Re-analysis of Ciacci, R. (2024). Banning the purchase of sex increases cases of rape: evidence from Sweden. Journal of Population Economics, 37(2), 1-30.

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The article "Banning the purchase of sex increases cases of rape: evidence from Sweden" by Ciacci (2024) claims that Sweden's 1999 ban on purchasing sex increased rapes by 44-62%[1]. Our re-analysis completely overturns the conclusion of the paper and shows that the results are caused by an error in the main regression specification. This error occurs when the author seeks to estimate a treatment effect with a regression specification including year fixed effects, despite having a treatment variable that does not vary within years. As this paper has strong policy implications and a potentially large policy impact we think it is crucial that the Journal of Population Economics retracts the paper to correct the erroneous findings.

The basics: graphical evidence shows no reform impact

The paper's main analysis consists of a regression discontinuity in time. The law was introduced at the national level and the analysis seeks estimate its effect by quantifying the immediate change in reported rapes when the reform was introduced. Looking at the development of reported rapes at the national level in Figure 1, it is very hard to reconcile the development around the reform (red vertical line) with the purported 44-62% 44-62% jump at this threshold claimed by the author.

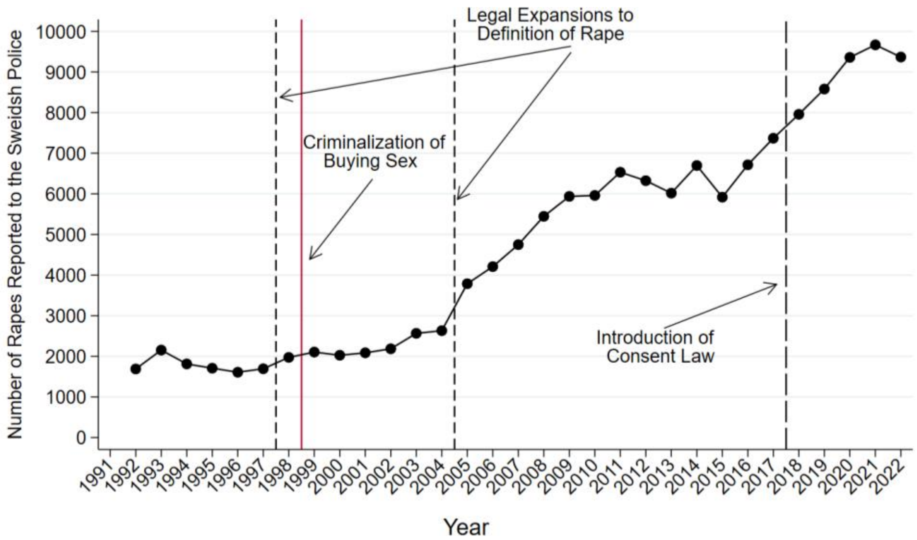

Figure 1. Number of reported rapes in Sweden, 1992-2002.

Note: Data downloaded from the Swedish National Council for Crime Prevention (Brå).

[1] The paper wrongly interprets log points directly as percentages. The preferred estimate in row four of column 1 of table 3 of the paper even suggests that the law increased rape rates by a staggering exp(0.643)-1 = 90%.

There is also no graphical evidence of a jump upward in reported rapes at the reform threshold in the month-county-level data used in the paper. We could not obtain the author's dataset but downloaded the original dataset on reported rapes from the Swedish National Council for Crime Prevention (Brå).[1] Our summary statistics closely replicate the author's (see the log file at the end of this document). We follow the paper and transform the number of reported rapes as log(reported rapes + 1). Figure 2 shows a standard Regression Discontinuity plot using county and month fixed effects, a bandwidth of 29 months and polynomial trends in the running variable using the RDRobust package (Calonico et al., 2017). Dropping the month and/or county fixed effects or applying a linear control function does not change the conclusion (results in Appendix Figures A3-A6).

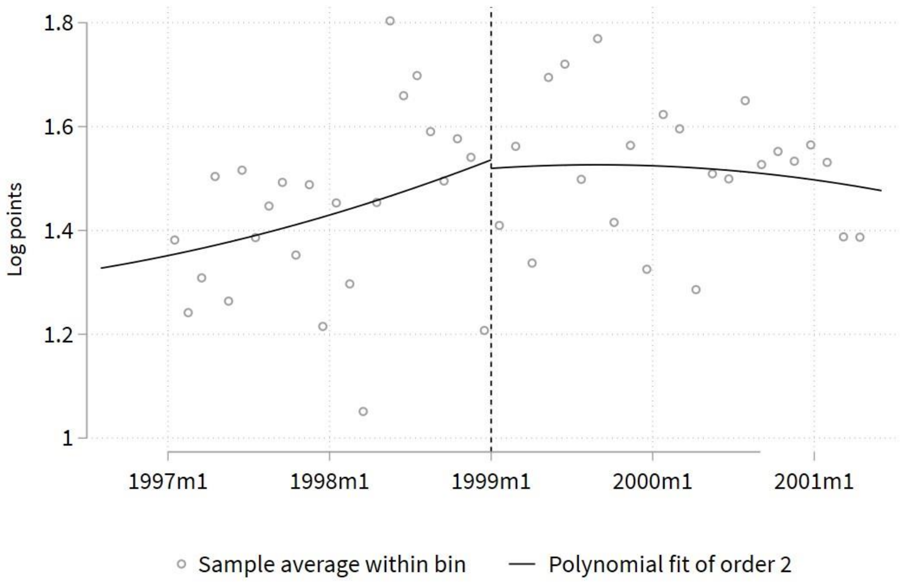

Figure 2. Regression discontinuity plot for the 1999 reform.

Notes: Regression discontinuity plot made using STATA's -rdrobust- and a bandwidth of 29 months, including county and month fixed effects, and second-order polynomial control functions. This is equivalent to Equation 1, without the year fixed effects. N = 1,113.

Explaining the paper's large treatment effect

The paper's headline result comes from an error in the regression specification. This error leads to a situation where the paper's reported treatment effect at the reform threshold in fact captures something entirely different. The treatment effect reported in Table 3 of the paper does not capture a change in the number of reported rapes when the reform was introduced. Instead, it mainly captures the average difference in reported rapes between the months of December and January over the whole study period. This section explains the error in detail.

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[1] We downloaded county-month data for all reported, attempted, and completed indoor and outdoor rapes committed against individuals 15 and older (crime codes 0622, 0624, 0626 and 0628 up to and including June 2007, 0644-0651, 0656-0663, and 0684-0699 from July 2007 onwards).

The paper main results come from estimating Equation (2) on p. 37:

$$log(rape_{rmy}) = \beta_1 \mathbb{I}\{y \geq Jan99\} + \beta_2 \mathbb{I}\{y \geq Jan99\} + \gamma officers_{ry} + \alpha_r + \alpha_m + \alpha_y + \epsilon_{rmy} \quad (1)$$

where the outcome variable is the log of the number of reported rapes in county *r*, month *m*, and year *y*. The first variable takes the value 0 for all months before January 1999 and 1 for the months thereafter. We refer to this variable as the *treatment variable* and name it *Treat* in our regressions. The second term is a control function for the running variable to each side of the reform threshold. *Officers* is a control variable for the number of police officers, which we do not have access to here. Importantly, the regression equation includes fixed effects for county, month, and year (α_r, α_m, and α_y).

Equation (1) is impossible to estimate because of collinearity problems between the treatment variable and the year and month dummies. A key problem is that the treatment variable is perfectly collinear in the year dummies. After including the year dummies, there is no variation left in the outcome variable between the observations where the treatment variable takes the values 1 and 0. STATA handles this problem by dropping variables whose point estimates cannot be estimated due to lack of variation. Standard commands such as -xi-, -areg- or -reghdfe- drops the treatment variable from the regression when estimating Equation (1). The log-file at the end of this document demonstrates this fact.

