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A tale of oil production collapse

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ABSTRACT

Lack of and delayed investment in high capital-intensive industries along with mismanagement can lead to collapse in output. This article focuses on the recent Venezuelan experience, a country with an oil-based rentier economy whose oil industry collapsed. We use synthetic control methods to compare actual oil production performance in Venezuela with a counterfactual scenario since the beginning of Hugo Chavez's presidency in 1999. Our findings indicate that the synthetic Venezuela outperforms the actual Venezuelan oil production, with the gap increasing notably since the late 2000s. On average, actual oil production in Venezuela was approximately 1 million barrels per day lower than the synthetic scenario during the 1999–2021 period. The results are robust to including additional predictors and a battery of placebo test.

1. Introduction

The oil industry is capital intensive, requiring substantial investment, for both increasing capacity and for operating. As pointed out by Espinasa et al. (2017), with no spare capacity, to expand oil production, four steps must be taken: exploration, drilling, extraction and commercialization. There is a lead time to increase capacity and bring production on stream. Hence, lack of and delayed capital investment will drive the oil industry to a disastrous situation.

The oil industry in many countries is nationally owned through a public company that takes over most of the oil activities, becoming a challenge to meet managerial efficiency and to guarantee an stable institutional framework. As stated by Manzano and Monaldi (2008), the oil industry's specific features strongly influence the institutional framework and the political economy of the sector.[1] Manzano and Monaldi (2008) posited that such characteristics of hydrocarbon exploitation interact with the institutional and contractual environment to explain the political economy of taxation and expropriation. The authors provide a comprehensive analysis of the evolution of the political economy of the oil sector for the main Latin American producers from the mid 1990s to mid 2000s. Along the same line, Corrales et al. (2020) provide a more recent analysis for Latin American countries covering the oil boom-bust cycle of 2003–2016.

When studying the evolution of the oil sector of the main Latin American producers, the case of Venezuela is especially striking because its recent poor performance stands in contrast to its previous standing as the most important Latin American oil producer and exporter and one of the main players in the oil world market. Venezuela was one of the OPEC's founding members, being the top oil exporting country until the early 1970s, while currently it has become a minor oil supplier.

The Venezuelan state is the owner of the oil reserves as clearly established in the first Venezuelan Petroleum Law of 1922. Until 1975, privately owned foreign firms were in charge of oil extraction and the Venezuelan government received the corresponding royalties and taxes. During the 1960s the increase in royalties and taxes negatively affected investment leading to declining oil production and eventually the nationalization of the Venezuelan oil industry in January 1976. This also marked the beginning of a new phase for the oil industry in Venezuela when a public company, *Petróleos de Venezuela Sociedad Anónima* (PDVSA), was created to manage the whole oil business with full autonomy; notwithstanding, oil production continued decreasing until 1985.[2]

The positive expectations on the long-term world oil demand in the late 1980s and the beginning of 1990s, as well as the increase in estimated Venezuela's oil reserves made PDVSA put forward several

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[1] Manzano and Monaldi (2008) list the following oil industry's characteristics: important rents, large sunk investments, high proportion of oil reserves concentrated in countries with weak institutions and high political risks; in addition, oil products are massively consumed good and politically salient and have high price volatile.

[2] Factors related to meeting the OPEC quotas and Venezuela's oil reserves lower than other OPEC countries were determinants in such a decrease.

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investment projects to increase oil production considerably. However, such projects could not be undertaken with domestic capital, making necessary the creation of joint ventures with foreign firms. This process was named *apertura petrolera*.[3] Crude oil production almost doubled from 1985 to the late 1990s reaching 3447 kb/d (thousands of barrels per day) in 1998. Nevertheless, things started turning in 1999 with the arrival of Hugo Chavez in office and tensions rose between the new government and PDVSA. Oil production decreased in 1999, fluctuated until 2005 and started declining continuously since 2006. In 2021, crude oil production was estimated to be 654 kb/d.[4]

As described by Hernández and Monaldi (2016) and Monaldi et al. (2021), the Venezuelan oil industry is one of the most recent and most striking examples of an oil industry collapse driven by lack and delay of investment and mismanagement. In Venezuela, not only has the oil sector collapsed, but other key sectors, such as the electric industry that has suffered a substantial decline. León-Vielma et al. (2022) point to disinvestment and mismanagement, as well as, the institutional framework, as the main drivers of the collapse of the electric industry in Venezuela.

Venezuela is an oil-rentier country and, therefore, the decline in the oil industry has caused a substantial drop in income per capita with dramatic economic and social consequences, triggering an unprecedented migration.[5] Venezuela's poor economic growth had been widely studied in the literature on the Dutch disease and resource curse (Rodríguez and Sachs, 1999; Agnani and Iza, 2011, among others). The recent collapse of Venezuela's economy and society has not been addressed by the Dutch disease and resource curse literatures. Jraissati and Jakee (2022) offer a distinct perspective, suggesting that the collapse of the Venezuelan economy was predominantly influenced by endogenous factors rather than exogenous ones.

This article focuses on the Venezuelan oil production since it is the driver of Venezuela's economy and social welfare. We do not go in depth in explaining the details of the events that drove the collapse of the industry, which have been already analyzed in a recent article by Monaldi et al. (2021).

Undoubtedly Chavism, the political regimen at the time, played a significant role in the diminished performance of the Venezuelan oil industry and its eventual collapse. No significant shock to the world oil market occurred that could be considered a common factor that would have negatively affected other countries' oil production during the study period. Furthermore, other exporting countries with similar profiles have performed relatively close to their expected trends, while Venezuela's oil production has followed an unthinkable trend. Moreover, the declining Venezuelan oil production cannot be attributed to the depletion of oil reserves. On the contrary, Venezuela became the country with the largest oil proven reserves since the late 2000s. Lack of capital investment and mismanagement tend to explain the collapse of the Venezuelan oil industry; having as exacerbating factors PDVSA taking over non-oil activities to support social programs and the lack of foreign investors in the oil sector due to the uncertainty in the Venezuela's institutional framework and, in particular, unexpected changes to the oil industry related legislation.

Our research question is what might have been the path of Venezuela's oil production if Chavism had followed a business-as-usual oil policy. Therefore, the article's main contribution is to provide an estimation of the lost oil production during the Chavism period. To answer our research question, we rely on synthetic control methods (SCM) to construct a counterfactual of Venezuela's oil production, a "synthetic Venezuela's" oil production, to be compared with the actual performance of Venezuela's oil production. The SCM has been recently regarded as "the most important innovation in the policy evaluation literature in the last 15 years" (Athey and Imbens, 2017). Moreover, because of its easy interpretability, the SCM has been widely applied in empirical research.

