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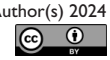
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The Socio-Economic Impact of an Abrupt Loss of Oil: A Synthetic Control Approach in the Case of Sudan

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Abstract
With the secession of South Sudan in 2011, the Republic of Sudan experienced a sudden loss of more than 70% of its oil reserves. Few countries have experienced such a dramatic macroeconomic adjustment within a short period of time. While earlier studies have explored the socio-economic impacts of oil discoveries, little is known about what happens in the case of an abrupt reversal of an oil windfall. We make use of the synthetic control method to isolate the effects of such an abrupt oil loss. We find little evidence of oil-induced socio-economic effects with the exception of higher unemployment.

Keywords
Oil, Sudan, synthetic control method, resource curse, growth, corruption

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Introduction

There has been an expanding literature (consisting of cross-country and case-study analyses) providing support to a resource curse hypothesis (i.e. to the underperformance of resource-rich countries across several socio-economic indicators, see, for example, Murshed, 2017). A common resource curse transmission mechanism relates to the so-called Dutch Disease theory, where abundant oil typically frustrates growth through impacting export diversification. Increased demand for minerals and spending in non-tradables can crowd-out exports, initiate a process of de-industrialisation and raise unemployment rates (see Fattah, 2017). Another strand of the resource curse literature links oil dependence to corruption and weak institutions (see Orihuela, 2018). Lack of transparency and democratic accountability in many resource-rich settings intensifies rent-seeking and corruption. The spread of corruption leads to misallocation of resources and, hence, to the crowding out of local and foreign investment, which, in turn, hampers long-run economic growth and employment.

Oil was first discovered in Sudan by Chevron in 1974. The second Sudanese civil war starting in 1983 and the deteriorated diplomatic relations between Sudan and the United States dampened the interest of Western energy corporations in Sudan's petroleum sector. Gradually, Asian energy corporations (such as the China National Petroleum Corporation, Petronas and the Indian Oil and Gas Corporation) entered and dominated Sudan's oil market since the mid-1990s with commercial oil extraction commencing in 1999. A detailed discussion on the history of Sudan's petroleum sector can be found in IMF (2020).

Contrary to other oil-rich macroeconomic failures, oil was largely perceived as a contributor to economic growth in Sudan between 1999 and 2010. During these years, the economy was growing at an average of 6% per annum supported by rising oil prices and investment in related infrastructure (for oil processing, refining and transportation). Oil production peaked at 480,000 barrels oil per day (kbopd) in 2010, accounting for almost a fifth of the overall gross domestic product (GDP) value (IEA, 2024). Nonetheless, this oil-led growth was unable to solve some structural macroeconomic challenges, as in the case of persistently high unemployment rates (which were close to 15% during the same period, see Khalifa, 2016). Sudan's export mix has traditionally been highly concentrated, with few primary commodities dominating exports (e.g. cotton, sesame, groundnuts, oil between 1999 and 2010, and gold more recently). The participation of manufacturing in exports has historically been very limited. Unfortunately, the discovery of oil did not support export diversification in Sudan. While oil exports were growing steadily to dominate Sudan's total exports, non-oil exports were diminishing in magnitude; by the time of South Sudan's secession in 2011, oil represented 98% of Sudan's total exports (and manufactured goods only 0.3% respectively, World Bank, 2022).

In January 2011, an independence referendum took place in oil-rich South Sudan. More than 98% of the population voted in favour and, as a result, Sudan lost its southern territories and more than 70% of its proven oil reserves by July of the same year (when the official independence was South Sudan was declared). In the immediate aftermath of the separation, oil production in the Republic of Sudan dropped to 130 kbopd and Sudan has become a net oil importer ever since (IEA, 2024).

In that respect, Sudan is a rare macroeconomic experimental case study of a country abruptly losing more than 70% of its oil reserves (and hence by definition reducing its oil dependence). There have been earlier cases of resource-rich regions breaking away from another country to claim statehood. For example, oil-rich East Timor gained independence from Indonesia in 2002, but the overall macroeconomic effect in Indonesia was minimal given its relative small size. Pakistan's separation from India in 1947 is another case study that has received much attention.

Unlike Sudan, India however did not suffer a significant loss in mineral resources due to the secession of Pakistan (which was not particularly mineral-rich, with the exception of gypsum reserves). The greatest impact was confined to the agricultural sector, where India lost 22 out of the country's 70 million acres of fertile irrigated land as a result of Pakistan's secession (Mehra, 2020). This left India with a shortage of food grains, cotton and jute (while being one of the major global exporters of raw cotton and raw jute in earlier decades).

Our analysis utilises the synthetic control method (SCM) to compare the evolution of selected macroeconomic and institutional indicators for both Sudan and a comparative synthetic Sudan unit in the aftermath of the South Sudan secession in 2011 (and the corresponding loss of most of its oil reserves). The study covers the period between 1995 and 2018 and aims to assess whether the abrupt reduction in oil dependence since 2011 might have triggered a 'reversed resource curse' captured through improved economic growth, increased export diversification, reduced unemployment and lower corruption. While institutions encompass a wide range of formal and informal rules and norms, our empirical focus is on corruption (given the increased attention this has received within the resource curse literature). The synthetic unit is constructed as to imitate the evolution of the corresponding socio-economic indicators in the pre-2011 (pre-secession) period. Deviations in the aftermath of the South Sudan secession and oil loss (during 2011–2018) are then consecutively attributed to the corresponding loss of oil wealth. A set of predictors for each outcome indicator help define optimal weights that minimise the prediction error between the actual Sudan outcomes and the ones of the synthetic Sudan in the pre-2011 period. The synthetic Sudan unit, in other words, represents a credible counterfactual, against which one can measure the impact of oil loss on Sudan in the post-2011 period.

