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# The impact of military downsizing on two Italian communities: a counterfactual approach using the Synthetic Control method

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# The impact of military downsizing on two Italian communities: a counterfactual approach using the Synthetic Control method

In this paper we propose a quasi-experimental approach to assess the effect that a downsizing of the largest experimental military base in Europe, located in Sardinia, Italy, had on local economies. The study shows the fruitfulness of the Synthetic Control method for assessment of socio-economic impacts on a single treated unit, when other standard methods for impact evaluation are not feasible. It is shown that the local communities analysed have been characterised by different level of frailty, which should be attentively considered if further downsizing of the base will be placed on the political agenda.

Keywords: military downsizing; local economic impacts; counterfactual methods; synthetic control

JEL: H43, O22, R53, R58

## 1. Introduction

The European defence sector has undergone substantial changes after the end of the Cold War in 1989. The geography of military spending, including the location of defence-related facilities, has been transformed (Camerin and Gastaldi 2018), and a process of demilitarization has taken place, due to technological development, budgetary cuts, changes in the geopolitical context and in the international strategic and logistic framework (Bagaeen 2006; Simion-Melinte 2012; Hercik et al. 2014; Kádár 2014; Fabris and Camerin 2017). The process of defence restructuring was anticipated overseas, with the "Base Realignment and Closure Act" (BRAC) of 1988, which caused the closure of over one hundred military facilities across the United States (Cidell 2003), in response to the need of more efficient public spending. Other BRAC rounds followed in 1991, 1993, 1995 and 2005, so that more than 350 military installations have been closed in the process (Lee

2018). In Europe, the defence personnel (military and civilian) has been steadily reduced in the last two decades, mainly because of internal restructuring processes (see Dubois-Maury [1998] for France; Doak [1999] for the UK; Brandis [2005] for Spain). In the period 2006-16, the total defence personnel in Europe decreased by over 23%, with 112 thousand civilian and 423 thousand military personnel cutbacks (European Defence Agency 2018).

In a public welfare perspective such a process does not come without social costs. A military installation may have a significant economic and social impact on the community in which it is located (Kriesel and Gilbreath 1994; Woodward 2014), just as any other large industry. Thus, the local communities often oppose the loss of such facilities, especially if the local economy has become directly dependent on the military sector. This is the reason why the European Commission, since the early 1990s, launched some initiatives[1] (such as KONVER, RECITE and Demilitarized Network) in order to 'help the process of economic adjustment in defence-dependent regions (...) and to investigate best practices of conversion' (Jauhiainen et al. 1999).

Yet, as shown in the extensive review by Droff and Paloyo (2015), the evidence on the impact of military downsizing on regional and local economies is not so clear: cases are reported where the estimated impact of shutting down military installations was devastating for the economies of their respective regions in Texas and New Mexico (Soden, Schauer, and Conary 2005); other studies, though, reach less dramatic conclusions. In a research dealing with military downsizing in California, Dardia et al. (1996) found that 'while some of the communities did indeed suffer, the effects were not catastrophic' and 'not nearly as

1 A review of European funded projects for regeneration of military sites in Italy can be found in Camerin (2017).

severe as forecasted', a result that was later confirmed by Bradshaw (1999). Further studies, such as Hooker and Knetter (2001), Poppert and Herzog (2003) and Lee (2018) in the US, Andersson et al. (2007) in Sweden, Paloyo, Vance and Vorell (2010) in Germany, did not find significant socio-economic impacts on the local communities after closures or downsizing of military bases. A military base closure in certain situations might even trigger new development opportunities, creating more jobs and income than in the preceding military dependent economy (Hansen 2004; Bagaeen 2006). In Zimmer (2004) and Overbeck (1999) it is reported that US military closures in 1992 compelled the Philippines to find alternative solutions for economic development, so that the loss of about 14,000 jobs for domestic employees and an annual volume of spending of about $700 million by the US forces was eventually more than compensated. Accordingly, the response to a downsizing of a military base can be quite heterogeneous. As pointed out by the Commission of the European Communities (1992) on European regions' dependence on defence activities, the capacity of a local economy to react positively to defence cutbacks is related to the level of frailty (i.e. dependence on the military facility) of the local economy.

In practice, ad-hoc case analysis is needed to evaluate the social impact of military downsizing and to assess the frailty level of the community (Markusen and Brzoska 2000; Cidell 2003). But, as emphasized by Droff and Paloyo (2015), such assessment should be based on rigorous methods and analysis of the data. As a matter of fact, lack of good data is a major hinder to the application of econometric methods: firstly, because data on the military economy are more difficult to obtain due to security issues; secondly, because data at local (county, and especially town) level are poorer than data at a regional or country level.

