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Natural resource curse: link with bank stability, business model and credit policy

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Abstract:

This study uses a set of bank-level data to examine how natural resource rents affect bank stability. Our findings indicate that bank stability is adversely influenced by natural resource rents. Unlike previous research, which attributes the low level of financial development in resource-based countries to external factors, our study emphasises banks' internal behaviours. We found that limited bank intermediation in these countries serves as a protective measure against the additional risks posed by natural resource rents. Credit rationing helps banks mitigate credit risks, which are particularly pronounced in resource-based economies. Furthermore, risk diversification through bank business models is not sufficient to dampen the negative impact of natural resource rents, thereby contributing to greater financial instability in these countries.

Key words: resource curse, bank stability, business model, credit policy.

JEL Classification: G21; G28; N50.

1. Introduction

Banking instability is a major concern for financial system regulators. For decades, economists have studied the causes of crises, as well as strategies for managing and preventing them, Laeven and Valencia (2013). Over the past 20 years, sharp fluctuations in natural resource prices on international markets have drawn attention to how this volatility affects the banking system, thus leading to the emergence of a new body of literature known as the financial resource curse. Several studies have examined the impact of natural resource price shocks on banking fragility. Broadly, the literature identifies three key manifestations of the financial resource curse: financial instability, low financial intermediation, and weak financial development in resource-based countries.

Beck (2011), Kinda et al. (2016), and Mlachila and Ouedraogo (2019) assess the effects of natural resource price shocks on banking indicators associated with financial fragility. Their findings reveal adverse effects on measures of bank soundness, such as profitability, solvency, and non-performing loans, as well as impacts on financial development indicators, including deposits, private sector credit, and the credit-to-deposit ratios. They attribute these negative effects to both macroeconomic consequences of natural resource price shocks and the behavioural responses of economic agents, which, in turn, weaken banks' financial stability. Examples include declining economic growth, rising unemployment, reduced savings, and lower tax revenues. Additionally, they emphasise the role of institutional strength in mitigating the adverse effects of resource price fluctuations.

The literature on the financial resource curse relies primarily on aggregate banking data for analysis. To the best of our knowledge, Beck and Poelhekke (2023) are the only authors to use bank-level data. Their results indicate that natural resource price shocks negatively affect variables measuring banking intermediation, credit distribution and deposits levels, corroborating earlier studies. Additionally, they highlight that natural resource windfalls are often diverted to offshore banks through foreign asset accumulation or channelled into surging government expenditures. Consistent with this perspective, most research on the financial resource curse attributes its effects to external factors, such as the behaviour of economic agents, macroeconomic conditions, and institutional quality.

Our model introduces a different approach which models the relationship between bank risk, business models, and credit policies. This framework allows us to capture the dynamics barely analyzed by previous literature on the financial resource curse. By placing banks at the centre of the analysis, we examine their risk management strategies in response to resource windfalls. At this purpose, we construct a database of 164 countries and 6,848 banks, in which bank level data are coupled with country characteristics. We relate in our model a bank stability variable to a variable measuring resource rents, bank credit policy, bank business model, and some country characteristics. Specifically, we extend Köhler's (2015) model of bank stability and business models by incorporating a total resource rents variable to assess how banks respond to the added instability introduced by resource rents, and a bank credit policy variable to capture how resource rents affect bank credit distribution. Our findings suggest that credit rationing in resource-based economies serves as a strategy for mitigating heightened credit risk. Furthermore, these resource-based countries experience greater financial fragility and instability, regardless of their chosen risk management approach.

Finally, banking system fragility and low intermediation are a result of banks' responses to resource rents and further lead to weak financial development. Our findings indicate that banks become increasingly unstable beyond a certain threshold of natural resource wealth. Our analysis remains robust across multiple robustness checks, including outlier tests, placebo tests, heterogeneity, endogeneity, and various definitions of the resource rents variable. The results also hold when controlling for different bank types. Additionally, we validate our findings using an alternative definition of bank risk, Le Petit and Strobel (2013) and by examining the two components of the Z-score employed as a bank risk variable (Fosu et al., 2017; Köhler, 2015). Finally, our results remain consistent across different sample compositions, including whether or not Islamic banks are included. This is particularly relevant since Islamic banks play a key role in the banking systems of oil-exporting MENA countries.

The remainder of our article is structured as follows. Section 2 reviews the literature on the financial resource curse and financial instability, providing the foundation of our model, which examines financial resource curse dynamics through bank instability and risk management. Section 3 presents the empirical analysis, beginning with descriptive statistics that offer initial insights into our research question. We then use an econometric model to analyse financial resource curse effects through banks' behaviour. Finally, we conclude with key findings and policy implications.

2. Literature review

2.1. The financial resource curse

The literature on financial resource curse suggests that resource-based countries tend to have less developed financial systems. Beck (2011) empirically demonstrates that while these countries have banks that are better capitalised and more profitable, they tend to make less credit. Again, Beck and Poelhekke (2017) examine the relationship between resource rents and various financial development indicators, such as the growth of total foreign assets and aggregate savings. They find a negative relationship, thus supporting the financial resource curse hypothesis by showing that resource price booms lead to a decline in aggregate loans due to reduced deposits. This low level of financial development is largely attributed to banks' limited intermediation capacity in resource-based economies, as well as to the impact of resource price shocks on the banking system. Roughly, the literature on the financial resource curse can be categorised into three main themes. The first highlights how the curse manifests through low financial development. The second links it to financial instability driven by resource price volatility. The third attributes it to weak financial intermediation, which constrains credit distribution and overall economic growth.

Financial resource curse evidenced as financial instability

The literature emphasises the negative impact of resource price volatility on financial development, Van der Ploeg and Poelhekke(2009). Eberhardt and Presbitero (2021) estimate the effect of natural resource price volatility on financial crises and find a very strong and significant relationship between the two, especially for developing countries. Their findings challenge conventional explanations for financial crises in these economies, suggesting that credit booms and foreign capital inflows are not the primary causes of financial crises. More specifically, natural resource price shocks play a key role in undermining financial stability. In the same vein, several studies link resource price shocks to financial crises, instability, and, in some cases, bank failures and bankruptcies (Eberhardt & Presbitero, 2021; Kinda et al., 2016; Mlachila & Ouedraogo, 2017).

Furthermore, resource price shocks translate into financial instability, ultimately leading to lower financial development. Indeed, Mlachila and Ouedraogo (2017) provide evidence of this relationship by regressing various financial development indicators on a resource price shock variable while controlling for institutional and macroeconomic factors. Their results indicate that both positive and negative shocks adversely affect financial development, though strong financial institutions help in mitigating these effects. Similarly, Kinda et al. (2016) assess the impact of natural resource price shocks on financial fragility using a sample of 71 countries. Their findings show a negative impact, as such shocks contribute to rising bank costs, an increase in non-performing loans, and heightened crisis occurrence. Additionally, they examine how resource price shocks affect bank liquidity, profitability, and provisions for non-performing loans. Their study underscores the importance of macroprudential policies in addressing bank fragility and preventing crises triggered by natural resource price shocks.

Financial resource curse evidenced as low financial development

Another stream of literature highlights the negative impact of natural resources on financial development, namely through weak institutions. As previously discussed, the adverse effects of resource price fluctuations on the financial system are more pronounced in countries with weak institutional frameworks. Indeed, numerous studies emphasise the crucial role that institutions play in economic development and especially in shaping financial system. Kassouri et al. (2020) study the impact of oil resources on financial development while controlling for institutional quality. Using a panel smooth transition regression model with two regimes, they regress financial development indicators on oil price, control variables, and a threshold variable (democratic accountability). Their findings indicate that rising oil price negatively affects financial development in countries with weak democratic accountability, whereas they have a positive impact in countries with stronger institutional frameworks.

Furthermore, Bhattacharyya and Hodler (2014) develop a theoretical model demonstrating that resource rents are linked to low financial development unless institutions are strong enough to enforce contracts and promote savings

and investment through the financial system. Indeed, using a sample of 133 countries, they find that resource rents negatively impact financial development, with this effect being more pronounced in countries with weaker institutions. Their findings emphasise that institutional quality is a key factor in explaining the adverse relationship between resource rents and financial development. As Acemoglu and Johnson (2005) argue, well-defined and enforced property rights create incentives for investment, enabling financial institutions to channel resource windfalls through investment in productive activities. Similarly, contract enforcement ensures the proper functioning of financial system. These findings hold across different definitions of resource rents, institutional indicators, and estimation methodologies.

