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Patriarchy, Pandemics and the Gendered Resource Curse Thesis: Evidence from Petroleum Geology

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Patriarchy, Pandemics and the Gendered Resource Curse Thesis:

Evidence from Petroleum Geology

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Abstract

This paper examines features shared by societies built around oil and the impact of COVID-19. For our cross-sectional analysis, we use epidemiological data on COVID-19, country-level long-run oil production data, and data on petroleum geology for econometric identification. We first document that a country's long run oil production is associated with a significantly higher number of COVID-19 deaths. Exploring mechanisms, we find that women's election into political offices reduces the risk from COVID-19, but only in oil-poor countries. Furthermore, we find robust evidence that petroleum-wealth reduces the percentage of women in parliament. Oil contributes to a gender imbalance in the population and affects the labour force market participation rate for men more than for women. Overall, these findings highlight the risk and plausible mechanisms of COVID-19 vulnerability in oil-exporting countries. Policy makers should be aware of these effects.

Keywords: COVID-19, petroleum, demographic transformation, patriarchy

JEL codes: H5, I1, J16, P48

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1. Introduction

Does patriarchy— a system of society in which men predominantly hold power and women are largely excluded from it—matters for disease pandemics such as the COVID-19? In a world facing a growing threat from climate change to global warming and disease pandemics, it is essential to understand if reforms supportive of women's political participation and contribution to health policy decisions can enhance public health outcomes (Haines and O'Neil, 2018; Wenham, 2020).

Anecdotal evidence suggests that countries with a woman as a state leader and/or that are predominantly governed by women are better able to manage the COVID-19 pandemic.[1] Research provides support for the hypothesis that gender-specific preferences affect the allocation of public funds. As a social planner, a woman may prioritise social and health investments over military expenditures and endorse pro-poor policies that promote equality (D'Amico, 2010). Female representation may also affect public policy because of gender differences in risk-taking behaviours[2] and because women are less likely to sacrifice the common good for personal benefits (e.g., Eckel and Grossman, 1998; Dollar *et al*., 2001; Swamy *et al*., 2001).

Justifying why a *gendered* political economy perspective would be important for understanding COVID-19 impacts needs to go beyond anecdotal narratives. The perspective has received limited research attention, likely in part because the causal mechanisms are hard to identify and demonstrate. In an explorative study, Leung *et al*. (2020) investigate the impact of gender equality on public health outcomes during the ongoing Covid-19 pandemics. Their results show a strong positive effect of both gender equality and the proportion of women in legislation on public health expenditures but also an unexpected negative correlation between the Human Development Index (HDI) and the percentage of women in the legislature, and no significant effect of HDI on public health expenditure.[3]

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[1] These countries include Germany, Argentina, Barbados, South Korea, Denmark, Iceland, New Zealand, and Taiwan. See The secret weapon in the fight against coronavirus: women, What Do Countries with the Best Coronavirus Responses Have In Common? Women Leaders, and Sexual politics in times of pandemic

[2] In a well-known experimental study, Ertac and Gurdal (2012) show that male leaders take more risk than female leaders when they decide for their group. Females, who are prepared to take on leadership roles, are no different in terms of how much risk they take for themselves or for others in their group. The opposite is found for males; those males that would like to lead tend to take more risk on behalf of the group.

[3] Leung *et al*. (2020) use publicly available data for 210 countries. Gender equity is measured as the Gender Inequality Index which ranks counties in terms of the gender gap for reproductive health, empowerment and

Could the topic be investigated within the context of the resource curse thesis? The adverse effects of natural resource wealth on a country's wellbeing are well documented, specifically for petroleum.[4] Recent studies have extended the resource curse literature to population health (*e.g.*, Wigley *et al.,* 2017; Keller, 2020). Earlier this literature had been extended to the gender gap in political representation (Ross, 2008). The gendered resource curse thesis suggests that petroleum-rich countries typically possess strong patriarchal norms, laws, and political institutions. There are 96 oil-producing countries in the world (EIA, 2020) which make this a relevant issue. If gender equality and woman's inclusion in politics matters for health outcomes, it may also explain why such countries may be of greater risk in times of public health crisis.

There are important other features shared by societies built around oil. Due to the presence of large numbers of migrant men, oil-rich regions commonly have unbalanced population sex ratios (Dyson, 2012; Cunningham *et al.*, 2020). A population with a sex-ratio imbalance could be at higher risk of death from COVID-19. It is known that men relative to women may be at greater risk both from COVID-19 (Cai, 2020; Lancet, 2020) and from mortality during a recession (Garcy *et al.*, 2012, Sulemana *et al*., 2019). Labour force participation in oil-societies is predominately patriarchal (see Ross, 2008); men with jobs tied to the oil sector may be harder hit in times of recession and may experience increased risks from COVID-19 (Garcy *et al.*, 2012).

In this study, we ask if oil production increases the risk of people dying from COVID-19 infection and explore the channels of patriarchy and the gendered resource curse. For our cross-sectional analysis, we exploit epidemiological data on COVID-19 (December 31, 2019, to June 2, 2020), the percentage of parliamentary seats in a single or lower chamber held by women, and country-level data on oil production per capita (averaged over the period 1966 to 2008). We include as additional controls geographic, institutional and economic variables, age demographic distribution, investment in health care and underlying prevalence of diabetes and cardiovascular disease. To isolate the effect of petroleum wealth on the outcomes of interest, we exploit the geology of petroleum formation (Cassidy, 2019).

Our main estimation results show that crude oil production is associated with a significantly higher death rate from COVID-19. Also, we find that oil reduces the number of

labour force participation (UNDP, 2020). The Human Development Index (HDI) is a composite measure that combines income, life expectancy and education.

[4] Petroleum dominates the global market for natural resources (90 % of the trade in minerals). Another reason for the focus on petroleum is data availability (see Wigley *et al*., 2017).

COVID-19 tests but increases the response as measured by the government response stringency index. Next, we find evidence that a higher percentage of women in parliaments increases the number of tests carried out and reduces the number of COVID-19 death, but only when oil production is zero. We find robust evidence that oil reduces the percentage of women in parliaments, relative to men, reduces female force participation, and increases the male proportion of the total population (gender imbalance in population demographics). These findings emphasise the patriarchal nature of economies built on extractive industries and are suggestive of why these economies suffer more COVID-19 deaths.

