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The economic consequences of Hugo Chavez: A synthetic control analysis

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ABSTRACT

We use the synthetic control method to perform a case study of the impact of Hugo Chavez on the Venezuelan economy. We compare outcomes under Chavez's leadership and polices against a counterfactual of "business as usual" in similar countries. We find that, relative to our control, per capita income fell dramatically. While poverty, health, and inequality outcomes all improved during the Chavez administration, these outcomes also improved in each of the corresponding control cases and thus we cannot attribute the improvements to Chavismo. We conclude that the overall economic consequences of the Chavez administration were bleak.

1. Introduction

Popular accounts of economic events often put the credit or blame for outcomes squarely on the national leader. It seems intuitive that heads of state and their policies are significantly responsible for economic outcomes. But intuition is a poor guide for establishing causality. To say that a leader caused an outcome is to say that without that particular leader, things would have been significantly different, and establishing the counterfactual can be a tricky process. Recently, Abadie and Gardeazabal (2003) and Abadie et al. (2010, 2015) have proposed and developed an approach to case studies which creates a statistical synthetic control to serve as a counterfactual to an observed treatment.[1] They then identify the effect of a treatment in a single region by comparing outcomes there to those in the control constructed from similar regions and states that did not experience the same treatment.

Here we use the method to study the effects of one particular leader, Hugo Chavez, on his country, Venezuela. Chavez is a controversial figure who won 3 elections, re-wrote Venezuela's constitution, re-structured its Supreme Court, and survived coup and recall attempts. Poverty fell, inequality fell, clinics opened, and Chavez was hailed as a hero by many. At the same time, Venezuela is a major oil exporter and oil prices boomed during much of Chavez's tenure, raising the question

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[1] Abadie and Gardeazabal (2003) developed the method in order to identify the effect of terrorism in the Basque Country in Spain. Abadie et al. (2010) explain the technique in detail and analyze the effect of a change in California's tobacco regulations. Gautier et al. (2009) and Montalvo (2011) provide additional applications to the analysis of terrorism. And of course the synthetic control method has seen numerous recent applications including affirmative action (Hinrichs, 2012), compulsory voting (Fowler, 2013), economic liberalization (Billmeier and Nannicini, 2013), natural disasters (Cavallo et al., 2013), employment legislation (Bohn et al., 2014), and advances in energy production technology (Munasib and Rickman, 2015).

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of whether any positive outcomes under Chavez's tenure as president were really due to his leadership and policies. To answer this question, we need to know how Chavez's Venezuela fared relative to how it would have fared if politics and policies in Venezuela had remained "business as usual", and we measure business as usual by a weighted average of control countries that best fit Venezuela's experience in the 30 years before Chavez. Using Abadie's terminology, we create a synthetic Venezuela and compare its outcomes to those that occurred under Chavez, specifically investigating average incomes, health & poverty outcomes, and inequality.

We find that average income rose significantly slower under Chavez than it would have without him, as shown by the performance of the synthetic control. The gap between the control and the treated unit is quite large, on the order of thousands of dollars per capita.

We also find that while health and poverty outcomes improved under Chavez, they are not particularly different than what occurred in the synthetic control. Finally, we see little evidence that Chavez lowered inequality beyond what occurs in the synthetic control. Thus, under Chavez, Venezuela experienced lower average incomes, but did not produce any greater levels of health improvement, poverty abatement, or inequality reduction, as it likely would have without his leadership and policies.

While the synthetic control method as applied here does not give us a causal test of exactly how Chavez affected Venezuela's economy, the results we find are consistent with an explanation that emphasizes the importance of institutions for economic progress. As we will discuss further in later sections, upon taking office Chavez immediately began the process of creating a new constitution, one that concentrated power in the executive branch and greatly limited the checks and balances that existed in the old system. He further used a large super-majority in the new National Assembly to gain the ability to rule the country by executive decree. In sum, Chavez policies dramatically changed Venezuela's political institutions.

Our results on how Chavismo and its associated politico-institutional changes affected Venezuela relative to the synthetic counterfactual is at least partly related to other recent work on the impact of national leaders. Jones and Olken (2005) address causality between leaders and economic growth by focusing on leaders who died in office due to natural causes or accidents. They find that leaders are highly influential, especially in autocratic systems with few constraints on the executive. On the other hand, Easterly and Pennings (2014) take a growth accounting approach and argue that, "only a small fraction of the variation in growth in autocracies can be explained by variation in leader quality."

The paper most closely related to ours is Garcia Ribeiro et al. (2013). They study the effect of the 1959 Cuban revolution on Cuba's subsequent per-capita income, finding that it is substantially depressed relative to their control. They do not consider any other possible economic effects of the revolution.[2]

Our paper is organized as follows. Section 2 provides some background on the Venezuelan economy. Section 3 explains how the synthetic control is created, and how potential control countries are chosen. Sections 4, 5, 6 and 7 present our results on per-capita income, health, poverty, and inequality, respectively. Section 8 concludes.

2. Chavez and the politico-economic institutions of Venezuela

Venezuela is a highly urbanized, ethnically diverse South American country of roughly 30 million people. Despite gaining independence in 1821, the country did not enjoy a peaceful transfer of power from one party to another until 1969. Venezuela is a founding member of OPEC, and since the 1973 oil crisis, its economic fortunes have risen and fallen with oil prices. From 1958 to 1998, Venezuela was democratic with its politics dominated by two political parties. However, poor economic performance in the 1990's created popular unrest.

Hugo Chavez was a military officer who launched an unsuccessful coup in 1992. He was pardoned in 1994 by then president Rafael Caldera. In 1998 Chavez handily won the presidency and launched his "Bolivarian Revolution" in 1999 with the formation of a constitutional assembly that produced a new constitution, which placed a lot of emphasis on social progress and human rights. It also converted the legislature from bi-cameral to unicameral and greatly increased the powers of the executive branch. It increased the presidential term from 5 to 6 years and allowed for the president to hold the office for 2 consecutive terms. In 2000, a mega-election was held for the presidency, the new national assembly and other offices. Chavez won and his party won 101 of 165 seats in the Assembly, which then granted Chavez the right to rule by decree. In 2004, Chavez and the national assembly increased the number of Supreme Court justices from 20 to 32, allegedly "packing" the court with his supporters. Chavez won re-election in 2006, and in 2007 was granted the right to run again in 2012 in a referendum.[3]

These were not just paper changes; they are reflected in many subjective indices that are used in the institutions and growth literature. For example, the Constraints on the Executive variable from the Polity project averaged a value of 6.0 in the 14 years before Chavez (1985–1998) but only 4.2 in the 14 years (1999–2012) of Chavez's rule (a 30% fall). Polity's

[2] We thank Alberto Abadie for bringing this working paper to our attention when giving us comments on an earlier draft of our paper.

[3] A full analysis of the events and policies of the Chavez regime is beyond the scope of this paper, but beyond what is listed in the text, Chavez took greater control over the national petroleum company, imposed price controls on many items and limited access to foreign exchange to many individuals and businesses. He also experienced a failed coup in 2002 and a failed recall in 2004. We discuss the relationship between Chavez and the Venezuelan oil industry in more detail in Appendix B.

Political Competition variable fell 26% between the two periods and Venezuela's average Democracy score fell 45% between the two periods (from 8.5 to 4.5). In all three cases, the lower numbers indicates less political accountability for the chief executive.[4]

Chavez also presided over multiple waves of nationalizations, which included industries (energy, iron, steel, cement, mining), food (rice production, grocery chains, farmland, food distribution), and services (banking, telecommunications, hotels). These actions were substantial as they also correspond to changes in widely used institutional variables. For example, the International Country Risk Guide (ICRG) data includes an "investment profile" variable that is partly determined by risk of expropriation. That variable fell (indicating a worsening investment climate) from an average of 5.54 in the pre-Chavez period to an average of 3.75 during his time as president, a fall of 32%.

In sum, whatever its virtues, Chavez's revolution concentrated power in the executive branch and weakened the checks and balances that existed in the previous system. Thus from the perspective of the influential literature linking institutions to growth (see for example Knack and Keefer (1995), Hall and Jones (1999), Easterly and Levine (2003), Rodrik et al. (2004), Acemoglu et al. (2005), these facets of Chavismo should correlate with diminished economic performance of the Venezuelan economy.[5]

However, the fact that on the one hand, Chavez is viewed by many as a hero who improved the lives of average Venezuelans, and, on the other hand, is considered by many others as one who severely damaged the Venezuelan economy speaks to the difficulty of establishing a clear counterfactual, which we undertake in what follows.

3. Creating the synthetic control

3.1. The method

We want to estimate the difference of Chavez and his policies on incomes, health, poverty, and inequality in Venezeula. To do this, we need a control that tells us where the outcome variable for the country in question would have been without Chavismo. Since an exact control does not exist (we have no post-1999 observations on Venezuela where Chavez was not president), we create a control group by synthesizing the performance of countries similar to Venezuela.[6] The synthetic Venezuela is simply a weighted average of the other countries; for example, per-capita income in synthetic Venezuela is a weighted average of per-capita income in the control countries. Since none of the control countries have Chavez (or someone with similar policy interventions) as their leader, the synthetic control should be independent of the direct effects of his election. To the extent that the synthetic control accurately captures the other influences on the Venezuelan economy, it represents precisely the counterfactual we desire.

The two most important concerns here are the choice of countries (which we address in the next subsection) and the assignment of weights across countries. One solution would be to simply choose weights that minimize the difference between the pre-Chavez performance of the synthetic control and the pre-Chavez performance of Venezuela. We impose the restriction that the weights on each country in the control be non-negative and sum to one. In our case, many countries are assigned a weight near zero, with only a handful of countries receiving non-trivial weight for each outcome variable.

