

# Extractive industries, government revenue and female economic participation: evidence from the Democratic Republic of Congo

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## Abstract

**Purpose** – The study aims to assess how government revenue can moderate the negative effect of extractive industries on female economic participation.

**Design/methodology/approach** – The focus is on the Democratic Republic of Congo using data for the period 1991–2022. The empirical evidence is based on the autoregressive distributed lag estimation approach.

**Findings** – It is established from the findings that extractive industries have a negative unconditional effect on female economic participation, while government revenue dampens the negative effect of extractive industries on female economic participation. Furthermore, there are critical levels of government revenue that should be reached in order for extractive industries to no longer have a negative effect on female economic participation. The corresponding government revenue thresholds are 8.9032 (% of gross domestic product (GDP)) in the short run and 14.3529 (% of GDP) in the long run. Above these thresholds, the interaction between extractive industries and government revenue yields positive outcomes on female economic participation. Policy implications are discussed.

**Originality/value** – The present study contributes to the extant literature by assessing how government income can moderate the negative effect of extractive industries on female economic participation.

**Keywords** Extractive industries, Government revenue, Female economic participation, The DRC

**Paper type** Research paper

## 1. Introduction

The purpose of this study is to assess the relevance of government revenues in the interaction between income from mineral resources and gender economic inclusion in the Democratic Republic of Congo (DRC). The motivation of the problem statement is premised on three fundamental elements in the relevant scholarly and policy literature on the subject, notably: (1) the growing debate on the resources curse hypothesis and how it is relevant to countries that substantially rely on the export of natural resources for government income; (2) the imperative to increase gender economic inclusion, especially in countries that are torn by wars owing to the resource curse, and (3) gaps in the extant literature on the subject. The three motivational perspectives are expanded in the same order as highlighted in what follows.

**JEL Classification** — H53, I28, O13, L25, D73, O55

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First, concerning the evolving debate on the resource curse hypothesis, according to [Ngassam et al. \(2024\)](#), from a practical standpoint, earnings from natural resources may supply the funds required to promote economic growth. Moreover, governments can use the revenue from natural resources to finance infrastructure projects that attract both leisure and business travelers, such as roads, convention centers and information and communication technology ([Brunnschweiler and Bulte, 2008](#); [James, 2015](#)). Regretfully, decades of empirical research have shown that countries that rely heavily on natural resources fare economically worse than those that do not ([Sachs and Warner, 1995](#); [Chandan, 2021](#); [Ngassam et al., 2024](#)). The curse of the natural resource hypothesis has been investigated in many areas of economic development over the course of several decades, including financial development ([Bhattacharyya and Hodler, 2014](#)), happiness ([Mignamissi and Kuete, 2021](#)), income inequality, health outcomes ([Wigley, 2017](#)), export diversification ([Djimeu and Omgba, 2019](#)) and many other areas. The present study contributes to the resource curse literature by assessing how government revenue can moderate the negative effect of extractive industries on female economic participation in the DRC. Accordingly, there is a growing policy concern about how more women can be involved in the formal economic sector.

Second, [Emeka et al. \(2024\)](#) state that female labor force participation (FLFP) and female employment are the two viewpoints used to study the impact of gender economic inclusion on economic complexity. Gender inequality in labor participation is a recurring theme in the research that is now available about FLFP ([Idowu and Owoeye, 2019](#); [Anwar, 2022](#); [Enaifoghe and Maseko, 2023](#); [Ibourk and Elouaourti, 2023](#)). According to the International Labor Organization's 2020 report, women make up just 25% of all workers in Africa. This suggests that among the four people who are engaged in the workforce, three are men and one is a woman ([Balioune-Lutz, 2021](#)). Similarly, [Thaddeus et al. \(2022\)](#) discovered that the agricultural sector progressively replaces the industrial sector when FLFP drops in Africa, translating to low complexity for the region. Furthermore, women's participation in the labor force is critical to a country's socio-economic development, especially in Africa, where women account for more than half of the population ([United Nations Procurement Division, UNPD, 2020](#)). Increasing the proportion of women in the workforce will empower them, help them to realize their full potential and increase the region's economic development. The present study is focused on nexuses between government income, extractive resources and female economic inclusion in the DRC because of an apparent gap in the extant literature.

The extant literature on extractive industries, government revenue and female economic participation in the DRC has not focused on the problem statement being considered in this study. The extant studies in the attendant DRC-centric literature closest to the present positioning are, *inter alia*, [Reichel \(2020\)](#), who has focused on the relevance of financial inclusion of men and women in the gold mining communities of the DRC. [Urmiche Diya Lipoko et al. \(2021\)](#) have been concerned with gender discrepancy in economic inclusion, especially as it pertains to young women in the DRC. [Rapanyane \(2022\)](#) has provided an Afro-centric perspective of the involvement of China in the DRC in the light of conflicts that are driven by the exploration of mineral resources. [Tshinu \(2022\)](#) has been concerned with how the resource curse can be understood in light of economic development in the DRC, while [Kalombo \(2022\)](#) provides insights into the nexus between strategic natural resources and sustainable development in the DRC.

