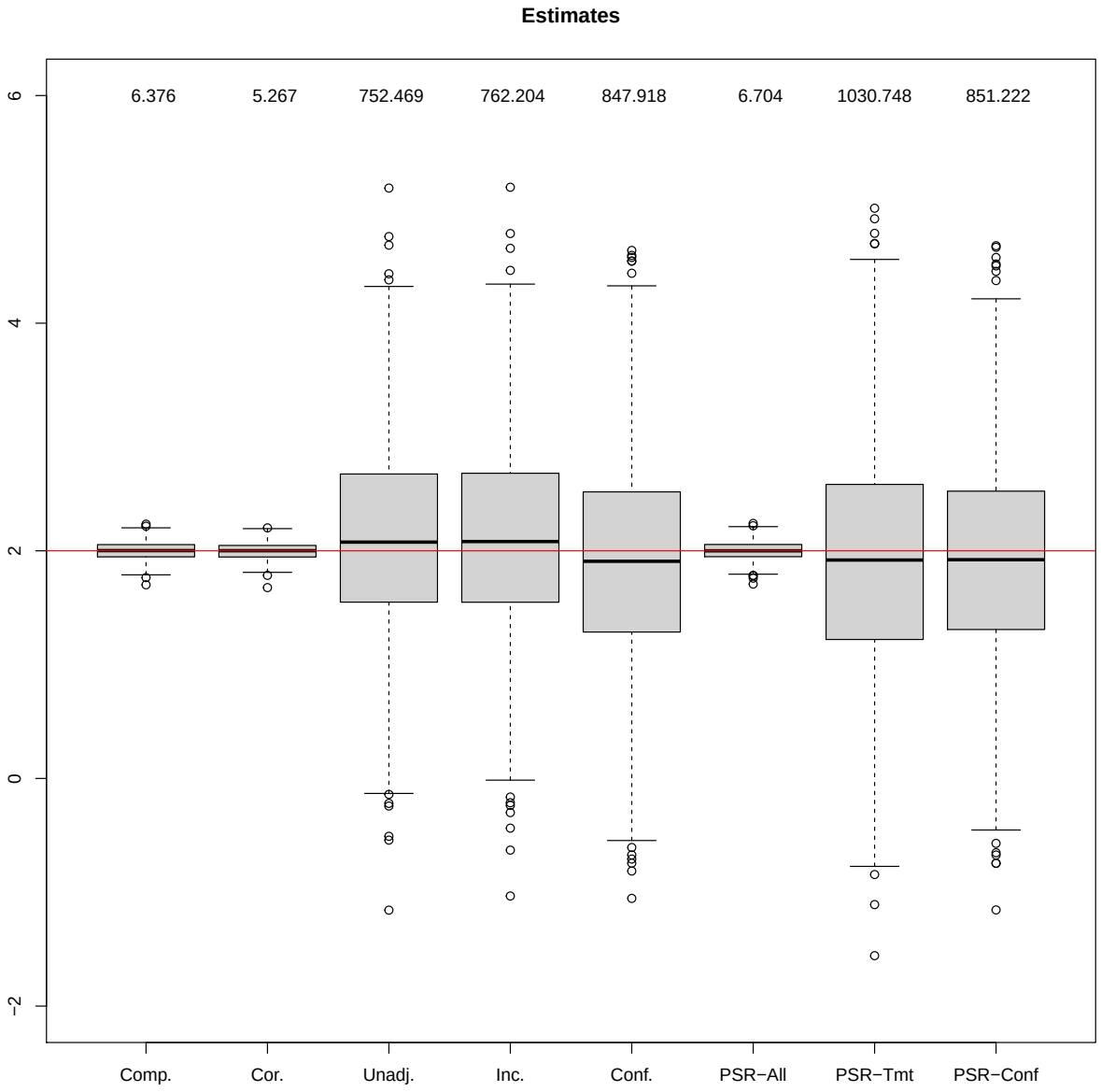
Setting 3: True PS values