When looking at the relevant SCM related literature, Grier and Maynard (2016) and Absher et al. (2020) showed evidence of a significant negative gap between Venezuela's actual per capita GDP and synthetic Venezuela's GDP path since 1999, the year when Hugo Chavez took office (or technically the beginning of the Chavism era). Grier and Maynard (2016) and Absher et al. (2020) also showed further evidence on the effects of Chavism on social indicators such as poverty rate, health, criminality, inequality, infant mortality. In the context of the Venezuelan oil industry, Jardón et al. (2020) estimated the effects of PetroCaribe on the three dimensions of sustainable development (GDP per capita, human development index and CO2 emissions per capita) for a sample of Caribbean countries.[6] Moreover, Munasib and Rickman (2015) used the SCM to evaluate the impact of the shale gas and tight oil boom on the economies of Arkansas, North Dakota and Pennsylvania; and more recently, Pellegrini et al. (2021) evaluated the impact of oil extraction on social indicators in the region of Basilicata, Italy. In the literature exploring the impact of political disruptions on the economy, Suwanprasert (2023) examines the economic consequences of Thailand's 2006 military coup. Using the synthetic control method, he constructs a counterfactual scenario of Thailand without the coup. His findings indicate no significant changes in GDP, inflation, and unemployment post-coup. However, there is a temporary decline in consumption as a percentage of GDP, along with increases in military spending and international tourism in the short term. As noted, the related articles on Venezuela primarily evaluate either the performance of Venezuela's socio-economic variables during Chavism or the impact of oil exports and production on these variables. In contrast, our article focuses specifically on the impact of Chavism on Venezuela's oil industry, particularly crude oil production. The closest article to ours found in the relevant literature is the study by Reimer et al. (2017), who evaluated the effects of changes of oil taxes on oil production and exploratory and development wells drilled in Alaska.

The rest of the article is organized as follows. Section 2 describes some relevant empirical facts. Section 3 lays out the empirical strategy. Section 4 presents the data and empirical results. Section 5 discusses the main findings. Section 6 presents robustness checks, and Section 7 concludes and summarizes the policy implications.

2. Empirical facts

Fig. 1 shows Venezuela's crude oil production for the period 1980–2021.[7] There was a continuous increase in oil production from the mid 1980s until 1998, the year that Hugo Chavez was elected president. The vertical line in Fig. 1 on the year 1999, indicates the beginning of the new political regime.

In 2001, the newly elected government passed a law on hydrocarbons completely changing PDVSA from a fully autonomous public company for the development of the strategic oil plan to an affiliate subdued to the Minister of Oil and Mining. Under the new law the executive branch of the government had the power to design and to develop the oil strategy. The new law was one of the main triggers

[3] The opening of the Venezuela's oil industry to private firms. Details on this can be found in Giusti (1999) and recently, in Monaldi et al. (2021).

[4] U.S. sanctions from 2017 are believed to have exacerbated the fall as suggested by Weisbrot and Sachs (2019).

[5] See Human Right Watch World report 2022 at https://www.hrw.org/world-report/2022/country-chapters/Venezuela, The UN Refugee Agency https://www.unhcr.org/venezuela-emergency.html.

[6] PetroCaribe is an oil cooperation agreement established in 2005 between Venezuela and Caribbean countries. It aims to facilitate the supply of subsidized crude oil or the exchange of crude oil for other products, thereby supporting the energy needs of participating nations.

[7] Next section provides the reasons why we focus on the period 1980–2021, the selection of the countries and the variables included in the estimation.

Fig. 1. Venezuela's crude oil production.1980–2021.
Source: British Petroleum.

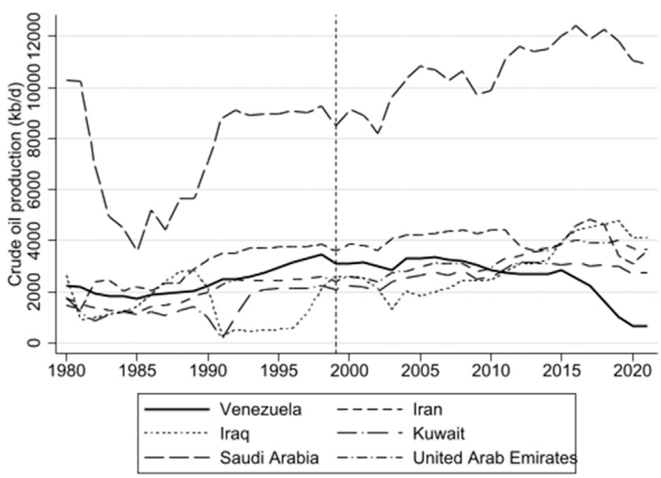

Fig. 2. Major OPEC countries' crude oil production.1980–2021.
Source: British Petroleum.

of the oil strike that took place between late 2002 and early 2003 with a significant negative impact on oil production as shown in Fig. 1. After temporary increases in 2004 and 2005, oil production started to decrease continuously in 2006. As suggested by Weisbrot and Sachs (2019), financial sanctions starting in August 2017 could have worsened the Venezuela oil industry performance. However, sanctions could, by no means, explain the (earlier) collapse of the Venezuela oil industry as rebutted by Hausmann and Muci (2019), and as Fig. 1 shows, there is a clear change in the trend of oil production in 1999 being negative since mid 2000s.

Fig. 2 shows the oil production for major OPEC countries. In 1980, with the exception of Saudi Arabia, differences in production were not too large across the rest of the countries ranging from 2646 kb/d in Iraq to 1467 kb/d in Iran, being Venezuela the third largest OPEC producer. However, at the end of the sample period, Venezuela is the only OPEC country that has experienced a dramatic decrease in oil production. In 1980 Venezuela accounted for 8.7% of the total OPEC production, accounting for only 2.4% in 2021. Currently, Venezuela is the fourth lowest OPEC producer; only producing more oil than Congo, Gabon and Equatorial Guinea, all traditionally considered OPEC minor producers.

Fig. 3 shows the proven reserves for major OPEC countries. Running out of reserves is not a reasonable explanation for the Venezuelan oil industry performance since the mid 2000s. The Venezuela's case is

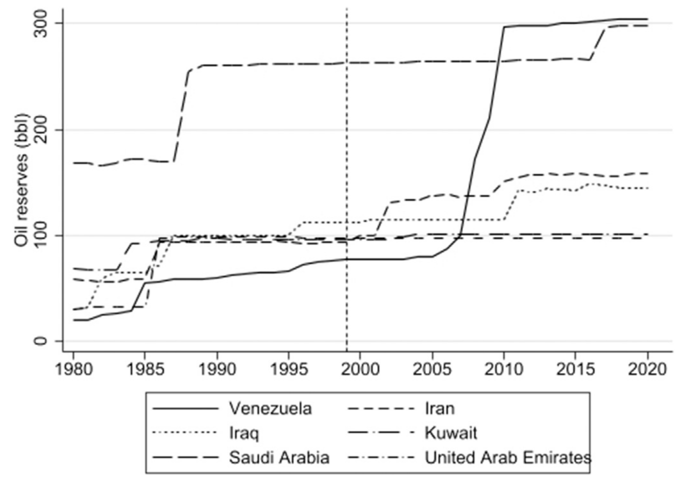

Fig. 3. Major OPEC countries' oil reserves.1980–2021.
Source: British Petroleum.

shocking since it is the country with the largest oil proven reserves worldwide, precisely, since late 2000s.

The current conditions of Venezuela's oil industry made the country incapable of reacting to adjust its oil supply, precisely, because the country faces an extreme capacity constraint. In fact, Venezuela oil production has been far below the assigned OPEC quota in the last decade, suggesting that Venezuela's oil supply is extremely inelastic.

3. Empirical strategy

Our empirical approach is based on the widely used synthetic control method (SCM) proposed by Abadie and Gardeazabal (2003) and further developed by Abadie et al. (2010, 2014). The SCM allows us to evaluate the effect of an intervention that in this study can also be regarded as a structural break caused by the change in the Venezuelan oil policy. The objective of the SCM is to obtain a counterfactual for Venezuela's oil production to be compared with the actual Venezuela's oil production. Following the literature, we refer to the counterfactual as the synthetic control or, in our case, Synthetic Venezuela's oil production. We construct a synthetic Venezuela's oil production with data from a set of donor countries with similar characteristics and not affected by the intervention.