While the above approach might simply put a lot of weight on countries that happen to perform similarly to Venezuela during our pre-Chavez sample, we wish to select countries that actually have similar economic processes to Venezuela. That is, we seek countries with similar relationships between outcome variables such as per-capita income and their determinants. To achieve this, we use time-invariant indicator variables and minimize the difference between the weighted average of these variables for the synthetic control and the values of these variables for Venezuela.[7] Countries with more similar indicator variables to Venezuela will receive higher weight in creating the control. We also put more value on similarity in explanatory variables that have more influence over the outcome variable.[8]

[4] The only other countries which see declines in institutional scores in our donor pool are Colombia (with significantly smaller declines in all scores) and Malaysia (which only experiences a small decline in executive constraints and never receives significant weight in any synthetic control). We discuss robustness to excluding Colombia from our donor pool in Appendix A. The indices of Political Rights and Civil Liberties compiled by Freedom House show a similar decline in freedom in the Chavez era compared to the 1972–1998 period, and the same pattern (no country has a similarly strong decline in institutions, with Colombia being the closest) holds in both Freedom House scores.

[5] Our paper is not designed to make claims about the causality of institutions on growth, but our results are consistent with the lessons of that literature. See Glaeser et al. (2004) for an alternative perspective on the issue.

[6] For a more detailed technical discussion of the synthetic control method, see Abadie et al. (2010).

[7] A full list of variables and their sources is available in Table 1.

[8] Mathematically, let X_1 represent the vector of all indicator variables for Venezuela and Y_1 represent the vector of pre-Chavez outcome variables. Similarly, let X_0 be the matrix whose columns are vectors of indicator variables for the potential control countries and Y_0 is the matrix whose columns are vectors of their pre-Chavez outcome variables. The column vector of weights is designated W, with the weight assigned to country j equal to the jth individual element of W. We choose weights to minimize the distance function $D = \sqrt{(X_1 - X_0W)'V(X_1 - X_0W)}$, where V is a positive-definite diagonal matrix. The procedure for creating the synthetic control follows three steps: (1) select any positive-definite diagonal matrix V (we initially use the identity matrix) and solve for weights as a function of this matrix, $W(V)$; (2) given this function $W(V)$, choose a new V so that it minimizes the mean squared prediction error over the pre-Chavez period $MSE = (Y_1 - Y_0W(V))'(Y_1 - Y_0W(V))$; (3) return to step 1 with this new V and repeat until MSE is minimized, then find the final distance-minimizing weight matrix W^*.

Table 1
Data and sources.

Variable	Countries	Years	Mean	St.Dev.	Max	Min	Source
Improved sanitation rate, 1990	15	–	70.07%	16.65%	94.00%	37.00%	
Infant mortality (per 1k), 1970–2012	22	43	40.19	32.27	168.20	2.20	World Development Indicators
Life expectancy, 1970–2011	22	42	68.21	7.94	81.30	41.18	(The World Bank, 2013)
% of pop. below $5/day, 1980–2006	15	27	51.21%	15.76%	92.34%	12.29%	
Gini coefficient, 1981–2010	18	30	42.91	8.47	75.26	22.50	SWIID v4.0 (Solt, 2009)
GDP per capita, 1970–2009	29	40	9005.29	9258.27	51,093.77	389.74	
Avg. pop. growth, 1970–1998	32	–	1.96%	0.87%	3.90%	0.19%	
Investment share 1970	29	–	19.49	7.21	34.20	7.08	
Investment share 1990	30	–	19.73	8.99	45.46	4.59	Penn World Table v7.0
Government share 1970	29	–	9.80	7.04	37.09	1.20	(Heston et al., 2011)
Government share 1990	30	–	10.31	6.50	35.20	1.80	
Openness 1970	29	–	52.63	42.65	190.23	9.16	
Openness 1990	30	–	58.04	43.91	187.02	11.92	
PolityII 1970	29	–	-0.83	7.80	10.00	-10.00	
PolityII 1990	29	–	3.38	6.85	10.00	-10.00	
Exec. constraints 1970	29	–	3.45	2.38	7.00	1.00	Polity IV dataset
Exec. constraints 1990	29	–	4.79	2.08	7.00	1.00	(Marshall and Jaggers, 2005)
Durability 1970	29	–	24.28	34.93	161.00	0.00	
Durability 1990	29	–	30.24	41.29	181.00	1.00	
Avg. yrs. of school, 15+ 1970	29	–	4.44	2.39	10.79	1.38	Barro
Avg. yrs. of school, 15+ 1990	29	–	6.66	2.24	12.23	3.44	and
Avg. yrs. of prim. school, 15+ 1970	29	–	3.21	1.52	6.95	0.93	Lee
Avg. yrs. of prim. school, 15+ 1990	29	–	4.23	1.15	6.80	2.29	(2010)
Oil wealth p.c. 1995	26	–	4290.09	9268.12	33,674.33	0.00	Wealth of Nations Dataset
Subsoil asset wealth p.c. 1995	26	–	5,462.14	10,822.97	43,058.32	0.00	(The World Bank, 2011)
Maternal mortality (per 100k), 1990	15	–	123.33	61.46	220.00	38.00	GHO Data Repository (WHO, 2013)
St. dev. of inflation, 1980–1998	23	–	199.41	429.10	1498.75	2.49	IMF (2013)

Table 2
Estimated synthetic control weights for each outcome variable.

	Outcome variables				
	Income	Infant Mort	Life Exp	Poverty	Inequality
Algeria	0.00	0.00	0.00	–	–
Argentina	0.00	0.00	0.99	20.38	0.40
Brazil	7.25	0.00	0.00	0.00	0.00
Canada	20.35	0.00	0.00	–	0.00
Chile	0.00	0.00	0.00	0.00	0.00
Colombia	0.00	0.00	0.00	79.62	6.85
Costa Rica	0.00	0.00	0.00	0.00	0.00
El Salvador	0.00	10.00	6.27	0.00	0.00
Guatemala	0.00	2.25	0.00	0.00	–
Honduras	0.00	0.00	0.00	0.00	–
Indonesia	0.00	–	–	–	0.00
Iran	42.24	0.00	0.00	–	–
Iraq	0.00	–	–	–	–
Mexico	12.67	0.00	0.00	0.00	0.00
Nigeria	–	3.10	8.46	–	0.01
Norway	0.00	33.98	18.86	–	5.19
Panama	0.00	41.69	44.53	0.00	0.00
Paraguay	0.00	–	–	0.00	–
Peru	17.49	0.00	0.00	0.00	0.00
Uruguay	0.00	8.97	20.89	0.00	87.55
Model fit pre-intervention					
RMSPE	0.068	0.32	0.16	6.23	1.48
APE-to-mean ratio	0.35%	0.28%	0.002%	2.16%	0.17%
SCM inference: permutation test					
RMSPE ratio	4.27	1.36	4.76	0.80	2.44
p-value: RMSPE	0.00	0.35	0.12	0.79	0.21

Note: Columns show the weight assigned to each country in the synthetic controls for Venezuela. Each column includes a synthetic control for a different outcome variable. A dash (–) indicates that the country is not available in the dataset for the given comparison. Weights are in percentage points. Rounding errors may prevent columns from summing to 100. APE-to-mean ratio indicates the average pre-intervention prediction error divided by the average pre-intervention outcome value.

3.2. The control countries

Abadie and Gardeazabal (2003) make the point that the synthetic control method described above depends on choosing countries that plausibly have similar economic processes to the country with the intervention. Abadie et al. (2015) put it this way, "to avoid interpolation biases, it is important to restrict the donor pool to units with characteristics similar to the treated unit. Another reason to restrict the size of the donor pool and consider only units similar to the treated unit is to avoid overfitting."[9]

In order to capture similarities of geography, history, culture and heavy reliance oil exports, we use almost all Latin American countries and OPEC member countries with available data.[10] We also include Canada and Norway, which are major oil exporting countries but are not OPEC members.[11]

We are studying 5 outcome variables: Per-capita income, life expectancy, infant mortality, poverty, and inequality. We thus create a distinct synthetic control for each of these variables. A full list of countries included in each synthetic control group, along with the weights assigned, is included in Table 2. In total, we consider 20 potential control countries, although data is not available for all countries for all synthetic controls.

3.3. The synthetic control for per-capita income

For the case of per-capita income we have 19 potential control countries. For indicator variables we use income levels from four pre-Chavez years (1970, 1977, 1983, 1987).[12] We use the average population growth rate 1970–1998 from the Penn World Table, openness to trade in 1970 and 1990 also from the Penn World Table, and two educational attainment variables in 1970 and 1990 from the Barro and Lee (2010) database.

[9] Note that in Abadie and Gardeazabal (2003) the donor pool is restricted to the non-Basque regions of Spain. In Abadie et al. (2010), the donor pool is restricted to US states that did not greatly raise their cigarette taxes during California's "treatment period". Finally Abadie et al. (2015) uses 16 OECD countries as potential donors to construct a synthetic West Germany.

[10] We do not consider Bolivia, Ecuador, or Nicaragua as potential controls as they experienced a political transition and constitutional change similar to Venezuela's during our sample period.

[11] We consider an expanded set of countries and a more restricted set of countries in Appendix A.

[12] We also consider the years 1970, 1977, 1989, and 1998. The results are nearly identical.

Table 3
Indicator fits & *V*-matrix, GDP per capita.