The author uses a STATA command that delivers a point estimate on the treatment variable despite the collinearity issue. The cost is that the point estimate on the treatment variable no longer captures the intended jump in the outcome at the reform threshold. The author uses the -reg- command with "i.s" in front of the categorical variables for month, year, and county (exact specification in footnote[1]). In cases of multicollinearity, this command "prioritizes" variables listed earlier in the line of code. Listing the treatment variable first ensures a point estimate but causes the program to automatically drop dummies from the sets of year and month dummies to obtain variation enough to do so. Estimating Equation (1) with the author's command drops the dummies for the month of December and the year 2001, in addition to the already excluded reference categories (the dummy for year 1997 and for the month of January).[2]

We show in Table 1 the results in the paper require the exact regression command used by the author. We then show graphically that the remaining variation used to estimate those results come not from variation at the reform threshold but from seasonal variation in reported rapes between the months of December and January.

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[1] The exact stata code the author uses is: reg lrape Treat Treat_running running police i.regionc i.year i.month [sample restriction for the bandwidth], cl(regionc_m).

[2] To the best of our knowledge, the following happens. To get an estimate for the treatment variable, STATA must drop a year dummy among the "treatment years", which ends up being the dummy for the last year (2001). The *Treat* variable now compares 1997 and 2001. As some month dummies only take the value one in either 1997 or in 2001, STATA must drop either an additional year dummy or an additional month dummy to get an estimate on the treatment variable. The author's code lists the year dummies before the month dummies, making STATA drop an additional month dummy (December).

The first column in Table 1 reproduces the paper's main results from Table 3 (column 1, row 1).[1] The small discrepancy between our point estimate of 0.557 and the paper's estimate of 0.555 likely stems from our analysis missing the control variable for the number of police officers. This result of an increase in the number of rapes from the reform disappears completely if we remove the year fixed effects from the regression specification (column 2). The same thing happens if we remove the month fixed effects (column 3) or both the year and month fixed effects (column 4).[2] In column (5) we show that the result largely disappears just from changing the order of the fixed effects in the regression command so that month fixed effects come before the year fixed effects.[3]

Table 1. Re-estimation of the paper's main effect with alternative regression specifications. All estimations use STATA's -reg- command with "i.s" to include fixed effects.

		Treatment effect after removing…			Switched order of year and month F.E.s in the regression command
	Replication of the paper's main result from Table 3, Column 1, Row 1	Year F.E.s	Month F.E.s	Year and Month F.E.s	
	(1)	(2)	(3)	(4)	(5)
Treat	0.557*	0.0010	-0.166	-0.007	0.124
	(0.308)	(0.072)	(0.211)	(0.067)	(0.265)
Observations	1,113	1,113	1,113	1,113	1,113
County F.E.	x	x	x	x	x
Month F.E.	x	x			x
Year F.E.	x		x		

Note: Results from estimating Equation 1 as in the original paper (Column 1) and with modified fixed effects structures across columns. The estimates in column 5 come from a specification where we list the month fixed effects before the year fixed effects in the regression command in STATA. This prioritizes the month fixed effects over the year fixed effects when the program drops dummies to obtain an estimate on the treatment variable, such that, compared to the paper's main analysis, an additional year (2000) is dropped instead of the month December.

We conduct two analyses to show that the paper's main estimate captures seasonal variation between December and January. The literature has documented that rape is one of the crimes with the strongest seasonality and that the lowest reported numbers occur in December (see e.g., Falk, 1952 and McDowall et al., 2012). The left-hand side of Figure 3 compares the variation in the treatment variable in the raw data (dashed line) and the variation left in that variable in the paper's main specification (the solid line). We obtain the latter by, first, regressing the treatment variable on the control functions for the

[1] For the entire column 1 of table 3 of the paper, the point estimates that we (the paper) find are, from top to bottom: 0.557 (0.555), 0.549 (0.548), 0.279 (0.294), 0.628 (0.643).

[2] Removing only the month fixed effects means that the treatment effect captures the difference between 1997 and 2001, while keeping the linear time trends constant.

[3] Changing the order in this way causes STATA to drop the dummy for 2000 instead of the December dummy. The resulting estimation controls for all monthly variation and the point estimate on the treatment variable estimates the difference in the outcome variable between 1997 and both 2000 and 2001, while adjusting for time trends.

running variable and all fixed effects not dropped by STATA in the author's original code. We then plot the residuals from this regression over the sample period. These residuals shows that the variation in the treatment variable used to obtain its point estimate in the paper only clearly deviates from zero in December and January. These deviations do not systematically differ in the pre- and post-treatment periods. In other words, the treatment variable has now become independent of the reform year.

The right-hand side of Figure 3 does the same exercise for the outcome variable. We do the same residual transformation for the outcome variable (log(rapes+1)), excluding the treatment dummy. This transformation keeps the seasonal variation in the outcome across December and January, but removes the systematic yearly variation. The figure shows that rape rate in January of year t generally well exceeds that of December t-1, which is also true in the raw data. As a reference to Figure 3, we show in Appendix Figure how the residual variation of a correctly specified RD in time, without year FEs, should look like.

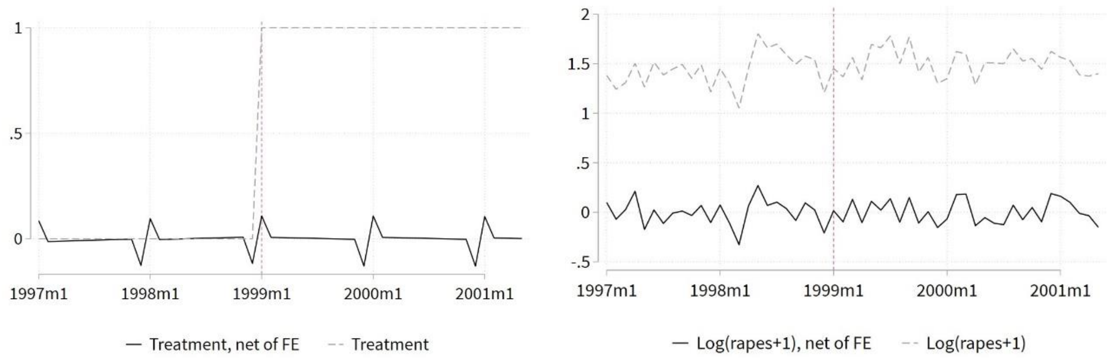


Figure 3. Residual variation in the treatment and outcome variables.

Note: The figure on the left shows the residual variation in the treatment (left) and outcome (right) after controlling for the first order polynomial trends in the running variable and fixed effects that are not dropped in Ciacci's (2024) main specification. In both cases the raw variable is shown in dashed gray lines. Figure A1 shows the same plot for the restricted sample with bandwidth 9.

Combining the evidence in the two plots in Figure 3, it becomes clear that the main analysis in Ciacci (2024) is mainly picking up variation in reported rapes across December and January. The difference in reported rapes across December and January is close to 0.10 log points in the event window. If we estimate the difference between the two months with a dummy for January the estimate would be around 1. The reason that we get a larger point estimate on the treatment variable is that difference across December and January in the "residualized" treat is not 1, but rather 0.2. This means that the regression slope between reported rapes and the residualized treatment dummy will be about 0.5 (0.1/0.2).

To further illustrate that the analysis is merely picking up seasonality we repeat the analysis is the same sample but pretend that the ban happened either in January 1998, January 2000, January 2001, or January 2002. Figure 4 plots the coefficient on the treatment variable for each of these variations. Most "placebo reform years" have a similar size of the treatment effect as the paper's main result, reiterating the fact that the analysis more or less exclusively picks up seasonality rather than the effect of the ban.

