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The threshold effect of HDI on the relationship between financial development and oil revenues

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ABSTRACT

This paper tried to study the threshold effect of the Human Development Index (HDI) on the relationship between oil revenues and financial development. For this purpose, the threshold regression model is used. In addition, the financial depth index was considered as a measure of financial development. Data were collected with annual frequency (1990–2018) from the most recent statistics published by the Central Bank, Statistics Center of Iran, and OPEC website. The results showed that oil revenues in Iran had a negative significant effect on financial development. This result is consistent with the resource curse phenomenon, despite the expectation of the protective role of oil in the economy of Iran. However, at high levels of human development (index value that is upper than threshold value), this negative impact was reduced. Therefore, promoting human development can be mentioned as a solution to compensate for the negative effect of oil revenues. In addition, the variables of production growth and capital inventory, as expected, had a positive significant effect on financial development.

1. Introduction

The financial sector is one of the most important economic pillars of countries. Perhaps the most traditional definition of economics is the evidence of this claim. In the economic literature, economics is referred to as the science of optimal allocation of scarce resources. Financial resources are one of these resources in today's monetary economies. Therefore, a strong financial sector can be considered to be a necessity for achieving the economic growth and development. The importance of financial sector has led to several studies that address the financial sector's various aspects and its relationship with the key economic variables (e.g. Reid, 2010; Choong and Chan, 2011; Elsayed, 2013; Quixina and Almeida, 2014; Serge Mandiefe, 2015; Paun et al., 2019).

A strong and sustainable financial sector by financing economic activities can be a factor in the economic growth and development (Beck et al., 2002; Rajan and Zingales, 2003; Estrada et al., 2010; Dwumfour and Ntow- Gyamfi, 2018). Financial sector provides the ground for generating deposits by collecting stagnant funds and transferring them to sectors that are facing financial deficits. One of the major economic sectors that can provide these funds is the natural resources sector. Countries with natural resources (e.g. oil, gas, and minerals) have the opportunity to develop their financial sector by using these resources.[1] Yet perhaps the first concept that comes to mind when mentioning the natural resources is the resource curse that makes it difficult to accept the natural resources as a factor in creating financial development.

Empirical evidence suggests that most countries dependent on the natural resources are low in terms of financial development (Elhannani et al., 2016; Mlachila and Ouedrago, 2017). Indeed, the high dependence of these countries on natural resource wealth can lead to a decline in the ability of the financial sector to allocate funds, through large fluctuations in real exchange rates and increased uncertainty in investment decisions (Badeeb and Lean, 2017b). On the other hand, a decline in financial demand due to a contraction of the tradable sector also hinders the development of the financial system. However, strengthening the financial system can lead to a positive relationship between the wealth of these resources and economic growth in these countries by transferring revenues from natural resources to productive investment and the real sector of the economy (Erdogan et al., 2020). Investment in human development is one of the productive investments that play an important role in economic growth and development.

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[1] Taken from Dwumfour and Ntow-Gyamfi (2018).

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Economic literature states that natural resource revenues can have different effects on human development. The results of studies show that in countries rich in natural resources, these incomes can provide the necessary financial resources for the accumulation of human capital and lead to its development. In contrast, a number of researchers, including Gylfason, have found that natural capital destroys human capital and slows growth (Shao and Yang, 2014). Indeed, it is how natural resources are managed and used that makes them an opportunity or a threat to human development. The cost of these revenues in education, training, or even adequate living conditions improves the quality of human capital. In contrast, rent-seeking and misuse of these revenues weaken human capital.

Strengthening human capital also leads to further financial development by improving the knowledge, information, skills and abilities of economic agents. This will not only increase the level of savings and productive funds, but also increase the demand for financial services, especially innovative services. Therefore, natural resource revenues also have an indirect impact on the financial development of natural resource countries through the human capital channel. However, there is an important issue in this context, which is the impact of human capital on the use of natural resource revenues. Higher levels of human development can lead to appropriate management, generation and productivity of these revenues in several ways. First, with higher levels of human capital, economic agents are expected to have more knowledge and skills to properly manage natural resource revenues. Higher levels of human capital may also mean that some of these revenues are used to improve the knowledge and skills of human resources and, consequently, to generate these revenues. In addition, higher levels of human capital can lead to higher economic efficiency and lower rent-seeking activity.

To date, several studies have examined the various dimensions of the resource curse phenomenon and its implications for financial development. Higher human development seems to be able to lead to a positive relationship between natural resource abundance and financial development. Indeed, the hypothesis examined in this study is the positive crucial role of human development on the relationship between financial development and oil revenues. This topic has not been addressed in various studies in this context despite its great importance. In view of the above introduction, this study empirically examines the impact of oil revenues on Iran's financial development and the role of human capital in this context. The remainder of this paper is organized as follows. Section 2 reviews the literature of the subject matter theoretically and empirically. In Section 3, the research method is presented and elaborated, and Section 4 analyzes the estimation results. Finally, conclusion is presented Section 5.

