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Follow the money: Does the financial sector intermediate natural resource windfalls? ☆

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ABSTRACT

Why is the financial sector underdeveloped in resource-rich economies? Using a large panel dataset, we find slower growth in both financial sector deposits and private sector lending in countries that experience an unexpected natural resource windfall as measured by shocks to exogenous world prices. This effect is driven by countries with repressed financial systems and weak governance structures. The smaller role for the financial sector is accompanied by a stronger role of governments in channeling financial capital into the economy. The lack of private financial intermediation of natural resource windfalls hampers the development of the financial sector, which we interpret as evidence for a resource curse in financial development.

1. Introduction

An extensive literature has not only shown that natural resources can exacerbate challenges of macroeconomic management, but points to a fundamental problem faced by countries that produce non-renewable natural resources: how to transform subsoil wealth into productive assets such as financial, human and physical capital (van der Ploeg and Venables, 2012)? While the need to absorb windfalls gains and macroeconomic tools to manage them appropriately have been discussed extensively by academics and policy makers alike, this paper focuses on the key role of the financial system in this process of absorbing and intermediating natural resource windfall gains. Exploiting price changes in commodities such as oil, gas, metals and mineral as the exogenous component of (non-renewable) natural resource windfall gains, we show systematic evidence for a slower process of financial development in countries that rely more on natural resources.

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The literature documenting the importance of financial development for economic development has shown the critical role of the financial system in intermediating and pooling savings into loans and investment. In turn, resource rents channeled through the financial system should help develop the financial system by providing resources and increase demand for lending and non-lending services. While the literature has explored the importance of financial development for fiscal policy space, monetary policy transmission and exchange rate choice,[3] there is a limited literature on the effectiveness of the financial system in absorbing and intermediating natural resource rents.

This paper gauges whether natural resource windfalls are associated with changes in financial sector deposits and lending, for which we construct a panel dataset of over 100 developed and developing countries over the period 1970 to 2017, covering a period of high commodity price volatility. We follow these windfalls as they travel through the financial system by tracing different components of deposits and lending, and interacting them with measures of institutions, financial repression and direct government involvement in the economy. We address endogeneity by isolating windfalls arising from unexpected and exogenous world price changes that affect a country's effective natural resource production value, using predetermined quantities of resources extracted as weights.

Our empirical analysis sheds light on different theories on the relationship between natural resource windfall gains and financial intermediation, which guide our understanding under which institutional or policy conditions the financial sector may help or hinder the development of resource-rich countries. On the one hand, the *resource absorption hypothesis* argues that natural resource wealth, through financial deepening, provides a broader funding basis for financial institutions and markets and increases demand for financial services. For example, influential papers by Mansoorian (1991) and Manzano and Rigobon (2007) have shown that natural resource booms lower constraints to international borrowing by increasing collateral and raising public demand for loans. Similarly, higher resources entering the financial sector can result in a higher supply of loans to enterprises and households. More generally, the higher wealth accruing from such windfall gains can increase the demand for financial services even if the rents themselves are saved in sovereign wealth funds. Sectors related to the mineral sector will experience an economic upswing and rising profits and wages will feed into more financial system deposits.[4]

On the other hand, the *financial resource curse hypothesis* argues that natural resource abundance undermines financial sector development if resource-related wealth is shifted out of the domestic financial system, either into foreign investment conduits and offshore sovereign wealth funds (Andersen et al., 2017), or into non-financial wealth, such as real estate. Lower savings rates in resource abundant countries might further reduce the intermediation capacity of the financial system by limiting the available domestic funding base (van der Ploeg and Venables, 2013). Further, an extensive literature has documented the institutional resource curse, i.e. resource-abundant countries being less likely to develop the institutional framework that also underpins the financial system (Engerman and Sokoloff 1997, 2000; Sala-i-Martin and Subramanian, 2013; Bulte et al., 2005; Beck and Laeven, 2006).

Finally, the effect of natural resource windfalls might vary across countries with different levels of institutional development, different regulatory frameworks or different market structures of the financial system. This *modified financial resource curse hypothesis* posits that the capacity of financial systems to absorb and intermediate natural resource windfall gains might depend on the ability of banks to easily set interest rates and compete with each other, the ability of new entrants – both domestic and foreign – to enter the market and sufficient liquidity in capital market to support the banking system in allocating resources to their best uses and to more sectors of the economy.[5] Another important criterion (often related to political structure and institutional framework in a country) is the organizational, ownership and governance structure of the natural resource sector, which determines who takes decisions on the distribution and use of windfall gains.

While these theories focus on the long-run relationship between natural resource wealth and financial sector development, our identification strategy considers the short-term relationship between windfall gains from changes in natural resource prices and changes in financial sector deposits and loans. This is related to the long-term as financial sector deepening (the process of developing an efficient financial system) can be seen as the accumulation of positive funding and demand-side shocks over time in interaction with the underlying institutional and macroeconomic framework. While in the long-run there are important interaction and feedback effects – a broader and growing funding base might help increase intermediation efficiency and demand for institutional reforms – we focus on the short-term dynamics of additional resource revenues and the growth of financial sector deposits and loans, effectively comparing the extent to which GDP changes in non-resource-based economies compare to resource rent induced changes in GDP in their effect on financial sector deposits and loans.

Using a large cross-country sample over 48 years and controlling for the level of financial development, inflation, GDP growth and country fixed-effects, we find that financial system deposits tend to increase following the windfall – which

[3] See Caballero and Krishnamurthy (2004); Mishra et al. (2012); Aghion et al. (2006).

[4] The standard Dutch disease reallocation of factors of production to the most productive sectors (Corden and Neary, 1982) is income and welfare improving (at least in the short run) and would also increase the demand for financial services. The traded non-resource sector shrinks but the non-traded sector typically expands, as does the economy as a whole. Financial openness may exacerbate this process by a reduction in foreign financing constraints and eventually contribute to slower growth if technological progress is concentrated in the shrinking traded sector (Alberola and Benigno, 2017). Our focus in on the effects on the development of the domestic financial system as this may stimulate entrepreneurship and have positive long-run growth effects, but we will also examine the degree of liberalization of the financial system.

[5] This hypothesis is similar to findings in the capital account liberalization literature that has shown a threshold of institutional and financial development below which countries do not experience any positive growth effect from capital account liberalization (Kose et al., 2009).

is the optimal response to a transitory shock. However, comparing countries with similarly booming economies as captured by total GDP growth, we find that those countries where the boom is induced by an unexpected positive shock to the exogenous world price of its basket of natural resources experience slower growth (a relative decline) in private financial sector deposits. Moreover, we find that the relative volume of private sector lending also grows slower, although the relative decline in lending is mostly due to the relative decrease in deposits.[6] Indirectly, the cumulative effect of the commodity super-cycle results in a persistently depressed level of lending compared to the counterfactual.

Our findings are driven by non-OECD countries and countries with repressed financial systems. These country-level results hold across different types of deposit and are robust to multiple sensitivity analyses. In addition, we find evidence that foreign assets and government deposits with commercial banks increase following a natural resource price shock. Overall, our findings are consistent with the negative long-term relationship between the reliance of a country on natural resources and financial sector development. We also highlight the government as a major beneficiary of natural resource booms which undermines the financial intermediation process in the private sector.

Our paper adds to several literatures. First, we add to the literature on finance and growth. An expansive literature has shown the positive relationship between financial development and economic growth (see Levine, 2005, for an overview), especially at lower initial levels of financial development (e.g., Arcand et al., 2015). There is also evidence that countries with better developed financial systems suffer less economic volatility and that well-developed financial systems can mitigate the impact of real sector shocks (Beck et al., 2006) such as those originating from commodities (van der Ploeg and Poelhekke, 2009a). Economic outcomes in commodity exporters may depend more on financial development since they tend to suffer from more frequent banking crises if they are also low-income and follow a fixed exchange rate regime (Eberhardt and Presbitero, 2021). We add to this literature by focusing on the effect of exogenous changes in natural resource rents on changes in financial system lending and deposits. Our results show the limited role that domestic financial sectors play in absorbing and intermediating windfall gains from natural resource rents in countries with repressed financial system and restrictive regulatory frameworks.

Second, we add to the literature on the determinants of financial development. While a large literature has focused on macroeconomic stability and the institutional framework underpinning financial transactions, using regression analysis with data averaged over longer time periods, we focus on the short-term association of variation of financial system lending and funding with short-term variation in natural resource rents.[7] Our paper adds to this literature by showing that windfall gains from natural resource rents rather than non-resource income are associated with relative reductions in deposit-taking and lending by banks and thus undermine financial sector development in natural resource rich societies.

