Another case of the middle-income trap: Chile, 1900-1939

Source code available in github at: https://github.com/diodz/chile-middle-income-trap

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Figure 1

This is a markdown file that produces the figures of the article, the following produces figure 1, which shows the income of Chile relative to the United States and relative to the average between the average of the Europe 12 countries and the average of the Western Offshoots countries.

```
source('data_preparation.R')
source('structural_break_tests.R')

ggplot_relative_income()
```

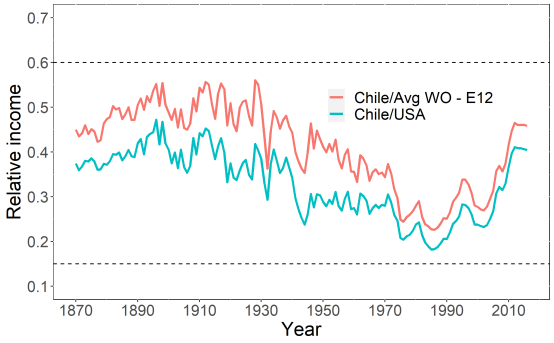

Figure 1: Source: Maddison (2018). Note: The horizontal lines represent the middle-income band. The line above shows the relative income between Chile and the average between Western Offshoots and Western Europe, while the line below shows Chile's relative income to the US. Western offshoots is the average income of the US, Canada, Australia and New Zealand together, while Western Europe is the average income of the group of countries comprised of: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Sweden, Switzerland, and the United Kingdom.

Figure 2

Figure 2 shows structural break tests of the relative income series of Chile and three countries or groups of countries. These figures are shown separately in this section, starting with the the relative income of Chile over the United States, following with the relative income of Chile and the average between the average of the Europe 12 countries and the average of the Western Offshoots countries, and finally against the Nordic 3 countries, the average of Sweden, Norway and Finland.

```
usa_rel <- get_relative_usa(1820)
#Figure 2_1a
```

```
plot_time_series(usa_rel, 'chile_relative', 1820, 'Figure 2_1a')
#Figure 2_1b
plot_Fstat_test(usa_rel, 'chile_relative', 1820, 'Figure 2_1b')

wo_e12 <- average_wo_e12()
#Figure 2_2a
plot_time_series(wo_e12, 'chile_relative', 1880, 'Figure 2_2a')
#Figure 2_2b
plot_Fstat_test(wo_e12, 'chile_relative', 1880, 'Figure 2_2b')

nordic3 <- get_Nordic3_relative()
#Figure 2_3a
plot_time_series(nordic3, 'chile_relative', 1880, 'Figure 2_3a')
#Figure 2_3b
plot_Fstat_test(nordic3, 'chile_relative', 1880, 'Figure 2_3b')
```

```
include_graphics(c('../figures/Figure 2_1a.png','../figures/Figure 2_1b.png'))
include_graphics(c('../figures/Figure 2_2a.png','../figures/Figure 2_2b.png'))
include_graphics(c('../figures/Figure 2_3a.png','../figures/Figure 2_3b.png'))
```