The second section briefly reviews the empirical resource curse literature, while the third section describes our empirical strategy and data. The fourth section presents the results of the empirical investigation based on the synthetic control estimates. We find little evidence of oil-induced socio-economic effects in the aftermath of the 2011 oil loss, with the exception of higher unemployment. Finally, the fifth section concludes.

A brief literature review on the resource curse

There is an expanding number of empirical studies examining the effects of resource dependence/abundance on economic growth and employment. Typically, this literature links economic growth to mineral resources through the effects of the latter on other economic and institutional fundamentals (see, for example, Savoia and Sen, 2021; Tiba, 2019). Dutch Disease effects are often perceived as a prominent mechanism in the resource curse literature (see Mien and Goujon, 2022). Oil dependence typically leads to overvalued currencies, loss of competitiveness, a reduction in non-oil exports, premature de-industrialisation and unemployment (Ouoba, 2016). The end result of this process can be a slowdown in economic growth, if tradables are indeed more conducive to growth than the non-tradables or the extractive sector (Murshed, 2017). Naturally, the net effect depends on the size of spillovers across sectors, the price elasticity of exported commodities and the labour intensity of their production (see Omojolaibi and Egwaikhide, 2014, for a discussion on potential 'resource blessing' effects). The failure to diversify the economic structure and its export mix during resource booms ultimately renders oil-rich nations more vulnerable to resource price volatility and more prone to macroeconomic fluctuations (Lashitew et al., 2021).

Others argue that low institutional quality as captured by rent-seeking behaviour and endemic corruption is a major transmission mechanism for the negative impact of oil resources on growth and employment (see Destek et al., 2023). The concentration of oil rents within few hands and geographic localities incentivises rent-seeking and erodes transparency (Savoia and Sen, 2021). In

many resource-rich contexts, corruption often becomes pervasive and manifests at multiple levels (from everyday small transactions to the higher levels of political kleptocracy). Some researchers indicate that the negative link between export concentration and growth in oil-rich countries passes through their inferior institutions. This strand of the literature argues that the contest over oil rents by elites hinders the investment and innovation needed to diversify exports (Matallah, 2020). However, it is important to note that some scholars challenge the assumption that oil necessarily promotes poor institutions. They argue, instead, that it is the quality of the institutions that prevailed before the commencement of extractive activity that determines the sign of the resource impact (Menaldo, 2016).

Few studies have dealt with the impact of oil on the Sudanese economy and their results have been mixed and inconclusive. In her descriptive study, Nour (2011) shows that although oil did accelerate growth in Sudan, the oil sector was also associated with a number of economic and developmental challenges. Her study discusses how excessive oil reliance limited export diversification, rendering the Sudanese economy more vulnerable to price shocks in global commodity markets. Furthermore, Khalifa (2016) showed that non-oil exports dropped steadily since 1999, leading to a sharp increase in agricultural imports and persistent current account deficits. A recent study by Abbass Ali (2023) investigates the impact of the oil reserve shift (from Sudan to South Sudan) on the macroeconomic performance and export diversification for both economies. She concludes that Sudan's oil loss was associated with improved macroeconomic performance and export diversification. In parallel, the sudden influx of oil revenues in South Sudan led to a premature oil dependence and export concentration. However, Hassan and Abdullah (2015) focus on the impact of oil on the service sector in Sudan between 2000 and 2012 and attest a beneficial effect. Their study indicates that the emergence of the oil sector supported growth in certain service sectors (as in the case of construction, communication, hotels and hospitality, and transportation). Regarding institutional effects, Jerome et al. (2005) suggests that rent-seeking in the oil industry in Sudan weakened government efficiency and facilitated the spread of corruption. Oil rents may have also reduced demand for greater democratic accountability during the pre-2011 period of robust economic expansion.

Synthetic control method: data and methodology

Synthetic control method

Our analysis employs the SCM to examine the socio-economic impact of an abrupt loss in oil reserves due to South Sudan's secession. This methodology allows us to create counterfactual units (synthetic Sudan) that simulate the time evolution of specific outcome variables in a business-as-usual scenario. Moreover, the SCM does not require the same strict assumptions normally required for difference-in-differences and panel data analysis. In contrast, the SCM constructs control units using a weighted combination of a pool of donor units (i.e. the country units that have not experienced any similar shock in the form of losing substantial territory or oil reserves). These weights are optimally chosen to minimise the distance between the actual and synthetic values prior to the identified shock/intervention (see Abadie et al., 2010; Abadie and Gardeazabal, 2003). In other words, the control group (synthetic unit) mirrors the treatment group as closely as possible prior to the shock, so that any deviations in the aftermath of the shock can be attributed to the shock itself.

Different to other customary methods of statistical inference, Abadie et al. (2010) provide a method of inference for the syntactic control analysis that depends on a permutation distribution. According to this method, the shock treatment is repeatedly applied for all untreated units in the donor pool. This creates an individual placebo effect each time. The permutation distribution is

then used to derive a *p*-value (statistical significance) for each post-intervention estimate based on the proportion of untreated units, which have an estimated effect at least as large as that of the treated unit. This method is called the Non-Restricted Donor Sample (NRDS) inference method. However, this inference method can result in overconservative *p*-values, when untreated units in the donor pool do not closely match the trajectory of the outcome variable for the treated unit prior to the intervention (Fenton Villar and Papyrakis, 2017). To address this concern, Abadie et al. (2010) came up with a revised method of inference. This method simply adjusts the estimated effects measured in the treatment period against the pre-intervention deviation. It practically divides the post-intervention effect size by the pre-treatment root mean squared prediction error. The *p*-values are generated from the proportion of the treated units that have an estimated effect at least as large as that of the treated unit (Fenton Villar and Papyrakis, 2017; Galiani and Quisorff, 2017). This revised method (which we use subsequently for our analysis) is called the Adjusted NRDS) method.