Financial resource curse evidenced as low level of weak financial intermediation

Do and Levchenko (2007) explain that demand for external finance shapes a country's financial development. In resource-based economies, key sectors often operate independently of external financing. Firms in the resource sector rely on windfall revenues to meet their internal financial needs, reducing their reliance on banks for funding. As a result, these funds are not intermediated through the financial system. Moreover, banking intermediation remains weak for firms operating in non-resource sectors, as they often struggle to access financing and experience declining activity due to Dutch disease, Damette et al. (2023). Even when these non-resource firms operating in resource-based countries seek loans, they receive less credit than their counterparts in non-resource-based countries. Consequently, despite receiving resource windfalls, banks in resource-based economies fail to intermediate these inflows effectively. Batthacharyya and Holder (2014) highlight this mechanism in their theoretical model of the financial resource curse. They demonstrate that when contracts are not enforced, savings do not flow through banks to fund investment projects. As a result, bank intermediation in resource-based economies remains ineffective, thereby hindering financial development.

Furthermore, low financial intermediation in resource-based countries can also be attributed to risk management challenges. Indeed, Beck and Poelhekke (2017) explain that, against all odds, resource price booms lead to a decline in aggregate loans due to a reduction in deposits. Therefore, banks struggle to absorb natural resource windfalls and effectively intermediate them for economic growth. Such episodes are also marked by an increase in non-performing loans, indicating poor investment decisions. Several studies highlight the adverse effects of natural resources on bank stability. Dwumfour and Ntow-Giamfy (2018) show that banks in resource-based countries face considerable challenges in managing risk. Articles quoted above in the first sub-section mentioning the link between resource price shocks and financial instability, underscore the difficulties faced by banks in resource-based countries when fulfilling their financial intermediation role, because of weakness in risk management.

Finally, this issue may also explain the prevalence of credit rationing in these countries. Credit rationing occurs when banks have sufficient liquidity but restrict lending to economic agents. Beck (2011) observes that while banks in resource-based economies tend to be better capitalised and more profitable, they extend less credit. An important area for further investigation is how resource windfalls adversely affect risk management and credit distribution, given banks' profit-maximizing objectives. Such an analysis would provide deeper insights into the financial resource curse by explaining the higher incidence of credit rationing in resource-based countries.

2.2. Bank risk

The literature on banking, risk and instability are explained through market structure, which encompasses competition, concentration, and market power. Indeed, the structure of the banking market influences risk-taking behaviour, and banks adopt specific business models to manage risk and mitigate instability.

Market structure and banking stability

The banking system is intrinsically concentrated, as financial operations must be conducted on a large scale to be profitable. Moreover, scale is crucial for diversification, which helps banks manage risk—an inherent aspect of banking. Consequently, more concentrated banking systems tend to be more stable, as banks can diversify their assets more effectively Calice et al. (2021). However, this raises concerns about competition in highly concentrated banking systems.

Boyd and De Nicolo (2005) analyse the relationship between competition (measured by concentration) and risk. Their model of banking system concentration and risk incentives suggests that as concentration increases, banks raise interest rates, which in turn elevates borrowers' default risk, ultimately increasing banks' exposure to risk. Their explanation is as follows: When borrowers face higher interest rates, they adjust their investment strategies to ensure loan repayment. This often involves taking on greater risks. As a result, lower competition in the banking system (reflected in higher concentration) will ultimately lead to increased risk in banks' portfolios. This conclusion is rooted in the model developed by Allen and Gale (2000), later adapted to a model addressing contracting problems in loan markets with moral hazard considerations. Ultimately, the broader literature remains divided on the impact that market structure has on banking risk and instability.

Bank business models and banking stability

A bank's business model is closely tied to risk management. Köhler (2015) defines a bank's business model by how bank generates profit, targets customers, and the distribution channels it employs. In the literature, business models are typically assessed based on funding and income structures—specifically, the share of non-interest income in total operating income and the share of non-deposit funding in total liabilities. Roughly, investment banks rely more on non-interest income and non-deposit funding, whereas retail banks derive a larger portion of their income from interest and depend more on deposit funding.

Several studies examine the relationship between business models and banking stability. Demirgüç-Kunt and Huizinga (2010) find that diversification, as measured by the share of non-interest income and non-deposit funding, has a weak impact on stability. However, they also show that higher proportions of non-interest income and non-deposit funding tend to increase instability for most banks. In contrast, Altunbas et al. (2011) argue that banks with more diversified income structures exhibit more stability.

More specifically, Köhler (2015) examines the impact of business models on the stability of European banks from 2002 to 2011. His sample includes both listed and non-listed banks, ensuring broader representation across different business models. He finds that diversification in income and funding structures depends considerably on the business model. Listed banks, particularly investment banks, rely more on non-interest income and non-deposit funding, whereas interest income and deposit funding predominate in certain types of non-listed banks, namely savings, cooperative, and retail-oriented banks.

Köhler's (2015) results highlight that the effect of diversification on stability varies by bank types. Indeed, an increased share of non-interest income and non-deposit funding will affect the stability of banks differently, depending on whether they are investment or retail banks. Greater non-deposit funding reinforces the stability of investment banks, while retail banks benefit from non-interest income. Additionally, Köhler's conclusions are in line with DeYoung and Torna (2013), who find that during financial crises, bank failures are not driven solely by non-interest income itself but rather by its composition—specifically asset-based non-traditional activities that substantially increase the probability of failure.

3. Methodology

3.1. Data

This study examines the financial resource curse and bank stability by combining bank-level and macroeconomic data. Country level data come from World Development Indicators. Bank-level balance sheet and income statement data are obtained from Bank Focus, covering annual observations from 2011 to 2022. This large sample includes both resource-based and non-resource-based countries. Since we use bank-level and country-level characteristics as control variables in our model, banks within the same country share identical country-specific characteristics. Our final dataset is a micro–macro one with three dimensions: bank, country, and year. Following Beck and Poelhekke (2023), we exclude countries such as Germany and United States, as their large number of banks could introduce bias. Indeed, they recommend excluding any country representing more than 5% of the sample, as unbalanced clusters could downward bias cluster-robust standard errors. Additionally, we exclude countries with fewer than four banks, as suggested by Beck (2011). Further, we exclude banks with fewer than three consecutive observations and those reporting negative interest or non-interest income, in line with Fosu et

al. (2017). The final sample consists of 6,848 banks across 164 countries. To mitigate the influence of outliers, all variables are winsorised at the 1% and 99% levels.

3.2 A first look at the data: banking sector characteristics in resource-based and non-resource-based countries

In this section, we conduct an initial statistical analysis of variables capturing bank stability, as it lies at the core of our research question. We assess whether there are statistically significant differences between banks operating in resource-based countries and those operating in non–resource-based countries. Table A in the appendix presents descriptive statistics comparing banks in resource-based countries (Panel A) and those in non-resource-based countries (Panel B) in terms of profitability, capitalisation, and risk. Difference-in-means tests indicate that the two groups differ across these characteristics. Bank profitability is proxied by return on assets (ROA) and return on equity (ROE). Banks in resource-based countries appear to outperform their counterparts in non-resource-based countries in both metrics, with ROA averaging 9.1 compared to 6.51 and ROE at 1.33 compared to 0.75. Capitalisation is assessed using the equity-to-assets ratio and total capital adequacy ratio. Again, banks in resource-based countries exhibit higher capitalisation than those in non-resource-based countries. The equity-to-assets ratio is 19.04 for banks operating in resource-based countries, compared with 13.56 for those in non–resource-based countries. Similarly, the total capital adequacy ratio is 23.81 for the former group, against 20.09 for the latter.

Regarding bank risk, we consider three measures: (1) loan loss reserves as a proportion of gross customer loans and advances, (2) loan loss reserves as a proportion of impaired loans, and (3) the non-performing loans ratio. Banks in resource-based countries exhibit higher risk average with values of 5.62, 199.49, and 6.10, respectively, compared with 6.49, 96.00, and 3.89 for banks in non–resource-based countries. Additionally, we introduce a measure of bank stability: the widely used Z-score measure, which quantifies the number of standard deviations by which profits must decline for a bank to face insolvency. A higher Z-score indicates greater profitability and capitalisation i.e. bank stability, whereas a lower Z-score reflects increased profit volatility, i.e. bank instability. The literature presents different approaches for calculating the Z-score. In this study, we follow the methodologies of Hesse and Cihák (2007) and Lepetit and Strobel (2013).[1]

According to Hesse and Cihák (2007), $Z\text{-}score_1$ is calculated as:

$$Z_{it1} = (ROA_{it} + EA_{it}) / \sigma(ROA_T)$$

where $T = 1, \ldots, t$, ROA_{it} is the return on assets, and EA_{it} represents equity-to-assets. This formulation considers only the most recent ROA value while computing $\sigma(ROA)$ over the entire sample period T.

Following Lepetit and Strobel (2013), $Z\text{-}score_2$ is calculated as:

$$Z_{it2} = (\mu(ROA_T) + EA_{it}) / \ \sigma(ROA_T)$$

where $T = 1,\ldots,t$, $\mu(ROA_T)$ represents the sample mean of ROA over period T. This version modifies $Z\text{-}score_2$ by computing the sample mean and sample standard deviation over the full sample horizon T. Both Z-score measures suggest that banks in resource-based countries experience higher profit volatility, as their scores are lower than those of banks in non-resource-based countries. For banks operating in resource rich country $Z\text{-}score_1$ is equal to 2.65 on average (3.12 for $Z\text{-}score_2$), compared with 3.00 (3.33 respectively) for banks in non-resource based countries .