The present paper deals with the case of a downsizing in the largest experimental base in Europe, a military site known as Poligono Interforze Salto di Quirra (PISQ) in Sardinia, Italy. A change occurred in the military enrolment regime, which was mandatory until 2005, and voluntary thereafter, which had a shrinking effect on the military population (personnel and families), just as a downsizing of the military base. The approach taken in this paper to assess the effect of such a change is based on the Synthetic Control method proposed by Abadie and collegues (Abadie and Gardeazabal 2003; Abadie, Diamond, and Hainmueller 2010, 2015). This quasi-experimental technique is especially suitable when the analysis involves a single treated unit, for example a single territorial entity which is affected by a change that does not involve other comparable untreated units. Examples of application of the method include assessment of the economic impact of the 1990 German reunification (Abadie, Diamond, and Hainmueller 2015); the long-term economic impact of a natural disaster (Coffman and Noy 2012); the effects of nuclear power facilities on local income levels (Ando 2015); and, in the defence field, the economic effects of conflicts and terrorism (Abadie and Gardeazabal 2003; Castañeda and Vargas 2012; Bilgel and Karahasan 2017; Echevarría and García-Enríquez 2018). Closer to the application presented in this paper is the research by Zou (2018), who analyses the local economic impact of military personnel presence. Zou (2018) estimates the effects of military personnel contraction during the years 1988-2000 in the USA on various aspects of the local economy (such as prices of local labour, housing, and product markets). The author uses the Synthetic Control as first step in a two-stage estimation approach. Another related research can be found in the unpublished report by Sanch-Maritan & Vedrine (2015), who apply the Synthetic Control to estimate the effect of Air Force military base closures occurred in France between 2003-2014 on local unemployment. In either case the authors estimated the effects of a policy change on a conspicuous number of target units, and used data at county or departmental level.

In the current case, the analysis has been conducted on two target units, and the data is at municipality level. From a methodological point of view, the challenge has been to construct a suitable dataset, since official statistics at municipal level are quite sparse. The analysis has been conducted using different performance indicators, selecting a preferred specification through goodness of fit criteria, and validating the estimates by means of a placebo test and two additional sensitivity tests.

The structure of the paper is the following: the next section presents the methods; section 3 describes the case study, while section 4 exposes the Synthetic Control application and the results. Section 5 concludes the paper.

## 2. The Synthetic Control Method

The Synthetic Control is a method first introduced by Abadie and Gardeazabal (2003) to estimate the economic effects of terrorism in the Basque country. The core idea of the method is to use a weighted average of control units to compute the counterfactual of the treated unit in case it was not treated.

Let $Y$ be the outcome variable that is observed for a sample of $J+1$ units (e.g., municipalities) indexed by $j$ and $j=1$ is the case of interest, that is, the unit exposed to the event or intervention ("treated unit"); units $j=2,\dots,J+1$ are potential comparison units (they constitute the "donor pool"). Furthermore, it is supposed that all units are observed at different time periods $t=1,\dots,T$ where $T_0$ is the number of pre-intervention periods and $T_1$ is the number of post-intervention periods, with $T=T_0+T_1$.

Using the potential outcomes framework of Rubin (1974), let $Y^1$ be the outcome observed in case of intervention, and $Y^0$ the outcome had the intervention not occurred. Unit 1 is exposed to the intervention of interest during periods $t = T_0 + 1, T_0 + 2, \ldots, T$ and the intervention has no effect during the pre-treatment period $t = 1, 2, \ldots, T_0$. The aim is to measure the effect of the intervention on some post-intervention outcome:

$$\hat{\alpha}_{1t} = Y_{1t}^1 - Y_{1t}^0 \qquad t \geq T_0 \tag{1}$$

The problem is that for $t \geq T_0$ it is not possible to observe both $Y_{1t}^1$ and $Y_{1t}^0$ , and we need to estimate $Y_{1t}^0$ (counterfactual outcome). The idea of synthetic control is to use a weighted average of the outcomes for untreated units, where each vector of weights $\boldsymbol{W} = (w_2, w_3, \ldots, w_{J+1})$, with $w_j \geq 0$ and $w_2 + w_3 + \cdots + w_{J+1} = 1$, represents a potential synthetic control. Hence, the value of the counterfactual outcome can be approximated by:

$$\textstyle\sum_{j=2}^{J+1} w_j^* Y_{jt} \tag{2}$$

and the effect calculated as:

$$\hat{\alpha}_{1t} = Y_{1t} - \textstyle\sum_{j=2}^{J+1} w_j^* Y_{jt} \qquad t \geq T_0 \tag{3}$$