Our paper contributes to two strands of the literature: a first strand on the implications of the gendered political economy and a second strand on the resource curse from a public health perspective. Starting from the first one, there is now an extensive literature on the gender-specific health and economic implications of the COVID-19. Studies have focused on why men may be at higher risk than women (Cai, 2020; Lancet, 2020), others suggest that women may be more vulnerable to COVID-19 (Alon *et al.*, 2020; Bradbury-Jones and Isham, 2020; de Paz *et al*., 2020). However, such analyses are confined to health and economic determinants. They have often ignored gender inequality and if this constitutes an obstacle to health outcomes (Wenham, 2020). Applying a gendered lens to the political economy determinants of health crisis management could justify the need for political reform that prioritise women's inclusion in decision making at the national and global level for improving life chances and wellbeing in times of global crises. Our contribution to this literature is with showing how the gendered resource curse constitutes channels that heighten the risk of COVID-19.

Our paper is also related to the literature on the health outcomes in the context of the natural resource curse (De Soysa and Gizelis, 2013; Cockx and Francken, 2014; Keller, 2020). Existing studies show that petroleum-rich countries have a higher risk of disease epidemics such as HIV/AIDS (De Soysa and Gizelis, 2013) and endemic diseases such as malaria (Chang and Wei, 2019). The natural resource curse perspective suggests that oil-rich states are likely to be relatively more impacted because of lacking economic development, poor health care systems (Keller, 2020), and limited quality governance to effectively manage shocks (De Soysa and Gizelis, 2013). However, recent studies have questioned the scope for the existence of an economic resource curse by showing benefits to health outcomes in the long run from oil wealth (Stijins 2006, Sterck 2016). Another ongoing debate in this literature is with the empirical assessment of cross-country health outcomes. It requires capturing the cross-country variation in oil wealth in a measure that is independent of institutional quality, current oil revenues and other country characteristics. This debate by itself emphasises the need to explore alternative channels of the impact of COVID-19 pandemic in oil-exporting countries given that *a priori* expectations may be ambiguous. To deal with this endogeneity issue, we follow the recent study by Cassidy (2019). Specifically, we use data on geologic features of sedimentary basins across countries. Sedimentary basins have geographical importance for hydrocarbon formation and plausibly not influenced by socioeconomic and political factors that influence COVID-19 and women participation in political leadership.

We also contribute to the literature on health and the natural resource curse regarding the broader impact of the disease. A pandemic such as the COVID-19 is different from other epidemics. It is more widespread, and governmental mitigation responses may rapidly transform health risk into income and employment risks, and political risks. These risks from a pandemic could be aggravated in petroleum-rich countries. In these countries revenues from oil export make up the main part of government budgets, and a sharp fall in oil demand due to the COVID-19 could indirectly affect health outcomes.

The rest of the paper proceeds as follows. Section 2 illustrates the conceptual model and reviews the several possible mechanisms that could underlie a relationship between oil and the risks from a disease pandemic. Section 3 describes the identification strategy adopted and the data. Section 4 contains the main results. It also offers a discussion of the main findings and the channels of mechanisms supporting our hypothesis. We conclude in Section 5.

2. Oil and risks from COVID-19: possible directions of causality

COVID-19 was declared a pandemic on 30 January 2020 by the WHO and is expected to have a deadlier impact in developing countries (Gilbert *et al.,* 2020). As with other infectious diseases, the risk from COVID-19 on developing countries could be disproportionately heightened by the resource curse in oil-rich countries (De Soysa and Gizelis, 2013; Cockx and Francken, 2014; Keller, 2020). Oil-rich countries have less investment in human resources, poor governance and institutional capacities to manage risk. These countries also have a narrow revenue base as their economy responds to the oil price shocks induced by COVID-19. If intervention-based strategies are conditional on public action and government commitment, then these circumstances may heighten the health risk from COVID-19.

However, the question is whether this mechanism is strong enough to elevate the risk of COVID19 in terms of health outcomes (Figure 1). Alternative reasoning is that resource rents enable social welfare policies to be funded quickly. So oil-exporting countries may be relatively well prepared to address the social welfare risks due to restriction of economic activities and loss of livelihoods from the pandemic.

From an empirical perspective, the link between resource abundance and risk can go in both directions (Fig. 1). Because vaccines are not available at the beginning of the pandemic outbreak, the containment requires non-pharmaceutical interventions such as voluntary quarantine of infected persons, workplace closure and bans on non-essential public gatherings, among other measures (Hatchett *et al.,* 2007). The restriction of economic activities—shutdowns and firm exits—may lead to oil-demand shortages and impose liquidity constraints on budget executions.

The first objective of our research is to provide empirically evidence that oil matters for COVID-19, *i.e*., for the risk of death, and also for non-pharmaceutical interventions such as tests and for the extent of governments' responsiveness to stemming the outbreak of infection from the pandemic. The risk from COVID-19 is correlated with the underlying socioeconomic and demographic distribution (*i.e.*, age) and determinants of health that may simply reflect the greater stock of human capital or medical facilities (Fig 1). Alternatively, it may reflect the demographic distribution (sex-ratio) and gendered political economy features generally excluded from human health and resource curse studies, but which possess particular relevance for developing economies. Oil can lead to a population sex-ratio in favour of men. As the COVID-19 data reveals, men are more likely to be at higher risk, and a predominantly male population may be more vulnerable.

The second objective of this research is a preliminary investigation of the link between gender inequality in political participation and COVID-19 risk. While gender gaps in political participation and health outcomes from COVID-19 in most countries are well observed, the record of the published research that link this gap to the health risk is scarce. Much of what we know is rather suggestive and based on anecdotes that have not been rigorously subjected to empirical data.

Having ascertained the presence of a gender gap in political participation and a higher risk from COVID-19, our third objective is to assess the extent to which these disparities stem from the gendered resource curse associated with oil-rich countries. Ross (2008) first observed that women had made less progress toward gender equality in the Middle East than in any other region, a situation often termed the gendered resource curse. Petroleum wealth is found to reduce labour force participation among women, which in turn reduces their political influence, and it is associated with strong patriarchal norms, laws, and political institutions.