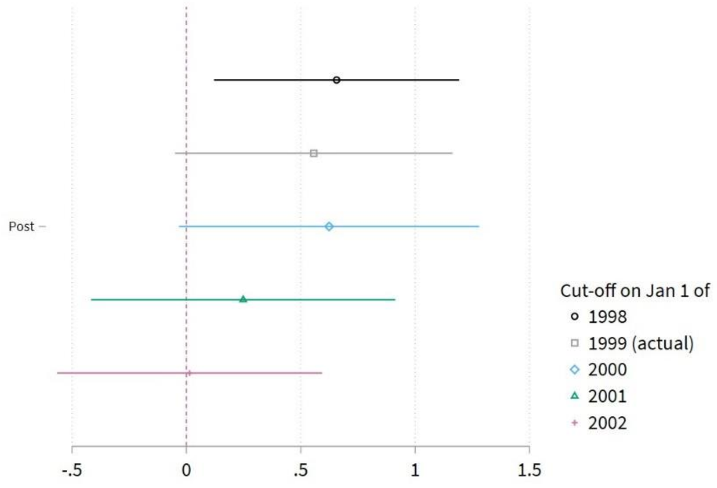


Figure 4. Placebo test using alternative cut-offs, with a bandwidth of 29 months.

Note: Estimation of Equation (1) using the author's original code (command in footnote 1) with placebo thresholds for the reform.

Additional econometric problems

The methods used to produce the paper's main result suffer from additional large econometric problems. One is the failure to correctly cluster the standard errors, which greatly exaggerates statistical precision. Recall how the paper uses county-month-level data to estimate the impact of a reform that was introduced in all counties at the same time. The main results in the paper use standard errors clustered at the county-month level, which erroneously assumes the absence of serial and spatial correlation in the outcome. As the level of treatment assignment is the country—and not the county—conventional wisdom suggests that standard errors should be clustered on the country level (Abadie et al. 2023). *This problem alone renders the paper's analysis infeasible as there is only one cluster, regardless of the regression specification*.

A second concern stems from the using log-transformed number of county-level rapes as an outcome. This does not identify a policy relevant estimand, but rather an average relative effect on the county level. As Sweden's counties are very differently sized and thus have wildly differing numbers of crimes, the choice of outcome variable overweighs counties with small baseline levels of rape. A Swedish policy maker caring about the country-wide rate of sexual assault would rather be interested in the total effect. In addition, regressions of log+1-transformed outcomes cannot retrieve average relative effects in the presence of zeros in the outcome variable (Chen and Roth, forthcoming).

Conclusion

The regression discontinuity in time of Ciacci (2024), which is the main analysis in the paper, identifies a seasonal effect rather than a regression discontinuity around Sweden's ban on purchasing sexual services. Re-analysis with corrected regression specifications that capture the intended treatment effect show the absence of any reform effect on the number of rapes. This lack of an effect aligns with the flat time trend in reported rapes around the reform—a fact evident in basic graphical analysis that are not included in the paper.

The analysis discussed in this comment is the paper's headline result. The second identification strategy is an RD in time with a first differenced outcome variable, which faces the same issue as we have outlined in this text. Even if we have not been able to scrutinize the remaining three analyses due to the author's reluctance to share his replication files, neither of these analysis estimates the effect of the implementation of the ban.

References

Abadie, A., Athey, S., Imbens, G. W., & Wooldridge, J. M. (2023). When should you adjust standard errors for clustering?. *The Quarterly Journal of Economics*, *138*(1), 1-35.

Calonico, S., Cattaneo, M. D., Farrell, M. H., & Titiunik, R. (2017). rdrobust: Software for regression-discontinuity designs. *The Stata Journal*, *17*(2), 372-404.

Chen, J., & Roth, J. (forthcoming). Logs with zeros? Some problems and solutions. *The Quarterly Journal of Economics*.

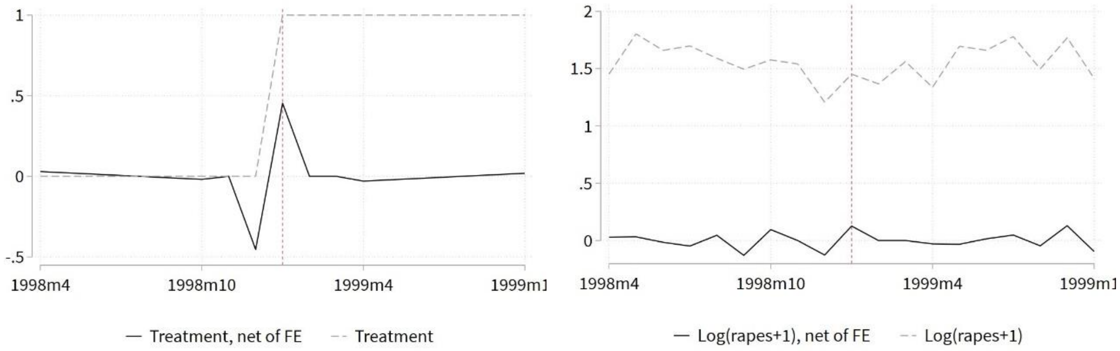
Ciacci, R. (2024). Banning the purchase of sex increases cases of rape: evidence from Sweden. *Journal of Population Economics*, *37*(2), 1-30.

Falk, G. J. (1952). The influence of the seasons on the crime rate. *J. Crim. L. Criminology & Police Sci.*, *43*, 199.

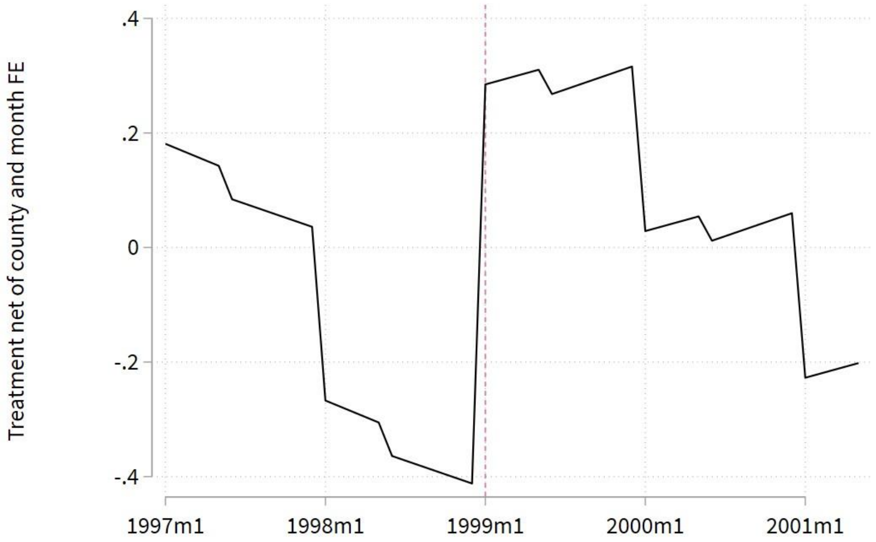
McDowall, D., Loftin, C., & Pate, M. (2012). Seasonal cycles in crime, and their variability. *Journal of quantitative criminology*, *28*, 389-410.