The formulation in equation (2) to approximate the counterfactual $Y_{1t}^0$ can be justified by a simple linear factor model for the outcome $Y_{it}^0$ such as:

$$Y_{it}^0 = \delta_t + \boldsymbol{\theta}_t \boldsymbol{Z}_i + \boldsymbol{\lambda}_t \boldsymbol{\mu}_i + \varepsilon_{it} \tag{4}$$

where $\delta_t$ is an unknown common factor across units, $\boldsymbol{Z}_i$ is a vector of observed covariates, $\boldsymbol{\theta}_t$ is a vector of unknown parameters, $\boldsymbol{\lambda}_t$ is a vector of unobserved common factors, $\boldsymbol{\mu}_i$ is a vector of unknown factor loadings, and the error terms are unobserved transitory shocks with zero mean. Abadie, Diamond, and Hainmueller (2010) demonstrate that if a vector of weights $\boldsymbol{W}^*$ exists such that:

$$\sum_{j=2}^{J+1} w_j^* Y_{j1} = Y_{11}, \sum_{j=2}^{J+1} w_j^* Y_{j2} = Y_{12} , \ldots\ldots, \sum_{j=2}^{J+1} w_j^* Y_{jT_0} = Y_{1T_0} \text{ , and } \sum_{j=2}^{J+1} w_j^* \boldsymbol{Z}_j = \boldsymbol{Z}_1 \quad (5)$$

then, under standard conditions, the difference $Y_{it}^0 - \sum_{j=2}^{J+1} w_j^* Y_{jt}$ will be close to zero if the number of pre-intervention period is large relative to the scale of the transitory shocks.

The model (4) is a generalization of the difference in difference (fixed effect) model where the effects of unobserved confounders $\boldsymbol{\lambda}_t$ are assumed to be constant over time, so that they can be eliminated by taking time differences (Abadie, Diamond, and Hainmueller 2010).

Define $\boldsymbol{X}_1$ the vector of pre-intervention k characteristics for the treated unit (the variables in $\boldsymbol{Z}$ as well as linear combinations of the outcomes in the pre-intervention period) and $\boldsymbol{X}_0$ a matrix containing the same variables for the unaffected units (the j-th column represents the specific characteristics for the j-th untreated unit in the donor pool). The vector of weights $\boldsymbol{W}^*$ is chosen to minimize some distance between $\boldsymbol{X}_1$ and $\boldsymbol{X}_0\boldsymbol{W}$, subject to the constraint imposed on the weights. Abadie and Gardeazabal (2003) and Abadie, Diamond, and Hainmueller (2010) employed the following measure of discrepancy:

$$\|X_1\text{-}X_0W\|_V=\sqrt{(X_1\text{-}X_0W)'V(X_1\text{-}X_0W)} \quad (6)$$

where **V** is some (k x k) symmetric and positive semi-definite matrix assigning different weights to each covariate in predicting the outcome. The choice of **V** influences the mean square error of the estimator. An optimal choice for **V** assigns weights to linear combinations of the variables in $\boldsymbol{X}_0$ and $\boldsymbol{X}_1$ to minimize the mean square error of the synthetic control estimator. The resulting synthetic control approximates the trajectory of the outcome variable of the affected unit in the pre-intervention period, so that $\mathbf{V}$ is a positive definite and diagonal matrix, such that the root mean squared prediction error (RMSPE) of the outcome variable is minimized for the pre-intervention period:

$$RMSPE = \left(\frac{1}{T_0}\sum_{t=1}^{T_0}\left(Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt}\right)^2\right)^{1/2} \quad (7)$$

where the RMSPE measures the lack of fit between the outcome variable for any particular unit and its synthetic counterpart.

Given the small number of statistical units in treatment and comparison group, usual large sample inferential techniques cannot be applied to judge the significance of the estimated effect. Nevertheless, inference can be obtained by means of a “placebo test” applying the synthetic control method to any other unit not exposed to the intervention. In a placebo test ‘the distribution of a test statistic is computed under random permutations of the sample units’ assignments to the intervention and non-intervention groups’ (Abadie, Diamond, and Hainmueller 2010, 497). This kind of procedure has its justification within the randomization model for inference. This approach to inference dates back to Fisher and the design of experiments (Rosenbaum 2002), and is based on the idea that the assumption of random sampling from some population with a specified distribution is not necessary: the only relevant probability distribution for inference is the one generated by the random assignment of available subjects to the treatment groups. Supposing that of the N subject available for the study, n are assigned to the treatment and N-n are assigned to the control group. Randomly reassigning the N available subjects such that n are assigned to the treatment group and N-n to the control group produces $\binom{N}{n}$ equally likely randomizations, and the one observed is only one of them. If the null hypothesis states that there is no treatment effect, a probability distribution for the test statistic can be constructed by calculating the test statistics for each possible randomization. The probability under the null hypothesis of any one of this randomization is $1/\binom{N}{n}$ and the p-value of the randomization test for the null hypothesis can be calculated as the probability of getting a value of the test statistic as extreme as, or more extreme than, the observed test statistics (Ernst 2004).

In our case, the synthetic control method is iteratively applied to every other control unit in the donor pool producing a distribution of estimated impacts for the untreated units, and the estimated effect of the actual intervention is compared with this distribution to assess whether or not it is large relative to the effect estimated for a randomly chosen unit. If the placebo study shows that the effect for the treated unit is unusually large relative to the effects for the untreated units then there is evidence of a significant effect of the intervention.