Third, we add to the literature on natural resource rents and their impact on economic development (see van der Ploeg, 2011, for a survey, and more recently e.g. Aragón and Rud, 2013; Caselli and Michaels, 2013; Jacobsen and Parker, 2016; Cavalcanti et al., 2019). The cross-country literature has focused on the relationship between natural resource dependence and national income growth and the reasons behind poor outcomes. For example, van der Ploeg and Poelhekke (2009a)van der Ploeg and Poelhekke, 2009b and Bhattacharya and Hodler (2014) find respectively that natural resource dependence can be a drag on economic growth by increasing macroeconomic volatility, which can be mitigated by more developed financial systems, but that low financial development itself may be a result of poor contract enforcement in resource-rich countries with weak political institutions. Furthermore, van der Ploeg and Venables (2012) explore several reasons why most countries are unable to turn natural resource wealth into optimal investment strategies. However, they discuss the domestic financial sector mostly indirectly and only in so far as private saving decisions are altered. This paper adds to this literature by investigating how windfall income affects the funding of banks and their lending behavior. Adverse effects of nature resource production induced windfall income on the ability of the financial sector to intermediate capital may seriously constrain countries in their goal of achieving sustainable growth, while unrestrained direct spending by governments all too often leads to unproductive projects, especially in developing countries with lower quality governance (Bates, 1981; Robinson and Torvik, 2005; Afonso et al., 2010).

The remainder of the paper is organized as follows. The next section presents our indicators of natural resource rents and financial sector development. Section 3 discusses the methodology and section 4 presents the main results. Section 5 offers a series of robustness tests. We delegate additional results and robustness tests to the Online Appendix (OA). Section 6 concludes.

2. Data

To test the relationship between financial deepening and natural resource windfalls and the different hypotheses discussed above, we construct data for a broad cross-section of countries over the period 1970 to 2017, covering a period of high commodity price volatility (Jacks, 2019). See Beck et al., 2000 in Appendix Table A1 reports descriptive statistics, definition, and source, for each of the variables, while Appendix Table A2 list all countries and periods in our sample.

[6] Starting from the view that loans create deposits, rather than the other way around, we find similar results.

[7] This is also different from Bhattacharya and Hodler (2014) who relate the level of natural resource rents as a share of GDP to the level of financial development (private credit over GDP), with both averaged over five-year periods.

2.1. Natural resource rents

To credibly isolate an exogenous shock, we construct a price index that tracks world commodity prices and uses a country's initial predetermined quantities of extraction of various minerals as weights.[8] We use the World Bank (2011) data set on resource extraction (including oil, gas, coal, bauxite, copper, lead, nickel, phosphate, tin, zinc, gold, silver, and iron ore) which is available between 1970 and 2008, and we update prices and quantities to 2017 using the USGS Minerals Yearbooks.[9] Multiplied by world prices net of unit costs the data yields rents.[10] There is a wide variation in our sample for total natural resource rents, ranging from zero to 178 % of GDP. The log changes in total rents range from −627 % to 546 %, with a mean of 9.6 %, suggesting substantial shocks to these economies.

A change in the world price of, for example oil, will only translate into a substantial windfall in those countries that produce a lot of oil. We therefore use initial extraction quantities of each mineral c in each country i and use these as weights to construct the price index such that: $P_{it} = \sum_c p_{ct} q_{ic1970} / \sum_c p_{c1970} q_{ic1970}$. The benefit of this approach is that the weights are predetermined.[11] Windfalls may also occur through changes in quantities extracted (such as due to new discoveries) and changes in unit costs, but these are less exogenous than price shocks because quantities and unit costs may be driven by (past) changes in prices.[12]

2.2. Financial development and institutional indicators

As used by the expansive financial development literature over the past two decades, financial development is summarized in the ratio of private credit to GDP. In our sample, this ratio has a mean of 18 % in 1960 and 55 % in 2017. We look closer at the development of the financial sector by using several other measures. First, we use several indicators of deposits in the financial system, all taken from the IMF's International Financial Statistics, unless stated otherwise. Specifically, we focus on deposits by the (i) total financial system, including banks and non-bank financial institutions and (ii) banking system deposits. We also consider different sources of deposits, such as government deposits with commercial banks[13] to investigate whether additional resource revenues result in more net savings by the government in the form of banking system deposits. We also use offshore bank deposits, i.e., the amount of deposits held outside the economy, based on data from the BIS. We track net foreign assets by commercial banks to test whether changes in resource rents are associated with higher funding of banks from abroad or higher investment by banks abroad. We do not normalize by GDP and we use data in current US dollars rather than in local currency to thus control for the effect of depreciations or appreciations, especially due to changes in natural resource prices.[14]

Second, we use an indicator of domestic sector lending, notably total credit to the private sector, a standard indicator of total lending by financial institutions to non-financial domestic private households and enterprises. We also use an indicator of bank lending to central and local governments and to state-owned enterprises to capture funding pressures by governments and government-owned enterprises.

Finally, we also control for heterogeneity in the level of institutional development, with data from the International Country Risk Guide (ICRG) and the financial liberalization database put together by Abiad et al. (2010), and for the private versus state and foreign ownership of mines using mine-level data from Gu (2014).

3. Methodology

To test the different hypotheses proposed by theory, we relate changes in the commodity price index to changes in financial sector deposits and loans in dynamic panel regressions that use annual observations over the period 1970 to 2017 for up to 108 countries. We start by using the following regression set-up to show the average effect of windfalls on financial sector variables:

[8] Others have also used price indices to measure natural resource shocks such as Deaton and Miller (1996), Bazzi and Blattman (2014) and Harding and Venables (2016). However, they have used as weights the *export* volume by resource and country, with export shares often fixed to one base year. We believe however that the volume of production is more relevant since trade shares will underestimate resource booms that are (partly) consumed domestically, such as the recent shale gas boom in the United States.

[9] See https://www.usgs.gov/centers/nmic/minerals-yearbook-metals-and-minerals. More recent versions of the World Bank data no longer split minerals and no longer separate prices from production and unit costs. The USGS Mineral Yearbooks do not track unit costs, which we extend by applying the country's GDP deflator. Unit costs and quantities are only used in Table OA1 and robustness Table OA8, and these results are robust to limiting the sample to 2008.

[10] The unit cost estimates are best for major producers, but partly imputed for other countries. If data for a single year was available, it was assumed that production costs remained constant in real terms using the US GDP deflator. Missing data between two different years with data were linearly interpolated. If no data was available then geographic proximity and similarity between the ratios of offshore active drilling rigs to total active drilling rigs between the two countries were used. See Bolt et al. (2002) for more details on the construction of unit costs.

[11] In robustness tests we show that our core results are robust to changing our preferred index to indices where extraction weights change over time, including a Paasche index fixed to 1970 prices instead of quantities, and Laspeyres chained indices where we lag the quantity weights by three or five years.

[12] Online Appendix Fig. 1 shows the development and dispersion around the mean of the natural resource price index across our sample period. The average price shock is 5.3%, while quantities change on average by 3.2% per country-year. The average change in cost is 4.9%. In Section 5 we experiment with alternative price indices and with controlling for changes in quantities and unit costs directly and find very similar results.

[13] We use the name "commercial bank" synonymous with the term "deposit money bank" as used by the IMF's International Financial Statistics.

[14] Moreover, natural resources are typically traded in US dollars.

$$\Delta F_{it} = \alpha \Delta F_{i,t-1} + \beta_1 \Delta P_{it} + c_i + \varepsilon_{it} \quad (1)$$

where F is one of our financial development indicators or macro-aggregates, P is the natural resource price index, i denotes country and t year. We include country fixed effects c_i, so that our coefficient estimates capture within-country variation: rather than focusing on cross-country relationships, we gauge how a change in natural resource rents within a country relates to changes in financial sector deposits and loans within this country.[15] Fixed effects control for important unobserved time-invariant characteristics of the institutional and regulatory framework of both the financial and the natural resource sectors.[16] As changes in financial sector deposits and loans might be persistent, we include the lagged dependent variable and cluster standard errors on the country-level, thus allowing for arbitrary heteroskedasticity and correlations of error terms within but not across countries.[17] First differencing also ensures that the model is stationary. We progressively augment equation (1) with controls for inflation (since all variables are measured in nominal terms), GDP, and initial financial development. A positive coefficient β_1 would be evidence in favor of the *resource absorption hypothesis*, while a negative coefficient, would be evidence in favor of the *financial resource curse hypothesis*. Interacting ΔP_{it} with indicators of the institutional and regulatory framework will allow us to test for the *modified financial resource curse hypothesis*.