2. Literature review

2.1. Theoretical framework

The cost of accessing data and conducting financial transactions motivated the establishment of an institution called the financial market. In fact, these markets were a solution that could solve the problems of information friction and exchange by providing financial intermediation services (Levine, 1997). With the quantitative, qualitative, and efficiency improvement of financial intermediation services, financial development took place. Following the early research by Schumpeter (1911), Robinson (1952), McKinnon (1973), and Shaw (1973), many studies have addressed the relationship between financial development and economic growth. These studies, emphasizing the effect of financial sector development on the economic growth model of countries, introduced at least four main channels for this effect. The first channel is, in fact, the well-known definition of financial sector. Financial intermediaries transfer excess and stagnant funds to productive sectors that are facing financial deficits. It can also help encourage and increase savings rates by providing innovation and more attractive financial tools. Reducing the cost of financial transactions due to economies of scale and risk-sharing are two other channels through which the financial sector can boost the productive activities and, consequently, the economic growth (Choong and Chan, 2011).

It has so far been accepted that the financial sector development facilitates the economic growth. Yet one of the issues in this regard is the difference in the development of the financial sector of countries. One of the reasons that the economists point out is the difference in the demand for financial services in various countries. Secure demand is one of the drivers of financial development. In addition, sometimes demand is adequate, but structural barriers prevent the supply from increasing accordingly (Rajan and Zingales, 2003). Thus, financial sector development can be addressed by both supply and demand of the financial sector. This paper, by emphasizing the demand for financial services, addresses the role of natural resources. As mentioned in the introduction, the natural resources are one of the sectors that are closely related to the financial sector of different countries. Because almost all countries, at least in the field of oil and petroleum products, depend on the natural resources sector.

Empirical evidence suggests that most natural resource-dependent countries are at a low level of financial development. Although studies have shown a negative relationship between the natural resource abundance and financial development, it is not possible to say surely. In other words, wealth from the natural resources is definitely not a negative factor (Shahbaz et al., 2018). This has led to the attention of many researchers among the determinants of financial development, natural resources, and the rent of this resources. In this regard, the resource curse hypothesis (RCH) is mentioned in particular. In contrast, many scholars, contrary to the orthodox view of natural resources, consider them to be a stimulus for financial development. In fact, there are several factors that can turn the natural resources into a blessing (or curse) for countries (Khan et al., 2020).

Understanding the relationship between the resource abundance and financial development is important for several reasons. First, it provides relevant information about the resource curse phenomenon. In addition, since financial development is an important mechanism for the long-term economic growth, any impact of the resource abundance on the financial sector can also affect the pace of economic growth. Understanding the relationship between the resource abundance and financial development helps the policymakers develop appropriate strategies for the resource curse phenomenon. In addition, the analysis of this relationship can deepen the understanding of the financial development mechanism (Yuxiang and Chen, 2011).

The relationship between the natural resource abundance and financial development can be studied in several aspects. In terms of the resource curse, the over-exploitation of natural resources leads the inputs to leave the production sector. Hence, the productive and tradable sectors face setbacks and declining competitiveness. However, the trade sector is one of the key determinants of financial development, especially in the developing countries. Therefore, the natural resource abundance can negatively affect the pace of financial development. On the other hand, the rents of natural resources can undermine the credibility of government policies by providing opportunities for profiteering and corruption (Hassan, 2013).

Feeling false security and lack of proper economic management, following the availability of abundant natural resources, have a negative impact on social capital. Given the place of social capital in financial development, it can be expected that the financial development pace will decrease with the natural resource abundance. Moreover, rents and income from the natural resources can act as an alternative to private sector savings. Therefore, if the financial structure in countries rich in natural resources is weak, the natural resource abundance is associated with the emergence of various forms of deviation in the economy. Inadequate banking competition, lack of alternative banking institutions for financing, limited coverage of credit information, and poor creditor rights are the manifestations of weak financial sector (Hassan, 2013).

Indeed, all of the aforementioned channels have examined the relationship between resource wealth and financial development through the lens of resource curses. It is true that institutional quality, good governance, and thus proper management and governance of oil revenues can make natural resources a blessing for the economy. But in the meantime, the quality of human capital will also be critical. This is a topic that has not been properly addressed in the economics literature. The accumulation of human capital and, in other words, human development through the education of individuals and the promotion of technical knowledge and productivity of economic agents can play an important role in the economic growth and development of countries. This has been emphasized by various scholars and economists (including Adam Smith) throughout history.

Cuznets, who received the Nobel Prize in Economics in 1971, and Schultz (1961), known in the economic literature as the father of human development theory, argued that human development and investment in higher human capital formation are an important factor in economic development and growth of countries are considered (Mehdiloo et al., 2016). Human capital includes skills, knowledge (Hussain et al., 2021), and vitality of individuals, and represents the long-term development of education, health, and social welfare. People with higher knowledge and skills have better access to information and show less risk aversion in their behavior (Sahabi et al., 2011). Therefore, the overall level of knowledge and skills of individuals in society is expected to have a significant impact on the proper management of oil revenues and the reduction of economic instability in oil-dependent countries.