The statistical analysis indicates that banks in resource-based countries are more profitable and better capitalised but also face higher risk and lower financial stability due to greater earnings volatility. This finding aligns with previous studies (Beck, 2011; Beck and Poelhekke, 2023).

3.3 The model

Our model examines the relationship between bank stability, captured by the above calculated Z-score and total natural resource rents. We incorporate banks' credit policies in addition as the literature suggests that banks in

[1] Also used in Köhler (2015) and Fosu et al. (2017).

resource-based countries tend to extend fewer loans (Beck, 2011; Beck & Poelhekke, 2017; Damette et al., 2023; Dwumfour & Ntow-Giamfy, 2018). Indeed, those authors indicate that banks not only distribute fewer loans overall but also tend to direct credit toward firms operating in the resource sector, as they are perceived as less risky. Therefore, including a measure of bank credit policy in our model helps us capture the extent of credit rationing and its effect on bank risk. The ratio of gross loans to total assets reflects the *bank asset mix* and a bank's propensity to extend credit, allowing us to assess how credit rationing affects risk exposure.

Furthermore, banks' stability is shaped by their business model, as evidenced by Demirgüç-Kunt and Huizinga (2010) and Köhler (2015). The business model defines how banks generate profits, the type of customers they serve, and the distribution channels they use. To capture these characteristics, we incorporate income and funding structures into our model. Specifically, some banks derive a larger share of revenue from non-interest income and/or rely more heavily on non-deposit funding for credit activities. The literature suggests that these business model differences impact banks' risk-taking behaviour. Banks with a higher proportion of non-interest income, up to a certain extent, may experience greater instability, as they are less dependent on interest income. We include the ratio of non-interest income to gross revenue in our model, to assess whether banks use this diversification strategy to maintain their financial stability. Conversely, banks with a significant share of non-deposit funding tend to be riskier, Shleifer and Vishny (2010). We consider the ratio of customer deposits to total funding as a measure of reliance on deposit funding.

Following Fosu et al. (2017) and Köhler (2015), we examine the relationship between bank risk, bank business models, credit policy, and our variable of interest: total natural resource rents. Additionally, we account for the marginal effect of total rents on the two aforementioned variables. This specification is relevant to our research question, as both the literature and descriptive statistics (see Table 1) suggest that resource rents may exert a marginal effect through bank business models and credit distribution. Therefore, we first consider the marginal effect of bank credit distribution as influenced by natural resources. Indeed, the literature on natural resources highlights low levels of financial development, limited credit to the economy, and weak banking intermediation due to fluctuations in commodity prices (Beck, 2011; Beck & Poelhekke, 2023). Especially, Damette et al. (2023) emphasise the difficulties firms face in accessing credit in resource-based countries. Then, we analyse the marginal effect of total rents on bank business models, through their interaction with the income and financing structure of banks. DeYoung and Torna (2013) have shown that despite the stabilising role of non-interest income, an excessively large share of this income can be a source of instability, as some of it may stem from volatile sources. They highlight that when non-interest income primarily comes from asset-based, non-traditional activities such as asset securitization and investment banking, it increases banks' fragility. Finally, we consider a three-way interaction between total rents, credit policy, and business model variables. Our three models for analysing the relationship between bank risk, resource rents, bank business models, and credit policy are as follows:

Model 1:

$$\ln(Risk_{i,j,t}) = \alpha_1 + \beta_1 TOTAL_RENTS_{j,t-1} + \beta_2 TOTAL_RENTS^2{}_{j,t-1} + \beta_3 LOANS_ASSETS_{i,j,t} + \beta_4 BUSINESS_MOD_{i,j,t} + \gamma_1 X_{i,j,t} + \delta_1 Z_{j,t} + \mu_j + \nu_t + \varepsilon_{i,j,t} \quad (1)$$

Model 2: Extends Model 1 by incorporating interaction terms between total resource rents, and bank business models, as well as between total resource rents and credit policy.

$$\ln(Risk_{i,j,t}) = \alpha_2 + \lambda_1 TOTAL_RENTS_{j,t-1} + \lambda_2 TOTAL_RENTS^2{}_{j,t-1} + \lambda_3 LOANS_ASSETS_{i,j,t} + \lambda_4 BUSINESS_MOD_{i,j,t} + \lambda_5 (BUSINESS_MOD_{i,j,t} * TOTAL_RENTS_{j,t-1}) + \lambda_6 (LOANS_ASSETS_{i,j,t} * TOTAL_RENTS_{j,t-1}) + \gamma_2 X_{i,j,t} + \delta_2 Z_{j,t} + u_j + w_t + e_{i,j,t} \quad (2)$$

Model 3: Builds on Model 2 by introducing triple interaction terms between total resource rents, bank business models, and credit policy.

$$\ln(Risk_{i,j,t}) = \alpha_3 + \theta_1 TOTAL_RENTS_{j,t-1} + \theta_2 TOTAL_RENTS^2{}_{j,t-1} + \theta_3 LOANS_ASSETS_{i,j,t} + \theta_4 BUSINESS_MOD_{i,j,t} + \theta_5 (BUSINESS_MOD_{i,j,t} * TOTAL_RENTS_{j,t-1}) + \theta_6 (LOANS_ASSETS_{i,j,t} * TOTAL_RENTS_{j,t-1}) + \theta_7 (BUSINESS_MOD_{i,j,t} * LOANS_ASSETS_{i,j,t} * TOTAL_RENTS_{j,t-1}) + \gamma_3 X_{i,j,t} + \delta_3 Z_{j,t} + \eta_j + \omega_t + \vartheta_{i,j,t} \quad (3)$$

Where:

$TOTAL_RENTS_{j,t-1}$ represents total natural resource rents as a percentage of GDP in country *j* at year $t-1$. $LOANS_ASSETS_{i,j,t}$ is the ratio of loans to total assets for bank *i* in country *j* at year *t*. $BUSINESS_MOD_{i,j,t}$ is a vector comprising two variables: the non-interest income share and the ratio of non-deposit funding to total assets for bank *i* in country *j* at year *t*. $X_{i,j,t}$ represents a set of bank-specific control variables. $Z_{j,t}$ represents a set of country-specific control variables. μ_j , u_j and η_j denotes country fixed effects. ν_t , w_t, and ω_t denotes year fixed effects. $\varepsilon_{i,j,t}$, $e_{i,j,t}$ and $\vartheta_{i,j,t}$ is the error term. Following Moulton (1990) the standard errors are clustered at the bank level.

About the resource rent variable

The literature on resource rents debates the appropriate proxies for measuring this variable. Some authors, such as Brunnschweiler and Bulte (2008), advocate for subsoil assets or proven reserves, while others, including Sachs and Warner (1995) and Beck (2011), favour resource exports as a share of GDP. We consider total natural resource rents as the sum of natural resources exports (oil, coal, gas, minerals and forests) as a share of GDP. To address endogeneity concerns, as recommended by Badeeb et al. (2017), and to maintain consistency with previous studies on the financial resource curse, we use the one-period lag of resource rents as a share of GDP. Additionally, these data are available for a broad range of countries and time periods, thus enhancing the robustness of our analysis.

Bank control variables

As previously mentioned, we include several control variables to account for both bank-specific characteristics. The first one is bank size, measured as the logarithm of the bank's total assets. Indeed, the banking industry benefits from economies of scale, which play a key role in cost reduction, diversification, and risk management. However, bank size may also have a negative impact on bank stability, which may seem counter intuitive but is well-documented in the literature. For example, Köhler (2015) and Boyd and Runkle (1993) suggest that larger banks are more likely to engage in risky behaviour, consistent with the "too big to fail" hypothesis. This risk-taking tendency offsets the benefits of risk diversification achieved through economies of scale.

Besides, we incorporate the ratio of total equity to total assets into our model to apprehend bank capitalisation. This measure captures how banks manage bankruptcy risk. According to financial theory, better capitalised banks are less risky, Demirgüç-Kunt and Huizinga (2010). Another bank specific variable in our model is the growth rate of total assets. Altunbas et al., 2011) suggest that rapidly growing banks tend to be more unstable and vulnerable to bankruptcy. This variable is particularly relevant to our analysis, given the volatility of resource windfalls received by banks. Finally, we incorporate the ratio of reserves for impaired loans to gross loans to account for credit risk exposure. As evidenced in the literature, higher credit risk exposure undermines bank stability and weakens risk management (Beck et al., 2013; Fosu, 2014; Mergaerts and Vennet, 2016).

Country control variables

A third set of variables is included in our model to account for country characteristics. We control for a country's level of development using GDP per capita, real GDP growth and the inflation rate[2] as they grasp macroeconomic health and fluctuations of the country. Country with higher level of development and a steady and strong growth will contribute in bank stability, by increasing their revenues and therefore capital buffers, Berger and Bouwman, 2009. Inflation has a negative impact on banks stability, as it may refer to some macroeconomic uncertainty, which could foster bank risk taking and translate into banking instability, Albertazzi et al.(2025).

