

Rudrajit Dey
Jeff Thurk
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Introduction:

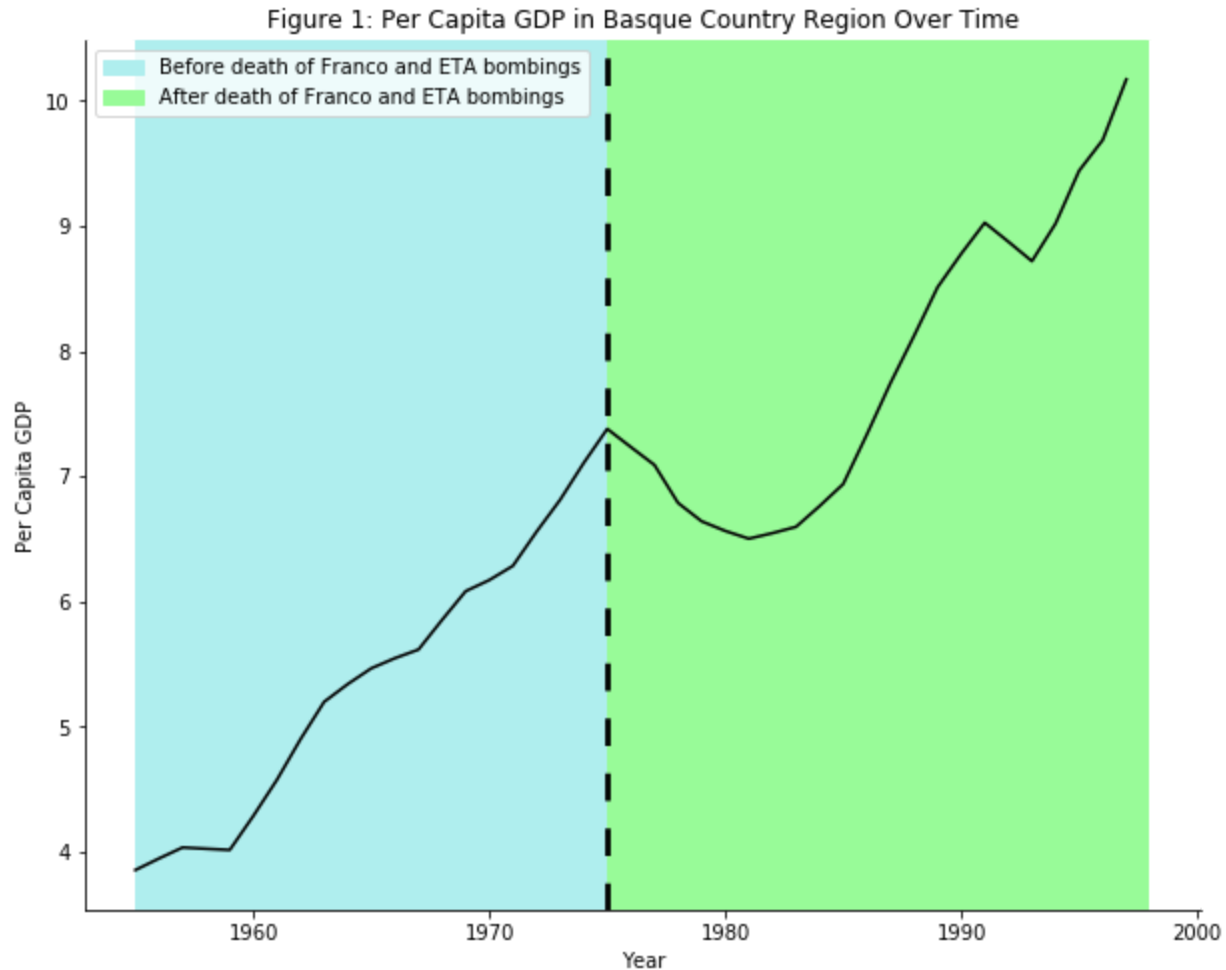
ETA, an armed leftist nationalist and separatist organization that originated in Spain's Basque region, launched the region into pandemonium with a series of bombings after the death of Francisco Franco around 1975. This series of bombings allows the Basque Country to be used as a treatment region to see how terrorism affects the economy, specifically the GDP per capita of the region. The other regions of Spain can be used as a control, with the underlying assumption that unlike other economic shocks, the effects of terrorism can be limited to the Basque region without impacting the other regions.