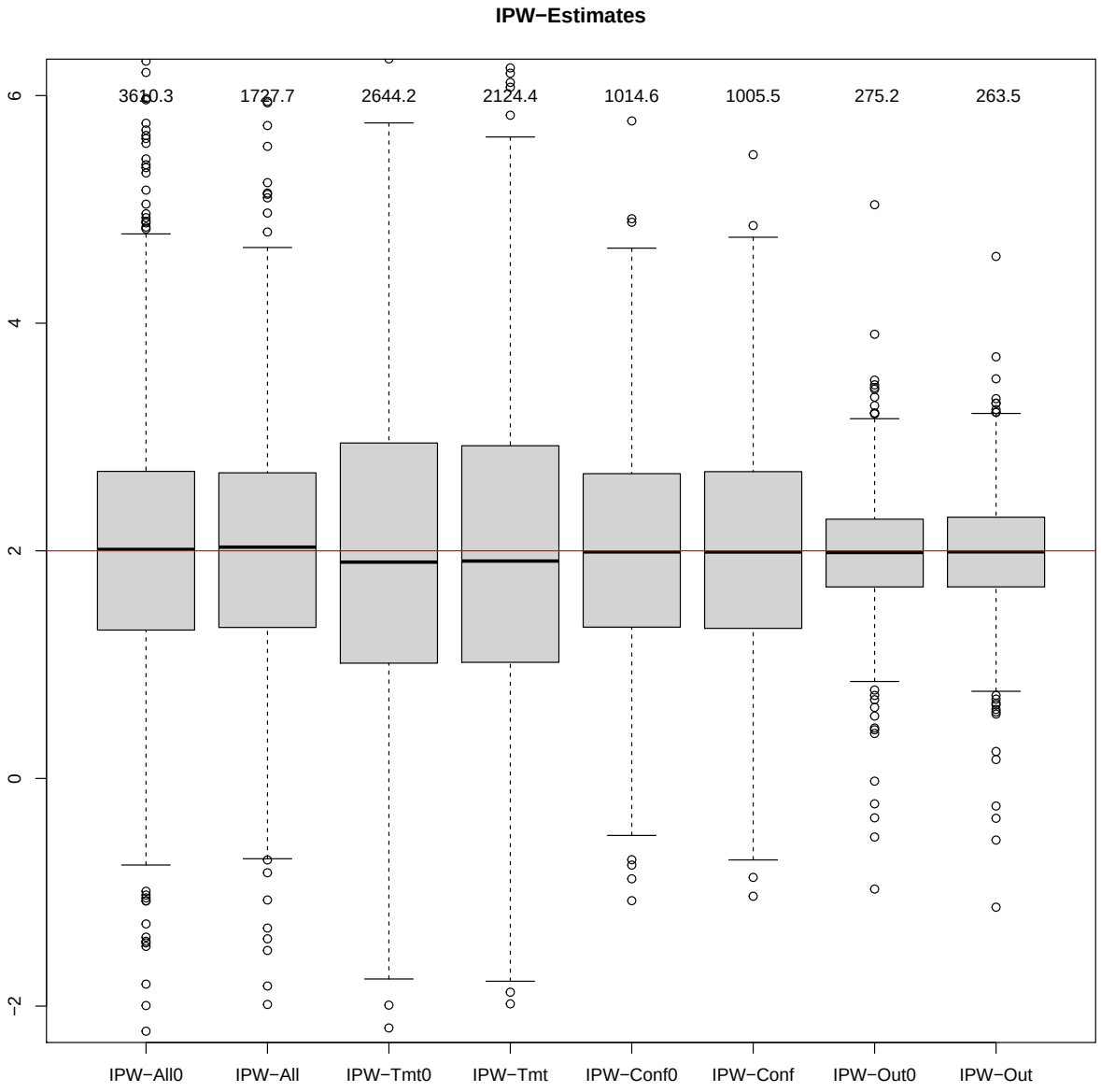
Setting 3: Stratification



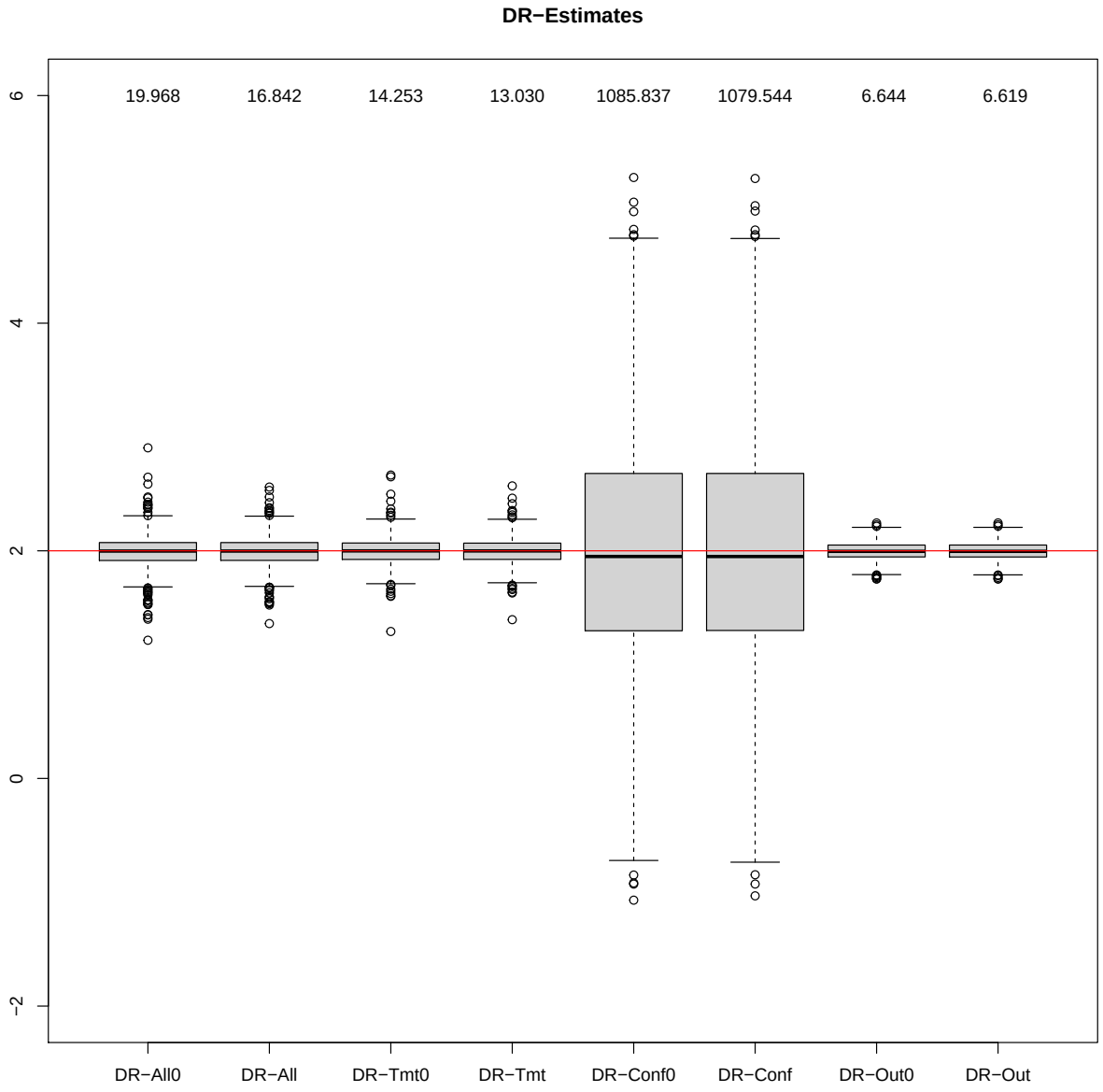
