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What drives Saudi airstrikes in Yemen? An empirical analysis of the dynamics of coalition airstrikes, Houthi attacks, and the oil market

by Dawud Ansari, Mariza Montes de Oca, Helen Schlüter

Energy Access and Development Program

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Authors: Dawud Ansari [a b *], Mariza Montes de Oca [b c], Helen Schlüter [a]

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Abstract

Since 2015, Saudi Arabia has led a foreign military intervention against the Houthi movement, which took over major parts of Yemen. The intervention, which manifests mainly in airstrikes, has attracted widespread controversy in media and politics as well as a large body of (qualitative) academic literature discussing its background and ways to escape it. Complementary to these efforts and connecting to the literature on oil and conflict, this study provides unique quantitative insights into what drives the extent of military interaction. We use a vector autoregressive (VAR) model to analyse the interactions between Saudi airstrikes in Yemen, gains of the Houthi movement on Yemeni ground, their attacks on Saudi Arabian soil, and crude oil prices. Our approach builds on high-resolution data from the Yemen Data Project and the Armed Conflict Location and Event Data Project.

Our results show not only that the airstrike campaign has been factually impotent to repulse the Houthi movement but also that the movement's expansion in Yemen has not driven Saudi airstrikes. These findings draw both suitability and justification of the intervention further into question. Moreover, although the data fail to show that oil price levels drive the developments, our model identifies oil price volatility as a determinant for the airstrikes. However, the intervention has, in turn, no significant effect on oil markets. Besides adding to the academic discourse on oil and conflict, our results have implications for energy and climate policy: a coordinated transition might not deteriorate regional security, while uncertainty and fluctuations can increase conflict potential.

Keywords

Saudi Arabia; Yemen war; VAR model; oil prices; military conflict; regime legitimacy

Declaration of Competing Interest

The authors declare no competing interests.

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[a] Energy Access and Development Program – EADP, Wilmersdorfer Str. 122-123, 10623 Berlin, Germany
[b] DIW Berlin (German Institute for Economic Research), Mohrenstr. 58, 10117 Berlin, Germany
[c] Resource Economics Group, Humboldt University of Berlin, Hannoversche Str. 27, 10115 Berlin, Germany
* Corresponding author: ansari@eadp.eu

1. Introduction

Yemen is hosting the "world's largest humanitarian crisis" (UNOCHA, 2021). Roughly four million civilians have been displaced, some five million are on the brink of acute famine, and more than 200,000 lives have already been lost (UNOCHA, 2020, 2021; WFP, 2021). The current crisis stems from a foreign military intervention in a multifactional civil war: since 2015, a coalition led by Saudi Arabia has been striking various targets in Yemen, after its government was ousted by an armed rebel group, *Ansar Allah* (colloquially known as the *Houthi* movement). Civilian casualties and conflicting interests–some argue that "the harm suffered by Yemeni civilians is not an unfortunate but necessary by-product" (Beavers, 2021, p. 210)–have given rise to an intense global controversy regarding the war and its legitimacy, even including (upcoming) decisions by UK courts, the US Senate, and the International Criminal Court (Maletta, 2021).

Since the war's onset in 2015, the academic community has engaged in a vivid discourse. Scientific publications cover analyses of the various actors (e.g. Clausen, 2018, 2019; Darwich, 2016, 2018, 2020; Hill, 2017; Tynan, 2020; Zweiri, 2016), future prospects (e.g. Esfandiary & Tabatabai, 2016; Feierstein, 2017; Heinze, 2018), and the consequences on society and infrastructure (e.g. Al-Saidi et al., 2020; Ansari et al., 2019; Gleick, 2019; Jiang et al., 2017; Sowers & Weinthal, 2021). However, and despite the vast number of contributions, the scholarship on drivers and dynamics has been limited to qualitative approaches, particularly political theory and case studies. While they allow for an in-depth analysis of the complex background, quantitative empirical work could provide robust evidence and an objective evaluation.

Therefore, this article presents the first comprehensive quantitative empirical analysis of the Yemen war, its dynamics, and its drivers[1]. Precisely, we use high-resolution data from the Yemen Data Project (2021) and the Armed Conflict Location and Event Data Project (ACLED: Raleigh et al., 2010) in a vector autoregression (VAR) framework to study the (dynamic) interaction of Saudi Arabian airstrikes, Houthi progress inside Yemen, and their attacks on Saudi Arabia. Furthermore, due to the economic structure of Saudi Arabia, we add oil prices (and their volatility) to the analysis. The VAR approach allows us to generate robust insight on which factors have driven one another. In particular, it allows us to capture interdependencies and feedbacks instead of oversimplifying the complexities of political decision-making. Among the various links traced by the model, our main interest is to examine which factors have driven the extent of the Saudi Arabian airstrike campaign.

As such, our study connects to the rich qualitative literature investigating the motivations and drivers of the war. Since our data are macroscopic in nature, this study does not substitute the available literature, but it complements the various theoretical investigations with insight from a top-down perspective. First, we focus on investigating the intensive margin of war, i.e. the extent of military interaction, instead of investigating the conflict's root causes. Second, we analyse the role of tangible, measurable indicators (in contrast to theory-driven papers, which focus on more abstract relationships). Third, and most importantly, we fuel the ongoing debate about the conflict with robust numerical evidence; the fact that our model captures the complex interrelations between conflict (and economic) indicators allows us to assess some of the explanations for the war discussed in the (theoretical) literature.

[1] This article focuses on Saudi Arabia's role vis-a-vis the Houthi government of Sana'a in a binary fashion. This is, of course, only a narrow snapshot of the entire conflict, which entails a variety of actors with ambiguous goals and quickly shifting alliances.

Furthermore, our study connects and contributes to the literature on oil and interstate conflict. Various empirical contributions, most notably the works by Colgan (2010, 2013, 2014), have emphasised that oil producers may be more prone to (initiate) conflict. Recent studies have started investigating the role of price volatility in this (Bakırtaş & Akpolat, 2020; Caporin et al., 2020; Erdoğan et al., 2020; Hendrix, 2017). Scholars have also picked up these threads to analyse the potential impacts of and barriers to climate change mitigation. As a common understanding, stringent climate policies require the phase-out of (most) fossil fuels (Ansari et al., 2020), which causes dropping prices and stranded oil reserves (Ansari & Holz, 2020). Based on this, some researchers have argued that decarbonisation policies will ultimately exacerbate regional instabilities and cause (violent) conflict (see e.g. Ureta, 2020; Vakulchuk et al., 2020; Van de Graaf, 2018). Quantitative evidence for this hypothesis has, however, been sparse and ambiguous to this point.

Therefore, our study makes numerous contributions. First, our results on the interaction of conflict indicators supply the international discourse on the Yemen war with first robust quantitative evidence on tangible drivers and dynamics. Second, our study expands the scholarly knowledge on the behaviour of authoritarian states and interstate conflict. Third, our results regarding the effect of lower oil prices on conflict in a key region for hydrocarbon production contribute towards shaping global climate policies.

The remainder of the paper is organised as follows: we start with an overview of the conflict, the Houthi movement, and Saudi Arabia's political and economic situation. Subsequently, we give a brief and selective synopsis of how political theory connects to our empirical indicators. We then move on towards describing the dataset and the empirical setup. In a combined results-and-discussion section, we present and interpret the results using regression tables and impulse response plots. Lastly, we summarise our findings and consider their implications for policy and academia.

2. Background

2.1. Recap: War in Yemen 2015-2020

25 March 2015 marks the beginning of the Saudi-led military intervention in Yemen. Operation Decisive Storm and its successor Operation Restoring Hope—Saudi Arabia's largest military intervention since the 1930s (Tynan, 2020)—follow the turbulent events surrounding an insurrection. In September 2014, the Houthi movement took over the nation's capital, Sana'a, and ousted Abdrabbuh Mansur Hadi's transitional government—a structure created in 2012 in the aftermath of Yemen's national chapter of the Arab Spring.

On 7 March 2015, after fleeing the capital, overthrown transitional president Hadi declared the move unlawful and formally requested assistance from the Gulf Cooperation Council (GCC), the Arab League of Nations, and the United Nations Security Council (UNSC). In his letter, Hadi denounced the "criminal attacks being committed by the Houthis against our people" and urged the GCC and its allied states "to provide immediate support in every form and take the necessary measures, including military intervention, to protect Yemen and its people from the ongoing Houthi aggression, [and to] repel the attack that [was] expected at any moment on Aden and the other cities of the South [...]" (UNSC, 2015, pp. 4-5). The GCC's national ambassadors to the UN jointly responded in an affirmative statement to the UNSC, expressing their "responsibility towards the Yemeni people" and acknowledging the need to protect Yemen and the region "from the aggression of the Houthi militias, which have always been a tool of outside forces" (ibid.).

Under the de-facto lead of Saudi Arabia, which supplies the vast majority of the operation's resources (Tynan, 2020), a coalition of initially eight countries[2] launched its military offensive against targets in Yemen. While some coalition efforts have gone to the deployment of ground troops—notably, the UAE's efforts in Yemen's south and the mass co-optation of local militias and tribes, which is outside of the scope of this analysis—, the operation's true focus is the sky. Especially Saudi Arabia has been running a continuous campaign of airstrikes against "Houthi targets" (Orkaby, 2017, p. 93).

On 26 March 2015, the coalition started its air force mission, first moving to eliminate Yemen's air force and air defence capacities; two days after the first airstrikes, Saudi Arabia claimed air superiority and declared a no-fly zone. Between the onset of the war and the end of February 2020, a total of 62,195 separate airstrikes were recorded, with civilian casualties[3] estimated at 18,408 (see Data section).

At the onset of the conflict, the Houthi movement controlled most of what used to be the former Republic of (North) Yemen. Throughout the first years of the war, the Houthis were increasingly pushed back, and Saudi-supported troops limited the Houthis' access to the coastline. However, from 2019 onwards, new offensives allowed the Houthi movement to turn the tables: they retook all of Sana'a Governorate and started expanding southwards and eastwards.

Besides the struggle inside Yemen, the Houthi movement has also targeted Saudi Arabia, primarily focussing on the border region[4]. Since 5 May 2015, supported by local allied separatists, they have led offensives on the Saudi province of Najran; starting in mid-2016, clashes have also erupted in Jizan province. Beyond that, there has been an increasing number of ballistic missiles and, since 2018, also drone attacks on Saudi Arabia. Some attacks reached far upcountry, with missiles targeting Jeddah in 2016 and Riyadh in 2017. Drone attacks have noticeably included Saudi Arabian oil infrastructure: a first attack hit facilities in Yanbu in 2017, whereas strikes on Abqaiq and Khurais in 2019 shortly paralysed half the country's export capacities.

2.2. Yemen's path to conflict and the Houthi movement

Understanding the pre-war dynamics in Yemen is vital for understanding the military intervention. This section outlines the political context that eventually led to the Houthi takeover and the ousting of Yemen's transitional government.

Yemen's revolution of 2011 is the anchor for most developments, though much of the dynamics were set into motion long before. Separated into a republican north and a socialist south until 1990, the country has been subjected to (tribal) conflict and civil war alongside economic misery for the past decades. Much of it resulted from grand corruption and divide-and-conquer tactics initiated by the former central government—a "shadowy group" (Clausen, 2018, p. 562) surrounding the country's former president, Ali Abdullah Saleh. Financed mainly through foreign aid and (now-absent) hydrocarbon revenue, he and his allies constructed a large-scale patronage

[2] The coalition initially encompassed Saudi Arabia, the United Arab Emirates, Sudan, Bahrain, Kuwait, Qatar, Egypt, Jordan, Morocco, and Senegal. Over the course of the conflict, Senegal, Qatar, Morocco, and Sudan recused themselves from the coalition.

[3] While the majority of coalition airstrikes would come without civilian losses, a few infamous events had a substantial death toll. For instance, a strike on funeral preparations at the Al-Kubra hall in Sana'a in 2016 killed 132 people and wounded 695, a strike on a wedding in Taiz in 2015 killed 131, and a strike on a school bus in Sa'dah in 2018 led to the death of 49 children.