Objective: Determine the causal impact of terrorism by ETA on the per capita GDP of the Basque Country region of Spain.

Exploratory Data Analysis:

Figure 1 shows the general trend of the per capita GDP of the Basque Country. The trend plunges right after the terrorist bombings around 1975, and then starts increases back up. After constructing a first difference equation by having GDP per capita as the dependent variable and the period indicator (before and after the terrorist interventions) as the independent variable, we can see that the average per capita GDP increases by 2.48449 units after the 1975 terrorist interventions (refer to Table 2).

This shows an expected problem: there are many confounding variables that could have affected the per capita GDP other than the terrorist bombings. To solve for this problem, the Basque Country per capita GDP must be compared to a control region that wasn't affected by the bombings. The comparison, using the difference-in-differences method, removes the confounding effects after the terrorist intervention period and arrive at the real causal impact of the bombings.



Difference-in-Differences:

The assumption under the DiD model is that the trend of the control group provides an adequate proxy for the trend that would have been observed in the treatment group (Basque country) in absence of the treatment (ETA bombings). As such, the difference in the change in slope would be the actual treatment effect.

For this analysis the control region was selected using two requirements:

1. High correlation between the control region's per capita GDP and the per capita GDP of the Basque country before 1975.
2. The control region is not located close to the Basque region. This is based on the assumption that the Basque region bombings did not affect the control region.

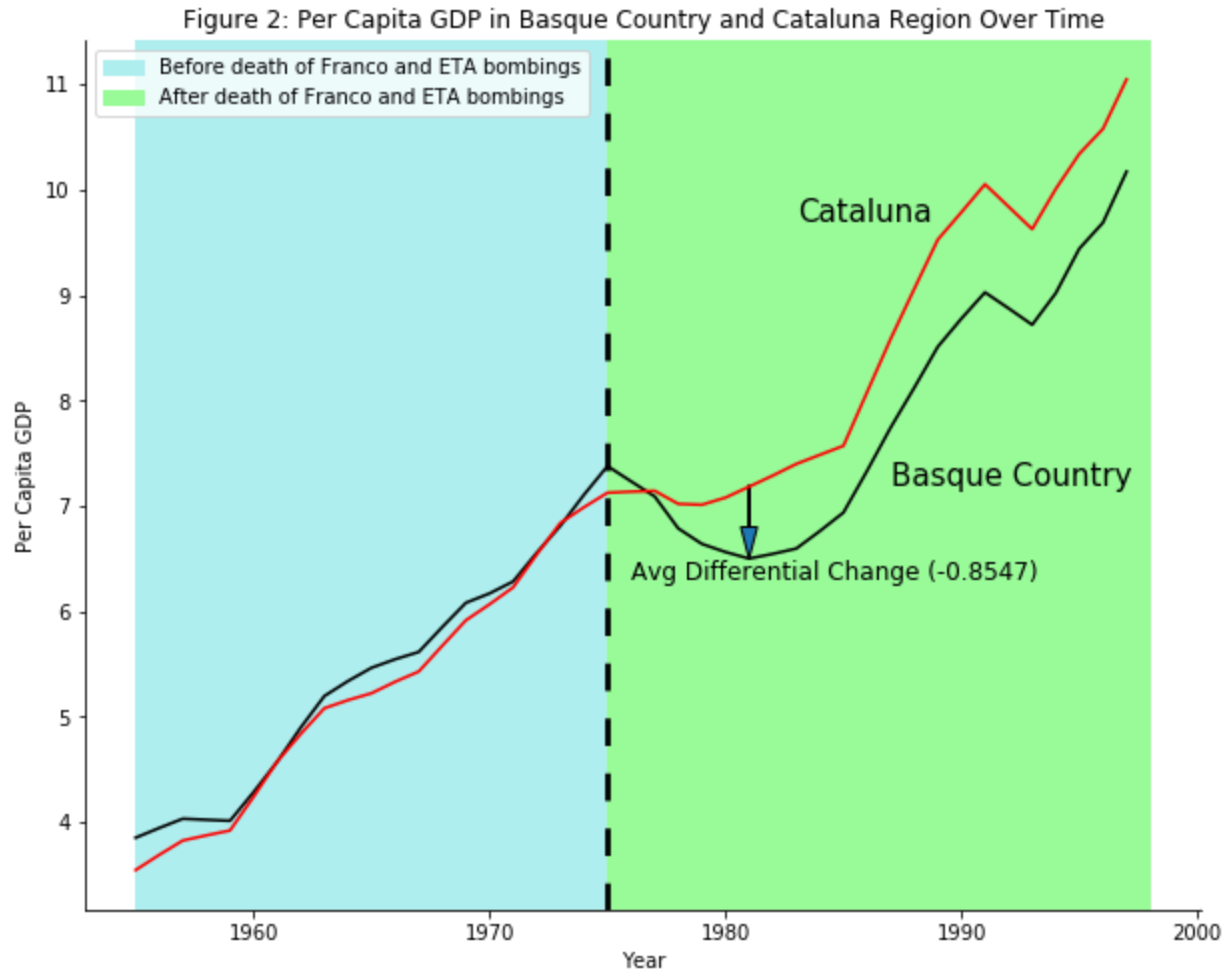
Using these criteria, it was found that Catalonia is the best control region to be used in the DiD model. Refer to Table 1 to see correlation in per capita GDP between the Basque region and the other Spanish regions. Catalonia and Aragon both have very high correlation in per capita GDP with the Basque region, however Catalonia is farther away from the Basque region than Aragon, and as such fits better as the control given the second criteria.