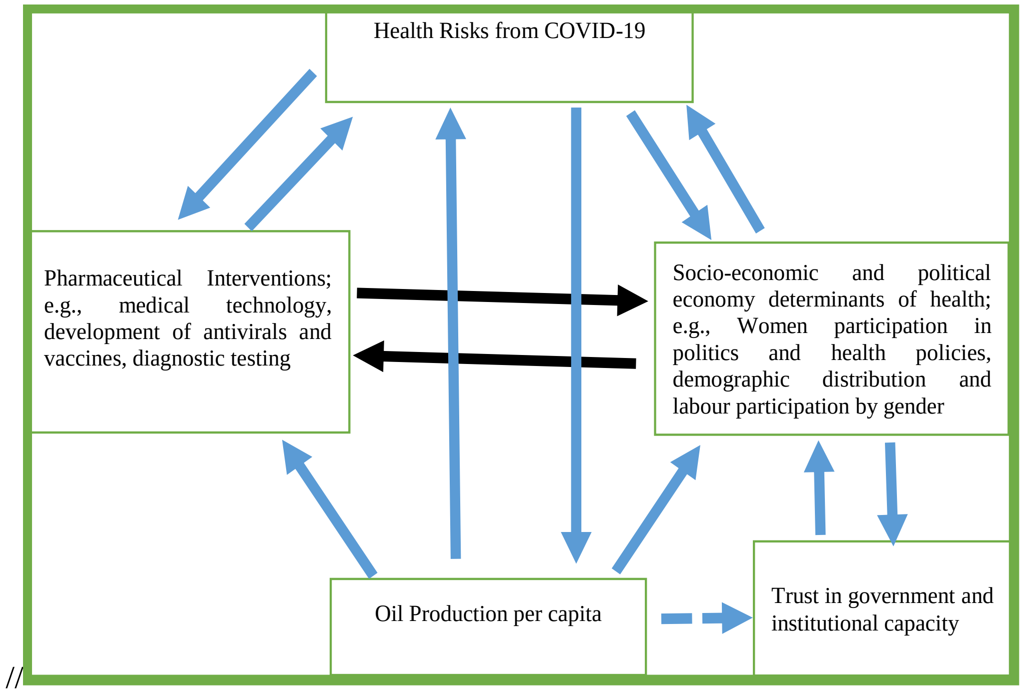

Figure 1: Oil and COVID-19: Possible Direction of Causality

For this third objective, we examine the political participation of women and other features of patriarchy in oil-rich countries as a mechanism to explain the risk from COVID-19. This objective is essentially a mapping operation, one that will help establish to what extent women have been included in political representation and how the degree of incorporation varies with the amount of long-run oil production. We empirically isolate the effect of oil on patriarchy using geologic features of petroleum formation. As argued by Norris (2009) and many since, the empirical identification of the effect of oil toward gender equality as employed in Ross (2008) is insufficient to establish whether petroleum is core to the observed gender disparities in elected offices.

3. Identification Strategy and Data Sources

3.1 Identification Strategy and Estimating Equations

In this study, we estimate the effect of oil per capita on risk from COVID-19 using the geologic features of sedimentary basins responsible for petroleum formation as the instrumental variable. The identification strategy builds on a recent study by Cassidy (2019).[5]
The estimating equations are:

$$Y_{ir} = \beta logOil_{ir} + \delta' X_{ir} + \phi' M_{ir} + \psi' G_{ir} + \Omega' T_t + \alpha_r + \varepsilon_{ir} \quad (1)$$

$$logOil_{ir} = \pi Sedimentary\_basin_{ir} + \sigma' X_{ir} + \theta' M_{ir} + \gamma' G_{ir} + \eta' T_t + \lambda_r + \xi_{ir} \quad (2)$$

where Y_{ir} is the outcome of interest for county *i* in region *r*; T denotes month dummies since the time of the outbreak in China (December 2019 to June 2020) and α_r and λ_r are region-level fixed effects. The seven regions are classified as: Sub-Saharan Africa; Latin America and the Caribbean; East Asia and the Pacific; Eastern Europe and Central Asia; Rest of Europe and Neo Europe; the Middle East and North Africa, and South Asia.

In our main regression, Y represents the average of the country-level log of death per million from COVID-19 from Dec 2019 to June 2020. In Eqn. (1), *logOil* denotes the log average annual oil production per capita. Arguably, the effect of oil on health risks depends on the amount of oil produced per capita and not on the absolute quantities. Higher levels of outputs relative to population, afford states more spending on public health, providing health infrastructure and coordinate efforts to reduce the risk of death from COVID-19.

Y tells us about the risk of COVID-19 at varying *logOil* levels. To investigate other COVID-19 related factors that are indirectly related to death, we replace *Y* in Eqn (1) with the COVID-19 tests per thousand carried out and the government response stringency index, which is a composite measure based on indicators, including the closure of schools and workplaces and travel bans. Data on tests and stringency of response can indicate the level of monitoring and the progress of government effectiveness at containment which can both be used to predict health-care needs.

It is not just oil revenues, and the capacity and quality of the health care system, other country-level characteristics may be important as well. The vector *X* comprises of country-level institutional, economic and demographic factors like stringency index, population

[5] Cassidy (2019) uses the spatial distribution of geologic features of sedimentary basins to isolate the effect of exogenous cross-country variation in oil wealth on democracy, fiscal capacity development, corruption, and GDP per capita.

density, median age, income per capita, the percentage of the population aged 15-64, share of the population living in extreme poverty, the share of the population that is 65 years and older, male percentage of the population, the share of men and women who smoke and international inbound tourists[6]. Countries differ in patterns of international travel and thus vary in terms of importation risk from COVID-19 hotspots, not just merely in their functional ability to detect and respond to health emergencies (Gilbert *et al*., 2020).

The vector M comprises country-level medical infrastructure and health indicators such as nurses, doctors and hospital per capita, reported COVID-19 cases per million, diabetes prevalence (% of the population aged 20 to 79) in 2017 and the death rate from cardiovascular disease in 2017.