Setting 3: PS Regression



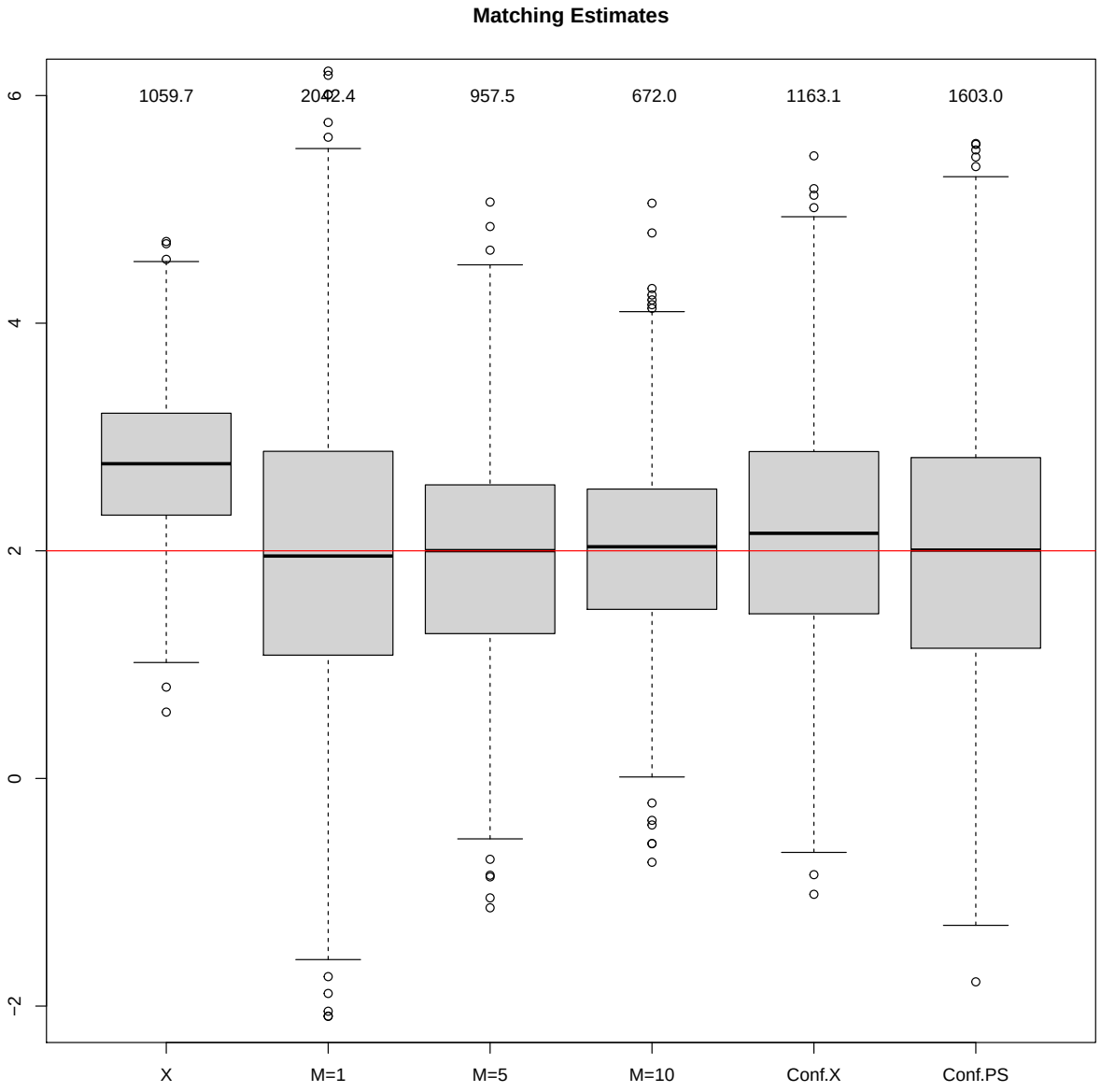
Setting 3: IPW