High-quality human capital is capable of turning the curse of resources into a blessing by accelerating financial development and improving the quality of life. This is because with the accumulation of human capital, the supply and demand of money and financial services in society are strengthened. Moreover, educated people tend to be better at managing financial (and natural) resources than illiterate and unskilled people. Although the relationship between human capital and financial development has not been examined in the numerous studies on human development, the existing economic literature suggests that human capital contributes to financial development (Zaidi et al., 2019). Since the bulk of the total budget and source of funding for government expenditure in oil producing countries is revenue from the sale of petroleum and petroleum products, human development in these countries will also be closely linked to these revenues.

In general, oil revenues can affect human capital in two opposite ways. On the one hand, by funding the government's education budget, these revenues provide the basis for strengthening and developing the education system. The government can also use the revenues to provide education subsidies or free education to the general public. Therefore, oil revenues can improve human capital. On the other hand, a rent-seeking government could turn these revenues into tools for anti-development policies rather than funding educational infrastructure. Moreover, revenues from these resources could reduce demand for skilled knowledge and labor. Alternatively, they may cause some elites and economic agents to withdraw from productive activities and turn to rent-seeking. As a result, the increase in oil revenues is accompanied by a weakening of human capital (Nademi and Zobeiri, 2017). Therefore, the level of human development in countries dependent on oil revenues, including Iran, may indicate to some extent the productive or rent-seeking use of these revenues. It is also expected that oil revenues will circulate more favorably in the country's economy by improving public knowledge and empowering economic agents. As Shahbaz et al. (2018) noted, educating investors and training entrepreneurs can lead to more efficient use of financial resources.

2.2. Research background

According to the stated theoretical foundations, it can be expected that previous studies in this field fall into two general categories: those which referred to the natural resources as curse for countries that depend on them, and those which explored the ability to turn resources into a blessing by providing solutions. This section addresses a number of this studies that have specifically investigated the relationship between financial development and natural resources.

Khan et al. (2020), emphasizing the importance of the role of appropriate financial institutions, addressed the relationship between financial development and rents of natural resource for Pakistan. They found that the rents of natural resources in this country had a negative impact on financial development. In contrast, institutional quality promote the financial development. Elbadawi and Soto (2012) emphasized the role of political institutions in this regard. In a paper, studying the relationship between rents of natural resource, political institutions, and economic growth, they found that policy institutions influenced the nature of natural resources. Natural resource-rich countries that rank low in terms of political institutions (governance and political action) are likely to experience the resource curse phenomenon. In contrast, well-ranked countries can use the rents of natural resource to boost their economic growth.

Asif et al. (2020) also investigated the resource curse hypothesis in the context of the dynamic interaction between financial development and resource disaster in Pakistan. The results showed that in the short-term, rents of natural resource increased the Pakistan's financial development. While in the long-run, this relationship is negative. Therefore, in the long-run, the resource curse hypothesis can be verified. In contrast, Badeeb and Lean (2017a) accepted the hypothesis of natural resource disaster for Yemen with certainty. They studied the impact of the natural resource abundance and financial development on the value added of various economic sectors in Yemen. The results showed that the financial sector development did not play a significant role in the prosperity of the real sectors of the economy (agriculture and production). In contrast, the service sector thrives with the financial sector development.

In Iran, among the studies that are more closely related to the relationship between financial development and natural resources, one can mention Ahmadian Yazdi and Aboutorabi (2019). In their study, they addressed the role of financial development in converting the rents of natural resource into foreign capital for Iran. The results showed that the rents of natural resource had a positive effect on foreign capital. In addition, some aspects of financial development in the short-term increased the impact of resource rents on foreign capital, while this healing effect was not confirmed.

Aboutorabi et al. (2013) studied the effect of oil revenues on the causal relationship between financial development and economic growth for Iran. The results showed that in the bilateral causality test (excluding the index of oil revenue share), causality is held from growth to financial development. While in the three-variable causality test, the causal relationship from growth to financial development is weakened. Moreover, causality is rejected from growth to financial development. The results of this study confirmed that resources abundance might have a negative impact on demand for the financial sector.

The difference between the present paper and the mentioned studies is the role of human development in the relationship between natural resources and financial development. Because the proper use of financial resources is possible with human development, which can be interpreted as training people and improving the skills and quality of human resources. In addition, it provides the opportunity to use financial resources properly.

3. Methodology

Introducing the financial sector as a bridge in the transfer of savings, one can say that a developed financial system can strengthen the economic growth by optimally allocating resources, accumulating capital, and advancing technology. But this connection is also important in the opposite direction. If the economic growth is not at an acceptable level that can absorb the facilities provided by financial development, the

above-mentioned actions will not be fruitful for the financial sector (Chizoba Benneth and Ikechukwu, 2017). Economic growth will lead to the financial sector development by increasing the demand for financial services. Meanwhile, the extraction of natural resources can reduce the trade (and, consequently, economic growth) by shifting the factors of production from the tradable sector to the non-tradable sector. Given the place of business in the financial development, it is natural that this debilitating effect of the natural resources will also reduce the financial development (Shahbaz et al., 2018).