We make use of the SCM due to its multiple benefits (in relation to other commonly used methodologies, such as panel data regressions, difference-in-difference estimations and time series techniques). SCM optimally constructs a comparative unit that imitates the behaviour of the outcome variable in the pre-treatment period as closely as possible; this limits any biases associated with a subjective selection of comparative units. It also allows effects to vary over time and does not rely on extrapolation of data trends. Fenton Villar and Papyrakis (2017) provide a detailed discussion on the merits of SCM against other econometric techniques.

Data

Our SCM model covers the period between 1995 and 2018. The starting year reflects the time when oil extraction began to have a visible impact on the Sudanese economy and was also chosen as to maximise the availability of data for all potential donor countries that will compose synthetic Sudan. The intervention year is 2011 (demarcating hence the pre- and post-treatment periods), coinciding with the secession of South Sudan and the corresponding loss of more than 70% of proven oil reserves for the Republic of Sudan.

To construct the counterfactual synthetic unit for Sudan, we define a comparative donor pool of countries. This consists of countries which never experienced a similar shock/intervention (in the form of a substantial loss/drop of oil revenues) throughout the whole period of analysis (i.e. in both the pre- and post-intervention periods). Along these lines, we have excluded from our donor pool all countries that experienced changes in their borders between 1995 and 2019 (as in the case of Serbia, Kosovo, Timor-Leste, and Montenegro). This is to ensure that donor countries composing the counterfactual synthetic unit did not go through a similar treatment/shock to the one of Sudan in 2011. Moreover, our selected donor countries must meet certain conditions. Donor pool countries must have been consistently oil-rich throughout the period of analysis. This is again to ensure that Sudan will be the only country experiencing an abrupt change in oil dependence during the period of analysis (and hence help isolate any socio-economic effects thereof). For this reason, we only include 23 donor countries for which oil rents consistently accounted for at least 10% of their GDP (see Appendix 1 for donor countries and weights). As a robustness check we have also replicated the analysis using as an alternative donor pool those countries for which fuel exports account for at least 30% of total export value.

We assess the performance of some key socio-economic outcome variables in the aftermath of the negative oil shock. These outcome variables are economic growth, unemployment, export diversification, and corruption. The selection of variables is based on their well-established nexus with oil rents in the natural resource curse literature, as discussed earlier in the literature review

section. For export diversification, we make use of the export product concentration index of UNCTAD (2022). The index takes the values between 0 and 1 (where higher values indicate highly concentrated export baskets and less export diversification). Growth in GDP per capita is measured by the annual growth in real GDP per capita (in 2010 constant US dollars). The unemployment rate refers to the share of the labour force that is without work but available for and seeking employment. Data for growth in GDP per capita and unemployment are provided by the World Development Indicators website of the World Bank (2022). Finally, we rely on three alternative indices to evaluate changes in corruption outcomes. The first corruption index is a broad measure of *political corruption*, capturing the extent of corruption acts carried out by political officers (involving both petty and grand types of corruption). The second corruption index relates to *executive corruption* and measures

> whether and how routinely do members of the executive or their agents grant favours in exchange for bribes, kickbacks, or other material inducements, and how often they steal, embezzle, or misappropriate public funds or other state resources for personal or family use. (V-Dem, 2022)

The third measure of corruption refers to *regime corruption* and measures the extent to which those occupying political office abuse power for private or political gain. All three corruption indices take values between 0 and 1 with higher values corresponding to higher levels of corruption. Corruption data come from the Varieties of Democracy dataset (V-Dem, 2022). Our study makes use of a large number of predictor variables for our outcome variables to ensure the smallest possible distance between actual and synthetic values in the pre-treatment period.[1] Similar to other SCM analyses, we have also included the lagged values of outcome variables as predictor variables to control for unobservable characteristics and ensure the best possible fit in the pre-intervention period. The complete list of these predictors (as well as outcome variables) is provided in Appendix 2.

Findings and discussion

Effect on per capita growth and unemployment

According to the resource curse theory, oil dependence has a negative impact on both unemployment and growth in the long run (which may become reversed in the aftermath of an abrupt oil loss as in the case of Sudan in 2011). As can be seen in Figures 1 and 2, the consistently positive oil-led growth in the pre-intervention (pre-2011) period coincides with stubbornly high levels of unemployment. The left-hand side of both figures display the trajectory of growth and unemployment

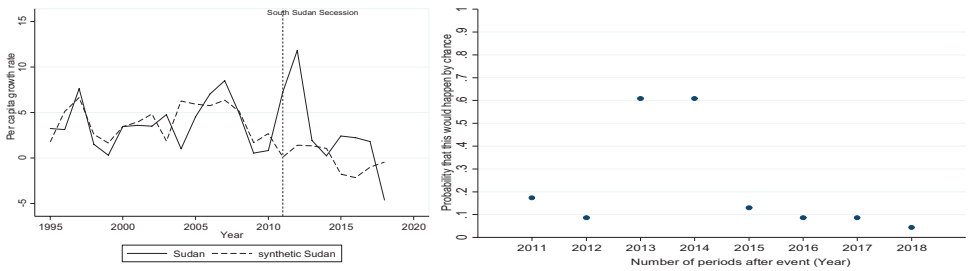

Figure 1. Per capita growth and adjusted *p*-values.