Appendix

A1: Residual variation in the restricted sample with bandwidth 9

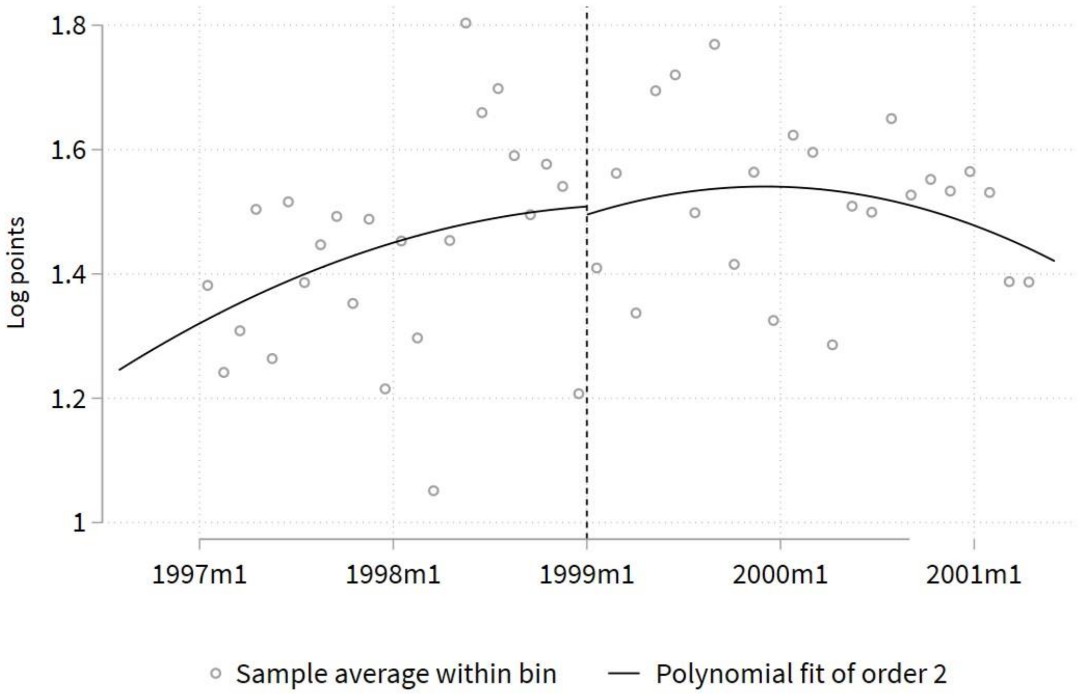


A2: Residual variation in the whole sample with bandwidth 29, excluding year FE

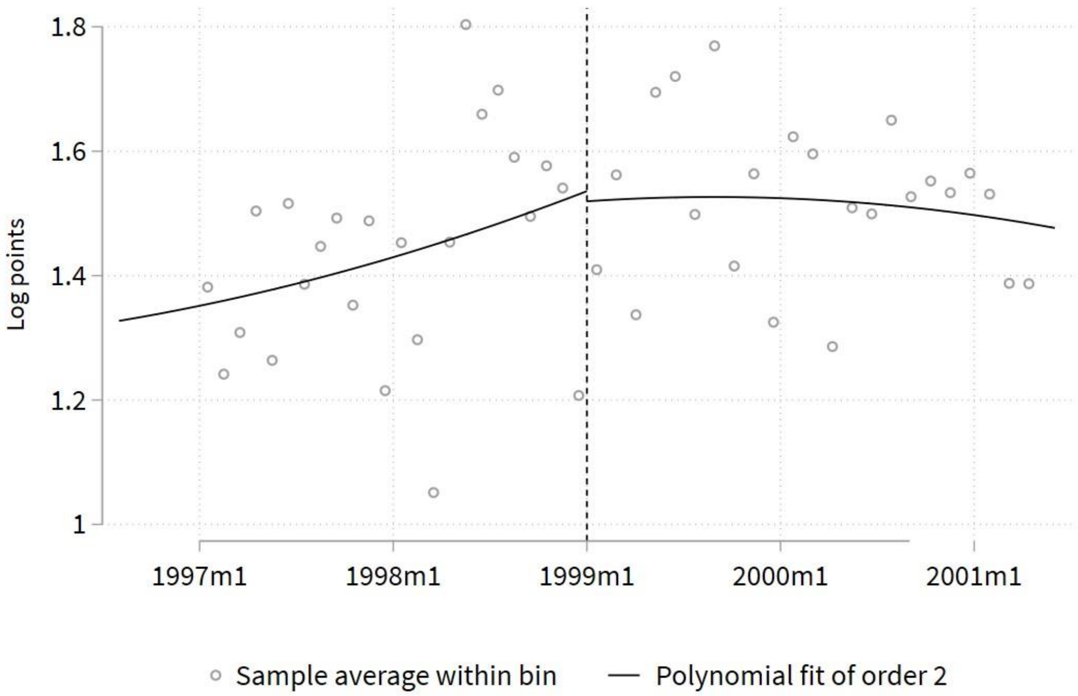


[All subsequent Figures follow Fig. 2 apart from the modification in the title]