However, a large post-intervention gap in the outcome variable between the treated unit and its synthetic counterpart is not indicative of a large effect of the intervention if the synthetic control does not closely reproduce the outcome prior to the intervention, i.e. if there is lack of fit (measured by the RMSPE) for the outcome variable prior to the intervention. Placebo runs with poor fit in the pre-treatment period are not informative in evaluating the chance of estimating a large post-intervention impact for a unit with a good fit prior to the intervention. One possible solution could be to exclude those units beyond a certain level of RMSPE in the pre-treatment period. Alternatively, it is possible to look at the distribution of the ratios of post/pre-intervention RMSPE. The main advantage of the latter is that it avoids choosing a cut-off for the exclusion of placebo runs with a bad fit (Abadie, Diamond, and Hainmueller 2010). From this distribution, a p-value for the significance of the impact can be calculated by the fraction of the effects greater than, or equal to, the one estimated for the treated unit: in absence of randomization, this p-value can be as well regarded as the probability of obtaining an estimate at least as large as the one for the treated unit when the intervention is reassigned randomly in the sample (Abadie, Diamond, and Hainmueller 2015).

## 3. The Case Study

The military Polygon of *Salto di Quirra* was created in 1956, in the geopolitical aftermath of World War II, in order to allow the air force to carry out its activities (military training, trial and evaluation of new weapons, in particular missile weapons, meteorological and space research). The PISQ is situated in Sardinia, Italy, and it is parcelled out into two separate areas: the first one is located inland, in an area of approximately 12,700 hectares; the second one is in the coastal area of *Capo San Lorenzo*, and it occupies about 1,100 hectares (see Figure 1). In the last decade, the PISQ employed, on average, about 700 military personnel, 50% of which pertaining to the Air Forces, 35% to the Army and 15% to the Navy. Civilian workers include about 160 workers of a private company, located in the coastal area, which provides logistics and technical support; and about 115 employed in cleaning, catering, maintenance jobs. The bulk of the military facilities is located in the municipal jurisdictions of *Perdasdefogu* and *Villaputzu* (henceforth, respectively, PD and VP), focus of the present research (see Figure 1). In 1959 the Polygon became inter-service (Air Forces, Army and Navy), and henceforth referred to as *Poligono Interforze Salto di Quirra* (PISQ). At present, it is the largest experimental base in Europe for weapons testing and rocket launching, with an advanced radar network which allows monitoring and data collection useful in both military and civil aviation, and in space research. At the time of the installation the inland area was characterized by a subsistence economy, with low population density and poor infrastructure and services endowments; a little market agriculture was present only in the coastal territory of *Quirra*. The military installation initially brought jobs, infrastructures and services, and was seen as a trigger for economic development (see Esu and Maddanu [2017]). However, the last decades have witnessed a decline of socioeconomic conditions in the territory, as can be seen from the statistics reported in Table 1, drawn from the two last available censuses (2001 and 2011).

**[Figure 1 near here]**

In both towns we observe a demographic decay in the period. The population intercensal variation is null in VP (just like the regional average) and negative in PD (-1.3%), while the ageing index has increased from 135 to 228 in PD and from 113 to 188 in VP (in either case the value is higher and grows much more than the regional index between 2001 and 2011, which increased from 116 to 164). The share of population older than 74 has increased from about 10% to almost 15% in PD, and from 7% to 10% in VP, not very dissimilar from the regional level; while the share of children in the age 0-6 range has decreased especially in VP (from 5.5% to 3.7%).

**[Table 1 near here]**

The education statistics reveal that PD citizens have invested more on human capital than their VP neighbours, in particular as regards the university education of youth (under 30) that has overcome the regional value at 2011. Yet, the youth unemployment rate in PD was higher than in VP, and higher than the regional average (48.5% in 2011), and it increased quite more than in the whole region, while in VP, by contrast, youth unemployment decreased between 2001 and 2011. If we also consider the adult population, the unemployment rates are lower in PD than in VP, and lower than the regional average (17% and 21% the male and female unemployment rate in Sardinia), even if the inter-census trend has been less favourable. However, this apparently positive outcome can be attributed to the low participation in the labour market: the male activity rate in PD is 56%, while in VP is 58.55%, and 59.8% in the whole region. The gap is even stronger when considering the female activity rate: 29.24% in PD vs. 36.7% in VP and 40.7% in the region, with an increase of six percentage points in ten years for both, contrary to PD. In fact, the poor labour market conditions in PD are confirmed by the data on employment: in PD the male employment rate has decreased through the intercensal period, from 52% in 2001 to 47.6% in 2011 (similar to the regional decrease); while in VP it has increased from 47.6% to 49.1%. The female employment rate has slightly increased in PD (from 21.8% to 22.7%), while the increase in VP is decidedly more marked (from 21% to 27.5%) even than the regional growth, although the level is still lower than the average in Sardinia (from 30.2% to 32.2% in 2011). The negative trend of most PD labour market indicators can be explained with the weakness of the market economy, as the small shares of employment in agriculture, industry and tertiary commercial sectors show; whereas about 60% of the employment in PD is in the public sector, largely dependent on PISQ. In contrast, the employment in VP is mainly related to market sectors, with higher shares than the regional average in the agriculture (10.8% in VP vs 7.6% in Sardinia) and commercial sectors (25.3% in VP vs 21.8% in Sardinia). The problem is that these are in large part low quality jobs: the share of low skilled jobs in 2011 is 23.1% in VP vs. 16.9% in PD (the latter matching the regional average, that is 16.7%); while both in VP and in PD the share of high skilled jobs is smaller than in the whole region: 18.8% in VP, 20.4% in PD, vs. a regional average of 29.6%.