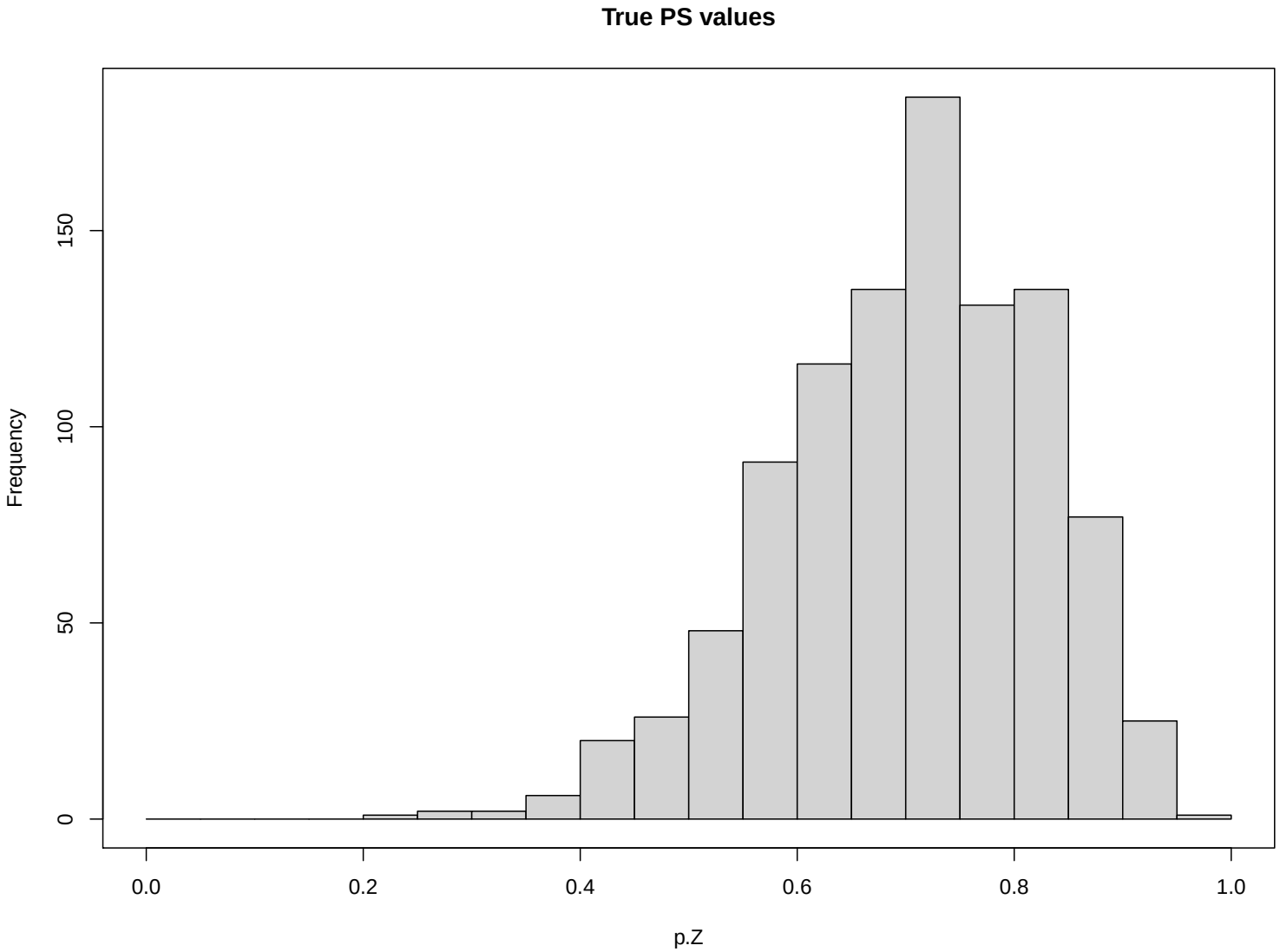
Setting 3: DR AIPW



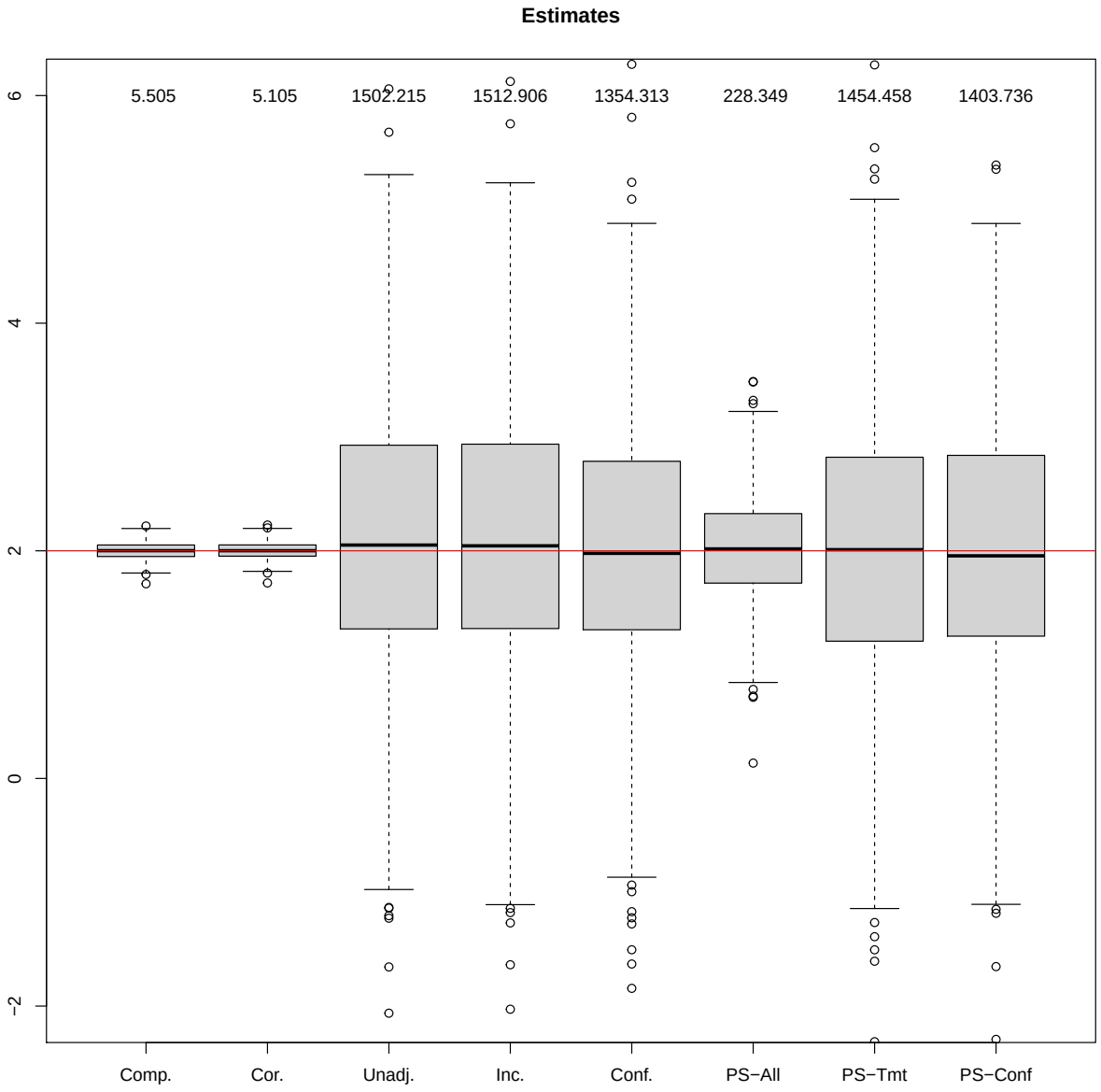