We also include in our model concentration measured as the share of the three largest banks in each country, to capture the banking system structure. More concentrated banking systems tend to allow for economies of scale

[2] We consider both GDP per capita and GDP growth in regressions, as they capture two different ideas, consistently with Kohler (2015). However, our results are qualitatively the same, when we consider only one of them.

and greater diversification, which is in line with the specific of the banking industry. Ultimately, this may help maintain financial stability. However, large banks may also rely on the "too big to fail" hypothesis discussed earlier and take on greater risk, which could foster bank instability. We then include the real interest rate in our model. The literature indicates that lower real interest rates increase bank fragility by encouraging risk-taking behavior (Beck et al., 2008; Akinci et al., 2023).

Because banks in resource-based countries are often described in the literature as having restrictive credit policies, we include in our analysis two regulatory variables related to the credit distribution : strength of legal rights and depth of credit information indices. The first regulatory variable measures "the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending". A high value of this index indicates a strong propensity for banks to provide credit. The second regulatory variable is depth of credit information, which "measures rules affecting the scope, accessibility, and quality of credit information available through public or private credit registries".

Regarding the variables used in our model, Table 1 presents descriptive statistics for banks operating in both resource-based and non-resource-based countries. Overall, the variables exhibit greater dispersion in the former, supporting the idea that banks in resource-based countries experience higher volatility. The data suggest that, on average, loan distribution is lower in resource-based countries than in non-resource-based countries. Consequently, the share of non-interest income is higher, indicating that banks in resource-based countries compensate for lower interest revenue from credit by diversifying their income sources. Again, the share of customer deposits in total funding is lower, while asset growth is notably higher and more volatile, as reflected by its greater standard deviation. Moreover, the equity-to-assets ratio is higher, reinforcing the earlier observation that banks in resource-based countries tend to be better capitalised. Finally, reserves for impaired loans are also higher, implying an elevated perceived risk among these banks. Descriptive statistics for country-specific variables, as well as the correlation matrices, are reported in Appendix Table B and Table C.

Table 1: Descriptive statistics of bank-level variables used in our model as control variables

Panel A : Resource-based countries

Variable	Obs	Mean	Std. Dev.	Min	Max
Gross loans / Assets	17065	.57***	.23	.00	.99
Non-interest income/ Gross revenues	17228	.44***	.27	0	1.2
Non deposits funding/ Total funding	16225	34.56***	33.07	0	99.92
Total assets (log)	17311	.19***	.02	.15	.27
Asset growth	16115	.17***	.31	-.41	1.45
Equity / Assets	17307	19.47***	17.17	.36	95.72
Z-score (log)	15848	2.65***	.95	-.19	4.99

Panel B: Non-resource-based countries

Variable	Obs	Mean	Std. Dev.	Min	Max
Gross loans / Assets	48907	.58	.23	.00	.99
Non-interest income/ Gross revenues	49782	.32	.24	0	1.2
Non deposits funding/ Total funding	46341	23.22	24.75	0	99.92
Total assets (log)	50606	.20	.02	.15	.27
Asset growth	47621	.10	.23	-.41	1.45
Equity / Assets	50371	14.33	16.31	.36	95.72
Z-score (log)	46267	3.00	.96	-.18	5.01

Note: *** indicates significance at the 0.01 level for the mean comparison test.

3.3. Results

Our first model includes variables related to the bank business model and credit policy, along with control variables that capture both bank- and country-level characteristics. The latter help account for the broader environment in which banks operate, as this context influences their risk-taking behaviour.

Results from Model 1 (Table 2) indicate that total resource rents positively affect bank stability, measured by the Z-score. Banks serve as financial intermediaries for channelling natural resource windfalls, holding deposits for

companies engaged in resource exports, which increases their liquidity. This abundance of liquidity favours bank stability, representing the initial effect of resource windfalls. However, the coefficient for the squared term of total rents is negative, suggesting that beyond a certain threshold, a higher share of natural resources in GDP negatively impacts bank stability. Combining the two coefficients, the squared variable is overall higher, indicating that the negative effect dominates beyond a specific threshold of natural resource windfalls.

The variable measuring banks' propensity to provide credit is positively associated with stability, implying that banks issuing more loans tend to be more stable. This finding aligns with the literature, which highlights that lending activity involves information collection, thereby improving the management of default risk, Freixas (2005).

Variables related to the business models have some slight positive impacts on risk. A greater share of non-interest income is linked to higher stability and lower risk. This reflects the benefits of income diversification, particularly through fee-based, non-traditional activities (Altunbas et al., 2011; DeYoung & Torna, 2013). Again, the coefficient of the ratio of non-deposit funding to total funding, is positive and close to zero, when significant suggesting that managing risk through funding diversification barely improve bank stability in our sample.

Finally, an interesting result worth mentioning is that the introduction of regulatory variables dampens the negative impact of the squared total rents variable. Especially, the coefficient on the strength of legal rights is negative, which is counter-intuitive, as it suggests that a stronger propensity to extend credit increases financial instability. However, this result may be associated with the abundance of resource windfalls on banks' balance sheets. Indeed, such a phenomenon has been observed during periods of large capital inflows through the banking systems of countries prior to crises, such as the Asian financial crisis of 1997 and the subprime crisis of 2008. Such a financial position may increase bank fragility in a regulatory environment that favors credit expansion.

Model 2 builds upon the specification of Model 1 by integrating, on the one hand, the interactions of the total rents term with the variable related to bank credit policy (measured by the ratio of gross loans to total assets) and, on the other hand, variables related to the bank business model. Overall, the coefficients of the control variables are qualitatively consistent with those displayed in Model 1.

As for the marginal effects, the negative coefficient of the interaction term between total rents and the ratio of gross loans to total assets indicates that a higher loan ratio negatively impacts bank stability. This result is consistent with the behaviour of banks in resource-based countries, which tend to ration credit. This credit rationing serves as a risk management strategy: the more banks reduce credit to the economy, the better they can manage financial stability. Several studies corroborate this trend in banking intermediation in resource-based countries. For example, Dwumfour and Ntow-Giamfy (2018) and Eberhardt and Presbitero (2021) highlight the challenges banks face in managing risk due to natural resource price volatility.

Regarding the marginal effect with bank business models, the coefficient of the interaction term between total rents and non-interest income is non-significant indicating that no marginal effects go through this risk strategy diversification. However, the marginal effect of total rents through the share of non-deposits funding is slightly positive, suggesting that a dampening impact of resource rents, although weak, goes through this channel.

Overall, to fully assess the impact of natural resources on bank stability, we must sum the coefficients on total rents, the squared term, and the marginal effects of the interaction terms. The coefficients of the business model interaction terms are either positive or non-significant and substantially smaller than the coefficient of the credit policy interaction term, implying an overall negative effect, even after accounting for the combined effect of total rents and its squared term. Thus, our findings show that the negative impact of natural resources on bank stability materializes only beyond a certain threshold and is further shaped by banks' business models and credit policy choices, both of which being closely related to their risk management strategies. Consequently, this model highlights the channels through which natural resources may act as a catalyst for banking instability.

Table 2: Model 1

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total rents (t − 1)	-0.0181	0.550***	0.802***	0.685***	0.642***	0.936***	0.906***	0.804***	0.694***
	(0.104)	(0.109)	(0.126)	(0.132)	(0.134)	(0.181)	(0.199)	(0.185)	(0.200)
Square total rents (t − 1)	0.352	-0.574**	-0.861***	-0.595**	-0.602**	-0.980***	-1.113***	-0.441	-0.456
	(0.217)	(0.223)	(0.237)	(0.247)	(0.247)	(0.322)	(0.329)	(0.310)	(0.335)
Gross loans / Assets	0.159***	0.155***	0.155***	0.159***	0.161***	0.115***	0.152***	0.0861**	0.0934*
	(0.0238)	(0.0239)	(0.0241)	(0.0244)	(0.0244)	(0.0283)	(0.0383)	(0.0362)	(0.0491)
Non-interest income/ Gross revenues	0.0293*	0.0431***	0.0426***	0.0426***	0.0420**	0.000983	-0.0137	0.0149	0.0145
	(0.0161)	(0.0162)	(0.0163)	(0.0163)	(0.0163)	(0.0199)	(0.0247)	(0.0233)	(0.0272)
Non deposits Funding / Total funding	-4.49e-05	5.81e-05	0.000133	0.000182	0.000158	0.000337**	-0.000251	0.000297	1.59e-05
	(0.000143)	(0.000144)	(0.000148)	(0.000149)	(0.000150)	(0.000163)	(0.000243)	(0.000194)	(0.000283)
Total assets (log)	1.238**	-0.414	-0.423	-0.0552	-0.0225	1.879**	2.576***	4.954***	5.138***
	(0.562)	(0.581)	(0.661)	(0.687)	(0.687)	(0.754)	(0.869)	(0.896)	(0.986)
Asset growth	0.0331***	0.0382***	0.0420***	0.0403***	0.0391***	0.0338***	0.0246*	0.0271**	0.0163
	(0.00898)	(0.00901)	(0.00907)	(0.00909)	(0.00909)	(0.0107)	(0.0127)	(0.0132)	(0.0159)
Equity / Assets	0.0377***	0.0378***	0.0378***	0.0379***	0.0379***	0.0368***	0.0352***	0.0375***	0.0363***
	(0.000730)	(0.000745)	(0.000750)	(0.000755)	(0.000754)	(0.000813)	(0.000935)	(0.000965)	(0.00114)
Gdp_c (t-1)				-0.0852***	-0.0774***	-0.0842**	-0.0917**	-0.191***	-0.190***
				(0.0265)	(0.0266)	(0.0327)	(0.0458)	(0.0468)	(0.0609)
Inflation (t-1)					0.000660*	0.000382	0.00162	0.00226***	0.000832
					(0.000356)	(0.000549)	(0.00102)	(0.000783)	(0.00107)
Interest rate (t-1)						-0.0295	0.000538	0.129	0.0199
						(0.0655)	(0.112)	(0.0859)	(0.119)
Depth of credit information								-0.173	-0.116
								(0.190)	(0.224)
Legal rights								-0.934***	-0.729***
								(0.197)	(0.236)
Concentration							-0.00191***		-0.00106***
							(0.000303)		(0.000319)

