# Ako vyhodnotiť zmenu politiky

Lukáš Laffers

Katedra matematiky, Univerzita Mateja Bela

Vedatour 2025

# Dnes

Nastala zmena politiky: nová udalosť, nová daň, nový zákon.

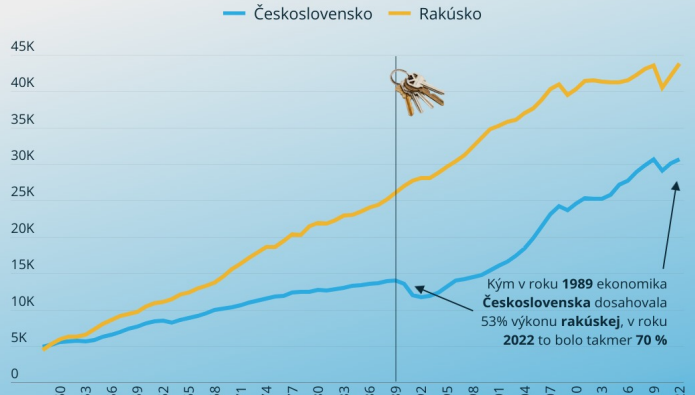
Spôsobilo to niečo?? Malo to impakt??

Ťažko povedať...

# Aj pre ekonomiku bol rok 89 kľúčovým

ifp

## Hrubý domáci produkt na obyvateľa, v cenách 2011$




Aj pre ekonomiku bol rok 89 kľúčovým
ifp
Hrubý domáci produkt na obyvateľa, v cenách 2011$
Československo
Rakúsko
45K
40K
Pani porovnavate dva neporovnatelne ekonomicke systemy. Kde studovali. Na strednej vyssej uctovnej?
6h Like Reply
2
20K
15K
10K
5K
0
Kým v roku 1989 ekonomika Československa dosahovala 53% výkonu rakúskej, v roku 2022 to bolo takmer 70 %
1950 1953 1956 1959 1962 1965 1968 1971 1974 1977 1980 1983 1986 1989 1992 1995 1998 2001 2004 2007 2010 2013 2016 2019 2022

# Otázky

Bolo prijatie eura výhodné pre Slovenskú ekonomiku?

Aký bol vplyv objavenia ropy pre Nórsku ekonomiku?

Aký bol vplyv Brexitu pre nezamestnanosť UK?

# Nemáme

Bolo prijatie eura výhodné pre Slovenskú ekonomiku?
Slovensko, ktoré neprijalo euro.

Aký bol vplyv objavenia ropy pre Nórsku ekonomiku?
Nórsko, ktoré neobjavilo ropu.

Aký bol vplyv Brexitu pre nezamestnanosť v UK?
Spojené kráľovstvo, ktoré neprijalo Brexit.

Zmena na individuálnej úrovni (človek).

Zmena na agregátnej úrovni (mesto, štát).

Zmena na individuálnej úrovni (človek).
Väčšinou nájdeme niekoho podobného.

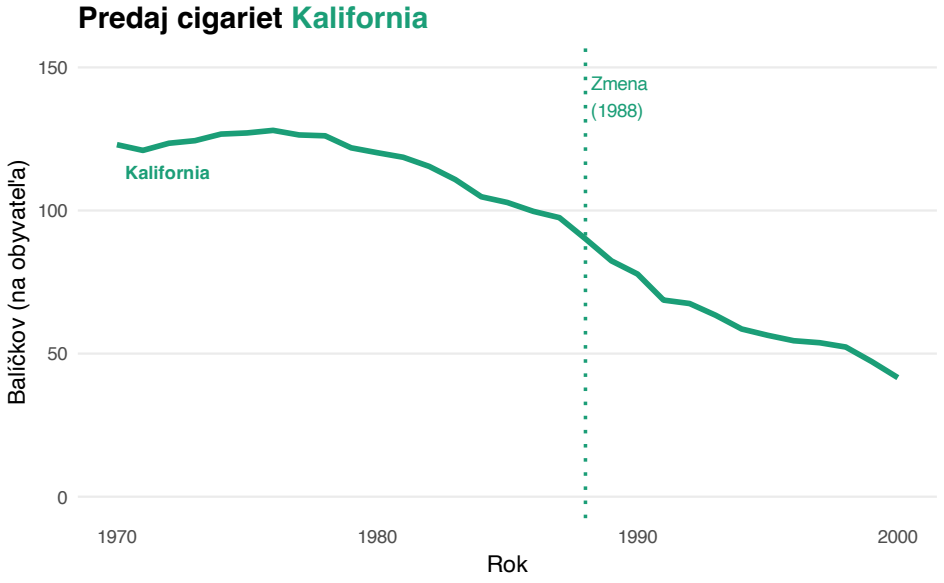
Zmena na agregátnej úrovni (mesto, štát).
Tu už je to ťažšie.

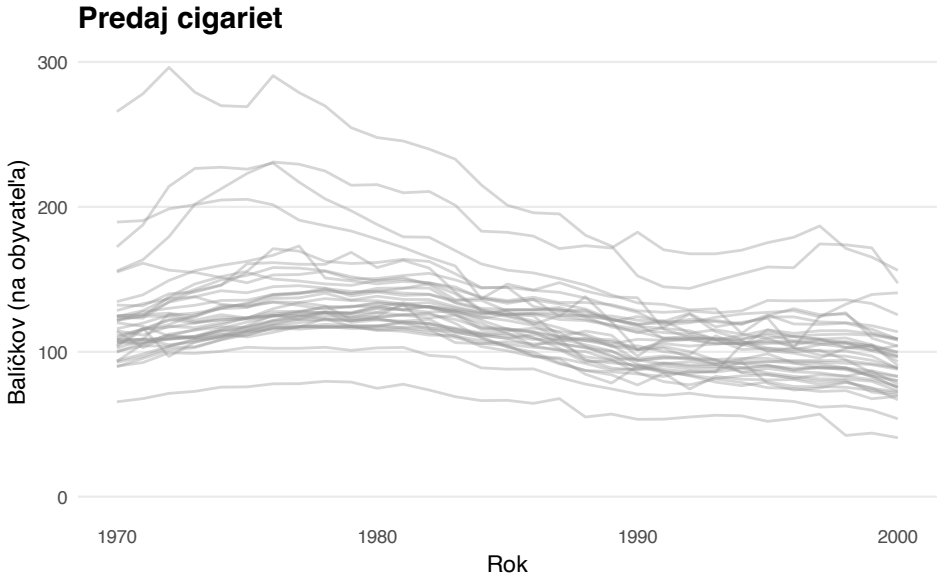
# Príklad

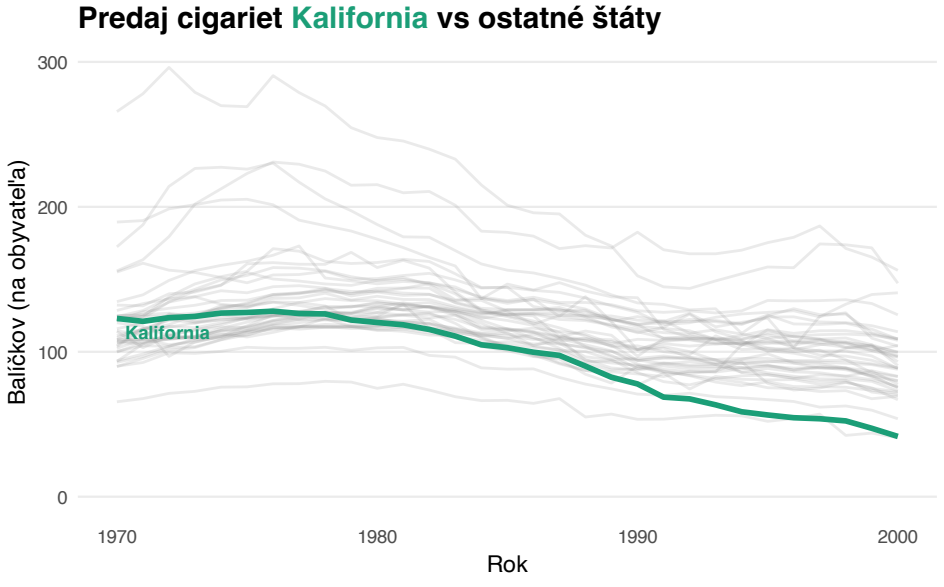
V roku 1988 zaviedol štát Kalifornia 25% daň na tabakové výrobky.

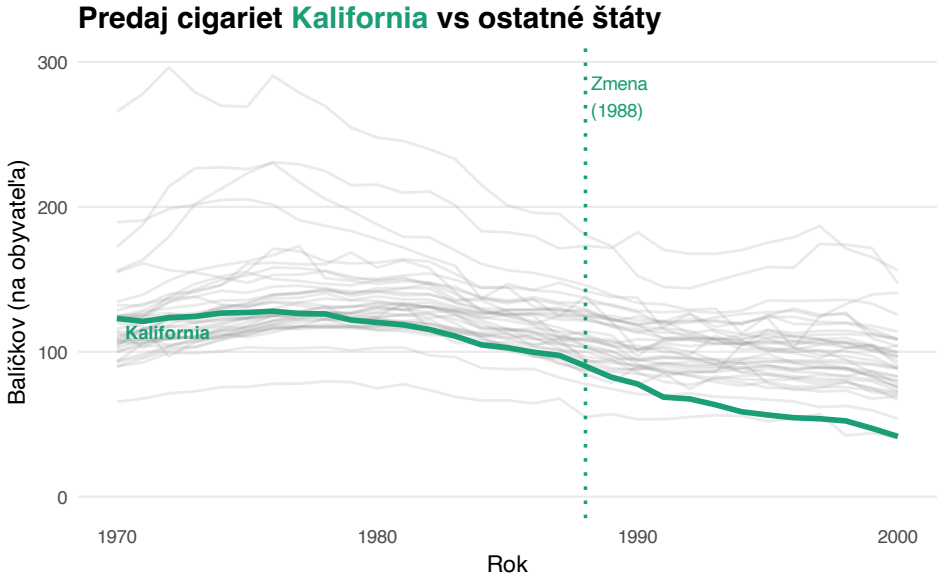
Zákaz automatov na tabakové výrobky a kusového predaja cigariet.