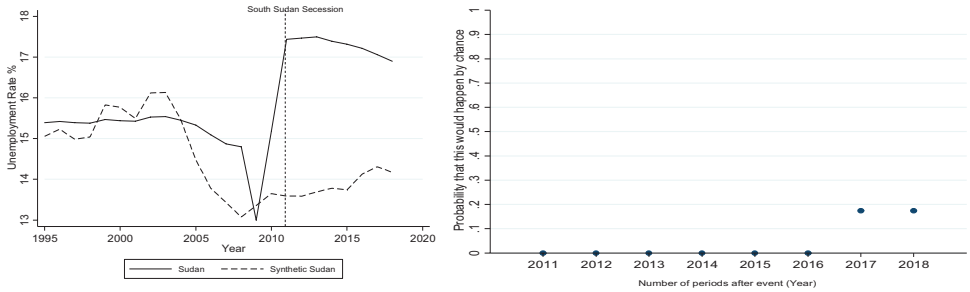

Figure 2. Unemployment rates and adjusted *p*-values.

both for the actual and synthetic values, with the timing of the 2011 oil shock (associated with the secession of South Sudan) marked by a vertical dotted line. The right-hand side of both figures display the statistical significance and corresponding adjusted *p*-values for the outcome gaps between real Sudan and synthetic Sudan for all post-treatment years. Figure 1 demonstrates a mixed picture of both positive and negative gaps for growth between the actual and synthetic values. The gap is, however, statistically significant (at the 10% level) only for 4 post-treatment years. Focusing on the statistically significant results, Sudan's growth seems to outperform synthetic Sudan in 2012, 2016 and 2017 (with the gap being as high as 8 percentage points in 2012). However, in 2018 the situation becomes reversed with Sudan's per capita growth lagging behind that of synthetic Sudan (by approximately 3 percentage points).

Sudan experienced high rates of economic growth during the pre-intervention period of oil-led expansion. As the extractive sector gradually crowded-out other economic activities (primarily agriculture and manufacturing) during the pre-2011 period, the loss of most oil reserves left the economy more susceptible to macroeconomic volatility. The exceptionally improved economic performance in 2012 is attributed to particularly favourable weather conditions at the time that supported increased agricultural yields and resulted in an expansion of agricultural output by about 6%. Growth since 2012 has been weaker compared with the pre-secession years (also as a result of weak performance in the service sector, which heavily relied on extractive rents in the past). However, this subdued growth was still superior compared with the counterfactual synthetic unit (i.e. in comparison to other countries that remained oil dependent during a period of challenging economic conditions and reduced profitability for the global oil markets). Finally, the sharp decline in per capita growth in 2018 coincides with a period of political instability and public discontent that ultimately led to the termination of Omer Al-Bashir's 29-year reign a year later.

Figure 2 shows the evolution of unemployment in the pre and post-treatment period for both Sudan and synthetic Sudan. The figure displays a substantial divergence in unemployment between Sudan and synthetic Sudan in the post-intervention period with a positive gap ranging between 3 and 4 additional percentage points for Sudan. The unemployment gap is also statistically significant (at the 1% level) for the first 6 years since the loss of the South Sudanese reserves (i.e. between 2011 and 2016). Figure 2 hence suggests that adverse developments in the oil sector are associated with the unemployment increments observed since 2011. The abrupt and substantial loss of oil reserves did not only increase the already high unemployment rates (since the majority of the labour force in the oil fields came from the North) but further exacerbated problems in the labour market. This is related to structural labour conditions that have for a long time received little attention by the Sudanese authorities. With the oil sector providing limited employment opportunities (at least directly), the agricultural sector established itself as the main job provider in rural areas

with more than 45% of the workforce employed in this sector. During the oil-boom years, many rural young workers sought better working opportunities in urban areas. The majority of young workforce that migrated from Sudanese villages to cities were shifting their jobs from the agricultural sector to the service sector. This gradual rural-urban labour shift exposed these young (and largely unskilled) migrants to risks. After the 2011 loss of oil reserves, the urban service sector ceased to expand in value and employment without the support of the oil industry; this left most migrated workers without jobs and few opportunities to seek alternative employment elsewhere. As mentioned earlier, during the oil boom period, there was a crowding-out of manufacturing which reduced employment opportunities within the industrial sector, as well as the overall demand for practical training and skills. In the pre-2011 years of oil domination, 62% of higher education students were involved in humanities in comparison to only 32% of them in sciences (African Economic Outlook, 2022). This both hindered the opportunities of workers to switch employment in alternative sectors once the oil and service sectors suffered, as well as constrained the ability of the more advanced manufacturing sector to remain competitive and expand. In the pre-secession period, the agricultural sector was equally neglected, with agricultural exports falling in value (see Gadkarim, 2010; Khalifa, 2016), while in several cases oil exploration and extraction led to land degradation lowering agricultural yield potential (and the ability of local pastoral communities to earn income and livelihoods, see Pantuliano, 2010). The unemployment gap since 2011 largely reflects blatant short-sightedness from the perspective of policy makers who failed to channel oil rents in the pre-secession period towards developing the competitiveness and potential of activities outside the oil and service sectors (Sharfi, 2014). Economic uncertainty in the earlier years following the secession of South Sudan (combined with high inflation rates) also reduced inflows of foreign direct investment as foreign investors sought safer destinations for their portfolios (adding hence an additional credit constraint to the potential development of non-oil production opportunities). Replicating the analysis for the alternative donor group based on fuel exports yields very similar qualitative findings (Appendix 3). As a robustness check, we rerun the SCM graph for alternative intervention years (e.g. 2 and 4 years prior to 2011, when the actual secession took place). Our results indeed point to a 2011-specific effect (attributed hence to the South Sudanese secession shock).

Effect on export concentration

We now shift our attention to the potential impact of a negative oil shock (in the form of the post-2011 secession of South Sudan and corresponding loss of oil reserves and rents for the Republic of

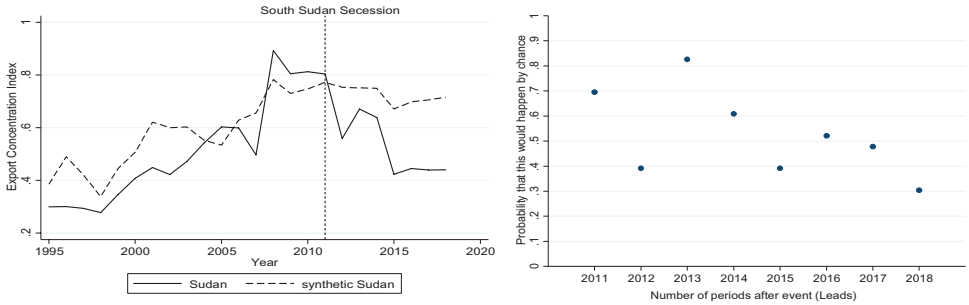

Figure 3. Export concentration index and adjusted *p*-values.