Setting 3: Matching



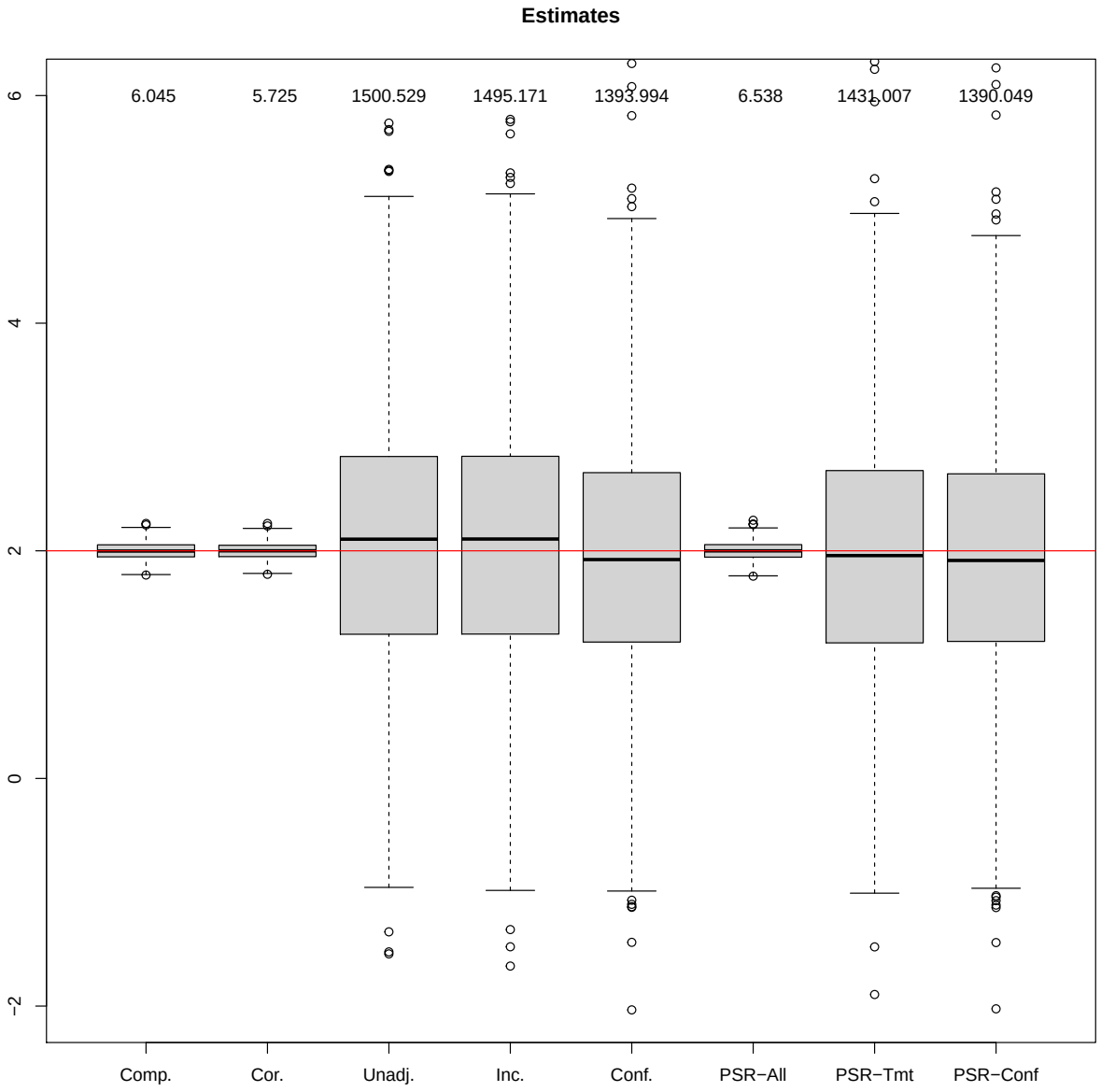