A windfall may affect deposits and lending directly, but also indirectly if the windfall pushes up GDP and inflation. To separate the direct effect of the windfall on financial sector variables from indirect effects via GDP and inflation, we use a structural vector autoregressive model. We start out with a rational autoregressive-distributed lag model, which includes a lagged dependent variable and lags of endogenous right-hand-side variables and estimate a fully dynamic reduced-form vector autoregressive (VAR) model (Lütkepohl, 2006):

$$\Delta Y_{it} = A^{-1}B_1\Delta Y_{it-1} + A^{-1}B_2\Delta P_{it} + A^{-1}DZ_{it-1} + A^{-1}C_i + A^{-1}\varepsilon_{it} \quad (2)$$

where $\Delta Y_{it} = (\Delta F_{it}, \Delta \text{GDP}_{it}, \pi_{it})'$. $A^{-1}B_1$, $A^{-1}B_2$, and $A^{-1}D$ are 3x3 matrices of parameters to be estimated. The matrix Z includes controls such as initial (predetermined) financial development. Motivated by the fact that windfall shocks dissipate quickly (as shown in Figure OA2) and by the more formal recommendation of AIC and BIC criteria, we include no lags of the windfall variables. GDP is taken from the World Bank's World Development Indicators and π is the log difference of its deflator. We then multiply the above model by a matrix A. As is standard in the VAR literature, this model can be estimated and identified by assuming a causal ordering of the three endogenous variables included in ΔY_{it}. We assume that $A = \begin{bmatrix} 1 & \cdot & \cdot \\ 0 & 1 & \cdot \\ 0 & 0 & 1 \end{bmatrix}$, where the $[\cdot]$ are parameters to be estimated. This means that both GDP and inflation are allowed to influence deposits contemporaneously, to ensure that we estimate the effect of a windfall on a measure of financial development relative to GDP's effect on the demand for financial services. Inflation may also move nominal GDP simultaneously, but we assume that deposits affect GDP and inflation only with a delay. Since deposits are equal to income saved for future spending, we believe this assumption is justified.[18]

We then estimate the structural model with iterated seemingly unrelated regression (based on feasible generalized least squares) to allow the error terms to be correlated and perform a bootstrap to generate standard errors, where we resample from within each country to preserve clustering of standard errors at the country level. However, because the models are nested the estimates collapse to OLS and we can also cluster the standard errors by country directly. As a robustness check we perform Arellano-Bond GMM estimates which instrument the endogenous variables with their lagged levels (Arellano and Bond, 1991). The baseline specification is thus:

$$\Delta F_{it} = \alpha_1 \Delta F_{i,t-1} + \beta_1 \Delta P_{it}$$

$$+\Gamma_0 \Delta X_{it} + \Gamma_1 \Delta X_{i,t-1} + \delta Z_{it-1} + c_i + \varepsilon_{it} \quad (3)$$

where $\Delta X_{it} = (\Delta \text{GDP}_{it}, \pi_{it})'$ and Γ_j are 1x2 matrices of parameters.

Our main parameter of interest is β_1. Because real commodity prices trend upwards in levels (Jacks, 2019) we first difference the data to make them stationary and focus on the short run effects of a shock to the annual *change* in natural resource prices, which tend to be relatively transitory. We run similar regressions for different components of deposits. When the left-hand-side is a measure of lending, we include deposits as a fourth endogenous variable and add lending to the front of the causal ordering.[19]

[15] Online Appendix Fig. 2 shows that natural resource price shocks are not persistent, which allows us to test for the short-term effects of windfall gains on financial sector deposits and lending.

[16] In short panels, the correlation between the fixed effects and the error term introduces a downward bias in the parameter α, and an upward bias if the fixed effects are excluded. However, the bias goes to zero as the time dimension approaches infinity, see Nickell (1981). In our case, T typically equals 47, which, in combination with the fact that the estimate of α with and without fixed effects is very close (see Section 4) suggests that the bias is minor (Bond, 2002). We perform Arellano-Bond GMM estimates as a robustness check (Arellano and Bond, 1991).

[17] Results are robust to allowing for two-way clustering on both countries and years, which includes arbitrary cross-sectional spatial dependence.

[18] Because matrix A is lower-triangular this is equivalent to a recursive VAR and we do not overidentify the structural VAR.

[19] In Section 4.3 we explore the robustness to an alternative ordering.

4. Results

We start our empirical analysis with a panel regression of the level of financial system deposits and lending on the level of natural resource rents. Online Appendix Table OA1 confirms previous results that higher natural resource rents are associated with lower levels of financial development, even when controlling for the level of GDP per capita and an indicator of institutional development.[20] The regressions control for country and year fixed effects, with standard errors clustered on the country level; thus, we are exploiting within-country and within-year variation in natural resource rents and financial development. The results hold for both the lending side of financial development as for the deposit-taking side. We also find a negative relationship between natural resource rents and the loan-deposit ratio in the banking system.

While these results are consistent with the previous literature, they do not control for endogeneity, as the share of mineral rents in GDP is not exogenous. We therefore split resource rents into its price and quantity components and focus on year-to-year changes in world prices from now on.

In Appendix Table OA2, we further explore the relationship between changes in the mineral price index and macroeconomic aggregates, including gross assets and liabilities form Lane and Milesi-Ferretti (2007). The results show that a sudden windfall as measured by a year-to-year change in the value of the mineral price index is positively associated with growth in total foreign gross assets (column 1), aggregate savings (column 2), household and non-household consumption (columns 3 and 4) and government consumption (column 5). These findings are in line with the theoretical optimal response to an unexpected windfall increase in income, as they are partially saved to smooth consumption (Van der Ploeg and Venables, 2012). Set against this background pattern, we now turn to our main estimation equation that traces windfall shocks through the private financial system.

The result of estimating equation (1) shown in columns (1) to (3) of Table 1 show that compared to a non-resource-related GDP shock, natural resource windfalls result in a relative decline in financial sector deposits. Starting with column (1), we find that a year-to-year change in the value of the mineral price index is associated with an *increase* in the volume of financial system deposits. However, when we add non-mineral GDP in column two, is reduced by almost two-thirds, while the coefficient on non-mineral GDP is positive and significant. When we finally add the change in total GDP in column three, we find that price induced windfalls predict a relative *decline* in financial system deposits. The results suggest that an increase in GDP leads to more deposits, but when comparing the effect of an average change in GDP to the effect of a similarly sized change in GDP that is due to an unexpected mineral windfall, we find that windfalls predict a relative crowding out of financial system deposits. This is a novel finding in the literature, which we will explore further in the following. While the short-term effect of a 1 % price shock is a −0.061 % relative decline in financial system deposits, the long-term effect is −0.076 %, thus somewhat stronger. The effect of an average price shock, equal to 5.2 %, is thus a 0.3 % relative decrease in deposits. These findings are consistent with the financial resource curse rather than resource absorption hypothesis.[21]

The results in columns (4) to (6) of Table 1 show a similar pattern for growth in credit. While a year-to-year change in the value of the mineral price index is associated with an *increase* in the volume of credit (column 4), the coefficient size more than halves when we control for non-mineral GDP (column 5), but turns negative and insignificant when we control for GDP (column 6).

In Table 2, we show the result of estimating equation (3) where we separate short-run from long-run effects and explicitly model the response of GDP. The results in columns (1a) to (1c) confirm our findings . A positive price shock results in a relative decrease in the volume of deposits (column 1a) and an increase in GDP and inflation (columns 1b and 1c).[22] We also find a strong positive contemporaneous relationship between GDP growth and growth in financial systems deposits, confirming that higher GDP growth also increases growth in financial system deposits, unless higher GDP growth is caused by a natural resource price shock. Compared to the counterfactual of a country growing at similar speed, a doubling of commodity price inflation induces a relative decline of deposit growth by 4.5 %.

Fig. 1 illustrates the effect of windfall gains under two different scenarios of the evolution of financial sector deposits and GDP growth after a shock in $t = 0$, averaged across countries, relative to a no-shock baseline scenario. These impulse response estimates use the baseline estimates of equation (3) and trace the model five periods ahead. The left panel shows the no-shock baseline (assuming that Δ log *mineral price index* remains zero in all periods) with the consequence that growth in GDP and financial deposits co-move over the four subsequent periods.[23] Scenario 1 shows the effect of a doubling of Δ log *mineral price index*; while we see a jump in GDP growth after the shock, the increase in financial system deposits is much *less* than that of the increase in GDP: the difference on impact is 7.7 percentage points, which is almost half a standard deviation. Scenario 2 imposes a shock to GDP growth that is equal to the response of GDP growth to the mineral price shock of Scenario 1, but imposes that Δ log *mineral price index* remains zero in all periods, thus showing a scenario of a shock of similar magnitude to GDP growth in an equally volatile but *non*-resource-based economy. Both GDP and deposit growth jump by the same amount, with the effect dissipating over the subsequent periods, but both series co-moving. Fig. 2 compares the two scenarios and shows that following a GDP growth shock, growth in deposits is higher in an equally volatile non-resource-based economy than in a

[20] Definitions and data sources of additional variables used in the Online Appendix are reported in Table OA11.

[21] In sensitivity analyses, we find no significant evidence for non-linear effects as effect of the price shock is not significantly different for positive nor negative shocks (see Table OA3).

[22] We confirm the negative coefficient on financial system deposits when using the Arrellano and Bond (1991) difference GMM estimator.

[23] The movement in GDP and deposits under this scenario is due to past changes in GDP and deposits.

Table 1
The direct and relative effect of natural resource windfalls on private sector deposits and lending.