To the best of the knowledge, the extant literature has not focused on understanding interactions between government revenue and extractive industries in the light of promoting female economic inclusion. Therefore, the present study departs from the underlying literature ([Reichel, 2020](#); [Urmiche Diya Lipoko et al., 2021](#); [Rapanyane, 2022](#); [Tshinu, 2022](#); [Kalombo, 2022](#)) by assessing how government revenue can moderate the negative effect of extractive industries on female economic participation in the DRC using data for the period 1991–2022. The empirical evidence is based on the autoregressive distributed lag (ARDL) estimation approach. It is established from the findings that extractive industries have a negative unconditional effect on female economic participation, while government revenue dampens

the negative effect of extractive industries on female economic participation. Furthermore, there are critical levels of government revenue that should be reached in order for extractive industries to no longer have a negative effect on female economic participation. The corresponding government revenue thresholds are 8.9032 (% of gross domestic product (GDP)) in the short run and 14.3529 (% of GDP) in the long run. Above these thresholds, the interaction between extractive industries and government revenue yields positive outcomes on female economic participation. Hence, the policy relevance of the present study is also premised on the perspective that policymakers are provided with actionable levels of government revenue at which the resource curse phenomenon is no longer apparent within the remit of female economic inclusion.

The rest of the study is structured as follows: [Section 2](#) provides insights into the theoretical underpinnings and the relevant literature, while the data and methodology are covered in [Section 3](#), and [Section 4](#) provides the empirical results and corresponding discussion, while [Section 5](#) concludes with policy implications and future research directions.

## 2. Theoretical underpinnings, conceptual framework and testable hypotheses

The literature on the “curse from natural resources” points to three visions. The first is the one that [Sachs and Warner \(1995\)](#) justified as the curse. According to [Smith \(2015\)](#), [Arin and Braunfels \(2018\)](#), [Jaimes and Gerlagh \(2020\)](#) and [James \(2015\)](#), the second vision is the promising perspective or a resource blessing. The third vision put forth by [Apergis and Payne \(2014\)](#) argues that the blessing or curse from natural resources depends on a number of factors, including the exchange rate ([Arezki and Ismail, 2013](#); [Van Der Ploeg and Poelhekke, 2017](#)), the quality of institutions ([Apergis et al., 2014](#); [Arezki and Gylfason, 2013](#); [Tadadjeu et al., 2023a](#); [Asongu and Odhiambo, 2024a](#)), the state’s capture by powerful groups and the employment channel ([Ngassam et al., 2024](#)). According to this third view, depending on the previously described variables, reliance on or abundance in natural resources can either be a blessing or a curse. Exploitation of or reliance on natural resources can, in fact, increase the likelihood of authoritarianism, lengthen the tenure of political power, cause disputes and encourage corruption ([Arezki and Gylfason, 2013](#); [Yilanci et al., 2021](#); [Tadadjeu et al., 2023b](#)). The relevance of the natural resource curse is also contingent on how government income is tailored towards mitigating the effect of such a curse on economic and inclusive development outcomes such as female economic participation. In what follows, we argue that government income can moderate the nexus between extractive industries and female economic inclusion in view of dampening the natural resource curse.

The schematic framework largely builds on [Akpa et al. \(2024\)](#) on the nexus between governance and inclusive development. Accordingly, the schematic framework underlying the problem statement shows that the incidence of extractive industries on female economic inclusion is contingent on governance, which is the moderating variable. Accordingly, the main channel is extractive industries, the outcome variable is gender economic inclusion and the moderator is governance in terms of government income or revenue. Accordingly, if government resources are properly mobilized from extractive industries and tailored to promote inclusive development, positive externalities can be expected in terms of increased female economic participation. The relevance of governance in promoting inclusive development ([Tchamy, 2021](#)) has been documented in the extant literature on the resource curse ([Sachs and Warner, 1995](#); [Apergis et al., 2014](#); [Asongu and Odhiambo, 2024a](#)), and contemporary evidence from the Nordic countries in the management of resource wealth confirms the importance of government income in moderating the negative externalities of extractive industries on inclusive development outcomes ([Martela et al., 2020](#); [Yang et al., 2023](#); [Tadadjeu et al., 2023a, b](#)).

*H1.* Extractive industries have a negative unconditional effect on female economic participation.

