Econometrics

Synthetic Control

Paul P. Momtaz

The Anderson School
UCLA

Motivation

Idea:

When few treated and controls, construct weighted combination of potential controls to approximate most relevant characteristics of treated

Example: Abadie and Gardeazabal, AER, 2003.

Motivation

Abadie and Gardeazabal (2003)

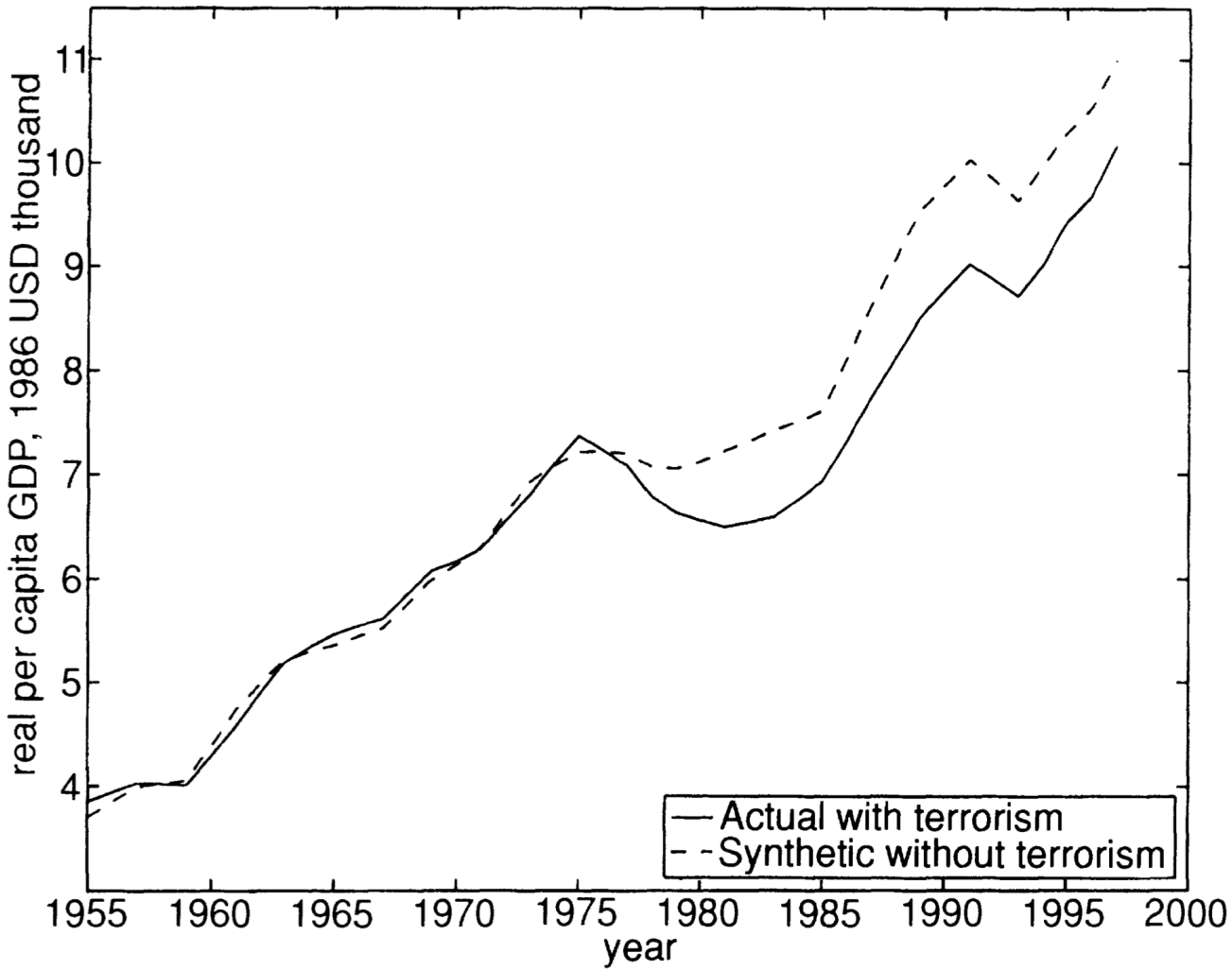

FIGURE 1. PER CAPITA GDP FOR THE BASQUE COUNTRY

Motivation

Abadie and Gardeazabal (2003)