[4] The boundary between both countries was subject to a longstanding dispute and is partially blurry, especially towards the inland.

network used for the co-optation of elites and the embezzlement of public funds (Ansari, 2016; Heibach & Transfeld, 2018).

In 2011, protests increasingly called for regime change. While the revolution started as a civilian project, the process was quickly seized by opportunistic elements from Ali Saleh's patronage network, who defected[5] from the government and officially aligned with the protests (Hill et al., 2013). The process formally ended with a GCC-brokered deal that saw a transfer of power to Ali Saleh's vice president, Abdrabbuh Hadi, who would lead a transitional government; simultaneously, Yemen's National Dialogue Conference (NDC) should support pluralism and representation while setting up the new Yemeni state (Clausen, 2018).

The Houthi movement—officially named *Ansar Allah*—was one of the parties participating in the NDC. The group, which has its roots in a youth movement (*Al-Shabab Al-Mu'min*') founded in 1990, emerged as a religious response by the Shiite Zadi school to the spread of Saudi-inspired Salafi groups in Yemen (Zweiri, 2016). In 2004, failed attempts by Ali Saleh's government to co-opt the movement led to increasing tensions and forced the movement into a politically more active role (Clausen, 2018). Over the period 2004-2010, Sa'dah—the country's most northwestern province and home to the Houthi movement—would see a series of six brutal wars led by the central government against the Houthis (Boucek, 2010; M. Brandt, 2014). In these wars, the government also resorted to airborne attacks, causing widespread damage among civilians and local infrastructure (Boucek, 2010). Saudi Arabia's active participation in the Yemeni government's crackdown on Sa'dah (Boucek, 2010) fuelled the region's antagonism towards the kingdom.

Ironically, the government's use of an iron fist against Sa'dah and the Houthis is what elevated their power. The government's rhetoric, which used *Houthi* as an umbrella term for all tribal Zaydi groups, led to an increasing unification under the Houthi banner in the country's north (Zweiri, 2016). The civilian population in Sa'dah turned loyal to the Houthis in the wake of continued devastation by government offensives against the governorate and increasingly pushed the movement into the role of a local government (Clausen, 2018).

The GCC Initiative, signed by Ali Saleh in Riyadh in November 2011, remained an elitist project split along traditional power lines (Tynan, 2020); it had never achieved—or even aimed at—constructing a democratic and representative government (Transfeld, 2016). Therefore, it is no surprise that most of the Yemeni political landscape in 2011 was still dominated by members of the pre-2011 establishment, especially the circle around General Ali Mohsen and *Bayt al-Ahmar* (Hill et al., 2013; Transfeld, 2016; Yadav, 2017). Eventually, the pre-2011 patronage network was just as alive as before the revolution, and it used this (unstable) period to maximise its influence in a future Yemen (Alley, 2013; Clausen, 2018; Nußberger, 2017). The Houthis participated in the NDC but condemned it for being a mere 'soft' forum, which would allow for pluralism in voices but not in power or resources (Yadav, 2017). After the transitional government introduced a controversial attempt to lift fossil-fuel subsidies in 2014, the Houthi movement took over the capital and briefly introduced the Peace and National Partnership Agreement (PNPA); it was a short-lived experiment of a unity government that collapsed quickly (Clausen, 2018; Transfeld, 2016).

As a bottom line, decades of self-serving domestic power play by the former central government and a failed political transition laid the groundwork for the government takeover and, eventually,

[5] With regard to the climate- / resource-policy dimension of this article, it is worth mentioning the role of Yemen's oil industry. Oil rents, the cornerstone of the patronage network, decreased substantially from 2002 onwards, which may have been a catalyst in the collapse of Yemen by increasing the tendency to defect from the patronage network (see Ansari, 2016).

the military intervention. The Houthi movement poses an anti-American and anti-Saudi countermovement to the Yemeni establishment[6]. Continued marginalisation by the central government (which increasingly collaborated with the US for the international *war on terror*) alongside hostility and interference from Saudi Arabia's government created the imaginary of an indigenous, corruption-fighting resistance force, both in self-identification and public perception (Clausen, 2018; International Crisis Group, 2009, 2017). Therefore, Saudi Arabian airstrikes and their perception as a *war on Yemen* have continued to fuel support for the movement, despite well-documented human rights violations (International Crisis Group, 2017; UNHCR, 2019)

2.3. Shifts in Saudi Arabia

Though far less violent, Saudi Arabia has also undergone significant changes over the past two decades. They amount to a shift in paradigms from being a diplomatic power broker built on religious capital to a nationalist and agile military force. These changes were partially organic and developed in response to the Arab Spring. Still, it was a change at the top that exacerbated the developments.

Before 2009, Saudi Arabia's modus operandi was to achieve leadership in the region by protecting and spreading its politico-religious approach (Yamani, 2009). Darwich (2020) even argues that regional leadership was not an objective but a means to preserve stability and the (domestic) status quo. Besides this approach, stability within Saudi Arabia traditionally relied on a clear pattern of rule and royal succession, a coherent ideology, economic prosperity derived through oil rents, and state institutions providing effective control of society (Yamani, 2009). Saudi Arabia, an absolute monarchy, is home to a tribally, sectarian, and culturally diverse population, and the government's ability to create stability has been the glue keeping the system together. Therefore, before 2011, some light opposition was, in fact, not only tolerated but actively encouraged by the palace (Tynan, 2020). Competing factions would be co-opted–or even created–to neutralise their forces and legitimise the royal palace by showcasing the chaos either participation or alternatives would bring (Lacroix, 2011).

Nevertheless, shifts in the regional landscape, especially the Arab Spring, forced the government to refine its survival strategies (Yamani, 2009). As mentioned by Shamaileh (2019, p. 952), even for "Saudi Arabia, the state that has epitomised the role that oil can play in maintaining autocratic rule, the reverberations of the Arab Spring were felt as minor protests popped up within the Kingdom". Moreover, with former King Abdallah bin Abdulaziz passing away in 2015, King Salman bin Abdulaziz and, more visible to the world, his son Mohammad bin Salman (MBS) took over the country. Starting as a Minister of Defence in 2015, MBS rose to the level of Crown Prince in 2017 and is currently managing most of the kingdom's matters—against (initial) opposition[7] from within the royal family, who opposed breaking with the traditions for royal succession (Mallat, 2018; Tynan, 2020).

The new aggressiveness is perhaps best exemplified by 2017's "purge" (Stenslie, 2018, p. 76), during which MBS ordered the arrest of more than 200 business leaders and royal relatives whom he suspected to be critics on the grounds of alleged corruption charges. Over the subsequent years, arrests (including torture and death sentences) increasingly turned towards the general population under the banner of a new "Saudi nationalism"—a "top-down initiative" that sought to turn away from the country's religious identity (Al-Rasheed, 2021, p. 163). This trend merged with the post-Arab Spring tendency to dramatise domestic threats, especially the

[6] Nevertheless, opportunism is a strong determinant for local alliances, as shown e.g. by the frequent shits from Ali Saleh and his loyal followers.
[7] It would, however, be wrong to conclude that MBS's government has no backing within the country. In fact, MBS might have a better connection to younger generations than previous rulers had (Tynan, 2020).

religious opposition, which was swiftly declared terrorist (Tynan, 2020). However, the centralisation of power and the strong repression of dissidents are not signs of Saudi Arabia shifting to a new ideology (ibid.). Instead, MBS established a "new form of nationalist legitimacy" that breaks the structures of previous elites and aims at "undermin[ing] traditional power structures"—it equates to an "abolition of ideology [, which] is itself a new, if temporary, type of legitimacy"; as such, "the regime has dealt with the Arab Spring [...] through a survival strategy that […] has been through the breakdown of ideology rather than the strengthening of one" (ibid., pp. 95-96).

This fundamental change in the kingdom's identity naturally translates to a shift in foreign policy. The new Saudi Arabia is bolder by seeking a visible status: the former soft power has recently led military interventions in Bahrain and Syria, a blockade of neighbouring Qatar, and a cold war against Iran (Darwich, 2020). The change equals to moving away from using money and diplomacy towards militarism, a strategy whose success might depend on the 'ability to preserve its continuity' and is perhaps intensified by the regional power vacuum created by the Arab Spring and the Obama administration's decreased presence in the region (Ragab, 2017, p. 38).

In this regard, Saudi Arabia's row with Iran has a special role. On an ideological level, Iran challenges the kingdom's traditional pan-Islamic identity (Darwich, 2016). However, as explained above, religion is mainly a means to create legitimacy for Saudi Arabia and increasingly abolished as such. Sectarianism is an unsatisfying explanation since the kingdom itself hosts a considerable Shiite population, and, throughout the last years, domestic and regional repression has mainly targeted the Sunni Muslim Brotherhood. Instead, the two countries' relationship to the US, intersecting geopolitical interests, and Iran's increased engagement in the region have actively shaped the rivalry (Keynoush, 2016; Ragab, 2017).

This pattern of ambiguity and pragmatism extends naturally to Saudi Arabia's approach towards Yemen. Tynan (2020, p. 106) notes that "alliances and enemies in Yemen have been defined more by their fluidity than anything else". Yemen's chapter of the Muslim Brotherhood[8], *Al-Islah*, is officially allied with Saudi Arabia in the war against Houthis, but it might be just as loathed as Iran (Ragab, 2017). The kingdom's stake in Yemen has a long tradition, and interferences range from co-optation to military interventions, most of which have served the purpose to "keep Yemen from presenting a united, powerful southern neighbour" (Tynan, 2020, pp. 103-104). The extent to which Yemeni issues are domesticated is also visible in the fact that the Saudi press labels Houthi attacks on the military coalition as terrorist attacks (ibid.). Since the 1970s, Yemen has been an easy source of inexpensive labour (Ansari, 2016), and it bears the permanent potential to challenge Saudi Arabia both militarily and ideologically (Tynan, 2020). Hence, the kingdom benefits from keeping Yemen disorganised enough to exercise its interests on the ground while simultaneously preventing a full breakdown with unforeseeable consequences. In other words, "for Riyadh, Yemen is a hornets' nest: if it breaks up, it will be hard to contain all the fragments" (Ragab, 2017, p. 44).

2.4. Saudi Arabia and a turbulent oil market

Although economic diversification has been declared a policy objective since the 1970s, Saudi Arabia's progress towards this goal has been fairly limited (Albassam, 2015). The country is still largely dependent on oil revenue, which is unlikely to change in the years to come (Malik, 2019). While Saudi Arabia managed to initiate new domestic sectors, crude oil noticeably accounts for

[8] Despite national variants of the Muslim Brotherhood throughout the region, they are not formally or operationally linked and bear substantial differences. Yemen's Al-Islah movement is more political and militarised than Egypt's Muslim Brotherhood, which is a mainly religious group.

roughly 90% of both government revenue and export earnings (Worldbank; EITI). Therefore, and even more than it is the case for the macroeconomy, Saudi Arabia's fiscal state and mode of governance depend on oil. Estimates for the expenses of the royal family reach 40% of the annual budget, two out of three employees work in the public sector, and the government subsidies various goods from housing to energy to water (IMF; Cordesman, 2019; al-Rasheed, 2021).

Meanwhile, the oil market has become more turbulent and contested. While the 2010s still started with oil prices exceeding $US 100 per barrel, they crashed in 2014, and spot prices plunged as low as $US 20 per barrel (see Ansari, 2017). Between late 2016 and early 2020, oil prices have again surpassed $US 60 per barrel but shown noticeable fluctuations (Ansari & Kemfert, 2020). Moreover, the rise of US tight oil[9] has made it increasingly difficult to control the market—a costly operation that Saudi Arabia has anyway been increasingly unwilling to undertake (Fattouh et al., 2016). For the years to come, oil producers also face the risk of climate policies leading to a gradual phase-out of energy-related oil consumption (Bradshaw et al., 2019). This situation bears high uncertainty and threatens to create asset stranding in Saudi Arabia (Ansari & Holz, 2020).