The trends discussed above reveal that in the intercensal period the socioeconomic and demographic structure in the territory, and especially in PD, has become weaker. Has the military downsizing contributed to the frailty of these local economies? Or is it the result of a historical trend, possibly aggravated by the general economic crisis, but independent of the military presence and related changes? The counterfactual analysis presented in this paper aims to disentangle the effect of the military downsizing, and thus of the military economy changes, from general trend effects, hence providing an answer to the above research questions. This may provide useful insights for policy making, since it is possible that in the near future a further downsizing will take place in the PISQ. Looking at how the local socioeconomic systems have reacted to the change may be useful to indicate to policy decision makers how resilient they are to such a process.

## 4. The empirical analysis

### *4.1 Data and variables*

The available dataset for application of the Synthetic Control method to our case study is an unbalanced panel, spanning from 1990 till 2011 (T=22), for all municipalities in Sardinia (N=377). The dataset contains information retrieved from ISTAT (2014), and from the Regional Environmental database SIRA (2011). Variables include population, household size, population by level of education and age, houses occupied by residents, population activity rate, and unemployment rate. The application of the Synthetic Control method requires continuous time series for the outcome variable and for at least some of the predictors at municipal level, before and after the intervention (i.e. the change occurred in the military enrolment regime in 2005). Unfortunately, GDP is not available at municipal level, and other potentially interesting outcome variables are produced at this level only in census occasions: for example, the share of houses occupied by residents, the population activity rate, and the unemployment rate (in general every 10 years, on occasion at some intermediate count in the intercensal period). We could use data on electricity consumption as a regressor, but not as an outcome variable, since this data was available only for the period 1995-2005; it was obtained from the Italian electric public company, which was a legal monopoly until July 2004. Given these constraints in the choice of outcome variables, we selected three variables as indicators of town well-being: Population, Income, and Wealth. Population accounts for total number of residents in town, and is available as annual data for the entire period 1990-2011. Increasing (decreasing) trends in the number of residents are associated with growth (decline) of socio-economic systems: a significant negative gap between the treated unit and its counterfactual would indicate a negative impact produced by the treatment. Obviously, the same argument holds for Income, i.e. average annual personal income in town; this data is obtained from fiscal records provided by the Ministry of Finance and covers the period from 1995 to 2010. We use the average income level resulting from the average of the gross personal income before taxes and deductions (in euros) deflated by the Consumer Price Index with base year 1995. Finally, to complement information obtained from the other two indicators, we use an indicator of wealth. The OECD Guidelines for Micro Statistics on Household Wealth (2013) indicate that the level of wealth is given by the value of financial and non-financial assets, where the latter include, for example, dwellings and other real estate, valuables, vehicles and other consumer durables, net of liabilities; and assets and liabilities should be valued at current market prices. Unfortunately, the data regarding financial assets, liabilities, and value of durables is not available at municipal level. In countries where official statistics are lacking, qualitative indicators of car ownership, housing facilities, and other durable goods owned by the household are often used as proxies of households' wealth (Sahn and Stifel 2003; Filmer and Pritchett 2001). In our application we resort to the data on the stock of vehicles owned in each municipality. The hypothesis is that ownership of a car can be regarded as a signal of well-being since it implies costs (annual circulation tax, insurance, fuel, etc.) that could be in part avoided (e.g. using transportation services). Although certainly not the best indicator, it is the best proxy for wealth at municipal level that we could work out given the available data. The vehicle data was obtained from the National Public Automobile Register, covering the period 1996-2010.

Table A.1 in Appendix reports the definition of the variables used in the empirical analysis.

### *4.2 Estimating the effect of military downsizing: results*

We performed two separate analyses for the two towns of interest, Perdasdefogu (PD) and Villaputzu (VP), using the Synth routine implemented in STATA by Abadie, Diamond, and Hainmueller (2010, 2015) for estimation of the synthetic control. As recommended, the initial donor pool (377 municipalities in Sardinia) has been adjusted to exclude the towns which had experienced the same treatment of our target towns or other shock types. Hence, we excluded from the donor pool the municipalities hosting large military posts for draftees training when military service was mandatory. Moreover, we excluded towns hosting petrochemical and metal industries, which suffered a severe crisis in the period under analysis. Also, in accordance with the synthetic control protocol, we excluded neighbouring towns, towns much larger or much smaller than our target units, and towns whose territorial boundaries changed in the relevant period. The final donor pools comprise 192 towns for PD and 110 towns for VP.