Looking at the coefficient of estimate for the interaction between the treatment and period variables (refer to Table 2 Second Difference-in-Differences parameter estimates), the per capita

GDP in the Basque Country reduced by 0.8547 because of the terrorist intervention. The average per capita GDP decreased by 0.8547 from before the bombings to after the bombings in the Basque country, relative to the Cataluna region.

Table 1: Per Capita GDP Correlation Table between Basque Region and other Spanish regions

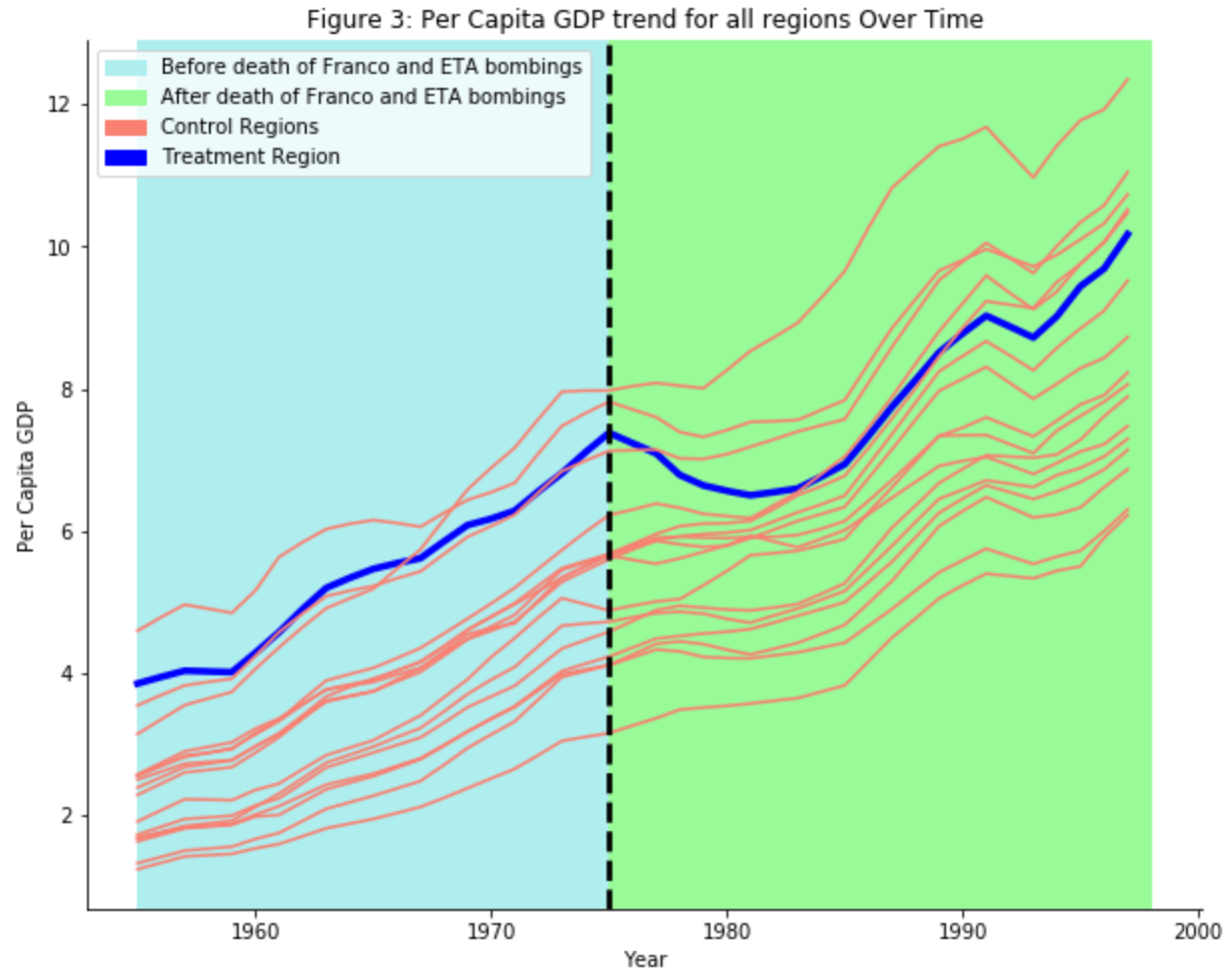
Basque_gdp	1.000000
Aragon_gdp	0.997043
Cataluna_gdp	0.996830
Navarra_gdp	0.996262
Rioja_gdp	0.995469
Asturias_gdp	0.995289
Cantabria_gdp	0.995258
Castilla_Y_Leon_gdp	0.992800
Murcia_gdp	0.991812
Valencia_gdp	0.991300
Madrid_gdp	0.988504
Baleares_gdp	0.987941
Andalucia_gdp	0.987689
Galicia_gdp	0.984275
Extremadura_gdp	0.984099
Castilla_La_Mancha_gdp	0.981486
Canarias_gdp	0.975647



Synthetic Difference-in-Differences:

The synthetic control group is constructed using a convex combination of all the other regions in Spain. The synthetic control group model works similar to the DiD by giving an idea of what the trend would like if the treatment hadn't occurred. Since the synthetic control group is constructed using all the other regions, it is important to look at the trend for all the 'control' regions. Figure 3 shows that all the regions have a similar upward trend in GDP per capita as the Basque country in the pre period. This suggests that the GDP per capita of the Basque country could be constructed relatively accurately using the data from the other regions.

Figure 4 shows how similar the trend is between the synthetic control group and the actual treatment group in the pre period, and how it deviates gradually once the treatment (ETA bombings) happens. The difference in the trends as shown in Figure 4 and Table 4 Synthetic Control group parameter estimates is the average treatment effect. We can conclude that the true causal impact of the terrorist bombings is a reduction of the GDP per capita of the Basque Country by 0.664477 on average in the post period.