Sudan) on the export structure of the Sudanese economy. Figure 3 presents and compares the evolution of the export concentration index for Sudan and its counterfactual synthetic Sudan (please note that higher values of the index correspond to higher levels of export concentration). In the pre-secession years, the extractive sector has been contributing to a steady reduction in export diversification consistent with the Dutch Disease process typically experienced by mineral-dependent economies (as a result of the Sudanese currency appreciation and the crowding-out of other non-oil exports, especially in agriculture and manufacturing, see also Nour, 2011). Regarding the post-intervention period, the left-hand side of the figure indicates that the export concentration values are smaller for Sudan compared with synthetic Sudan since 2011 and have been falling. This is likely a direct consequence of the dramatic contraction of the extractive sector and oil exports; while Sudan still needs to build more export-oriented and competitive industries, the abrupt loss of oil reserves consequently resulted in a more diverse export basket (with a larger representation of agricultural export commodities and gold). It is worth noting, however, that this took place at an early stage when the country still had to build alternative exporting sectors and diversify away from oil (i.e. at a time when the overall size of Sudan's export basket shrunk, making hence alternative sectors look larger in relative – but not necessarily – in absolute terms). Please note that the *p*-values displayed on the right-hand side indicate that the corresponding gaps and effects on export diversification are not statistically significant so that one can verify a direct causal pattern. Replicating the analysis for the alternative donor group based on fuel exports yields very similar qualitative findings (Appendix 4).

Effect on corruption

To test the hypothesis of a potential reversal of an 'institutional resource curse' (to the extent that reduced oil dependence may result in improved institutional quality and reduction in corruption), we apply the SCM methodology using three indices of corruption (namely political, executive and regime corruption). The left-hand side of Figures 4 to 6 provide a graphical illustration of the time path for our three indices of corruption both for real and synthetic Sudan. The right-hand side of the corresponding figures display the statistical significance of the gaps between Sudan and synthetic Sudan as obtained from the corresponding placebo tests.

In general, Figures 4 to 6 show small differences between Sudan and synthetic Sudan, especially for executive and regime corruption in the immediate years following the 2011 secession of South Sudan (with gaps being smaller than 0.05). The results suggest that Sudan performed worse in relation to its synthetic counterpart for most of the post-secession period, a situation that however becomes reversed since 2017. Nonetheless, all differences between the two lines (that could

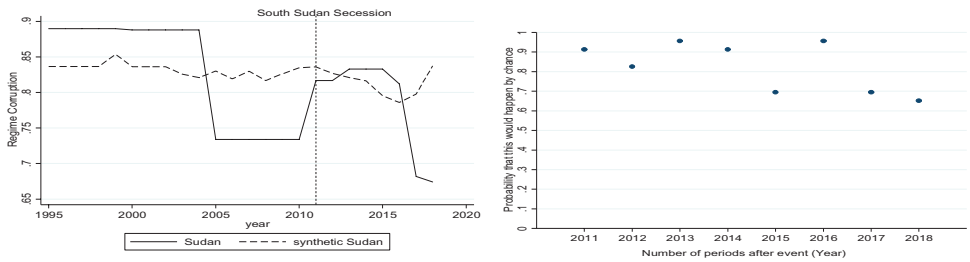

Figure 4. Regime corruption index and adjusted *p*-values.

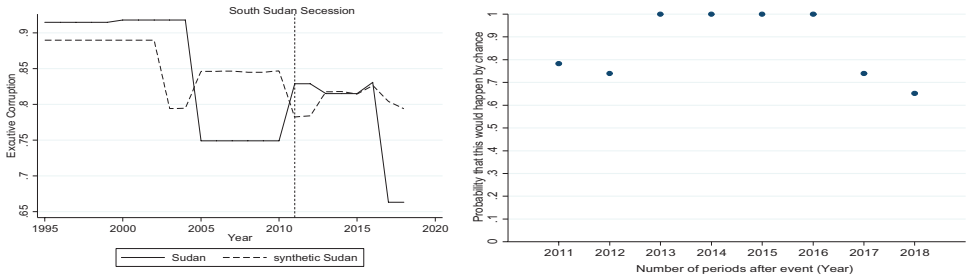

Figure 5. Executive corruption and adjusted *p*-values.

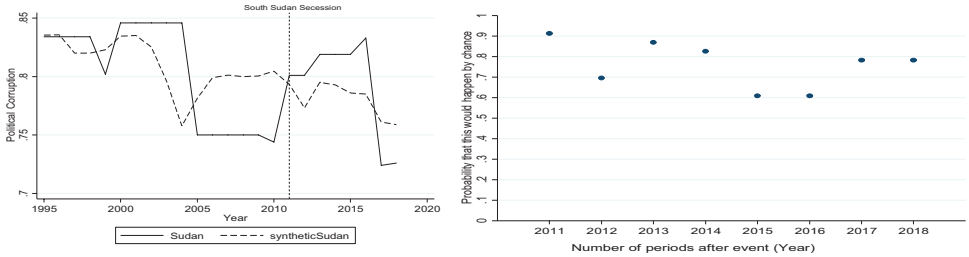

Figure 6. Political corruption index and adjusted *p*-values.