Variables	Actual Ven	Synth. Ven	*V*-matrix	LA average	OPEC average
Avg. GDP per capita	9,071	9040		5573	4376
Pop. growth rate	2.67	2.35	1817.27	2.10	2.66
Openness 1970	46.64	50.51	11,026.64	40.18	76.57
Openness 1990	46.65	48.50	9224.12	43.87	93.86
Total ed. 15+, 1970	3.74	4.16	1019.36	3.98	1.93
Primary ed. 15+, 1970	2.91	2.80	25,821.79	3.11	1.47
Total ed. 15+, 1990	5.11	6.57	0.40	6.17	4.50
Primary ed. 15+, 1990	3.76	3.92	11,145.97	4.29	2.80

Note: Table shows the values of indicator variables and the average pre-Chavez outcome variable for actual and synthetic Venezuela. Average GDP is an average over the pre-Chavez period, 1970–1998. GDP per capita is measured in 2005 dollars. Population growth is in percentage points. Government share is a fraction of GDP, in percentage points. Polity and Ex. Const. follow the polity scores scale. Durability and the education variables are measured in years. The *V*-matrix column includes the diagonal entries in the *V* matrix. They determine how much weight each indicator variable receives in the minimization problem for the weights, $W^* = \arg\min(X_1 - X_0W)'V(X_1 - X_0W)$. The values are normalized relative to the entry for the first variable in *V* (1970 GDP per capita), which equals one. Although they resemble regression coefficients, they are formulated differently and cannot be interpreted as either partial correlations or marginal effects.

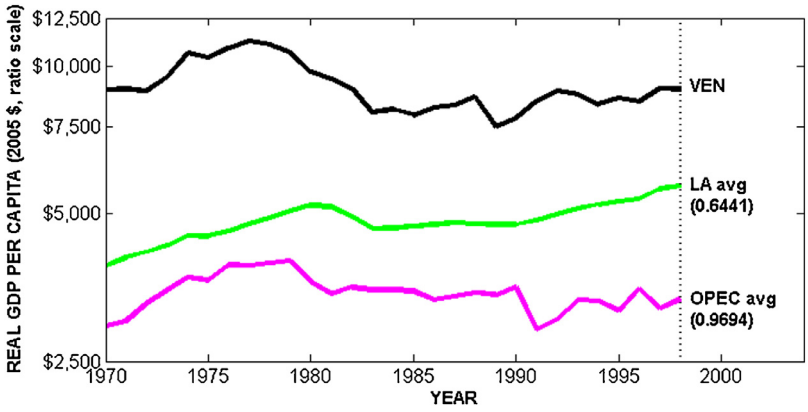

Fig. 1. Potential controls using regional averages. *Note*: Lines represent pre-1999 real GDP per capita for Venezuela (VEN), a simple average of Latin American countries (LA avg), and a simple average of OPEC countries (OPEC avg). The root mean square prediction error (RMSPE) of the two averages are in parentheses.

When we apply the algorithm to create a synthetic control, we end up with a control that is composed of 7% Brazil, 20% Canada, 42% Iran, 12% Mexico, and 17% Peru. Table 3 shows the pre-Chavez values of the indicator variables for actual Venezuela and for the synthetic Venezuela. Average income in the two series differs by only $14 and the values of the control variables between the control and Venezuela all match fairly closely. When we use the control to predict Venezuela's per capita income from 1970–1998, the root mean squared percentage error (RMSPE) is 0.068, or less than 7 percent.

3.4. Why do we need this fancy control?

It is important to note that the synthetic control mimics pre-Chavez Venezuela much better than simpler types of controls. In Fig. 1 we display the evolution of average per-capita income for Latin American (LA) control countries and our OPEC control countries. As can be seen, neither are appropriate controls. While the OPEC average series seems to move in a similar fashion, it is very far away from the Venezuela experience and would require a high degree of extrapolation to use as a control.[13] Furthermore, Table 3 shows that the average values in Venezuela of the covariates we used to construct the synthetic control are not well matched by either the LA or OPEC average values making any extrapolation fairly dangerous.[14]

Even judiciously picking a particular country as a control is not as good as the synthetic control. Fig. 2 compares Venezuela to the single closest LA country (Argentina) and the single closest OPEC country (Iran). While these fit better than the regional averages, their RMSPEs are.1467 and.2718 respectively, which are far worse that the RMSPE for our synthetic control (0.068). Finally, Fig. 3 displays our weighted average synthetic control and its superior ability to match per capita incomes in pre-Chavez Venezuela.

[13] The synthetic control technique does not allow any extrapolation outside of the support of our control country data. This is one practical reason to include higher-income countries like Norway and Canada – to ensure that the Venezuelan experience lies inside the support of the control data. We consider a normalized version which reduces this concern in Appendix A.

[14] The average values of predicted covariates for our other variables are available in Table 4.

Table 4
Indicator fits & *V*-matrices, health, poverty, & inequality.

Variables	Actual Ven	Infant Mort		Life Expectancy		Poverty		Inequality	
		Synth. Ven	*V*-matrix	Synth. Ven	*V*-matrix	Synth. Ven	*V*-matrix	Synth. Ven	*V*-matrix
avg. Poverty	51.93	–		–		50.8		–	
avg. Mortality	31.90	31.82		–		–		–	
avg. Life Exp.	69.22	–		69.22		–		–	
avg. Inequality	41.68	–		–		–		41.75	
Pop. Growth Rate	2.67	–	–	–	–	–	–	0.56	4429.71
log GDP per capita 1970	9.10	8.72	30,975.58	8.47	351.86	–	–	8.53	58,094.32
1970 Investment share	31.80	26.11	118,315.94	23.77	4787.64	22.11	108.74	17.37	6439.86
1990 Investment share	10.14	15.40	532,586.6	13.68	79,215	16.07	65.60	12.90	76,043.7
1970 Government share	5.87	12.86	2.69	12.43	7.73	4.51	15.61	5.77	35,044.67
1990 Government share	4.97	12.59	22,127.8	11.92	1965.29	4.64	320.95	7.10	16,765.02
PolityII score 1990	9	8.14	716,595.77	7.56	42,590.46	3.74	6.77	9.85	39,337.12
Durable score 1990	21	17.03	600.95	10.93	17,551.96	11.17	199.58	–	–
Exconstraints score 1990	6	6.11	400,814.68	5.9	62,328.3	4.98	346.60	6.92	4.39
PolityII score 1970	9	1.00	72,179.92	−0.24	13,410.62	7.80	9.51	7.97	99,601.63
Durable score 1970	1	11.76	848,731.76	10.12	126,632.05	27.70	8.44	–	–
Exconstraints score 1970	6	3.74	108,702.97	3.16	31	5.80	15.72	5.16	17,358.28
Inflation variation	26.12	8.40	3886.26	19.44	188,732.86	137.58	9.92	34.09	69,903.87
Oil wealth per capita	20,189.65	11,545.27	77,935.44	6627.96	7259.11	–	–	1824.26	4501.4
Subsoil asset wealth	22,775.54	–	–	–	–	–	–	2325.93	2694.5
Maternal mortality, 1990	94	100.99	250,650.77	157.59	786.78	149.82	4.23	–	–
Improved sanitation, 1990	82	76.64	1165.04	73.05	69.38	71.69	137.74	–	–

Note: Table shows the values of indicator variables and the average pre-Chavez outcome variable for actual and synthetic Venezuela. Population growth is in percentage points. Government share is a fraction of GDP, in percentage points. Polity and Ex. Const. follow the polity scores scale. Durability and the education variables are measured in years.
The *V*-matrix column includes the diagonal entries in the V matrix. They determine how much weight each indicator variable receives in the minimization problem for the weights, $W^* = \arg\min(X_1 - X_0 W)' V (X_1 - X_0 W)$. The values are normalized relative to the entry for the first variable in V (generally the earliest available value of the outcome variable), which equals one. Although they resemble regression coefficients, they are formulated differently and cannot be interpreted as either partial correlations or marginal effects.

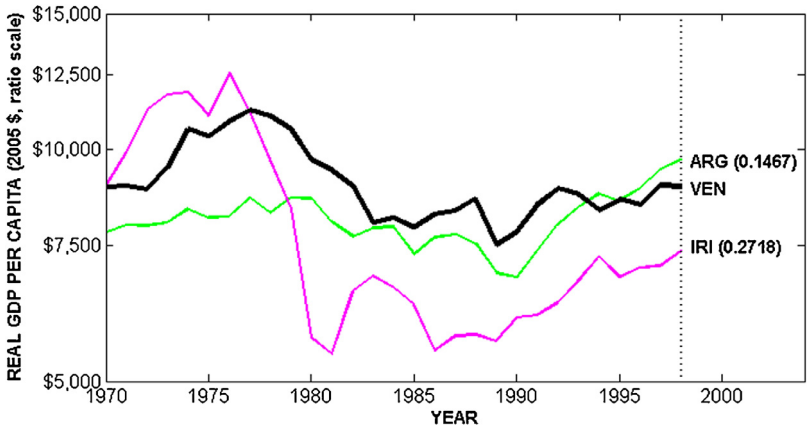

Fig. 2. Potential controls using single countries. *Note*: Lines represent pre-1999 real GDP per capita for Venezuela (VEN), Argentina (ARG), and Iran (IRI). The root mean square prediction error (RMSPE) of the two control countries are in parentheses.

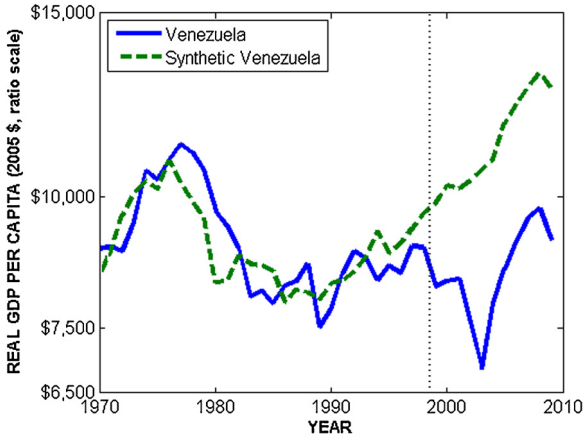

Fig. 3. Per-capita income. *Note*: The solid line represents observed (log) income per-capita in Venezuela, 1970–2009; the dashed line represents the synthetic control. The vertical dotted line indicates the end of the pre-Chavez years (1970–1998).