H2. Government revenue dampens the negative effect of extractive industries on female economic participation, and there are critical levels of government revenue above which, the negative effect of extractive industries on female economic participation changes to a positive effect.

Whether the above hypotheses withstand empirical scrutiny is a matter of empirical validity, which is the focus of the section that follows.

### 3. Data and methodology

#### 3.1 Data

Consistent with the motivation of the study, the focus of the present study is on the DRC. The corresponding data that are employed are for the period 1991–2022, and thus, there are theoretically sufficient degrees of freedom for an empirical analysis using the ARDL technique. The outcome variable that is employed is the FLFP rate (% of the female population aged between 15 and 64) in accordance with the extant gender economic inclusion literature (Asongu and Odhiambo, 2024b). Still in line with the problem statement, government revenue is employed as the moderating variables, whereas extractive industries are used as the main channel or mechanism. Accordingly, it is relevant to note that the objective of the study is to assess how government revenue moderates the incidence of extractive industries on female economic participation. Hence, it is for the underlying objective that government revenue and extractive industries are employed as moderating and channel variables, respectively. In accordance with the existing literature (Martela *et al.*, 2020; Yang *et al.*, 2023), government revenue is proxied by the sum of tax revenue, non-tax revenue and exceptional revenue (% of GDP), and the extractive industry is proxied with value added of the extractive industry (% of GDP), in line with the corresponding literature (Apeti and Edoh, 2023; Besada and Golla, 2023; Kalra and Afzal, 2023; Kinda and Thiombiano, 2024).

In order to account for variable omission bias and hence, avoid concerns about the robustness of the estimation exercise owing to shortcomings that are characteristic of bivariate estimations, the study accounts for five factors that have been documented to affect female economic inclusion, notably as follows: GDP per capita, population growth, inflation, female unemployment and the fertility rate (Iheonu *et al.*, 2020; Tchamyou *et al.*, 2023; Asongu *et al.*, 2024). In what follows, the expected signs of the considered variables are discussed. Consistent with the extant literature on the expected signs: (1) GDP per capita is expected to increase female economic participation contingent on extant levels of income inequality or the fruits of economic growth being equitably distributed across the population. (2) Population growth can lead to less female economic participation if the corresponding population growth is not characterized by relevant economic development policies tailored to create employment opportunities that are gender-inclusive. (3) Inflation can undermine gender economic inclusion given that women are more likely to be disadvantaged in terms of purchasing power from higher prices. (4) Female unemployment should intuitively decrease female economic participation. (5) The effect of fertility should be negative because women are logically more occupied with households and birth concerns, which decreases their active participation in the formal economic sector.

It is important to note that while the discussed expected signs are intuitive and consistent with the highlighted literature, these signs can also be unexpected if concerns about multicollinearity, which are overlooked in interactive regressions, influence the independent variables. It is therefore for this reason that consistent with Brambor *et al.* (2006) on the pitfalls of interactive regressions, net effects and thresholds are computed in this study in order to take into account the underlying concern of multicollinearity. The corresponding net effects and/or thresholds thus entail both the conditional and unconditional effects of the main channels (Tchamyou *et al.*, 2023; Asongu *et al.*, 2024).

The data used in this article are secondary data with an annual frequency. They come mainly from World Development Indicators (WDI) and the Central Bank of Congo (BCC) for the period from 1991 to 2022. Data on the participation of women in the labor market, GDP per capita, population, unemployment of women and women’s fertility are from WDI. The BCC provided data on public revenues, inflation and the extractive industry. [Table 1](#) presents the definition and measurements of the variables as well as the descriptive statistics, respectively, in Panel A and Panel B.