The variables have been standardized in order to eliminate the influence of the outcome measurement unit from the RMSPEs, so that their comparison is possible across variables and towns. The synthetic control is estimated for the three selected outcome variables (Population, Income and Wealth) using different predictors and specifications. For each model, the synthetic control (the counterfactual) is obtained as a weighted mean of a restricted number of donor units (ranging from 5 to 9) from the donor pool.

For the first outcome, Population, the predictors are some structural demographic variables, like the household size and the share of people older than 65 of age, the share of population with high school degree, the average activity rate (this variable has some predictive power only for PD), the per-capita electricity consumption (for VP), and the population levels at the beginning and the end of the pre-treatment period. The donor units that enter the synthetic controls for PD and VP are reported with their weights in Tables A.2 and A.3 in Appendix. It can be observed that the two donor pools include different towns, with 9 municipalities in both cases. Panels a) in Figures 2 and 3 display the population trends of our target units (PD and VP) and their synthetic counterfactuals. The RMSPE measures indicate a good fit for the PD regression model, as also suggested by the good balance of the predictors coefficients of the treated unit (PD) and its synthetic counterpart (Table A.2). The trend shows a continuous decline of population from 1990 to 2010. After 2005 the population dynamics diverges considerably between the treated unit and the synthetic control, and shows an evident negative gap (less than 7% in 2011) with respect to its synthetic counterfactual.

**[Figure 2 near here]**

The results seem less sound in the case of VP, probably due to a more erratic path in the data: the population trend for VP shows a less dramatic decline and a recovery in the years between 2003 and 2009, with a positive gap after 2006 (about + 1.3%) although the pattern is not so smooth and clear. It can be observed that the predictors' balance (Table A.3) is not so tight as in the PD case, and also that the RMSPE is slightly larger.

**[Figure 3 near here]**

The second outcome indicator in our assessment is Income, i.e. average personal income, as reported in income tax declaration files. The results of this analysis should be taken with some caution, since the (estimated) high level of tax evasion in Italy makes this data quite questionable for self-employment and rental income[2]. Tables A.4 and A.5 report the donor units involved in the synthetic control: in this case, the number of donors is smaller than in the case of the population (5 and 7 respectively for PD and VP). The predictors used are: share of population with a high-school degree; share of working age population; per-capita electricity consumption; per-capita income at the beginning of the pre-treatment period and one year prior to treatment. The balance of the predictors is worse than in the population case, especially for PD, giving rise to higher values of pre-treatment RMSPE. Inclusion of other predictors, such as occupational indicators, did not produce any better fit in the pre-treatment period, so they have been discarded from the final model. Panels b) in Figures 2 and 3 report the Income trends respectively for PD and VP, and their synthetic counterparts. We observe an increasing trend since 1995 (1998 for VP) until

2 For a thorough analysis of tax evasion and under-reporting income in Italy, refer to Albarea *et al.* (2019)

2004, then a decrease in the years 2005-2006, and some recovery in subsequent years. In this case both PD and VP have a worse post-treatment performance than their counterfactuals, indicating a negative impact on income, about 6% less in 2010 for PD and 5.3% less in 2011 for VP. However, as already noticed, the fit in the pre-treatment period is worse than the fit of the Population regressions, as shown by the larger values of RMSPE, especially in the case of PD.

The last outcome variable considered in this study is Wealth, for which we use as a proxy the number of circulating vehicles in town. The synthetic controls for PD and VP are reported in Tables A.6 and A.7.

In this case, the donor pool includes 9 units for both municipalities. The final selected regression for computing the synthetic control includes the number of inhabitants, the share of population aged 15-64 years, the share of population with a high-school degree, the household size, the per-capita electricity consumption, and the average number of vehicles in the pre-treatment period for both PD and VP. The predictors' balance is quite good and the RMSPE statistics indicate a good fit for both municipalities. Panels c) in Figures 2 and 3 show that the observed trend is increasing for both communities along the whole period, but the rate of change declines substantially after 2005 in the case of PD. Actually, a substantial negative gap (up to -10% in 2010) can be seen in the post-treatment period for PD, while the two trends of VP and its counterfactual are practically undistinguishable. The RMSPE measures indicate a good pre-treatment fit of the synthetic controls for both PD and VP, better than the synthetic controls obtained for the previous two outcome indicators.

Figures 4 and 5 report the placebo tests described in section 2, displaying the ratios between the post and pre-treatment RMSPE obtained for all towns in each donor pool. The graphs report the ratios ordered from the smallest to the largest and the vertical line represents the value of the ratio for treated unit. The placebo tests prove a significant negative effect of the treatment for PD when considering the Population and Wealth outcome indicators: the gap for population is larger than what observed in 93% of the other towns (p-value: 0.078); and the gap for Wealth is the highest (p-value: 0.000).