Dependent variable →	Δ log financial system deposits			Δ log private credit		
	[1]	[2]	[3]	[4]	[5]	[6]
Δ log mineral price index, base 1970	0.132***	0.048**	−0.061***	0.181***	0.087***	−0.018
	(0.017)	(0.022)	(0.015)	(0.014)	(0.016)	(0.016)
Financial development (t-1)		−0.000***	−0.000**		−0.001***	−0.001***
		(0.000)	(0.000)		(0.000)	(0.000)
Rate of inflation		−0.089***	−0.104***		−0.098***	−0.107***
		(0.022)	(0.023)		(0.029)	(0.034)
Δ log non-mineral GDP		0.579***			0.627***	
		(0.066)			(0.058)	
Δ log GDP			0.883***			0.895***
			(0.042)			(0.043)
Δ log financial system deposits (t-1)	0.277***	0.215***	0.200***			
	(0.036)	(0.035)	(0.035)			
Δ log private credit (t-1)				0.172***	0.108***	0.096***
				(0.038)	(0.034)	(0.033)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,204	4,104	4,104	4,324	4,239	4,239
Number of countries	107	107	107	108	108	108
R-squared	0.103	0.296	0.381	0.081	0.359	0.426

Notes: This table shows OLS estimates of the effect of unexpected and exogenous windfall in natural resource revenue based on world prices (Δ log *mineral price index*) on financial system deposits and private credit. By controlling for total GDP growth in columns 3 and 6 we estimate the differential effect of a windfall on countries that experience similar booms or busts but who experience them for different reasons. Robust standard errors are clustered by country shown in parentheses. A constant and country fixed effects are included but not shown. ***, **, * correspond to the 1%, 5%, and 10% level of significance, respectively.

resource-based economy. In other words, a shock to GDP growth for other reasons than a commodity boom would have increased deposit growth by almost half a standard deviation *more* and would have led to faster financial development.

The structural model in columns (2a) to (2d) of Table 2 shows that the consequent relative reduction in financial sector lending following a positive shock to natural resource windfall gains is due to the relative reduction in deposit funding. Here, we model private sector lending, financial sector deposits, GDP, and inflation in a system of four seemingly unrelated regressions. We impose the same structural assumption as before and in addition assume that growth in financial system deposits, GDP growth and inflation can impact private sector lending growth, while private sector lending growth cannot impact any of the other three variables contemporaneously, but only through lags. In terms of equation (2), we again assume that matrix A is lower triangular but *4x4* and that $\Delta Y_{it} = (\Delta \text{Lending}_{it}, \Delta \text{Deposits}_{it}, \Delta \text{GDP}_{it}, \pi_{it})'$. We find no significant impact of natural resource price shocks on private sector lending growth, positive and significant effects on GDP growth and inflation and (on impact) a negative and significant effect on growth in financial system deposits. A doubling of commodity price inflation reduces deposit growth by 3.8 % and thus indirectly lending growth by 0.038*0.257 = 1.0 %. We also find a positive and significant contemporaneous impact of growth in financial system deposits and GDP growth on private sector lending growth and a negative contemporaneous effect of inflation. Similar to the effect on deposits, we thus find that when comparing countries with similarly booming economies as captured by total GDP growth those countries where the boom is induced by an unexpected positive shock to the exogenous world price of its basket of minerals do not experience an increase in lending and, if at all, a decrease. We conclude that an increase in natural resource wealth appears to crowd out financial intermediation by banks, mainly by relatively reducing deposits.

We illustrate the long-run implications of our findings in Fig. 3. The top panel shows the difference between two scenarios, one where the system is shocked with a *sequence* of mineral price shocks that correspond to the log difference of the IMF commodity price index between 1994 and 2016, which is displayed in levels in the bottom panel. We estimate the baseline model and forecast the response of the level of lending to these mineral price shocks, as if the cycle started again in 2004. We also forecast a scenario that uses as input the GDP price shocks that we estimate in the first scenario to capture the effect on lending of an economy that grows equally fast but for other reasons than mineral price shocks. The difference between these two series is plotted in the top panel, which shows that lending declines in resource-intensive economies and shows a persistently depressed level of lending. The implication is a level of financial development (private credit over GDP) that is three percentage points lower in the mineral price scenario.[24]

[24] In Online Appendix Table OA4, we impose an alternative structural assumption. Specifically, in line with the view that it is lending that creates deposits, we assume that lending growth, GDP growth and inflation can impact growth in financial sector deposits, while growth in financial sector deposits can impact any of the other three only through lags but not contemporaneously. This is consistent with recent research by the Bank of England that lending is the primary channel through which money is created. Any loan automatically creates an off-setting deposit in a bank's balance sheet and through multiplier effect further deposits (McLeay et al., 2014). We thus define $\Delta Y_{it} = (\Delta \text{Deposits}_{it}, \Delta \text{Lending}_{it}, \Delta \text{GDP}_{it}, \pi_{it})'$. Our results are very similar to the results in Table 2, with a negative contemporaneous effect of price shocks on deposits. As before, we find positive relationships between deposit and lending growth.

Table 2
Natural resource windfalls and the relative decline in private sector deposits.

Dependent variable →	Δ log financial system deposits	Δ log GDP	Rate of inflation	Δ log private credit	Δ log financial system deposits	Δ log GDP	Rate of inflation
Method →	*SUR*			*SUR*			
	[1a]	[1b]	[1c]	[2a]	[2b]	[2c]	[2d]
Δ log mineral price index, base 1970	−0.045***	0.223***	0.136***	−0.001	−0.035**	0.224***	0.129***
	(0.017)	(0.016)	(0.017)	(0.016)	(0.016)	(0.016)	(0.016)
Financial development (t-1)	−0.000***	−0.001***	−0.000	−0.001***	−0.000***	−0.001***	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Rate of inflation	−0.187***	0.023		−0.093	−0.204***	0.017	
	(0.044)	(0.036)		(0.071)	(0.043)	(0.038)	
Rate of inflation (t-1)	0.119***	−0.004	0.699***	0.019	0.130***	−0.002	0.708***
	(0.040)	(0.030)	(0.051)	(0.044)	(0.042)	(0.031)	(0.050)
Δ log GDP	0.881***		0	0.648***	0.887***		0
	(0.040)			(0.093)	(0.039)		
Δ log GDP (t-1)	−0.082	0.117***	−0.224***	0.108**	−0.090	0.107**	−0.361***
	(0.064)	(0.043)	(0.052)	(0.049)	(0.065)	(0.044)	(0.080)
Δ log financial system deposits		0	0	0.265***		0	0
				(0.086)			
Δ log financial system deposits (t-1)	0.231***	0.018	−0.014	−0.025	0.170***	0.014	−0.062
	(0.057)	(0.026)	(0.044)	(0.033)	(0.054)	(0.027)	(0.051)
Δ log private credit					0		
Δ log private credit (t-1)				0.043	0.065*	0.011	0.193***
				(0.036)	(0.034)	(0.018)	(0.059)
Country FE	Yes			Yes			
Observations		4,099		4,065			
Number of countries	107			107			
R-squared	0.390	0.194	0.524	0.466	0.474	0.194	0.535

Notes: This table shows Semingly Unrelated Regression (SUR) of the effect of an unexpected and exogenous windfall in natural resource revenue based on world prices (Δ log *mineral price index*) on financial system deposits and private credit. The system 1a-1c is a structural vector autoregression and assumes the following ordering: no contemporaneous effect of deposits on GDP, on inflation. 2a-2d assumes the following ordering: no contemporaneous effect of lending on deposits, on GDP, on inflation. These identifying assumptions are denoted by 0 s in the table. The Breusch-Pagan test rejects the H0 of independence of the equations. See Section 3 for more details. By controlling for total GDP growth we estimate the differential effect of a windfall on countries that experience similar booms or busts but who experience them for different reasons. Robust standard errors are clustered (block, country) bootstrapped. A constant and country fixed effects are included but not shown. ***, **, * correspond to the 1 %, 5 %, and 10 % level of significance, respectively.

In Online Appendix Table OA5, we undertake several tests that potentially qualify our main results. Panel A reports the results for deposits and Panel B for private credit. First, while our empirical setup first differences the variables to wash out country-specific time-invariant effects and on top of that controls for country dummies that capture country-specific trends, we control explicitly for the importance of natural resources in an economy. Specifically, in columns 1 and 9, we interact the price shock with a measure of initial dependence, *1970 dependence,* which is the value of resources extracted in 1970 as a share of GDP and averages 6.2 % in this sample. The interaction is indeed negative and significant and the effect on lending turns negative and significant for the 90th percentile of most resource dependent countries. Second, we confirm our baseline results across different sample splits, including to (i) dropping the top producer country of each commodity, as these countries may exercise market power resulting in an endogenous world price (columns 2 and 10), (ii) limiting the sample to the most resource dependent countries (columns 3 and 11), and (iii) limiting the sample to OECD and (less developed) non-OECD economies (columns 4, 5, 12, and 13). Only among OECD countries does a windfall shock not lead to a relative drop in deposits.

In columns 6, 7, 14 and 15, we limit the sample to those countries that produce oil and gas, and those that produce other minerals to test whether the resource sectors in these countries are 'enclaves' with few linkages to other sectors in the economy. If that is the case, then we should find small and insignificant effects, especially for capital-intensive oil and gas. However, our results are not consistent with the enclave hypothesis as there are always effects through the financial system for the broader economy. The main coefficient of interest is indeed smaller for oil and gas, but the median price shock for oil and gas is three times larger than for other minerals. Our interpretation is that the enclave effect most likely operates at the local sub-national level and has more bearing on the real economy as opposed to the financial sector.[25]

In columns 8 and 16 we interact the price shock with a country's net importer status of fuels in 1970, and of ores separately, because net importers are adversely affected by an increase in prices. Net importer status for fuels indeed attenuate

[25] See for example Pelzl and Poelhekke (2021) who find that more labour-intensive extraction techniques have more local effects than capital intensive extraction techniques.