Due to substantial foreign assets, reasonably low public debt, and a very economical oil production, Saudi Arabia is more resilient than other suppliers (such as neighbouring Iraq). However, continued oil dependency and observed policy changes indicate that losing the grip on oil revenue is a central concern for the kingdom. While the early 2010's oil bonanza led to all-time highs in public spending, from 2015 onwards, government-administered water and energy tariffs have seen significant increases, and many public projects were stopped (Ansari, 2017; Krane, 2019). However, as exemplified by the move to raise public sector wages again in 2017, Saudi public spending moves with the oil price (Hathroubi & Aloui, 2020). As a bottom line, crude oil is and has been the cornerstone of Saudi Arabia.

3. Theoretical insights on the drivers

Our analysis focuses on the (potential) effects of three indicators on the extent of Saudi Arabian military engagement in Yemen: advances of the Houthi movement inside Yemen, their attacks on Saudi Arabia, and oil price developments. Due to their macroscopic nature, the three indicators cannot be matched to particular theories; rather, each indicator connects to multiple themes, some of which overlap. Most notably, the concept of diversionary war and a hegemonic struggle vis-a-vis Iran (both introduced in Section 3.1) connect, at varying degrees, to all three indicators. The following subsections discuss each indicator individually.

3.1. Military advances of the Houthi movement in Yemen

The Houthi movement's actions inside Yemen were presented as the official reason for the military intervention. Based on the principle of self-defence (UN Charter Article 51), President Hadi[10] requested support from the GCC and the UNSC to protect Yemen and "deter Houthi

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[9] Unconventional drilling enabled the U.S. petroleum sector to nearly double its production capacities between 2010 and 2014 by accessing tight oil (commonly mislabelled as 'shale oil'). Conventional oil production entails decade-long planning horizons and high ratios of capital expenditure and equity. Tight oil projects, however, have far shorter project durations and higher shares of operating expenditure; moreover, the market is characterised by smaller companies and debt financing. Thus, tight oil supply is more flexible than conventional oil supply, but extraction cost is generally higher. See Ansari (2017).

[10] Although Hadi's legitimacy is subject to legal debate, UNSC resolution 2216 eventually reaffirmed that the Council considers Hadi the legitimate President of Yemen; the legitimacy of his invocation of Article 51 and the request for a military intervention, however, are legally questionable. See Tzimas (2018)

aggression" (UNSC, 2015, pp. 4-5). The swift and affirmative response by the GCC ambassadors expresses their goal to prevent "the aggression of the Houthi militias" (ibid.). Hence, when used legitimately, airstrikes should mainly be driven by advances and attacks of the Houthi movement in Yemen. In turn, a successful airstrike campaign, as measured by its official goal, should decrease Houthi activities.

Beyond the official purpose, other reasons may motivate Saudi Arabia to intensify its military engagement in response to Houthi action in Yemen. Political theory provides two dominant theories for this. First, Saudi Arabia may use the Houthi movement as an "external military force to advance domestic political interests", also known as diversionary war (see Levy & Vakili, 1992; Oakes, 2006). Through this lens, Houthi attacks inside Yemen are framed as a foreign threat to generate cohesion or raise nationalism in Saudi Arabia. Whether a nation achieves its domestic policy objectives depends on its ability to mobilise the necessary means to enforce or establish it, i.e. its extractive capacity (Oakes, 2006). Diversionary war then represents a policy option that compensates for missing domestic policy instruments by using a more ideological mechanism to increase government legitimacy. This idea originates from sociological insights on in- and out-groups (Simmel, 1955), according to which cohesion within a group can be increased through conflict with an external group (Gent, 2009; Levy & Vakili, 1992). In this sense, the Saudi Arabian government may substitute the legitimacy lost from the shift away from its traditional ideology by uniting the country to fight against a foreign enemy (Tynan, 2020). Clausen (2019, p. 79) considers the war a usage of "external assertiveness to build [the] internal reputation of [Muhammed bin Salman]". Furthermore, Al-Rasheed (2021, p. 168) underlines that the fight against the Houthis has become the "dominant narrative in the new nationalism" implemented by MBS and that "airstrikes on Yemen since 2015 served to consolidate the domestic front under the pretext of defending the nation against foreign enemies: the Houthis and their Iranian backers" (p. 328).

Second, against the backdrop of the kingdom's hegemonic interests, the Houthi movement might endanger its power and security in the long run, leading to a repressive response (see Keohane, 2005). Anti-Saudism is deeply rooted in the movement, and its rhetoric suggests that attempts to invade Saudi Arabian mainland are likely if it gains full control over Yemen. Furthermore, as also discussed above, Saudi Arabia has an ideological and economic incentive to prevent a prospering Yemeni state, especially if it was to develop under a Houthi banner. This argument naturally extends to Iran and its (alleged) role in the conflict. Foreign interpretation and GCC media have often presented the Houthi movement as direct Iranian proxies, which may be a gross exaggeration (Baron et al., 2017; Stenslie, 2015; Tynan, 2020). Only a few weapon deliveries are evident, and Iran's role in the conflict has only increased after–and resulting from–accusations of a proxy war started (Clausen, 2018; Zweiri, 2016). Nevertheless, as argued, Saudi Arabia's new foreign policy identity is more agile and militarised, which is why the factual extent of Iranian involvement is less than the appearance. The latter can be sufficient to generate domestic legitimacy—a diversionary war— or gain international reputation (Darwich, 2018).

3.2. Attacks of the Houthi movement on Saudi Arabia

As a second indicator, we consider attacks by the Houthi movement on Saudi Arabia. As elaborated in Section 2, a few months into the war, the Houthi movement started to conquer Saudi border territory and lead airborne strikes further into the kingdom. Some reasons why this would trigger a Saudi airstrike response overlap with the first driver, but there are also distinct patterns of reasoning.

First and foremost, while responses to Houthi attacks inside Yemen are a foreign military intervention, airstrikes following attacks inside Saudi Arabia can be considered a sheer act of territorial defence. However, their nature is preventative at best: because the strikes target the Yemeni heartland instead of the combat area (see Section 2.1 and 4.1), the strategy aims to deter further Houthi action by disrupting their supply chains or creating fear. Moreover, a disproportionate airstrike response could tip the scale from material protection to retaliation. Foreign policies in authoritarian states tend to be more conflict-prone (Peceny & Butler, 2004), and they are chosen to deter competitors and please their domestic constituents (Ezrow & Frantz, 2011). With the kingdom's shift to a bolder foreign policy, its responses to confrontational events[11] have become swift, violent, and aim at deterring further dissidence. Hence, an overly strong response from airstrikes to Houthi attacks on Saudi Arabia may indicate retaliation as a dominant motive.

As discussed above, also much-needed legitimacy can be generated from unifying strikes against an enemy. As such, defending Saudi Arabia's territorial integrity against the Houthi movement satisfies Saudi citizens' needs of security and material welfare—two critical aspects for regime performance, according to (Desai et al., 2009; Gent, 2009; Von Soest & Grauvogel, 2017). Since Saudi Arabia presents the Houthis to its domestic audience not as a foreign military force but as terrorists, the *diversionary war* theory may also apply here. A government is perceived as legitimate when presenting itself as a guarantor of stability and territorial integrity (Radnitz, 2012), since territory is at the heart of human identity and unity (Tir, 2010).

The significance of (feared or perceived) territorial loss is furthermore reflected in prospect theory (see Levy, 1997; Tversky & Kahneman, 1989). The concept reflects that loss-related decision-making is inconsistent with expected-utility theory; applied to conflict, this implies that the military command may take actions that deliberately induce significant risk and lower expected outcomes if the reference setting, as perceived by the decision-maker, changed due to losses (Levy, 1997). Schenoni et al. (2020, p. 5) argue that "as the leaders of a declining state perceive tangible—for example, territorial—losses, they may bypass expected-utility reasoning. Overall, such a situation could lead to the type of risk-acceptant behaviour better predicted by prospect theory". They propose a multi-step mechanism linking power shifts and war: elites incur (or at least feel) losses, and the fact that decision-making happens in a small and insulated environment worsens their perception; this causes more aggressive planning and spurs military investments, which induces risky behaviour and is self-reinforced by sunk-cost considerations. Even though Saudi Arabia's territorial losses are marginal, it can be argued that the general violation of its territory causes the perceived loss of the kingdom's image of invulnerability and stability; furthermore, decision-making is direct and insulated, and the military spending that followed the government's rhetoric represents potent sunk costs. While Schenoni et al. (2020) explicitly frame the approach as an alternative to diversionary war, we consider that both theories are complementary for this case. Eventually, both theories—in addition to the retaliation argument—would suggest that Saudi Arabian airstrikes on Yemen will increase because of Houthi attacks within the kingdom's territory.

3.3. Oil price developments

Lastly, we look at oil price developments—in particular, (i) oil prices and (ii) oil price volatility—as potential drivers of Saudi military engagement in Yemen. The indicator stands out for not

[11] The new belligerence is apparent in incidents such as the broad diplomatic dispute with Canada over a Twitter statement, the increased abductions and killings of dissidents in exile, or the full military siege of a Saudi village in Qatif in response to demonstrations. See Al-Rasheed (2021).

being from the military domain. However, various empirical contributions emphasise that oil producers may be more prone to (initiate) conflict (Colgan, 2010, 2013, 2014; Hendrix, 2017). The oil's effect on the creation and strengthening of authoritarian governments (Ramsay, 2011) likely intermediates this effect since they are, in turn, more prone to initiate war (Weeks, 2012).

The most direct channel for oil prices to affect military engagement are revenues and budget. Lower oil prices limit the financial leeway of Saudi Arabia and decrease public funds. Estimates for the war's costs are as high as US$ 100 million daily (Darwich, 2020), which add to Saudi Arabia's excessive spending described above. Similarly, an oil-dependent economy is vulnerable to oil price volatility since the fluctuations are transmitted throughout the economy (Van der Ploeg & Poelhekke, 2009). Plunging or volatile oil prices may thus lead decision-makers to decrease the military budget.

However, it is also conceivable that Saudi Arabia's political economy causes increased military engagement amidst a shrinking budget. Economic stability, both in perception and reality, play a role in maintaining regime stability (Ali & Abdellatif, 2015) Oil-rich nations initiate *authoritarian bargains* (Assaad, 2014; Desai et al., 2009), in which oil rents finance costly wealth transfers to relevant social groups in exchange for them backing the social order; the *rentier state* derives legitimacy from resource revenue (Von Soest & Grauvogel, 2017). A loss of oil revenue can imply a gradual loss in legitimacy, which needs to be compensated with other means (Farzanegan, 2018; Loewe et al., 2021). In the context of an authoritarian state, the legitimacy gap may be closed by showcasing unity and military strength against an enemy; thus, falling oil revenues might feed the turning wheels of a diversionary war to increase legitimacy. Consistent with this argumentation, Al-Mawali (2015) and Bakırtaş and Akpolat (2020) show that oil income and prices drive up military expenditure in the region. Most recently, Erdoğan et al. (2020) and Caporin et al. (2020) emphasise that volatility may play a role too; we envision that the perception of an oil market that is more volatile and prone to generate losses may trigger a similar role in losing legitimacy. Decreasing oil prices (or increasing volatility) can thus also increase Saudi Arabia's military engagement. Furthermore, based on prospect theory, one could make the case that prolonged low oil prices or increased volatility can be perceived as tangible losses by the government and, thus, trigger the mechanism outlined in Section 3.2.