4. Results on per-capita income

4.1. Main result

Now we are ready to perform our experiment. We are taking the synthetic control as our representation of "business as usual" in Venezuela and we seek to see whether outcomes under Chavez deviate from this counterfactual benchmark. We have confidence in our control because it matches closely to actual outcome for the 30 pre-Chavez years and the indicator variables match fairly well between the control and Venezuela.

Fig. 3 plots actual and synthetic Venezuela both over the pre-Chavez period that we used to construct the control and the post-Chavez period where the control serves as our counterfactual. As can be seen, synthetic Venezuela tracks actual Venezuela upward through the high oil prices of the 1970s, downward during the financial turmoil of the late 1970s and early 1980s, and through the income increase in the early 1990s. However, after 1998 (the year of Chavez's successful presidential campaign) synthetic and actual Venezuela sharply diverge. By 2003, Venezuelan per-capita income is more than $3500 below that of synthetic Venezuela, and the gap exceeds $2500 in all subsequent years.[15] It appears that Chavez's leadership and policies were quite bad for the overall level of wealth in Venezuela. The RMSPE post-Chavez is 0.29, or more than four times as large as the pre-Chavez error.

[15] In Appendix A we consider a number of alternative specifications, including different donor countries, normalizing income, dropping countries that have received high weight, and using alternative sets of indicators. Our conclusions are similar to those presented here.

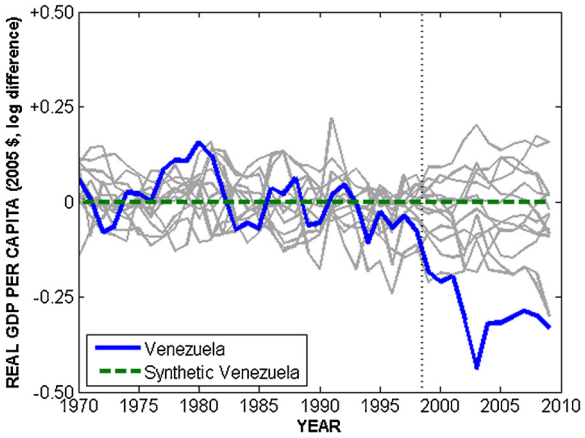

Fig. 4. Per-capita income Placebo Tests, restricted countries. *Note*: The bold line represents the difference between observed (log) income per-capita in Venezuela, 1970–2009, and the synthetic control; the synthetic control (dashed line) is normalized to zero. Gray lines represent placebo tests: deviations from synthetic control for the other countries in the dataset. This graph only include countries with pre-intervention root mean squared prediction error (RMSPE) less than 0.1025 (1.5 times that of Venezuela). It drops Chile, Indonesia, Iran, Iraq, Norway, and Panama.

4.2. Placebo test

The above findings are provocative, but need some additional context. To truly claim that Venezuelan performance is an outlier, we need some indication of out-of-sample precision in the absence of similar interventions. If overall predictability somehow fell after 1999, or if our synthetic control was actually a poor predictor of Venezuela pre-Chavez compared to what could be achieved for other countries, then our results would not be informative. We address these issues with a series of placebo tests. Specifically, we repeat the above exercise for each of the potential control countries we considered above.

That is to say, for each of the 19 countries, we develop a synthetic control using 1970–1998 data and compare the control to the actual country in both the pre- and post-intervention periods. We find that the average 1970–1998 RMSPE is 0.143 and the average 1999–2009 RMSPE is 0.164. In other words, the control countries as a group do not exhibit anything like the large deterioration in fit that Venezuela does. This finding lends support to the idea that the effect we see in Venezuela is attributable to the leadership and policies of Hugo Chavez.

Fig. 4 presents a graph of the placebo test results for those countries whose pre-1999 RMSPE is within 150% of Venezuela's. It includes the same information as Fig. 3, but highlights the divergence of actual Venezuela from where it would have been (as projected by synthetic Venezuela) and makes it comparable to the divergence in the placebos. The results show that the post-Chavez divergence in Venezuela is visibly larger than any of the divergences in the other countries. We see a strong Chavez effect in Venezuela and no Chavez effect outside of Venezuela.[16]

4.3. Move Chavez test

As an additional robustness test, we pretend that Chavez came to power in 1988 and repeat our experiment. That is, using the same potential control countries and indicator variables, but this time only examining the period from 1970 to 1988, we create a synthetic control for Venezuela and compare its performance with that of actual Venezuela before and after 1988. This test allows us to see if the result we found above is due to an inability to predict Venezuela out-of-sample for any time period, not just the Chavez era.

The composition of the new synthetic control is presented in Table 5. The weights are nearly identical, with a slight shift from Peru and Mexico to Brazil. The RMSPE for 1970–1988 is 0.061 while the 1989–1999 RMSPE is 0.099. We see no real deterioration of the control's ability to predict Venezuelan per-capita GDP in the out of sample interval here where there was no actual intervention. Fig. 5 shows very little change in our ability to track actual Venezuela post-intervention when we falsely assume that the intervention occurred in 1988.[17]

All in all, there is a strong case to be made that in terms of real income per capita, The Chavez administration's leadership and policies seriously hurt economic performance in Venezuela relative to what likely would have occurred with a "business as usual" set of policies (as given by the predictions of the synthetic control).

[16] In Table 2 we show that if the ratio of post-intervention to pre-intervention RMSPE for these placebos is viewed as a sampling distribution for the null of no impact of the intervention, we reject the hypothesis that Chavez had no effect on income at the 1% level.

[17] We performed this same check with our inequality and infant mortality data, yielding similar results. The composition of these synthetic controls are also displayed in Table 5.

Table 5
Countries and weights for move Chavez tests.

	Income	Infant Mort	Inequality
Algeria	0.00	0.00	–
Argentina	0.00	0.00	0.00
Brazil	0.00	0.00	0.00
Canada	15.96	0.00	0.00
Chile	0.00	0.00	0.00
Colombia	0.00	0.00	5.98
Costa Rica	32.89	0.00	7.10
El Salvador	0.00	0.00	41.34
Guatemala	0.00	24.68	–
Honduras	0.00	0.00	–
Indonesia	0.00	–	0.00
Iran	34.99	0.00	–
Iraq	0.00	–	–
Mexico	16.15	0.00	0.00
Nigeria	–	0.00	0.00
Norway	0.00	54.91	0.00
Panama	0.00	9.78	0.00
Paraguay	0.00	–	–
Peru	0.00	3.34	0.00
Uruguay	0.00	7.29	45.58
Model fit pre-intervention			
RMSPE	0.061	0.27	0.35
APE-to-mean ratio	0.71%	0.24%	0.14%
SCM inference: permutation test			
RMSPE ratio	1.62	6.27	10.17
p-value: RMSPE	0.58	0.12	0.07

Note: Table shows the weight assigned to each country in the synthetic control group for Venezuela. A dash (–) indicates that the country is not available in the dataset for the given comparison. Values are in percentage points. APE-to-mean ratio indicates the average pre-intervention prediction error divided by the average pre-intervention outcome value.

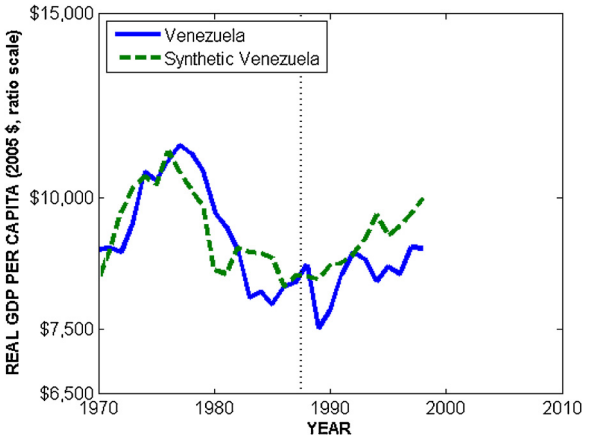

Fig. 5. Income Move Chavez Test. *Note*: The graph reproduces the synthetic control for income with the timing of the intervention (election of Chavez) artificially set to 1988 and run through 1998 in order to have the same number of out-of-sample observations while avoiding overlap with the actual Chavez years.

5. Results on health

Of course, GDP per capita is not the only dimension by which we should evaluate the Venezuelan economy. The Chavez government may not have considered average incomes a high priority, instead preferring to focus on improving health outcomes, reducing poverty or reducing inequality. We address each of these issues below, starting with health.

To identify the effect of Chavez's presidency on health outcomes, we consider annual observations from two variables—infant mortality for the period 1970–2012, and life expectancy for the period 1970–2011.[18] Due to data

[18] We also considered the mortality rate for children under age 5 for the same years, which yielded similar results.