Setting 4: True PS values



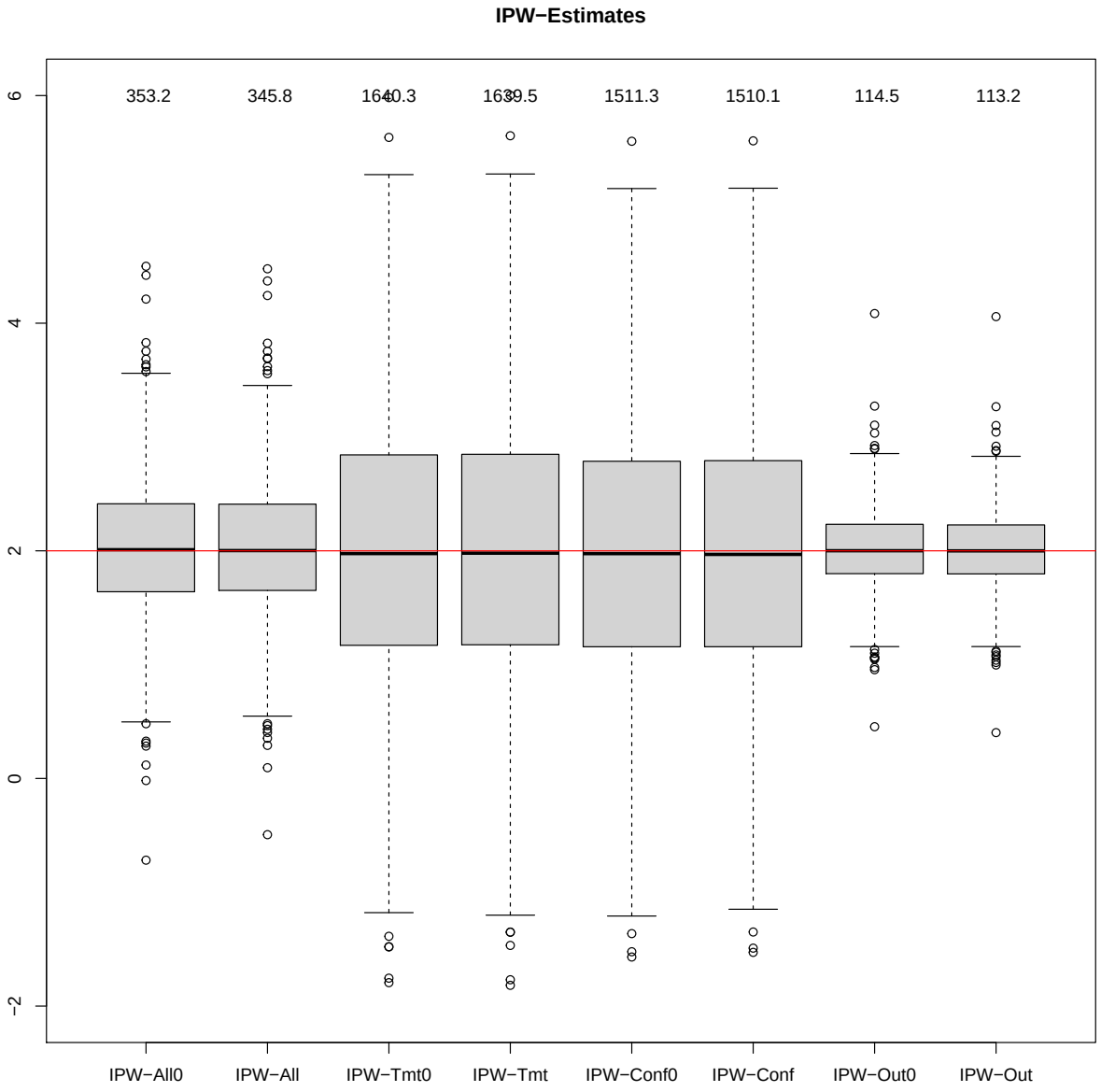
Setting 4: Stratification