Consider Y_{1t} the Venezuela's oil production in year t. Denote Y_{1t}^N the Venezuela's oil production without intervention and Y_{1t}^I the Venezuela's oil production with intervention. Thus, $\alpha_{1t} = Y_{1t}^I - Y_{1t}^N$ is the effect of the intervention. Considering that the year of the intervention is T_0, we write more formally:

$$Y_{1t} = Y_{1t}^N + \alpha_{1t} D_{1t} \tag{1}$$

Where D_{1t} is an indicator function that takes the value 1 whenever $t \geqslant T_0$ and zero otherwise. Therefore, $Y_{1t}^I = Y_{1t} = Y_{1t}^N + \alpha_{1t}$ for $t \geqslant T_0$.

The objective of the SCM is to obtain the effect of the intervention (α_{1t}) and for that we need to estimate Y_{1t}^N, not only for the post intervention period, but also for the pre-intervention period. This is precisely the advantage of the SCM that allows to construct a synthetic series for the whole period that reproduces as close as possible the actual series during the pre-intervention period and behaves as if the intervention had not occurred. That is what allows us to evaluate the effect of the intervention over time by comparing Y_{1t}^I to Y_{1t}^N for $t \geqslant T_0$.

To estimate Y_{1t}^N we rely on a sample of donor countries with similar characteristics to Venezuela. Let Y_{jt} the oil production of country j with $j = 2, 3, \cdots, J+1$.

Thus, we obtain:

$$\hat{Y}_{1t}^{N} = \sum_{j=2}^{J+1} w_j Y_{jt} \tag{2}$$

Where $\hat{Y}_{1t}^{N}$ is an estimate of Y_{1t}^{N}, w_j is the weight of the country j satisfying $1 \geq w_j \geq 0$ and $\sum_{j=2}^{J+1} w_j = 1$. w_j represents the weight of country j in synthetic Venezuela's oil production. Since w_j is unknown, we need to estimate it; thereby, we need predictors of Y_{jt} for $j = 2, 3, \cdots, J+1$.

Let $\boldsymbol{X_1}$ be a $Kx1$ vector containing the values of predictors for Venezuela's oil production and $\boldsymbol{X_0}$ a KxJ matrix that collects the values of the predictors for the J untreated countries' oil production. Let $\boldsymbol{V}$ be a $(K \times K)$ diagonal matrix with a nonnegative diagonal, where each element represents the importance of the different predictors.

$\boldsymbol{W}^*$, the optimal weight vector, is chosen to minimize the discrepancy between the predictors of Venezuelan Oil Production pre-Chavism, $\boldsymbol{X_1}$, and those of the control countries weighted accordingly, $\boldsymbol{X_0 W}$:

$$\parallel \boldsymbol{X_1} - \boldsymbol{X_0 W} \parallel_v = \sqrt{(\boldsymbol{X_1} - \boldsymbol{X_0 W})' \boldsymbol{V} (\boldsymbol{X_1} - \boldsymbol{X_0 W})} \tag{3}$$

subject to $1 \geq w_j \geq 0$, $(j = 2, 3 \ldots, J+1)$, and $\sum_{j=2}^{J+1} w_j = 1$.[8]

In this case, $\boldsymbol{V}$, the importance of the predictors, is determined so that the path of synthetic Venezuela's oil production before Chavez era closely resembles Venezuela's oil production path before Chavism.

To obtain $\boldsymbol{W}$, $\boldsymbol{V}$ is needed. So for each potential $\boldsymbol{V}$, there is a $\boldsymbol{W(V)}$.

Optimal $\boldsymbol{V}^*$ is chosen to minimize the Mean Squared Prediction Error *(MSPE)* of

$$\sum_{t \in T_0} (Y_{1t} - w_2(V) Y_{2t}) - \cdots - (w_{J+1}(V) Y_{J+1t})^2 \tag{4}$$

In Sum, $\boldsymbol{W}^*$ and $\boldsymbol{V}^*$ are found by minimizing Eqs. (3) and (4).

Choosing the timing of the intervention is a key issue. Sometimes, it is clearly defined as in Abadie et al. (2010) since it was determined by the passing of a law. In Abadie and Gardeazabal (2003), however, the year of intervention was not clearly defined, they choose 1970, while the ETA's terrorist activities started in 1968. The authors provide arguments for such a selection. For example, this can happen when the intervention is not just on a specific year, but rather a continuous process that has a starting year. We encountered a similar problem in our case. It is well known that tensions between the Venezuelan government and the Venezuelan oil industry's managers hardly started with the onset of the new government in 1999. However, it was not until 2001 that a new law on hydrocarbons was passed, which was one of the main causes of subsequent events and eventual drop in oil production. Another key event was the strike in the oil industry that started at the end of 2002 lasting until early 2003, with disastrous consequences for the Venezuelan oil industry and the whole economy. Thousands of experienced and skilled workers, from the lowest to the highest level, were laid off, marking a new era for PDVSA. Thus, we have three possible candidates for the intervention year, 1999, 2001 and 2003. In line with Grier and Maynard (2016), we chose 1999 based on the fact that at that time the relationship between PDVSA and the government started to change in spite of the fact that the legal and institutional framework remained the same. On the robustness section, we present the results when selecting alternative intervention years.

Following Abadie and Gardeazabal (2003), Abadie et al. (2010, 2014) and Abadie (2021), we build the donor pool considering the characteristics of Venezuela's oil industry. Given Venezuela's previous status as important oil exporting country and OPEC member, major OPEC members are natural candidates for the donor pool. In addition, regarding geography, history and culture, Latin American and Caribbean oil producing and exporting countries become a strong subgroup of potential donors. Moreover, there could be other non-OPEC countries whose oil industry could show similar characteristics to Venezuela's oil industry. It is important to keep in mind that our focus is on the Venezuelan oil industry rather than the whole economy. Furthermore, countries that resemble Venezuela's oil industry might be different to the countries that resemble Venezuela's GDP per capita. In addition, the SCM requires a balanced panel, which becomes another constraint for including countries in the donor pool. Thus, the donor pool includes: OPEC members (Algeria, Iran, Iraq, Kuwait, Saudi Arabia, United Arab Emirates), Latin American and Caribbean countries (Brazil, Colombia, Mexico and Trinidad and Tobago), North America (Canada and U.S.), Europe (Norway and United Kingdom), Asia (Malaysia and Indonesia) and Middle East (Qatar and Oman).[9,10]

The fact that most of the countries in the donor pool have performed over their trend allows us to make the usual assumption of no interference between units, that is, the outcomes of the untreated units are not affected by the Chavez's arrival in office.

The sample period is another issue that has to be carefully addressed. As pointed out by Abadie (2021), for the synthetic control estimator to be reliable it is necessary to have sufficient pre-intervention information. However, Abadie (2021) also warned of the possibility of structural breaks when using a too large pre-intervention period. Therefore, data on Venezuela and the donor pool are collected for the period 1980–2021. Thus, the pre-intervention period is 1980–1998. This period does not overlap with the nationalization of the Venezuelan oil industry that started in 1976 when the public oil company PDVSA was created; nor with the first years of this new regime. Before 1976, the Venezuelan oil industry mostly relied on concessions to foreign firms for oil extraction. Therefore, adding too much information especially before 1976 could bias the estimation of the synthetic control. In addition, data on oil exports are available since 1980. Moreover, since the 1980s the oil market started changing dramatically and becoming more competitive with the loss of OPEC's market share. Abadie (2021) also recommends having sufficient post-intervention information, especially when the effect of an intervention is expected to arise gradually over time and with the aim of having a more complete picture of the effects of the intervention over time. In this research, we have the post-intervention period 1999–2021.