The idea of a *race to burn the last barrel* (van der Ploeg, 2020) is a postulated concept leading to the same result but from a different perspective. Van de Graaf (2018) indicates that oil producers facing the prospects of asset stranding could engage in conflict (cf. Koubi et al., 2012). Saudi Arabia's behaviour during 2014's and 2020's oil crises indeed showed that the kingdom could favour protecting their long-run market shares over short-term profits (Ansari, 2017; Ansari & Kemfert, 2020). The concept lacks ample empirical evidence, but an exacerbation of conflict due to falling oil prices or increased volatility from climate policies remains a concern for policy (Koubi et al., 2012).

4. Data and empirical setup

4.1. Data

Our analysis considers the period from 21 March 2015 to 29 February 2020, where each week is one observation. This amounts to a total of 258 observations. We limit the temporal scope to February 2020 to avoid artefacts that might arise from the Covid-19 pandemic spreading thenceforth. Our data stem from the Yemen Data Project (2021) and the Armed Conflict Location & Event Data Project (ACLED; see Raleigh et al., 2010). The first dataset contains an entry for each reported event of an airborne coalition attack on Yemen from the onset of the war (26

March 2015) to date, including the precise date, the target and its location, the number of casualties, and the number of airstrikes. The second dataset entails entries of conflict-related events (including various forms of violent events, demonstrations, and non-violent conflict-related events), each one with its precise date, the event type, the involved actors, its location, the (estimated) number of fatalities, its source, and a narrative description of the event.

We derive our conflict indicators as follows (see Table 1 for an overview of the variables, Table 2 for descriptive statistics, and Figure 1 for a plot of the individual time series):

For the main variable, *airstrikes*, we sum up the airstrikes reported by all events within any given week as given by the Yemen Data Project[12]. In an average week, Saudi Arabia engaged in 241 airstrikes, while 2017 has seen the highest number (18,400 in total and 806 during the most intense week). Generally, the number of airstrikes gradually decreases starting from 2018; however, this trend appears reversed in the first months of 2020.

For the variable representing Houthi gains and actions inside Yemen, *houthi_attacks_YEM*, we count the number of military attacks by the Houthi movement inside Yemen for every week (corresponding to the blue dots in Figure 2). The indicator uses an automated filter that considers only events located on Yemeni soil, have the Houthi government as the main actor ('Military Forces of Yemen (2015-2016) Supreme Revolutionary Committee' and 'Military Forces of Yemen (2016-) Supreme Political Council'), and are categorised as attacks or territorial gains (categories 'Government regains territory', 'Air/drone strike', 'Shelling/artillery/missile attack', 'Attack'). Since the start of the war, Houthis have engaged in over 7,000 actions in Yemen, with a weekly average of roughly 28.

Table 1: Data overview

Variable name	Description	Source
airstrikes(t)	The number of coalition airstrikes on Yemen within week t	Yemen Data Project (2021)
houthi_attacks_YEM(t)	The number of Houthi-led territorial gains, air/drone strikes, and weapons or artillery use in the absence of further engagement inside Yemen within week t	Raleigh et al. (2010)
houthi_attacks_KSA(t)	The number of Houthi-led attacks of whichever kind and battles with mostly non-Houthi losses inside Saudi-Arabia within week t	Raleigh et al. (2010)
brent_price(t)	Average level of Brent crude oil price in $US per Barrel in week t	US Energy Information Administration (EIA)
volatility_CBOE(t)	Average level of the Chicago Board Options Exchange Crude Oil ETF volatility Index in week t	Federal Reserve Bank of St. Louis

Table 2: Descriptive statistics

Statistic	*airstrikes*	*houthi_attacks_YEM*	*houthi_attacks_KSA*	*brent_price*	*oilp_cboevol*
Mean	241.0	27.6	10.6	57.3	35.6
Median	217.5	24	10	58.0	33.0
Min	0	2	0	27.8	18.8
Max	806	73	39	85.4	74.0
Lower quartile	90.2	16	4	48.6	28.3
Upper quartile	340.8	38	15	65.4	41.5
Standard deviation	169.8	16.3	8.3	11.6	9.6
N	258	258	258	258	258

[12] Hence, we exclude Saudi-Arabian airstrikes north of the border, as they are technically not a foreign military intervention.

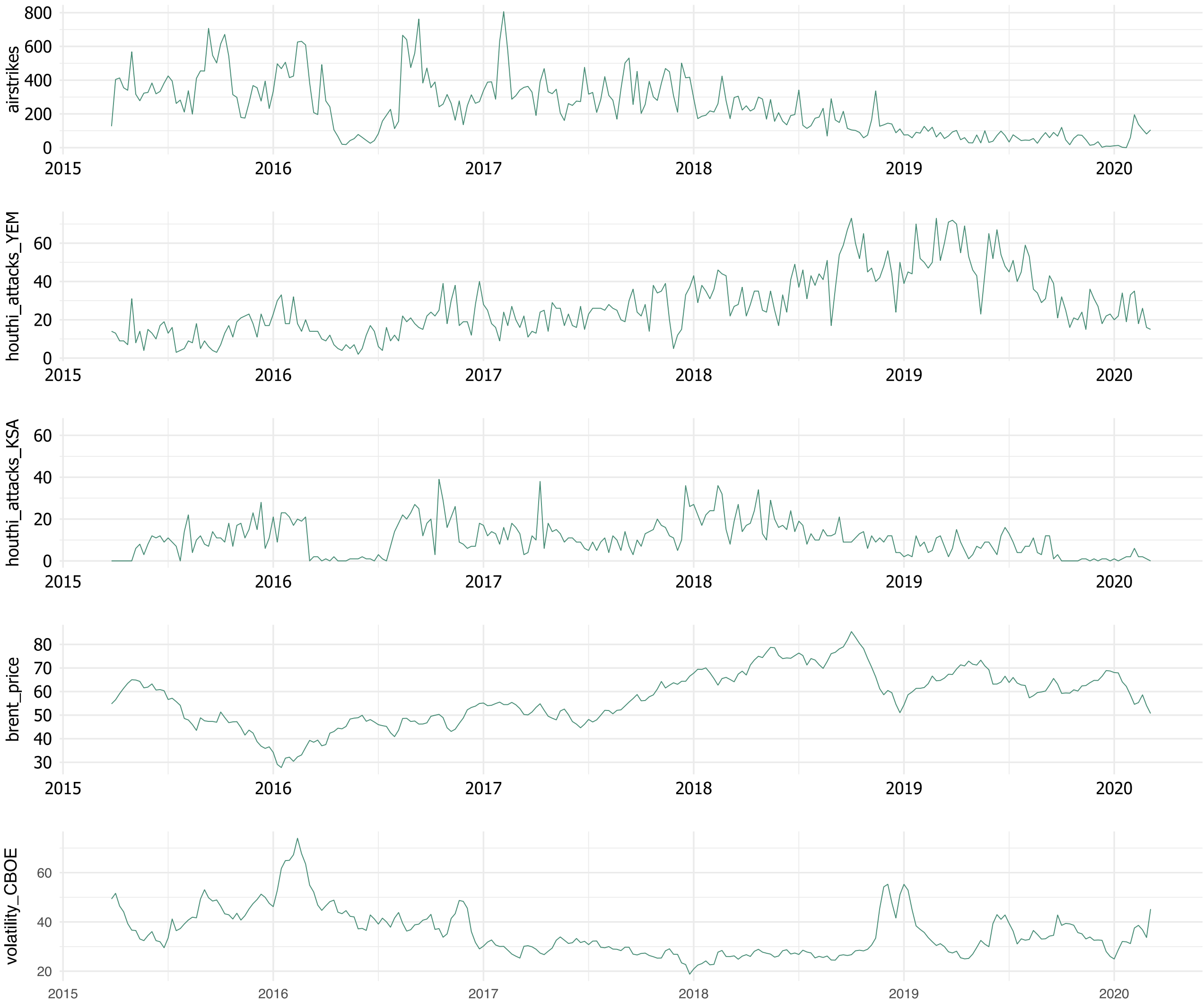

Figure 1: Visualisations of the time series

Concerning the variable representing Houthi action on Saudi Arabian territory, *houthi_attacks_KSA,* we count the number of Houthi-led attacks and battles that take place within Saudi Arabian territory for each week (corresponding to the yellow and red dots in Figure 2). This includes all forms of violence, such as airstrikes (also intercepted ones), acts of shelling, drone attacks, and assassinations. However, events that were initiated by Saudi Arabia (e.g. airstrikes or ground attacks against Houthi forces on Saudi Arabian soil) or events whose fatalities were almost exclusively limited to Houthis are excluded. On average, the Houthi movement engaged in ten weekly offensives on Saudi Arabian territory with a yearly maximum in 2018 (232 attacks) and numbers decreasing thereafter.

We employ two indicators related to oil price developments: weekly spot market prices of Brent crude oil and an oil price volatility measure.

For the spot price, *brent_price*, we obtain the weekly average level of Brent crude oil prices in $US per barrel from the US Energy Information Administration (EIA). Choosing Brent prices reflects its role as a global crude oil benchmark (Kilian, 2016). Nevertheless, Annex A1 presents sensitivity/robustness checks using WTI crude and the OPEC basket price. Over the period studied, weekly Brent crude prices averaged at roughly $US 57 per barrel.

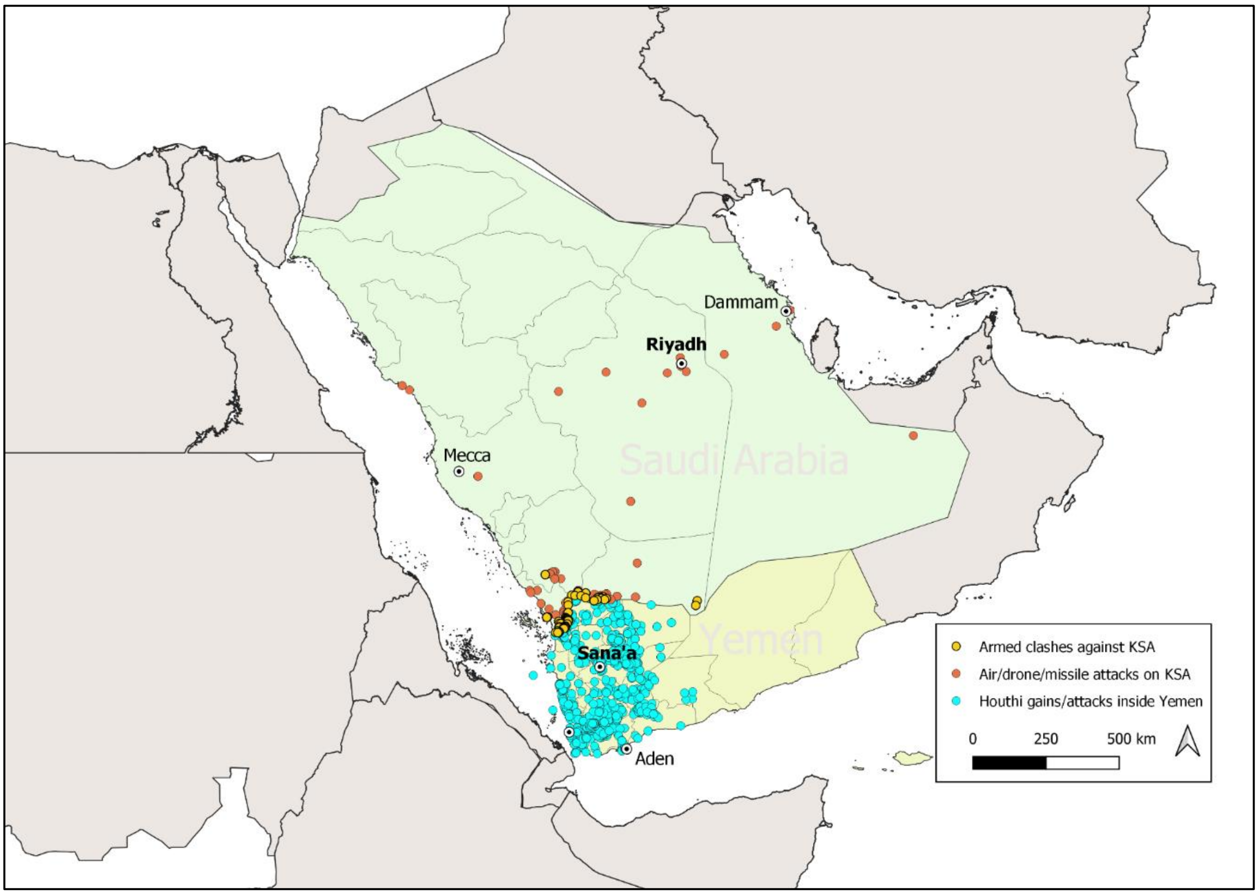

Figure 2: Map of the region with selected conflict events in Yemen and Saudi Arabia. Data: ACLED

As an indicator of oil price volatility, we use the Chicago Board Options Exchange (CBOE) Crude Oil ETF Volatility Index (OVX), hereafter labelled *volatility_CBOE*. This indicator measures the expected 30-day volatility implicit in oil futures prices. In other words, it measures the market's expectations of volatility for the following 30 days. For our analysis, we compute weekly averages from the daily value. We select this volatility indicator because of its ample use in the literature (see Lin & Tsai, 2019). Still, to prove the robustness of our approach, we also provide our own volatility estimates from a GARCH model (Annex A1).