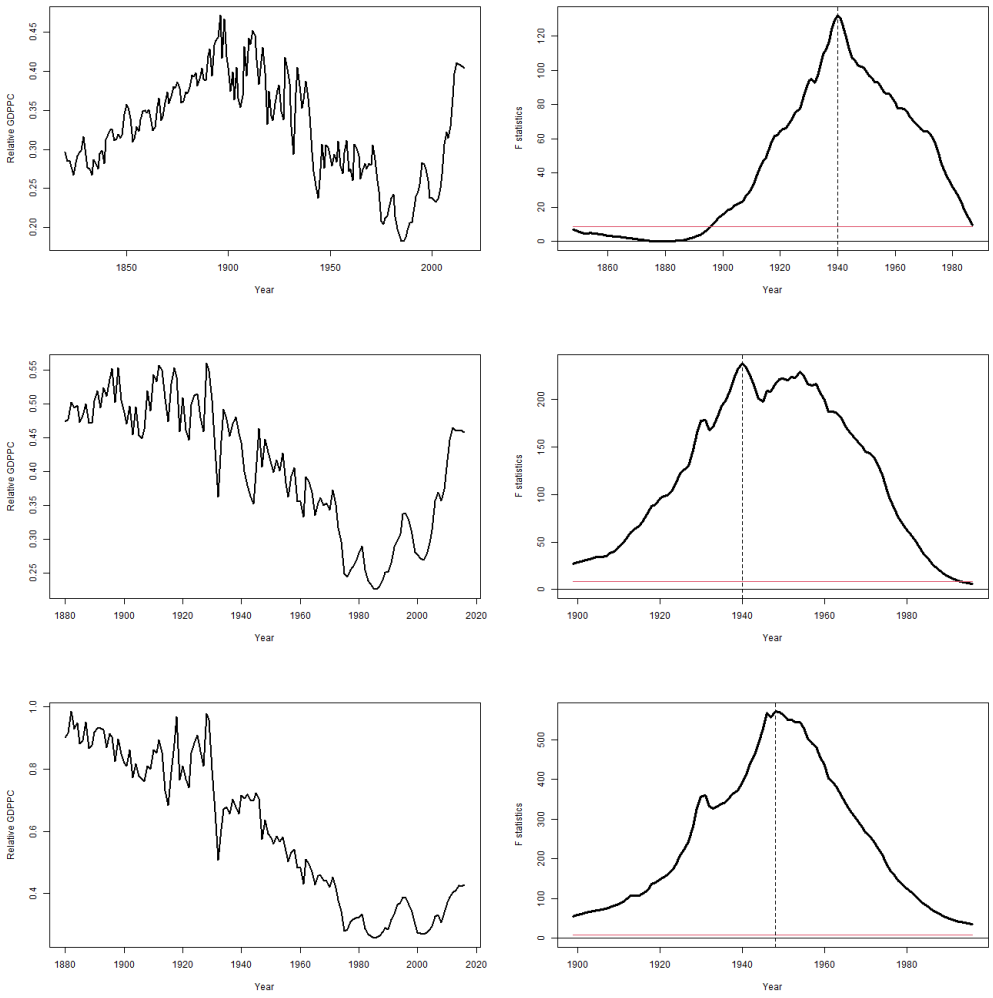

Figure 2: The top left figure shows Chile's GDP per capita relative to the USA, the middle left shows Chile relative to the simple average of Western Offshoots and Western Europe-12, and the bottom left one shows Chile's relative to the Nordic-3 countries. The figures on the right show the results of the F statistic to test for a structural break in level as in Zeileis et al. (2012) for each series, assuming relative income is constant. The highest value marks the most likely year for structural break on the series. In this case, 1948 in the bottom case (Nordic-3), while 1940 in the other two. The period considered in the analysis changes as some European countries' data starts later in the database.

Figure 3

Figures 3, 4 and 5 are results of the synthetic control method, which is implemented in Matlab. To produce these figures execute the script **main_synthetic_controls.m**. Nonetheless, we attach the images here for consistency.

```
include_graphics('../figures/Figure 3.png')
```

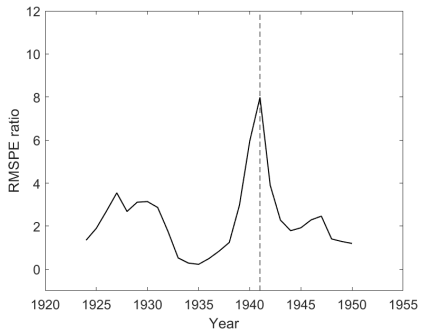

Figure 3: Ratio of the post-treatment RMSPE to the pre-treatment RMSPE between Chile and its synthetic counterfactual estimated changing the start of treatment from 1925 to 1950. An interval of 5 years from and after the treatment is considered when calculating the error term.

Figure 4

```
include_graphics(c('../figures/Figure 4_1.png','../figures/Figure 4_2.png'))
```

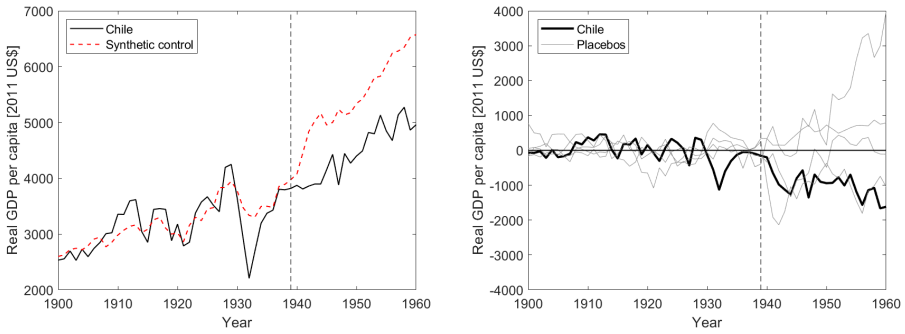

Figure 4: The synthetic control for Chile with the treatment set on 1939 is shown on the left side. The solid line shows Chile's GDP per-capita from Maddison (2018). The dashed line shows the synthetic control constructed from the control group. A placebo test is shown on the right side, where the black line represents Chile's GDP per capita gap with its synthetic control, and the lighter lines show the gap for the other countries in the sample with each country's own synthetic control. Only countries with a pre-treatment RMSPE of less than 1.5 times that of Chile are shown.

