The effect of same-sex marriage laws on different-sex marriage: Evidence from the Netherlands

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A1. The synthetic control method

As in Abadie et al. (2010), let subscript \(1\) indicate the Netherlands and \(W = (w_2, ..., w_{J+1})\) be the vector of weights assigned to the \(J\) potential donor countries. Without any restrictions on the weights, a sufficiently large number of potential donor countries and of determinant variables will lead to a synthetic control that matches perfectly the evolution of the marriage rate in the Netherlands prior to the introduction of the two laws. However, weights outside the \([0,1]\) interval are difficult to interpret and imply out-of-sample inference. Hence, the weights are restricted to lie in the unit interval \((0 \leq w_j \leq 1\) for all \(j\)) and to sum up to one \((\Sigma_{j=2}^{J+1} w_j = 1)\), which results in a synthetic control that will likely not match perfectly the trend in the marriage rate before the two laws.

For the synthetic control, the marriage rate \(m^*_1\) and its determinants \(X^*_1\) are calculated as weighted averages of the corresponding variables in the donor countries:

\[
m^*_1 = \sum_{j=2}^{J+1} w_j m_{jt} \quad \quad X^*_1 = \sum_{j=2}^{J+1} w_j X_{jt}
\]

Let \(T_0\) be the number of available periods before 1998 and let the vector \(K = (k_1, ..., k_{T_0})\) define a linear combination of the pre-1998 marriage rates for any country \(i\):

\[
\tilde{m}^K_i = \sum_{t=1}^{T_0} k_t m_{it}.
\]

Now consider \(M\) such linear combinations for the Netherlands: \(\tilde{m}^{K_1}_1, ..., \tilde{m}^{K_M}_1\), and define \(Z_1 = (X'_1, \tilde{m}^{K_1}_1, ..., \tilde{m}^{K_M}_1)'\) as the vector obtained by combining the determinants of the marriage rate prior to 1998 and these \(M\) linear combinations of the pre-1998 marriage rate in the
Netherlands. Next, consider the matrix $Z_0$ constructed by combining similar vectors for the $J$ potential donors, such that the $j$-th column of $Z_0$ is $(X_j', \bar{m}_j^{K_1}, \ldots, \bar{m}_j^{K_M})'$, where $X_j$ is the set of determinants of the marriage rate prior to 1998 in country $j$.

In principle, the linear combinations $(K_1, \ldots, K_M)$ are arbitrary. In practice, Abadie et al. (2010) suggest choosing $M = 1$ and $k_t = \frac{1}{T_0}$, which produce average marriage rates over the period before the intervention:

$$\bar{m}_i = \frac{1}{T_0} \sum_{t=1}^{T_0} m_{it}.$$  

The vector of data for the Netherlands becomes $Z_1 = (X'_1, \bar{m}_1)'$ and the corresponding matrix $Z_0$ for the donor countries has columns of the form $(X'_j, \bar{m}_j)'$ for the $j$-th donor country.

Given this structure of the $Z$ matrices, let $V$ be a diagonal matrix of loadings corresponding to all the variables (both the determinants $X$ and the marriage rate $m$). The optimal set of weights is the one that minimizes the weighted distance between $Z_1$ and $Z_0$:

$$W^*(V) = \arg\min V (Z_1 - Z_0 W).$$

The matrix $V$ can be arbitrary, but a natural choice is the one that minimizes the mean squared error of the marriage rate in the synthetic control relative to the actual marriage rate in the Netherlands (Abadie et al., 2010):