The selection of the predictors is also of crucial importance. Following Abadie (2021), we consider pre-intervention values of oil production, oil exports, oil proven reserves, oil consumption, refinery capacity, refinery capacity throughput, active rigs and oil rent as percentage of the GDP. The variables are averaged over a ten year period before the intervention, the 1989–1998 period. In Section 5 we show the robustness of the model to additional predictors.

4. Data and estimation results

Data of production, consumption, reserves of oil and refinery capacity come from British Petroleum.[11] Data on oil exports and active rigs come from the OPEC, while data on oil rents as a share of the GDP are from the World Bank.[12,13] We examine data for the period 1980–2021.

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[8] The restrictions on the elements of $\boldsymbol{W}$ prevent extrapolation outside the support of the control countries' growth predictors (Abadie and Gardeazabal, 2003; Abadie et al., 2010, 2014).

[9] Since the mid-2010s, the United States has emerged as a significant exporter of oil.

[10] Angola, Libya, Nigeria, Ecuador, Russia and Kazakhstan might also be good candidates for the donor pool. However, data were not available for some predictors.

[11] Source: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/oil-gas-and-coal-trade.html. Downloaded on August 22nd 2022.

[12] OPEC data source: https://asb.opec.org/data/ASB_Data.php Downloaded on August 22nd 2022.

[13] World Bank data source: https://data.worldbank.org/indicator/NY.GDP.PETR.RT.ZS Downloaded on August 22nd 2022.

Table 1
Summary statistics. Pre-intervention period: 1980–1998.

	Oil production (kb/d)		Oil consumption (kb/d)		Oil exports (kb/d)		Oil reserves (bbl)		Ref. Capacity (kb/d)		Ref. Capacity Tp. (kb/d)		Active rigs (units)		Oil rents/GDP (%)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Algeria	1238.91	141.68	180.39	27.04	336.19	130.83	9.40	0.90	435.89	2.87	395.52	49.78	33.47	15.86	14.50	5.67
Brazil	585.21	213.28	1294.08	252.96	3.22	6.36	3.84	2.05	1470.52	104.50	1182.55	126.97	41.12	26.35	0.75	0.39
Canada	2027.36	326.59	1820.28	122.14	598.56	293.29	42.67	3.83	1899.67	113.22	1523.21	137.88	261.18	100.52	1.62	1.09
Colombia	385.16	194.59	211.29	42.90	154.31	134.57	1.92	0.93	239.47	35.54	221.77	39.74	15.88	3.03	2.97	1.02
Indonesia	1509.68	96.82	632.86	200.75	916.54	163.03	7.42	2.51	778.70	199.99	712.11	154.76	54.18	17.35	8.21	5.59
Iran	2863.54	844.88	955.44	245.22	1983.75	618.95	81.81	17.04	1217.95	179.50	908.10	342.07	22.82	8.43	18.58	7.34
Iraq	1397.16	868.45	330.99	152.07	971.08	805.08	85.53	25.97	590.21	131.66	361.34	86.17	26.71	5.84	28.10	14.49
Kuwait	1428.37	558.98	119.42	29.68	838.54	365.96	89.72	11.89	710.37	140.63	581.71	229.90	5.71	2.71	35.51	11.11
Malaysia	543.47	154.79	271.65	112.64	373.86	74.82	2.19	0.64	257.00	86.33	209.56	90.39	9.53	3.54	6.57	3.03
Mexico	2973.68	298.76	1520.62	242.92	1511.65	209.85	33.98	10.78	1391.53	130.48	1220.98	86.93	106.94	63.18	5.60	3.04
Norway	1686.47	1009.57	194.57	10.82	1394.47	898.66	7.89	2.77	266.68	30.91	208.22	62.32	13.65	3.14	4.76	1.58
Oman	633.42	208.88	38.03	16.12	583.03	183.79	4.30	0.83	64.74	25.90	49.27	23.79	15.41	4.21	37.04	8.00
Qatar	439.03	113.68	30.23	11.90	342.32	80.51	4.73	2.97	53.00	18.07	41.84	22.70	5.41	3.73	35.18	11.22
Saudi Arabia	7407.78	2185.37	1099.29	252.02	5278.75	2059.17	222.05	46.44	1477.90	369.75	1294.95	388.56	15.94	8.14	33.95	11.86
Trinidad & Tobago	156.74	20.81	26.69	5.41	81.19	18.63	0.61	0.06	296.84	67.31	113.83	39.26	6.41	2.62	13.52	6.09
United States	9353.08	888.97	16908.00	1028.21	149.26	55.91	33.24	2.81	15951.47	916.89	13210.11	924.86	1297.59	738.94	0.84	0.77
UAE	1914.00	522.97	267.44	114.26	1594.73	397.88	77.17	31.45	188.68	56.09	172.57	65.36	20.18	9.92	23.32	7.36
United Kingdom	2364.56	383.76	1701.37	96.00	1348.35	273.23	5.39	1.36	1952.58	242.35	1552.89	145.09	41.24	14.93	1.12	0.84
Venezuela	2371.18	533.39	439.97	27.83	1362.48	440.90	53.12	19.10	1232.58	23.10	981.20	80.10	54.41	25.91	17.14	6.49
Total sample	2172.57	2406.43	1475.93	3698.19	1043.28	1293.34	40.37	55.37	1603.98	3448.00	1312.72	2863.84	107.78	331.81	15.10	14.61

kb/d : Thousand barrels daily.
bbl: Thousand million barrels.
Sources: British Petroleum, OPEC and World Bank.

Table 2
Oil production predictor means.

Variables	Venezuela	Synthetic Venezuela	V(diagonal)	Average of 18 control countries
Oil production (kb/d)	2746.44	2743.65	0.17	2352.62
Oil consumption (kb/d)	449.40	868.47	0	1646.64
Oil exports (kb/d)	1652.63	1633.22	0	1155.67
Oil reserves (bbl)	66.44	66.36	0.66	44.92
Refinery Capacity (kb/d)	1216.20	1131.49	0	1639.19
Refinery Capacity throughput (kb/d)	1033.72	982.69	0	1439.61
Active rigs (units)	70.60	70.53	0.17	82.93
Oil rents share on GDP (%)	17.27	14.41	0	13.68

Table 1 presents summary statistics for the variables and countries during the pre-intervention period of 1980–1998. In terms of oil production (consumption), the mean values ranged from 156.74 (26.69) thousand barrels per day for Trinidad & Tobago to 9,353.08 (16,908) for the United States, with Venezuela having a mean of 2,371.18 (439.97) thousand barrels per day, being above (below) of the mean of total mean sample, which is 2,172.57 (1,475.93) thousand barrels per day. Regarding oil exports, the mean values spanned from 3.22 thousand barrels per day for Brazil to 5,278.75 for Saudi Arabia, while Venezuela exported an average of 1,362.48 thousand barrels per day. The mean oil reserves varied widely, with Trinidad & Tobago holding the lowest at 0.61 billion barrels and Saudi Arabia the highest at 222.05 billion barrels. Venezuela had a mean of 53.12 billion barrels in reserves. Looking at refinery capacity (throughput), the range was from 53.00 (41.84) thousand barrels per day for Qatar to 15,951.47 (13,210.11) for the United States, and Venezuela had a mean capacity of 1,232.58 (981.20) thousand barrels per day. In terms of active rigs, the countries experienced a varied range, with Qatar having the lowest mean of 5.41 and the United States the highest at 1,297.59. Venezuela had a mean of 54.41 active rigs during this period. Finally, for oil rents as a percentage of GDP, the values spanned from 0.75% for Brazil to 37.04% for Oman, while Venezuela had a mean of 17.14% of its GDP coming from oil rents.