**[Figure 4 near here]**

In contrast, the effect estimated for VP based on these two indicators is not significantly different from what observed in the rest of the donor pool (p-value: 0.630 in the case of Population; p-value: 0.414 in the case of Vehicles). The results obtained with the Income outcome are rather different: based on the Placebo tests, we may say that a significant negative effect on income is observed for VP (p-value: 0.064) whereas there is not a significant effect for PD (p-value: 0.119). However, the bad fit observed for Income in both the pre-treatment regressions undermines the credibility of the results obtained through this indicator.

**[Figure 5 near here]**

### *4.3 Robustness checks*

We adopted two different approaches to validate the results of our counterfactual analysis. The first approach is the leave-one-out test described in Abadie, Diamond and Hainmueller (2010, 2015), which allows to examine the sensitivity of our main results to changes of the weights of donors used in building the synthetic control. We iteratively re-estimated the baseline model omitting one of the municipalities with a positive weight in each iteration. Of course, this implies some loss in goodness of fit but this sensitivity check allows to evaluate to which extent the results are driven by any particular control municipality.

Figures 6 and 7 report the outcome paths of the baseline model and each of the leave-one-out estimate (grey lines) for each outcome in the two municipalities. In the PD case, for Population the leave-one-out synthetic control with stronger departure from the baseline is the one that excluded the municipality C129; other leave-one-out synthetic controls show a very similar or slightly smaller (negative) effect. Considering Income, we can identify one leave-one-out synthetic control that results in a very different estimated impact, i.e. the one that excludes the unit C315 (which has a very large weight: 0.519); while in the counterfactual for Wealth, all leave-one-out synthetic controls except one (C82) follow a path similar to the synthetic baseline.

**[Figure 6 near here]**

Turning now to the counterfactuals for VP, we observe scarce robustness of the results for the outcome Population, with only two leave-one-out synthetic controls that closely follow the original synthetic, while the others show quite different paths. The results for the other two outcome indicators, Income and Wealth, are definitely more robust, since no large differences can be seen between different leave-one-out synthetics and the original.

**[Figure 7 near here]**

As a final validity test, we examined how the choice of different outcome lags affect the analysis. The selected model specifications are compared to alternative specifications where the outcome lags range from one lag to all lags, leaving other predictors unchanged. Moreover, we experimented the specifications suggested by Kaul *et al*. (2015) by using an average of the outcome variable across all pre-treatment years (when it is not already considered in the original specification), or using only the lag for the final year of the pre-treatment period. Tables 2 and 3 report the RMSPEs — the measure of the pre-treatment fit

— for various model specifications, and Figures 8 and 9 show the estimated trends. The pre-treatment outcomes vary noticeably with the choice of outcome lags.

**[Table 2 near here]**

**[Figure 8 near here]**

The specification including all lags in the pre-treatment period is always the best in terms of RMSPE; however, when we include all lags in the model other predictors have no effect on the pre-treatment outcome for the synthetic control, so precluding any indication on what affects future outcomes. The specification of the synthetic control model suggested by Kaul *et al*. (2015), with the average-lag or final-year-lag outcomes as regressors, often fits poorly, more so than most other alternatives. The lag specification selected for our analysis is always the second best choice (after the all lags specifications) in terms of RMSPE, thus lending support to the reliability of our results.

**[Table 3 near here]**

**[Figure 9 near here]**

### *4.4 Discussion*

From the description of the data developed in Section 3 it emerged that in the intercensal period 2001-2011 the socioeconomic structure has become weaker in both territories, and especially in PD, compared to the regional average. This posed the following research question: has the military downsizing caused such a decline, or have other comparable small communities suffered likewise in that period, which we recall includes the 2008 financial crisis, independently of the military presence? The counterfactual analysis, based on the synthetic control method, reveals that the socioeconomic system in PD has indeed suffered more than similar communities: the trends of our three outcome variables, Population, Income and Wealth, in PD are all declining in comparison with the corresponding synthetic counterfactuals. The results for VP are less evident in this respect. A negative effect can be seen when considering the outcome variable Income, but no effect is observed when the counterfactual is constructed for the other two outcome variables, Population and Wealth, which have proven, especially the latter, more reliable and statistically robust with respect to the synthetic control obtained for the variable Income. In practice, we may conclude that in the period considered the VP trends are not much different from those of similar communities, and thus that VP has been more resilient to the military downsizing with respect to PD. The socioeconomic structure depicted in Section 3 can help to explain such different levels of frailty: VP is characterised by a more diversified economic structure, with shares of employment in agriculture, industry and commercial sectors higher than the regional average; while the PD economy is fundamentally based on the public sector, i.e. dependent on the military base. We may confront those socioeconomic indicators with the corresponding weighted indicators obtained from the synthetic controls. Although not rigorous (a counterfactual constructed for a specific outcome variable is used to compare different socioeconomic variables), this approach allows us to gain some further insight on the impact of the change of military enrolment regime. In particular, we have used the synthetic control obtained for the Wealth outcome, which proved to be the most reliable, and have applied the Difference-in-Difference (DID) method to the target and counterfactuals values of the indicators. The DID results are reported in Table 4.