4.2. Model / Empirical strategy

We employ a vector autoregression (VAR) model to estimate the dynamics of the Yemen war. A VAR model expresses multiple variables as a function of each other's past; hence, it explains how the value of an indicator at a specific time results from its past values and the (past) values of other indicators. Since it considers all variables simultaneously, the result of a VAR captures the complex dynamics of a system with variables interacting with each other. The framework explicitly allows for feedback and intermediation between the different variables.

Formally speaking, a VAR(K, p) model covers a stochastic process, and it expresses a vector of K (endogenous) variables as a linear function of their p lags. The model thus covers k equations that are simultaneously estimated using a multivariate least squares approach (see Lütkepohl (2005) for a thorough background on VAR models).

The interaction of oil prices and other military variables is mostly investigated using panel data with fixed effects and logistic regression models (e.g. Colgan, 2010, 2013; Hendrix, 2017). In contrast, the VAR approach captures the endogeneity of various regressors and thus accounts for feedback among the variables. This is essential for our setting as the conflict indicators are prone to simultaneity as well as endogeneity: we expect all indicators to interact and determine each other. For instance, airstrikes in Yemen may drive Houthi attacks on Saudi Arabia, which destabilise oil prices, which may again affect Saudi Arabia's military engagement. VAR models are predominantly used in macroeconomics, but they are also present in the conflict literature (P. T. Brandt et al., 2011; Crescenzi & Enterline, 1999; Dizaji & Murshed, 2020).

Our VAR system follows the specification

$$\begin{pmatrix} airstrikes_t \\ houthi\_attacks\_YEM_t \\ houthi\_attacks\_KSA_t \\ oil\_developments_t \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{pmatrix} + \sum_{m=1}^{p} \begin{pmatrix} \beta_{11m} & \beta_{12m} & \beta_{13m} & \beta_{14m} \\ \beta_{21m} & \beta_{22m} & \beta_{23m} & \beta_{24m} \\ \beta_{31m} & \beta_{32m} & \beta_{33m} & \beta_{34m} \\ \beta_{41m} & \beta_{42m} & \beta_{43m} & \beta_{44m} \end{pmatrix} \begin{pmatrix} airstrikes_{t-m} \\ houthi\_attacks\_YEM_{t-m} \\ houthi\_attacks\_KSA_{t-m} \\ oil\_developments_{t-m} \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \\ u_{4t} \end{pmatrix}$$

where α_k represents the constant of equation k, $\beta_{k,\kappa,m}$ represents the direct effect of the m-th lag of variable κ on variable k, and u_k represents the error term of variable k. $oil\_developments_t$ refers to either *brent_price* or *volatility_CBOE*; in other words, we run two VAR models, one with price levels and one with volatility.

Based on this generic model definition, we will proceed as follows: In a first step, we will verify that series are stationary–a key assumption for a VAR model. We will assess the series' order of integration with an Augmented Dickey-Fuller (ADF) unit root test. Whenever necessary, a constant or a trend will be included to perform the nonstationary tests. In the second step, we will choose the optimal model. We will consider information criteria (BIC, AIC, and HQIC) and eventually select the optimal model according to a battery of misspecification tests, namely normality, serial correlation, heteroskedasticity, and stability. To confirm the model selection, we will furthermore test the residuals for stationarity. We run the estimations in R using the packages *vars* (Pfaff, 2008b), *tseries (*Trapletti & Hornik, 2020*)*, *urca* (Pfaff, 2008a), *rugarch* (Ghalanos (Ghalanos, 2020), and *mgarch* (Ghalanos, 2019).

In our model, we impose zero-restrictions based on the coefficients' t-statistics (at confidence level of 95%), then re-estimate the model. We refer to this as the "restricted model". Finally, we will simulate impulse response functions (IRFs), which will be the basis for deriving conclusions on the indicators' interactions.

5. Results and Discussion

In this section, we present and interpret our findings. The first subsection presents diagnostic tests for a large variety of possible specifications to determine the optimal setup. In the second one, we explain and present the model in reduced form. The last subsection presents the impulse responses derived from the model and the interpretations that they offer. The Annex offers additional tests and robustness checks. While readers interested in the estimation process might want to read all subsections, readers solely interested in the conflict-related findings and their implications may prefer jumping to Section 5.3

5.1. Model selection process

First, we verify stationarity. As conflicts are bound in time, it is safe to assume that the number of weekly conflict events will follow a stationary process. The same applies to *volatility_CBOE* (see Bekaert et al., 2013). Our ADF test results (see Annex A2) confirm these assumptions and indicate that all indicators but *brent_price* are indeed $I(0)$ at a 95% significance level, some with a deterministic trend. Regarding *brent_price*, we can confirm stationary for the first differences, meaning it is an $I(1)$ time-series. Hence, all time series fulfil the assumption of stationarity and can be included in levels (except for *brent_price*, for which we use first differences: *brent_diff*). A further advantage of this is that we can neglect unknown cointegration structures (Lütkepohl, 2011).

Next, we determine the optimal model from two separate specifications and varying lags to include. We consider one specification with oil price levels (*brent_diff*), hereafter referred to as *Model 1*, and another one that uses the oil price volatility, labelled *Model 2*. We furthermore label the highest lag included in a specification in parenthesis, such that *Model 1(p)* refers to Model 1 with p as the maximum number of lags included in the model. Table 3 presents the results for the model selection process for Model 1 and Model 2.

Regarding the optimal lag, information criteria show that the optimal lag number lies between 1 and 3 for both specifications. Therefore, we proceed with the model estimation and further diagnostic tests.

Table 3: Summary of test results for Model 1(p) and Model 2(p)

Model	**Lag**	**Relevant drivers in the *airstrikes* equation**				**Serial corr.**	**Heteros.**	**Normality**	**Stability**
		airstrikes	*houthi_attacks_KSA*	*houthi_attacks_YEM*	*brent_price*				
1	1	L1(+)	L1(+)			yes (PT,both) yes (LM, both)	no	no	structural break at *houhi_attacks_ yem*
	2	L1(+) L2(+)	L1(+)			yes (PT,both) no (LM, both)	no	no	yes
	3	L1(+) L3(+)	L1(+)			yes (PT,both) no (LM, both)	yes	no	structural break at *airstrikes*
		airstrikes	*houthi_attacks_KSA*	*houthi_attacks_YEM*	*volatility_CBOE*				
2	1	L1(+)	L1(+)		L1(+)	yes (PT, both) yes (LM, both)	no	no	structural break at *houhi_attacks_ yem*
	2	L1(+)	L1(+)	L2(-)	L1(+)	yes (PT, both) no (LM, both)	no	no	yes
	3	L1(+) L2(+)	L1(+)	L2(-)	L1(+)	yes (PT, both; LM, Edgerton-Shukur), no (LM, Breusch-Godfrey LM)	no	no	structural break at *houhi_attacks_ yem*

Note: PT both refers to the Portmanteau for large and small samples. LM both refers to the Breusch-Godfrey LM-test and its small sample counterpart, the Edgerton-Shukur test

The residuals of a well-specified VAR model should be white noise (i.e. uncorrelated with previous periods), heteroscedastic, and normal, and the model should show no structural breaks. First, we perform a test battery for the presence of serial correlation in the various models, using Portmanteau (PT), Breusch–Godfrey (BG), and Edgerton-Shukur (ES). The tests yield different results, meaning that the test battery is inconclusive regarding serial correlation. However, even under the presence of serial correlation, the estimates would remain consistent, and only the variances might be overestimated; this would result in overrejections (Grassini et al., 2013; Pesaran & Timmermann, 2009). In other words, the presence of serial correlation would increase the burden of proof that we require for the conclusions. Second, we perform an ARCH/heteroskedasticity test. Such a test allows us to reveal ARCH effects, i.e. clustered volatility areas that violate the constant variance assumption. The results from the ARCH test suggest the absence of heteroskedasticity since we fail to reject the null hypothesis in all cases except for *Model 1(3*). Subsequently, we test for normality. Our investigation cannot verify that the residuals are normally distributed in any model specification. However, although desirable, normality is a soft assumption–without it, the estimator can still be interpreted as a quasi-maximum likelihood (QML) estimator (see Bollerslev & Wooldridge, 1992). In our case, the lack of normality is likely driven by the presence of weeks with exceptionally large conflict interaction; this is supported by the fact that all conflict indicators are right-skewed (see Annex A3). Finally, we test for the presence of structural breaks with the stability test. *Model 1(2) and 2(2)* show stability, i.e. there are no indications for structural breaks. Based on these results, we conclude that *Model 1(2)and 2(2)* are suitable characterisations of our system of equations. From this result, we can infer that the conflict's dynamic structure is more complicated than a system including only a single lag could reflect.

Next, we look at the significant drivers in the airstrikes equation. Interpreting coefficients from a VAR is often impractical (we elaborate more on this in Section 5.2). However, and at the risk of simplification, we observe that oil price volatility is a relevant driver of airstrikes in *Model 2*, while *Model 1* fails to show that oil price levels are a significant driver in the airstrikes equation (Table 3). This statement is robust with respect to alternative oil price measures and evaluations of the dynamics as alternative specifications (Annex A1).

Therefore, we consider *Model 2(2)* the optimal specification to go forward with and focus on this model for the remainder of this paper. Further results for *Model 1(2)* are shown in Annex A4 and offer dynamics similar to Model 2(2); our main conclusions regarding the conflict indicators discussed in the coming sections apply to both models. While we were able to show that oil price volatility affects the intensity of conflict–a result that significantly adds to literature's understanding, which mostly investigates oil as a relevant factor for the onset of conflict–, we were not able to confirm the same for price levels.

5.2. Estimation results

This section presents the estimation results for our model. It consists of a VAR(2) representation of the system of equations represented by *airstrikes*, *houthi_attaks_YEM*, *houthi_attacks_KSA*, and *volatility_CBOE.* Table 4 contains the estimated coefficients. For this, we first estimated *Model 2(2)* without restrictions, and then we ran an estimation with all insignificant coefficients forced equal to zero. The results for the first, unrestricted estimation can be found in Annex A3. The table of coefficients itself only bears limited interpretability of the system dynamics, for which the indirect feedbacks between the variables are detrimental. The following subsection provides a deeper analysis of these dynamics and dependencies.