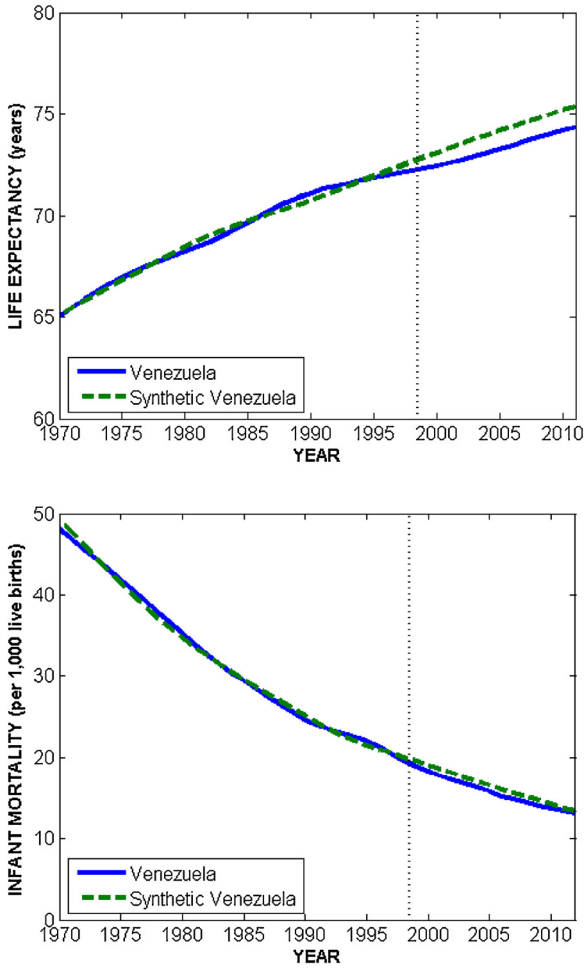

Fig. 6. Health outcomes. *Top Graph Note*: The solid line represents observed life expectancy in Venezuela, 1970–2012; the dashed line represents the synthetic control. *Bottom Graph Note*: The solid line represents observed infant mortality rate in Venezuela, 1970–2012; the dashed line represents the synthetic control.

limitations, we have 17 control countries for our two measures.[19] The compositions of the synthetic control for both measures of health are presented in Table 2. Fig. 6 shows that the synthetic controls do a good job of capturing the pre-Chavez performance for both measures, and that post-Chavez there is almost no discernible effect of Chavez's presidency on infant mortality. For life-expectancy we do see a small degree of divergence, as life expectancy slowly drops roughly one year below the synthetic control, a gap which persists through the end of the sample. Fig. 7 shows the placebo graphs with all 17 control countries.[20]

6. Results on poverty

We next consider the effect of Chavez's election on the poverty rate, measured by the percentage of the population living below five dollars per day. Comparable cross-country poverty data is difficult to find, and would likely be impossible if we required annual observations. Fortunately, the synthetic control method allows us to use observations that cover large enough periods that we have at least one observation per period for Venezuela and each of 14 control countries.[21] We

[19] Our indicator variables are investment and government shares in 1970 and 1990; the three Polity IV scores from 1970 and 1990; the standard deviation of inflation; access to improved sanitation in 1990; the 1970 level of per capita GDP; 1990 maternal mortality rate; oil wealth per capita in 1995; and the 1970 level of each annual series. Alternative sets of indicators do not have a substantial impact on either the pre-Chavez fit of the health variables or the fit of the placebos.

[20] For life expectancy, only 4 of the 17 countries have a pre 1999 RMSPE within 150% of Venezuela's; for infant mortality, only 1 country does. These fits are not substantially affected by changes in the choice of indicator variables used.

[21] We use the same indicator variables for poverty that we did for health, excluding initial GDP per capita and oil wealth.

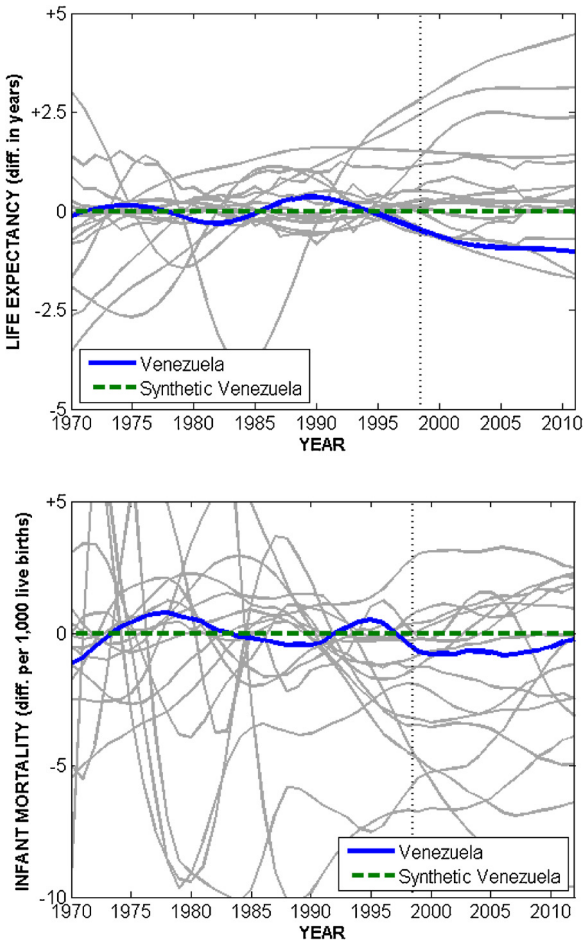

Fig. 7. Health outcomes placebo tests. *Top Graph Note*: The bold line represents the difference between observed life expectancy in Venezuela, 1970–2012, and the synthetic control; the synthetic control (dashed line) is normalized to zero. *Bottom Graph Note*: The bold line represents the difference between the observed infant mortality rate in Venezuela, 1970–2012, and the synthetic control; the synthetic control (dashed line) is normalized to zero. Both graphs show placebo tests (gray lines) for all other countries in the dataset, including those with poor pre-1999 fit.

are able to find poverty rates for three periods prior to 1998, and annual observations from 1998 to 2006, giving us four pre-Chavez periods and eight post-Chavez.[22]

Fig. 8 shows the poverty measure for Venezuela and for the synthetic control, which is composed of 20% Argentina and 80% Colombia. With so few pre-election data points and a limited set of control countries, it is unsurprising that the model does not fit as well as the average income model. Nevertheless, the synthetic control still captures the general upward trend in the poverty rate over the 1980s and 1990s. After the election, poverty experiences upward jumps in 2002 and 2003, but after 2003 trended down, falling significantly below the election-year levels by 2006. This pattern is roughly matched by the synthetic control, with the control in 2006 lying only slightly above the actual poverty rate in Venezuela.

To see how different actual and synthetic Venezuela really are, we create placebos just as we did for average income. We perform the same analysis for all 14 control countries and plot the deviations from their synthetic controls in Fig. 9, with the difference between synthetic and actual Venezuela shown in bold. This figure illustrates that the divergence between actual and synthetic Venezuela is well within the range seen from countries which do not experience the same change in leadership.[23] We find no evidence that Chavez had a significant impact on the poverty rate in Venezuela.

[22] For countries with more than one observation in each pre-1998 period, we average the available observations. We extrapolate the first-period (1980–1987) poverty rate for El Salvador and Paraguay, and interpolate the second-period (1988–1992) rate for Peru and the third-period (1993–1997) rate for Guatemala. We also interpolate a number of annual observations for the post-1998 observations. In most cases, the change in observed rates before and after the missing observation is only a few percentage points. Because of this we believe that linear interpolation is appropriate for the analysis.

[23] The RMSPE for the 1999–2006 period is actually less than the RMSPE for 1998 and earlier, indicating that we have a closer out-of-sample fit than pre-intervention. This is likely due to the small number of pre-intervention observations.

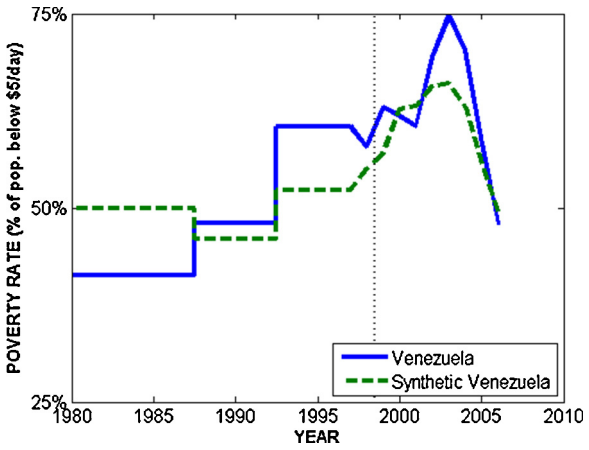

Fig. 8. Poverty rate. *Note*: The solid line represents observed poverty rate in Venezuela, 1980–2006; the dashed line represents the synthetic control. The vertical dotted line indicates the end of the pre-Chavez years (1980–1998).

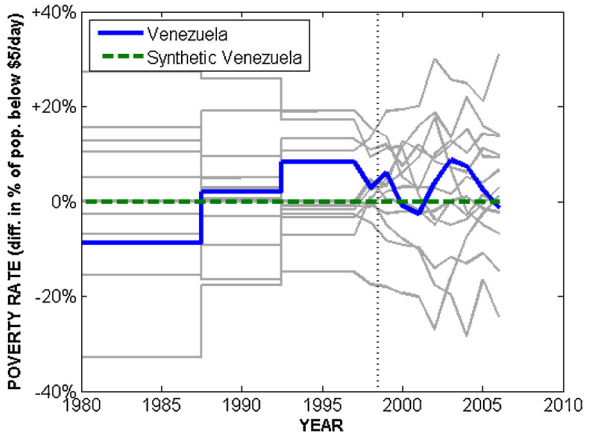

Fig. 9. Poverty rate placebo tests. *Note*: The bold line represents the difference between the observed poverty rate in Venezuela, 1980–2006, and the synthetic control; the synthetic control (dashed line) is normalized to zero. Gray lines represent placebo tests: deviations from synthetic control for all other countries in the dataset. The graph show all countries, including those with poor pre-1999 fit.