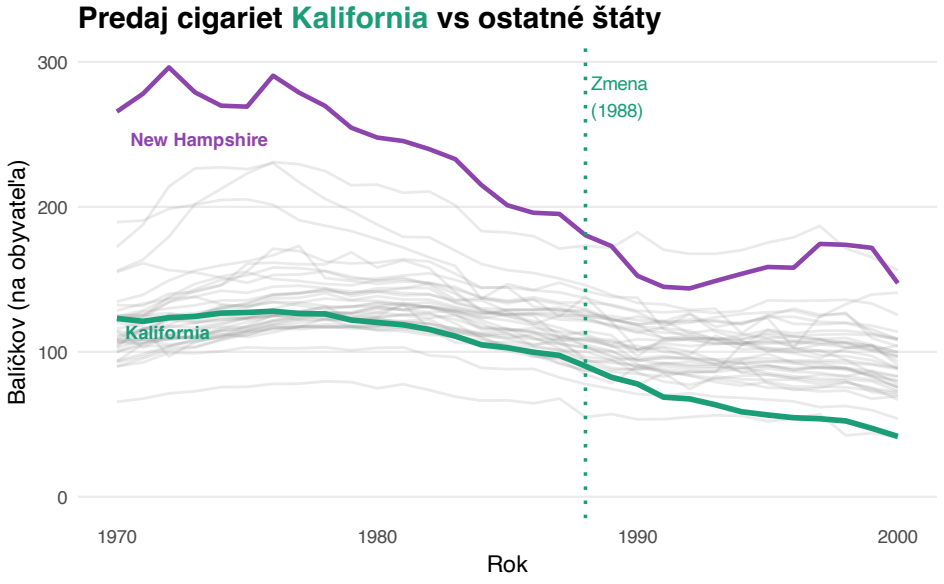
Príjmy z dane boli investované do programov na zlepšenie zdravia a proti-tabakové reklamy.

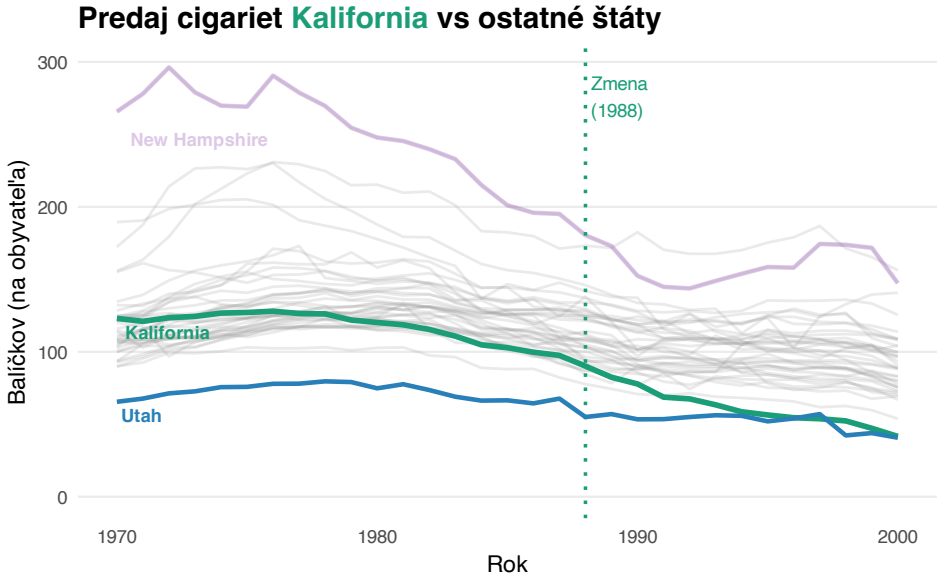

Predaj cigariet Kalifornia
150
100
50
0
Balíčkov (na obyvateľa)
Kalifornia
Zmena
(1988)
1970
1980
1990
2000
Rok

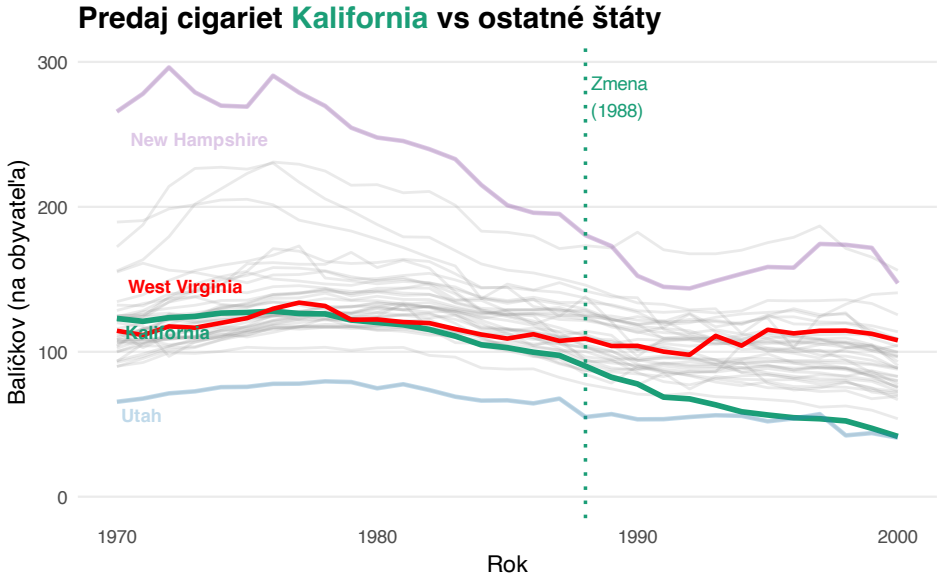

Predaj cigariet
300
200
100
0
Balíčkov (na obyvatela)
1970
1980
1990
2000
Rok

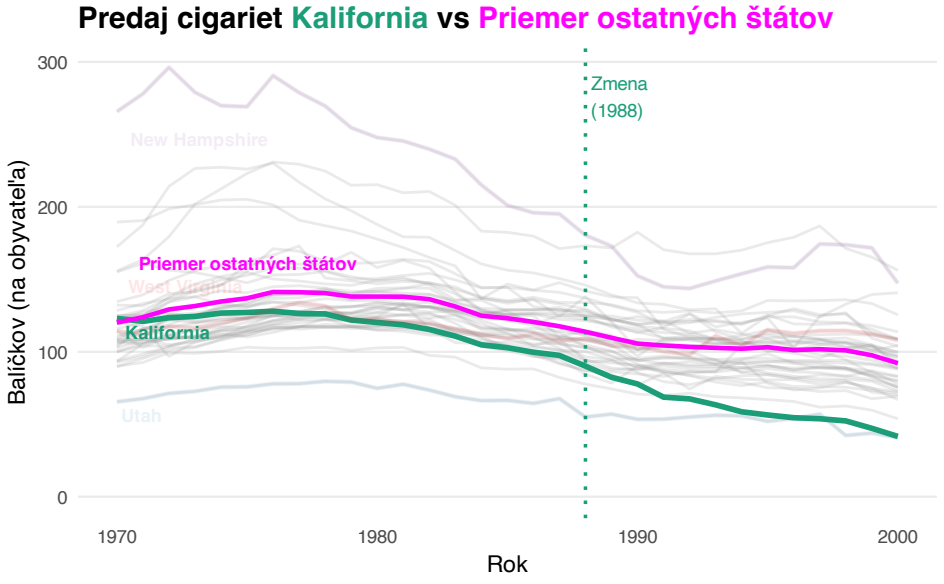

Predaj cigariet Kalifornia vs ostatné štáty
300
200
100
0
Balíčkov (na obyvateľa)
Kalifornia
1970
1980
1990
2000
Rok

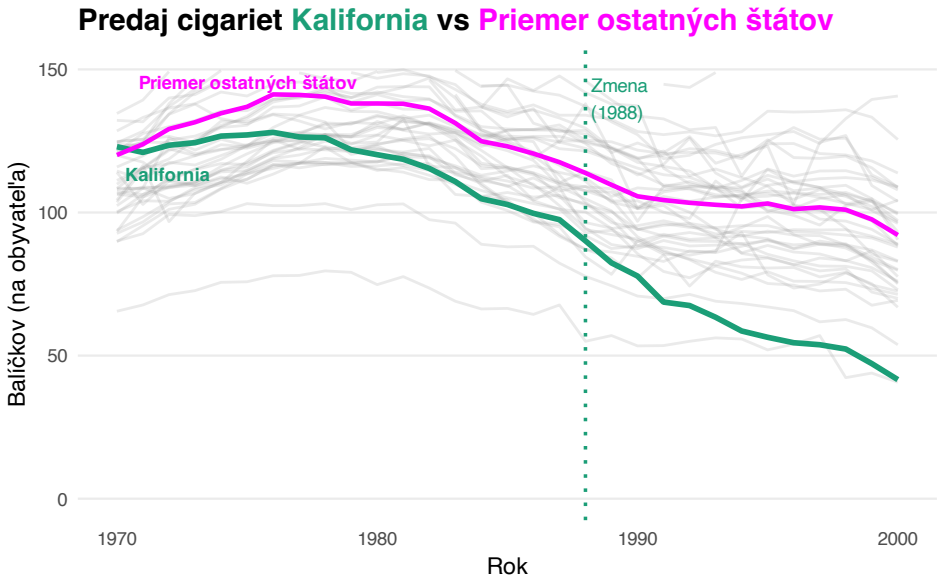

Predaj cigariet Kalifornia vs ostatné štáty
300
200
100
0
Balíčkov (na obyvateľa)
Zmena
(1988)
Kalifornia
1970
1980
1990
2000
Rok