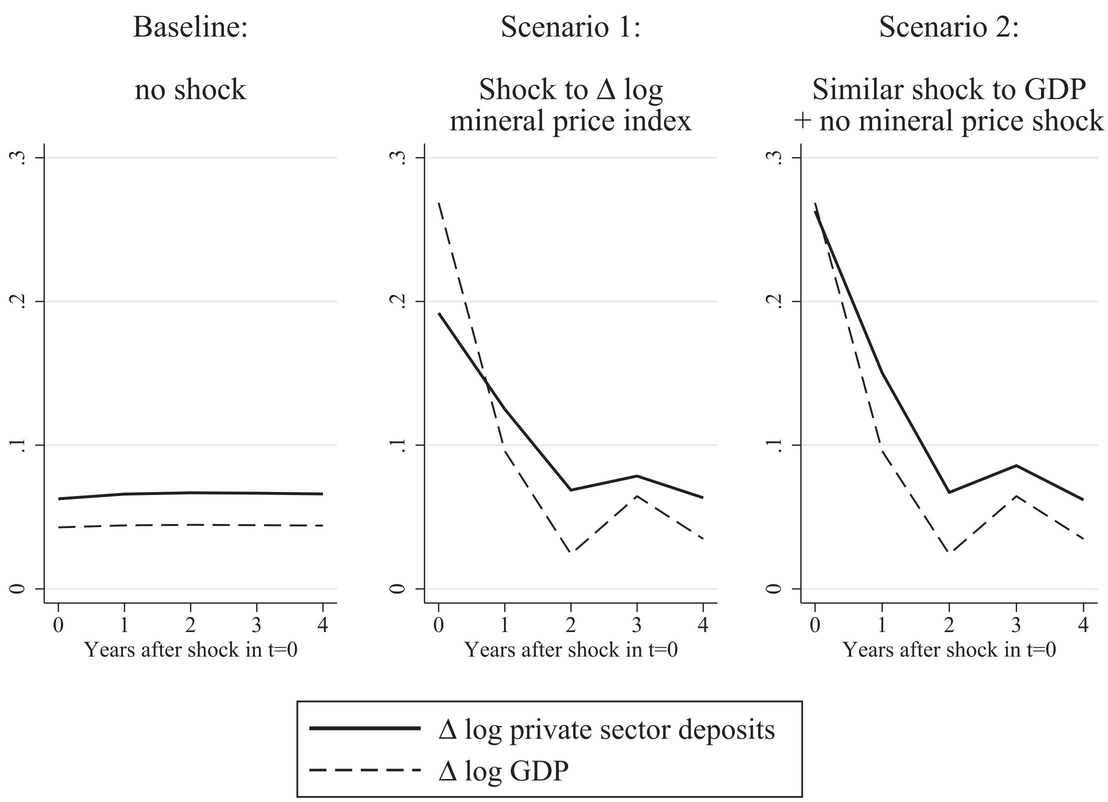

Fig. 1. Impulse response scenarios for private sector deposits and GDP. This graph plots three scenarios of the evolution of private sector deposits and GDP growth after a shock in t = 0, averaged across countries. The baseline scenario assumes that Δ log mineral price index remains zero in all periods. Scenario 1 imposes a shock to Δ log mineral price index as in Fig. 2. Scenario 2 imposes a shock to GDP growth that is equal to the respons to GDP growth to the mineral price shock of Scenario 1 but assumes that Δ log mineral price index remains zero in all periods. Impulse response estimates are obtained by forecasting the model of Table 2 five periods ahead.

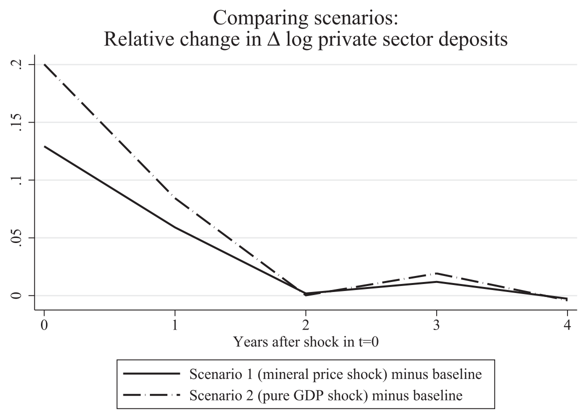

Fig. 2. Relative change in Δ log private sector deposits. This graph plots the relative change in log private sector deposits between the scenarios of Fig. 3. The solid line represents the rate of change from Scenario 1 (the mineral price shock) over and above what would happen under the baseline scenario of no shock. The dashed line represents the rate of change from Scenario 2 (the pure GDP shock) over and above what would happen under the baseline scenario of no shock. The pure GDP shock is equal in magnitude to the response of GDP to the mineral price shock in Scenario 1. The graph shows that the response of private sector deposits after a natural resource boom is much less than under a similarly-sized GDP shock that happens for other exogenous reasons.

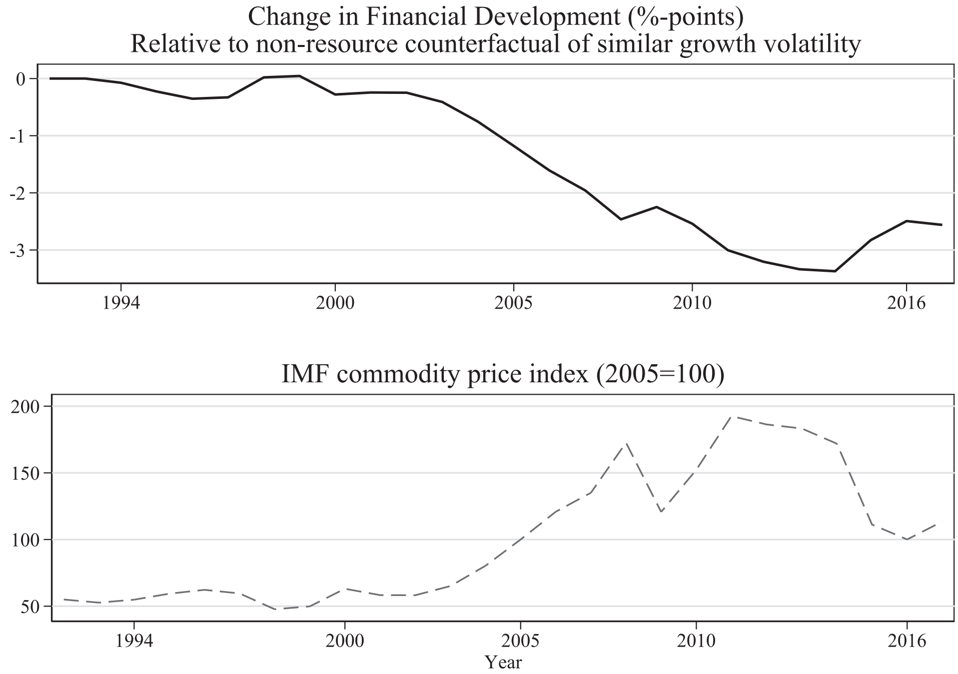

Fig. 3. The long-run effect of the commodity price super-cycle on lending. This graph plots the difference between two scenarios of the financial development response to a sequence of shocks (top panel). One scenario imposes a sequence of commodity price shocks that corresponds to the log changes in the IMF commodity price index since 1994 (bottom panel). According to Jacks (2019), commodities started a 'super-cycle' of appreciation and depreciation in 1994 that has neared its end in 2016. The other scenario, which we label the 'non-resource counterfactual of similar growth volatility', equals no commodity price shocks but a sequence of GDP growth shocks. The GDP growth shocks are equivalent in magnitude to the response of GDP to the commodity price shocks in the latter scenario. We thus compare the long-run development of lending in an economy where growth is driven by commodity prices, and one where similar volatile growth is driven by other causes.

the effect of the windfall shock on deposits but the interaction is insignificant. It is significant for lending, but the marginal effect of the price shock for net importers is close to zero and insignificant, as in the baseline regression.[26] In unreported regressions, available on request, we also control for non-linearity of the relationship between by defining episodes of large windfall gains based on the distribution of shocks in the price index. Specifically, we construct three dummies equal to 1 for observations where the Δ log mineral price index is in the top 95th, 90th or 80th percentile. For deposits, the results suggest that large windfalls are indeed worse, but the estimates are noisy. Only for the less restrictive category of top 20 % shocks do we find that these are significantly worse than the bottom 80 % of shocks.