Table 2 shows the average values of the pretreatment characteristics for Venezuela, Synthetic Venezuela and the average of the 18 countries in the donor pool. Overall, synthetic Venezuela is a much better match to Venezuela than the average of the donor pool. Average oil production, oil reserves and active rigs over the period 1989–1998 are the main predictors for the synthetic control.

Table 3 displays the weights for countries in the donor pool. The estimated weights indicate that Venezuela's oil production prior to the arrival of Hugo Chavez in 1999 is best reproduced by a combination of Algeria's, Canada's, Kuwait's, Norway's, Saudi Arabia's and UK's oil production. OPEC countries and high-income western countries have similar weights. This result is not surprising given that Venezuela is an OPEC country whose oil industry inherited the managerial skills of the foreign firms after the nationalization in 1976. During the pretreatment period, PDVSA was autonomously managed and it was seen as an exemplary large government owned company.

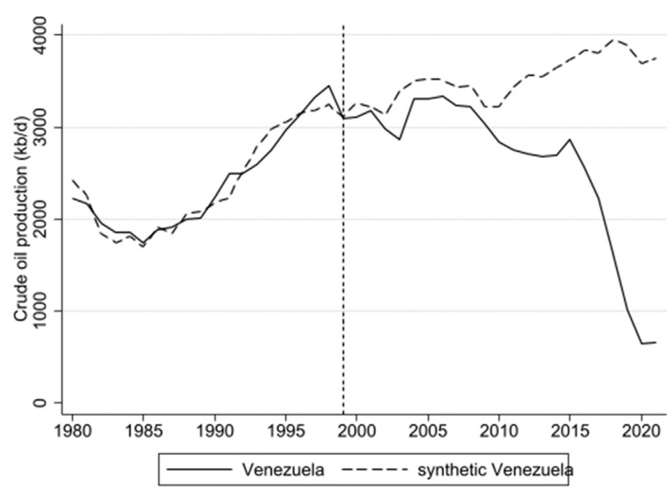

Fig. 4. Crude oil production: Venezuela vs. synthetic Venezuela.1980–2021.

Table 3
Country weights.

Country	Weight
Algeria	0.13
Brazil	0
Canada	0.23
Colombia	0
Indonesia	0
Iran	0
Iraq	0
Kuwait	0.24
Malaysia	0
Mexico	0
Norway	0.16
Oman	0
Qatar	0
Saudi Arabia	0.12
Trinidad & Tobago	0
United States	0
United Arab Emirates	0
United Kingdom	0.12

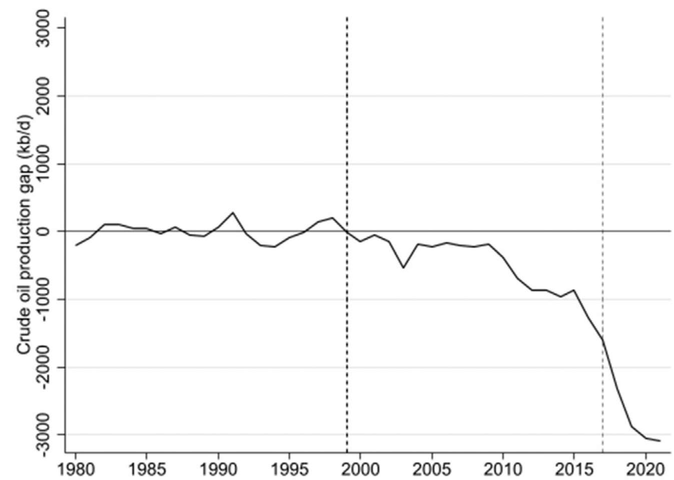

Fig. 5. Effect of the intervention: Crude oil production gap.

Fig. 4 shows the path of crude oil production for synthetic Venezuela compared to the actual crude oil production of Venezuela's over the 1980–2021 period. Visual inspection shows that synthetic Venezuela's oil production closely tracks the trajectory of the actual value of this variable for the pre-Chavism period. It appears that the SCM provides a sensible approximation to Venezuela's actual oil production over the period 1980–1998.

Harvey and Thiele (2021) state that when the target variable is nonstationary, as in this case, a synthetic control is regarded as valid if, in the absence of an intervention, the difference between the synthetic control and the actual variable is stationary; otherwise, it would result in the spurious presence of a stochastic trend in the intervention effect. Harvey and Thiele (2021) recommend the KPSS test to check for stationarity of the difference between the target variable (actual Venezuela) and the synthetic control (synthetic Venezuela) during the pre-intervention period and show that the test is useful even in small samples. We carried out the test and obtained a KPSS statistic of 0.071, which suggests a failure to reject the null of cointegration at any conventional level of significance.[14]

Fig. 4 also shows that in 1999 synthetic and the actual Venezuela's oil production had very similar values. However, from that year on, the synthetic Venezuela's oil production has been larger than the actual Venezuela's during the entire post-intervention period. Until late 2000s both series followed a similar trend with a relatively constant gap. Strikingly, from 2010 the two series have followed diverging trends. The synthetic Venezuela's oil production has followed a positive trend while the actual Venezuela's oil production has followed a negative trend, substantially increasing the gap over time. The economic slowdown in the developed economies starting in the mid 2000 leading to the worldwide financial crisis of 2007–2008 caused a lower oil demand affecting all oil exporting countries since the middle 2000s until the late 2000s. Therefore, it is expected that the synthetic control would also show a negative trend during the economic slowdown. Once the major developed countries went back to the path of economic growth in 2010, oil demand started increasing again and so, oil production and exports increased in most oil producing countries. However, it is in the early 2010s that actual Venezuela's and synthetic Venezuela's oil production start to follow diverging paths, precisely because the countries that have positive weights in the synthetic responded positively to the higher oil demand. It is possible that the global economic slowdown and financial crises may have masked Venezuela's strong capacity constraints and its negative trend in oil production, which could be attributed more to domestic oil policy than external factors.

Fig. 5 plots the yearly estimates of the impact of the arrival of Hugo Chavez on Venezuela's oil industry. It shows the yearly gaps in crude oil production between Venezuela and its synthetic counterpart. On the one hand, Fig. 5 shows that during the pre-intervention period the actual Venezuela's oil crude production fluctuates, on an annual average, around the synthetic Venezuela's at about 100 kb/d. On the other hand, Fig. 5 suggests that Chavez's arrival to office has had a large negative effect on Venezuela's crude oil production and this effect has been increasing over time. The magnitude of the estimated impact of the Chavism is substantial. The results suggest that for the entire 1999–2021 period crude oil production was reduced on average by about 1 million barrels per day, which means about 30% less every year with respect to the crude oil production in 1998. This amount is about the annual average oil production of Indonesia during the post-intervention period.

Given Venezuelan per capita income's dependency on oil production, our results align with previous studies, such as Grier and Maynard (2016) and Absher et al. (2020), which found that by the mid-2010s, Venezuela's per capita income was 30% lower than that of its synthetic control.

An additional line has been added to Fig. 5 for the year 2017 when financial sanctions were imposed on the Venezuelan government. We might well think that sanctions exacerbated the Venezuela's oil production collapse since the slope from 2017 is even steeper than the 2015–2016 period. However, Fig. 5 suggests that even without financial sanctions, Venezuela's oil production would have eventually collapsed.