Predaj cigariet Kalifornia vs ostatné štáty
300
200
100
0
Balíčkov (na obyvateľa)
Zmena
(1988)
New Hampshire
Kalifornia
1970
1980
1990
2000
Rok


Predaj cigariet Kalifornia vs ostatné štáty
300
200
100
0
Balíčkov (na obyvateľa)
Zmena
(1988)
New Hampshire
Kalifornia
Utah
1970
1980
1990
2000
Rok

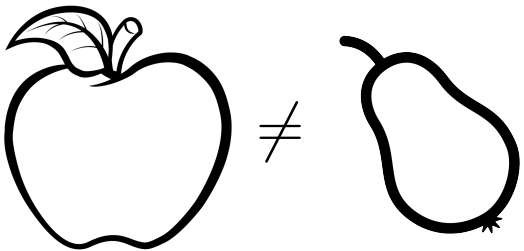

Predaj cigariet Kalifornia vs ostatné štáty
300
200
100
0
Balíčkov (na obyvateľa)
1970
1980
1990
2000
Rok
Zmena
(1988)
New Hampshire
West Virginia
Kalifornia
Utah


Predaj cigariet Kalifornia vs Priemer ostatných štátov
300
200
100
0
Balíčkov (na obyvateľa)
Zmena
(1988)
New Hampshire
Priemer ostatných štátov
West Virginia
Kalifornia
Utah
1970
1980
1990
2000
Rok

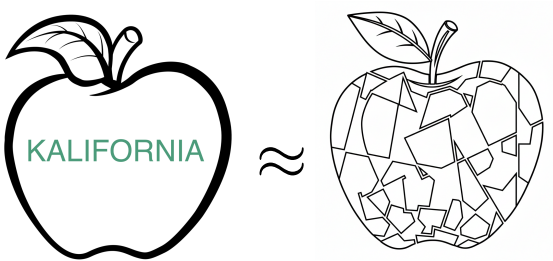

Predaj cigariet Kalifornia vs Priemer ostatných štátov
Priemer ostatných štátov
Kalifornia
Zmena
(1988)
150
100
50
0
Balíčkov (na obyvateľa)
1970
1980
1990
2000
Rok

# Kalifornia je iná ako ostatné štáty

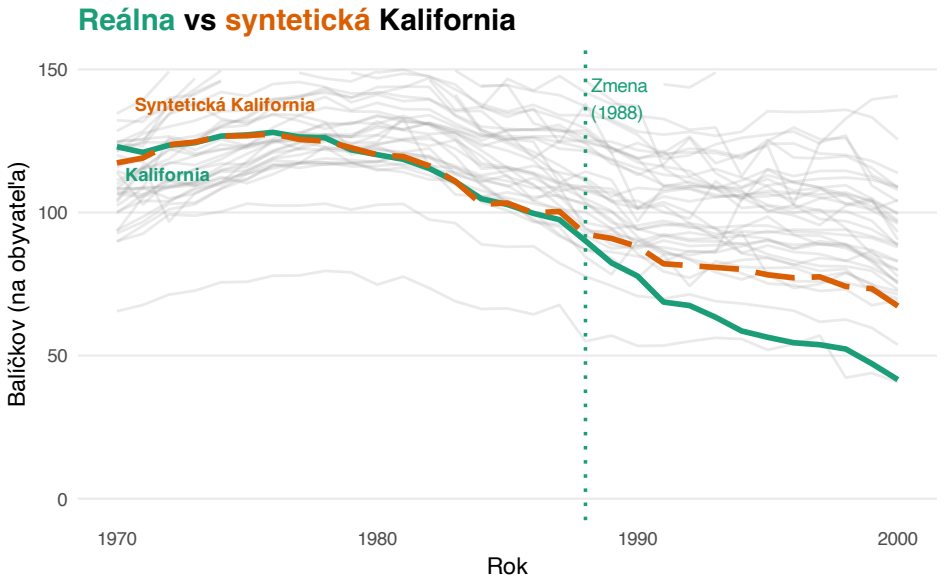
| | California | New Hampshire | Utah | West Virginia | Priemer ostatných štátov |
|---|---|---|---|---|---|
| Cig | 94.6 | 213.1 | 63.8 | 114.4 | 119.5 |
| Príjem | 10.1 | 10.0 | 9.7 | 9.7 | 9.9 |
| Pivo | 22.3 | 33.1 | 13.7 | 20.7 | 23.5 |
| 15–24% | 17.6% | 17.1% | 19.3% | 16.8% | 17.5% |
| Cena | 119.9 | 107.1 | 112.7 | 105.7 | 108.0 |
| Cig 1975 | 127.1 | 269.1 | 75.8 | 123.2 | 136.9 |
| Cig 1980 | 120.2 | 247.8 | 74.8 | 122.3 | 138.1 |
| Cig 1988 | 90.1 | 180.4 | 55.0 | 109.1 | 113.8 |

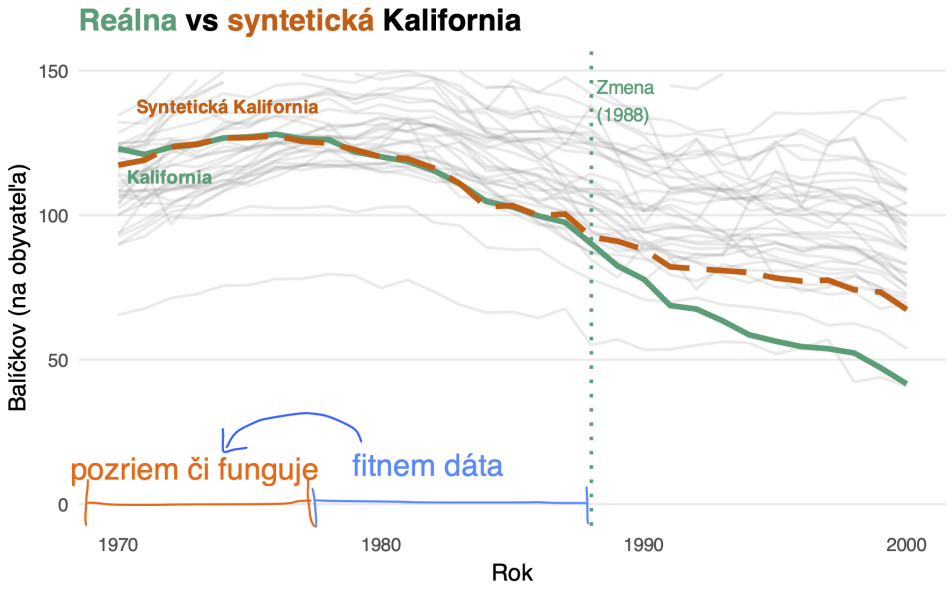


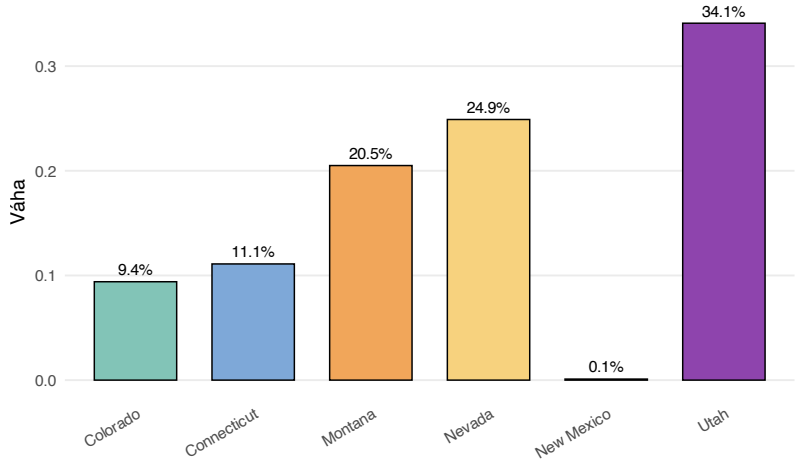

$\approx$ ?



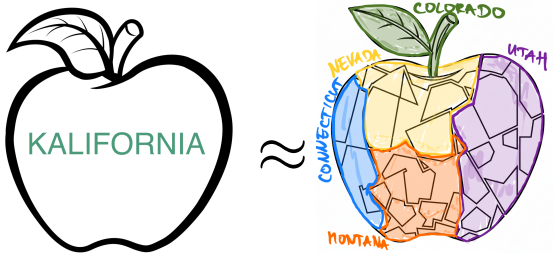

Umelá (syntetická) Kalifornia!