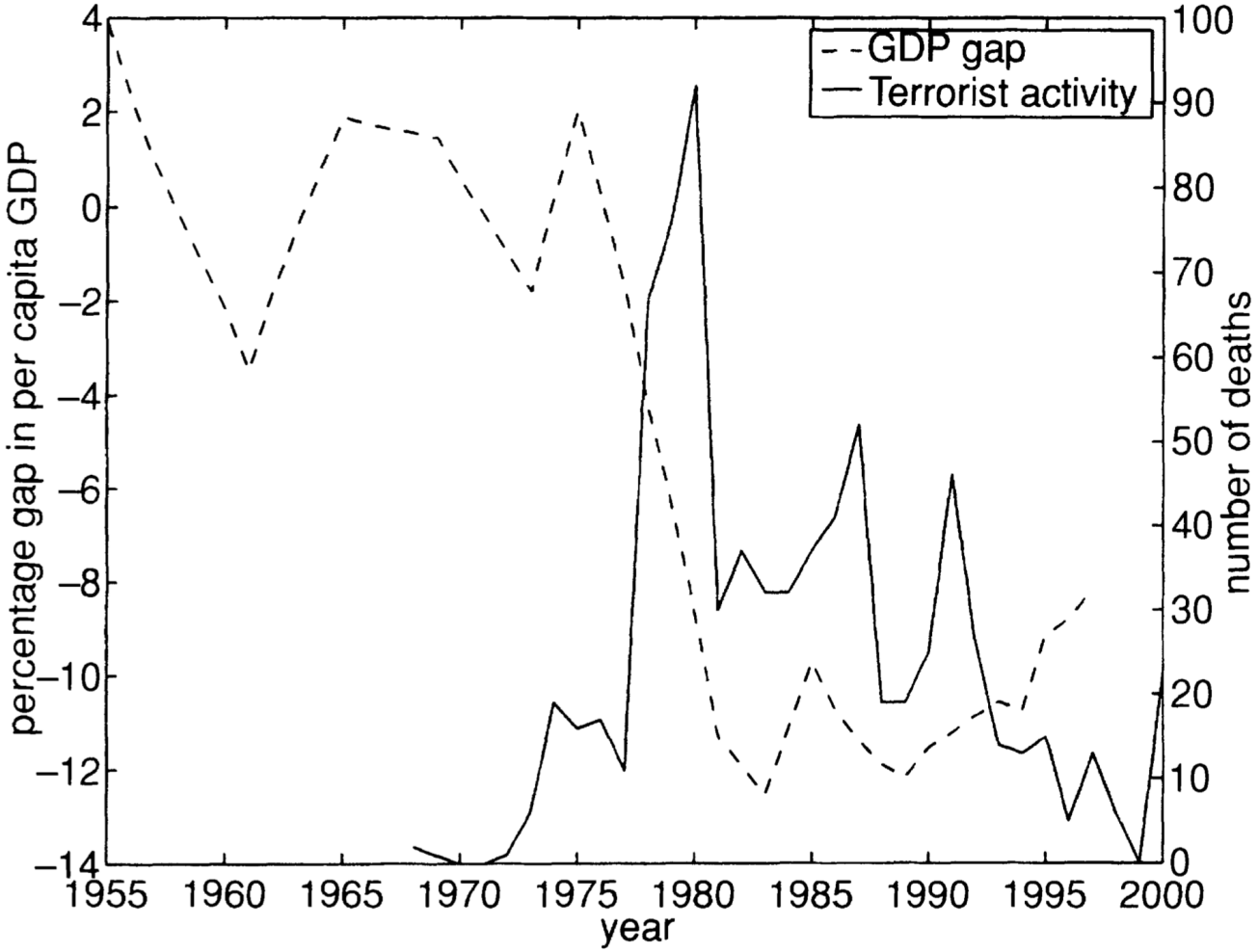

FIGURE 2. TERRORIST ACTIVITY AND ESTIMATED GAP

Motivation

Abadie and Gardeazabal (2003)

TABLE 3—PRE-TERRORISM CHARACTERISTICS, 1960'S

	Basque Country (1)	Spain (2)	"Synthetic" Basque Country (3)
Real per capita GDP[a]	5,285.46	3,633.25	5,270.80
Investment ratio (percentage)[b]	24.65	21.79	21.58
Population density[c]	246.89	66.34	196.28
Sectoral shares (percentage)[d]			
Agriculture, forestry, and fishing	6.84	16.34	6.18
Energy and water	4.11	4.32	2.76
Industry	45.08	26.60	37.64
Construction and engineering	6.15	7.25	6.96
Marketable services	33.75	38.53	41.10
Nonmarketable services	4.07	6.97	5.37
Human capital (percentage)[e]			
Illiterates	3.32	11.66	7.65
Primary or without studies	85.97	80.15	82.33
High school	7.46	5.49	6.92
More than high school	3.26	2.70	3.10

Sources: Authors' computations from Matilde Mas et al. (1998) and Fundación BBV (1999).

[a] 1986 USD, average for 1960–1969.

[b] Gross Total Investment/GDP, average for 1964–1969.

[c] Persons per square kilometer, 1969.

[d] Percentages over total production, 1961–1969.

[e] Percentages over working-age population, 1964–1969.

Construction of the Synthetic Control

$$W^* = \arg\min_W (X_1 - X_0 W)' V (X_1 - X_0 W)$$

where

- w is $y \times 1$ for y controls
- x_1 is $u \times 1$ for pre-treatment values of outcome predictors for treated
- x_o is $u \times y$ of pre-treatment values of outcome predictors for y controls
- V is diagonal matrix with relative importance of outcome predictors
- w^* defines combination of controls into synthetic control.

Weighting of Characteristics

V can be based on prior knowledge or

$$V^* = \arg\min_V (Z_1 - Z_0 W^*(V)'(Z_1 - Z_0 W^*(V))$$

Where

- z_1 is $v \times 1$ of outcome variables for treated pre-treatment
- z_0 is $v \times J$ of outcome variables for control pre-treatment

Pre-treatment outcome path

Synthetic control should be chosen by pre-treatment outcome path of **only the treatment unit**

$$W^* = \arg\min_W (Z_1 - Z_0 W)'(Z_1 - Z_0 W)$$

Placebo Study

Idea:

- Compare outcome of control unit that is similar to treated but did not receive treatment to synthetic version of other control units
- do placebo study for all controls
- can restrict donor pool (e.g., to geographic regions)

See Abadie Diamond Hainmueller (2010)