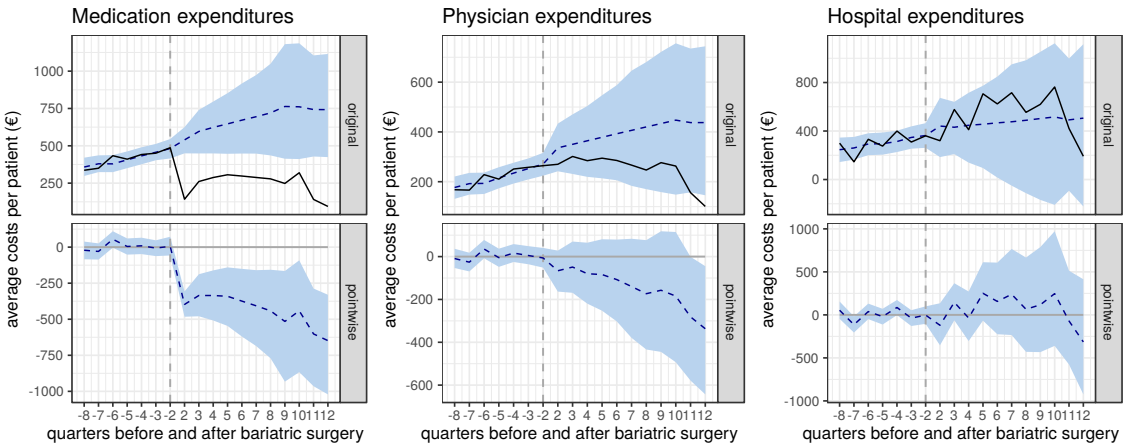
# Appendix

## A1. Sensitivity analysis (1): only individuals observed over the whole period ($N = 191$)

In this sensitivity analysis, we only include individuals that were observed over the whole 8 quarters before and 12 quarters after bariatric surgery ($N = 191$). This means we could include only individuals who underwent surgery in the year 2008. The direction of effects stays the same as in the main analysis but due to the smaller sample size it is more vulnerable to outliers. The relative cost-saving effect of bariatric surgery for medication expenditures is more than twice as high (-65% compared to -29% in the main analysis), probably because of the much steeper pre-intervention trend. Hospital costs increase less, but include a higher amount of uncertainty.



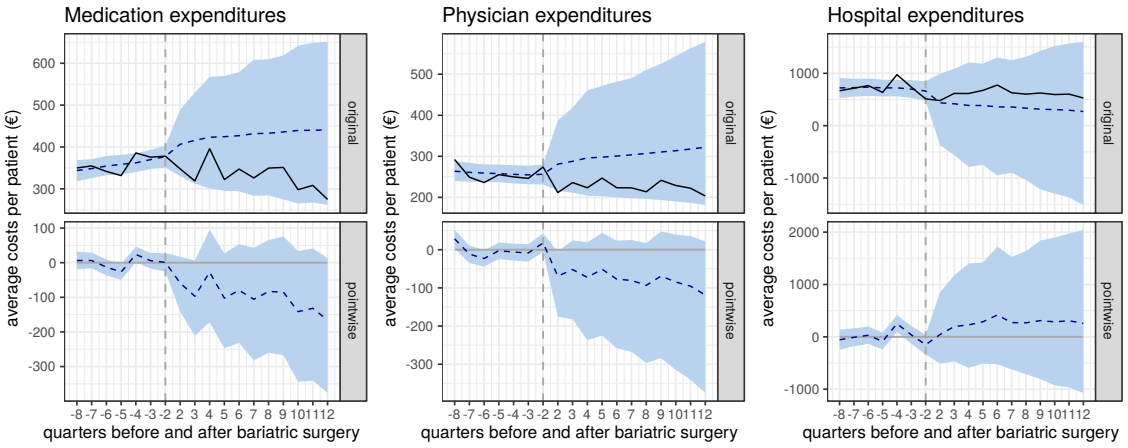

Average medication, physician, and hospital expenditures per person and quarter. The upper plots ("original") show the observed expenditures (solid black line) and the counterfactual synthetic controls (dashed blue line) including the 95% credible interval according to the Bayesian structural time series model. The lower plots ("pointwise") show the average difference between the observed and estimated values.