**Table 1.** Definitions of variables and descriptive statistics

Panel A: Definitions of variables					
Data	Definitions/ Measurements	Scholarly justifications	Expected signs	Sources	
Labor force participation rate, female (LFR)	% of female population (aged 15–64)	<a href="#">Asongu and Odhiambo (2024b)</a>		WDI	
Government revenue (RP)	Sum of tax revenue, non-tax revenue and exceptional revenue (% GDP)	<a href="#">Martela et al. (2020)</a> and <a href="#">Yang et al. (2023)</a>	Positive	BCC	
GDP per capita (PIBHAB)	GDP per capita constant 2015 US\$	<a href="#">Iheonu et al. (2020)</a> , <a href="#">Tchamyu et al. (2023)</a> and <a href="#">Asongu et al. (2024)</a>	Positive	WDI	
Population growth (POP)	Population growth (annual %)	<a href="#">Iheonu et al. (2020)</a> , <a href="#">Tchamyu et al. (2023)</a> and <a href="#">Asongu et al. (2024)</a>	Negative	WDI	
Inflation (INF)	Annual growth rate consumer price index in %	<a href="#">Iheonu et al. (2020)</a> , <a href="#">Tchamyu et al. (2023)</a> and <a href="#">Asongu et al. (2024)</a>	Negative	BCC	
Unemployment, female (UNF)	Unemployment, female (% of female labor force)	<a href="#">Iheonu et al. (2020)</a> , <a href="#">Tchamyu et al. (2023)</a> and <a href="#">Asongu et al. (2024)</a>	Negative	WDI	
Fertility rate, total (FER)	Fertility rate, total (births per woman)	<a href="#">Iheonu et al. (2020)</a> , <a href="#">Tchamyu et al. (2023)</a> and <a href="#">Asongu et al. (2024)</a>	Negative	WDI	
Extractive industry (IND)	Value added of the extractive industry in % GDP	<a href="#">Apeti and Edoh (2023)</a> , <a href="#">Besada and Golla (2023)</a> , <a href="#">Kalra and Afzal (2023)</a> and <a href="#">Kinda and Thiombiano (2024)</a>	Negative or positive	BCC	

Panel B: Standard descriptive statistics					
Variables	Observations	Mean	Maximum	Minimum	Standard deviation
LFR	32	68.3536	72.4880	62.8230	4.1686
RP	32	9.27532	16.7000	2.7000	3.9842
PIBHAB	32	438.9775	723.9866	322.4401	89.0680
POP	32	3.1626	4.7636	1.5819	0.5420
INF	32	741.6878	9796.9000	0.8200	1994.9450
UNF	32	3.0373	4.3850	2.2610	0.6255
FER	32	6.5492	6.7300	6.1560	0.1735
IND_RP	32	133.5565	311.3100	12.1200	93.9028
IND	32	12.7781	23.0600	4.0400	5.8832

**Note(s):** WDI: World Development Indicators of the World Bank; BCC: Central Bank of the DRC; LFR: labor force participation; RP: government revenue; PIBHAB: GDP per capita; POP: population growth; INF: inflation; UNF: female unemployment; FER: fertility rate and IND: extractive industry

**Source(s):** Authors’ own work

## 3.2 Methodology

This corresponding estimation technique that is adopted by the present study is that ARDL approach that has been documented to be relevant in the estimation of these kinds of problem statements, especially when the number of degrees of freedom exceeds 30 (Haruna *et al.*, 2023). This article analyzes the relationship between public revenues and women's participation in the labor market while considering the potential interaction between public revenues and the mining sector. To do this, our empirical specification is as follows:

$$\begin{aligned} \text{LFR}_t = & \beta_0 + \beta_1 \text{IND}_t + \beta_2 \text{RP}_t + \beta_3 \text{IND}_{t-1} \text{RP}_t + \beta_4 \text{INF}_t + \beta_5 \text{PIBHAB}_t + \beta_6 \text{FER}_t + \beta_7 \text{POP}_t \\ & + \beta_8 \text{UNF}_t + \mu_t \end{aligned} \quad (1)$$

where  $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$  and  $\beta_8$  are coefficients and  $\mu_t$  represents the "error" term.

$\text{IND}_{t-1} \text{RP}_t$  is the variable that controls how the extractive industry and government revenue interact. In the corresponding equation, LFP is FLFP, while RP denotes government revenue; PIBHAB is GDP per capita; POP denotes population growth; INF represents inflation, while UNF denotes female unemployment; FER reflects fertility rate and IND represents the extractive industry.

To estimate the previous empirical model, the ARDL model of the cointegration analysis of Pesaran *et al.* (2001) is used. The ARDL model allows, through its bounds test (Acar *et al.*, 2023), testing the existence of cointegration between the variables whether they are integrated of order one, zero or mutually cointegrated, unlike the Johansen cointegration test (1988, 1991). Furthermore, the ARDL model produces consistent estimates of the coefficients in the long run and has better performance in small samples (Yilanci and Kurca, 2024). Moreover, it simultaneously takes into account the serial correlation and the possible endogeneity of the regressors through an appropriate choice of the optimal lag that it requires in order to have a valid inference (Pesaran and Shin, 1995).