point to some oil-shock driven causal effect) are statistically insignificant as captured by the corresponding *p*-values displayed on the right-hand side of each. Other studies have also pointed to the limited time variability of institutional variables for Sudan and suggested that corruption seems to have become structural for the Sudanese economy (and hence less prone to change as a result of interventions and shocks). In other words, weak institutions are a persistent characteristic of the Sudanese economy that preceded the establishment of the extractive sector in the early 1990s. Ali et al. (2023) find similar results based on their vector autoregression specifications, where they explore the response of multiple institutional indicators (rule of law, executive corruption, electoral/participatory democracy, regime corruption and clientelism indices) to an oil impulse (shock). El-Nafabi (2010) attribute the deep-rooted and widespread nature of corruption among both the higher and lower echelons of public officials to the weak and ineffective internal control systems, deficiencies in accounting systems, non-deterrent penalties, low salary levels, extensive nepotism and absence of external auditing mechanisms. The presence of weak democratic institutions, where political power has often been exercised for personal or party gain, has also been contributing to high levels of ingrained political corruption. Ismail (2011) also links the extent of corruption in Sudan to the concentration of power within the hands of few political actors that stifled demands for higher levels of accountability. This is often attributed to the successive dictatorships that have dominated the system of political governance in Sudan since its independence in 1956. Moreover, the historical dependence on a very limited number of primary commodities (cotton and crops seeds in the 1980s and 1990s, petroleum in the 2000s and gold more recently) as the main source of government and export revenues contributed to the prevalence of a rent-based economy (and stifled transition to a more dynamic and competitive market economy). The slight improvement in

corruption scores since 2017 (although marginal in relative terms, given that Sudan still appears in the top 20 corrupt countries in international comparative rankings of transparency, see, for example, Transparency International, 2022), is likely to be attributed to the Anti-Corruption Committee finally becoming functional in 2016 as an independent body that 'receives complaints from citizens and reports from civil servants about alleged corruption and prepare investigative reports for the Ministry of Justice to present to the judiciary' (as well as to the 2015 Freedom of Information law that protected the right to disseminate and receive information, see Ardigo, 2020). Replicating the synthetic control analysis on corruption for the alternative donor group based on fuel exports yields very similar qualitative findings (corresponding graphs are provided in Appendix 5).

Conclusion and policy recommendations

Oil dominated the Sudanese economy for more than 15 years until the secession of South Sudan and the loss of its oil reserves in 2011. During these years, the extractive sector possibly induced significant structural changes with long-lasting effects on how the Sudanese economy functions and performs (even in the aftermath of the 2011 South Sudan secession). While there is much empirical research conducted on the developmental effects associated with oil dependence (as part of the so-called resource curse literature), little analysis has been devoted to examining the socio-economic impacts of a substantial reversal of an earlier oil windfall. Does such a negative oil shock and abrupt reduction in oil dependence translate into a reversal of the so-called resource curse? Do institutions improve as the extractive industry becomes less dominant in relation to other sectors? Inspired by its recent popularity in comparative econometric analysis, the SCM provides a strong analytical tool to examine the behaviour of key socio-economic variables as major interventions and shocks take place (as in the case of the South Sudanese secession and abrupt oil loss). This is achieved through the construction of a comparative counterfactual unit (a weighted basket of other countries that remained consistently oil rich) that closely imitates the socio-economic behaviour of Sudan prior to the intervention. Deviations in the aftermath of the South Sudan secession and oil loss (during 2011–2018) are then consecutively attributed to the corresponding loss of oil wealth. We hence adopt the synthetic control methodology to examine potential effects of an abrupt oil loss on several socio-economic variables (economic growth, unemployment, export concentration, and corruption indices). The selection of these variables is based on existing findings within the resource curse literature linking them to oil dependence. Our study contributes to the resource curse literature by focusing on the unique characteristics of the Sudanese economy to examine a potential reversal of the 'curse'. Sudan is a rare macroeconomic experimental case study of a country abruptly losing more than 70% of its oil reserves (and hence by definition reducing its oil dependence).

With the exception of unemployment (and growth for specific years), none of the other outcome variables appear to have been influenced in a statistically significant manner by the 2011 oil shock (as suggested by the corresponding *p*-values for the gaps between the actual and synthetic Sudan trajectories in the post-intervention period). Results on unemployment are, however, at odds with the hypothesis of a reversed resource curse in the case of an abrupt loss of oil wealth. The substantial loss of oil reserves did not only alleviate the persistently high unemployment rates but instead further exacerbated problems in the labour market. This links to structural and chronic labour conditions that undermined the development of alternative export-oriented and competitive industries (and hence employment opportunities outside the extractive sector). During the oil boom years, oil-induced Dutch Disease effects crowded out agricultural and manufacturing activity, concentrating most employment opportunities in the service sector. After 2011 and the loss of oil reserves, the urban service sector ceased to expand without the support of the oil industry; without

any dedicated efforts towards the development of other sectors, workers from the oil and service sectors largely failed to find alternative employment elsewhere. Here, one also needs to critically reflect on the labour market characteristics of Sudan and other Sub-Saharan economies, where a large share of the population works in the informal sector. Given that informal sector employment is largely not monitored and tracked, one needs to interpret changes in the International Labour Organisation–reported unemployment rates with some caution. Any reported rises in official unemployment figures can, hence, not necessarily capture reduced employment, but a shift from formal to informal work.

These results recognise the acute need for Sudan to diversify the structure of its production and exports to embark on a development path of sustained growth in output and unemployment. The long-neglected agricultural sector is a good starting point given its labour-intensive character (and could provide alternative livelihoods for those who cannot support themselves anymore from the service sector in urban areas). However, most of the agricultural sector is traditional and rainfed, limiting hence its ability to become a sustainable source of growth and jobs. Efforts should be accelerated to modernise the sector and integrate it within manufacturing (e.g. in the form of processed food). There can also be important opportunities on the light manufacturing front. Sudan's high-quality cotton production supported a vibrant textile industry in the 1970s, which declined in size over time. Reviving efforts in the cotton industry by replacing old technologies with more automated processes could reverse this declining pattern (together with the assistance of sophisticated textile-focused higher education, e.g. within the department of textile engineering at the Sudan University of Science and Technology, see Ahmed, 2018). Combatting corruption at multiple levels will also naturally assist in attracting foreign investment and reduce transaction costs for entrepreneurs (for bribes and other 'facilitation' fees). In addition, Sudan is currently going through a transitional period to achieve a full democratic political system by 2024 (which often represents a major step towards impeding and preventing political corruption, see Bergougui and Murshed, 2020).