Reálna vs syntetická Kalifornia
150
100
50
0
Balíčkov (na obyvateľa)
Syntetická Kalifornia
Kalifornia
Zmena
(1988)
1970
1980
1990
2000
Rok

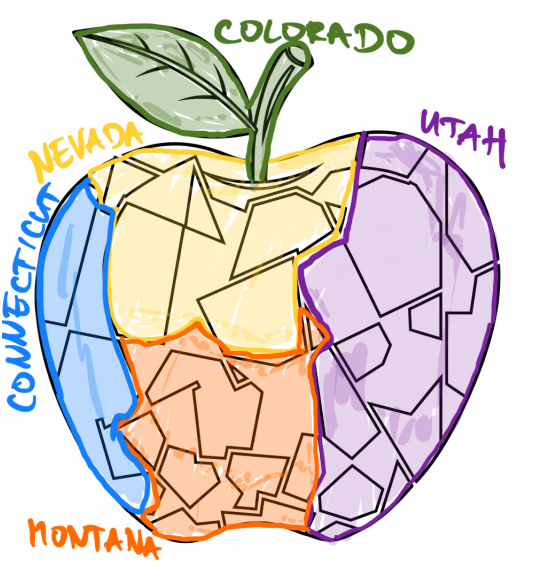

Reálna vs syntetická Kalifornia
150
100
50
0
Balíčkov (na obyvatela)
Syntetická Kalifornia
Kalifornia
Zmena
(1988)
pozriem či funguje
fitnem dáta
1970
1980
1990
2000
Rok




$$\text{Syntetická Kalifornia} = 0.094 \cdot \text{Colorado} + 0.111 \cdot \text{Connecticut} + 0.205 \cdot \text{Montana} + 0.249 \cdot \text{Nevada} + 0.001 \cdot \text{New Mexico} + 0.341 \cdot \text{Utah}$$

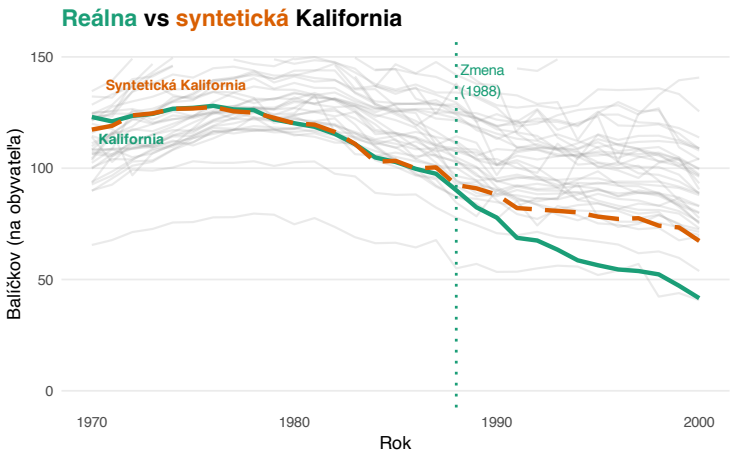


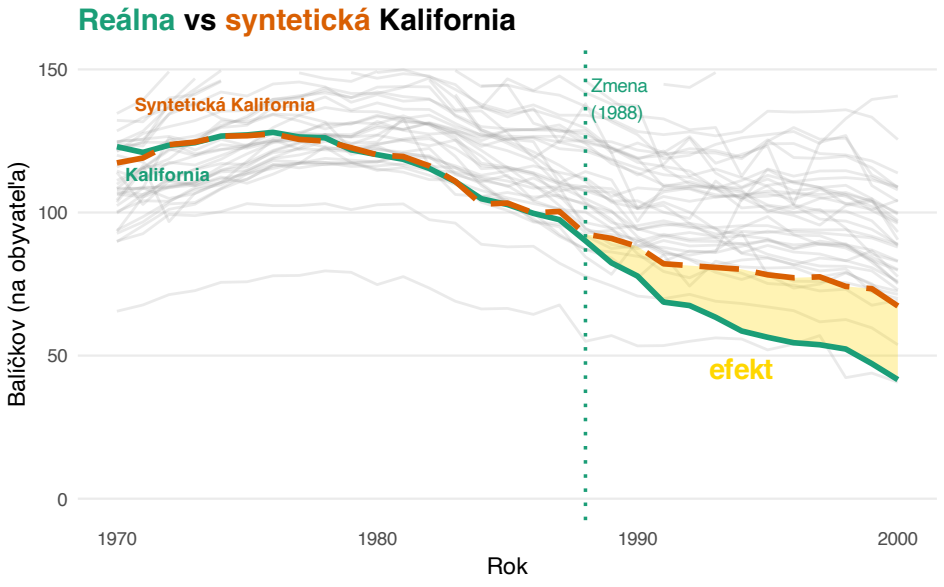

$$\begin{aligned}\text{Syntetická Kalifornia} = {} & 0.094 \cdot \text{Colorado} + 0.111 \cdot \text{Connecticut} + \\ & 0.205 \cdot \text{Montana} + 0.249 \cdot \text{Nevada} + \\ & 0.001 \cdot \text{New Mexico} + 0.341 \cdot \text{Utah}\end{aligned}$$


COLORADO
UTAH
NEVADA
CONNECTICUT
MONTANA

## Váhy syntetickej Kalifornie

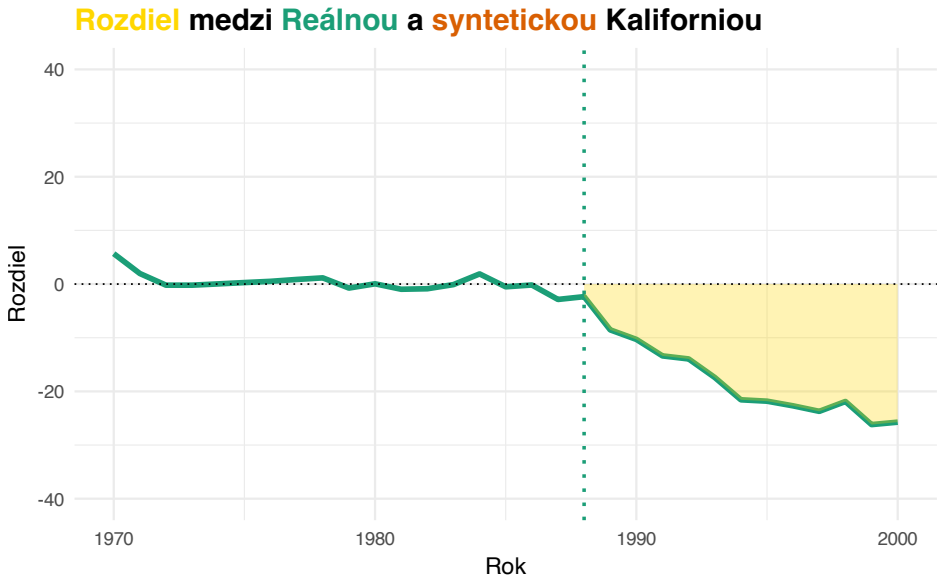
| Štát | Váha | Štát | Váha |
|---|---|---|---|
| Alabama | 0 | Nevada | 0.249 |
| Arkansas | 0 | New Hampshire | 0 |
| Colorado | 0.094 | New Mexico | 0.001 |
| Connecticut | 0.111 | North Carolina | 0 |
| Delaware | 0 | North Dakota | 0 |
| Georgia | 0 | Ohio | 0 |
| Idaho | 0 | Oklahoma | 0 |
| Illinois | 0 | Pennsylvania | 0 |
| Indiana | 0 | Rhode Island | 0 |
| Iowa | 0 | South Carolina | 0 |
| Kansas | 0 | South Dakota | 0 |
| Kentucky | 0 | Tennessee | 0 |
| Louisiana | 0 | Texas | 0 |
| Maine | 0 | Utah | 0.341 |
| Minnesota | 0 | Vermont | 0 |
| Mississippi | 0 | Virginia | 0 |
| Missouri | 0 | West Virginia | 0 |
| Montana | 0.205 | Wisconsin | 0 |
| Nebraska | 0 | Wyoming | 0 |