Our identification strategy is to exploit a vector of sedimentary basin characteristics, $Sedimetary\_basin$, as the instrumental variables for empirical identification of $logOil$ in Eqn (2). This identification is premised on the assumption that geologic features of sedimentary basins are not correlated with the underlying political, social and economic determinants of health and wellbeing.

According to Cassidy (2019), there are five prerequisites before oil formation, and accumulation can proceed. First, there must be sedimentary rock rich in organic material deposits. Source rocks are economically important when tectonic movements cause the surface area to sink, trap the organic debris and allow for sediments accumulation to form a sedimentary basin. Over time and under extreme heat and pressure, the buried organic materials are converted into hydrocarbons. After the source rock has been formed, sedimentary basins are formed in one of three general plate-tectonic environments.[7] To construct the instrumental variable from these geologic features requires aggregating the basin categories and determining which choice of the aggregate basin to include in the set of instruments. Our choice for $Sedimetary\_basin$ follows the approach in Cassidy (2019), where the general plate-tectonic environment and primary mechanism of subsidence are used to produce eight basin types: Convergent C-C mechanical area, Convergent O-C thermal area, Convergent O-C mechanical

[6] The number of tourists who travel to a country other than that in which they usually reside for a period not exceeding 12 months and whose main purpose in visiting is other than an activity remunerated from within the country visited.

[7] The first is a divergent environment, in which adjacent tectonic plates pull away from each other. The second is a convergent environment, in which tectonic plates collide causing one plate to pass underneath the other in a process known as subduction. The third is a wrench environment, in which adjacent tectonic plates move in opposite, parallel directions, rubbing alongside each other.

area, Convergent O-O area, Divergent thermal area, Wrench mechanical area, Divergent mechanical area, and Convergent C-C thermo-mechanical area.

Also following Cassidy (2019), we include geographical factors, G. To control for the basin variable's correlation with a country's physical size, G, includes a control for total land area. To control for the slower economic growth of countries with more land in the tropics and less access to waterways, data are included on both land area in the tropics and on a country's coastline. The area of mountainous land is included to capture higher levels of insurgency and civil war. Finally, G includes control for soil quality, which could influence development.

Next, we use the specification in Eqns (1) and (2) to examine pathways suggested by the analytical framework in section 2.1. To investigate plausible mechanisms that are related to the gendered political economy and patriarchy channels, we replace Y in Eqn (1) with the proportion of seats held by women in national parliaments, the female and male labour force participation rates, and population demographics (share of male population). In line with Ross (2008), we include additional controls for Muslim and Christian percentage of the population as a proxy measure of culture and also include proxies for legislation on gender equality and non-discrimination to account for reforms supportive of female political participation independent of oil.

3.2 Instrument Selection and test of Validity of Instrumental Variable

The validity of our identification strategy relies on two assumptions: first, that the instrumental variable is strongly correlated with the endogenous regressor, and second that the instrumental variables are excludable as direct causes of COVID-19 infections, fatality rate and other channels responsible for health outcomes. For the first assumption, we can show that the instruments are statistically correlated to the endogenous regressors through the first stage regression in Eqn. (2) (Angrist and Krueger, 2001). For the excludability restriction, we re-estimate Eqn (1) by replacing *logOil* with the instrument and by running a reduced-form regression to test if the instruments are significantly correlated with the dependents variable and other variables of interest that affect COVID-19 cases and test (Murray, 2006; French and Popovici, 2011). The results in Table A.1 in the Appendix support the validity of our identification assumption.

According to Roodman (2009), a large instrument collection will over-fit endogenous variables and weaken the Hansen test of the instruments' joint validity. The petroleum geology literature does provide no ranking of sedimentary basin types by petroleum potential (see Cassidy, 2019). To avoid instrument proliferation, we include a single instrument that maximises the first-stage F-statistic. Comparing the results across all basin types, the instrument that maximises the F-value is the Convergent C-C mechanical area (log p.c.).

3.3 Data

Our analysis uses three sources of data that are combined for the cross-sectional instrumental variable regression. The first data set is on COVID-19 cases, deaths and tests from the *European Center for Disease Prevention and Control* (ECDC) which is available in *Our World in Data* (see Roser *et al*., 2020). The sample period is from December 31, 2019, to June 2, 2020. The ECDC collects and aggregates data on COVID-19 cases, tests and deaths from countries around the world (Table 1a). We adjusted for population size to provide a first insightful result useful for cross-country analysis.

The *Our World in Data* COVID-19 dataset includes additional variables such as the Stringency index (a composite measure based on nine response indicators including school closures, workplace closures, and travel bans, rescaled to a value from 0 to 100 (100 = strictest response), population in 2020 and population density. It also includes median age, aged 65 older, GDP per capita, extreme poverty, the death rate from cardiovascular disease in 2017, and diabetes prevalence (% of the population aged 20 to 79 with diabetes in 2017). Lifestyle variables (% female smokers, % male smokers) and health infrastructure investment like hospital beds per thousand are also included (Roser *et al*., 2020).[8]

The second source of data is from Cassidy (2019). The dataset includes the instrumental variable in terms of the Convergent C-C mechanical area (log p.c.) and countries' geographic features: land in the tropics, access to waterways (coastline), the fraction of land covered with sedimentary Basin, and area of mountainous land (Table 1b). All geographic controls are measured as the surface area (in square kilometres) per 1,000 inhabitants in 1960. Also taken

[8] This data is collected from a variety of sources (United Nations, World Bank, Global Burden of Disease, Blavatnik School of Government, etc.). More information is available in the codebook.

from Cassidy (2019) is the data on oil production measured as the log of average annual metric tons per 1,000 inhabitants (averaged over 1966–2008). Countries with zero production were assigned values 0.001 to enable log transformation.

The third dataset includes on demographic and employment variables, such as labour force participation, the proportion of seats held by women in national parliaments[9] (%), law mandates on non-discrimination on gender in hiring[10], law mandates on equal remuneration for females and males for work of equal value[11], the male percentage of the population and international tourism (number of arrivals). The data are from the World Development Indicators (Worldbank, 2020). Table 1b summarises the key variables we use in our analysis.