In order to apply the cointegration test to bearings, Eq. (1) can be rewritten as follows:

$$\begin{aligned} \Delta \text{LFR}_t = & \vartheta_0 + \vartheta_1 \text{LFR}_{t-1} + \vartheta_2 \text{IND}_{t-1} + \vartheta_3 \text{RP}_{t-1} + \vartheta_4 \text{IND}_{t-1} \text{RP}_{t-1} + \vartheta_5 \text{INF}_{t-1} \\ & + \vartheta_6 \text{PIBHAB}_{t-1} + \vartheta_7 \text{FER}_{t-1} + \vartheta_8 \text{POP}_{t-1} + \vartheta_9 \text{UNF}_{t-1} + \sum_{i=1}^p a_i \Delta \text{LFR}_{t-i} \\ & + \sum_{j=0}^p b_j \Delta \text{IND}_{t-j} + \sum_{j=0}^p c_j \Delta \text{RP}_{t-j} + \sum_{j=0}^p d_j \Delta \text{IND}_{t-j} \text{RP}_{t-j} + \sum_{j=0}^p e_j \Delta \text{INF}_{t-j} \\ & + \sum_{j=0}^p f_j \Delta \text{PIBHAB}_{t-j} + \sum_{j=0}^p g_j \Delta \text{FER}_{t-j} + \sum_{h=0}^p h_j \Delta \text{POP}_{t-j} + \sum_{k=0}^p k_j \Delta \text{UNF}_{t-j} + \mu_t \end{aligned} \quad (2)$$

where  $\vartheta_1, \vartheta_2, \vartheta_3, \vartheta_4, \vartheta_5, \vartheta_6, \vartheta_7, \vartheta_8$  and  $\vartheta_9$  represent the long-term coefficients and  $a_i, b_j, c_j, d_j, e_j, f_j, g_j, h_j$  and  $k_j$  identifies the short-term coefficients.

Consistent with the extant literature (Acar *et al.*, 2023; Yilanci and Kurca, 2024), the terminal cointegration test is based on the standard  $F$ - and  $t$ -statistics. It involves a comparison of critical values generated by the sample size specific to the  $F$ -statistic. The critical values of  $F$  are values under an asymptotic regime (sample size equal to 1,000) and critical values for regimes of finished samples (sample size ranging from 30 to 80). The bounds test postulates as a null hypothesis the absence of cointegration between the variables. If the  $F$ -statistic is greater than the upper bound value, the null hypothesis is rejected. If the  $F$ -statistic is less than the lower bound value, the null hypothesis is accepted. If the  $F$ -statistic is between the values of the lower limit and the upper

limit, the result is not conclusive. The null hypothesis for Eq. (2) is  $\vartheta_1 = \vartheta_2 = \vartheta_3 = \vartheta_4 = \vartheta_5 = \vartheta_6 = \vartheta_7 = \vartheta_8 = \vartheta_9 = 0$ . The alternative hypothesis is  $\vartheta_1 \neq \vartheta_2 \neq \vartheta_3 \neq \vartheta_4 \neq \vartheta_5 \neq \vartheta_6 \neq \vartheta_7 \neq \vartheta_8 \neq \vartheta_9 \neq 0$ .

#### 4. Empirical results

##### 4.1 Presentation of results

In this section, the presentation of the empirical results begins with insights into the unit root tests that are provided in Panel A of Table 2, while Panel B of Table 2 discloses the corresponding Bound test for cointegration. The ARDL findings are provided in Table 3. The preliminary test results and the ARDL model results are thus presented in this section.

Before proceeding with the estimation of the ARDL model, we assess the stationarity of the variables and test the existence of the cointegration relationship between the variables. For the stationarity of variables, the Augmented Dickey–Fuller unit root test is used. The latter has, as a null hypothesis, the presence of a unit root and, as an alternative hypothesis, the absence of a unit root. The unit root test results are presented in Panel A of Table 2. This table indicates that the variables: (1) LFP, the interaction between government revenue and extractive industries (IND\_RP), GDP per capita (PIBHAB), population growth (POP), fertility rate (FER) and female unemployment (UNF) are stationary in first difference, while (2) inflation (INF) and government revenue (RP) are stationary in level series.

The results of Panel B of Table 2 show that the bounds test is conducted using the Akaike information criteria, using an ARDL of (1, 2, 1, 1, 1, 2, 2, 1, 1) as the basis. This breakdown presents the lowest values among the top 20 models. Furthermore, the null hypothesis – that there is no cointegration between the variables – is rejected. The statistical values of *F* are

**Table 2.** Unit root tests and Bounds test for cointegration

Panel A: Unit root tests			
Variables	Augmented Dickey–Fuller Level	First difference	Decision
LFR		−1.8173*	I(1)
IND_RP		−5.0141***	I(1)
IND		−6.3324***	I(1)
INF	−23.6222***		I(0)
RP	−6.4498***		I(0)
PIBHAB		−2.4340**	I(1)
POP		−5.9358***	I(1)
FER		−1.8590*	I(1)
UNF		−1.8194*	I(1)

  