Constant	1.945***	1.459***	1.446***	1.905***	1.848***	1.560***	1.582***	1.686***	1.702***
	(0.124)	(0.201)	(0.209)	(0.246)	(0.247)	(0.277)	(0.353)	(0.357)	(0.440)
Observations	59,750	59,750	59,750	59,509	59,496	40,647	28,447	27,195	20,508
Number of Banks	7,381	7,381	7,381	7,347	7,337	5,626	5,446	5,363	5,215
Country FE	NO	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	NO	NO	YES	YES	YES	YES	YES	YES	YES
R_squared	0.00173	0.266	0.266	0.263	0.264	0.277	0.281	0.294	0.295

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 3: Model 2

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total rents (t-1)	0.538**	1.150***	1.372***	1.249***	1.225***	1.243***	1.056***	1.299***	0.847
	(0.248)	(0.252)	(0.259)	(0.263)	(0.264)	(0.336)	(0.385)	(0.458)	(0.537)
Square total rents (t-1)	0.408*	-0.553**	-0.841***	-0.554**	-0.568**	-0.966***	-1.034***	-0.543	-0.330
	(0.234)	(0.233)	(0.245)	(0.255)	(0.254)	(0.334)	(0.339)	(0.343)	(0.381)
Gross loans / Assets	0.246***	0.245***	0.243***	0.250***	0.251***	0.202***	0.212***	0.187***	0.164***
	(0.0289)	(0.0290)	(0.0293)	(0.0297)	(0.0297)	(0.0385)	(0.0475)	(0.0512)	(0.0594)
Non-interest income/ Gross revenues	0.0275	0.0412**	0.0380*	0.0367*	0.0370*	-0.0352	-0.0367	-0.00781	-0.00767
	(0.0202)	(0.0203)	(0.0204)	(0.0204)	(0.0204)	(0.0261)	(0.0317)	(0.0303)	(0.0347)
Non deposits Funding / Total funding	-0.000945***	-0.000799***	-0.000739***	-0.000704***	-0.000699***	-0.000455*	-0.000829***	-0.000741**	-0.00111***
	(0.000232)	(0.000233)	(0.000235)	(0.000237)	(0.000236)	(0.000272)	(0.000320)	(0.000329)	(0.000370)
Total assets (log)	1.248**	-0.435	-0.493	-0.0941	-0.0640	1.838**	2.655***	4.858***	5.175***
	(0.562)	(0.582)	(0.661)	(0.687)	(0.687)	(0.759)	(0.870)	(0.890)	(0.979)
Asset growth	0.0316***	0.0368***	0.0408***	0.0389***	0.0378***	0.0332***	0.0229*	0.0267**	0.0140
	(0.00896)	(0.00900)	(0.00906)	(0.00907)	(0.00907)	(0.0107)	(0.0126)	(0.0131)	(0.0157)
Equity / Assets	0.0377***	0.0378***	0.0378***	0.0379***	0.0379***	0.0368***	0.0353***	0.0376***	0.0364***
	(0.000733)	(0.000747)	(0.000753)	(0.000757)	(0.000757)	(0.000818)	(0.000943)	(0.000970)	(0.00116)
(Total rents(t-1))*(Gross loans / Assets)	-1.412***	-1.455***	-1.427***	-1.451***	-1.451***	-1.153***	-0.832*	-1.373**	-1.123
	(0.315)	(0.316)	(0.318)	(0.321)	(0.321)	(0.391)	(0.478)	(0.565)	(0.728)
(Total rents(t-1))*(Non interest income/	-0.189	-0.168	-0.132	-0.114	-0.120	0.437	0.304	0.176	0.200
Gross revenues)	(0.206)	(0.209)	(0.209)	(0.209)	(0.209)	(0.269)	(0.272)	(0.347)	(0.362)
(Total rents(t-1))*(Non deposits Funding /	0.0109***	0.0103***	0.0105***	0.0107***	0.0104***	0.00747***	0.00664**	0.0111***	0.0136***
Total funding)	(0.00201)	(0.00202)	(0.00203)	(0.00204)	(0.00205)	(0.00228)	(0.00270)	(0.00281)	(0.00354)
Gdp_c(t-1)				-0.0923***	-0.0855***	-0.0936***	-0.101**	-0.191***	-0.185***
				(0.0264)	(0.0266)	(0.0326)	(0.0458)	(0.0467)	(0.0611)
Inflation (t-1)					0.000563	0.000437	0.00169*	0.00249***	0.00144
					(0.000344)	(0.000545)	(0.00102)	(0.000786)	(0.00109)
Interest rate (t-1)						0.0149	0.0473	0.171**	0.114

						(0.0657)	(0.114)	(0.0858)	(0.122)
Depth of credit information								-0.175	-0.0638
								(0.192)	(0.225)
Legal rights								-0.681***	-0.483**
								(0.194)	(0.239)
Concentration							-0.00172***		-0.000873***
							(0.000303)		(0.000321)
Constant	1.916***	1.448***	1.445***	1.943***	1.892***	1.618***	1.608***	1.666***	1.614***
	(0.127)	(0.202)	(0.210)	(0.247)	(0.248)	(0.279)	(0.355)	(0.358)	(0.444)
Observations	59,750	59,750	59,750	59,509	59,496	40,647	28,447	27,195	20,508
Number of BankID	7,381	7,381	7,381	7,347	7,337	5,626	5,446	5,363	5,215
Country FE	NO	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	NO	NO	YES	YES	YES	YES	YES	YES	YES
R-squared	0.00216	0.267	0.267	0.265	0.265	0.279	0.282	0.296	0.297

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Finally, we consider Model 3, which extends Model 2 by incorporating a three-way interaction between total rents, credit policy, and business model variables. The results are consistent with Model 2, and the coefficients associated with the three-way interaction terms are not statistically significant. Once again, when considering the sum of the coefficients on total rents, the squared term, and the two-way interaction terms, the negative effect remains dominant. Indeed, the business model–based risk management strategies adopted by banks barely dampen the instability stemming from total rents; they do not eliminate it entirely.

Ultimately, the destabilising effect of natural resources manifests through their credit policy. It is also worth noting that when we control for the regulatory environment by introducing the depth of credit information and strength of legal rights indices, we observe in columns 8 and 9 of Tables 3 and 4 that the negative impact of the square of total rents is non-significant (especially when controlling for banking system concentration), although the interaction terms between credit policy and total rents remain negative and significant. This suggests that the negative effect of natural resources tends to be mitigated by regulatory variables, which aim to reduce information asymmetry in the credit market and protect lenders' and borrowers' rights. Once again, this finding supports the argument that credit rationing by banks in resource-based countries is a response to the instability and risk induced by natural resource windfalls.