[9] Women in parliaments are the percentage of parliamentary seats in a single or lower chamber held by women.

[10] Whether law specifically prevents or penalizes gender-based discrimination in the hiring process; the law may prohibit discrimination in employment based on gender but be silent about whether job applicants are protected from discrimination. Hiring refers to the process of employing a person for wage and selecting by presenting a candidate with a job offer. Job advertisements, selection criteria and recruitment, although equally important, are not considered "hiring" for purposes of this question.

[11] Whether there is a law that obligates employers to pay equal remuneration to male and female employees who do work of equal value. "Remuneration" refers to the ordinary, basic or minimum wage or salary and any additional emoluments payable directly or indirectly, whether in cash or in kind, by the employer to the worker and arising out of the worker's employment. "Work of equal value" refers not only to the same or similar jobs but also to different jobs of the same value.

Table 1a: COVID-19 deaths and related statistics at the country level

Variable	**Number of countries**	**Mean per country**	**Std deviation**
Total cases	211	14,270	104,097
Total deaths	211	908	6,815
Total tests	84	306,178	736,471
Total cases per million	210	536	1,160
Total deaths per million	210	21	59
Total tests per thousand	84	13	17
Stringency Index (composite measure of Government response from 0 to 100 (100 = strictest response)	168	61	19
Cardiovascular disease death rate in 2017 (per 100,000 people)	186	256	116
Diabetes prevalence (% of population aged 20 to 79) in 2017	194	8.06	4.23
Female smokers (Share of women who smoke)	141	10.4	10.4
Male smokers (Share of men who smoke)	139	32.6	13.6
Doctors (per 1,000 people)	178	1.2	1.2
Nurses and midwives (per 1,000 people)	178	3.7	3.76
Hospital beds (per 1,000 people)	165	3	2.45

Source: *European Center for Disease Prevention and Control,* which is available in *Our World in Data* (see Roser *et al*., 2020).

Table 1b: Summary statistics on socioeconomic and demographic characteristics, oil production, geologic features of oil production and country geographical characteristics

Variable	Number of countries	Mean per country	Std dev
Socioeconomic and demographic characteristics			
GDP per capita (constant 2011 international dollars), most recent year available) [a]	183	19,516	19,810
Extreme poverty (Share of the population living in extreme poverty, most recent year available since 2010) [a]	121	13.9	20.5
Median Age of the population (UN projection for 2020) [a]	187	30.6	0.1
The proportion of seats held by women in national parliaments (%) [b]	240	16	8.6
Law mandates, equal remuneration for females and males for work of equal value (1=yes; 0=no) [b]	186	0.36	0.46
Law mandates, non-discrimination on gender in hiring (1=yes; 0=no) [b]	188	0.48	0.47
Population density (Number of people divided by land area, measured in square kilometres) [a]	199	361	1577
Log ages 15-64 total (% of total population) [a]	167	4.05	0.09
Labour force participation rate, female (% of female population ages 15+) [b]	212	50	15.0
Labour force participation rate, male (% of male population ages 15+) [b]	212	74	8.01
International tourism, number of arrivals (thousands) [b]	248	3.19	1.02
Oil production and geologic features of oil production [c]			
Oil production (log of average annual metric tons per 1,000 inhabitants (averaged over 1966–2008)	220	2.11	10.2
Convergent C-C mechanical area (log p.c.)	210	-8.51	2.9
The fraction of land covered with Sedimentary basin (km^2 per capita)	215	0.52	0.31
Country geographical characteristics [c]			
Log mountainous region (km^2 per capita)	179	-6.57	2.9
Log tropical region per capita (km^2 per capita)	182	-6.1	3.8
Log coastline per capita (km^2 per capita)	213	-8.6	3.3

[a] Data from *European Center for Disease Prevention and Control,* which is available in *Our World in Data* (see Roser *et al*., 2020). Data are for the most recent year available.
[b] Data from World Development Indicators (World Bank, 2020).
[c] Data from Cassidy (2019).

4. Results and discussion

We first examine the effects of petroleum wealth on the death rate from COVID-19 using data on historical oil production by country. In section 4.1.we then estimate effects for mechanisms as discussed in section 2.

4.1 Oil production and COVID-19

Table 2 presents the main results. In Table 2, Panel A presents the second stage of the IV estimates and Panel B presents the first-stage estimates. For the IV estimates, we report the F-values for testing the over-identification, weak identification and under-identification assumptions of the instrumental variables. The statistical diagnostics test and the first-stage regression (Panel B) supports the assumption that the Instrumental Variable is exogenous, and they improve the empirical identification of the estimates. We log-transformed both the dependent and independent variables to generate linearity in parameters and to aid in the interpretation of the results.

The regressions presented in the first two columns of Table 2 provide strong evidence that oil increases the risk of death from COVID-19. In column (i), the Instrumental Variable (IV-SLS) estimates indicate that a 1% higher annual oil production per capita (average over 1966- 2008) is associated with 1.39% higher risk of COVID-19 death per million from Dec 2019 to June 2020. In column (ii), the same difference in oil production increases the number of COVID-19 death (unadjusted for population) by 1.46%. The effects are statistically significant at 1%. The corresponding OLS estimates (columns iii and iv) are smaller in absolute magnitude than the IV estimates. The discrepancy between the OLS and IV results is consistent with endogeneity concerns with the natural resource curse (Cassidy 2019) and the measurement of COVID-19 related death (Roser *et al*., 2020). Richer countries may report more COVID-19 death because they are more effective at reporting and testing and because they have better hospitals where COVID-19 patients come for treatment (death are recorded by medical personnel in hospitals).

The results in Table 2 are consistent with the narratives supporting the negative effect of oil wealth on disease outcomes (De Soysa and Gizelis, 2013; Chang and Wei, 2019; Keller, 2020). The results also support Sterck (2016) in that any analysis of risks from infectious diseases should take account of the underlying conditions that affect both oil rents, heterogeneous country characteristics and measurement errors associated with epidemiological models of disease spread.