7. Results on inequality

Having considered average incomes, health outcomes, and poverty rates, we next use the synthetic control method to study the effect of Hugo Chavez and his policies on inequality in Venezuela. We want to acknowledge up front that there is no perfect panel dataset of Gini coefficients for applied researchers to use. We took two approaches to obtaining one. First we used the WIDER dataset and created our own panel by using all Ginis with quality at least as good as Venezuela's, averaging any multiple observations in a single year, and interpolating to fill in any missing years. That is to say, we made our own sausage.

Our other approach was to use the SWIID database of Solt (2009), which uses its own methods to make a panel from the WIDER and other data (store bought sausage). Since both approaches produced almost identical results, we only present here results using the SWIID database.

We have 14 potential control countries, and use the Abadie methodology to create a synthetic control for Venezuela that is composed of 7% Colombia, 5% Norway, and 88% Uruguay. Fig. 10 shows that, pre-Chavez, our synthetic control generally captures the trend of inequality in Venezuela. Post-Chavez, the control continues to track actual Venezuela until 2003, when Venezuelan inequality falls rapidly and steadily compared to the level predicted by the synthetic control, although the gap levels off toward the end of the sample.

Fig. 11 shows our now familiar placebo tests; as with income, we show the countries with pre-1999 RMSPEs within 150% of Venezuela's. Relative to other countries' synthetic controls, our control for Venezuela is fairly accurate pre-Chavez. The

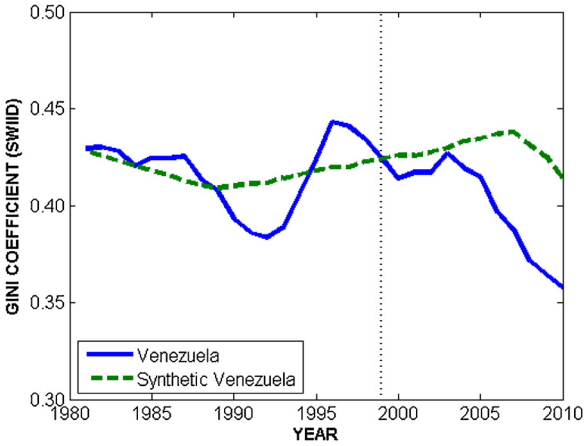

Fig. 10. Inequality (SWIID Gini coefficient). *Note*: The solid line represents observed Gini coefficient (SWIID) in Venezuela, 1981–2010; the dashed line represents the synthetic control.

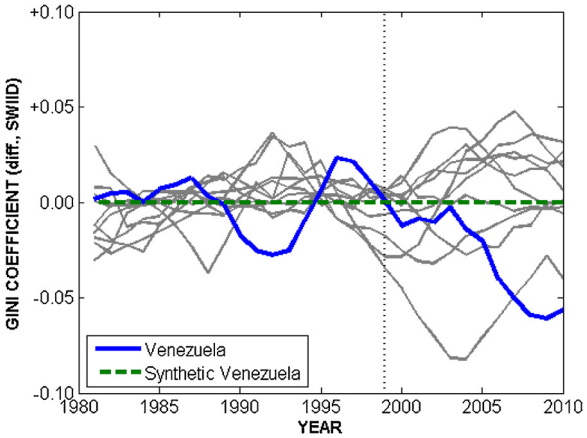

Fig. 11. Inequality Placebo Tests. *Note*: The bold line represents the difference between the observed Gini coefficient (SWIID) in Venezuela, 1981–2010, and the synthetic control; the synthetic control (dashed line) is normalized to zero. Gray lines represent placebo tests: deviations from synthetic control for the other countries in the dataset. This graph only include countries with pre-intervention root mean squared prediction error (RMSPE) less than 2.2212 (1.5 times that of Venezuela). It drops Costa Rica, Indonesia, Norway, and Peru.

figure shows that, although inequality after 2003 has certainly fallen, for the post-Chavez period taken as a whole we have little evidence of lower inequality in Venezuela relative to what there might have been without Chavismo.[24]

8. Conclusion

Identifying the effect of national leaders on economic outcomes is an important, but tricky, business. While in experimental sciences comparison to the right control group is relatively straightforward, clean experiments at the level of national economies are few and far between. Using the synthetic control method of Abadie and Gardeazabal (2003) and Abadie et al. (2010), we create a synthetic Venezuela, indicating how the country is likely to have performed if Hugo Chavez had not been elected to the Venezuelan Presidency in 1998.

We find that although average incomes rose somewhat during his time as president, they lagged far behind where they might have been if Chavez had not taken office. During his leadership, life expectancy grew while mortality and poverty rates fell. Yet we find no evidence that these gains are any different than they would have been with another national leader. If anything life expectancy rose slower than what the control predicted. On the positive side of the ledger, it may be the case that inequality fell faster than it would have without Chavez in office after 2003; but we see no evidence that his term in office as a whole reduced inequality more than it would have without him. While these results are not produced in a complete simultaneous model, they suggest that the observed reductions in inequality and poverty should not be attributed to Chavez's leadership, and that Chavez's legacy may have more to do with the harm caused to per capita incomes.

[24] Viewing the RMSPE ratios of our placebos as the sampling distribution of the null that Chavez had no impact on inequality, our *p*-value is only 0.21.

Table 6
Estimated synthetic control weights, change in donors.

	Expanded	LA &OPEC
Algeria	0.00	0.00
Angola	0.00	–
Argentina	92.25	95.69
Brazil	0.00	0.00
Canada	0.00	–
Chile	0.00	0.00
China	0.00	–
Colombia	0.00	0.00
Costa Rica	0.00	3.62
El Salvador	0.00	0.00
Guatemala	0.00	0.00
Honduras	0.00	0.00
India	0.00	–
Indonesia	0.00	0.00
Iran	0.00	0.00
Iraq	2.80	0.68
Malaysia	0.00	–
Mexico	9.89	0.00
Nigeria	0.00	0.00
Norway	4.95	–
Oman	0.00	–
Panama	0.00	0.00
Paraguay	0.00	0.00
Peru	0.00	0.00
United Kingdom	0.00	–
United States	0.00	–
Uruguay	0.00	0.00
Model fit pre-intervention		
RMSPE	0.115	0.149
APE-to-mean ratio	5.61%	10.90%
SCM inference: permutation test		
RMSPE ratio	1.86	1.08
p-value: RMSPE	0.44	0.67

Note: Columns show the weight assigned to each country in the synthetic controls for Venezuela. Each column includes a synthetic control for a different outcome variable. A dash (–) indicates that the country is not available in the dataset for the given comparison. Weights are in percentage points. Rounding errors may prevent columns from summing to 100. APE-to-mean ratio indicates the average pre-intervention prediction error divided by the average pre-intervention outcome value.

Table 7
Indicator fits & *V*-matrix, change in donors.

Variables	Actual Ven	Expanded sample		LA &OPEC	
		Synth. Ven	*V*-matrix	Synth. Ven	*V*-matrix
avg. GDP per capita	9071	8562		8083	
Pop. Growth Rate	2.67	1.49	14,886.77	1.56	19,580.36
Openness 1970	46.64	18.42	81,447.97	15.71	18,547.68
Openness 1990	46.65	29.54	352,649.32	24.26	41,065.41
GDP per capita Growth Rate	3.22	0.83	1,028,286.77	0.76	150,972.88
1970 Investment share	31.80	25.03	292,758.15	24.65	74,505.61
1990 Investment share	10.14	13.58	467,179.42	13.29	91,995.56
1970 Government share	5.87	9.17	377,201.76	9.49	47,231.03
1990 Government share	4.97	6.24	440,850.65	6.52	80,904.36
PolityII score 1990	9	6.7	266,691.97	7.00	74,979.55
Durable score 1990	21	10.53	450,230.16	9.72	85,048.64
Exconstraints score 1990	6	4.99	242,656.62	5.05	58,964.79
PolityII score 1970	9	–	–	-8.30	8,529.58
Durable score 1970	1	–	–	5.99	77,667.16
Exconstraints score 1970	6	–	–	1.22	5435.86

Note: Table shows the values of indicator variables and the average pre-Chavez outcome variable for actual and synthetic Venezuela. Average GDP is an average over the pre-Chavez period, 1970–1998. GDP per capita is measured in 2005 dollars. Population growth is in percentage points. Government share is a fraction of GDP, in percentage points. Polity and Ex. Const. follow the polity scores scale. Durability and the education variables are measured in years. *V*-matrix columns includes the diagonal entries in the *V* matrix. They determine how much weight each indicator variable receives in the minimization problem for the weights, $W^* = \arg\min(X_1 - X_0W)'V(X_1 - X_0W)$. The values are normalized relative to the entry for the first variable in V (1970 GDP per capita), which equals one. Although they resemble regression coefficients, they are formulated differently and cannot be interpreted as either partial correlations or marginal effects.

Appendix A. Robustness checks

A.1. Change in donor countries

We consider two alternative sets of countries for the GDP per capita analysis, one with an expanded sample and one with a restricted sample.[25] The first adds eight of the largest non-OPEC oil and gas producers for which adequate data is available. Several of these countries are not available in the Barro and Lee (2010) education dataset, so we instead use indicators of average growth, investment share of GDP, government share of GDP, and data from the Polity IV dataset of Marshall and Jaggers (2005). Note that with the change in indicator variables, the pre-intervention fit is much worse, as the overwhelming weight is now placed on a country which is a very poor match for Venezuela's initial GDP per capita.[26]

The second alternative includes only Latin American and OPEC countries which do not experience similar political regime changes in our sample and have adequate data available. Note that the fit of the model is also be worse when the choice of donor countries falls due to the difficulty of matching the initial scale of Venezuela's GDP per capita. This concern is addressed in Appendix A.2. It is also possible that the inability to use education as covariates significantly impacts the pre-Chavez fit. We address this concern in Appendix A.4.