5. Discussion

There are complex reasons behind the increasing gap between the synthetic Venezuela's oil production and the actual Venezuela's oil production. As discussed earlier, hardly had Chavez taken office, when

[14] Harvey and Thiele (2021) emphasize that while the synthetic control approach does not require donors' time series to be on the same growth path as the target, donors with nonstationary time series must share common trends with the target. They suggested that the validity of a potential donor may be assessed by the KPSS stationarity test on the difference between it and the target. The main value of the tests is to give an ordering of the potential candidates in terms of their likely validity. We carried out the test and found that most of the donors' oil production with positive weights share common trends with Venezuela's oil production during the pre-intervention period. Results are available upon request. We are grateful to the referee for highlighting the importance of considering stationarity in our application of the synthetic control method.

tensions between PDVSA and the government started. The first year of government witnessed the purging of PDVSA's CEO that came from the previous government, which had never been seen before. Supporters of the new government supplanted the higher-level management bodies. The new law on hydrocarbons in 2001 secured PDVSA's majority share in the joint ventures created with the opening of the sector to private capital in the 1990s. Moreover, the government took a more aggressive position with PDVSA, which lost its remaining little autonomy after the oil strike in 2003 when the government eventually took it over completely. The national oil company that had previously enjoyed complete autonomy until 1999 since its creation in 1976 became part of the executive branch of the government from 2003.

It was precisely after 2003 that the government started the well-known social programs, *las misiones*, with resources extracted from PDVSA and in likely detriment to the capital investment in the oil industry.

In 2005 the Venezuelan government launched a new investment plan called *Plan "Siembra Petrolera"* (Oil Sowing Plan) with an unusual long-term perspective through 2030, and with a medium-term projection of 5.4 m b/d (millions of barrels per day) by 2012.[15] The actual value of oil output for that year was about half of the projection. In 2006, a new law on hydrocarbons was passed changing the rules for foreign private companies established since the late 1990s during the *apertura petrolera*. The foreign firms were ordered to engage in a new model of collaboration by which PDVSA would have at least 51% of the ownership and would take over operational control of oil fields. Conoco Phillips and Exxon-Mobil did not accept the new association model and started legal process in international arbitration courts.[16] The Venezuelan government intentionally termed this process as the nationalization of the oil industry. In addition, in 2005 the Law of the Central Bank of Venezuela was modified to lift the obligation of PDVSA to sell 100% of its proceeds in foreign currency to the central Bank (Vera, 2015). Thus, PDVSA, now managed directly by the central government, would have fully discretionary power to use revenues in dollars for its off-budget to fund, for instance, *las misiones*. Moreover, the new law also removed the constraints that limited the Central Bank's from financing PDVSA in domestic currency (Monaldi et al., 2021) and established an optimal level for the international reserves. Therefore, whenever the international reserves are above the optimal level, the exceeding reserves are allocated to PDVSA for financing social programs and for other expenses.

Regarding oil exports, starting in 2005, the Venezuelan government began substituting traditional oil clients with new ones, thereby reorienting its oil export to countries like China, India and other politically allied nations, at the expense of exports to the U.S.[17] A substantial part of this new export policy was in the form of exchanging oil for goods with many countries worldwide; PetroCaribe may be the most representative example of such a policy.[18] In addition, new investment concessions for the private sector were mostly allocated discretionarily to firms from China, Russia, Iran and India (Monaldi et al., 2021).

With the notable increase in oil prices in 2008, the government introduced additional taxes on oil activity, with the most important being the Windfall Profits Tax (WPT). This law established a sliding scale rate, depending on the difference between oil market prices and a reference oil price set in the annual national budget. The government

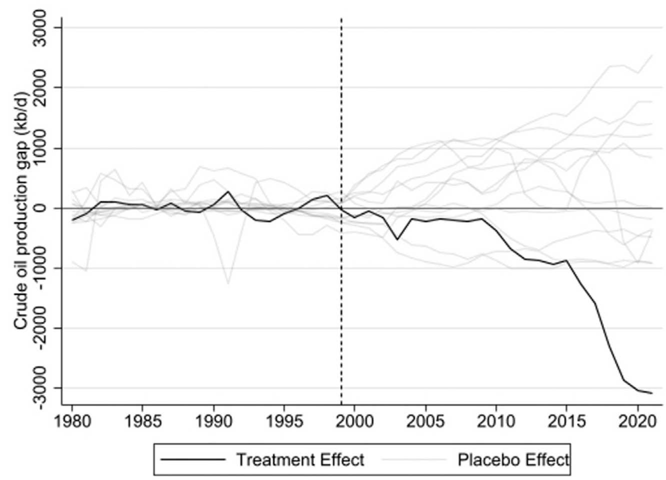

Fig. 6. Placebo test results.

estimated an oil price for the national budget low enough to claim more in taxes further reducing available resources for investment in the oil industry.

Hernández and Monaldi (2016), using data in PDVSA's Management Reports during the period 2010–2015, find that PDVSA's total investments were 20% to 30% lower than the projected investment with exception of the years 2011 and 2012. Hernández and Monaldi (2016) also finds that beside significant deviation from oil investment plan, the composition of investment shifted in favor of non-oil projects and in line with the new role given to PDVSA as a supplier of agricultural products, food goods, electric plants, etc.[19]

As pointed out by Weisbrot and Sachs (2019), in August 2017 financial sanctions prohibited the Venezuelan government from borrowing in US financial markets. In January 2019, sanctions were imposed on the oil industry banning US oil imports from Venezuela. In addition, billions of dollars of Venezuelan assets were also frozen in several western countries. Sanctions might have indeed widened the gap between the synthetic Venezuela's oil production and the actual Venezuela's oil production. However, the drop in production and the increasing gap in oil production dates back to the late 2000s.

6. Robustness checks

6.1. In-space placebo test

Fig. 6 shows the results from the placebo test. The gray lines represent the gap in crude oil production of the 18 countries in the donor pool. The superimposed black line denotes the gap estimated for Venezuela. Fig. 6 suggests that the estimated gap for Venezuela during the 1999–2021 period is unusually large relative to the distribution of the gaps for the countries in the donor pool.

6.2. In-time placebo test

We would argue that synthetic control is not biased to forward-looking the Venezuela's oil industry given the imminent participation of Hugo Chavez in the 1998 election. Nevertheless, we backdate the intervention year three years. In 1996 the *"Agenda Alternativa Bolivariana"* (Bolivarian Alternative Agenda) was published with the intention of sending a clear message on Hugo Chavez's participation in 1998 elections.

[15] This plan also subsidized gasoline to poor localities in the US through the Venezuelan refinery Citgo.

[16] In 2018 Conoco Phillips was entitled more than $2 billion from PDVSA and could seek legal authority to seize assets owned by PDVSA abroad (Krauss, 2018).

[17] In 2007 China and Venezuela created a joint fund with the China Development Bank (CDB) playing a key role. The CDB would lend money to the Venezuelan governments in exchange for oil and equipment purchase from Chinese firms (Wang and Li, 2016).

[18] See Jardón et al. (2020).

[19] We have omitted issues related to the Venezuela's exchange rate system, which has further complicated the PDVSA's financial operations.