Table 4: Restricted form VAR estimation results (Model 2.2)

	Dependent variable			
	airstrikes	houthi_attacks_YEM	houthi_attacks_KSA	volatility_CBOE
airstrikes.l1	0.69^{***} (0.04)		0.01^{***} (0.002)	
houthi_attacks_YEM.l1		0.50^{***} (0.06)		
houthi_attacks_YEM.l2	-1.18^{***} (0.35)	0.26^{***} (0.06)		
houthi_attacks_KSA.l1	3.18^{***} (0.85)	0.13^{**} (0.06)	0.45^{***} (0.06)	
houthi_attacks_KSA.l2			0.22^{***} (0.06)	0.06^{***} (0.02)
volatility_CBOE.l1	1.96^{***} (0.40)			1.21^{***} (0.06)
volatility_CBOE.l2				-0.23^{***} (0.06)
trend		0.04^{***} (0.01)	0.01^{**} (0.004)	
Observations	256	256	256	256
Note:	*p<0.1; **p<0.05; ***p<0.01. Standard errors reported in parenthesis			

5.3. Impulse response functions

Since all variables in a VAR model depend on each other, inferring system behaviour or larger conclusions from the raw estimation results is typically infeasible. Therefore, VAR studies make use of impulse response functions (IRF). They are visual representations of how the system of endogenous variables reacts to a shock to any variable. In other words, IRFs depict the system's simulated dynamics by showing how all variables respond if one is changed. They allow conclusions the dynamic interplay and help to investigate which variables ultimately drive one another.

Figure 3 shows the IRFs for all variable combinations in our model, partitioned into four panels. Each panel depicts the IRFs[13] for all four variables, i.e. how the four variables will change in response to a unit-standard-deviation shock[14] to any variable. The green (central) curve within the corridor corresponds to the value that our model predicts for any given week after the shock. The upper and lower limits of the predicted corridor (given by the silver and anthracite curves, respectively) represent the boundaries of the 95% confidence interval[15], i.e. the range of outcomes that are still not considered highly unlikely. For instance, Figure 3.a shows how the various indicators change with a unit-standard-deviation

[13] The horizontal axis represents the number of weeks after the simulated shock occurs, while the vertical axis measures the effect on a variable in its own unit (e.g. number of weekly attacks, etc.).

[14] For week zero, the IRF considers all indicators to have a value of zero. Then, the value of the variable in question for week zero is set equal to the value of its standard deviation. All other variables subsequently react to this 'shock' as prescribed by the estimated equation.

[15] The interval allows for the crucial interpretation of whether a response is significant: if the corridor covers the zero line, it means that we do not have sufficient evidence to conclude that the variable is (still) affected by the

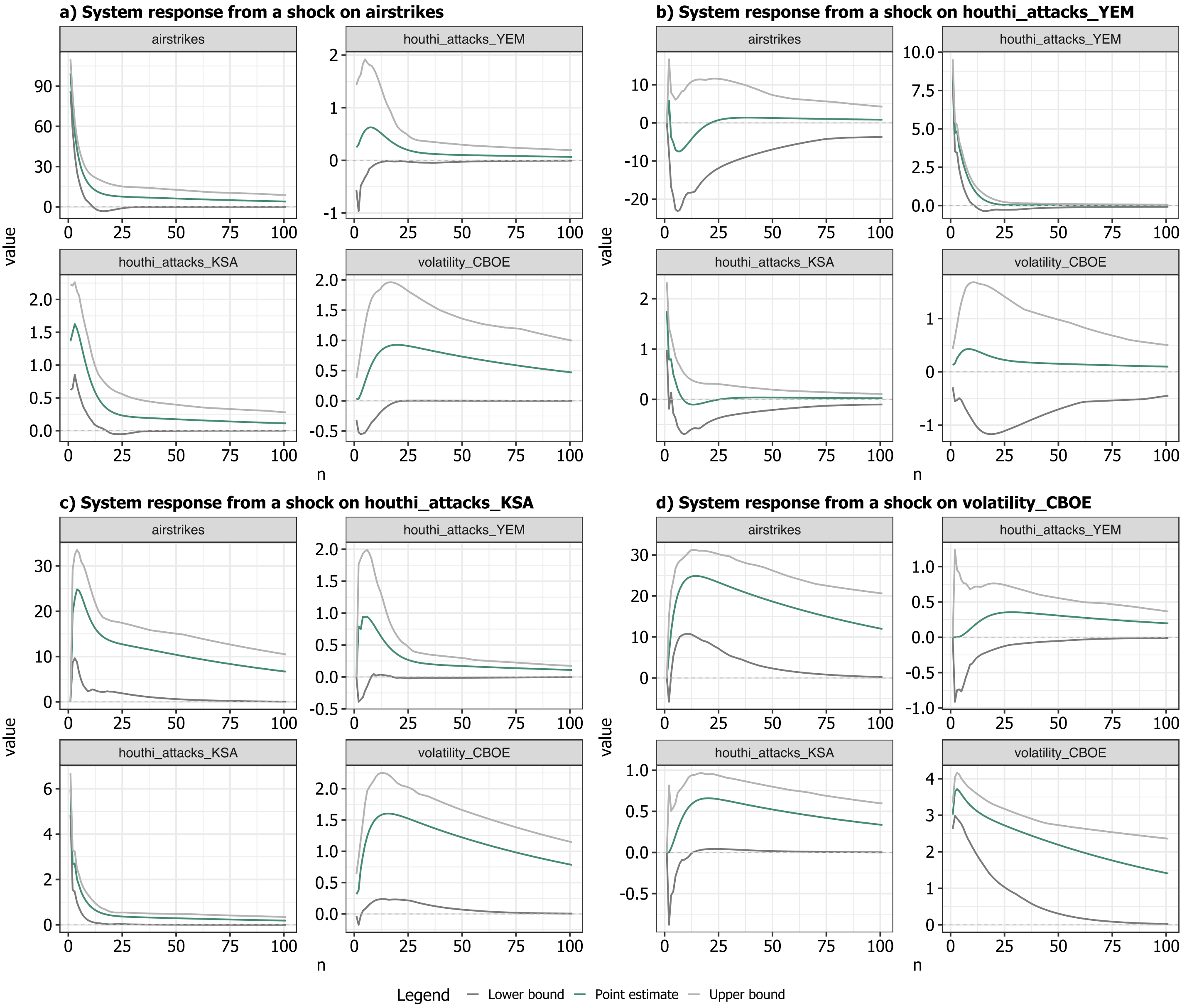

Figure 3: Impulse response functions

increase of Saudi airstrikes on Yemen. Thus, the green lines in Figure 3.a show the orthogonal responses of each variable in the VAR system resulting from this shock. We analyse and discuss each shock individually.

5.3.1. The dynamics in response to Saudi airstrikes

First, we look at the dynamics that result from an increase in Saudi Arabian airstrikes on Yemen (Figure 3.a). The IRFs reveal a positive, strong, and significant autocorrelation for a period of eleven weeks, as well as a positive and significant response from *houthi_attacks_KSA* within the first 17 weeks after the shock. The responses of the other two variables are positive but insignificant. All functions eventually converge towards zero, indicating that the system is indeed not explosive and that the VAR model is fitted properly.

shock. Vice versa, if the corridor does not cover the zero line, there is sufficient evidence to infer that the variable is affected by the shock in that given week.

These results bear the profound implication that Saudi Arabian airstrikes have no effect on Houthi attacks inside Yemen—which were the official justification for the military intervention. Opposed to its aim of repelling the Houthi movement, the results show that the intervention is factually impotent in doing so. Instead, the airstrikes further drive Houthi attacks on Saudi Arabia, probably in retaliation for the airstrikes—a spiral of violence, as evidenced by the strikes' heavy autocorrelation and further discussed in Section 5.3.3. Thus, the unambiguous result of the analysis is that the airstrike campaign has no potential to bring peace but instead induces further escalations.

Lastly, concerning the oil market, our results are not indicative of any effect on price volatility. In other words, an increase in airstrikes does not lead to a destabilisation of the oil market.

5.3.2. The dynamics in response to Houthi attacks in Yemen

Second, we look at the dynamic system response to a shock to Houthi attacks in Yemen (Figure 3.b). Here, the only significant response is a positive jump in Houthi attacks on Saudi Arabia (up to ten weeks after the shock), in addition to significant autocorrelation for twelve weeks. All other dynamics are statistically insignificant. Also in this case, we observe that all responses eventually converge to zero.

Most importantly, we do not observe a significant reaction from the airstrikes. Put into context, this implies that the airstrike campaign is not only inapt to stop the Houthi advances—as shown above—but also entirely unaffected by it. This result strongly contradicts the military intervention's official justification to stop the Houthi movement from advancing. In fact, the shape and position of the confidence interval show that, even under a drastically lowered burden of proof, there would be no evidence of any such relation. Hence, our results strongly suggest that the airstrike campaign is not guided by its official purpose, and that the extent of airstrikes is not chosen to repel a growing influence of the Houthi movement inside Yemen.

Noticeably, this point extends to *domestic* Houthi advances not being used for generating legitimacy or hegemony through increasing the airstrikes. While these channels might be relevant for explaining the war's onset and its continuity, our results cannot confirm that they are relevant for the extent of military interaction. However, as discussed in the next subsection, this is not the case for advances on Saudi soil.

Concerning the other two variables, we can infer the following. The briefly significant, positive response from *houthi_attacks_KSA* suggests a synergy between attacks inside and outside the country, i.e. the domestic and foreign advances appear coordinated. The absence of a significant response from *volatility_CBOE* implies that there is again no evidence that events inside Yemen affect the global oil market.

5.3.3. The dynamics in response to Houthi attacks in Saudi Arabia

Third, we investigate how the indicators react to Houthi-led attacks on Saudi Arabia (Figure 3.c). They are the only variable that renders significant responses from all other indicators. Aside from autocorrelation, we find strong, positive, and continuously significant effects on *airstrikes* and *volatility_CBOE* as well as a positive response from *houthi_attacks_YEM* that is briefly significant between week eight and 17 after the shock. Also in this case, all responses eventually converge to zero.

Starting with the airstrikes, the results prove that an attack on Saudi Arabia increases coalition airstrikes on Yemen. This behaviour matches the explanations discussed in Section 3: territorial defence, retaliation, diversionary warfare, and perceived losses leading to more aggressive behaviour. Although our macroscopic approach cannot provide a definite distinction between these theories, the IRF's exact shape offers suggestions. The response immediately peaks (week four) and drops sharply afterwards, consistent with territorial defence. However, the response's magnitude speaks in favour of retaliation and legitimacy building as ulterior motives: on average, a single attack on Saudi Arabia will cause a total of 12 airstrikes in response within the first ten weeks. Furthermore, the IRF's long tail is consistent with prospect theory; tangible losses of territory and legitimacy from a Houthi attack on Saudi Arabia may update the decision-maker's behaviour and eventually lead to a prolonged increase in airstrikes.

The very briefly significant, positive effect on *houthi_attacks_YEM* may also point at a synergy between domestic and foreign fronts; however, the effect's timing is difficult to explain.

Turning to *volatility_CBOE*, and in contrast to the results from the previous indicators, our results show that Houthi attacks on Saudi Arabia do have a relevant impact on global oil markets. On average, the attacks will lead to a significant elevation of price volatility lasting more than a year. This finding may also offer an additional explanation for the response of airstrikes since the losses from increased volatility may affect military decision-making too. The following subsection will discuss this issue further.

5.3.4. The dynamics in response to oil market volatility

Fourth, we consider the dynamics that result from oil market volatility (Figure 3.d). Unsurprisingly, the indicator shows significant autocorrelation, but there is also a continuously significant, positive response of *airstrikes*, as well as a brief period with a significant, positive response from *houthi_attacks_KSA*. There is, however, no significant response from *houthi_attacks_YEM*. Again, all estimates move towards zero, though the convergence process seems slower than in the other cases.