A.2. Normalized income values

We consider an alternative measure of GDP per capita by normalizing each country's log GDP. Instead of using the natural log of GDP per capita for each year, we first divide GDP per capita for each year by GDP per capita for that country in 1970, then take natural logs. Thus the 1970 value for each country is normalized to zero, eliminating the need for the algorithm to balance donors that have lower initial GDP per capita than Venezuela with donors that have higher initial GDP per capita. The results for all three sets of donors (from Appendix A.1) are shown in Tables 8 and 9.

All three are consistent with our main results. In particular, the problem of initial scale matching described in Appendix A.1 is removed, and the poor fit of the larger sample due to the change in indicators (which led to putting high weight on a country which was a poor match for Venezuela's initial income) seems to be resolved once we rescale the outcome data. Note also that the majority of the weight is placed consistently on the same countries: Peru, Costa Rica, and Nigeria (or Iran when Nigeria is unavailable).

A.3. Jackknife

Here we consider our baseline model for real GDP per capita while dropping each country receiving a non-trivial weight one at a time. So we consider versions of the model which exclude, in order, Brazil, Canada, Iran, Mexico, and Peru. The results for these versions of the model are presented in Tables 10 and 11. The exclusion of these countries have no meaningful effect on our results with the exception of Iran, which received the highest weight in the baseline model. The inclusion of Iran (or, as demonstrated in Appendix A.2, Nigeria) and seems critical to capturing the international oil boom early in the sample period.[27]

A.4. Alternative indicator choices

Finally, we considered several alternative sets of predictors before choosing our baseline model, which provides a good fit both to the covariates used to determine the weights W as well as a close fit to the pre-Chavez GDP per capita data (as measured by root mean squared error and the ratio of the mean prediction error to the mean of the data). Tables 12 and 13 show a selection of three alternative sets of covariates. Alternate 1 uses average population growth 1970–1998 and the education variables of the baseline model, but removes openness and adds average per capita GDP growth 1970–1998 and measures of investment and government shares of GDP from 1970 and 1990. Alternates 2 and 3 use the same sets of covariates used by our expanded sample and our Latin America & OPEC-only sample from A.1. The results for Alternates 2 and 3 show the removal of the education variables has a significant negative impact on the pre-Chavez fit. Alternate 1 has a pre-Chavez fit approximately as good as our baseline case (despite shifting weight away from Brazil and toward Argentina and Iraq), and presents similar inference.

Other variables considered include population level, 1970; variation in GDP deflator inflation, 1970–1998; oil wealth per capita, 1995; total subsoil asset wealth per capita, 1995; and average years of secondary and tertiary schooling, 1970 and

[25] The weights and inference are presented in Table 6. The fit of the predictors and the diagonal coefficients of the V matrix for each case are included in Table 7.

[26] If we drop the education data without adding other indicators, leaving only population growth and openness as covariates, the fit is still reduced from our main results, but only slightly. The p-value is somewhat higher, though, possibly due to the inclusion of countries which are unlikely to be well represented by the same factor model in the construction of placebos.

[27] If we run the Jackknife on the normalized baseline model from A.2, the weight on Iran becomes less of a concern. In this setting, dropping Iran causes the pre-intervention RMSPE to rise from 0.052 to 0.067, rather than 0.145. Although the results are no longer statistically significant at the 1% level, the p-value only rises to 0.11 rather than 0.32.

Table 8
Estimated synthetic control weights, normalized.

	Baseline	Expanded	LA &OPEC
Algeria	0.00	0.00	0.00
Angola	–	0.00	–
Argentina	0.02	0.00	0.00
Brazil	0.00	0.00	0.00
Canada	0.00	0.00	–
Chile	0.00	0.00	0.00
China	–	0.00	–
Colombia	0.00	0.00	5.40
Costa Rica	41.69	15.01	13.57
El Salvador	0.00	0.00	0.39
Guatemala	0.00	0.00	0.00
Honduras	0.00	0.00	0.00
India	–	0.00	–
Indonesia	0.00	0.00	0.00
Iran	23.86	0.00	0.00
Iraq	0.00	0.00	0.00
Malaysia	–	0.00	–
Mexico	0.00	0.00	0.00
Nigeria	–	30.22	28.40
Norway	0.00	0.00	–
Oman	–	0.00	–
Panama	0.00	2.49	1.80
Paraguay	0.00	0.00	0.00
Peru	34.43	52.27	50.44
United Kingdom	–	0.00	–
United States	–	0.00	–
Uruguay	0.00	0.00	0.00
Model fit pre-intervention			
RMSPE	0.052	0.062	0.061
APE-to-mean ratio	-0.50%	0.50%	-0.85%
SCM inference: permutation test			
RMSPE ratio	5.41	4.31	4.77
p-value: RMSPE	0.00	0.04	0.00

Note: Columns show the weight assigned to each country in the synthetic controls for Venezuela. Each column includes a synthetic control for a different outcome variable. A dash (–) indicates that the country is not available in the dataset for the given comparison. Weights are in percentage points. Rounding errors may prevent columns from summing to 100. APE-to-mean ratio indicates the average pre-intervention prediction error divided by the average pre-intervention outcome value.

1990. These other variables were either found to have virtually no weight placed on them in the matrix V or significantly reduced the number of donor countries due to data availability without having any positive impact on the pre-Chavez fit.[28]

Appendix B. Chavez and oil

Oil production in Venezuela rose steadily throughout the 1990's, peaking at 3.5 million barrels per day in 1997 and leveling off there. After 2001 it never reached 3 million barrels per day in any year under Chavez. To the best of our knowledge, there is no exogenous, external reason for this decline in oil production. No natural disaster or negative technology shock. Perhaps the previous regime ramped up production to an unsustainable level trying to offset the effects of low prices with greater sales volume, but many observers attribute the decline in production to Chavez and his policies.

Besides nationalizing many aspects of the industry, Chavez had a contentious relationship with the national petroleum company, PDVSA. In 2000, after a one-day strike, Chavez fired the civilian head of PDVSA and replaced him with an army general (Wilson, 2000). In 2003, after another strike, Chavez fired over 15,000 PDVSA employees including many senior technicians and managers.

According to The Economist author P.G. (2012),

> "The sector's decline began in 2003, following a strike by the employees and managers of Petróleos de Venezuela (PDVSA), the state oil company, in protest against Mr Chávez's leftist policies. When the conflict ended, the president had almost 20,000 workers sacked. Since then, PDVSA's chairman, Rafael Ramírez, has steadily replaced them with loyal chavistas: he has made it an explicit company policy to employ only supporters of the president. He has also

[28] We also considered the set of covariates from the baseline model and add as many of the countries in the expanded sample as possible. The results are broadly similar to those presented in the expanded model, including the spurious pre-intervention fit for several placebos leading to a similarly high *p*-value.

Table 9
Indicator fits & *V*-matrix, normalized.

Variables	Actual Ven	Baseline		Expanded sample		LA &OPEC	
		Synth. Ven	*V*-matrix	Synth. Ven	*V*-matrix	Synth. Ven	*V*-matrix
avg. GDP per capita	1.0154	1.0205		1.0102		1.0240	
Pop. Growth Rate	2.67	2.65	809,886.96	2.48	38,877.28	2.46	382,885.48
Openness 1970	46.64	47.07	545,741.72	39.63	23,788.77	37.71	313,492.88
Openness 1990	46.65	50.06	193,562.35	41.22	24,800.18	39.36	304,020.81
Total ed. 15+, 1970	3.74	3.71	445,907.22	–	–	–	–
Primary ed. 15+, 1970	2.91	2.88	810,189.85	–	–	–	–
Total ed. 15+, 1990	5.11	6.66	2.39	–	–	–	–
Primary ed. 15+, 1990	3.76	4.32	1.44	–	–	–	–
GDP per capita Growth Rate	3.22	–	–	-0.05	35,007.84	0.07	568,335.93
1970 Investment share	31.80	–	–	13.35	742.22	13.71	31,108.66
1990 Investment share	10.14	–	–	14.27	29,892.59	14.44	319,539.44
1970 Government share	5.87	–	–	6.16	36,912.57	5.86	292,440.66
1990 Government share	4.97	–	–	6.42	32,447.74	6.19	242,444.57
PolityII score 1990	9	–	–	4.37	21,515.55	4.57	247,053.00
Durable score 1990	21	–	–	17.73	27,913.43	18.20	31,0636.6
Exconstraints score 1990	6	–	–	5.16	23,647.73	5.22	287,769.64
PolityII score 1970	9	–	–	–	–	-3.91	45,515.66
Durable score 1970	1	–	–	–	–	9.83	315,388.27
Exconstraints score 1970	6	–	–	–	–	2.10	30,138.76

Note: Table shows the values of indicator variables and the average pre-Chavez outcome variable for actual and synthetic Venezuela. Average GDP is an average over the pre-Chavez period, 1970–1998. GDP per capita is measured in 2005 dollars. Population growth is in percentage points. Government share is a fraction of GDP, in percentage points. Polity and Ex. Const. follow the polity scores scale. Durability and the education variables are measured in years. *V*-matrix columns includes the diagonal entries in the *V* matrix. They determine how much weight each indicator variable receives in the minimization problem for the weights, $W^* = \arg\min(X_1 - X_0 W)' V (X_1 - X_0 W)$. The values are normalized relative to the entry for the first variable in V (1970 GDP per capita), which equals one. Although they resemble regression coefficients, they are formulated differently and cannot be interpreted as either partial correlations or marginal effects.

Table 10
Estimated synthetic control weights, Jackknife.