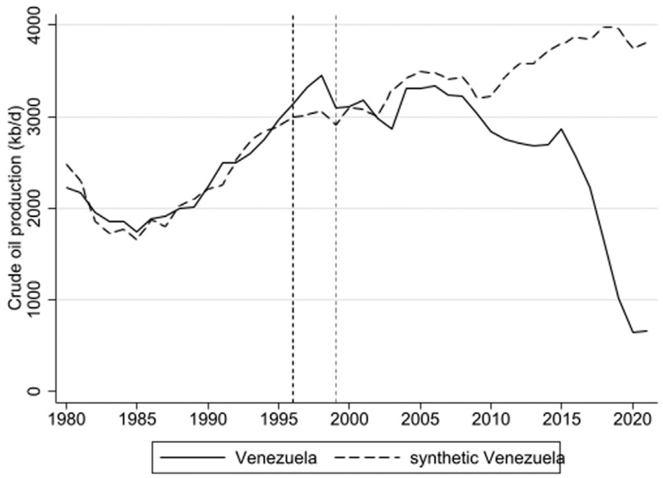

Fig. 7. Crude oil production: Venezuela vs. synthetic Venezuela.1980–2021. Backdating the intervention year to 1996.

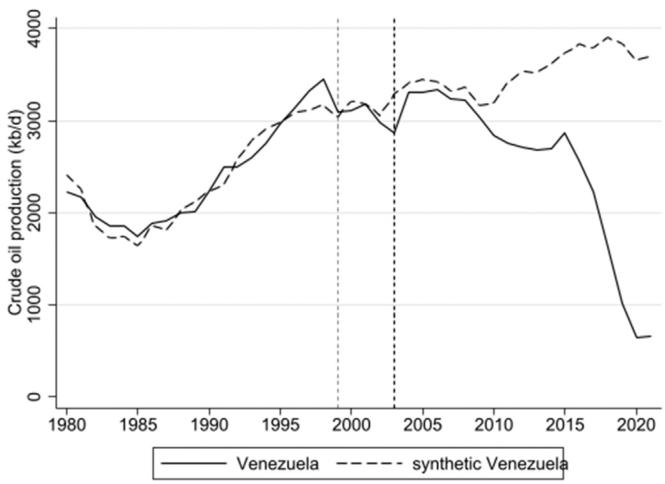

Fig. 8. Crude oil production: Venezuela vs. synthetic Venezuela.1980–2021. Setting intervention year to 2003.

Despite the revolutionary ideas in the *"Agenda Alternativa Bolivariana"* and Chavez's passionate speech during the period 1994–1998, Venezuelans and particularly the oil industry did not anticipate his political economy, as shown in Fig. 7 in which the intervention year is 1996.

As mentioned above, there were two other two possible years as candidates for the intervention year. Fig. 8 shows the results when selecting 2003 as the intervention year, also supporting our selection of 1999 as the intervention year.[20]

6.3. Leave-one-out (LOO) test

This test allows to evaluate the sensitivity of the main results to changes in the country weights. The idea is to provide evidence that no particular country with positive weight in Table 3 leads the results. Therefore, the baseline model is iteratively re-estimated to construct a synthetic Venezuela excluding in each iteration one of the countries with positive weight in Table 3. Fig. 9 shows that the results are fairly robust.

[20] This finding is also robust to changing the intervention to 2001.

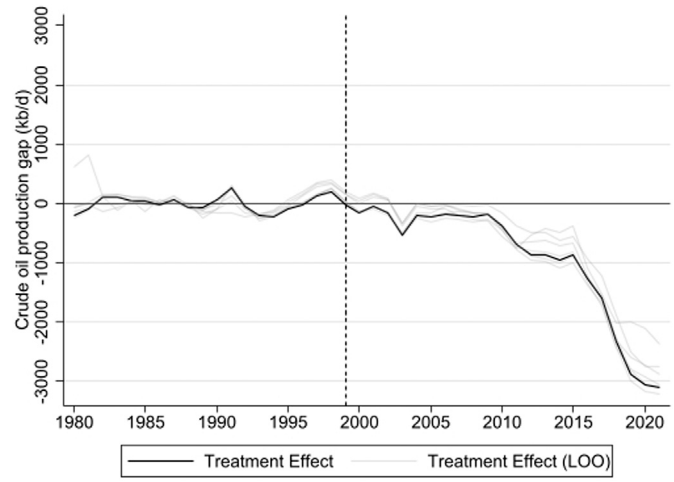

Fig. 9. Crude oil production: Leave-one-out (LOO) test.1980–2021.

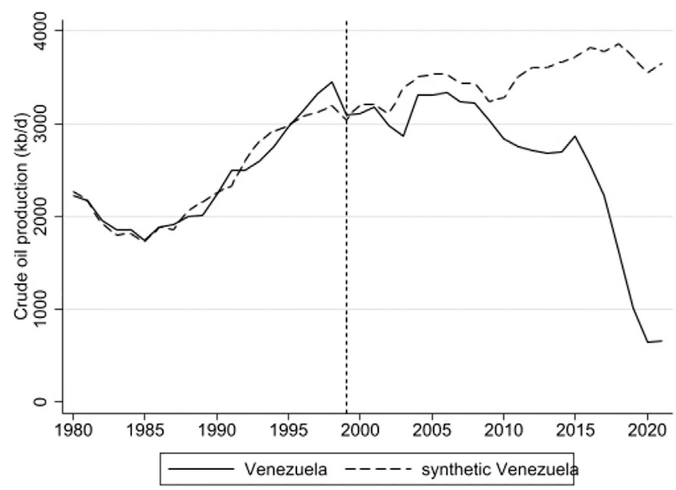

Fig. 10. Crude oil production: Venezuela vs. synthetic Venezuela.1980–2021. Introducing additional variables.

6.4. Including additional predictors

Gas industry and oil industry are highly intertwined. Many oil producing countries are also important gas suppliers. Therefore, in order to assess the robustness of our results, we include the following additional predictors related to the gas industry: gas production, gas consumption and gas reserves. Fig. 10 shows the results; no significant differences with respect to the main results can be observed. As expected, the donor countries and the predictors with positive weights changed. However, Canada, Kuwait, Norway and Saudi Arabia still account for about 65% and the variables oil production, oil reserves and active rigs account for 70%.

We also expand the list of predictors to include FDI net inflows as a percentage of GDP, electricity production from oil sources as a percentage of total electricity production, and fuel exports as a percentage of total merchandise exports.[21] Fig. 11 displays the results, which show no significant differences from the main findings. The donor countries with positive weights remain largely unchanged, with Algeria, Canada, Kuwait, Norway, Saudi Arabia, and the UK still accounting for about

[21] The sources for the additional variables are the International Monetary Fund, the International Energy Agency, and the World Bank, respectively. We are thankful to the anonymous referee for this suggestion.

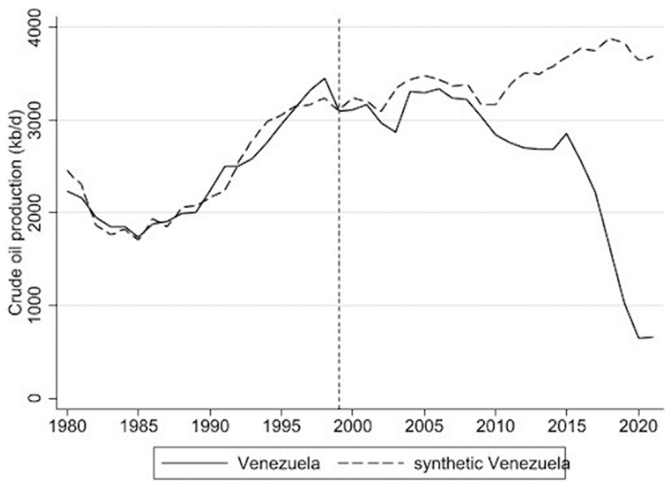

Fig. 11. Crude oil production: Venezuela vs. synthetic Venezuela.1980–2021. Introducing additional variables (FDI and others).