The development of human capital and training the individuals will reduce the information gap. In addition, trained people demand a variety of financial services (Shahbaz et al., 2018). Therefore, as mentioned in the literature section, human development may also play a crucial role in the impact of oil revenues on financial development. Indeed, trained and skilled economic agents can be expected to make better use of oil revenues. According to what has been mentioned so far, the model presented by Shahbaz et al. (2018) to explain the behavior of financial development can be used to achieve the purpose of the present paper:

$$F = f(R,\ Y,\ K) \tag{1}$$

Where, F is financial development, R is oil revenue, Y is production growth, and K is capital accumulation. In this paper, with a slight change, the ratio of liquidity to GDP (M_2/GDP) and GDP growth (at current prices) are used as the indices of financial development and production growth, respectively. The hypothesis examined in this study is the crucial role of human development in the relationship between oil revenues and financial development. Therefore, the HDI (Human Development Index) is considered as a status variable. Human development is also expected to affect the other two variables (output growth and capital stock). This is because the positive impact of economic growth on financial development depends largely on the increased demand for financial services and the facilities created by the financial sector. As mentioned earlier, economic agents with higher knowledge and skills will have a greater demand for financial services. Therefore, an increase in human capital is expected to enhance the impact of economic growth on financial development.

Physical capital is another explanatory variable of Eq. (1), which was included in the regression following Shahbaz et al. (2018). However, no specific effect for it is mentioned in the economic literature. As Shahbaz et al. (2018) found, the effect of physical capital on financial development can be positive or negative. Indeed, the rate of development of capital infrastructure and its relationship with financial development, as well as countries' fiscal policies, will be crucial in this regard.[2] However, it is important to note that human capital can enhance or weaken the effect of physical capital on financial development. The development of capital infrastructure, which prepares the ground for the development of economic activities and the attraction of skilled labor, may be accompanied by an increase in the demand for financial services. Therefore, an increase in human capital can be expected to reinforce the positive impact of physical capital on financial development. Yet, the nature of physical capital will be critical in this regard. It is also possible that the development of human capital will be accompanied by a reduction in physical capital.[3] Or the quality of human capital may not be sufficient to enhance the effect of physical capital on financial development.

Kelly (1980) found that more education reduces risk aversion and increases savings. In addition, low levels of knowledge may lead people to prefer physical assets to financial assets. Therefore, it seems that improving the level of education increases transactions in financial markets (Sahabi et al., 2011). According to what has been said so far, the impact of physical capital on financial development may also differ at different levels of human development.

The threshold effect and BDS[4] tests are used to examine the nature of relationships between variables. The null hypothesis in both of these tests is, in a sense, a linear relationship between the variables. If the null hypothesis is rejected, nonlinear techniques should be used for estimation. However, it is clear that the study of the role of HDI in the effect of oil revenue variables and two other explanatory variables, as well as the hypothesis pursued, leads the research to use nonlinear models. If the results of the threshold effect and BDS test also confirm this nonlinear relationship, the time series threshold regression model will be an appropriate model for estimation.

Threshold regression models are among nonlinear regression and regime switching models with broad applications in economics. In these models, there is a sample split value called the threshold parameter, based on which the data are divided into separate groups (Kourtellos et al., 2015). Although threshold regression models are popular in nonlinear time series, such as the threshold autoregressive (TAR) model of Tong (1983) (Wang, 2015), the smooth transition threshold (STAR) model of Chan and Tong (1986) and the nested threshold autoregressive (NeTAR) model of Astatkie et al. (1997) (Chong et al., 2015), these models are also suitable in cross-sectional applications. For example, Hansen (2000) used the threshold model to show that growth patterns differ between rich and developing countries (Yu and Fan, 2020). Hansen (1999) also developed the panel threshold regression (PTR) models (Erdogan et al., 2020). Hence, threshold regression models became one of the most widely used models in economic models.

The single-threshold model, in its simplest form, has the following format:

$$y_t = \mu + \beta_1 x_t I(q_t \le \gamma) + \beta_2 x_t I(q_t > \gamma) + e_t \tag{2}$$

Where q is the threshold variable, and γ is the threshold parameter. The values of q below γ are referred to as the first state, while the values above γ are referred to as the second state. Clearly, as the number of thresholds increases, the number of states will be increased. X shows explanatory variables that have different effects on y when q is above or below the threshold, and these effects are measured by β (Wang, 2015; Ahmadi Shadmehri et al., 2021). The mathematical expression of this statement is shown in Eq. (3):

$$y_t = \begin{cases} \mu + \beta_1 x_t + e_t, & q_t \le \gamma, \\ \mu + \beta_2 x_t + e_t, & q_t > \gamma. \end{cases} \tag{3}$$

In fact, the state variable is defined as follows (Eq. 4) and by substituting the state variable in Eq. (2), Eq. (3) is obtained:

$$I(q_t \le \gamma) = \begin{cases} 1, & q_t \le \gamma \\ 0, & q_t > \gamma \end{cases}$$

$$I(q_t > \gamma) = \begin{cases} 1, & q_t > \gamma \\ 0, & q_t \le \gamma \end{cases} \tag{4}$$

In Eq. (2) the state change was defined for x. While in threshold regression, all components or parameters of regression are subject to state change. The threshold value is unknown in the model and is calculated based on the least residual sum of squares (Khodavisi and Ezzati Shorgoli, 2020). No need to adjust nonlinear equations, evaluate statistical significance using the bootstrap method, and specify the number of thresholds endogenously are the advantages of threshold

[2] From the study of Shahbaz et al. (2018).