4.1. Institutional heterogeneity

We next show in Table 3 that our finding of a negative impact of natural resource windfalls are driven by financially repressed systems. As our sample contains countries at very different levels of financial development, here we allow the relationship between price changes in natural resources and financial sector deposits to vary across countries with different degrees of financial liberalization and institutional development. Specifically, we interact the price change in natural resources with an index of overall institutional quality as proposed by the International Country Risk Guide. The institutional index is the sum of several components, including a country's legal system (rule of law), the investment profile, corruption, government stability, and bureaucratic quality. We also interact the price change in natural resources with an index of the degree of financial liberalization, which is based on components that track the absence of credit controls, directed credit, interest rate controls, state ownership, and restrictions on capital account transactions (obtained from Abiad et al., 2010). In columns 1 and 4 we lag these by four periods such that they measure a country's institutional score before we measure dynamics in the financial sector. In columns 2 and 5 we use the same sample as in columns 1 and 4, respectively, but instead measure the two institutional indices at the start of the data such that they are time-invariant. This also allows us to 'observe' them for all recent years such that we can include more observations in columns 3 and 6 (the financial reform index is otherwise available until 2005). The result is that only the measures of *financial reform* enter positively and significantly,

[26] In unreported regressions we add the same interactions to the specifications in Table 2, which indeed shows that the price shock has a smaller positive effect on GDP and inflation for net importers of fuel. The fact that the net effect is still positive is likely due to countries that produce crude oil and/or natural gas but nevertheless import refined fuels.

Table 3
Heterogeneous effects: relative decline of deposits in financially restrictive countries.

	Dependent variable →	Δ log financial system deposits					
	Interaction variable →	*institutions index* ϵ*[0,40]*			*financial reform index* ϵ*[0,1]*		
		[1]	[2]	[3]	[4]	[5]	[6]
Δ log mineral price index, base 1970		-0.132	−0.129	−0.122	−0.215***	−0.094**	−0.078***
		(0.115)	(0.082)	(0.082)	(0.098)	(0.039)	(0.028)
Direct effect of interaction variable		0.002	–	–	−0.013	–	–
		(0.001)			(0.023)		
Δ log mineral price index	* Interaction variable (t-4)	0.003			**0.281****		
		(0.004)			(0.136)		
Δ log mineral price index	* Interaction variable (initial year)		0.004	0.004		**0.155***	**0.125****
			(0.003)	(0.003)		(0.082)	(0.059)
Lagged dependent variable		0.247*	0.251*	0.247**	0.310***	0.310***	0.315***
		(0.137)	(0.136)	(0.124)	(0.048)	(0.048)	(0.050)
Standard controls included		Yes	Yes	Yes	Yes	Yes	Yes
Country FE		Yes	Yes	Yes	Yes	Yes	Yes
Including all recent years where the raw institutional data is unavailable		No	No	Yes	No	No	Yes
Observations		2,599	2,599	2,672	1,971	1,971	2,482
Number of countries		99	99	99	67	67	67
R-squared		0.404	0.403	0.413	0.336	0.331	0.352

Notes: This table shows OLS regressions to estimate the effect of unexpected and exogenous windfall in natural resource revenue based on world prices *(*Δ log *mineral price index*) on deposit growth, where we control for an index of institutions and an index of financial sector liberalization, and their interaction with the windfall. Standard controls include lags 0 to 1 of inflation and GDP growth and financial development (t-4). Initial institutions (columns 2–3 and 5–6) are measured at the start of the available data. Columns 2 and 5 use the same sample as columns 1 and 4, resp. Columns 3 and 6 extend the interaction variable to the most recent years for which the time-varying institutional index is missing, which is possible because initial institutions are time-invariant. In columns 2–3 and 5–6 the direct effect of the interaction variable drops out because they are fixed effects. Robust standard errors are clustered by country shown in parentheses. A constant and country fixed effects are included but not shown. ***, **, * correspond to the 1%, 5%, and 10% level of significance, respectively.

partly off-setting the effect of the main effect of windfall gains.[27] In the Online Appendix (Table OA6), we present similar regressions with changes in private sector credit. As none of the institutional measures affect the direct relationship between windfalls and lending, we conclude that financial repression limits the financial sector's ability to attract deposits and thereby indirectly limits lending. This can also be interpreted as suggesting that many natural resource-rich countries have limited absorption capacity in their financial systems due to financial repression and the lack of a conducive institutional framework, preventing windfall gains from funding the financial sector.

Government restrictions on financial markets may also extend to government involvement in the natural resource sector itself, and countries vary widely in this regard, both in terms of the tax burden and of state ownership.[28] In the absence of more detailed data, we construct a proxy gauge, which uses mine-level data on the direct owners of over 1,500 mines producing 31 different metals and minerals, but unfortunately does not cover oil and gas.[29] For these mines we know the owner by type (state, private, domestic, foreign) and the ownership share. We use three variables that estimate for each country the average share of mines that is domestic and private owned, domestic state owned, and foreign owned. We hypothesize that if the domestic state ownership share of mines is higher, than a larger share of profits would go to the government directly, which will exacerbate the relative decline in deposits. Results reported in the Online Appendix (Table OA7) suggest that the relative decline of lending is concentrated in countries where at least 50 % of the resource sector is state-owned on average.[30] Natural windfall gains seem to largely bypass the financial sector, except for the few countries where extraction is done by private domestic companies and in which also the tax burden on the natural resource sector may be lower.

In summary, our results show a relative decline in deposit growth after natural resource windfall gains, which in turn results in lower lending growth, in countries with weak institutional frameworks and repressive regulatory frameworks. These results are not consistent with the *resource absorption hypothesis*, but rather provide evidence in favor of the *modified financial resource curse hypothesis*.

[27] The separate components of institutions were never significant when interacted on their own. The separate components of financial reform were only significant when interacted on their own in the specification of column 4. We conclude that it is the combination of reform rather than any specific component that matters.

[28] Norway extracts most of its oil and gas through a majority state-owned company (Statoil), as do Saudi Arabia (Saudi Aramco) and Brazil (Petrobras). In other countries most extraction is done by domestic private companies (such as in the United States), while many developing countries rely on foreign companies.

[29] The proprietary source is S&P Metals and Mining's predecessor RMG. We are grateful to Yuan Gu for sharing her aggregate data. The raw data can be found here: https://www.spglobal.com/marketintelligence/en/campaigns/metals-mining.

[30] When we also add an interaction with start-of-sample institutions, which may correlate with state ownership, as robustness (as in Table 3) the coefficient of interest becomes 0.068* (0.042) while the number of observations drops to 2,319. Available on request.

4.2. Where do the resource windfall gains go?

The results so far have shown a relative decline in financial system deposits after a resource windfall gain (compared to what a comparable shock in a non-resource-based economy would cause), which in turn explains a similar relative decline in private sector lending. In the following we will explore different types of deposits as well as other asset positions of banks to gain a more granular view of where natural resource rents flow to and how they are being used if they end up in the financial system. The results are presented in Table 4.

In column (1) we confirm our previous findings using the narrower measure of bank deposits (rather than total financial system deposits). The results in column (2) show that unlike domestic deposits, offshore deposits experience a relative increase after a resource windfall gain. The column (3) regression shows that banks increase their net foreign asset holding. The results in column (4) finally show that government deposits with commercial banks increase the most. When considering (in columns 5, 6 and 7) lending to the central government, state and local governments, and public companies, we find no significant effects, although these samples are also much smaller. The results thus suggest an increase in foreign asset positions of banks and an increase in claims of the government on banks.

In Table 5, we focus on the government as apparent recipient of resource windfall gains and document that higher government deposits following resource windfall gains correlate with higher government consumption. Government deposits do not lead to more lending, and thus do not aid financial development. Specifically, we regress the growth in government consumption and in private sector lending on growth in foreign asset holding, and on growth in government deposits with commercial banks. We also include the lagged dependent variable, private sector deposits (in column 2), and standard controls, including financial development, contemporaneous and lagged inflation and (in column 2) contemporaneous and lagged growth. We find a strongly positive and significant relationship between growth in government deposits with commercial banks and growth in government consumption and an insignificant relationship between growth in government deposits with commercial banks and growth in private sector lending. We conclude that windfall gains end up mostly in government accounts with banks and in foreign assets, but these in turn do not lead to financial intermediation as captured by growth in private lending. In other words, private sector firms do not necessarily find it easier to borrow from banks after a windfall, because the inflow of windfall funds does increase bank deposits that much.

4.3. Bank-level evidence of the effect of natural resource windfalls

We next turn to bank-level data to and make use of micro- rather than aggregate data, to be able to control for observed and unobserved bank-level characteristics that may influence the relationship between natural resource windfalls and financial intermediation. We have data available for almost 20,000 banks across 132 countries over the period 1986 to 2011. After conditioning on observables and dropping large clusters we are left with 6,237 banks in 105 countries between 1991 and 2011.[31] We modify the baseline model to include bank-level units of observation and regress:

$$\Delta F_{ibt} = \beta_1 \Delta P_{it} + \gamma_1 \Delta X_{it} + \gamma_2 \Delta Z_{ibt} + c_b + \varepsilon_{ibt}$$

where F is a bank-year level observation on the log of total deposits and short-term borrowing or log gross loans, P is the natural resource price index, X is an array of control variables at the country-year level including initial financial development, the rate of inflation and GDP growth, Z is an array of standard bank-year level characteristics including log total assets (size of the bank), net loans over total assets, and the non-interest share of total operating income, i denotes country, b bank, and t year. We include bank fixed effects c_b and cluster standard errors at the country level. We also test for the differential effect of resource price shocks on banks of different ownership. Specifically, we conjecture that foreign-owned banks might be less susceptible to the effects of natural resource rents, given their possible reliance on parent bank funding and lower susceptibility to governments' moral suasion.