| | Average expenditures after bariatric surgery | | |
|---|---|---|---|
| | Medication | Physician | Hospital |
| Actual | 242 | 250 | 537 |
| Predicted | 682 | 400 | 475 |
| 95% CI | [458, 935] | [197, 611] | [1, 876] |
| Absolute effect | -440 | -151 | 62 |
| 95% CI | [-693, -216] | [-361, 53] | [-339, 537] |
| Relative effect | -65% | -38% | 13% |
| 95% CI | [-102%, -32%] | [-90%, 13%] | [-71%, 113%] |
| Posterior tail area prob. $p$ | 0.01 | 0.06 | 0.36 |
| Posterior prob. of causal effect | 99% | 94% | 64% |

The causal effect of bariatric surgery based on the Bayesian structural time series model with synthetic controls. All values are 2016-Euros (€).

## A2. Sensitivity analysis (2): bootstrapped sample that contains $N = 5000$ observations in each quarter

In this sensitivity analysis, we re-sample (with replacement) individual observations to generate a data set that contains the same number of observations ($N = 5000$) in each quarter. Again the direction and magnitude of the effects are comparable to the main analysis, with the only exception of hospital costs having a lower probability of a causal effect.



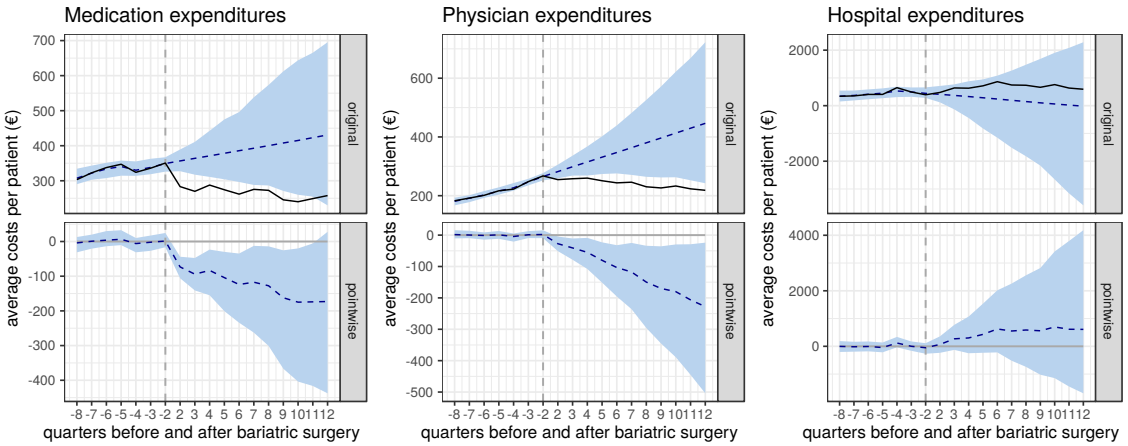

Average medication, physician, and hospital expenditures per person and quarter. The upper plots ("original") show the observed expenditures (solid black line) and the counterfactual synthetic controls (dashed blue line) including the 95% credible interval according to the Bayesian structural time series model. The lower plots ("pointwise") show the average difference between the observed and estimated values.

| | Average expenditures after bariatric surgery | | |
|---|---|---|---|
| | Medication | Physician | Hospital |
| Actual | 331 | 225 | 613 |
| Predicted | 422 | 303 | 351 |
| 95% CI | [297, 580] | [200, 494] | [-973, 1303] |
| | | | |
| Absolute effect | -91 | -78 | 262 |
| 95% CI | [-249, 34] | [-269, 25] | [-690, 1586] |
| | | | |
| Relative effect | -22% | -26% | 74% |
| 95% CI | [-59%, 8%] | [-89%, 8%] | [-196%, 452%] |
| | | | |
| Posterior tail area prob. $p$ | 0.05 | 0.05 | 0.18 |
| Posterior prob. of causal effect | 95% | 95% | 82% |

The causal effect of bariatric surgery based on the Bayesian structural time series model with synthetic controls. All values are 2016-Euros (€).

## A3. Sensitivity analysis (3): no covariate time series

In this sensitivity analysis, we do not use any covariate time series. With no covariates, the counterfactual is based only on linear trend calculation of the pre-intervention period. It is obvious that this model might produce overly extreme trends, especially in the case of physician expenditures. Confidence bands are also much wider. Effect estimates point in similar directions as the main analysis, but are generally larger.