	Drop Brazil	Drop Canada	Drop Iran	Drop Mexico	Drop Peru
Algeria	0.00	0.00	0.00	0.00	0.00
Argentina	0.00	0.00	0.00	0.00	0.00
Brazil	–*	2.43	20.45	12.45	0.00
Canada	17.35	–*	29.63	20.62	13.79
Chile	0.00	0.00	0.00	0.00	0.00
Colombia	0.00	0.00	0.00	0.00	0.00
Costa Rica	8.36	8.11	5.74	14.11	39.64
El Salvador	0.00	0.00	0.00	0.00	0.00
Guatemala	0.00	0.00	35.24	0.00	0.00
Honduras	0.00	0.00	0.00	0.00	0.00
Indonesia	0.00	0.00	0.00	0.00	0.00
Iran	38.99	43.28	–*	38.19	37.20
Iraq	0.00	0.00	8.93	0.00	0.00
Mexico	22.06	21.66	0.00	–*	9.37
Norway	0.00	14.61	0.00	0.00	0.00
Panama	0.00	0.00	0.00	0.00	0.00
Paraguay	0.00	0.00	0.00	0.00	0.00
Peru	13.24	9.90	0.00	14.62	–*
Uruguay	0.00	0.00	0.00	0.00	0.00
Model fit pre-intervention					
RMSPE	0.066	0.074	0.145	0.067	0.069
APE-to-mean ratio	0.56%	0.59%	1.65%	0.65%	0.54%
SCM inference: permutation test					
RMSPE ratio	4.53	4.28	1.59	4.30	4.49
P-value: RMSPE	0.00	0.00	0.32	0.00	0.00

Note: Columns show the weight assigned to each country in the synthetic controls for Venezuela. Each column includes a synthetic control for a different outcome variable. A dash (–) indicates that the country is not available in the dataset for the given comparison. Weights are in percentage points. Rounding errors may prevent columns from summing to 100. APE-to-mean ratio indicates the average pre-intervention prediction error divided by the average pre-intervention outcome value.

* These countries have been excluded in order to show the effect on the weights and fit of the model.

Table 11
Indicator fits & *V*-matrix, Jackknife.

Variables	Actual Ven	Drop Brazil Synth. Ven	Drop Canada Synth. Ven	Drop Iran Synth. Ven	Drop Mexico Synth. Ven	Drop Peru Synth. Ven
avg. GDP per capita	9071	9021	9018	8922	9013	9022
Pop. Growth Rate	2.67	2.40	2.35	2.10	2.38	2.57
Openness 1970	46.64	49.27	53.6	46.38	50.91	53.43
Openness 1990	46.65	49.72	53.09	52.34	51.05	58.87
Total ed. 15+, 1970	3.74	4.09	3.72	4.25	4.22	3.90
Primary ed. 15+, 1970	2.91	2.85	2.89	2.80	2.86	2.85
Total ed. 15+, 1990	5.11	6.66	6.44	6.09	6.64	6.70
Primary ed. 15+, 1990	3.76	4.06	4.09	3.91	4.05	4.28

Note: Table shows the values of indicator variables and the average pre-Chavez outcome variable for actual and synthetic Venezuela. Average GDP is an average over the pre-Chavez period, 1970–1998. GDP per capita is measured in 2005 dollars. Population growth is in percentage points. Government share is a fraction of GDP, in percentage points. Polity and Ex. Const. follow the polity scores scale. Durability and the education variables are measured in years. *V*-matrix values have been omitted from the table above, but are available from the authors upon request.

Table 12
Estimated synthetic control weights, alternate models.

	Alt. 1	Alt. 2	Alt. 3
Algeria	0.00	0.00	0.00
Argentina	13.31	75.65	66.85
Brazil	0.00	0.00	0.00
Canada	16.11	0.00	0.00
Chile	0.00	0.00	0.00
Colombia	0.00	0.00	0.00
Costa Rica	0.00	0.00	0.00
El Salvador	0.00	0.00	0.00
Guatemala	0.00	0.00	0.00
Honduras	0.00	0.00	0.00
Indonesia	0.00	0.00	0.00
Iran	36.63	0.00	0.00
Iraq	9.21	0.00	2.04
Mexico	18.82	0.00	0.00
Norway	0.00	9.38	13.31
Panama	0.00	0.00	0.00
Paraguay	0.00	0.00	0.00
Peru	5.91	14.97	17.79
Uruguay	0.00	0.00	0.00
Model fit pre-intervention			
RMSPE	0.060	0.122	0.111
APE-to-mean ratio	0.43%	6.44%	3.66%
SCM inference: permutation test			
RMSPE ratio	3.87	1.90	2.32
p-value: RMSPE	0.00	0.21	0.16

Note: Columns show the weight assigned to each country in the synthetic controls for Venezuela. Each column includes a synthetic control for a different outcome variable. A dash (–) indicates that the country is not available in the dataset for the given comparison. Weights are in percentage points. Rounding errors may prevent columns from summing to 100. APE-to-mean ratio indicates the average pre-intervention prediction error divided by the average pre-intervention outcome value.

> allowed Mr Chávez to use the company as a piggy bank for his "socialist revolution": last year, PDVSA spent twice as much on off-budget government programmes as it did on taxes, royalties and dividends."

After this, Chavez used the PDVSA as a jobs program for loyalists, greatly increasing hiring and increasingly used PDVSA profits for social program spending, allegedly at the expense of maintenance and R&D. "'The only maintenance they have done is to paint things red,' says Francisco Luna, a PDVSA union leader. 'They make everything look nice and pretty but underneath it is all rusted. They don't replace parts until they break,' he said, describing worker conditions as 'disastrous.'" (Mander, 2012)

It should be noted, though, that the decline in production under Chavez coincides with the spectacular rise in oil prices during his era. As shown in Fig. 12, there is no decrease in oil export revenues in the late 1990s or early 2000s.[29] On the contrary, export revenues from oil increased dramatically as prices rose from around $10/barrel at the start of his rule to over $100 a few years later.

[29] Data retrieved from OPEC (2015).

Table 13
Indicator fits & *V*-matrix, alternate models.

		Alt. 1		Alt. 2		Alt. 3	
Variables	Actual Ven	Synth. Ven	*V*-matrix	Synth. Ven	*V*-matrix	Synth. Ven	*V*-matrix
avg. GDP per capita	9071	9033		8487		8739	
Pop. Growth Rate	2.67	2.32	7.05	1.53	32214.27	1.54	3899.35
Openness 1970	46.64	–	–	20.56	34019.73	24.17	146899.40
Openness 1990	46.65	–	–	27.05	68164.47	32.11	168093.27
Total ed. 15+, 1970	3.74	4.11	11.28	–	–	–	–
Primary ed. 15+, 1970	2.91	2.9	4179.69	–	–	–	–
Total ed. 15+, 1990	5.11	6.59	2.46	–	–	–	–
Primary ed. 15+, 1990	3.76	4.09	8.95	–	–	–	–
GDP per capita Growth Rate	3.22	0.31	1333.25	0.86	145463.38	0.89	458172.27
1970 Investment share	31.80	17.75	16.32	24.42	114972.05	24.08	180208.98
1990 Investment share	10.14	22.83	72.4	14.65	109588.68	15.23	89349.51
1970 Government share	5.87	7.52	736.76	8.4	173186.41	8.30	117289.72
1990 Government share	4.97	8.79	182.38	6.09	145101.53	6.24	117125.24
PolityII score 1990	9	–	–	7.43	106552.67	-6.07	14574.21
Durable score 1990	21	–	–	11.01	130944.89	7.3	147631.15
Exconstraints score 1990	6	–	–	5.49	103749.12	1.8	25969.11
PolityII score 1970	9	–	–	–	–	7.25	154983.01
Durable score 1970	1	–	–	–	–	13.8	163731.62
Exconstraints score 1970	6	–	–	–	–	5.54	166418.96

Note: Table shows the values of indicator variables and the average pre-Chavez outcome variable for actual and synthetic Venezuela. Average GDP is an average over the pre-Chavez period, 1970–1998. GDP per capita is measured in 2005 dollars. Population growth is in percentage points. Government share is a fraction of GDP, in percentage points. Polity and Ex. Const. follow the polity scores scale. Durability and the education variables are measured in years. *V*-matrix columns includes the diagonal entries in the *V* matrix. They determine how much weight each indicator variable receives in the minimization problem for the weights, $W^* = \arg\min(X_1 - X_0W)'V(X_1 - X_0W)$. The values are normalized relative to the entry for the first variable in V (1970 GDP per capita), which equals one. Although they resemble regression coefficients, they are formulated differently and cannot be interpreted as either partial correlations or marginal effects.

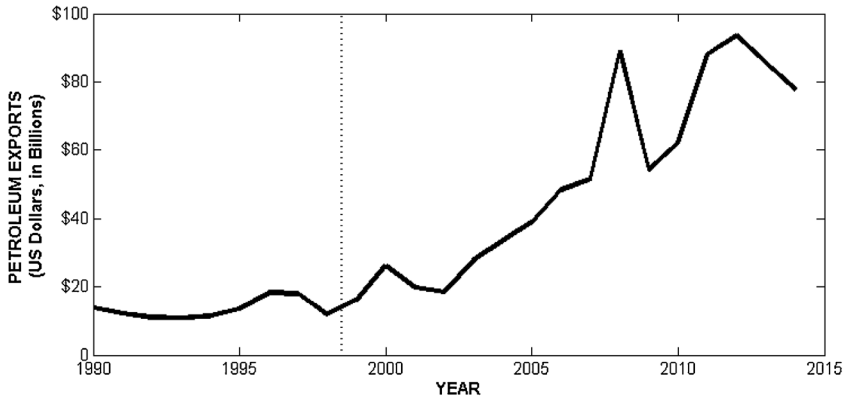

Fig. 12. Value of petroleum exports in Venezuela, 1990–2014. *Note*: The solid line represents the revenue from petroleum exports in Venezuela, 1990–2014. The dashed line shows Chavez's election.

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