$$V^* = \arg\min \sqrt{[m_1 - m_0 W^*(V)]' [m_1 - m_0 W^*(V)]},$$

where $m_1$ is the ($T_0 \times 1$) vector containing the marriage rate in the Netherlands and $m_0$ is the ($T_0 \times J$) matrix of marriage rates of the potential donors in the pre-intervention period. This ensures that the marriage rate in the synthetic control constructed using the resulting weights $W^*(V^*)$ is the best match to the marriage rate in the Netherlands in the period before 1998.
Abadie et al. (2010) suggest two ways to gauge the statistical significance of the actual-synthetic difference in the post-intervention period. The first is the type of permutation tests conducted in section 4.3. The second is to use the ratio of post- to pre-intervention $MSPE$ for the full sample of donors. Appendix Figure A2 plots the distribution of this ratio when the post-intervention is 1998–2000, after the introduction of registered partnership (panel a) or 2001–2005, after the legalization of same-sex marriage (panel b). In both cases, the pre-intervention period is 1988–1997. The Netherlands finds itself in the middle of the distribution in both graphs. The interpretation of these graphs is that if the intervention, registered partnership law or same-sex marriage law, were assigned randomly to a country in the sample, the probability of observing a pre-post relative difference in the marriage rate at least as large as in the Netherlands would be approximately 35%, corresponding to 6 countries (5 donors and the Netherlands) out of 16 having a $MSPE$ ratio as high as the Netherlands, both in the case of the registered partnership law and in the case of the same-sex marriage law. In the case of the different-sex marriage rate, the probability is the same, 35%, while in the case of different-sex unions, the probability is 23% for the period 1998–2000 and 41% for the period 2001–2005. If the post-intervention period is the entire 1998–2005, the probability is approximately 41% for all three measures. This probability is higher than the standard significance levels used in statistical tests, suggesting once again that the evolution of the Dutch marriage rate after the enactment of the two laws was not statistically different from its evolution in their absence, whether for all or only different-sex couples.
Table A1: Data sources, aggregate analysis

<table>
<thead>
<tr>
<th>Country</th>
<th>Marriage rate</th>
<th>Pop. 25-44</th>
<th>Urban pop.</th>
<th>Sex ratio</th>
<th>Age at first marriage</th>
<th>Life expect.</th>
<th>Share of girls in education</th>
<th>Fertility rate</th>
<th>Unemp. rate</th>
<th>GDP per capita</th>
<th>Marriage views</th>
</tr>
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<tbody>
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<td>OECD</td>
<td>WBES</td>
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<td>WVS</td>
</tr>
<tr>
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<td>ABS</td>
<td>WDI</td>
<td>WDI</td>
<td>ABS</td>
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<td>WBES</td>
<td>OECD</td>
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<td>OECD</td>
<td>WVS</td>
</tr>
<tr>
<td>Austria</td>
<td>E</td>
<td>E</td>
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<td>WDI</td>
<td>E</td>
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<td>WBES</td>
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<td>WVS</td>
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<tr>
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<td>E</td>
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<td>WDI</td>
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<tr>
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<td>OECD</td>
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<td>WDI</td>
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<td>WBES</td>
<td>OECD</td>
<td>OECD</td>
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<td>WVS</td>
</tr>
<tr>
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<th>Country</th>
<th>Weight</th>
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<td>Turkey</td>
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<tr>
<td>Japan</td>
<td>0.001</td>
<td>United States</td>
<td>0.002</td>
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Table A3: Municipalities included in the Bible belt

<table>
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<tr>
<th>Municipality</th>
<th>Votes for conservative parties (%)</th>
<th>Municipality</th>
<th>Votes for conservative parties (%)</th>
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</thead>
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<tr>
<td>Urk</td>
<td>66.50</td>
<td>Brakel</td>
<td>31.74</td>
</tr>
<tr>
<td>Genemuiden(^1)</td>
<td>52.52</td>
<td>Tholen</td>
<td>31.70</td>
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<tr>
<td>Staphorst</td>
<td>50.07</td>
<td>Barneveld</td>
<td>31.09</td>
</tr>
<tr>
<td>Rijssen(^2)</td>
<td>48.58</td>
<td>Hasselt(^1)</td>
<td>28.95</td>
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<tr>
<td>Bunschoten</td>
<td>43.10</td>
<td>Liesveld</td>
<td>28.12</td>
</tr>
<tr>
<td>Kesteren(^3)</td>
<td>39.09</td>
<td>Middelharnis</td>
<td>27.99</td>
</tr>
<tr>
<td>Ijsselmuiden(^4)</td>
<td>38.39</td>
<td>Sliedrecht</td>
<td>25.34</td>
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<td>Oldebroek</td>
<td>37.92</td>
<td>Katwijk</td>
<td>25.32</td>
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<td>Nieuw-Lekkerland</td>
<td>37.54</td>
<td>Zederik</td>
<td>24.03</td>
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<tr>
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<td>37.37</td>
<td>Scherpenzeel</td>
<td>23.99</td>
</tr>
<tr>
<td>Kerkwijk(^5)</td>
<td>36.79</td>
<td>Ouderkerk</td>
<td>23.93</td>
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<tr>
<td>Nunspeet</td>
<td>36.47</td>
<td>Veenendaal</td>
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<td>Woudenberg</td>
<td>23.55</td>
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<tr>
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<td>Korendijk</td>
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<td>Reimerswaal</td>
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<td>Echteld(^6)</td>
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<td>Zevenhuizen-Moerkapelle</td>
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<td>Dirksland</td>
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Table A4: Degree of religiosity of different ethnicities