Table 4: Model 3

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total rents (t-1)	0.727**	1.403***	1.614***	1.482***	1.460***	1.522***	1.113**	1.811***	1.281*
	(0.295)	(0.299)	(0.304)	(0.309)	(0.310)	(0.398)	(0.497)	(0.563)	(0.740)
Square total rents (t-1)	0.385	-0.585**	-0.868***	-0.581**	-0.594**	-0.977***	-1.021***	-0.615*	-0.402
	(0.236)	(0.235)	(0.247)	(0.257)	(0.256)	(0.335)	(0.346)	(0.348)	(0.392)
Gross loans / Assets	0.245***	0.244***	0.242***	0.249***	0.250***	0.202***	0.213***	0.186***	0.160***
	(0.0288)	(0.0289)	(0.0292)	(0.0295)	(0.0295)	(0.0380)	(0.0456)	(0.0501)	(0.0564)
Non-interest income/ Gross revenues	0.0258	0.0388*	0.0356*	0.0343*	0.0345*	-0.0378	-0.0383	-0.0105	-0.00778
	(0.0204)	(0.0205)	(0.0205)	(0.0206)	(0.0205)	(0.0262)	(0.0320)	(0.0305)	(0.0355)
Non deposits Funding / Total funding	-0.000956***	-0.000813***	-0.000752***	-0.000716***	-0.000710***	-0.000468*	-0.000828***	-0.000764**	-0.00115***
	(0.000232)	(0.000233)	(0.000235)	(0.000237)	(0.000237)	(0.000272)	(0.000317)	(0.000329)	(0.000366)
Total assets (log)	1.244**	-0.441	-0.499	-0.0996	-0.0692	1.822**	2.665***	4.810***	5.136***
	(0.562)	(0.582)	(0.661)	(0.687)	(0.687)	(0.759)	(0.866)	(0.887)	(0.972)
Asset growth	0.0318***	0.0371***	0.0411***	0.0392***	0.0382***	0.0336***	0.0230*	0.0278**	0.0146
	(0.00897)	(0.00901)	(0.00906)	(0.00908)	(0.00908)	(0.0107)	(0.0126)	(0.0133)	(0.0157)
Equity / Assets	0.0377***	0.0378***	0.0378***	0.0379***	0.0379***	0.0368***	0.0353***	0.0375***	0.0364***
	(0.000732)	(0.000747)	(0.000752)	(0.000757)	(0.000757)	(0.000817)	(0.000940)	(0.000966)	(0.00115)
(Total rents(t-1))*(Gross loans / Assets)	-1.745***	-1.900***	-1.857***	-1.864***	-1.868***	-1.644***	-0.952	-2.214***	-1.858*
	(0.431)	(0.431)	(0.432)	(0.438)	(0.438)	(0.539)	(0.724)	(0.763)	(1.114)
(Total rents(t-1))*(Non interest income/	-0.431	-0.492	-0.458	-0.443	-0.458	0.0875	0.171	-0.325	-0.0799
Gross revenues)	(0.317)	(0.321)	(0.320)	(0.321)	(0.321)	(0.423)	(0.399)	(0.485)	(0.476)
(Total rents(t-1))*(Non deposits Funding /	0.00953**	0.00853**	0.00896**	0.00952**	0.00929**	0.00583	0.00716	0.00578	0.00827
Total funding)	(0.00373)	(0.00376)	(0.00377)	(0.00382)	(0.00381)	(0.00447)	(0.00542)	(0.00557)	(0.00722)
(Total rents(t-1))*(Gross loans / Assets)*	0.00221	0.00289	0.00237	0.00169	0.00152	0.00252	-0.00122	0.00894	0.0103
(Non deposits Funding/ Total funding)	(0.00595)	(0.00598)	(0.00598)	(0.00605)	(0.00605)	(0.00710)	(0.00984)	(0.00909)	(0.0139)

(Total rents(t-1))*(Gross loans / Assets)*	0.500	0.673	0.683	0.697	0.717	0.705	0.311	0.902	0.418
(Non-interest income/ Gross revenues)	(0.575)	(0.580)	(0.579)	(0.581)	(0.581)	(0.711)	(0.778)	(0.806)	(0.958)
Gdp_c (t-1)				-0.0916***	-0.0847***	-0.0918***	-0.102**	-0.187***	-0.183***
				(0.0264)	(0.0266)	(0.0326)	(0.0457)	(0.0465)	(0.0610)
Inflation (t-1)					0.000566	0.000434	0.00169*	0.00245***	0.00144
					(0.000344)	(0.000545)	(0.00102)	(0.000786)	(0.00109)
Interest rate (t-1)						0.0133	0.0470	0.167*	0.115
						(0.0657)	(0.114)	(0.0857)	(0.122)
Depth of credit information								-0.166	-0.0483
								(0.192)	(0.226)
Legal rights								-0.691***	-0.481**
								(0.194)	(0.239)
Concentration							-0.00172***		-0.000882***
							(0.000303)		(0.000321)
Constant	1.918***	1.451***	1.447***	1.941***	1.889***	1.611***	1.612***	1.649***	1.610***
	(0.127)	(0.202)	(0.210)	(0.247)	(0.248)	(0.279)	(0.355)	(0.358)	(0.444)
Observations	59,750	59,750	59,750	59,509	59,496	40,647	28,447	27,195	20,508
Number of Bank ID	7,381	7,381	7,381	7,347	7,337	5,626	5,446	5,363	5,215
Country FE	NO	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	NO	NO	YES	YES	YES	YES	YES	YES	YES
R_squared	0.00214	0.268	0.268	0.265	0.265	0.279	0.283	0.296	0.298

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

3.4. Robustness checks

We conduct several robustness checks to validate our findings, drawing from the literature on both the resource curse and bank stability.

Outliers

We begin by removing outliers from our sample: i.e. countries with total rents exceeding 50% and then 40% (Table B.1 in the Online Appendix (OA)). Even after excluding these cases, the baseline models (1, 2, and 3) remain consistent with our previous findings. Our results continue to show that natural resource rents negatively impact bank stability after a certain threshold. Additionally, banks' credit policies are characterised by credit rationing as a risk management strategy. Furthermore, we find the same pattern for the two-way and three-way interaction terms, whose sum with the coefficients on total rents and the square of total rents remains negative. Therefore previous conclusions are not driven by countries with total rents above 40% or 50%.

Placebo test

Conversely, we conduct a placebo test to determine whether banks operating in countries with low total rents (less than 5%) experience the same counter-effects on their business models and/or adopt the same credit policies. Table 5 shows no negative signs for the "squared total rents variable" and the absolute term is non-significant. Again, the coefficients associated with credit policy and non-deposit funding are non-significant. However, the coefficient of the share of non-interest income in total revenue is negative. This may indicate that an excessive reliance on non-interest income contributes to instability, consistent with the findings from DeYoung and Torna (2013).

Heterogeneity test

Third, natural resources vary by type. In line with the resource curse literature, we test our baseline models (1, 2, and 3) separately for oil, gas, coal, and minerals (Table B.2 in OA). Results are largely consistent with the original model using total rents. When considering the sum of the coefficients on total rents, the square of total rents, and the two-way and three-way interaction terms, the negative effect dominates, implying an overall negative impact of total rents on bank stability.

Alternative measures of total rents

Lastly, we test the robustness of our results based on different definitions of the total rents variable. Given the high volatility of natural resource prices, the literature proposes various calculation methods to assess how well they align with the original model. Here, we consider the economic weight associated with each of the five resource rents. The four alternative measures of resource rents are as follows:

- *Resource rents (mean $t-3$ to $t-1$)*: For each country *j*, this represents the average value of resource rents over the three years preceding survey year *t.*
- *Resource rents (mean $t-5$ to $t-1$)*: For each country *j*, this represents the average value of resource rents over the five years preceding survey year *t.*
- *Resource rents ($t-1$ fixed weights)*: For each country *j*, this corresponds to the weighted average (over the period 2011 to 2022) of each type of natural resource rent as a share of GDP, relative to total rents share in the previous year ($t-1$).
- *Resource rents ($t-1$ time-varying weights)*: For each country *j*, this reflects the weight of each natural resource for year *t*, relative to total rents share in the previous year ($t-1$).

Again, our results (Table B.3 in OA) remain roughly consistent with the main findings across Models 1, 2, and 3. Regardless of the definition of total rents, the conclusions of our model hold. The only exception concerns resource rents (mean from t–5 to t–1), for which the squared term is not statistically significant. Nevertheless, the sum of all significant coefficients associated with resource rents remains negative.

Alternative measure of Z-score

The second group of robustness tests is based on the bank stability-risk literature. As an alternative, we use a different measure of the Z-score for our dependent variable, as proposed by Lepetit and Strobel (2013). The results are presented in the first three columns of Table 6, and they remain consistent with those obtained using the traditional Z-score.