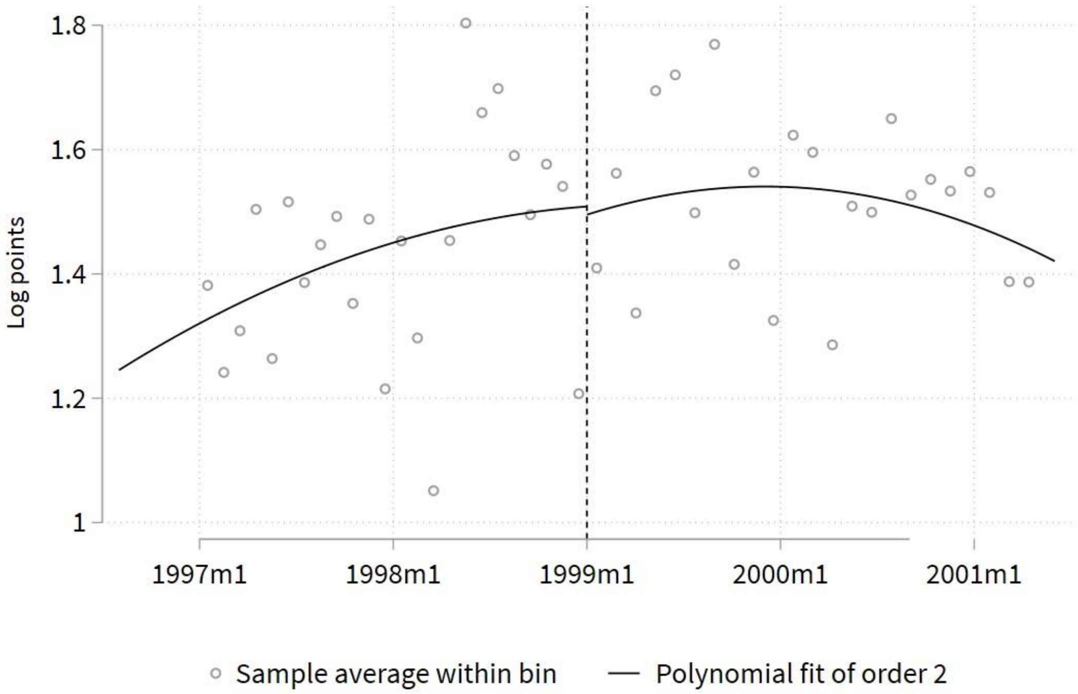
A3: RD plot dropping month FE



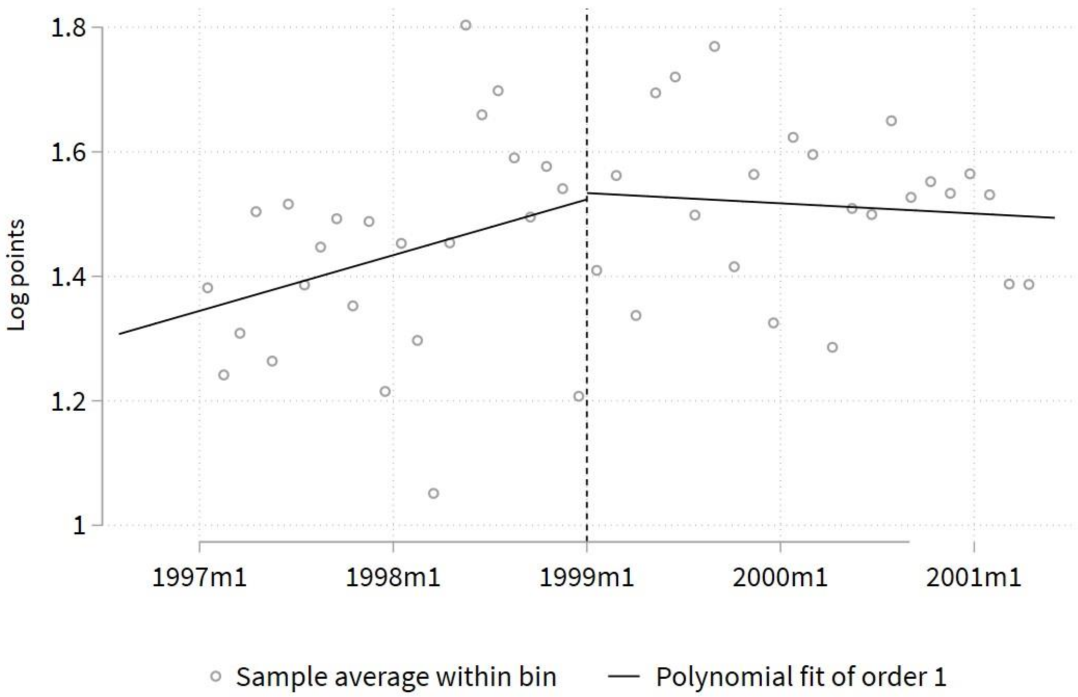
A4: RD plot dropping county FE



A5: RD plot dropping month and county FE



A6: RD plot using linear trends



Statistics/Data analysis

```
      name:  <unnamed>
       log:  C:\Users\adema\Dropbox\Projects_own\SwedenRape_replication\Ciacci_JOPE24_
> replication.smcl
  log type:  smcl
 opened on:  24 Mar 2024, 19:57:01

1 .
2 .
3 .
4 .     *TABLE 1:

5 .
6 .     *matches table 1B: perfectly

7 .
8 .     su completed_over_15 attempted_over_15 outside_over_15 inside_over_15 all_over_1
> 5 if year<1999
```

Variable	Obs	Mean	Std. dev.	Min	Max
completed~15	504	4.809524	8.059633	0	60
attempted~15	504	1.347222	2.798124	0	38
outside_o~15	504	1.565476	2.760067	0	23
inside_ov~15	504	4.59127	7.834242	0	57
all_over_15	504	6.156746	9.916813	0	67

```
9 .
10.     *matches table 1c: very close

11.
12.     su completed_over_15 attempted_over_15 outside_over_15 inside_over_15 all_over_1
> 5 if year>=1999
```