[3] In the economy with overlapping generations, in each period the accumulation of physical capital is obtained from the deduction of consumption and the investment in human capital from the production of the previous period (Noferesti et al., 2017). Therefore, human capital may be associated with a reduction in the accumulation of physical capital.

[4] Brock, Dechert, and Scheinkman (BDS) Test The BDS is a test for dependence in time series data based on the correlation dimension. This test can be used for testing non-linear dependence. It can be used to check whether residuals are iid or not. This non-parametric test in studies is used to test the nonlinear structure in a time series or to test whether the time series creation process follows nonlinear dependencies or not.

regression models (Erdogan et al., 2020; Yıldırım et al., 2021). Also, the possibility of examining the structural break in the relationship between variables and Ease of estimation are other advantages of these models. The usability of these models in cross-sectional, time series and panel data make them suitable to explain many economic phenomena.

With the descriptions of the threshold regression model, Eq. (1) is written as follows:

$$logF_t=\mu+\beta_1 logR_t I(HDI_t\leq\gamma)+\beta_2 logR_t I(HDI_t>\gamma)+\varphi_1 logY_t I(HDI_t\leq\gamma) +\varphi_2 logY_t I(HDI_t>\gamma)+\alpha_1 logK_t I(HDI_t\leq\gamma)+\alpha_2 logK_t I(HDI_t>\gamma)+e_t \quad (5)$$

In this study, the threshold variable is the Human Development Index (HDI). Eq. (5) is a situation with a single threshold for HDI. By specifying the number of HDI thresholds, the number of parameters of the explanatory variables (R, Y, K and even intercepts of the different states) are determined. As explained above, values of q below γ are called the first state (low human development), and values above γ are called the second state.

A review of the available literature shows that the nonlinear relationship between oil revenue variables and financial development has not yet been examined in any study. Also, examining the role of human development in the impact of oil revenues on financial development is another distinguishing feature of the present study from other studies. The hypothesis examined in this study is that the negative impact of oil revenues on financial development decreases with higher levels of human development. Therefore, different states in which the HDI can be classified are considered, and the relationship between oil revenues and financial development in these states is measured.

The required statistics and information were collected in a time series with annual frequency from the Central Bank of the Islamic Republic of Iran, the Statistics Center, and the OPEC website. Statistical data on oil revenues were calculated using the official exchange rate in Rial. In order to homogenize the data used, the logarithmic form and per capita variables were used. Also, after estimating the regression, the validity of the results is checked using robustness tests. For this purpose, the robust standard deviation is calculated. Changes are also made in the estimation method and the set of explanatory variables, and the results are compared to the first estimate (primary results). If the results of the new estimates confirm the first estimates, the validity of the obtained results cannot be questioned and the preliminary results can be reliable. This study is over the period of 1990–2018 with annual frequency and for the country of Iran.

4. Results and discussion

In order to estimate the final model, several steps need to be taken. The nature of the data determines the first step. The results of model estimation using time series data are highly sensitive to the variables stationary. Since economic variables data are generally secondary and not stationary, this sensitivity is very considerable. Because ignoring this sensitivity leads to a lot of bias. In this regard, the Augmented Dickey-Fuller (ADF) test was applied. Moreover, in order to study the results more accurately and verify them, the stationary of the variables was also studied applying the Phillips-Perron (PP) test, which is actually a generalized form of ADF. The results of these two tests are summarized in Table 1.

Table 2
Result of the BDS test.

Dimensions	Test statistic	Significance prob.	Result
2	0.059	0.00	Linear relationship rejected
3	0.131	0.00	Linear relationship rejected
4	0.181	0.00	Linear relationship rejected

Source: Research findings.

The results of Table 1 show that the variables do not have the same degree of stationary. In this case, the variables lag in regression should be used. But using lags means turning long-term relationships into short-term relationships. In this regard, the co-integration test can be helpful. If the variables have the same degree of integration, there is a long-term relationship between them, and differentiation can be avoided. In the econometric literature, several methods have been introduced to study the accumulation degree of variables. This paper studies the estimated residuals. For this purpose, it is necessary to estimate the final model and, then, check the residuals stationary. Due to the priority of the co-integration test, the results of this test were reported first.