Table 5: Placebo test

VARIABLES	(1)	(2)	(3)
Total rents (t-1)	20.88	37.78	51.10
	(33.64)	(34.84)	(37.20)
Square total rents (t-1)	-2,540	-3,196	-3,331
	(4,410)	(4,420)	(4,424)
Gross loans / Assets	0.256***	0.260***	0.259***
	(0.0678)	(0.0682)	(0.0682)
Non-interest income/ Gross revenues	0.0458	0.0602	0.0601
	(0.0514)	(0.0514)	(0.0512)
Non deposits Funding / Total funding	-0.00213***	-0.00218***	-0.00220***
	(0.000649)	(0.000653)	(0.000655)
Total assets (log)	1.790	1.606	1.632
	(2.169)	(2.172)	(2.168)
Asset growth	-0.0731***	-0.0723**	-0.0722**
	(0.0283)	(0.0283)	(0.0283)
Equity / Assets	0.0415***	0.0415***	0.0415***
	(0.00301)	(0.00301)	(0.00301)
(Total rents(t-1))*(Gross loans / Assets)		-7.432	-33.76
		(9.429)	(23.74)
(Total rents(t-1))*(Non interest income/ Gross revenues)		-40.23***	-59.06**
		(8.458)	(26.57)
(Total rents(t-1))*(Non deposits Funding / Total funding)		0.0844	-0.0390
		(0.0535)	(0.0625)
(Total rents(t-1))*(Gross loans / Assets)*(Non deposits Funding/ Total funding)			0.340*
			(0.178)
(Total rents(t-1))*(Gross loans / Assets)*(Customer deposits / Total funding)*(Non-interest income/ Gross revenues)			41.87
			(48.46)
Constant	2.254***	7.155	2.282***
	(0.518)	(7.739)	(0.518)
Observations	11,406	11,406	11,406
Number of BankID	2,146	2,146	2,146
Country FE	YES	YES	YES
Year FE	YES	YES	YES
R_squared	0.153	0.153	0.153

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Decomposing Z-score into risk-adjusted profits and risk-adjusted capital

Following Köhler (2015), we further test the robustness of our results by considering as dependent variable for model 1, 2 and 3 risk-adjusted profits (Z_ROA) and risk-adjusted capital (Z_EA), which decomposes the traditional Z-score. The results for Z_ROA are displayed in columns 4 to 6 and in columns 7 to 9 for Z_EA of Table 6. Again, we observe that the results remain qualitatively the same. Indeed, the same pattern highlighted in Tables 2 to 4 emerges: Both risk-adjusted profits and risk-adjusted capital are negatively impacted by natural resource rents. However, for risk-adjusted capital, the negative impact of the squared total rents variable disappears but the sum of coefficients related to total rents, the square of total rents, and the two-way interaction terms is negative, still consistent with our original conclusion.

Table 6: Robustness tests with alternative measures of risk

	Z-score			Z_ROA			Z_EA		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total rents (t-1)	2.628***	3.045***	3.450***	2.026***	2.789***	2.603***	0.419***	0.653***	0.767***
	(0.392)	(0.570)	(0.802)	(0.397)	(0.602)	(0.713)	(0.106)	(0.236)	(0.255)
Square total rents (t-1)	-2.138***	-1.579**	-1.663**	-2.140***	-2.169***	-2.144**	-0.155	-0.135	-0.136
	(0.801)	(0.782)	(0.779)	(0.804)	(0.840)	(0.844)	(0.196)	(0.205)	(0.208)
Gross loans / Assets	0.183***	0.353***	0.333***	0.205***	0.335***	0.337***	0.175***	0.223***	0.233***
	(0.0545)	(0.0580)	(0.0615)	(0.0520)	(0.0626)	(0.0630)	(0.0224)	(0.0271)	(0.0253)
Non-interest income/ Gross revenues	-0.268***	-0.302***	-0.307***	0.389***	0.359***	0.360***	0.00519	-0.00297	-0.00270
	(0.0454)	(0.0495)	(0.0493)	(0.0466)	(0.0584)	(0.0590)	(0.0137)	(0.0165)	(0.0163)
Non deposits funding / Total funding	0.00203***	-0.00128**	-0.00131***	-0.00176***	-0.00306***	-0.00305***	8.70e-05	-0.000460**	-0.000461**
	(0.000369)	(0.000503)	(0.000504)	(0.000366)	(0.000503)	(0.000504)	(0.000131)	(0.000218)	(0.000219)
Total assets (log)	10.49***	10.54***	10.49***	10.08***	10.22***	10.23***	-3.029***	-3.150***	-3.123***
	(1.020)	(1.002)	(1.001)	(0.832)	(0.831)	(0.831)	(0.667)	(0.668)	(0.669)
Asset growth	-0.0830***	-0.0921***	-0.0918***	0.344***	0.342***	0.341***	-0.0212***	-0.0223***	-0.0220***
	(0.0211)	(0.0209)	(0.0209)	(0.0237)	(0.0238)	(0.0238)	(0.00668)	(0.00668)	(0.00668)
Equity / Assets	0.0373***	0.0372***	0.0372***	0.0177***	0.0178***	0.0178***	0.0383***	0.0383***	0.0383***
	(0.00134)	(0.00132)	(0.00132)	(0.00121)	(0.00121)	(0.00121)	(0.000758)	(0.000758)	(0.000760)
(Total rents(t-1))*(Gross loans / Assets)		-2.790***	-3.474***		-2.217***	-1.899**		-0.749**	-0.947**
		(0.516)	(1.158)		(0.622)	(0.933)		(0.297)	(0.379)
(Total rents(t-1))*(Non interest income/		-0.218	-0.391		0.259	0.406		0.0277	-0.201
Gross revenues)		(0.569)	(0.830)		(0.563)	(0.804)		(0.172)	(0.250)
(Total rents(t-1))*(Non deposits Funding/		0.0410***	0.0299***		0.0150***	0.0176**		0.00637***	0.00876***
Total funding)		(0.00506)	(0.00782)		(0.00494)	(0.00821)		(0.00186)	(0.00301)
(Total rents(t-1))*(Gross loans / Assets)*			0.0200*			-0.00480			-0.00455
(Non deposits Funding / Total funding)			(0.0107)			(0.0120)			(0.00443)
(Total rents(t-1))*(Gross loans / Assets)*			0.267			-0.259			0.470
(Non interest income/ Gross revenues)			(1.387)			(1.475)			(0.452)
Constant	0.305	0.295	0.312	-2.773***	-2.813***	-2.815***	1.884***	1.904***	1.896***

	(0.308)	(0.308)	(0.308)	(0.268)	(0.269)	(0.269)	(0.205)	(0.206)	(0.206)
Observations	58,230	58,230	58,230	53,531	53,531	53,531	60,175	60,175	60,175
Number of BankID	7,366	7,366	7,366	7,161	7,161	7,161	7,390	7,390	7,390
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.246	0.251	0.252	0.156	0.159	0.159	0.293	0.294	0.294

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Endogeneity issue with instrumental variables

To further mitigate potential endogeneity concerns, we complement our baseline specification, which includes the lagged values of total rents and the square of total rents, with an instrumental variable (IV) strategy as a robustness check. This approach allows us to assess whether our core results are robust to an alternative identification strategy. We use international commodity price, drawn from the IMF's Primary Commodity Price Database, as instrument as well as countries' endowments in natural resources, from the World Bank's Natural Capital Data Hub. Commodity price index is a composite index for both fuel and non-fuel commodities. The composite price index is a valid instrument, because while changes in global commodity prices affect total rents, they do not directly affect bank stability. Again, resource endowments are specific to country; although they influence total rents, they are not directly related to bank stability. Indeed, there is no direct link between commodity price shocks (or resource endowments) and bank stability. Specifically, we instrument total rents and its squared term using the lagged values of commodity price index (t-3 to t-1) and its squared terms (t-2 to t-1). We also include the interaction term between endowment and commodity prices. The IV estimates are roughly consistent with those obtained in the baseline models 1, 2, and 3. The sum of the coefficients associated with total rents remains negative, reinforcing our main findings. The marginal effects of total rents associated with business model variables are statistically non-significant, thereby confirming that, in the presence of natural resources, neither income diversification nor funding diversification strategies attenuate the adverse effect of total rents on bank stability.(see Table B.4 in the Online Appendix).

Controlling for bank types

We conducted additional robustness checks by incorporating bank types into our three baseline models (Table B.5 in the OA).[3] Our findings here remain consistent with the main results. We also re-estimate our baseline regression models both with and without Islamic banks, given that several oil-exporting countries include Islamic banks in their financial systems. The results remain qualitatively the same, further confirming the robustness of our conclusions.

Changing the sample

Furthermore, we test the robustness of our results by considering different sample sizes based on the total number of banks per country. Specifically, we analyse samples where the number of banks per country ranges first between 4 and 100, as in Beck (2011), then between 4 and 150, and finally 4 and 200. The results remain qualitatively unchanged across all sample variations. Additionally, we exclude OECD countries then high-income countries from our sample to test whether our results depend on sample composition. Again, our results still hold, indicating that our findings are independent of the sample choice.

3.5. Discussion

Previous studies on the financial resource curse have highlighted the adverse effects of resource rents on banking aggregates (Beck, 2011; Beck & Poelhekke, 2017; Kinda et al., 2016; Mlachila & Ouedraogo, 2017). These studies indicate that resource rents contribute to increased banking fragility, reduced banking intermediation, and slower financial development in resource-based countries.

Our study complements this literature by emphasizing the role of internal bank factors in the financial resource curse. Using a bank risk model that incorporates bank credit policies and business models, we provide deeper insights into the issue. Our findings suggest that resource rents negatively impact bank stability by influencing credit policies. Specifically, banks restrict credit in economies with high resource rents as a risk-mitigation strategy. This may be because they perceive firms outside of the resource sector as riskier, thereby leading to a concentration of lending in the resource sector, which appears more stable compared to non-booming industries. This credit allocation pattern contributes to the stagnation of other sectors, Damette et al (2023).