The results across the four columns in Table 2 are conditional on additional controls. A consistent finding across the column is that more cases per capita of COVID-19 is strongly correlated with a higher death rate. Similarly, we find in columns (i) and (ii) that the non-pharmaceutical response (as measured by the Government Response Stringency Index) may help to reduce the risk of death from COVID-19. Also, a higher male sex-ratio in the total population makes a country at greater risk of death from COVID-19. Increasing the number of health care workers like doctors and nurses reduces the number of people dying from COVID-19. These findings emphasise the importance of social-distancing and the introduction of other containment measures to reduce the risk from the pandemic disease. Second, they emphasise the importance of support and investment to increase the number of health care workers.

In Table 3, we specifically examine the COVID-19 related interventions that can potentially reduce a country's risk. The first intervention is COVID-19 testing, and the second is the government's stringency response. Since the outbreak of the pandemic, the World Health Organisation has repeatedly called on countries to test for the virus. In countries such as South Korea and Germany, who initiated early and widespread testing, detection and isolation and quick treatment for those with the disease prevented further spread and reduce mortality. Testing is also essential in the bigger picture for the economy: knowing who has been infected and has been conferred immunity from COVID-19 can help ease the lockdown.

Columns (vi) and (vii) in Table 3 shows that oil-producing countries are associated with less population-weighted COVID-19 testing but column (v) shows that larger oil production implies more COVID-19 population unweighted tests. In column (viii), we find that oil increases the government response stringency to the COVID-19. Generally, a more stringent government response to the COVID-19 will imply a lower death rate. However, as pointed out by Barnett-Howeel and Mobarak (2020), being very stringent may be counterproductive in developing countries where typically a large share of the population depends on the informal sector. Though flattening the COVID-19 disease curve, the shutdown of national economies exposes these people to sharp income shocks and health risks.

Table 2: Results: Oil and COVID-19 Death

	Dependent variables:			
	Log death per million	Log death	Log death per million	Log death
	(i)	(ii)	(iii)	(iv)
Log Oil per capita	1.39***	1.46***	0.05**	0.12**
	(0.24)	(0.25)	(0.02)	(0.03)
COVID-19 Cases per million	0.79***	0.89***	0.73***	0.84***
	(0.025)	(0.03)	(0.04)	(0.08)
GDP per capita	-0.28	-0.57**	0.34	0.06
	(0.18)	(0.2)	(0.69)	(1.2)
Government Stringency Index	-0.10***	-0.09***	-0.01	-0.007
	(0.02)	(0.02)	(0.02)	(0.04)
Tourist Arrival, Numbers	-1.09***	-0.41	0.27***	0.96***
	(0.23)	(0.26)	(0.04)	(0.08)
Male Population	51.78***	66.5***	27.48**	41.8**
	(4.75)	(5.5)	(9.16)	(13.8)
Doctors per capita	-1.08***	-0.85**	-0.29	-0.05
	(0.15)	(0.18)	(0.36)	(0.6)
Nurses per Capita	-0.69***	-1.5***	-0.27	-1.09
	(0.14)	(0.15)	(0.56)	(0.93)
Hospital beds per capita	1.23***	1.31***	-0.15	-0.09
	(0.27)	(0.51)	(0.32)	(0.37)
Extreme Poverty	0.01	0.03	-0.05	-0.03
	(0.05)	(0.06)	(0.22)	(0.38)
Median Age	-2.8**	-2.2	3.22*	3.9*
	(1.25)	(1.44)	(1.5)	(1.9)
Male Smokers	2.71***	2.19***	0.76	0.2
	(0.34)	(0.40)	(0.79)	(0.88)
Population density	0.59**	0.42***	0.21	0.03
	(0.09)	(0.11)	(0.25)	(0.36)
Estimator	IV-SLS	IV-SLS	OLS	OLS
Under-identification test	49.52	49.52		
Cragg-Donald F statistic	44.19	44.19		
Kleibergen-Paap rk F-stat	49.29	49.29		
Number of observations	8,807	8,807	8,807	8,807

Notes: All specifications include geographic controls (coastline, the fraction of land covered with sedimentary Basin, mountainous area, tropical area), the prevalence of diabetes and death from Cardiovascular disease (2017), the share of female smokers, age 15-64, month dummies and region fixed effects.
The IV specifications use $Sedimetary\_ Basin$ (ln_convCC_mech_1960_pc) as an instrument for oil production per capita. Robust standard errors are in parentheses. $* p < 0.10$, $** p < 0.05$, $*** p < 0.01$.

Panel B: First Stage Estimates

	Instrumented Variables	
Instrumental Variables	Oil per capita	Oil per capita
Convergent C-C mechanical area (log p.c.)	0.13***	0.13***
	(0.01)	(0.01)

Table 3: Oil, COVID-19 Tests and Stringency measures

	Dependent variables:			
	Log COVID-19 Tests	Log COVID-19 Tests per thousand	Log COVID-19 Tests (7-day smoothed) per thousand	[a] Government Response Stringency Index
	(v)	(vi)	(vii)	(viii)
Log Oil per capita	0.18***	-0.10***	-0.20***	1.01***
	(0.02)	(0.02)	(0.02)	(0.19)
COVID-19 Cases per million	0.4***	0.39***	0.37***	0.48***
	(0.01)	(0.01)	(0.01)	(0.02)
GDP per capita	0.25***	1.06***	0.73***	-0.87***
	(0.07)	(0.06)	(0.06)	(0.12)
Government Stringency Index	-0.07**	0.04*	0.18***	
	(0.02)	(0.02)	(0.02)	
Male Population	-6.97***	-16.8***	-16.9***	22.8***
	(1.27)	(1.01)	(1.1)	(4.5)
Doctors per capita	0.56***	0.37***	0.45***	-0.91***
	(0.04)	(0.03)	(0.04)	(0.13)
Nurses per Capita	-0.34***	0.19***	-0.04	0.14
	(0.04)	(0.04)	(0.04)	(0.11)
Hospital beds per capita	-0.11*	-0.17***	-0.14**	1.3***
	(0.06)	(0.04)	(0.04)	(0.2)
Extreme Poverty	-0.23***	-0.09***	-0.14***	0.33***
	(0.02)	(0.02)	(0.01)	(0.04)
Population density	0.11***	-0.05***	-0.08***	0.47***
	(0.02)	(0.02)	(0.02)	(0.09)
Estimator	IV-SLS	IV-SLS	IV-SLS	IV-SLS
Under-identification test	338.55	338.55	182	52.47
Cragg-Donald F statistic	349.01	349.01	173.9	48.13
Kleibergen-Paap rk F-stat	461.53	461.53	228.9	52.4
Number of observations	3,889	3,889	4,051	8,807