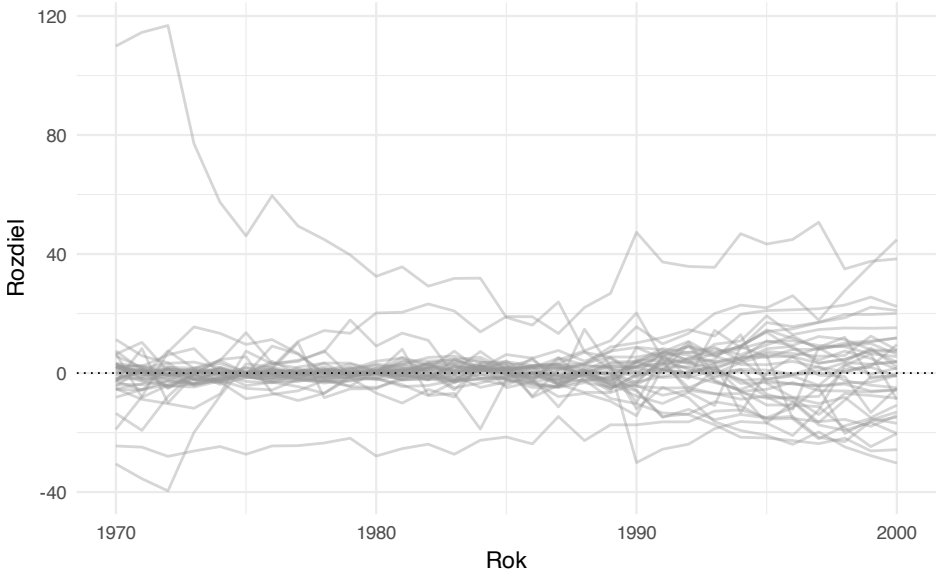


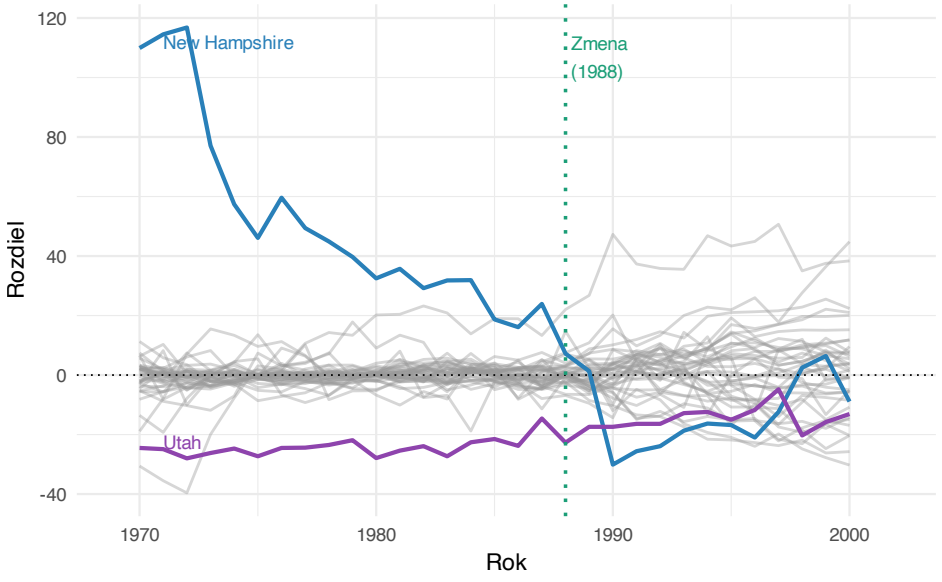

Reálna vs syntetická Kalifornia
150
100
50
0
Balíčkov (na obyvateľa)
Syntetická Kalifornia
Kalifornia
Zmena
(1988)
efekt
1970
1980
1990
2000
Rok

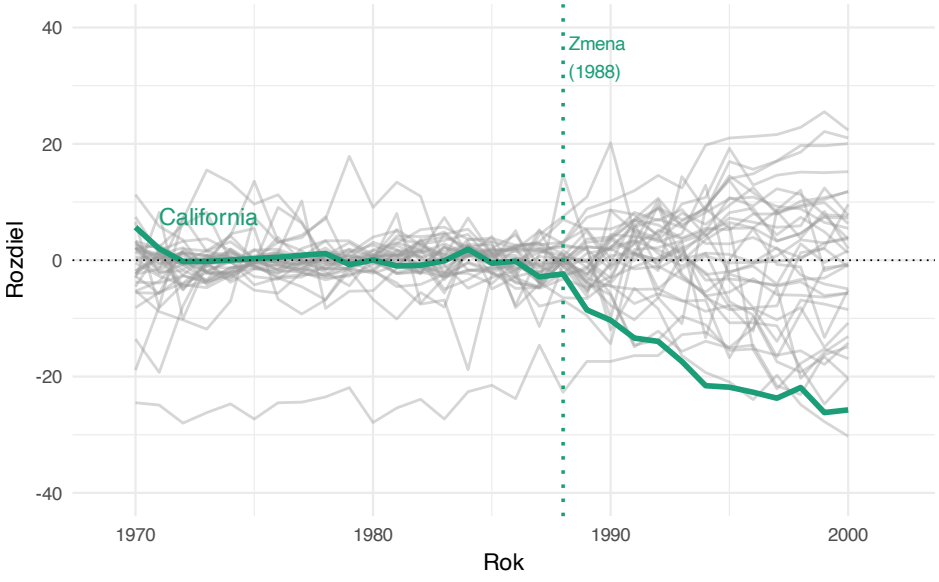
| | California | New Hampshire | Utah | West Virginia | Priemer ostatných štátov | Synthetic Unit |
|---|---|---|---|---|---|---|
| Cig | 116.2 | 247.6 | 71.5 | 118.3 | 130.6 | 116.0 |
| Príjem | 10.0 | 9.9 | 9.7 | 9.6 | 9.8 | 9.8 |
| Pivo | 24.3 | 35.0 | 13.3 | 19.8 | 23.7 | 24.1 |
| 15–24% | 17.9% | 17.4% | 19.5% | 17.0% | 17.8% | 18.0% |
| Cena | 66.6 | 61.0 | 64.2 | 67.9 | 64.5 | 66.1 |
| Cig 1975 | 127.1 | 269.1 | 75.8 | 123.2 | 136.9 | 126.8 |
| Cig 1980 | 120.2 | 247.8 | 74.8 | 122.3 | 138.1 | 120.2 |
| Cig 1988 | 90.1 | 180.4 | 55.0 | 109.1 | 113.8 | 92.4 |

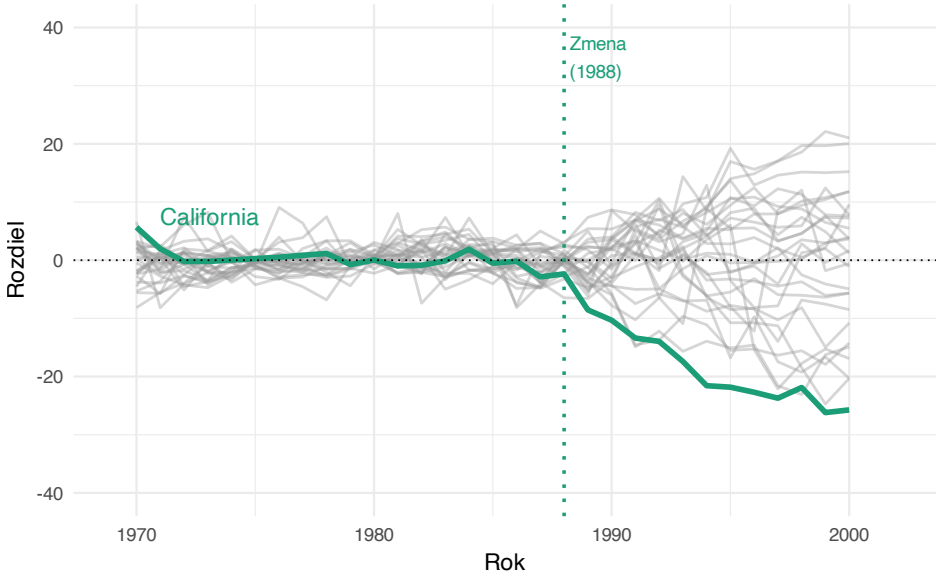
| | California | New Hampshire | Utah | West Virginia | Priemer ostatných štátov | Synthetic Unit |
|---|---|---|---|---|---|---|
| Cig | 116.2 | 247.6 | 71.5 | 118.3 | 130.6 | 116.0 |
| Príjem | 10.0 | 9.9 | 9.7 | 9.6 | 9.8 | 9.8 |
| Pivo | 24.3 | 35.0 | 13.3 | 19.8 | 23.7 | 24.1 |
| 15–24% | 17.9% | 17.4% | 19.5% | 17.0% | 17.8% | 18.0% |
| Cena | 66.6 | 61.0 | 64.2 | 67.9 | 64.5 | 66.1 |
| Cig 1975 | 127.1 | 269.1 | 75.8 | 123.2 | 136.9 | 126.8 |
| Cig 1980 | 120.2 | 247.8 | 74.8 | 122.3 | 138.1 | 120.2 |
| Cig 1988 | 90.1 | 180.4 | 55.0 | 109.1 | 113.8 | 92.4 |


Rozdiel medzi Reálnou a syntetickou Kaliforniou
40
20
0
-20
-40
Rozdiel
1970
1980
1990
2000
Rok