This has been a first empirical attempt to examine the links between an abrupt oil shock (in the form of substantial loss of national territory and oil reserves) and several socio-economic outcomes with the use of a novel experimental method (i.e. the SCM). There are naturally several limitations and opportunities for future research. Our analysis is limited to examining aggregate macroeconomic impacts for the Republic of Sudan. This has prevented us from examining more localised effects of oil extraction. Improved regional data availability in the future could allow one to replicate the synthetic control methodology at the subnational level. This will allow to evaluate subnational oil-shock impacts, especially for regions and localities that were previously excessively dependent on oil reserves (e.g. in the vicinity of the South Sudanese border). Another limitation relates to the limited availability of macroeconomic data for South Sudan; this has prevented us from examining, in parallel, the corresponding impacts for the South Sudanese economy (which 'inherited' to a large extent most oil reserves after its secession). Improved data availability will allow future researchers to replicate our analysis in the case of South Sudan, where the macroeconomic oil shock in 2011 was of the opposite sign.

Author's note

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Note

1. For the sake of consistency, we have used the same predictors for all outcome variables.

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Appendix 1

Table 1. List of donor pool countries and weights by outcome variable.

Outcome variable	Per capita growth	Unemployment	Export concentration	Executive corruption	Regime corruption	Political corruption
Donor pool	Weight	Weight	Weight	Weight	Weight	Weight
Algeria	0	0.043	0	0	.455	0
Angola	0.142	0	0	0	0	0
Azerbaijan	0.03	0	0.754	0.087	0	0
Congo Rep.	0	0	0	0	0	0
Ecuador	0	0	0	0	0	0
Egypt	0.308	0	0	0.165	0	.048
Equatorial Guinea	0.035	0	0	0.04	.25	0
Gabon	0	0	0	0	0	0
Iran Rep.	0.051	0.021	0	0	0	0
Iraq	0	0	0	0.341	.049	.443
Kazakhstan	0	0	0	0.245	0	0
Kuwait	0	0	0	0	0	0
Libya	0	0.575	0	0.122	0	.351
Nigeria	0.238	0.171	0	0	.245	0
Oman	0	0	0	0	0	0
Qatar	0	0	0	0	0	0
Russia Federation	0	0	0.207	0	0	0
Saudi Arabia	0	0	0	0	0	.049
Trinidad and Tobago	0	0	0	0	0	.001
Turkmenistan	0.043	0	0.038	0	0	0
United Arab Emirates	0	0	0	0	0	.021
Venezuela	0.077	0.191	0	0	0	.087
Yemen Re.	0.077	0	0	0	0	0

Appendix 2

Table 2. Outcome and predictor variables used in the synthetic control analysis.

Outcome variable	Variable description	Data source
Per capita Growth	GDP per capita is gross domestic product divided by midyear population. Data are in constant 2010 US dollars.	World Bank (2022)
Unemployment	Refers to the share of the labour force that is without work but available for and seeking employment.	World Bank (2022)
Export Concentration	Shows to what extent exports of an economy is concentrated on few products rather than among several products.	UNCTAD (2022)
Executive Corruption	Measures whether and how routinely members of the executive, or their agents grant favours in exchange for bribes, kickbacks, or other material inducements.	V-Dem (2022)
Regime Corruption	The extent to which political actors use political office for private or political gain. If focuses on specific set of actors – those who occupy political offices – and a set of corrupt acts that relate to neopatrimonial rule	V-Dem (2022)
Political Corruption	This broad measure of corruption refers to executive, legislative and judicial corruption, capturing both petty and grand types of corruption (and involving both bribery and theft).	V-Dem (2022)
Predictor Variable	**Variable Description**	**Data Source**
Oil Rent	Oil rents are the difference between the value of crude oil production at world prices and total costs of production.	World Bank (2022)
Fuel export (% of merchandise imports)	Fuels comprise the commodities in SITC section 3 (mineral fuels, lubricants and related materials).	World Bank (2022)
Log of Population	Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.	World Bank (2022)
Foreign direct investment	Foreign direct investment are the net inflows of investment to acquire a lasting management.	World Bank (2022)
Trade share of GDP	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic production.	World Bank (2022)
Military expenditure	Military expenditures data from SIPRI are derived from the NATO definition.	World Bank (2022)
Education expenditure	General government expenditure on education (current, capital, and transfers) is expressed as a percentage of total general government expenditure on all sectors	World Bank (2022)
Control of corruption	Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests.	World Bank (2022)
Regulatory quality	Perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	World Bank (2022)
Rule of law	Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	World Bank (2022)

Appendix 3

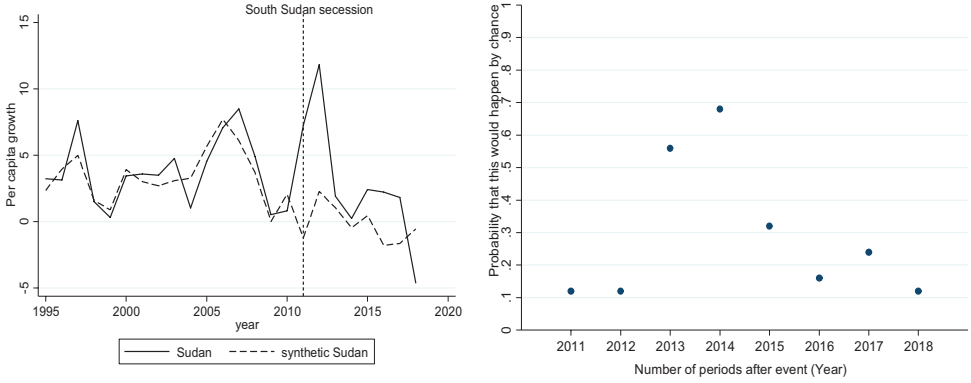

Figure 7. Per capita growth and adjusted *p*-values (fuel exports group).