[a] The Government Response Stringency Index is a composite measure based on nine response indicators including school closures, workplace closures, and travel bans, rescaled to a value from 0 to 100 (100 = strictest response)

All specifications include geographic controls (coastline, the fraction of land covered with sedimentary Basin, mountainous area, tropical area), tourist arrival, median age, age 15-64, month dummies and region fixed effects. The IV specifications use $Sedimetary\_Basin$ (ln_convCC_mech_1960_pc) as an instrument for oil production per capita. Robust standard errors are in parentheses. $* p < 0.10$, $** p < 0.05$, $*** p < 0.01$.

	Panel B: First Stage Estimates			
	Instrumented Variables			
Instrumental Variables	Oil per capita	Oil per capita	Oil per capita	Oil per capita
Convergent C-C mechanical area (log p.c.)	-0.58***	-0.58***	-0.42***	0.13***
	(0.02)	(0.02)	(0.02)	(0.02)
F-test of Excluded instruments	461.32	461.32	228.9	52.4

4.2 Mechanisms: Patriarchy and the Gendered Resource Curse Thesis

In this section, we explore an additional mechanism to explain the results. We first estimate a reduced-form relationship of the effect of women political participation on COVID-19 outcomes, conditional on whether a country produced oil. We measure women political participation with the proportion of women in elective positions in the parliaments, and conditional on the interactive effect of oil, test the effect on the COVID-19 death rate:

$$C19_{ir} = \tau S_{ir} + \Upsilon Oil_{ir}(D = 1) + \vartheta(S_{ir} \times Oil_{ir}(D = 1)) + \Pi K_{ir} + \Omega' T_t + \alpha_r + \varepsilon_{ir} \qquad (3)$$

where $C19_{ir}$ denotes the COVID-19 deaths in country *i* in region *r*. In a further regression, we replace $C19_{ir}$ by the number of COVID-19 tests. In Eqn (3), S is the proportion of seats occupied by women in a country's parliament, and $Oil(D=1)$ is a dummy variable that takes on the value of one if country *i* produced oil and zero otherwise . The estimates on S and $(S \times Oil)(D = 1))$, indicate the difference between the effect of women participation and COVID-19 outcomes between oil-producing and non-oil-producing countries. K is a vector of other controls, T a vector of month dummies and α denotes the region-specific fixed effects.

The results in Table 4 give, *prima facie*, evidence supportive of the media reports that countries with women in elective political positions may be more effective at managing the risk from COVID-19. To give credence to these findings and media reports, we examine the assertion in Ross (2008) that oil leads to patriarchy, causes a gender gap in political participation, sex-ratio imbalance in the population, and gender gap in labour force participation. For this analysis we return to Eqns (1) and (2).

Column (xiii) of Table 5 shows that a higher oil production reduces the share of women in a country's parliament and column (xiv) shows that oil increases the number of males relative to females in the population. Oil contributes more to the male labour force participation rate than to female labour force participation (columns xv and xvi). These effects of oil are as expected: they are consistent with findings that oil abundance reduces shift female labour participation (Ross, 2008; Kotsadam and Tolonen, 2016; Maurer and Potlogea, 2017).

It has become obvious that the risk of dying from COVID-19 is higher for males than females (Cai, 2020; Lancet, 2020). This is likely of further importance in the oil-based societies which have a skewed population sex-ratio. Differences in COVID-19 clinical outcomes are attributed to biological (*e.g.*, hormonal and genetic) factors and behavioural differences (*e.g.*, smoking and gender-based lifestyle choices which affect the level of pre-existing diseases such as chronic lung disease and cancer). Differences in COVID-19 clinical outcomes due to the economic fallout from the pandemic could be more pronounced in a male-dominated society. The impact of oil-shocks on employment are male-biased (Maurer and Potlogea, 2020). More men work in industries that are intricately linked to oil sectors than women and maybe harder hit with the recession than women.

Table 4: Women Political participation and risk from COVID-19

	Dependent variables:			
	Log death per million	Log death per million	Log Test per thousand	Log Total Tests
	(ix)	(x)	(xi)	(xii)
Women Seats in Parliaments	-1.04*	-1.8**	85.87***	96.29***
	(0.49)	(0.44)	(3.98)	(3.97)
Oil (D=1)		-2.34	565.34***	649.4***
		(1.46)	(26.2)	(26.19)
Interaction (Seat × Oil)(D=1)		1.24*	-169.76***	-193.69***
		(0.5)	(7.87)	(7.85)
COVID-19 Cases per million	0.81***	0.81***	0.68**	0.67***
	(0.10)	(0.1)	(0.04)	(0.04)
GDP per capita	1.97***	1.91*	47.293***	50.58***
	(0.65)	(0.82)	(2.2)	(2.19)
Government Stringency Index	0.01	0.02	-0.64***	-0.64
	(0.05)	(0.05)	(0.03)	(0.03)
Estimator	OLS	OLS	OLS	OLS
Within R-Sq	0.79	0.79	0.94	0.95

Notes: All specifications include geographic controls (coastline, the fraction of land covered with sedimentary Basin, mountainous area, tropical area), doctors, nurses and hospital beds per 1,000 people, median age, number of Tourists (arrival), the share of the population in extreme poverty, population density, the prevalence of diabetes and death from Cardiovascular disease (2017), the share of and male and female smokers, age 15-64, month dummies and region fixed effects. Robust standard errors are in parentheses. $*\ p < 0.10$, $**\ p < 0.05$, $***\ p < 0.01$.