Variable	Obs	Mean	Std. dev.	Min	Max
completed~15	4,032	10.95064	17.58661	0	330
attempted~15	4,032	1.401538	2.363249	0	20
outside_o~15	4,032	2.747272	4.402066	0	69
inside_ov~15	4,032	9.604911	15.69068	0	268
all_over_15	4,032	12.35218	19.35978	0	337

```
13.
14.
15.
16.     *TABLE 3:

17.
18.     *Panel A:

19.
20.     *linear:

21.
22.     reghdfe lrape Treat Treat_running running if ym>=468-29&ym<=468+28 , absorb( i.c
> ounty_id i.year i.monthn) cl(regionc_m)
note: Treat is probably collinear with the fixed effects (all partialled-out values ar
> e close to zero; tol = 1.0e-09)
note: running is probably collinear with the fixed effects (all partialled-out values
> are close to zero; tol = 1.0e-09)
(MWFE estimator converged in 3 iterations)
note: Treat omitted because of collinearity
note: running omitted because of collinearity

HDFE Linear regression                              Number of obs   =      1,113
Absorbing 3 HDFE groups                             F(   1,    251) =       0.09
Statistics robust to heteroskedasticity             Prob > F        =     0.7646
                                                    R-squared       =     0.6893
                                                    Adj R-squared   =     0.6789
                                                    Within R-sq.    =     0.0001
Number of clusters (regionc_m) =        252         Root MSE        =     0.5380
```

```
                                 (Std. err. adjusted for 252 clusters in regionc_m)
------------------------------------------------------------------------------
                    |               Robust
              lrape | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
--------------------+---------------------------------------------------------
              Treat |          0  (omitted)
      Treat_running |  -.0028504   .0095105    -0.30   0.765    -.0215809    .0158801
            running |          0  (omitted)
              _cons |   1.498214   .0739956    20.25   0.000     1.352482    1.643945
------------------------------------------------------------------------------

Absorbed degrees of freedom:
-----------------------------------------------------+
 Absorbed FE | Categories  - Redundant  = Num. Coefs |
-------------+---------------------------------------|
   county_id |        21           0          21     |
        year |         5           1           4     |
      monthn |        12           1          11    ?|
-----------------------------------------------------+
? = number of redundant parameters may be higher

 23.
 24.         reg lrape Treat Treat_running running i.county_id i.year i.monthn if ym>=468-29&
  > ym<=468+28 , cl(regionc_m)
  note: 2001.year omitted because of collinearity.
  note: 12.monthn omitted because of collinearity.

  Linear regression                               Number of obs     =      1,113
                                                  F(36, 251)        =     191.04
                                                  Prob > F          =     0.0000
                                                  R-squared         =     0.6893
                                                  Root MSE          =     .53796

                                        (Std. err. adjusted for 252 clusters in regionc_m
  > )
  ------------------------------------------------------------------------------------
  _
                                     |               Robust
                               lrape | Coefficient  std. err.      t    P>|t|     [95% conf. interval
  > ]
  -----------------------------------+------------------------------------------------
  _
                               Treat |   .5568148   .3079761     1.81   0.072    -.0497319    1.16336
  > 1
                       Treat_running |  -.0028504   .0095105    -0.30   0.765    -.0215809    .015880
  > 1
                             running |  -.0074393   .0086436    -0.86   0.390    -.0244626     .00958
  > 4
                                     |
                           county_id |
                      Dalarnas län   |   .5019831    .091006     5.52   0.000     .3227505    .681215
  > 7
                      Gotlands län   |  -.1994007   .0812403    -2.45   0.015    -.3594001   -.039401
  > 2
                    Gävleborgs län   |    .788728   .1465863     5.38   0.000      .500032    1.07742
  > 4
                      Hallands län   |   .3649361    .111068     3.29   0.001     .1461921    .583680
  > 1
                     Jämtlands län   |   .1761314   .0792411     2.22   0.027     .0200693    .332193
  > 5
                    Jönköpings län   |   .3825924   .0828216     4.62   0.000     .2194784    .545706
  > 3
                        Kalmar län   |   .3748502   .1082674     3.46   0.001     .1616218    .588078
  > 5
                   Kronobergs län    |   .0314958   .1009829     0.31   0.755    -.1673861    .230377
  > 7
                  Norrbottens län    |   .2058376   .0980807     2.10   0.037     .0126716    .399003
  > 5
                        Skåne län    |   2.143233   .0745388    28.75   0.000     1.996432    2.29003
  > 4
                   Stockholms län    |   2.937079   .0777341    37.78   0.000     2.783985    3.09017
  > 3
```

```
    Södermanlands län |   .9527143   .0789544    12.07   0.000     .7972167    1.10821
> 2
          Uppsala län |   .8798043   .0863238    10.19   0.000     .7097929    1.04981
> 6
         Värmlands län |   .4765262   .0804472     5.92   0.000     .3180886    .634963
> 8
    Västerbottens län |   .5396367   .0973486     5.54   0.000     .3479125    .731360
> 9
   Västernorrlands län |   .3729463   .0852003     4.38   0.000     .2051477    .540744
> 9
     Västmanlands län |   .8319146   .0765897    10.86   0.000     .6810742    .982755
> 1
Västra Götalands län |   2.355823    .068673    34.30   0.000     2.220574    2.49107
> 2
           Örebro län |   .7313701   .0976599     7.49   0.000     .5390328    .923707
> 3
    Östergötlands län |   1.070573    .089398    11.98   0.000     .8945074    1.24663
> 9
                      |
                 year |
                 1998 |   .1917383   .1119922     1.71   0.088     -.028826    .412302
> 6
                 1999 |  -.2121943   .1787743    -1.19   0.236    -.5642832    .139894
> 6
                 2000 |  -.1082858   .1038397    -1.04   0.298     -.312794    .096222
> 4
                 2001 |          0  (omitted)
                      |
               monthn |
                    2 |  -.0188299   .0596535    -0.32   0.753    -.1363151    .098655
> 3
                    3 |  -.0407073   .0668523    -0.61   0.543    -.1723702    .090955
> 6
                    4 |  -.0216406   .0604279    -0.36   0.721    -.1406509    .097369
> 6
                    5 |   .1310855    .055271     2.37   0.018     .0222315    .239939
> 6
                    6 |   .1957247   .0708884     2.76   0.006     .0561129    .335336
> 5
                    7 |   .2095033   .0636418     3.29   0.001     .0841633    .334843
> 3
                    8 |    .173899   .0678984     2.56   0.011     .0401759    .307622
> 1
                    9 |   .2073559   .0814291     2.55   0.011     .0469844    .367727
> 3
                   10 |   .1194069   .0714449     1.67   0.096     -.021301    .260114
> 8
                   11 |   .1629268   .0602403     2.70   0.007     .0442859    .281567
> 7
                   12 |          0  (omitted)
                      |
                _cons |   .3941587   .1764662     2.23   0.026     .0466155    .741701
> 9
----------------------+----------------------------------------------------------------
  _

25.
26.     *quadratic:

27.
```

```
28.      reghdfe lrape Treat Treat_running Treat_running_2 running running_2 if ym>=468-2
  > 9&ym<=468+28 , absorb( i.county_id i.year i.monthn) cl(regionc_m)
  note: Treat is probably collinear with the fixed effects (all partialled-out values ar
  > e close to zero; tol = 1.0e-09)
  note: running is probably collinear with the fixed effects (all partialled-out values
  > are close to zero; tol = 1.0e-09)
  (MWFE estimator converged in 3 iterations)
  note: Treat omitted because of collinearity
  note: running omitted because of collinearity

  HDFE Linear regression                              Number of obs   =      1,113
  Absorbing 3 HDFE groups                             F(   3,     251) =       0.05
  Statistics robust to heteroskedasticity             Prob > F        =     0.9853
                                                      R-squared       =     0.6893
                                                      Adj R-squared   =     0.6783
                                                      Within R-sq.    =     0.0001
  Number of clusters (regionc_m) =        252         Root MSE        =     0.5384

                                     (Std. err. adjusted for 252 clusters in regionc_m)
  ------------------------------------------------------------------------------------
                   |               Robust
             lrape | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
  -----------------+------------------------------------------------------------------
             Treat |          0  (omitted)
     Treat_running |  -.0027381   .0215178    -0.13   0.899    -.0451165    .0396402
   Treat_running_2 |  -.0002004   .0007797    -0.26   0.797     -.001736    .0013352
           running |          0  (omitted)
         running_2 |   .0000955   .0005558     0.17   0.864    -.0009991      .00119
             _cons |   1.503803   .0981683    15.32   0.000     1.310465    1.697142
  ------------------------------------------------------------------------------------

  Absorbed degrees of freedom:
  -----------------------------------------------------+
   Absorbed FE | Categories  - Redundant  = Num. Coefs |
  -------------+---------------------------------------|
     county_id |        21           0           21     |
          year |         5           1            4     |
        monthn |        12           1           11    ?|
  -----------------------------------------------------+
  ? = number of redundant parameters may be higher

29.
30.      reg lrape Treat Treat_running Treat_running_2 running running_2 i.county_id i.ye
  > ar i.monthn if ym>=468-29&ym<=468+28 , cl(regionc_m)
  note: 2001.year omitted because of collinearity.
  note: 12.monthn omitted because of collinearity.

  Linear regression                                 Number of obs     =      1,113
                                                    F(38, 251)        =     181.16
                                                    Prob > F          =     0.0000
                                                    R-squared         =     0.6893
                                                    Root MSE          =     .53844

                                          (Std. err. adjusted for 252 clusters in regionc_m
  > )
  ---------------------------------------------------------------------------------------
  _
                          |               Robust
                    lrape | Coefficient  std. err.      t    P>|t|     [95% conf. interval
  > ]
  ------------------------+--------------------------------------------------------------
  _
                    Treat |   .5494193   .3037072     1.81   0.072    -.0487199    1.14755
  > 8
            Treat_running |  -.0027381   .0215178    -0.13   0.899    -.0451165    .039640
  > 2
          Treat_running_2 |  -.0002004   .0007797    -0.26   0.797     -.001736    .001335
  > 2
                  running |  -.0049887   .0156449    -0.32   0.750    -.0358008    .025823
  > 4
                running_2 |   .0000955   .0005558     0.17   0.864    -.0009991      .0011
  > 9
```