According to the last column of Table 1 and the probability of significance in both ADF and PP tests, it can be said that the results of the co-integration test confirm the establishment of a long-term relationship between the variables. Therefore, we can take the second step in estimating the model that is to investigate the nature of the relationships between the variables in terms of linearity. Although the subject and nature of the research indicate a nonlinear relationship between the variables, this was investigated using conventional econometric techniques. In this regard, the threshold effect test and BDS test were applied. The results of these tests are summarized in Table 2 and Table 3.

The significance probability of BDS test statistic shows that the null hypothesis can be rejected with certainty. Rejecting the null hypothesis means rejecting the linear relationship between the variables. The threshold variable in the present study is the HDI. The significance probability of the effect test indicates that there is single threshold for human development (HDI). The threshold for HDI was estimated to be 0.66. Index values below 0.66 are referred to as the first state (low human development). Similarly, the second state represents index values above 0.66 (high human development). Therefore, nonlinear estimation techniques should be used in estimation. Threshold regression model is one of the set of nonlinear models that can be used to achieve the research goal. In this model, first, the threshold for the state variable must be determined according to the information criteria or previous information. Next, according to the number of thresholds, the

Table 3
The Results of Threshold effect test and threshold value.

Threshold	F-statistic	Critical Value (0.05 level)
Single	26.32	13.98
Double	3.51	15.72
Threshold Value	0/66	

Scaled F-statistic: 78.96 and 10.53.
Source: Research findings.

Table 1
Results of the durability test.

Variable	ADF test			PP test		
	Test statistic	Significance prob.	Test result	Test statistic	Significance prob.	Test result
FDI	−5.506	0.00	I(0)	−6.421	0.00	I(0)
Oil revenues	−4.87	0.00	I(1)	−4.969	0.00	I(1)
Production growth	−3.757	0.00	I(0)	−3.76	0.00	I(0)
Capital accumulation	−3.913	0.00	I(1)	−3.42	0.04	I(1)
HDI	−4.809	0.00	I(1)	−4.797	0.00	I(1)
Accumulation test	0.00			0.00		

Source: Research findings.

Table 4
Results of the model estimation.

Variable	First state (HDI<0.66)		Second state (HDI ≥ 0.66)	
	Coefficient (%)	Significance prob.	Coefficient (%)	Significance prob.
Production growth	0.003	0.00	−0.004	0.14
Capital accumulation	56.20	0.00	37.12	0.00
Oil revenues	−27.02	0.00	−9.96	0.01

Source: Research findings.

different situations in which the model is placed are specified. In the last step, the estimation is done. A summary of the results of these steps is provided in Table 4.

According to Table 4, the threshold value of the HDI is estimated at 0.66. Lower and higher HDI values describe two conditions for the relationships between variables. Index values below 0.66 are known as the first state (low human development). Similarly, the second state depicts index values above 0.66 (high human development). As mentioned in Section 3, the variables are in logarithmic and per capita form. Hence, the coefficients are expressed as a percentage. It is also necessary to mention that the results of regression models can be interpreted in terms of model type, statistical sample, explanatory variables set, and number of observations. Therefore, the results are approximate to reality. Now, considering the two points mentioned, the estimated coefficients are addressed.

Except for production growth, all explanatory variables (in both states) have a significant impact on financial development. Production growth in the first state has a positive significant effect on financial development. With the increase in production growth in a state where the HDI is at a low level, financial development increases by 0.003%. As expected from the theoretical foundations, the production growth stimulates financial development. However, it can be said that the negligible coefficient proves that the production growth of Iran's economy during the years under study has not been able to lead to considerable financial development. In the case of high human development, this coefficient was −0.004%. Yet since its significance is not statistically confirmed, this result cannot be interpreted and an analysis cannot be presented based on it.

Capital accumulation in both states has a positive significant effect on financial development. With the accumulation of capital, the financial sector develops more. However, a significant decrease in the coefficient of this variable in the second state shows that human development did not help to strengthen this effect. As if the effectiveness of this variable also decreased. With 1% more capital accumulation, financial development in the first state increases by about 56% and in the second situation by about 37%. But the noteworthy point in Table 4, which is the focus of the present study, is the huge difference in the coefficient of oil revenues. Oil revenues in both low and high human development have a significant negative impact on financial development. The difference is that in the latter state, this negative impact was significantly reduced. Therefore, one can say that improving the HDI can be a solution to improve the weakening effect of oil revenues.

Finally, as stated in the methodology section, the validity of the results is checked using robustness tests. In the final estimate, the robust std. error is calculated. The values of the robust standard deviation of the coefficients were at a low level. In order to evaluate the stability of the results as well as possible,[5] changes were made in the estimation conditions and the set of explanatory variables, and then the results of the estimation were compared to the results of the first estimation. In this context, output growth was first removed from the equation, and the regression was estimated taking into account the two explanatory variables, capital stock and oil revenues. Although the magnitude of the coefficients differed from the results of the first estimation, the sign of the coefficients and the change in the magnitude of the coefficients in the two states of low human development and high human development confirmed the results of the first estimation. The next step was to add output growth back into the equation. But this time, instead of the HDI index, the education index (education expenditure (% of GNI)) was used as the threshold variable. In the new estimate, the sign and asymmetric effect of the variables in the two states matched the results of the first estimate.