The results in Table 6 show that changes in resource prices significantly reduce the bank-level volume of deposits, supporting our earlier findings at the country level. The coefficients in the bank-level regressions are larger than the regressions on the country-level, but follow the same pattern. Specifically, a 10 % increase in natural resource prices results in a 1.1 % reduction in deposits, relative to banks in countries that experience similar but non-resource-related growth rates.[32] These regressions control for bank-fixed effects and the global growth in deposits. This finding is consistent with Agarwal et al. (2020), who examine the bank-level effects of national shocks to the value of resource exports net of imports since 2004 and find that price shocks negatively correlate with lending for the average bank and only increase for banks directly exposed to the resource sector. Gilje (2019) finds, using local county-level data on the US shale boom, that while a boom increases absolute levels of local deposits these only translate into lending in those areas dominated by small (local) banks, which may also be more directly exposed to the resource sector than larger and more diversified banks.

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[31] We drop large countries with many banks (Germany and the United States) because simulations have shown that cluster-robust standard errors can be biased downwards if the clusters are unbalanced in size. Rogers (1994) suggests that no cluster should contain more than five per cent of the data.

[32] We restrict the sample to observations for which all three dependent variables are observed, of which government securities is the limiting factor. Table OA10 reports the same specifications with larger sample sizes and shows that the results become more precisely estimated.

Table 4
Components of deposits and credit.

	Components of Δ log *financial system deposits*				Components of Δ log *private credit*		
Dependent variable →	Δ log bank deposits	Δ log offshore bank deposits	Δ log foreign assets (banking institutions)	Δ log government deposits with banks	Δ log claims on central government	Δ log claims on state and local governments	Δ log claims on public non-financial corp.
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Δ log mineral price index, base 1970	−0.041**	0.042	0.232***	0.279***	0.109	0.163	0.105
	(0.016)	(0.031)	(0.085)	(0.091)	(0.133)	(0.194)	(0.107)
Lagged dependent variable	0.201**	−0.175***	−0.060	−0.253***	−0.082*	−0.312***	−0.122
	(0.083)	(0.059)	(0.051)	(0.086)	(0.048)	(0.033)	(0.099)
Standard controls included	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,052	2,035	2,005	3,000	2,852	1,037	1,614
Number of countries	107	107	101	100	99	49	66
R-squared	0.532	0.051	0.024	0.095	0.013	0.121	0.060

Notes: This table shows OLS estimates to estimate the effect of unexpected and exogenous windfall in natural resource revenue based on world prices (Δ log *mineral price index*) on sub-categories of financial system deposits and credit. By controlling for total GDP growth we estimate the differential effect of a windfall on countries that experience similar booms or busts but who experience them for different reasons. Standard controls include inflation and GDP growth, and initial financial development. We drop insignificant trailing lags of control variables, such that columns 1 and 3 also include a lag of inflation, and columns 1 to 4 a lag of GDP growth. Columns 5 to 7 control for deposit growth and in column 6 also its lag. Robust standard errors are clustered by country shown in parentheses. A constant and country fixed effects are included but not shown. ***, **, * correspond to the 1%, 5%, and 10% level of significance, respectively.

Table 5
Do government deposits lead to spending or to lending?

	Δ log central government consumption expenditure	Δ log private credit
	[1]	[2]
Δ log foreign assets (banking institutions)	0.015**	−0.017**
	(0.006)	(0.007)
Δ log government deposits with banks	0.012**	0.005
	(0.006)	(0.005)
Lagged dependent variable	0.081**	−0.007
	(0.035)	(0.050)
Δ log private-sector deposits with banks		0.147***
		(0.035)
Standard controls included	Yes	Yes
Country FE	Yes	Yes
Observations	1,815	1,834
Number of countries	93	95
R-squared	0.048	0.490

Notes: This table shows OLS regressions to estimate the effect of government deposit growth on government consumption and private lending. Standard controls include mineral quantity and unit cost changes, inflation (and its lag in column 1), deposit growth in column 2, GDP growth and its lag in column 2, and initial financial development. Robust standard errors are clustered by country shown in parentheses. A constant and country fixed effects are included but not shown. ***, **, * correspond to the 1%, 5%, and 10% level of significance, respectively.

The bank-level regressions also show a negative significant impact of natural resource price shocks on relative private sector lending growth when banks are not foreign owned (columns 3 and 4).[33] Finally, the results in columns (5) and (6) show a significant positive relationship between resource price shocks and banks' investment into government securities. Specifically, a 10 % positive shock to natural resource prices results in a 2.5 % increase in banks' government holding (column 5). When

[33] Within the sample of Table 6, 51 banks become foreign owned and 5 become no longer foreign owned (in Table OA10, 98 banks become foreign owned and 15 become no longer foreign owned). A third of banks are foreign owned over time. We also explored the level of institutions for differential effects among banks, but neither affected the results.

Table 6
Bank-level analysis: Natural resource windfalls and the relative decline in deposits.

	Dependent variable →	Δ log total deposits and short-term borrowing		Δ log gross loans		Δ log government securities	
		[1]	[2]	[3]	[4]	[5]	[6]
Δ log mineral price index, base 1970		−0.113**	−0.092*	−0.032	−0.060*	0.250*	0.243*
		(0.054)	(0.053)	(0.032)	(0.032)	(0.141)	(0.125)
Lagged dependent variable		−0.113**	−0.112**	−0.114*	−0.115*	−0.203***	−0.203***
		(0.054)	(0.054)	(0.066)	(0.066)	(0.018)	(0.018)
Bank's log tot assets (t-1)		−0.008*	−0.008*	0.004	0.003	0.004	0.004
		(0.005)	(0.004)	(0.005)	(0.005)	(0.009)	(0.009)
Bank's Net Loans / Tot Assets (t-1)		0.001	0.001	−0.002**	−0.002***	0.005***	0.005***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Bank's Non-interest share of total operating income (t-1)		−0.000	−0.000	0.000	0.000	−0.000	−0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Δ log global deposits		0.347***	0.339***				
		(0.084)	(0.084)				
Δ log mineral price index, base 1970	* Bank foreign owned (t-1)		−0.092		0.119*		0.032
			(0.063)		(0.068)		(0.213)
Bank foreign owned (t-1)			−0.008		−0.068***		−0.016
			(0.021)		(0.021)		(0.038)
Standard controls included		Yes	Yes	Yes	Yes	Yes	Yes
Bank FE		Yes	Yes	Yes	Yes	Yes	Yes
Observations		6,001	6,001	6,001	6,001	6,001	6,001

Notes: This table shows OLS regressions to estimate the effect of unexpected and exogenous windfall in natural resource revenue based on world prices (Δ log *mineral price index*) on deposit growth, loan growth, and investment in government securities, at the bank level. We drop large clusters (Germany and the United States) because simulations have shown that cluster-robust standard errors can be biased downwards if the clusters are unbalanced in size. The sample is further restricted to observations for which we observe all three dependent variables: Online Appendix Table OA9 reports results for larger samples. Rogers (1994) suggests that no cluster should contain more than five per cent of the data. We control for bank-level characteristics, which are interacted with the windfall. Standard controls include inflation, GDP growth and initial financial development. Columns 3 to 6 also control for the lag of GDP growth, and lags 0 to 1 of deposit growth. Robust standard errors are clustered by country shown in parentheses. A constant and bank fixed effects are included but not shown. ***, **, * correspond to the 1%, 5%, and 10% level of significance, respectively.

exploring differences across banks of different ownership, we find that the difference between domestic and foreign-owned banks affects gross loans most (column 4).[34]

In summary, the bank-level regressions confirm our aggregate regressions in that natural resource price shocks result in lower growth in financial system deposits, and show more evidence for a negative direct impact on bank lending. At the same time, banks hold more government securities following a natural resource price shock. As in the case of the aggregate regressions, it is important to note that these results are effectively comparing a positive growth shock due to natural resource rents with a positive growth not due to natural resource rent changes. This evidence points again to a process of dis-intermediation following exogenous natural resource price increases, consistent with the overall story of a natural resource curse in the financial sector documented in the literature.

5. Robustness tests

In this section, we subject our baseline regressions of changes in deposits and private sector lending to a series of additional robustness tests. First, the literature has recently started to use discoveries of giant oil and gas fields to identify the effects of natural resources (Arezki et al., 2017) To see if such giant discoveries affect our results, we use the same database as Arezki et al., from Horn (2003) and include discoveries in our baseline model. We allow for lagged effects because of the delay between discovery and production and possible export. We use dummies equal to 1 in any year between 1960 and 2003 that a country discovers at least one oil or gas field with a size of at least 500 million of barrels of oil equivalent (MMBOE) ultimately recoverable reserves, zero otherwise.[35] In addition, we measure discoveries as the log of field size in terms of ultimately recoverable reserves discovered. The results in Table 7 show that these discoveries do not affect our main results. We still find a relative decline in deposits following a resource price shock. Similarly, we find a less significant impact of natural resource price shocks on private sector lending. The discoveries themselves tend to increase deposits with a delay of 3 years, but the effects are small. Typically, discovery is followed by a substantial period of investment of 2–10 years to make

[34] We also experimented with interacting the windfall shock with the financial institutional variable of Table 3. However, this did not yield any significant results, most likely due to the small resulting sample size, because bank data starts in 1996 but the financial institutional data ends in 2005. In addition, we added to column 6 of Table 6 an interaction between the windfall shock and the bank's initial ratio of government securities held to total gross loans: we find a positive, but insignificant interaction.