Panel B: Bounds test for cointegration			
Model	ARDL (1, 2, 1, 1, 1, 2, 2, 1, 1)		
F-statistic	5.9015		
Significance	I(0) Bound	I(1) Bound	
10%	1.66	2.79	
5%	1.91	3.11	
2.5%	2.15	3.40	
1%	2.45	3.79	

**Note(s):** \*, \*\* and \*\*\* denote statistical significance at 10, 5 and 1% levels, respectively. LFP: labor force participation; RP: government revenue; PIBHAB: GDP per capita; POP: population growth; INF: inflation; UNF: female unemployment; FER: fertility rate and IND: extractive industry

**Source(s):** Authors' own work

**Table 3.** Results of ARDL (dependent variableLFR)

Variables	Model ARDL (1, 2, 1, 1, 1, 2, 2, 1, 1) Coefficient	Standard Error
<i>Short-run results</i>		
D(IND)	-0.0828**	0.0338
D(IND(-1))	0.0869***	0.0154
D(RP)	-0.0374	0.0318
D(IND_RP)	0.0093**	0.0029
D(INF)	-0.0003***	0.0000
D(PIBHAB)	-0.0234***	0.0044
D(PIBHAB(-1))	-0.0282***	0.0034
D(FER)	-22.4387***	2.0240
D(FER(-1))	11.8203**	3.8751
D(POP)	-0.2872***	0.0817
D(UNF)	-1.5638***	0.2230
CointEq(-1)	-1.3429***	0.1340
RP Threshold	8.9032	
<i>Long-run results</i>		
IND	-0.2928***	0.0544
RP	-0.1167***	0.0220
IND_RP	0.0204***	0.0038
INF	-0.0002***	0.0000
PIBHAB	0.0031***	0.0008
FER	-34.2793***	4.4815
POP	-0.3510**	0.1443
UNF	-2.0448***	0.4003
RP Threshold	14.3529	
<i>Residual diagnostic tests</i>		
Test applied	Test hypothesis	Prob
Breusch-Pagan-Godfrey test	Heteroskedasticity	0.9733
Breusch-Godfrey test	Autocorrelation	0.1144
Jarque-Berra test	Normality	0.8199
<b>Note(s):</b> *, ** and *** denote statistical significance at 10, 5 and 1% levels, respectively. LFP: labor force participation; RP: government revenue; PIBHAB: GDP per capita; POP: population growth; INF: inflation; UNF: female unemployment; FER: fertility rate and IND: extractive industry		
<b>Source(s):</b> Authors' own work		

higher than the higher-borne critical values. Diagnostic tests show that there is no autocorrelation of errors at the 1, 5 and 10% significance levels. Additionally, errors are homoscedastic and follow normal law at the 1, 5 and 10% thresholds.

When the findings are viewed in terms of the testable hypothesis, it is apparent that both *Hypothesis 1* and *Hypothesis 2* are valid, not least, because in the light of the findings: (1) Extractive industries have a negative unconditional impact on female economic participation, which is a confirmation of evidence of the Dutch disease, and (2) government revenue moderates the negative effect of extractive industries on female economic participation. Moreover, there is a threshold of government expenditure at which the overall incidence of extractive industries on female economic participation changes from negative to positive. Hence, *Hypothesis 2* is also valid. Accordingly, in the light of the established positive conditional or interactive effects, the study is consistent with the relevant literature on interactive regressions in computing government income thresholds at which the total effect of extractive industries on the outcome variable or female economic participation is zero. It follows that above the computed thresholds, the overall effect of extractive industries on female economic inclusion becomes positive.

It is relevant to clarify the computation above with some examples in order to enhance readability and flow. The put the underlying point in more perspective, the short-term government revenue threshold in Table 3 is obtained by taking the absolute value of the quotient of the unconditional effect of extractive industries and the corresponding conditional or interactive effect of extractive industries (i.e.  $8.9032 = 0.0828/0.0093$ ). It follows that 8.9032 (% of GDP) of government expenditure is required in order to change the sign of the unconditional effect of extractive industries from negative to positive. Accordingly, at the corresponding threshold of government expenditure, the attendant net effect is zero or  $0.000 = -0.0828 + (0.0093 * 8.9032)$ . In the corresponding computation, 8.9032 (% of GDP) is the government revenue threshold,  $-0.0828$  is the unconditional effect of extractive industries and 0.0093 reflects the attendant conditional or interactive effect of extractive industries. The computation is consistent with contemporary interactive literature (Tchamyou, 2019; Asongu and Le Roux, 2023).

It follows that when government expenditure exceeds the computed thresholds, the overall effect of extractive industries changes from negative to positive. For instance, if the targeted government expenditure changes from the computed threshold to 9.000%, the overall effect of extractive industries on female economic participation becomes positive. In other words,  $0.0009 = -0.0828 + (0.0093 * 9.000)$  becomes the total effect of extractive industries on female economic participation, contingent on government expenditure that is 9.000% of GDP.