Then the conditions of the equation were reset to the original state. This time, the variable of government spending in education (Government expenditure on education, total (% of GDP)) was included in the regression as a control variable. The results of this estimation also differed from the results of the first estimation only in the magnitude of the coefficients. Although the results of the estimates made did not call into question the validity of the results of the first estimates for any of the changes made so far, the research continued as much as possible for further validation. Once again, a regression was estimated, and this time the change was made only for oil revenues. In other words, the effects of oil revenues on the two states of high and low HDI were estimated. Yet, this change in the state was not assumed to affect of the capital stock and output growth variables. The results of this estimation were also consistent with the results of the first estimation. The changes in model conditions and the replication estimates were repeated several more times, even at higher thresholds. And in all the estimates obtained, no acceptable result was observed that differed from the results of the first estimation, except for the magnitude of the coefficients. The results of these studies are presented in the appendices of the present study (Eq. 6, 7, 8, 9, 10, 11, and results are presented in Table A-1, A-2, A-3, A-4, A-5 and A-6).

5. Conclusion

In the present paper, the relationship between oil revenues and financial development in the Islamic Republic of Iran was investigated in terms of the role of human development. For this purpose, the time series data of production growth, oil revenues, capital accumulation, and HDI were used. Moreover, the financial depth (M_2/GDP) index was used as a measure of financial development. Data were extracted with annual frequency (1990–2018) from the most recent statistics published by the Central Bank, Statistics Center of Iran, and OPEC website. Due to the nonlinear nature of the relationships between the variables, the threshold regression model was used to estimate the model.

The results showed that oil revenues in Iran had a negative significant impact on financial development. This result is consistent with the resource curse phenomenon despite the expectation of the protective role of oil in the economy of Iran. However, at high levels of human development (index value that is upper than threshold value), this negative impact was reduced. Therefore, promoting human development can be mentioned as a solution to compensate for the negative effect of oil revenues. The results are consistent with the studies of Asif

[5] The changes were limited to what was possible for the researchers. For example, due to limited access to statistical information, it was not possible to extend the time period. Since statistical information on a number of economic variables related to financial development and the research subject was incomplete, there were also many limitations in adding control variables.

et al. (2020); Khan et al. (2020) and Aboutorabi et al. (2013). The results also confirm the hypothesis of this research. Based on the results can be said that higher human development (as well as institutional quality and good governance) can make natural resources a blessing for the economy. Human development also be able to lead to a positive relationship between natural resource abundance and financial development.

In fact, as different studies in the field of resource curses have pointed out, the misuse of oil revenues turns the blessings of natural resources into curses. Human development is an effective step towards more efficient and principled use of oil revenues—a step that increases the demand for large-scale financial services. Hence, it also promotes the financial development.

As expected, the production growth variable has a positive significant effect on financial development. As production growth increases, the financial transactions in inside and outside of country increases. Naturally, this increase requires the quantitative and qualitative development of the financial sector and the introduction of new financial instruments. In addition, the financial innovations created are attracted to financial transactions due to the prosperity of the economy. This cycle creates a mutual boom in which the production growth leads to financial development, and financial development leads to further production growth. Yet the coefficient of this variable was estimated to be very small. This result are expected given the situation of Iran's economy in recent years. However, logarithm means considering the long-term trend of variables, independent of the short-term fluctuations. Hence, in the short-run, this relation may have larger numerical values. But the long-term trend of the financial development index has little elasticity to the production growth.

In both states, the capital accumulation variable has a positive significant effect on financial development. But with the promotion of human development, this effect diminished. As more capital accumulates, demand in the financial sector and, consequently, financial development increases. In the economic literature, however, there is no definite discussion of this. The results also showed that human capital in Iran is not enough to strengthen the positive impact of capital accumulation on financial development. In a general summary of the role of human development, one can say that this index reduces the weakening effect of oil revenues, and thereby promotes financial development. While reducing the effect of capital accumulation, it has a negative impact on financial development. The results of robustness tests did not call into question the validity of the estimation results.

Declaration of competing interest

None.

Data availability

The authors do not have permission to share data.

APPENDIX. A. The Results of Robustness Tests:

In the order mentioned in the text.

A-1: F = (R, Y, K)

$$logF_t = \beta_1 logR_t I(HDI_t \le \gamma) + \beta_2 logR_t I(HDI_t > \gamma) + \varphi_1 logY_t I(HDI_t \le \gamma) + \varphi_2 logY_t I(HDI_t > \gamma) + \alpha_1 logK_t I(HDI_t \le \gamma) + \alpha_2 logK_t I(HDI_t > \gamma) + e_t \quad (6)$$

Table A-1
Results of the model estimation (with Robust std. err.)

Variable	First state (HDI<0.66)			Second state (HDI ≥ 0.66)		
	Coefficient (%)	Robust std. err.	Significance prob.	Coefficient (%)	Robust std. err.	Significance prob.
Production growth	0.003	0.000006	0.00	−0.004	0.000003	0.14
Capital accumulation	56.20	0.07	0.00	37.12	0.04	0.00
Oil revenues	−27.02	0.06	0.00	−9.96	0.03	0.01

Source: Research findings.