Table 5: Gender disaggregated effect of oil

	Dependent variable:			
	The proportion of seats held by women in national parliaments (%)	Male population (% of total population)	Male Labour force participation rate (% of male population ages 15+)	Female Labour force participation rate (% of female population ages 15+)
	(xiii)	(xiv)	(xv)	(xvi)
Log Oil per capita	-0.55***	0.004***	0.12***	0.08***
	(0.14)	(0.0004)	(0.03)	(0.02)
GDP per capita	1.34***	0.01***	-0.19***	-0.09**
	(0.27)	(0.001)	(0.06)	(0.04)
Law mandates equal remuneration for females and males	-1.24***	-0.007***	0.32***	0.27***
	(0.32)	(0.0007)	(0.07)	(0.05)
Law mandates non-discrimination based on gender in hiring	-0.58***	-0.003***	0.12***	0.23***
	(0.17)	(0.0007)	(0.03)	(0.03)
Population in Extreme poverty	0.12***	-0.004***	-0.01	0.04***
	(0.04)	(0.0005)	(0.008)	(0.005)
Population density	0.37***	0.005***	-0.11***	-0.11***
	(0.12)	(0.0003)	(0.02)	(0.02)
Male population	-24.04***		5.59***	7.07***
+	(6.58)		(1.48)	(1.1)
Percentage Muslims, 1950	-0.01***	0.0003***	0.002***	-0.005***
	(0.003)	(0.00002)	(0.0007)	(0.0005)
Percentage Christians, 1950	0.02***	0.0004***	-0.004***	-0.01***
	(0.004)	(0.00002)	(0.001)	(0.0007)
Estimator	IV-SLS	IV-SLS	IV-SLS	IV-SLS
Under-identification test	15.21	173.5	15.21	15.21
Cragg-Donald F statistic	15.24	204.15	15.24	15.24
Kleibergen-Paap rk F-stat	15.48	217.39	15.48	15.48

Notes: All specifications include region fixed effects. Additional controls include median age, the share of female smokers, age 15-64, share of the population with age above 65, month dummies and geographic controls (coastline, the fraction of land covered with sedimentary Basin, mountainous area, tropical area).
The IV specifications use *Sedimentary_basin* (ln_convCC_mech_1960_pc) as an instrument for oil production per capita. Robust standard errors are in parentheses. ∗ $p < 0.10$, ∗∗ $p < 0.05$, ∗∗∗ $p < 0.01$.

Panel B: First Stage Estimates

	Instrumented Variables			
Instrumental Variables	Oil per capita	Oil per capita	Oil per capita	Oil per capita
Convergent C-C mechanical area (log p.c.)	0.13***	0.47***	0.13***	0.13***
	(0.03)	(0.03)	(0.03)	(0.03)
F-test of Excluded instruments	15.48	217.39	15.4	15.4

5. Conclusions and Policy Discussion

This paper began with a general question: Are people living in countries whose governments are predominantly female less likely to die from the COVID-19? It is an important question given that in many parts of the world women are less politically interested, informed, and efficacious than men (Verba, 1997) and their inputs and expertise are missing in the response to COVID-19 (Wenham, 2020).

Our analysis answers this question in the affirmative. The finding of this paper supports the media reports that countries with women in elective political positions may be more effective at managing the risk from COVID-19. This research also speaks to political-economic characteristics of resource-rich countries important for public health outcomes. It is consistent with the gendered resource curse thesis (Ross 2008) and with research on why resource-rich states are more likely to have worse health outcomes (De Soysa and Gizelis, 2013).

Oil-rich countries are also associated with other patriarchal features that may increase their vulnerability to health shocks from COVID-19. The first mechanism investigated builds on the differential impact of risks from COVID-19 by gender and on the tendency for oil-rich societies to have a skewed population sex-ratio. The second mechanism builds on the gender gap in labour force participation and on the tendency of men to be affected more by a recession than women. We find evidence in support of these alternative mechanisms. This is contrary to the common assertion that women will be particularly vulnerable to COVID-19 economic downturns (de Paz *et al.*, 2020).

While this paper has shed some light on the vulnerability to COVID-19 shocks by exploring the gendered political economy channel, much more can still be done. First, as more data becomes available, better data can be used to validate the results. Second, our research does not claim that the mechanisms investigated are exhaustive of all possible political economy determinants of health outcomes. Further research would need to investigate other aspects of political economy such as age, experience and the education of political leader, the type of political system, *e.g.*, democracy versus socialist, previous communist experience and the possibility of exposure to colonial rule. Finally, given that certain groups, *e.g.*, blacks and minority groups, are vulnerable, much more thought needs to be given to the best mechanisms for protecting those groups by making them more involved in critical policy decisions that affect health outcomes.

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Appendix

Table A.1: Reduced-Form regression for excludability assumption of instrumental variables

	COVID-19 Death per million	**COVID-19 cases per million**	**COVID-19 tests per thousand**	**Percentage of parliamentary seats held by women**
Convergent C-C mechanical area (log p.c.)	0.11	0.07	0.06	0.003
	(0.15)	(0.03)	(0.06)	(0.02)
COVID-19 cases per million	0.74***			
	(0.05)			
GDP per capita	0.3	0.42	1.07**	0.23
	(0.74)	(0.47)	(0.29)	(0.17)
Stringency Index	-0.02	0.31***	0.16*	
	(0.02)	(0.03)	(0.07)	
Male Population (% of total population)	23.01**	13.8	-13.9**	2.95
	(8.6)	(10.13)	(3.39)	(2.9)
Doctors (per 1,000 people)	-0.32	0.39**	0.24	
	(0.43)	(0.15)	(0.20)	
Nurses (per 1,000 people)	-0.39	-0.51*	0.28	
	(0.51)	(0.24)	(0.16)	
Hospital beds (per 1,000 people)	0.22	-0.08	0.24	
	(0.25)	(0.27)	(0.36)	
Observations	8,885	8,885	3,826	10,572
Within R-sq	0.81	0.88	0.82	0.26

Note*:* Table 2 tests the assumption that the instrumental variables are excludable as directly correlated to the COVID-19 related infections.

Additional controls include demographic attributes like median age, proportion of population within 15-65, population density, share of male and female smokers, prevalence of diabetes and risk of cardiovascular death, coastline per capita, proportion of people living in extreme poverty, tourist arrival, and geographic controls region fixed effects and month dummies.

$p < 0.05$, $^{***}p < 0.01$. Std. Err. in parenthesis are robust for 7 clusters at the regional level.