county_id						
Dalarnas län	.5019831	.0910907	5.51	0.000	.3225837	.681382
> 5						
Gotlands län	-.1994007	.0813159	-2.45	0.015	-.359549	-.039252
> 3						
Gävleborgs län	.788728	.1467227	5.38	0.000	.4997634	1.07769
> 3						
Hallands län	.3649361	.1111713	3.28	0.001	.1459886	.583883
> 7						
Jämtlands län	.1761314	.0793148	2.22	0.027	.019924	.332338
> 7						
Jönköpings län	.3825924	.0828987	4.62	0.000	.2193266	.545858
> 1						
Kalmar län	.3748502	.1083682	3.46	0.001	.1614234	.58827
> 7						
Kronobergs län	.0314958	.1010769	0.31	0.756	-.1675712	.230562
> 8						
Norrbottens län	.2058376	.0981719	2.10	0.037	.0124918	.399183
> 3						
Skåne län	2.143233	.0746082	28.73	0.000	1.996295	2.29017
> 1						
Stockholms län	2.937079	.0778064	37.75	0.000	2.783842	3.09031
> 5						
Södermanlands län	.9527143	.0790279	12.06	0.000	.797072	1.10835
> 7						
Uppsala län	.8798043	.0864042	10.18	0.000	.7096347	1.04997
> 4						
Värmlands län	.4765262	.0805221	5.92	0.000	.3179412	.635111
> 3						
Västerbottens län	.5396367	.0974392	5.54	0.000	.3477341	.731539
> 3						
Västernorrlands län	.3729463	.0852796	4.37	0.000	.2049915	.540901
> 1						
Västmanlands län	.8319146	.076661	10.85	0.000	.6809338	.982895
> 4						
Västra Götalands län	2.355823	.0687369	34.27	0.000	2.220448	2.49119
> 7						
Örebro län	.7313701	.0977508	7.48	0.000	.5388538	.923886
> 3						
Östergötlands län	1.070573	.0894812	11.96	0.000	.8943436	1.24680
> 3						
year						
1998	.1909672	.111892	1.71	0.089	-.0293997	.411334
> 2						
1999	-.2259986	.1913364	-1.18	0.239	-.602828	.150830
> 7						
2000	-.1238796	.1300992	-0.95	0.342	-.3801049	.132345
> 6						
2001	0	(omitted)				
monthn						
2	-.0184373	.0591358	-0.31	0.755	-.1349029	.098028
> 2						
3	-.0398726	.0664586	-0.60	0.549	-.1707602	.09101
> 5						
4	-.0203142	.0603447	-0.34	0.737	-.1391607	.098532
> 2						
5	.1329532	.0547539	2.43	0.016	.0251176	.240788
> 8						
6	.1962225	.0705017	2.78	0.006	.0573723	.335072
> 7						
7	.2098944	.0632666	3.32	0.001	.0852933	.334495
> 4						
8	.1741928	.0678669	2.57	0.011	.0405317	.30785
> 4						
9	.207562	.0805414	2.58	0.011	.048939	.366185
> 1						
10	.1195349	.0709536	1.68	0.093	-.0202054	.259275
> 2						
11	.162986	.0599751	2.72	0.007	.0448674	.281104

```
> 6
              12 |           0  (omitted)
                 |
           _cons |    .4051883   .1846862     2.19   0.029     .0414562    .768920
> 3
-----------------+----------------------------------------------------------------
  _


31.
32.     *Panel B:

33.
34.     *linear:

35.
36.     reghdfe lrape Treat Treat_running running if  ym>=468-9&ym<=468+9 , absorb( i.co
> unty_id i.year i.monthn) cl(regionc_m)
note: Treat is probably collinear with the fixed effects (all partialled-out values ar
> e close to zero; tol = 1.0e-09)
note: running is probably collinear with the fixed effects (all partialled-out values
> are close to zero; tol = 1.0e-09)
(MWFE estimator converged in 3 iterations)
note: Treat omitted because of collinearity
note: running omitted because of collinearity

HDFE Linear regression                            Number of obs   =        399
Absorbing 3 HDFE groups                           F(   1,    251) =       0.26
Statistics robust to heteroskedasticity           Prob > F        =     0.6095
                                                  R-squared       =     0.7063
                                                  Adj R-squared   =     0.6797
                                                  Within R-sq.    =     0.0010
Number of clusters (regionc_m) =        252       Root MSE        =     0.5499

                             (Std. err. adjusted for 252 clusters in regionc_m)
-------------------------------------------------------------------------------
              |               Robust
        lrape | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
--------------+----------------------------------------------------------------
        Treat |          0  (omitted)
Treat_running |   .0192672   .0376711     0.51   0.609    -.0549245     .093459
      running |          0  (omitted)
        _cons |   1.510223   .0891677    16.94   0.000      1.33461    1.685835
-------------------------------------------------------------------------------

Absorbed degrees of freedom:
-----------------------------------------------------+
 Absorbed FE | Categories  - Redundant  = Num. Coefs |
-------------+---------------------------------------|
   county_id |        21           0          21     |
        year |         2           1           1     |
      monthn |        12           1          11    ?|
-----------------------------------------------------+
? = number of redundant parameters may be higher

37.
38.     reg lrape Treat Treat_running running i.county_id i.year i.monthn if ym>=468-9&y
> m<=468+9 , cl(regionc_m)
note: 1999.year omitted because of collinearity.
note: 12.monthn omitted because of collinearity.

Linear regression                               Number of obs     =        399
                                                F(33, 251)        =      80.91
                                                Prob > F          =     0.0000
                                                R-squared         =     0.7063
                                                Root MSE          =      .5499
```

(Std. err. adjusted for **252** clusters in **regionc_m**
>)