**[Table 4 near here]**

It can be seen that VP is better than its counterfactual as regards labour market participation (both male and female) and the male employment rate; and close to the counterfactual (figures near to zero) for most other labour market indicators. PD is definitely worse than its synthetic control in all the labour market indicators: male, female, and especially youth unemployment rates; male and female labour force participation; male and female employment rates. The share of employment in the public sector has decreased both in PD and in VP in comparison with their respective counterfactuals (as a possible consequence of the downsizing of the military base). However, industry census data (not reported here for conciseness) show that in VP these job losses have been compensated by additional employment, especially in the building and in the hospitality sectors, so that the total number of jobs in the 2001-2011 period has slightly increased (+4%); in contrast, in PD the total number of employees has shrunk in the 2001-2011 period by 34%.

We may conclude that the VP socioeconomic system seems indeed to have been more resilient than the PD system to the downsizing of the military basis. But, as discussed in Section 3, both municipalities are actually lagging behind the regional average on most indicators of socioeconomic well-being, so that either town would require specific policy measures to support a more robust economic development.

## 5. Conclusions

The research presented in this paper was aimed at analysing the effect that the downsizing of a military facility, due to a change in the regime of military conscription, had on the socioeconomic system of two local communities in Italy. The work presents, in our view, several points of interest: it is one of the few case studies using an econometric approach for assessment of military impacts on local economies. The merit of using econometric methods in the analysis of military changes was emphasised by Droff and Paloyo (2015), and well supported by Lee (2018). The present paper adds to Zou (2019), and the unpublished research by Sanch-Maritan and Vedrine (2015), to demonstrate the advantage of the synthetic control methodology in this field. To our knowledge, this is the first application on this issue dealing with data at municipal level: the other two related applications cited above use data at county or departmental level. This very disaggregated data level has required some effort for the construction of an original dataset, and detection of outcome variables, available at annual frequency, which could be sufficiently indicative of the local communities' socioeconomic conditions. In addition, we showed how different statistical methodologies can be applied to check the robustness of the synthetic control estimates.

The counterfactual analysis presented in this paper has shown that the two communities involved in the case study have been characterised by a different degree of resilience to the change of policy, which has caused military downsizing. The analysis of resilience of a local community to a shock is relevant for policy purposes, since specific policy measures can be implemented to mitigate the risk of severe consequences in the social and economic local systems. It can be said that the VP community is endowed with a richer *territorial capital* (Camagni and Capello 2010): it is a coastal territory, with better opportunities for agriculture and tourism related activities, and its labour market may benefit from proximity to other municipalities characterised by a more advanced tourism development. As put forward by Martin (2012), a community resilience to a shock derives from several factors: 'a region's economic structure; the competitiveness and innovative propensity of its firms; the relational linkages of its firms with networks of other producers and customers in other regions and other countries; the skills of its workforce; its entrepreneurial culture'. But the author also emphasises the fundamental role of institutions:

> But regional economic resilience is also about political economy: not only about how the region's firms and industries react and adjust, but also about how local institutional, cultural and political conditions mediate and respond to those reactions, about how national policy may help or hinder a region's recovery.

The need for action both at national and local level in the context of military conversions was pointed out by De Penanros and Serfati (2000), and more recently by Droff and Malizard (2019). As regards the two towns considered in our case study, we have seen that they are characterised by different levels of resilience capacity. In the case of PD, frail and strongly dependent on the military economy, a comprehensive set of territorial governance actions should be required to enable the community to sustain a further downsizing of the military base. The PD community should be helped to develop new economic activities, also in the private sector, with a more productive engagement of its human capital resources. In the case of VP, we have seen that the community is more resilient, thanks to a relatively more diversified economic structure, and to more favourable employment conditions in economic activities related to the tourist sector. The VP socioeconomic indicators however lag quite behind the regional average, and political measures would also be needed in this case to favour a sustainable growth path. In particular, it is advisable for the community to avoid the so-called "beach disease" (Mazzola, Pizzuti and Ruggieri 2019; Kožić 2019): i.e. a pathological dependence on the tourist sector. This happens when most resources are transferred towards tourism-related industries, and displaced from the development of other economic activities, hence reducing the degree of resilience to possible changes in the tourism market, especially when tourist services are at a relatively basic level. In Kožić's (2019) words:

> [...] driven by the earning opportunities in the tourism sector, young people could be less willing to enrol in university programs. This could finally lead to deterioration of the human capital necessary for the development of other industries capable of producing the highest value added.

This is what is likely to be happening already in the VP community: low human capital investments, i.e. low educational levels, associated with an increase of employment in tourism related sectors. The VP community should be helped to develop programs aimed at increasing the human capital endowment and entrepreneurial activities characterised by high quality in the supply of goods and services.

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