120
80
40
0
-40
Rozdiel
1970
1980
1990
2000
Rok


120
80
40
0
-40
Rozdiel
New Hampshire
Utah
Zmena
(1988)
1970
1980
1990
2000
Rok


40
20
0
-20
-40
Rozdiel
California
Zmena
(1988)
1970
1980
1990
2000
Rok


40
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-20
-40
Rozdiel
California
Zmena
(1988)
1970
1980
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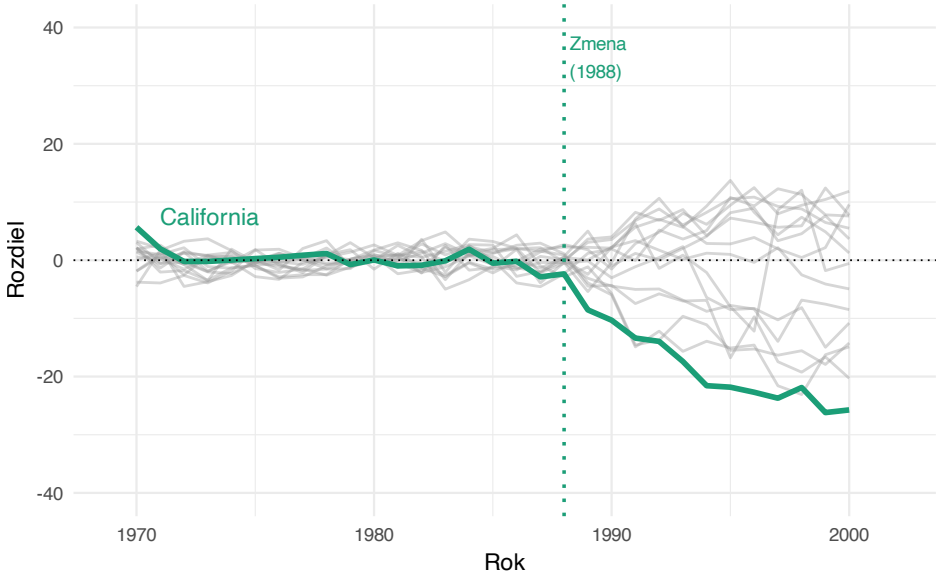
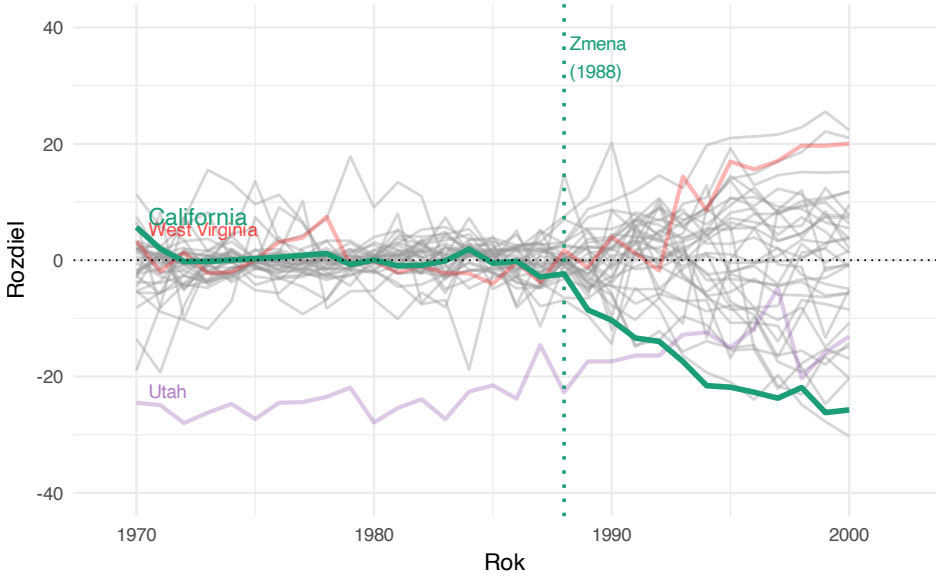
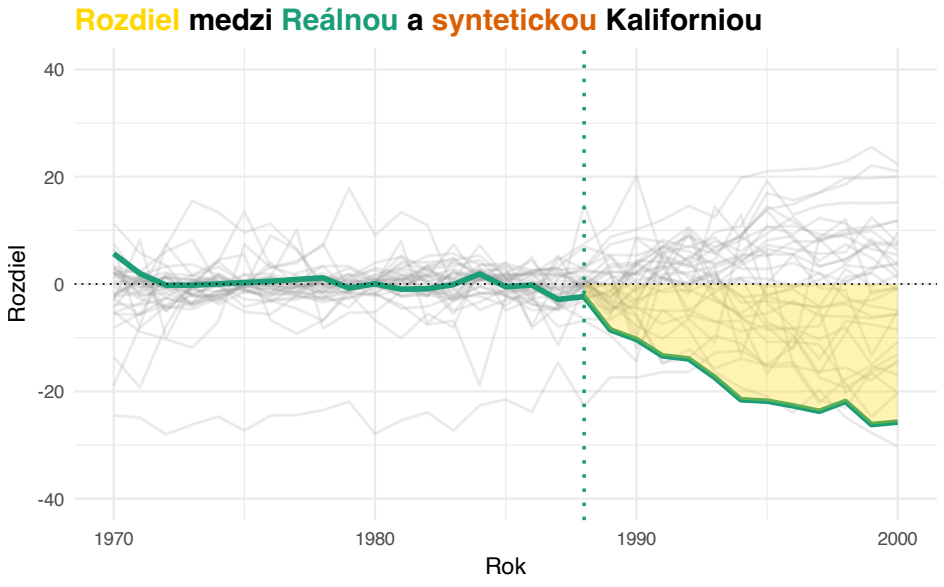
2000
Rok


40
20
0
-20
-40
Rozdiel
California
Zmena
(1988)
1970
1980
1990
2000
Rok


40
20
0
-20
-40
Rozdiel
Zmena
(1988)
California
West Virginia
Utah
1970
1980
1990
2000
Rok


Rozdiel medzi Reálnou a syntetickou Kaliforniou
40
20
0
-20
-40
Rozdiel
1970
1980
1990
2000
Rok

Ako nájsť váhy? Niečo, niečo, matematika.

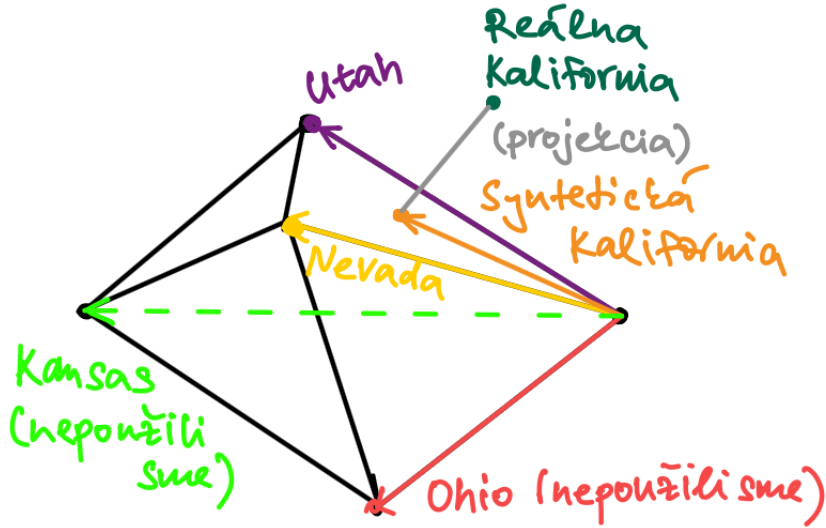
Chceme aby sa Syntetická Kalifornia podobala na Ozajstnú Kaliforniu.

Nájdeme váhy tak, aby

$$\sum_{h=1}^{k} \text{dôležitosť}_h \cdot \left( \underbrace{X_{h1}}_{\text{Ozajská Kalifornia}} - \underbrace{\sum_{j=2}^{J+1} \text{váha}_j \cdot X_{hj}}_{\text{Syntetická Kalifornia}} \right)^2$$

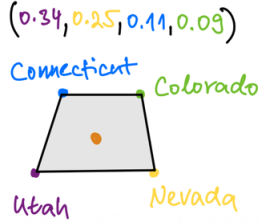
bolo čo najmenšie.

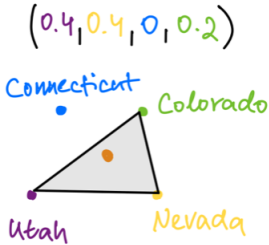
- váha krajiny $j$
- dôležitosť premennej $h$

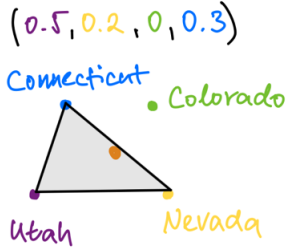



(modifikácia) Abadie (2021)


Connecticut
Colorado
Utah
Nevada


(0.34, 0.25, 0.11, 0.09)
Connecticut
Colorado
Utah
Nevada


(0.4, 0.4, 0, 0.2)
Connecticut
Colorado
Utah
Nevada


(0.5, 0.2, 0, 0.3)
Connecticut
Colorado
Utah
Nevada

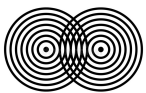
# Veľkosť efektu

- Aký efekt by sme očakávali?
- Ako presne meriame premennú, ktorá nás zaujíma?
- Efekt musí byť **veľký** takže ho nájdeme aj v zašumených dátach

# Očakávania

- Čo ak je zmena očakávaná už skorej?
- Oznámenie zmeny je dôležité, nie implementácia

# Interferencia



- čo ak zmena ovplyvní aj okolité štáty?
- radšej z menšieho počtu ale rozumnejších jednotiek.

# Výhody

- žiadne divoké modelové predpoklady
- váhy sú zromumiteľné
- môžeme zafixovať váhy dopredu!
- sme blízko dát $\rightarrow$ metóda je jednoduchá!

Okrem toho

[dramatická pauza]

Táto metóda je veľmi vizuálna.