_ lrape	Coefficient	Robust std. err.	t	P>|t|	[95% conf. interval	
>]						
_						
Treat	**.2787213**	**.1693014**	**1.65**	**0.101**	**-.054711**	**.612153**
> 6						
Treat_running	**.0192672**	**.0376711**	**0.51**	**0.609**	**-.0549245**	**.09345**
> 9						
running	**-.0343071**	**.0256362**	**-1.34**	**0.182**	**-.0847965**	**.016182**
> 3						
county_id						
Dalarnas län	**.7495456**	**.1558481**	**4.81**	**0.000**	**.442609**	**1.05648**
> 2						
Gotlands län	**-.2615691**	**.1183793**	**-2.21**	**0.028**	**-.4947125**	**-.028425**
> 8						
Gävleborgs län	**1.105797**	**.2518026**	**4.39**	**0.000**	**.6098814**	**1.60171**
> 2						
Hallands län	**.302767**	**.1769095**	**1.71**	**0.088**	**-.0456492**	**.651183**
> 2						
Jämtlands län	**.2457741**	**.1351385**	**1.82**	**0.070**	**-.0203758**	**.511924**
> 1						
Jönköpings län	**.4026154**	**.1479738**	**2.72**	**0.007**	**.1111869**	**.694043**
> 9						
Kalmar län	**.3607637**	**.1758688**	**2.05**	**0.041**	**.0143971**	**.707130**
> 4						
Kronobergs län	**.1105295**	**.1365447**	**0.81**	**0.419**	**-.1583898**	**.379448**
> 8						
Norrbottens län	**.3958219**	**.1598245**	**2.48**	**0.014**	**.0810539**	**.710589**
> 8						
Skåne län	**2.263676**	**.1366962**	**16.56**	**0.000**	**1.994458**	**2.53289**
> 3						
Stockholms län	**3.020081**	**.11448**	**26.38**	**0.000**	**2.794617**	**3.24554**
> 5						
Södermanlands län	**.95789**	**.1345392**	**7.12**	**0.000**	**.6929204**	**1.2228**
> 6						
Uppsala län	**1.016797**	**.1297566**	**7.84**	**0.000**	**.7612464**	**1.27234**
> 7						
Värmlands län	**.6401013**	**.1864534**	**3.43**	**0.001**	**.2728888**	**1.00731**
> 4						
Västerbottens län	**.6787313**	**.160088**	**4.24**	**0.000**	**.3634443**	**.994018**
> 3						
Västernorrlands län	**.5521723**	**.1034744**	**5.34**	**0.000**	**.3483837**	**.75596**
> 1						
Västmanlands län	**.9293849**	**.1597668**	**5.82**	**0.000**	**.6147305**	**1.24403**
> 9						
Västra Götalands län	**2.462496**	**.1093221**	**22.53**	**0.000**	**2.247191**	**2.67780**
> 2						
Örebro län	**.7529544**	**.1466689**	**5.13**	**0.000**	**.4640957**	**1.04181**
> 3						
Östergötlands län	**1.170182**	**.1544863**	**7.57**	**0.000**	**.8659273**	**1.47443**
> 7						
year						
1999	**0**	(omitted)				
monthn						
2	**-.069461**	**.1292341**	**-0.54**	**0.591**	**-.3239824**	**.185060**
> 5						
3	**.140222**	**.1704995**	**0.82**	**0.412**	**-.19557**	**.476013**
> 9						
4	**-.0488092**	**.1725627**	**-0.28**	**0.778**	**-.3886645**	**.291046**
> 1						
5	**.3295654**	**.1491377**	**2.21**	**0.028**	**.0358446**	**.623286**
> 2						
6	**.2651452**	**.158208**	**1.68**	**0.095**	**-.0464392**	**.576729**
> 7						

```
                    7 |    .368735   .1424665     2.59   0.010      .088153    .649317
> 1
                    8 |   .1987535   .1624095     1.22   0.222    -.1211056    .518612
> 6
                    9 |   .3113608   .1331327     2.34   0.020     .0491611    .573560
> 4
                   10 |   .1997648   .1463216     1.37   0.173    -.0884097    .487939
> 3
                   11 |   .2990938   .1296324     2.31   0.022      .043788    .554399
> 6
                   12 |          0  (omitted)
                      |
                _cons |   .3227494   .1512292     2.13   0.034     .0249094    .620589
> 4
                      |
------------------------------------------------------------------------------------------
  _

39.
40.     *quadratic:

41.
42.     reghdfe lrape Treat Treat_running Treat_running_2 running running_2 if  ym>=468-
  > 9&ym<=468+9 , absorb( i.county_id i.year i.monthn) cl(regionc_m)
  note: Treat is probably collinear with the fixed effects (all partialled-out values ar
  > e close to zero; tol = 1.0e-09)
  note: running is probably collinear with the fixed effects (all partialled-out values
  > are close to zero; tol = 1.0e-09)
  (MWFE estimator converged in 3 iterations)
  note: Treat omitted because of collinearity
  note: running omitted because of collinearity
  note: running_2 omitted because of collinearity

  HDFE Linear regression                              Number of obs   =        399
  Absorbing 3 HDFE groups                             F(   2,    251) =       0.42
  Statistics robust to heteroskedasticity             Prob > F        =     0.6557
                                                      R-squared       =     0.7070
                                                      Adj R-squared   =     0.6796
                                                      Within R-sq.    =     0.0033
  Number of clusters (regionc_m) =        252         Root MSE        =     0.5500

                                (Std. err. adjusted for 252 clusters in regionc_m)
  --------------------------------------------------------------------------------
                  |               Robust
            lrape | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
  ----------------+---------------------------------------------------------------
            Treat |          0  (omitted)
    Treat_running |   .2254045   .2491389     0.90   0.366    -.2652647    .7160738
  Treat_running_2 |  -.0171781   .0197143    -0.87   0.384    -.0560047    .0216485
          running |          0  (omitted)
        running_2 |          0  (omitted)
            _cons |   1.279674   .3045444     4.20   0.000     .6798861    1.879462
  --------------------------------------------------------------------------------

  Absorbed degrees of freedom:
  -----------------------------------------------------+
   Absorbed FE | Categories  - Redundant  = Num. Coefs |
  -------------+---------------------------------------|
     county_id |        21           0          21     |
          year |         2           1           1     |
        monthn |        12           1          11    ?|
  -----------------------------------------------------+
  ? = number of redundant parameters may be higher
```

```
43.
44.     reg lrape Treat Treat_running Treat_running_2 running running_2 i.county_id i.ye
  > ar i.monthn if ym>=468-9&ym<=468+9 , cl(regionc_m)
  note: 1999.year omitted because of collinearity.
  note: 11.monthn omitted because of collinearity.
  note: 12.monthn omitted because of collinearity.

  Linear regression                               Number of obs     =        399
                                                  F(34, 251)        =      79.53
                                                  Prob > F          =     0.0000
                                                  R-squared         =     0.7070
                                                  Root MSE          =     .55001

                                         (Std. err. adjusted for 252 clusters in regionc_m
  > )
  ------------------------------------------------------------------------------------
  _
                      |               Robust
                lrape | Coefficient  std. err.      t    P>|t|     [95% conf. interval
  > ]
  ------------------------------------------------------------------------------------
  _
                Treat |   .6276393   .2794845     2.25   0.026     .0772056    1.17807
  > 3
        Treat_running |   .8232952   .3215753     2.56   0.011     .1899654    1.45662
  > 5
      Treat_running_2 |  -.0171781   .0197143    -0.87   0.384    -.0560047    .021648
  > 5
              running |  -.4081372   .1750691    -2.33   0.021    -.7529288   -.063345
  > 6
            running_2 |  -.0249121   .0144522    -1.72   0.086    -.0533751    .003550
  > 9
                      |
            county_id |
         Dalarnas län |   .7495456    .156062     4.80   0.000     .4421877    1.05690
  > 4
         Gotlands län |  -.2615691   .1185418    -2.21   0.028    -.4950325   -.028105
  > 7
       Gävleborgs län |   1.105797   .2521482     4.39   0.000     .6092006    1.60239
  > 2
         Hallands län |    .302767   .1771523     1.71   0.089    -.0461275    .651661
  > 5
        Jämtlands län |   .2457741    .135324     1.82   0.071    -.0207412    .512289
  > 5
       Jönköpings län |   .4026154   .1481769     2.72   0.007     .1107868     .69444
  > 4
           Kalmar län |   .3607637   .1761102     2.05   0.042     .0139216    .707605
  > 8
       Kronobergs län |   .1105295   .1367321     0.81   0.420     -.158759     .37981
  > 8
      Norrbottens län |   .3958219   .1600439     2.47   0.014     .0806219    .711021
  > 9
            Skåne län |   2.263676   .1368838    16.54   0.000     1.994089    2.53326
  > 3
       Stockholms län |   3.020081   .1146372    26.34   0.000     2.794308    3.24585
  > 5
   Södermanlands län |     .95789   .1347239     7.11   0.000     .6925566    1.22322
  > 3
          Uppsala län |   1.016797   .1299347     7.83   0.000     .7608956    1.27269
  > 8
        Värmlands län |   .6401013   .1867093     3.43   0.001     .2723848    1.00781
  > 8
   Västerbottens län |   .6787313   .1603078     4.23   0.000     .3630115    .994451
  > 1
  Västernorrlands län |   .5521723   .1036164     5.33   0.000      .348104    .756240
  > 7
    Västmanlands län |   .9293849   .1599861     5.81   0.000     .6142986    1.24447
  > 1
  Västra Götalands län |   2.462496   .1094721    22.49   0.000     2.246895    2.67809
  > 7
           Örebro län |   .7529544   .1468703     5.13   0.000     .4636992     1.0422
  > 1
```

```
   Östergötlands län |   1.170182   .1546984     7.56   0.000     .8655096    1.47485
> 4
                     |
                year |
                1999 |          0  (omitted)
                     |
              monthn |
                   2 |  -.4575686   .1970747    -2.32   0.021    -.8456993   -.069437
> 9
                   3 |  -.5518128   .3170348    -1.74   0.083      -1.1762    .072574
> 6
                   4 |  -1.003536   .4341347    -2.31   0.022    -1.858547   -.148525
> 1
                   5 |  -.7177825   .4241852    -1.69   0.092    -1.553199    .117633
> 4
                   6 |  -.8078214   .4185016    -1.93   0.055    -1.632044    .016400
> 8
                   7 |   -.662848   .3810805    -1.74   0.083    -1.413371     .08767
> 5
                   8 |  -.7244435   .3428756    -2.11   0.036    -1.399723   -.049163
> 8
                   9 |   -.436448   .2635609    -1.66   0.099    -.9555208    .082624
> 8
                  10 |  -.3056533   .1906899    -1.60   0.110    -.6812095    .069902
> 8
                  11 |          0  (omitted)
                  12 |          0  (omitted)
                     |
               _cons |  -.0261686   .2710671    -0.10   0.923    -.5600245    .507687
> 2
---------------------+--------------------------------------------------------------
  _

45.
46.
47.
48.     log close
      name:  <unnamed>
       log:  C:\Users\adema\Dropbox\Projects_own\SwedenRape_replication\Ciacci_JOPE24_
> replication.smcl
  log type:  smcl
 closed on:  24 Mar 2024, 19:57:05
------------------------------------------------------------------------------------
```