[3] In Table B4 of the online appendix and for our original sample, we consider a narrow definition of commercial banks and distinguish three types: retail banks, universal commercial banks, and wholesale commercial banks. We also conduct robustness checks using a broader definition of commercial banks, adding credit unions, private banks, and trading and investment banks. The results are not displayed for the sake of brevity, however they are consistent with our baseline models.

In our study bank business model mitigates banking instability through the marginal effect operating via non-deposit funding. However, the positive impact of this financial structure diversification, is not sufficiently strong to offset the negative marginal effects associated with resource rents. in resource-based countries, bank deposits largely originate from natural resource export revenues, and diversification of banks' funding structures through non-deposit financing is not sufficient to offset the adverse effects of resource rents. As a result, banks in these economies are particularly vulnerable to the "curse" associated with natural resource price volatility. This relative fragility persists regardless of their business model.

From an income-generation perspective, this relative fragility still persists irrespective of the share of non-interest income. Our findings suggest that, in response to fluctuations in natural resource rents, banks in resource-based countries become increasingly fragile. While, in theory, a higher share of non-interest income contributes to greater bank stability, this effect does not necessarily hold in resource-based countries (Eberhardt & Presbitero, 2021 and Van der Ploeg & Poelhekke, 2009). Indeed, the marginal effects of resource rents through non-interest income remain statistically insignificant in attenuating the adverse impact of resource rents. This finding suggests greater instability among banks operating in resource-based economies.

Moreover, the financial sector's failure to reallocate resource windfalls to firms in non-resource sectors prevents banks from exercising their expertise in credit distribution. Consequently, banks are unable to fulfil their role as financial intermediaries, which involves assessing firms' investment potential and using this criterion for credit allocation. As a result, the financial system remains underdeveloped, as its fundamental function—mobilising deposits for credit allocation—is not effectively carried out in practice. To summarize, our model helps explain why natural resources contribute to financial instability, credit rationing, and weak financial system development.

4. Concluding remarks

In this study, we construct a micro–macro dataset combining bank- and country-level data to examine how banks respond to resource rents. We build on the model developed by Fosu et al. (2017) and Köhler (2015), which incorporates banks' business models, and extend it by introducing a resource rents variable as well as a credit policy variable. This framework allows us to capture not only the direct impact of resource rents on bank stability, but also how resource rents interact with banks' credit allocation and diversification strategies as reflected in their business models.

Our model indicates that resource rents serve as a funding source for banks in resource-based countries. However, beyond a certain threshold, total resource rents negatively impact bank stability, as evidenced by the negative coefficient of the squared total rents variable. Furthermore, our findings highlight that, in the presence of resource rents, the bank business model slightly dampens the negative impact of resource rents. Indeed, the marginal effect of resource rents associated with credit policy is stronger than that operating through income and funding diversification. These results indicate that, unlike banks in other countries, the business model is not a strong means of reducing risk exposure. Resource rents increase bank instability in resource-based countries; despite the mitigating role of income and funding diversification strategies. This explains why banking system instability is more pronounced in resource-based countries than in non-resource-based countries, thus contributing to broader financial instability in these economies.

Additionally, our results show that resource rents negatively affect banks' credit policies, leading to credit rationing in resource-based economies. While this aligns with previous literature, our study adds to the explanation by identifying credit rationing as a risk-mitigation response by banks. By limiting credit distribution, banks fail to fully exercise their expertise as financial intermediaries, resulting in an atrophied banking sector in resource-based countries and thus a less developed financial system overall, as measured by banking aggregates (Beck, 2011). Moreover, our study complements Damette et al. (2023) by explaining why firms in resource-based countries receive less credit from banks.

Our findings further support the idea that when credit information systems are robust and borrowers' and lenders' rights are protected, the negative impact of resource rents diminishes. This underscores the importance of financial authorities in strengthening the credit risk environment by improving banks' access to information on firms' creditworthiness, especially those operating in the non-resource sector. Greater attention should be devoted to

credit information bureaus in order to collect comprehensive data and enhance banks' confidence in financing these firms.

Additionally, ensuring the legal protection of borrowers and lenders fosters trust within the financial system. Such reforms would enable banks to better fulfil their role and exercise their expertise in loan distribution, which is essential for financial development and economic growth. Finally, financial authorities in resource-based countries could establish a special fund to guarantee loans granted to firms operating in the non-resource sector. Unlike firms in the resource sector, these firms cannot rely heavily on internal funding, which would otherwise strengthen their loan applications. Such a measure would help enhance banks' trust and confidence in financing these firms.

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APPENDICES:

Table A: Descriptive statistics for profitability, capitalisation, and risk measures

Panel A: **Resource-based countries**

Variable	Obs	Mean	Std. Dev.	Min	Max
ROE	15842	9.1***	12.50	-55.09	53.18
ROA	15863	1.33***	2.07	-8.69	11.05
Equity/Assets	17054	19.04***	15.89	1.09	94.68
Total capital adequacy ratio (as reported)	8977	23.81***	17.29	6.73	134.6
Loan loss reserves/ Gross cust. loans and advances	13221	5.62***	7.93	0	55.62
Loan loss reserves/ Impaired loans	11974	199.49***	232.20	10.36	1500
NPLs ratio (as reported)	14297	6.10***	6.08	0	29.79
ln zscore1	15848	2.65***	.95	-.19	4.99
ln zscore2	13997	3.12***	1.15	-1.04	6.06

Panel B: Non-resource-based countries

Variable	Obs	Mean	Std. Dev.	Min	Max
ROE	46765	6.51	10.76	-55.36	53.14
ROA	47012	.75	1.61	-8.68	11.05
Equity/Assets	49245	13.56	13.93	1.04	94.7
Total capital adequacy ratio (as reported)	32312	20.09	13.20	6.73	134.5
Loan loss reserves/ Gross cust. loans and adv.	37834	6.49	7.89	0	55.71
Loan loss reserves/ Impaired loans	35686	96.00	123.73	10.36	1500
NPLs ratio (as reported)	42017	3.89	4.38	0	29.79
ln zscore1	46267	3.00	.96	-.18	5.01
ln zscore2	42630	3.33	1.17	-1.05	6.06

Notes: Data are yearly from 2011 to 2022. ** denotes significance at 5% level for the mean comparison test. Data source is BankFocus. Variables are winsorised at 1% and 99%.

Appendices

Table B : Descriptive statistics of macroeconomic control variables used in our model

Panel A: Resource-based countries

Variable	Obs	Mean	Std. Dev.	Min	Max
Gdp_c	17414	14604.82***	20341.21	263.36	76712.28
Gdp growth	17562	2.98***	4.2	-50.33	86.82
Inflation (deflator)	17562	8.43***	16.98	-30.2	604.94
Inflation (cpi)	17474	6.99***	14.90	-3.23	557.20
Concentration	14095	51.53***	21.51	26.92	100
Depth of credit information	10204	6.1***	2.3	0	8
Legal rights	10204	5.5***	2.7	0	12

Panel B : Non-resource-based countries

Variable	Obs	Mean	Std. Dev.	Min	Max
Gdp_c	50366	28695.25	25314.62	470.42	191194.56
Gdp growth	50346	1.86	3.71	-54.33	25.12
Inflation (deflator)	50346	2.94	5.53	-4.62	85.54
Inflation (cpi)	49317	2.70	7.79	-3.74	254.94
Concentration	36964	58.28	16.86	17.16	100
Depth of credit information	33656	6.4	1.8	0	8
Legal rights	33656	5.2	2.6	0	12

Table C : Correlation matrices

Bank-specific data

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Gross loans / Assets	1.000						
(2) Non-interest income/ Gross revenues	-0.336*	1.000					
(3) Non deposits funding/Totla funding	0.062*	0.285*	1.000				
(4) Total assets (log)	0.028*	-0.161*	-0.004	1.000			
(5) Asset growth	-0.101*	0.077*	0.049*	-0.063*	1.000		
(6) Equity / Assets	-0.148*	0.226*	0.126*	-0.437*	-0.023*	1.000	
(7) Z-score 1(log)	0.087*	-0.233*	-0.116*	0.162*	-0.172*	-0.012*	1.000

** p<0.05*

Country characteristics data

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Gdp_c	1.00						
(2) Gdp growth	-0.14*	1.00					
(3) Inflation (deflator)	-0.22*	0.01*	1.00				
(4) Inflation (CPI)	-0.22*	-0.01*	0.87*	1.00			
(5) Concentration	0.45*	-0.12*	-0.28*	-0.15*	1.00		
(6) Depth of credit information	0.00	-0.11*	-0.04*	-0.03*	0.01	1.00	
(7) Legal rights	0.03*	0.09*	-0.03*	-0.04*	-0.01*	0.14*	1.00

** p<0.05*

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- OnlineAppendix.pdf