Figure 5

```
include_graphics(c('../figures/Figure 5_1.png','../figures/Figure 5_2.png'))
```

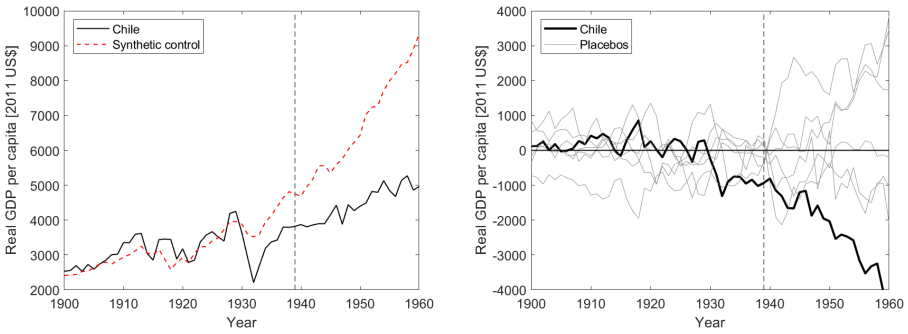

Figure 5: The synthetic control for Chile with the treatment set on 1939 is shown on the left side, with the highest weighted country left-out of the sample as a robustness test. In our case, this country is Portugal. The solid line shows Chile's GDP per-capita from Maddison (2018). The dashed line shows the synthetic control constructed from the control group. A placebo test is shown on the right side, where the black line represents Chile's GDP per capita gap with its synthetic control, and the lighter lines show the gap for the other countries in the sample with each country's own synthetic control. Only countries with a pre-treatment RMSPE of less than 1.5 times that of Chile are shown.

Tables 2a & 2b

We first part of this code estimates a Bai Perron test to the relative income series of Chile and the United States, as shown in Table 2a. The second part uses the relative income series between Chile and the average of the Nordic-3 countries.

```
usa_rel <- get_relative_usa(1820)
bai_perron(usa_rel, 'chile_relative', 1820)
```

```
##
##   Optimal (m+1)-segment partition:
##
## Call:
## breakpoints.formula(formula = time_series ~ 1)
##
## Breakpoints at observation number:
##
## m = 1            121
## m = 2      49    121
## m = 3   29 59    121
## m = 4   29 59    121 168
## m = 5   29 62 92 121 168
##
## Corresponding to breakdates:
##
## m = 1                  1940
## m = 2        1868      1940
## m = 3   1848 1878      1940
## m = 4   1848 1878      1940 1987
## m = 5   1848 1881 1911 1940 1987
##
## Fit:
##
## m   0         1         2         3         4         5
## RSS    0.8517    0.5080    0.3458    0.3259    0.3100    0.2972
## BIC -502.7760 -594.0387 -659.2308 -660.3068 -659.6434 -657.3871
```

```
nordic3 <- get_Nordic3_relative()
bai_perron(nordic3, 'chile_relative', 1880)
```

```
##
##   Optimal (m+1)-segment partition:
##
## Call:
## breakpoints.formula(formula = time_series ~ 1)
##
## Breakpoints at observation number:
##
## m = 1         69
## m = 2      51 79
## m = 3      51 73 93
## m = 4   20 51 73 93
## m = 5   20 51 73 93 113
```

```
##
## Corresponding to breakdates:
##
## m = 1             1948
## m = 2        1930 1958
## m = 3        1930 1952 1972
## m = 4   1899 1930 1952 1972
## m = 5   1899 1930 1952 1972 1992
##
## Fit:
##
## m   0         1         2         3         4         5
## RSS    7.5274    1.4404    0.6882    0.4846    0.4106    0.3861
## BIC    1.1337 -215.5709 -306.9282 -345.1251 -357.9891 -356.5906
```