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<th>Netherlands</th>
<th>Turkey</th>
<th>Morocco</th>
<th>Antilles (Aruba)</th>
<th>Suriname</th>
<th>Western countries</th>
<th>Non-Western countries</th>
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<td>Very important</td>
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<td>80.8</td>
<td>94.3</td>
<td>--</td>
<td>--</td>
<td>25.5</td>
<td>66.1</td>
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<tr>
<td>Rather important</td>
<td>20.7</td>
<td>12.7</td>
<td>4.8</td>
<td>--</td>
<td>--</td>
<td>29.9</td>
<td>17.7</td>
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<tr>
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<td>34.8</td>
<td>3.9</td>
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<td>--</td>
<td>--</td>
<td>26.8</td>
<td>10.3</td>
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<tr>
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<td>27.8</td>
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<td>0.1</td>
<td>--</td>
<td>--</td>
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<td>6.0</td>
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<td>2,263</td>
<td>51,145</td>
<td>39,590</td>
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<td>1</td>
<td>40</td>
<td>26</td>
<td></td>
<td></td>
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<tr>
<td>Very important</td>
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<td>61.2</td>
<td>--</td>
<td>--</td>
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<td>22.7</td>
<td>46.3</td>
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<tr>
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<td>23.0</td>
<td>--</td>
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<tr>
<td><strong>C. Frequency of attending religious gatherings (other than special occasions such as weddings and funerals) – Longitudinal Internet Studies for the Social sciences, wave 1 (January and April 2008)</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>At least once a month</td>
<td>16.5</td>
<td>37.5</td>
<td>31.8</td>
<td>40.0</td>
<td>25.0</td>
<td>11.3</td>
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<tr>
<td>Only on special religious days or less often</td>
<td>27.5</td>
<td>50.0</td>
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<td>40.0</td>
<td>75.0</td>
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<td>Never</td>
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<td><strong>D. Frequency of prayer (other than when attending religious gatherings) – Longitudinal Internet Studies for the Social sciences, wave 1 (January and April 2008)</strong></td>
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Notes: Each cell represents the percentage of respondents within the column who agree with the statement represented on the row. The World Values Survey is run in different countries and column headings refer to the country of residence of the respondent for Panels A and B. The Longitudinal Internet Studies for the Social sciences is a survey run among Dutch residents and column headings refer to the ethnicity of the respondent for panels C and D.
Figure A1: Evolution of two measures of the marriage rate in the Netherlands

Notes: The crude marriage rate is defined as the number of different-sex marriages per 1,000 individuals. The "correct" marriage rate is measured as the number of different-sex marriages per 1,000 single individuals 18 years old or older. The lines represent the change in each indicator with respect to 1988 on a logarithmic scale, using data on different-sex marriages from Statistics Netherlands over the period between 1988–2005.
Figure A2: Ratio of post/pre-intervention MSPE, Netherlands and full sample of donors

(a) Post-intervention period: 1998–2000 (after the registered partnership law)

(b) Post-intervention period: 2001–2005 (after the same-sex marriage law)
Figure A3: The evolution of all marriages and first marriages for one of the spouses
Figure A4: Comparison of counterfactuals, pre- and post-interventions
Figure A5: The seasonal pattern of marriages in the Netherlands
Figure A6: Kaplan-Meier estimates of the survival function (the probability of being single, by age)
Figure A7: The education system in the Netherlands and the definition of different levels of educational attainment

Note: Numbers next to arrows represent percentages of a cohort.
Figure A8: The four largest cities and the Bible-belt municipalities