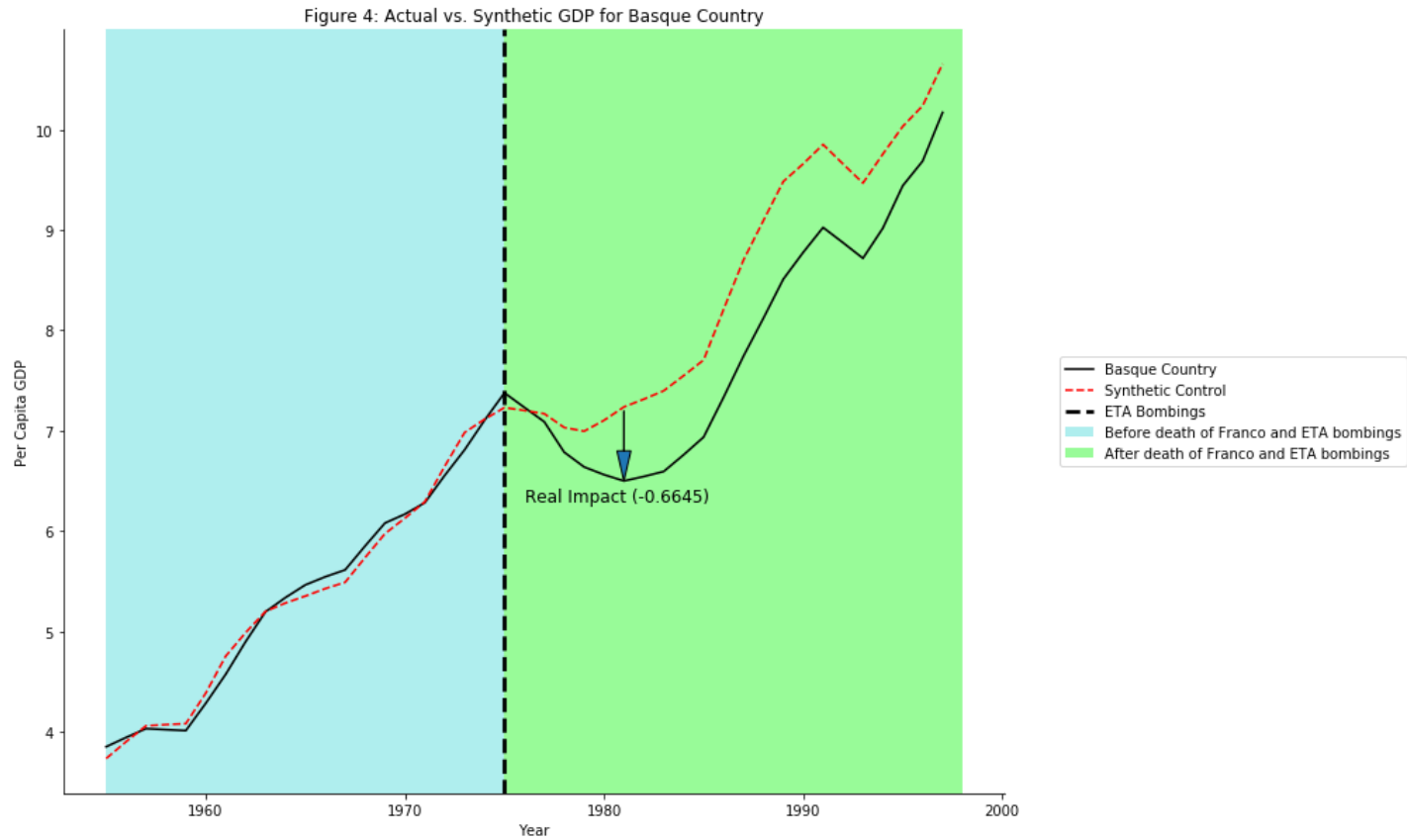


Table 2: Coefficient estimates for per capita GDP of the Basque region

	First-Difference Regression	Difference-in-Differences Regression	Synthetic Difference-in-Differences
period	2.484449	3.339185	3.148926
treatment	NaN	0.138678	0.007987
period:treatment	NaN	-0.854736	-0.664477