A-2: F = (R, K)

$$logF_t = \beta_1 logR_t I(HDI_t \le \gamma) + \beta_2 logR_t I(HDI_t > \gamma) + \alpha_1 logK_t I(HDI_t \le \gamma) + \alpha_2 logK_t I(HDI_t > \gamma) + e_t \quad (7)$$

Table A-2
Results of Eq. (7) estimation

Variable	First state (HDI<0.66)			Second state (HDI ≥ 0.66)		
	Coefficient (%)	Robust std. err.	Significance prob.	Coefficient (%)	Robust std. err.	Significance prob.
Capital accumulation	0.55	0.11	0.00	0.39	0.04	0.00
Oil revenues	−0.22	0.09	0.01	−0.12	0.03	0.00

Source: Research findings.

A-3: F = (R, Y, K) with new threshold Var

$$logF_t = \beta_1 logR_t I(Ede_t \le \gamma) + \beta_2 logR_t I(Ede_t > \gamma) + \varphi_1 logY_t I(Ede_t \le \gamma) + \varphi_2 logY_t I(Ede_t > \gamma) + \alpha_1 logK_t I(Ede_t \le \gamma) + \alpha_2 logK_t I(Ede_t > \gamma) + e_t \quad (8)$$

Ede: New Thereshold Var. education expenditure (% of GNI)

Table A-3
Results of Eq. (8) estimation

Variable	First state (Edu<3.3)			Second state (Edu ≥ 3.3)		
	Coefficient (%)	Robust std. err.	Significance prob.	Coefficient (%)	Robust std. err.	Significance prob.
Production growth	0.00001	0.00001	0.06	0.00003	0.00001	0.00
Capital accumulation	0.77	0.11	0.00	0.58	0.18	0.00
Oil revenues	−0.44	0.1	0.00	−0.29	0.15	0.06

Source: Research findings.

A-4: F = (R, Y, K, exp)

exp: government spending in education (Government expenditure on education, total (% of GDP))

$$\begin{aligned} logF_t = {} & \beta_1 logR_t I(HDI_t \le \gamma) + \beta_2 logR_t I(HDI_t > \gamma) + \varphi_1 logY_t I(HDI_t \le \gamma) + \varphi_2 logY_t I(HDI_t > \gamma) + \alpha_1 logK_t I(HDI_t \le \gamma) + \alpha_2 logK_t I(HDI_t > \gamma) \\ & + \omega_1 exp_t I(HDI_t \le \gamma) + \omega_2 exp_t I(HDI_t > \gamma) + e_t \end{aligned} \quad (9)$$

Table A-4
Results of Eq. (9) estimation

Variable	First state (HDI<0.66)			Second state (HDI ≥ 0.66)		
	Coefficient (%)	Robust std. err.	Significance prob.	Coefficient (%)	Robust std. err.	Significance prob.
Production growth	0.00003	0.000006	0.00	−0.000008	0.000002	0.00
Capital accumulation	0.55	0.08	0.00	0.42	0.03	0.00
Oil revenues	−0.27	0.08	0.00	−0.16	0.03	0.00
Exp	0.00	0.000002	0.23	0.0000009	0.000	0.00

Source: Research findings.

A-5: F = (R, Y, K)

$$logF_t = \mu + \beta_1 logR_t I(HDI_t \le \gamma) + \beta_2 logR_t I(HDI_t > \gamma) + \varphi_1 logY_t + \alpha_1 logK_t + e_t \quad (10)$$

Table A-5
Results of Eq. (10) estimation

Variable	First state (HDI<0.66)			Second state (HDI ≥ 0.66)		
	Coefficient (%)	Robust std. err.	Significance prob.	Coefficient (%)	Robust std. err.	Significance prob.
Oil revenues	−0.11	0.04	0.00	−0.09	0.05	0.1
Cons.	0.00007	0.00001	0.00	0.00007	0.00001	0.00
	Coefficient (%)		Robust std. err.		Significance prob.	
Production growth	0.00001		0.000003		0.00	
Capital accumulation	−0.39		0.1		0.02	

Source: Research findings.

A-6: F = (R, Y)

$$logF_t = \mu + \beta_1 logR_t I(HDI_t \le \gamma) + \beta_2 logR_t I(HDI_t > \gamma) + \varphi_1 logY_t + e_t \quad (11)$$

Table A-6
Results of Eq. (11) estimation

Variable	First state (HDI<0.66)			Second state (HDI ≥ 0.66)		
	Coefficient (%)	Robust std. err.	Significance prob.	Coefficient (%)	Robust std. err.	Significance prob.
Oil revenues	−0.18	0.04	0.00	−0.15	0.04	0.00
	Coefficient (%)		Robust std. err.		Significance prob.	
Production growth	0.00001		0.000005		0.01	
Cons.	0.00004		0.000005		0.00	

Source: Research findings.

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