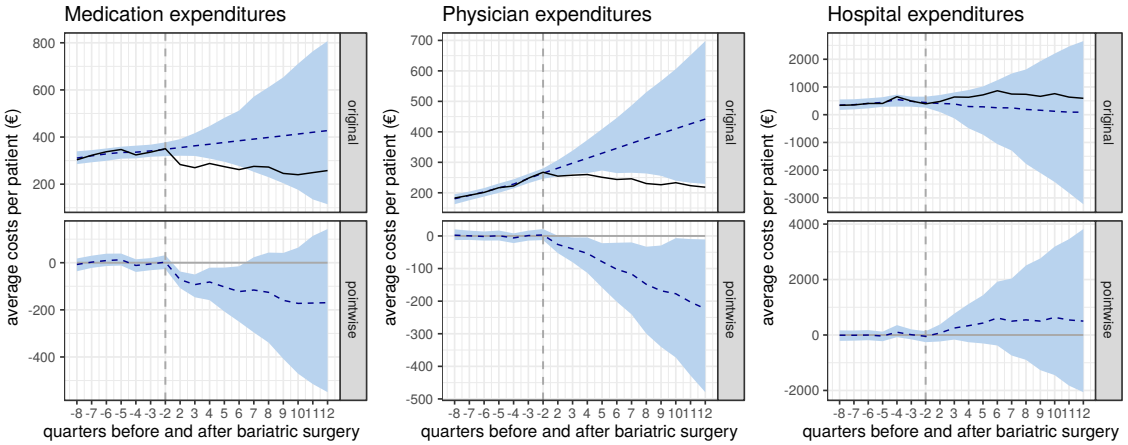

Average medication, physician, and hospital expenditures per person and quarter. The upper plots ("original") show the observed expenditures (solid black line) and the counterfactual synthetic controls (dashed blue line) including the 95% credible interval according to the Bayesian structural time series model. The lower plots ("pointwise") show the average difference between the observed and estimated values.

| | Average expenditures after bariatric surgery | | |
|---|---|---|---|
| | Medication | Physician | Hospital |
| Actual | 265 | 240 | 677 |
| Predicted | 393 | 364 | 195 |
| 95% CI | [292, 539] | [265, 492] | [-1478, 1336] |
| Absolute effect | -120 | -123 | 483 |
| 95% CI | [-274, -27] | [-252, -25] | [-659, 2156] |
| Relative effect | -33% | -34% | 248% |
| 95% CI | [-70%, -7%] | [-69%, -7%] | [-339%, 1108%] |
| Posterior tail area prob. $p$ | 0.02 | 0.01 | 0.23 |
| Posterior prob. of causal effect | 98% | 99% | 77% |

The causal effect of bariatric surgery based on the Bayesian structural time series model with synthetic controls. All values are 2016-Euros (€).

## A4. Sensitivity analysis (4): random noise

In this sensitivity analysis, we include three random noise time series as covariates. These covariates were randomly sampled from a standard normal distribution and are not predictive for the outcome. The resulting model is very similar to the previous one without covariates. Differences are likely due to random variaton of the Gibbs sampling and the large amount of uncertainty. The variable selection part of the BSTS model correctly considers all covariates irrelevant and does not include them in the final model. Again, the counterfactual is based mostly on pre-intervention trends.




Average medication, physician, and hospital expenditures per person and quarter. The upper plots ("original") show the observed expenditures (solid black line) and the counterfactual synthetic controls (dashed blue line) including the 95% credible interval according to the Bayesian structural time series model. The lower plots ("pointwise") show the average difference between the observed and estimated values.

| | Average expenditures after bariatric surgery | | |
|---|---|---|---|
| | Medication | Physician | Hospital |
| Actual | 265 | 240 | 677 |
| Predicted | 391 | 372 | 230 |
| 95% CI | [326, 477] | [226, 463] | [-1360, 1529] |
| | | | |
| Absolute effect | -125 | -132 | 448 |
| 95% CI | [-212, -61] | [-223, 15] | [-851, 2037] |
| | | | |
| Relative effect | -32% | -35% | 195% |
| 95% CI | [-54%, -16%] | [-60%, 4%] | [-371%, 888%] |
| | | | |
| Posterior tail area prob. $p$ | 0.01 | 0.07 | 0.26 |
| Posterior prob. of causal effect | 99% | 93% | 74% |

The causal effect of bariatric surgery based on the Bayesian structural time series model with synthetic controls. All values are 2016-Euros (€).