In the same vein, when the long-run analysis is considered, the corresponding government expenditure threshold is 14.3529 (% of GDP), as apparent on the right-hand side of Table 3. The same computational insights used in the computation of the short-run government expenditure threshold are also applied in the computation of the corresponding long-run government expenditure threshold.

In terms of diagnostics tests, the Breusch–Godfrey test indicates that there is an absence of autocorrelation in the model given that the probability value is greater than the conventional thresholds, namely 1, 5 and 10%. The Breusch–Pagan–Godfrey and Jarque–Berra tests indicate that the errors are homoscedastic and follow a normal distribution at thresholds of 1, 5 and 10%. Moreover, while the correlation matrix is disclosed in Table 4, it does not affect the interpretation of the independent variables of interest from which thresholds are computed because, according to Brambor *et al.* (2006), thresholds are computed in interactive regressions because the concern of multicollinearity, which is captured by a correlation matrix, is overlooked. Hence, in order to take into account the concern of multicollinearity that is overlooked, the computed thresholds involve the unconditional and conditional or interactive estimates of the mechanism.

#### 4.2 Further discussion of results

It is relevant to first discuss the control variables before engaging the nexus between the main findings and the extant literature. First, government revenue is negatively significant at the 1% level in the long run and negatively insignificant in the short run with respective coefficients of  $-0.0374$  and  $-0.1167$ . The unexpected negative sign is traceable to the high correlation between the interactive term and government revenue. This is contrary to expectations from the extant literature discussed in the data section (Iheonu *et al.*, 2020; Tchamyou *et al.*, 2023; Asongu *et al.*, 2024). Second, GDP per capita has an unexpected negative sign of  $-0.0234$  in the short run and an expected positive sign of 0.0031 in the long term, both at the 1% significance level. The unexpected short-run effect may be explained by the fact that developed countries are associated with higher levels of gender inclusion, compared to their poor counterparts (Iheonu *et al.*, 2020; Tchamyou *et al.*, 2023; Asongu *et al.*, 2024).

Third, population growth has the expected negative effect of  $-0.2872$  and  $-0.3510$  in the short run and long run, respectively, at 1 and 5% significance levels (Iheonu *et al.*, 2020; Tchamyou *et al.*, 2023; Asongu *et al.*, 2024). Fourth, inflation reflects the expected negative effect of  $-0.0003$  and  $-0.0002$ , respectively, at the 1% significance level in the short term and

**Table 4.** Correlation matrix

	FER	IND	IND_RP	INF	LFR	PIBHAB	POP	RP	UNF
FER	1.000000								
IND	-0.714671	1.000000							
IND_RP	-0.643556	0.944592	1.000000						
INF	0.262708	-0.476717	-0.448769	1.000000					
LFR	0.836305	-0.887964	-0.821001	0.360306	1.000000				
PIBHAB	-0.301456	0.051997	0.000845	0.427712	-0.209447	1.000000			
POP	-0.231740	0.218439	0.220465	0.448684	-0.264848	0.203797	1.000000		
RP	-0.451469	0.662119	0.838355	-0.512013	-0.563647	-0.233436	0.127928	1.000000	
UNF	-0.885901	0.791296	0.689218	-0.227607	-0.951398	0.341925	0.283797	0.383868	1.000000

**Note(s):** LFP: labor force participation; RP: government revenue; PIBHAB: GDP per capita; POP: population growth; INF: inflation; UNF: female unemployment; FER: fertility rate and IND: extractive industry

**Source(s):** Authors' own work

long term. This is consistent with the extant literature (Iheonu *et al.*, 2020; Tchamyoun *et al.*, 2023; Asongu *et al.*, 2024). Fifth, unemployment engenders the expected negative effect of  $-1.5638$  in the short run and  $-2.0448$  in the long term, both at the 1% significance level. This is also consistent with the attendant literature discussed in the data section (Iheonu *et al.*, 2020; Tchamyoun *et al.*, 2023; Asongu *et al.*, 2024).

Sixth, the fertility rate is linked to the expected negative incidence of  $-22.4387$  and  $-34.2793$ , respectively, at the 1% significance level, which is consistent with the extant literature (Iheonu *et al.*, 2020; Tchamyoun *et al.*, 2023; Asongu *et al.*, 2024). Seventh, the unconditional effects of extractive industries are both negative in the short term and long term, with respective values of  $-0.0828$  at the 5% significance level and  $-0.2928$  at the 1% significance. However, the underlying negative signs can become positive contingent on a threshold of governance expenditure, which has been discussed in the previous section. The three estimated coefficients with lags are not used in the computation of thresholds because (1) the corresponding estimated coefficients are not apparent in the long run and (2) not all constituents needed for the computation of thresholds are associated with lags.