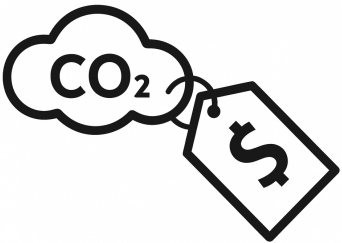
[pauza na smiech]

Vraciame sa k dôležitej otázke:

# Ako urobiť zmysluplné porovnanie?

# Príklady

## Uhlíková daň vo Švédsku




(Andreson, 2019)

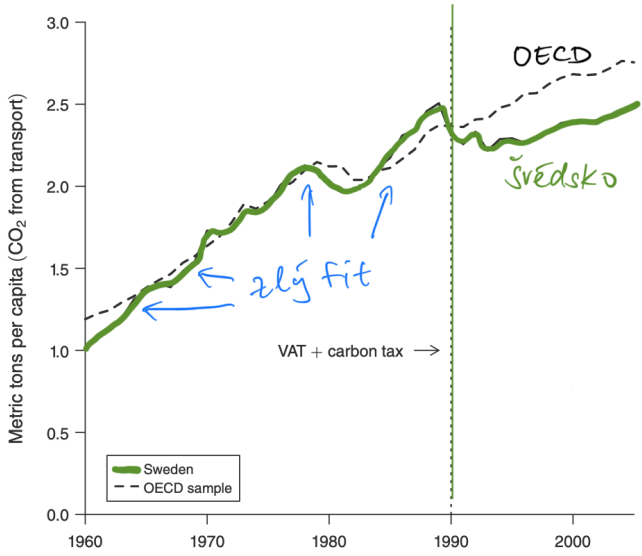
## Euro na Slovensku

(Žúdel a Melioris, 2016)

## Očkovacia lotéria v Ohio

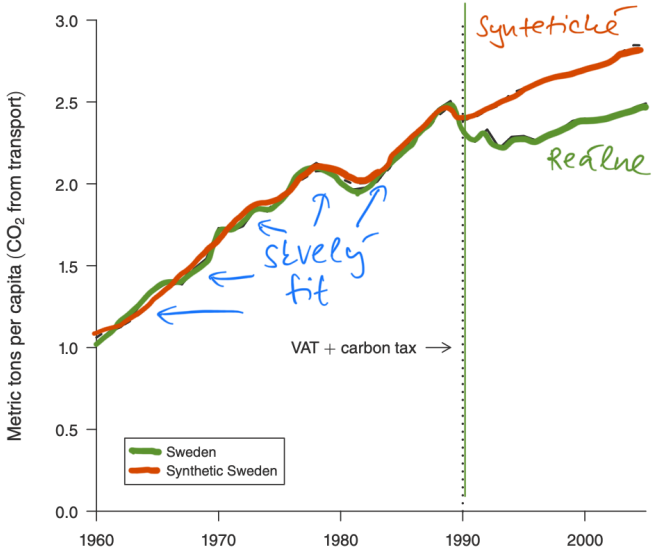
(Lang, Esbenshade a Willer, 2023)

# Príklad 1: Uhlíková daň vo Švédsku




Andrersson (2019)

# Umelohmotné Švédsko



# Skutočné Švédsko vs Umelohmotné Švédsko

| Variables | Sweden | Synth. Sweden | OECD sample |
|---|---|---|---|
| GDP per capita | 20,121.5 | 20,121.2 | 21,277.8 |
| Motor vehicles (per 1,000 people) | 405.6 | 406.2 | 517.5 |
| Gasoline consumption per capita | 456.2 | 406.8 | 678.9 |
| Urban population | 83.1 | 83.1 | 74.1 |
| $CO_2$ from transport per capita 1989 | 2.5 | 2.5 | 3.5 |
| $CO_2$ from transport per capita 1980 | 2.0 | 2.0 | 3.2 |
| $CO_2$ from transport per capita 1970 | 1.7 | 1.7 | 2.8 |

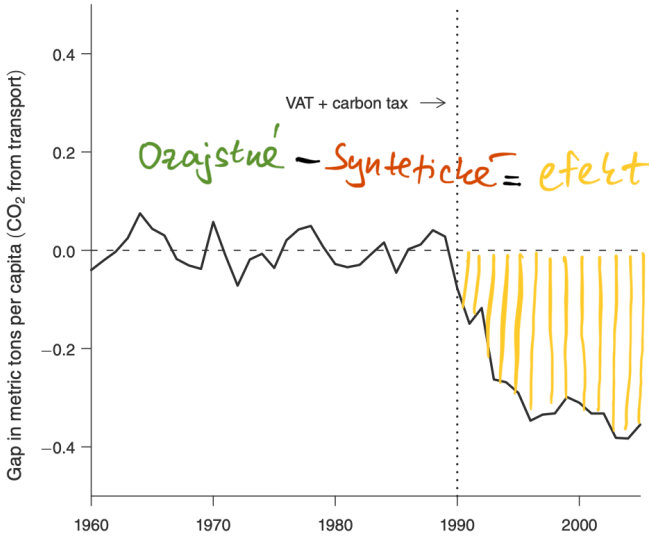
Andrersson (2019)

# Váhy

| Country | Weight | Country | Weight |
|---|---|---|---|
| Australia | 0.001 | Japan | 0 |
| Belgium | 0.195 | New Zealand | 0.177 |
| Canada | 0 | Poland | 0.001 |
| Denmark | 0.384 | Portugal | 0 |
| France | 0 | Spain | 0 |
| Greece | 0.090 | Switzerland | 0.061 |
| Iceland | 0.001 | United States | 0.088 |


Andrersson (2019)

# Efekty


VAT + carbon tax
Ozajstné − Syntetické = efekt
Gap in metric tons per capita ($CO_2$ from transport)
0.4
0.2
0.0
−0.2
−0.4
1960
1970
1980
1990
2000

# Placebo

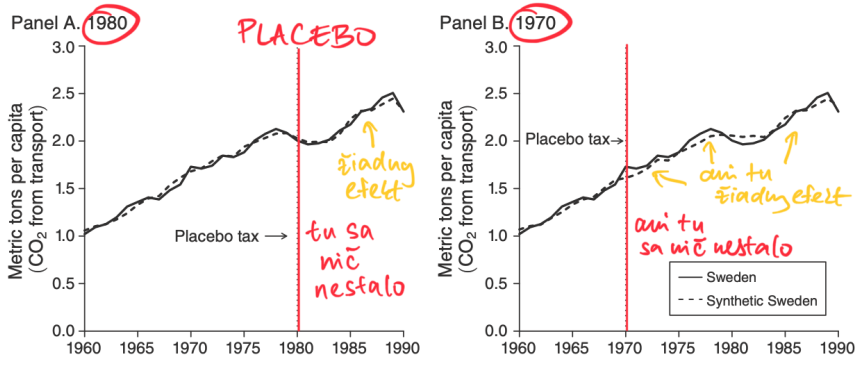
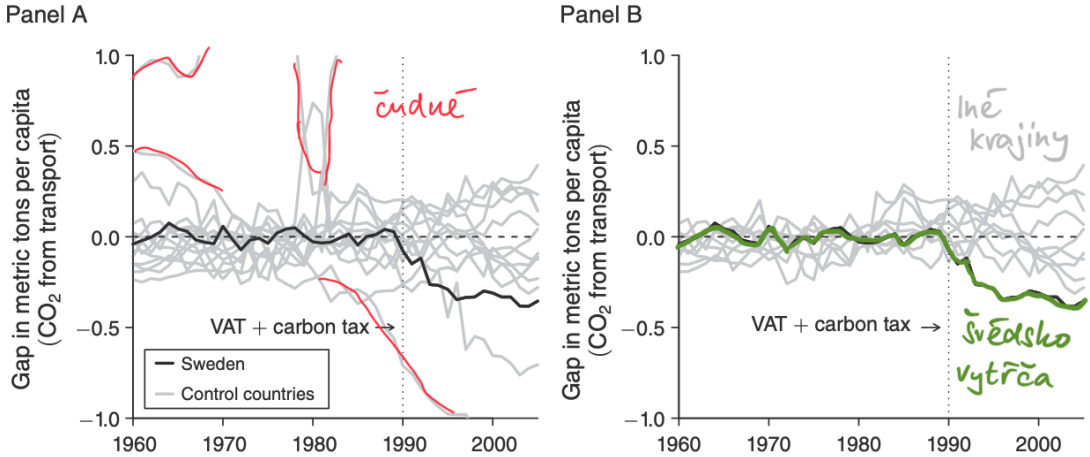


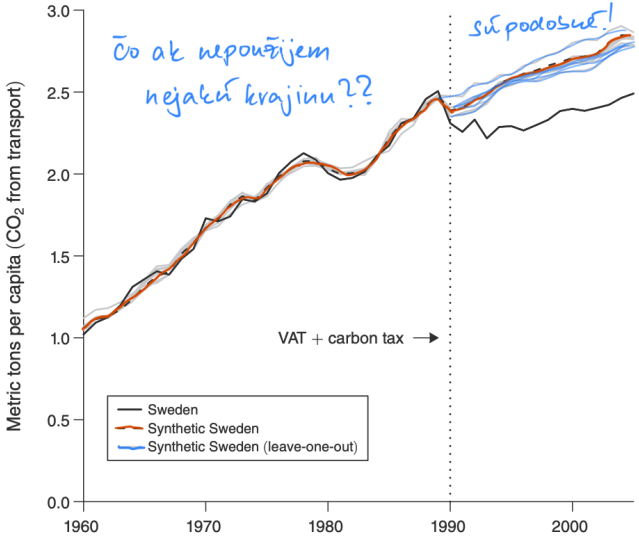

FIGURE 6. PLACEBO IN-TIME TESTS

Andrersson (2019)

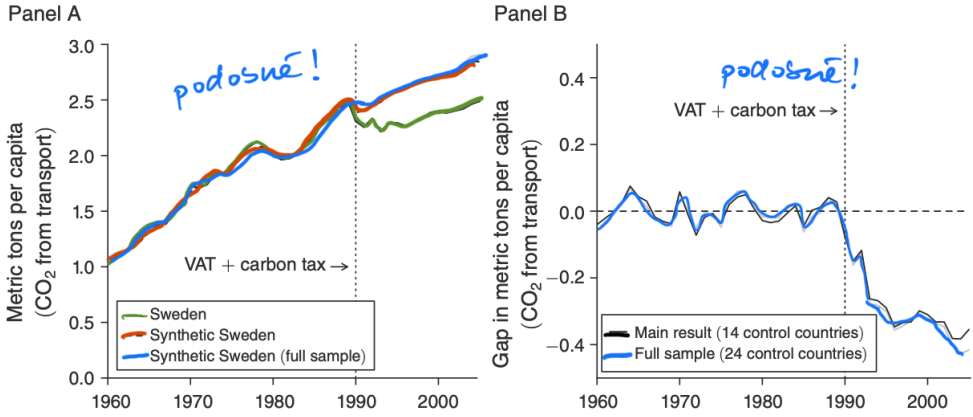



Andrersson (2019)