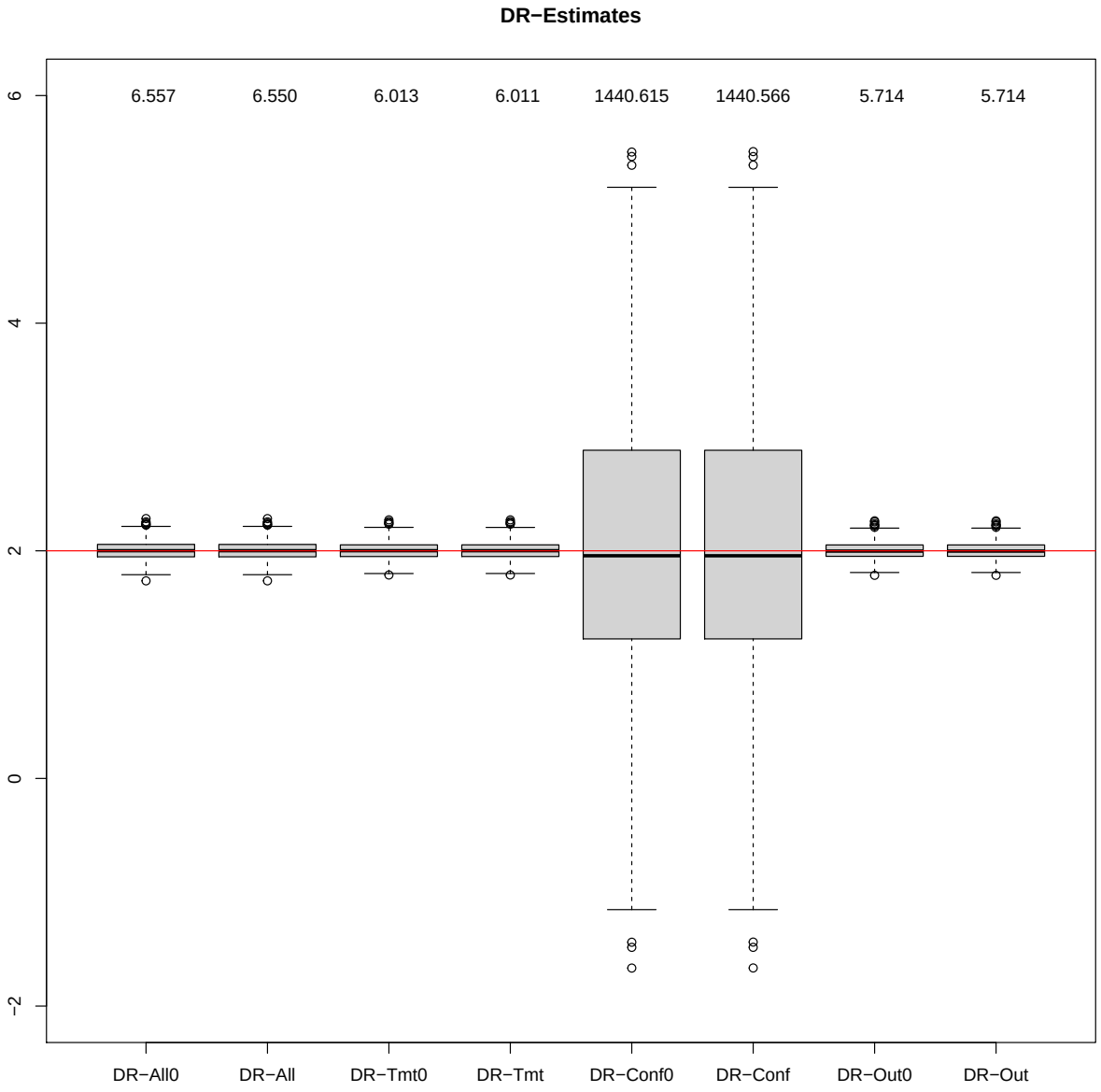
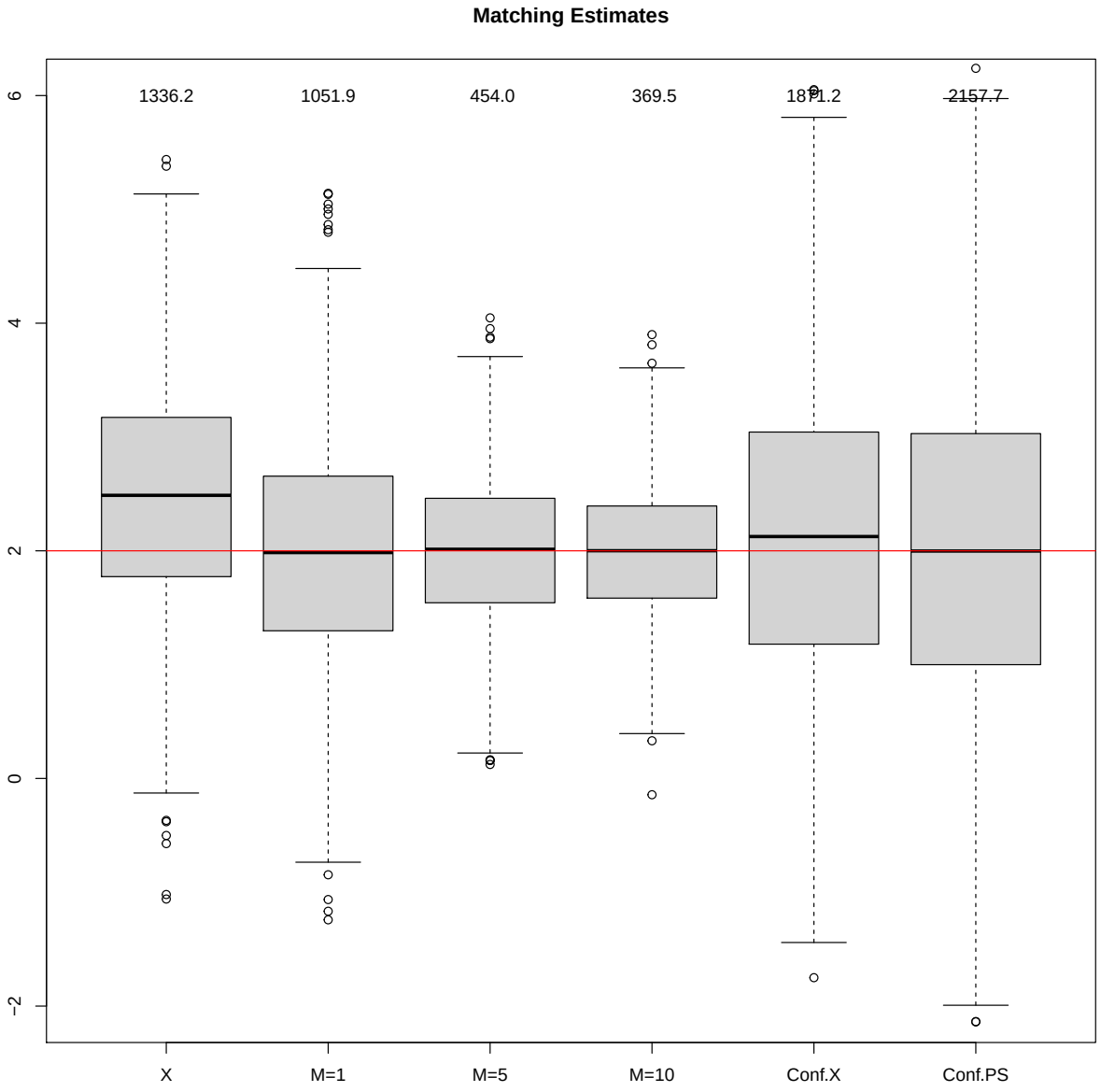
Setting 4: PS Regression



Setting 4: IPW



Setting 4: DR AIPW



Setting 4: Matching