94% of the weights. More noticeable changes occur among the predictors with positive weights, where oil production, oil exports, and refinery capacity throughput collectively account for approximately 100%.

7. Conclusion and policy implications

This article quantifies the loss in crude oil production since Hugo Chávez took office in 1999 in Venezuela. We use the Synthetic Control Methods to estimate a synthetic Venezuela's oil production to be compared with the actual Venezuela's. Variables related to the oil industry activity are used as predictors along with the past values of the oil production. The donor countries include a wide sample of oil exporting countries, both OPEC and non-OPEC members. We show that between 1999–2021, synthetic Venezuela's oil production outperformed Venezuela's actual oil production. Our findings are robust to the introduction of additional variables, in-space and in-time placebo tests and leave-one-out test. A back of the envelope calculation suggests that on average the loss of crude oil production was about 1 million barrels per day during the Chavism (1999–2021).

The results suggest two key factors in the collapse of Venezuelan oil production: mismanagement of the oil industry and lack of the investment during the Chavism. An uncertain institutional framework that discourages effective policies and decline in physical investment along with an unprecedented discretionary decision making have placed Venezuela among the four lowest OPEC crude oil producers in the past few years.

This study suggests that the collapse of the Venezuela's oil industry is neither caused by the contraction of the global economy nor by the decline of the Venezuelan oil reserves. On the contrary, oil is still a major commodity in high demand and Venezuela is the country with the largest proven oil reserves. The relevant literature suggests that the collapse of the oil industry is due to a structural change in the domestic oil policy, our results support this hypothesis. We would argue that the Venezuelan oil company previously autonomously managed with market criteria, became highly politicized and at the service of the government. One key determinant in the recovery of the Venezuelan oil sector is capital investment, particularly foreign capital. To attract foreign capital, Venezuelan oil legislation must be changed, setting credible and clear rules for long term investment and redefining the relationship of the oil industry with the rest of the Venezuelan public sector.

It is possible that there is still some remaining structures of the former oil industry to build on to start the revival of this sector. In addition, the experience of Brazil's oil public company (Petrobras) could be useful to inform the necessary management changes. The human capital is another aspect that need to be addressed. While thousand of skilled workers who emigrated may be willing to return, similar to the FDI attraction, skilled workers might return if they can clearly assess a positive long-term perspective. Moreover, under a new era based on efficiency, the domestic gasoline market would have to be less subsided or even be fully liberalized.

CRediT authorship contribution statement

Henry Aray: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **David Vera:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Abadie, A., 2021. Using synthetic controls: Feasibility, data requirements, and methodological aspects. J. Econ. Lit. 59, 391–425.
Abadie, A., Diamond, A., Hainmueller, J., 2010. Synthetic control methods for comparative case studies: estimating the effect of California's tobacco control program. J. Amer. Statist. Assoc. 105, 493–505.
Abadie, A., Diamond, A., Hainmueller, J., 2014. Comparative politics and the synthetic control method. Am. J. Political Sci. 59, 495–510.
Abadie, A., Gardeazabal, J., 2003. The economic costs of conflict: a case study of the Basque Country. Amer. Econ. Rev. 93, 113–132.
Absher, K., Grier, K., Grier, R., 2020. The economic consequences of durable left-populist regimes in Latin America. J. Econ. Behav. Organ. 177, 787–817.
Agnani, B., Iza, A., 2011. Growth in an oil abundant economy: The case of Venezuela. J. Appl. Econ. 14, 61–79.
Athey, S., Imbens, G.W., 2017. The state of applied econometrics: Causality and policy evaluation. J. Econ. Perspect. 31 (2), 3–32.
Corrales, J., Hernandez, G., Camilo Salgado, J., 2020. Oil and regime type in Latin America: Reversing the line of causality. Energy Policy 142, 111347.
Espinasa, R., ter Horst, E., Guerra Reyes, S., Manzano, O., Molina, G., Rigobon, R., 2017. A micro-based model for world oil market. Energy Econ. 66, 431–449.
Giusti, L.E., 1999. "La apertura" : The opening of Venezuela's oil industry. J. Int. Aff. 53 (1), 117–128.
Grier, K., Maynard, N., 2016. The economic consequences of Hugo Chavez: A synthetic control analysis. J. Econ. Behav. Organ. 125, 1–21.
Harvey, A., Thiele, S., 2021. Cointegration and control: Assessing the impact of events using time series data. J. Appl. Econometrics 36, 71–85.
Hausmann, R., Muci, F., 2019. Don't blame washington for Venezuela's oil woes: A rebuttal. Am. Q. Retrieved September 10, 2022, from: https://www.americasquarterly.org/article/dont-blame-washington-forvenezuelas-oil-woes-a-rebuttal/.
Hernández, I., Monaldi, F., 2016. Weathering collapse: An assessment of the financial and operational situation of the venezuelan oil industry. In: CID Working Paper Series 2016.327. Harvard University, Cambridge, MA.
Jardón, A., Kuik, O., Tol, R.S.J., 2020. Causal effects of PetroCaribe on sustainable development: A synthetic control analysis. Manch. Sch. 88, 156–210.

Jraissati, J., Jakee, K., 2022. Venezuela's collapse: Exogenous shock or institutional design? Econ. Aff. 42, 344–360.

Krauss, C., 2018. ConocoPhillips wins $2 billion ruling over venezuelan seizure. The New York Times, April 26, sec. Business Day. Retrieved September 9 2022, from: https://www.nytimes.com/2018/04/25/business/energy-environment/conocophillips-venezuela-ruling.html.

León-Vielma, J.E., Ramos-Real, F.J., Hernández Hernández, J.F., 2022. The collapse of Venezuela's electricity sector from an energy governance perspective. Energy Policy 167, 113009.

Manzano, O., Monaldi, F., 2008. The political economy of oil production in Latin America. Economía 9, 59–103.

Monaldi, F., Hernández, I., de La Rosa Reyes, J., 2021. The collapse of the Venezuelan oil industry: The role of above-ground risks limiting foreign investment. Resour. Policy 72, 102116.

Munasib, A., Rickman, D.S., 2015. Regional economic impacts of the shale gas and tight oil boom: A synthetic control analysis. Reg. Sci. Urban Econ. 50, 1–17.

Pellegrini, L., Tasciotti, L., Spartaco, A., 2021. A regional resource curse? A synthetic-control approach to oil extraction in Basilicata, Italy. Ecol. Econom. 185, 107041.

Reimer, M.N., Guettabi, M., Tanaka, A.L., 2017. Short-run impacts of a severance tax change: Evidence from Alaska. Energy Policy 107, 448–458.

Rodríguez, F., Sachs, J.D., 1999. Why do resource-abundant economies grow more slowly? J. Econ. Growth 4, 277–303.

Suwanprasert, W., 2023. Consequences of Thailand's 2006 military coup: Evidence from the synthetic control method. Eur. J. Political Econ. 80, 102475.

Vera, L., 2015. Venezuela 1999-2014: Macro-policy, oil governance and economic performance. Comp. Econ. Stud. 57, 539–568.

Wang, Q., Li, R., 2016. Sino-venezuelan oil-for-loan deal the Chinese strategic gamble? Renew. Sustain. Energy Rev. 64, 817–882.

Weisbrot, M., Sachs, J., 2019. Economic Sanctions As Collective Punishment: The Case of Venezuela. Center For Economic and Policy Research.