# Robustnosť


Čo ak nepoužijem nejaku krajinu??
sú podobné!
Metric tons per capita ($CO_2$ from transport)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1960
1970
1980
1990
2000
VAT + carbon tax
Sweden
Synthetic Sweden
Synthetic Sweden (leave-one-out)

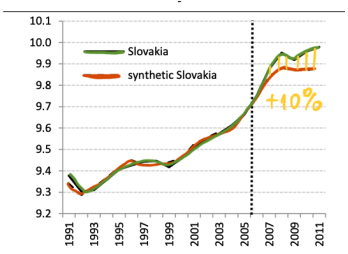
# Robustnosť (zasa)

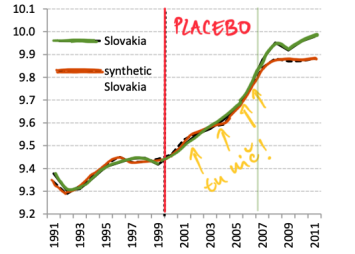


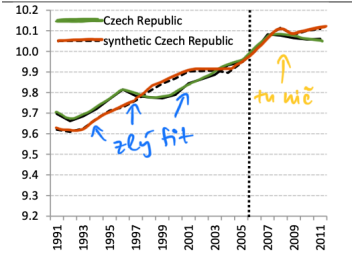

Andrersson (2019)

# Euro na Slovensku

# Euro na Slovensku (2006 - vstup do ERM II)



# Ohio - vakcinačná lotéria

*Journal of Experimental Political Science* (2023), **10**, 242–260
doi:10.1017/XPS.2021.32

CAMBRIDGE UNIVERSITY PRESS

RESEARCH ARTICLE

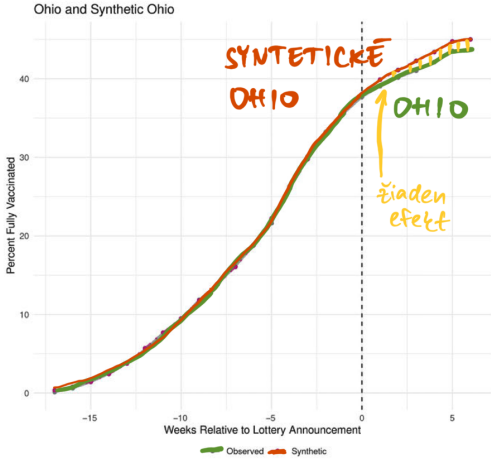
# Did Ohio's Vaccine Lottery Increase Vaccination Rates? A Pre-Registered, Synthetic Control Study

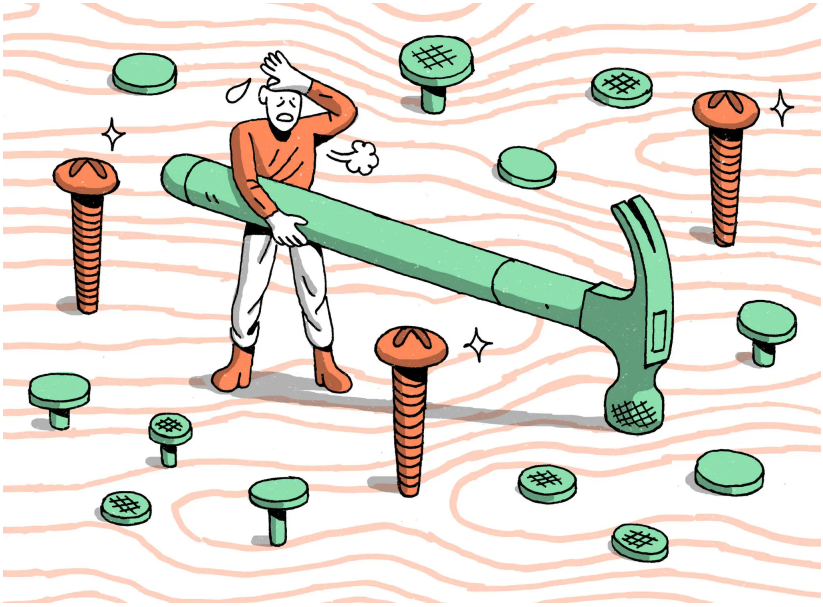
David Lang[1]*, Lief Esbenshade[2] and Robb Willer[3]

[1]Graduate School of Education, Stanford University, Stanford, CA, USA. Twitter: @DavidnLang, [2]Graduate School of Education, Stanford University, Stanford, CA, USA. Twitter: @liefEsbenshade and [3]Stanford University, Stanford, CA, USA. Twitter: @RobbWiller
*Corresponding author. Email: dnlang86@stanford.edu

**Abstract**

Overcoming vaccine hesitancy is critical to containing the COVID-19 pandemic in the United States. To increase vaccination rates, the State of Ohio launched a million dollar lottery in May 2021. Following a pre-registered analysis, we estimate the effects of Ohio's lottery program *Vax-a-Million* on COVID-19 vaccination rates by comparing it to a "synthetic control" composed of eight other states. We find a statistically insignificant 1.3% decrease in the full vaccination rate in Ohio at the end of the lottery period. We investigate the robustness of our conclusion to model specifications through a multiverse analysis of 216 possible models, including longer time periods and alternative vaccination measures. The majority (88%) find small negative effects in line with the results of our pre-registered model. While our results are most consistent with a decrease in vaccination rate, they do not allow a firm conclusion on whether the lottery increased or decreased vaccine uptake.





Wren McDonald (NY Times)



Guo, Jeff. 2015. "Seriously, Here's One Amazing Math Trick to Learn What Can't Be Known." Washington Post, October 30.

Douglas, Jason. 2018. "How an Analysis of Basque Terrorism Helps Economists Understand Brexit." WallStreet Journal, November 7.

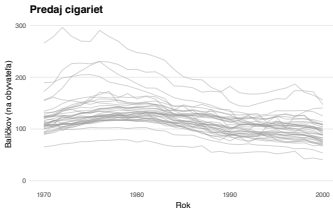
# Synthetic Control Method

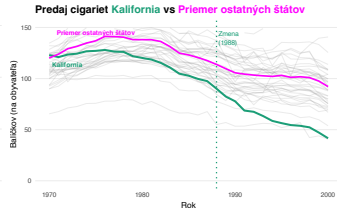
- Alberto Abadie (MIT Economics)
- spolu s Javier Gardeazabal v roku 2003

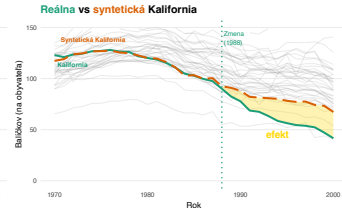
# Zhrnutie

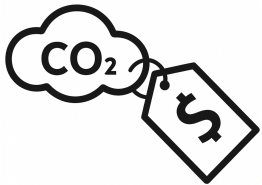

KALIFORNIA

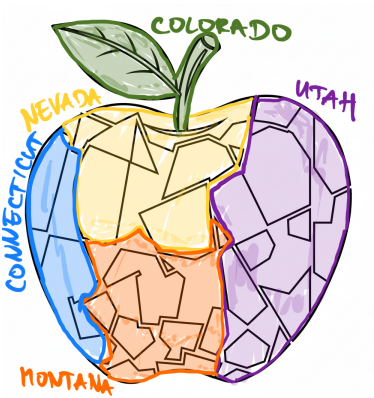

KALIFORNIA

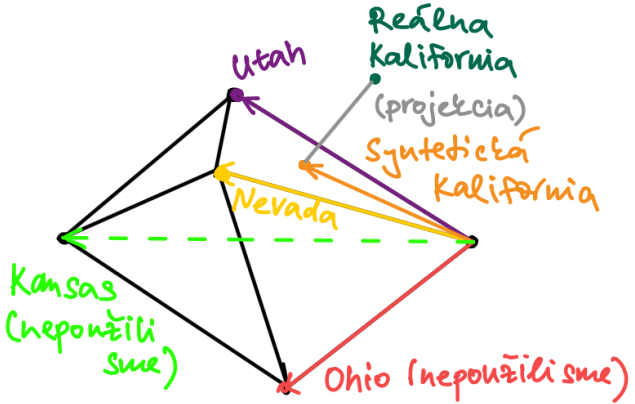

Predaj cigariet
Balíčkov (na obyvateľa)
300
200
100
0
1970
1980
1990
2000
Rok


Predaj cigariet Kalifornia vs Priemer ostatných štátov
Priemer ostatných štátov
Kalifornia
Zmena
(1988)
Balíčkov (na obyvateľa)
150
100
50
0
1970
1980
1990
2000
Rok


Reálna vs syntetická Kalifornia
Syntetická Kalifornia
Kalifornia
Zmena
(1988)
efekt
Balíčkov (na obyvateľa)
150
100
50
0
1970
1980
1990
2000
Rok


CO2
$




Ďakujem za pozornosť. lukaslaffers.github.io #UMBmath