Beyond the control variables, in terms of the nexus between the established findings and the extant literature, such linkages can be discussed in two main strands, especially as they pertain to (1) the linkages between these findings and the DRC-centric literature and (2) the connection between the established results and the broader literature on extractive industries. These are discussed in the same chronology, as highlighted in what follows.

First, the established findings substantially depart from the available DRC-centric literature that is focused on extractive industries. Accordingly, the findings are distinct from, *inter alia*, Reichel (2020), who has concentrated on the importance of financial inclusion for both men and women in the DRC's gold mining communities; Urmiche Diya Lipoko *et al.* (2021), who have addressed gender disparities in economic inclusion, particularly concerning young women in the DRC; the study by Rapanyane (2022), which offers an Afro-centric viewpoint on China's involvement in the DRC in relation to conflicts involving mineral resources; the analysis by Tshinu (2022), which shows that the resource curse could be comprehended in the context of the DRC, and Kalombo (2022), who has offered insights into the relationship between strategic natural resources and sustainable development in the DRC.

Second, from the broader extractive industries literature, the findings are distinct from *inter alia*, a strand of literature on comprehending new media trends in the extractive industry's corporate, economic and social responsibilities (Yousefian *et al.*, 2023; Maybee *et al.*, 2023; Neto and Mallett, 2023) and how shocks, uncertainty and climate change affect the underlying industry (Ezeaku *et al.*, 2021; Li and Umair, 2023; Yuan *et al.*, 2023; Schwab and Diaz, 2023). Ultimately, the study departs from two strands of literature in showing that the nexus between extractive industries and development outcomes is not linear but could be contingent on moderating or policy variables.

## 5. Concluding implications and future research directions

The study has assessed how government revenue can moderate the negative effect of extractive industries on female economic participation in the DRC using data for the period 1991–2022. The empirical evidence is based on the ARDL estimation approach. It is established from the findings that extractive industries have a negative unconditional effect on female economic participation, while government revenue dampens the negative effect of extractive industries on female economic participation. Furthermore, there are critical levels of government revenue that should be reached in order for extractive industries to no longer have a negative effect on female economic participation. The corresponding government revenue thresholds are 8.9032 (% of GDP) in the short run and 14.3529 (% of GDP) in the long run. Above these thresholds, the interaction between extractive industries and government revenue yields positive outcomes on female economic participation. Policy implications are discussed in what follows.

First, while extractive industries can be detrimental to inclusive development prospects, policymakers who have been viewing this relationship as exclusively linear could be getting their dynamics very inaccurately, especially as it pertains to the essence of policymakers in employing the relevant policy variables that moderate and/or dampen the natural resource curse or the unfavorable effect of natural resources on economic development. It follows that in light of the findings from the present study, policymakers should no longer view the relationship between extractive industries and inclusive outcomes such as female economic participation as a linear or direct relationship. Secondly, increasing government income is a relevant strategy for mitigating the downsides of the natural resource curse. Moreover, the relevant thresholds of government income should be substantiated by empirical validity. Hence, policymakers in the DRC should increase government revenue beyond the established thresholds in order to expect the exploitation of extractive industries to promote female economic participation.

Third, the fact that the government income thresholds are higher in the long term compared to the short term is evidence that governments should look for other private mechanisms of promoting female economic participation because while in the short run, it is not very expensive for the government, and in the long run, over-reliance on government income to promote female economic participation in the light of extractive industries may not be feasible. Hence, complementary policies should be formulated and implemented both in the short and medium terms in order to avoid the higher burden on government revenue in the long term. Such complementary policies could entail, *inter alia*, more corporate social responsibility at the level of extractive industries that is tailored to promote female formal LFP. The complementary policies could also be tailored such that a specific percentage of women from the domestic economy are required for foreign investments in the extractive industry. In this regard, foreign investors should be aware of the gender component of local staff during their recruitment processes in the country.

The findings in this study obviously leave room for future studies, especially in view of assessing if the findings in this study withstand empirical scrutiny within other developing countries that are highly resource-dependent. Moreover, reconsidering the analysis within the remit of other UN Sustainable Development Goals is a worthwhile future research endeavor. Furthermore, employing the relevant panel data estimation techniques to assess how insights motivating this study could be applied to a broad set of countries is also a worthwhile future research endeavor. It is also worth noting that the study is based on government revenue as opposed to government expenditure due to data availability constraints. Hence, future research could focus on government expenditure, as the relevant data become available, especially as it pertains to which specific government expenditures drive female economic participation.

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#### **Further reading**

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