Evidently, the number of Saudi airstrikes in Yemen is significantly driven by oil market volatility. The effect's magnitude is relatively small (a peak of 25 relative to *CBOE_volatility*'s high standard deviation of 9.6), but it has a long duration, and it wears off smoothly instead of showing an immediate drop following the peak. The IRF is inconsistent with budgetary concerns; in that case, oil market volatility would lower the number of airstrikes. Also, recalling the insignificance of oil price levels (see Section 5.2), we learn that fiscal concerns do not (directly) affect Saudi Arabian military engagement in Yemen. Instead, the response and its duration indicate long-term behavioural mechanisms leading to more aggressive decision-making; a more volatile oil market increases Saudi airstrikes on Yemen. The response's shape is unfortunately not offering further suggestions on the exact reason. It could be an attempt to compensate for legitimacy lost due to dampened oil revenue, amplified risk-taking behaviour stemming from a changed perception of tangible losses, or oil politics and long-term market concerns carried on to the security domain (see Section 3.3). Also, put in context with the volatility's extensive autocorrelation, both variables push one another: volatility brings more volatility, which affects decision-making in the long run. However, and crucially, oil price volatility being a driver of the airstrike campaign is further evidence that the military intervention is not (exclusively) driven by its legitimate purpose.

Surprisingly, while oil price volatility does not drive Houthi attacks inside Yemen, it has a briefly significant effect on their actions in Saudi Arabia—roughly half a year after the shock. We admit that this pattern is difficult to rationalise but suggest the following explanation: the Houthi military aims to strike Saudi Arabia and its oil infrastructure when it is most vulnerable, i.e. during price fluctuations. It might be unlikely to find this intersectoral awareness inside the Houthi movement, but this could further indicate that Iran provides at least strategic advice to the rebels.

6. Conclusion

In his letter requesting military assistance from the GCC, Yemeni transition president Hadi expressed his concerns of Yemen being "dragged into a war that will consume everything". After more than five years, and despite numerous peace initiatives and ceasefires, an end to Yemen's all-consuming war is out of sight.

Therefore, our article has taken on the challenge to provide first numerical insight into the war's dynamics and, in particular, the question of whether the coalition airstrike campaign has been driven by and effective against the rising Houthi movement in Yemen. To this end, after a thorough discussion of the conflict's background and the reasons for Saudi Arabian military engagement discussed in the literature, we have used a VAR model to assess the interplay of Saudi Arabian airstrikes, Houthi attacks inside and outside of Yemen, and oil market developments.

Our findings have clearly and robustly shown that the extent Saudi Arabian military engagement has neither been driven by efforts to save Yemen, nor that it has been successful in deterring the Houthi movement from holding their grip on Yemen; an increase in Houthi attacks on Yemen does not produce an increase in airstrikes, and Saudi airstrikes do not cause a significant reaction from Houthi attacks inside Yemen. Instead, coalition airstrikes on Yemen both cause and react to Houthi attacks on Saudi Arabian territory. Thus, and as a bottom line, the military intervention is self-reinforcing, unsuitable for changing the situation inside Yemen, and unresponsive to its official purpose. Instead, our results have proven that oil market volatility exacerbates the airstrike campaign. While—contrary to what might be expected from the literature on oil and conflict—there was no evidence of oil price levels affecting the airstrike campaign, their volatility causes a prolonged increase in the number of strikes.

We are aware that other drivers may not be considered due to the empirical setup, which forces us to restrict their numbers. Nevertheless, we have included the most central conflict variables, and the oil price proxies a wide range of global/Saudi economic indicators. Moreover, in this article, we have given ample proof for our results' robustness, which extends to alternative measures and alternative model specifications.

With this, our article provides a substantial contribution to the academic and political discourse on the Yemen conflict as well as the literature on the nexus between conflict and oil prices. Regarding the latter, our results show that oil does not only play a role in the onset of conflict, but it even affects the dynamics and extent of war. These findings offer new research perspectives towards a generalisation of the results and a theoretical elaboration of the role of oil price volatility in conflict behaviour. Moreover, these insights provide guidance for global climate policy, which is going to decrease oil prices. On this point, our results suggest that decreasing prices themselves do not necessarily threaten regional stability, but that climate policy needs to ensure a certain and smooth transition to prevent conflict. This result is in line with other studies (e.g. Ansari & Holz, 2019) emphasising that the energy transition itself is not bound to cause systematic agitation, but that uncertainty needs to be the primary concern.

Concerning the political and academic debate, our work is complementary to the rich body of academic and professional literature that analyses the conflict—and its reasons—from various qualitative angles. While our research approach is not suitable for verifying the exact underlying political and behavioural mechanisms, it has provided robust, empirical insight into the conflict's dynamics. On this point, we are convinced that our research has significant implications for discourse and policy. Our findings clearly show that the military intervention has been unsuccessful; it has proven unable to suppress the Houthi movement, and there is no evidence that the movement's grasp on the country—the official reason for the intervention—affects the airstrike campaign. Instead, our analysis has shown that the airstrike campaign reacts to attacks on Saudi Arabian soil and oil price volatility. Although the former may constitute a legitimate case of territorial defence, the shape and the timing of the airstrike response we found in the data suggest that retaliation, legitimacy-seeking, and increased risk-taking behaviour play major roles. This is corroborated by oil price volatility driving the military strikes, a factor that could not be further from the intervention's official target and instead connects to the abovementioned behavioural themes. Therefore, we are convinced the results should draw the intervention and arms exports to the region further into question and increase international scrutiny.

Annex

A1. Robustness and sensitivity analyses

We prove our results' robustness by considering alternative model specifications with different oil price indicators (see Figure 4). Regarding price levels, we also test West Texas Intermediate (*WTI_price,* obtained from the US Energy Information Administration*)* and the OPEC basket price (*OPEC_basket_price*, obtained from OPEC*)*. They represent alternative crude benchmarks, the former being preferably used in the US and the latter representing an index of regional prices, including Arab Light, Basra Light, Kuwait Export, and Merey. Regarding volatility measures, we also consider an indicator of observed volatility *(volatility_GARCH)*, which we estimated using a generalised autoregressive conditional Heteroscedasticity (GARCH) model (see Bollerslev, 1986; Ghalanos, 2020). We used a standard GARCH(1,1) model.

Our results are robust with respect to alternative oil price measures. Oil price volatility is again a relevant driver of airstrikes, while oil prices are not. Concerning the results of our test battery and the significant drivers of *airstrikes* (Table 5) we generally achieve results similar to those from our main specifications. However, none of the alternative models is stable, verifying our choice of *Model 2(2)*.

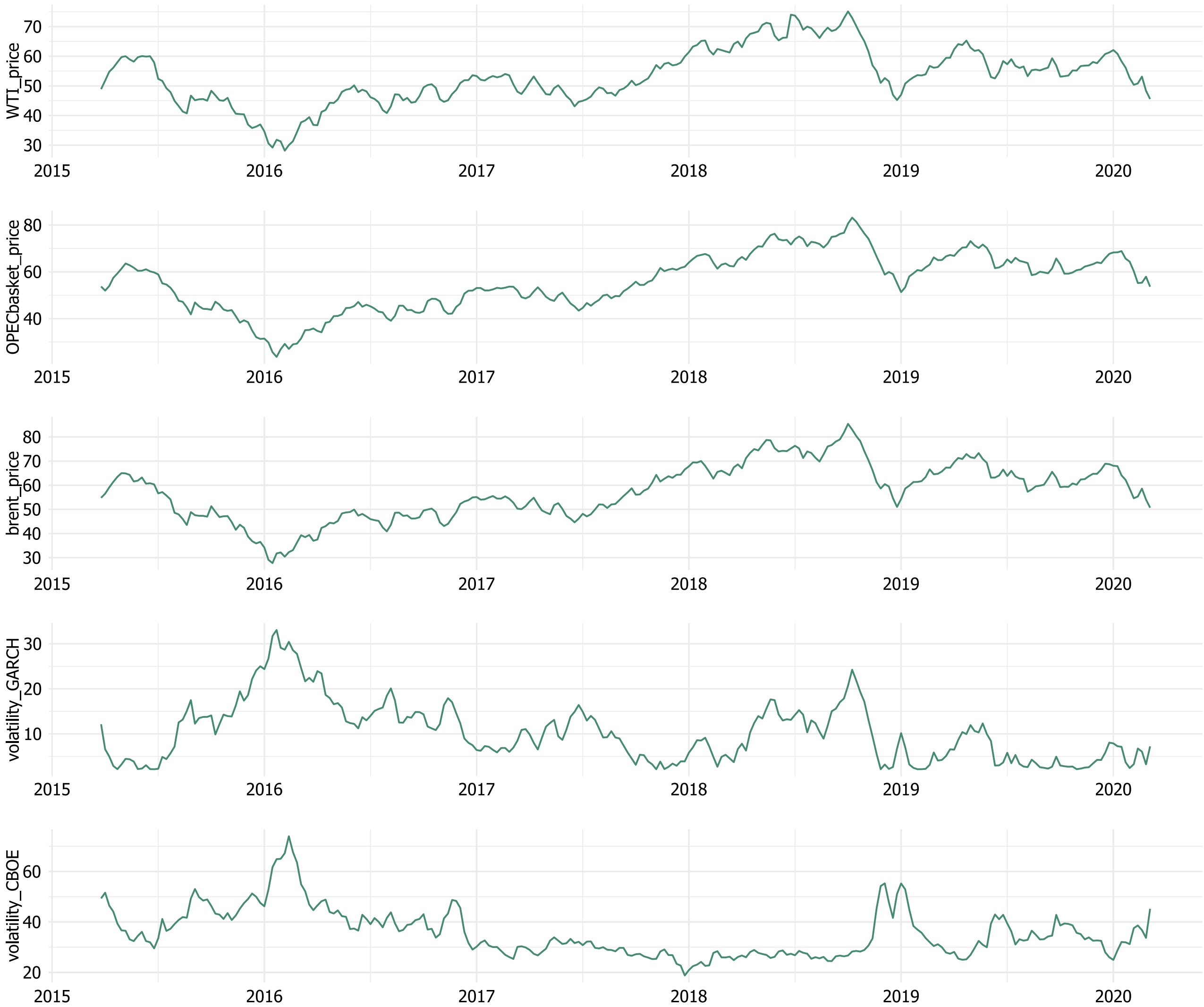

Figure 4: Time series visualisation for the alternative indicators

Table 5: Summary of test results for the alternative oil price indicators

Model	Lag	Relevant drivers in the *airstrikes* equation				Serial corr.	Heteros.	Normality	Stability
		airstrikes	*houthi_attacks_KSA*	*houthi_attacks_YEM*	*WTI_price_diff*				
3	1	L1(+)	L1(+)			Yes (PT, both), yes (LM, both)	Yes	No	Structural break at *airstrikes*
	2	L1(+) L2(+)	L1(+)			Yes (PT, both), no (LM, both)	No	No	Structural break at *airstrikes*
	3	L1(+) L3(+)	L1(+)			Yes (PT, both), no (LM, both)	No	No	Structural break at *airstrikes*
		airstrikes	*houthi_attacks_KSA*	*houthi_attacks_YEM*	*OPECbasket_price_diff*				
4	1	L1(+)	L1(+)			Yes (PT, both), yes (LM, both)	No	No	Structural break at *airstrikes*
	2	L1(+) L2(+)	L1(+)			Yes (PT, both), no (LM, both)	No	No	Structural break at *airstrikes*
	3	L1(+) L3(+)	L1(+)			Yes (PT, both), no (LM, both)	Yes	No	Structural break at *airstrikes*
		airstrikes	*houthi_attacks_KSA*	*houthi_attacks_YEM*	*Volatility_GARCH*				
5	1	L1(+)	L1(+)		L1(+)	Yes (PT, both), yes (LM, both)	No	No	Structural break at *houthi _attacks_YEM* and *airstrikes*
	2	L1(+)	L1(+)		L2(+)	Yes (PT, both), no (LM, both)	No	No	Structural break at *houthi _attacks_YEM* and *airstrikes*
	3	L1(+) L3(+)	L1(+)		L2(+)	Yes (PT, both), no (LM, both)	Yes	No	Structural break at *houthi _attacks_YEM* and *airstrikes*
	4	L1(+) L3(+)	L1(+)	L2(-) L4(+)	L4(+)	Yes (PT, both), no (LM, both	No	No	Structural break at *houthi _attacks_YEM*

Note: PT both refers to the Portmanteau for large and small samples. LM both refers to the Breusch-Godfrey LM-test and its small sample counterpart, the Edgerton-Shukur test

A2. Unit root analysis

We test the presence of a unit root using the Augmented Dickey-Fuller (ADF) test in several settings, ranging from general (including both constant and trend) to specific (neither constant nor trend included). From the results (Table 6), we confirm our variables' order of integration (last column). We underline the respective values to indicate the most appropriate test setting based on the F-statistic. The results confirm at a 95% confidence level that all variables, except for *brent_price*, are stationary in levels. In other words, the variables' order of integration is 0 (I(0)). *brent_price* is stationary after taking first differences, i.e. I(1).