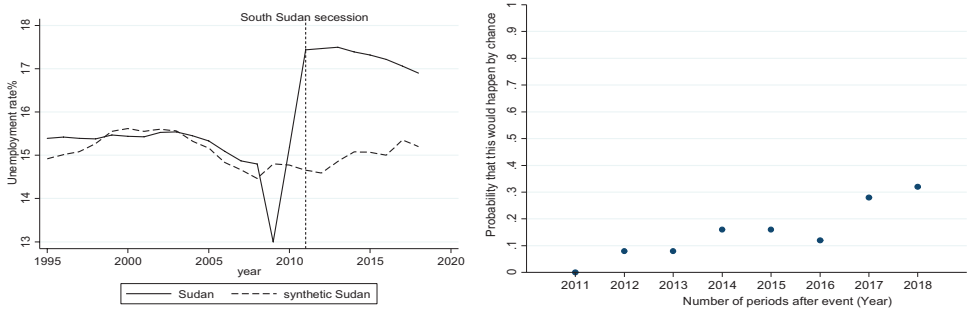

Figure 8. Unemployment rate and adjusted *p*-values (fuel exports group).

Appendix 4

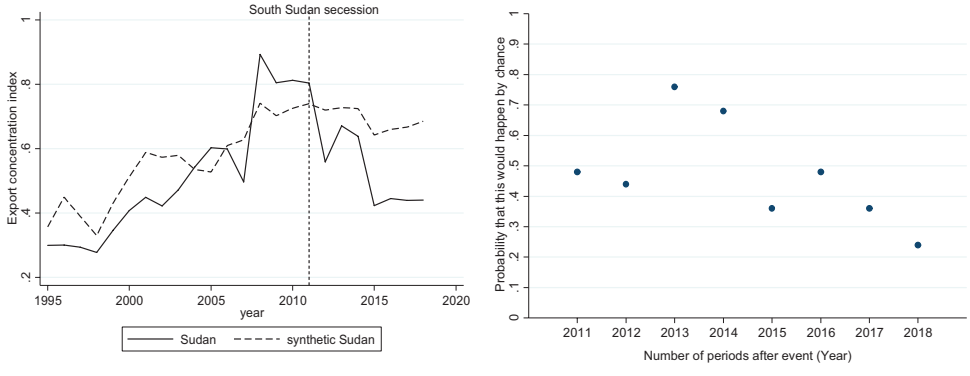

Figure 9. Export concentration index and adjusted *p*-values (fuel exports group).

Appendix 5

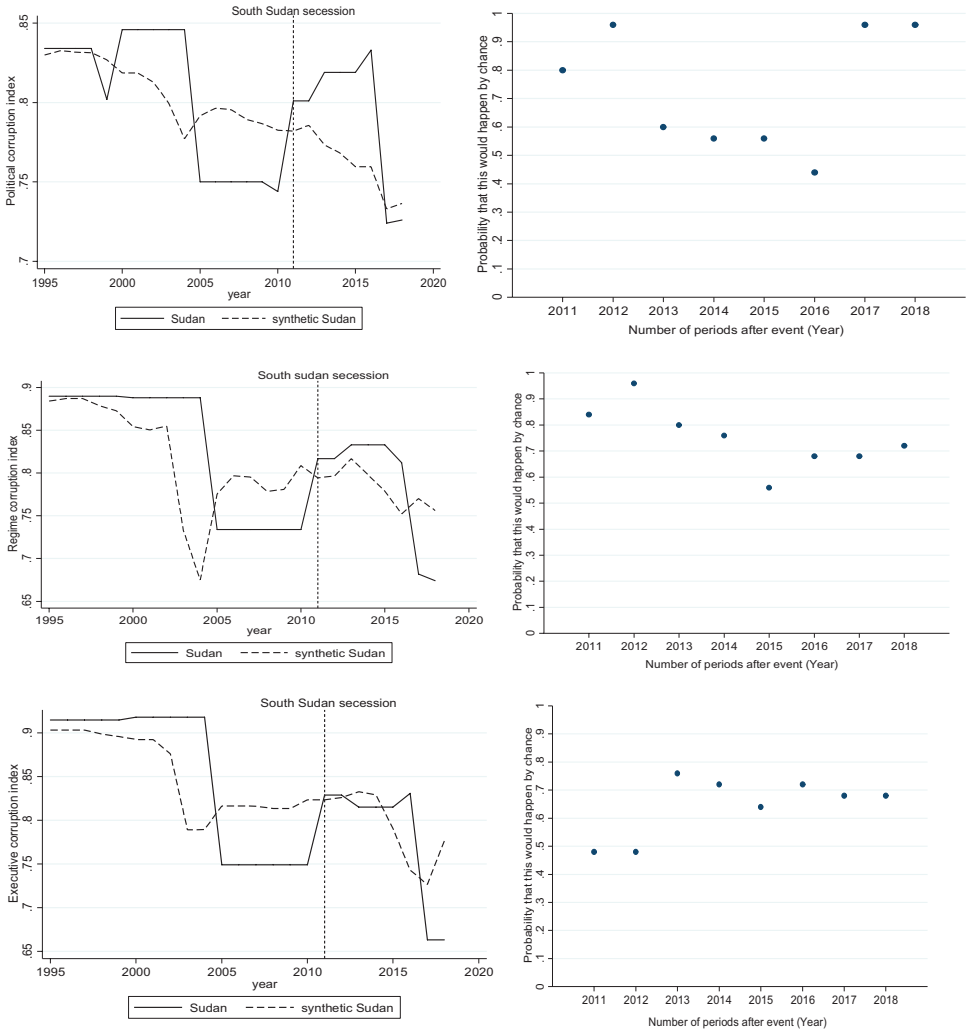

Figure 10. Corruption indexes and adjusted *p*-values (fuel exports group).