Table 6: ADF unit root tests

Variable	**Constant & trend** Test value (critical values -3.98 ,-3.42, and -3.13 at 1%, 5% and 10%)	**Constant** Test value (critical values -3.44,-2.87, and 2.57 at 1%, 5% and 10%)	**None** Test value (critical values -2.58,-1.95 and -1.62 at 1%, 5% and 10%)	**Order of integration**
airstrikes levels log	 -6.115 -5.155	 -4.4015 -3.8347	 -2.5376 -0.8835	 I(0) I(0)
houthi_attacks_YEM Levels log	 -4.508 -5.203	 -3.5444 -3.8340	 -1.6870 -0.7384	 I(0) I(0)
houthi_attacks_KSA levels log	 -5.619 -4.402	 -5.4351 -4.2033	 -2.9835 -1.8490	 I(0) I(0)
brent_price levels first difference log first difference log	 -2.1946 -10.601 -2.3365 -11.626	 -1.8836 -10.6201 -1.9293 -11.4054	 -0.5335 -10.641 -0.2649 -11.427	 I(1) I(1)
volatility_CBOE In levels: First difference Log First difference log	 -3.4731 -11.0341 -3.1774 -11.2894	 -3.4904 -11.0266 -3.2367 -11.2803	 -0.9323 -11.0529 -0.2711 -11.2047	 I(0) I(0)

Notes: Lags are optimally selected using the AIC criterion. Underlining represents that this is the right equation for the ADF test according to the F test on the trend and the constant.

A3. Additional results for Model 2.2

As an intermediate step to reach the restricted VAR model discussed in the main body, we perform an unrestricted VAR model regression for Model 2.2. Table 7 shows the corresponding estimated coefficients. For the final model (results in Table 4), we impose zero restrictions on those coefficients not statistically significant at the 95% confidence level and re-estimate the model. Furthermore, and especially to understand the model's normality, Figure 4 shows histograms of the four included variables.

Table 7: Unrestricted VAR model 2.2

	Dependent variable			
	airstrikes	houthi_attacks_YEM	houthi_attacks_KSA	volatility_CBOE
airstrikes.l1	0.62***	0.0001	0.01	0.002
	(0.06)	(0.01)	(0.004)	(0.002)
airstrikes.l2	0.07	0.001	0.005	-0.002
	(0.06)	(0.01)	(0.004)	(0.002)
houthi_attacks_YEM.l1	0.36	0.50***	0.03	0.01
	(0.70)	(0.06)	(0.05)	(0.02)
houthi_attacks_YEM.l2	-1.22*	0.27***	-0.0004	-0.01
	(0.71)	(0.06)	(0.05)	(0.02)
houthi_attacks_KSA.l1	2.53**	0.16*	0.43***	-0.03
	(1.04)	(0.09)	(0.07)	(0.03)
houthi_attacks_KSA.l2	0.77	-0.06	0.20***	0.07**
	(1.04)	(0.09)	(0.07)	(0.03)
volatility_CBOE.l1	1.99	-0.27	0.02	1.21***
	(2.09)	(0.19)	(0.13)	(0.06)
volatility_CBOE.l2	-0.04	0.28	-0.04	-0.24***
	(2.09)	(0.19)	(0.13)	(0.06)
trend	-0.08	0.04***	0.01	0.003
	(0.12)	(0.01)	(0.01)	(0.004)
Observations	256	256	256	256
Note:	*p<0.1; **p<0.05; ***p<0.01. Standard errors reported in parenthesis			

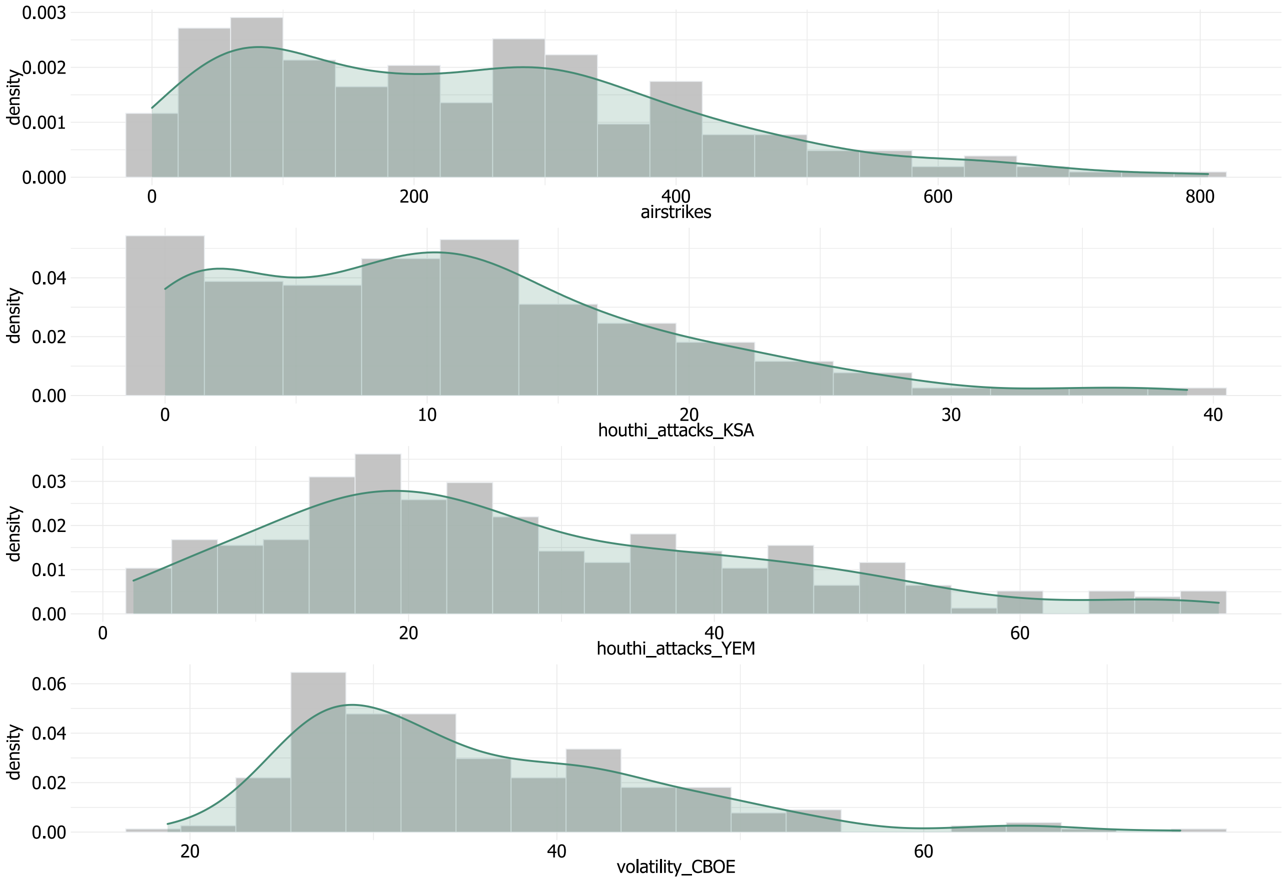

Figure 5: Histograms of the indicators in Model 2.2

A4. Results for Model 1.1

This section presents the IRFs of *Model 1.2* (see Figure 6). As the responses' shapes and confidence intervals show, the model offers similar conclusions to those derived from Model 2.2 (with the obvious exception of those regarding oil price developments).

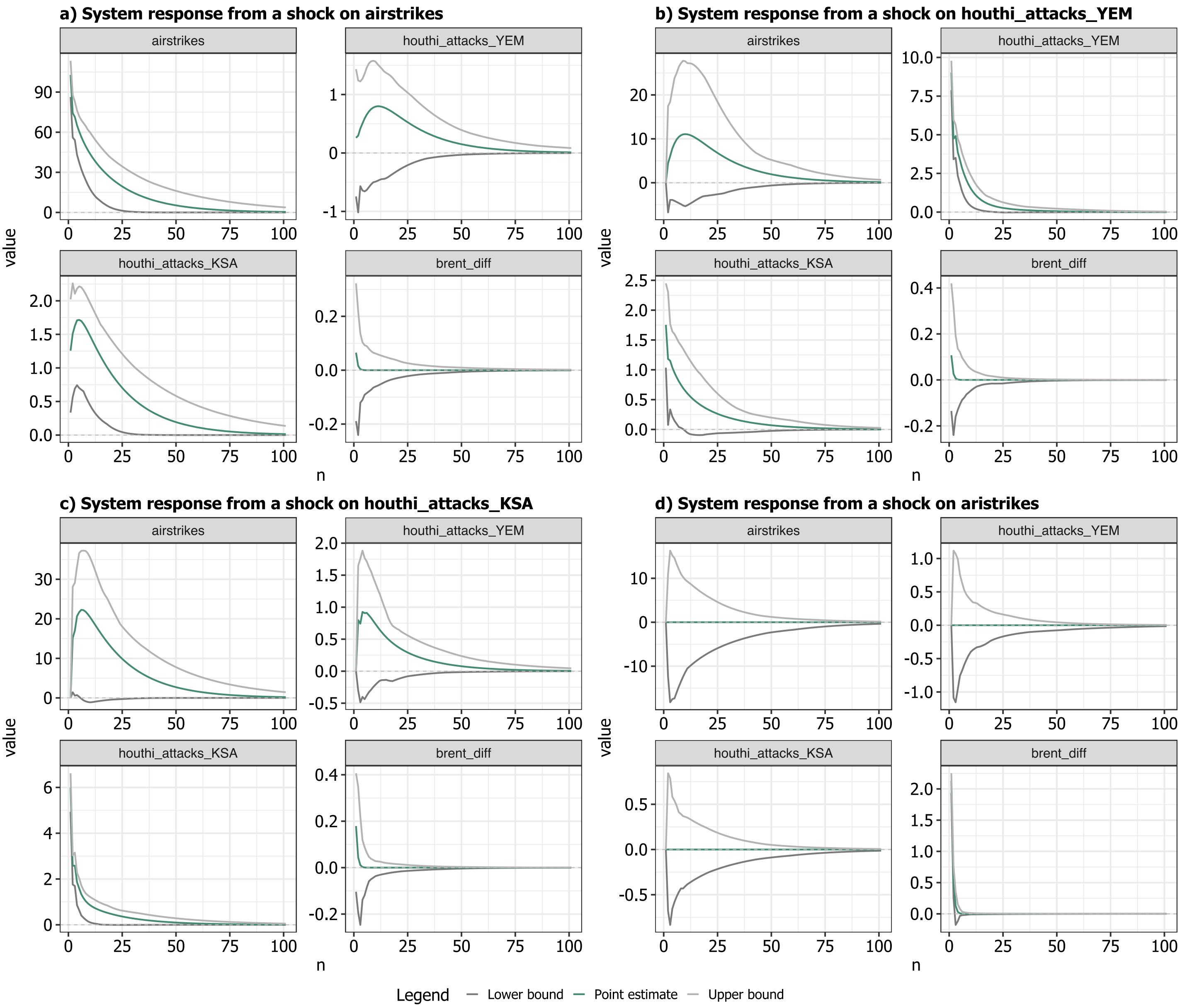

Figure 6: Impulse response functions of *Model 1.2*

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