[35] A factor of 1/0.006 is applied to convert gas in trillions of cubic feet to equivalent million barrels of oil.

Table 7
Robustness: Controlling for giant oil and gas field discoveries.

Dependent variable →	Δ log financial system deposits			Δ log private credit		
Discovery measured as →	*dummy*	*dummy*	log *ultimately recoverable reserves*	*dummy*	*dummy*	log *ultimately recoverable reserves*
	[1]	[3]	[3]	[4]	[5]	[6]
Δ log resource price index, base 1970		−0.046***	−0.045***		−0.005	−0.005
		(0.016)	(0.016)		(0.018)	(0.018)
Lagged dependent variable	0.227***	0.228***	0.228***	0.001	0.001	0.001
	(0.053)	(0.053)	(0.053)	(0.040)	(0.040)	(0.040)
Discovery	0.013	0.014	0.002	0.032*	0.032*	0.005*
	(0.014)	(0.014)	(0.002)	(0.018)	(0.018)	(0.003)
Discovery (t-1)	−0.011	−0.010	−0.002*	−0.026*	−0.026*	−0.004*
	(0.007)	(0.007)	(0.001)	(0.014)	(0.014)	(0.002)
Discovery (t-2)	0.001	0.001	0.000	−0.013	−0.013	−0.002
	(0.011)	(0.010)	(0.001)	(0.012)	(0.012)	(0.002)
Discovery (t-3)	0.012*	0.012*	0.002*	−0.017*	−0.017*	−0.002
	(0.007)	(0.007)	(0.001)	(0.010)	(0.010)	(0.001)
Discovery (t-4)	0.008	0.009	0.001	0.020	0.020	0.003
	(0.007)	(0.007)	(0.001)	(0.015)	(0.015)	(0.002)
Discovery (t-5)	0.000	0.001	−0.000	−0.022	−0.022	−0.003
	(0.011)	(0.010)	(0.001)	(0.017)	(0.017)	(0.002)
Discovery (t-6)	−0.017	−0.016	−0.002	−0.017*	−0.017	−0.002
	(0.012)	(0.012)	(0.002)	(0.010)	(0.010)	(0.001)
Discovery (t-7)	0.003	0.004	0.001	−0.003	−0.003	−0.000
	(0.010)	(0.010)	(0.001)	(0.012)	(0.012)	(0.002)
Discovery (t-8)	0.000	−0.000	−0.000	0.007	0.006	0.001
	(0.007)	(0.007)	(0.001)	(0.012)	(0.012)	(0.002)
Discovery (t-9)	−0.001	0.001	0.000	0.007	0.007	0.001
	(0.009)	(0.009)	(0.001)	(0.010)	(0.010)	(0.001)
Discovery (t-10)	−0.003	−0.002	−0.000	−0.028**	−0.028**	−0.004**
	(0.009)	(0.009)	(0.001)	(0.012)	(0.012)	(0.002)
Standard controls included	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,098	4,098	4,098	3,959	3,959	3,959
Number of countries	107	107	107	107	107	107
R-squared	0.390	0.392	0.392	0.461	0.461	0.461

Notes: This table shows OLS regressions to estimate the effect of unexpected and exogenous windfall in natural resource revenue based on world prices (Δ log *mineral price index*) on measures of deposit and credit growth, controlling for two measures of oil and gas field discovery. Hydrocarbons include oil, natural gas and coal. Standard controls include lags 0 to 1 of inflation and GDP growth in columns 1 and 2, and initial financial development. Columns 3 and 4 also include deposit growth but drop the lag of inflation which was always insignificant. Robust standard errors are clustered by country shown in parentheses. A constant and country fixed effects are included but not shown. ***, **, * correspond to the 1%, 5%, and 10% level of significance, respectively.

the fields productive and our regressions pick up an immediate effect on private credit (that is reversed in later years), presumably to finance the investment (Lei and Michaels, 2014; Toews and Vézina, 2020). Discovery leads to more substantial deposits several years after discovery. In contrast, positive price shocks that increase the value of current extraction directly lead to extra revenue. This windfall is however only partially intermediated by the financial system.[36]

Second, in the Online Appendix, we test the sensitivity of our findings to the use of different price indices. We have so far used a price index with extraction weights of base year 1970, but other indices commonly used in other contexts are the Paasche index and the Laspeyres chained index, where we allow the base year to change over time. Specifically, for each country, we construct the log change in the Paasche price index[37] of metals and minerals, with price base year 1970. We also include the log change in metal and minerals revenue (value of production) divided by the Paasche price index of metals and minerals, which indexes windfalls due to changes in production, and the log change in Paasche unit production cost index of metals and minerals, with base year 1970. For the Laspeyres chained index we allow for the index to be chained to extraction weights lagged three or five years. From the perspective of the windfall shocks these weights are predetermined but allow for some changes in the composition of mineral baskets. Results in Table OA8 show that these choices do not affect the main result that deposits relatively decline with a natural resource price shocks while there is a negative but mostly insignificant effect on private sector lending.

[36] In unreported results we also tested for anticipation effects (as in Cust and Mihalyi, 2017) by including leads of discovery events, but these were never significant, both when including and excluding our measure of windfall gains.

[37] The Paasche price index for several different minerals c that are mined in country i is defined as$P_i = \sum_c p_{ct} q_{ict} / \sum_c p_{c,t=0} q_{ict}$. The log first difference of this index for one good c is equivalent to the rate of inflation in good c. For multiple goods, it tracks the overall export price level faced by a country that produces a basket of goods.

Third, countries with sovereign wealth funds might be better able to smooth external shocks by keeping resource revenues in offshore accounts rather than letting all of them flow into the domestic economy. Norway for example, invests oil revenue directly abroad and only consumes the annual return on investment. We attempt to control for this possibility by constructing an indicator equal to 1 for each country-year in which a country has a natural resource based sovereign wealth fund. This is admittedly a crude measure because there is wide variation in the size of funds, their political independence and their management (Bernstein et al., 2013).[38] With this caveat in mind, our regressions presented in Table OA9 show significantly stronger negative effects on both deposits and lending for countries with a sovereign wealth fund. However, this effect is due to major oil exporters having sovereign wealth funds, such as Saudi Arabia. Deposits and lending show a much weaker relative decline for non-OPEC member countries with sovereign wealth funds. The differences in the way in which SWFs are run thus matters for the degree of intermediation by the private sector of windfall resource revenue.

6. Conclusion

This paper tests opposing hypotheses on the effect of natural resource windfall gains on the availability of financial services as measured by financial sector development. The *resource absorption hypothesis* posits a positive impact of additional income and wealth from windfall gains on financial sector deposits and loans and thus financial sector deepening. The *financial resource curse hypothesis* argues that additional resources do not enter the financial sector, but rather go into government coffers and off-shore accounts, while at the same time intermediation efficiency is negatively impact by the resource reliance of an economy; this ultimately points to a negative impact of resource windfall gains on financial sector deepening. A *modified financial resource curse hypothesis* argues that this is more likely to hold in countries with weak institutional and repressive regulatory frameworks. We argue that this undermines financial development and, ultimately, growth.

Our results show that the financial system plays a much more limited role in absorbing windfall gains, especially in countries with repressed financial systems and are thus in line with the *modified financial recourse curse hypothesis*. Specifically, controlling for the level of financial development, inflation, GDP growth and country fixed-effects, we find slower growth in the volume of financial sector deposits in countries that experience an unexpected natural resource windfall. Compared to the counterfactual of a country growing at similar speed, a doubling of commodity price inflation induces a relative decline of deposit growth by 4.5 % but increases relative growth of foreign assets by 23.2 % and government deposits with banks by 27.9 %, which in turn raises government consumption but not private lending. Moreover, we find that the relative volume of loans at the bank level also declines, although the decline in lending at the aggregate level is mostly due to the relative decrease in deposits.

Our results are in line with anecdotal evidence. For example, in 2004, the central bank governor of Nigeria wrote that "our banks are not engaged in strict banking business in terms of savings intermediation--- they are traders--- trading in foreign exchange, in government treasury bills" (Soludo, 2004, p5) and: "One of the recent developments in the banking system, which is of great concern to the monetary authorities is the significant dependence of many Nigerian banks on government deposits, with the three tiers of government and parastatals accounting for over 20 percent of total deposit liabilities of deposit money banks." (Soludo, 2004, p6).

Our results thus stress the importance of financial system development for economic growth, including in resource-rich countries. Strengthening financial institutions and financial reform is essential to turn future windfall natural resource income into more productive investment. Future work requiring substantial data collection would benefit from more detailed analysis of how governments tax and spend natural resource income. Our results also speak to the literature on natural resource curse and shows the importance of the financial sector as mechanisms through which natural resource rents can impede the development of a country.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jimonfin.2022.102769.

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[38] Countries with a natural resource based sovereign wealth fund are: Algeria, Azerbaijan, Botswana, Brunei Darussalam, Chile, Equatorial Guinea, Gabon, Iraq, Kazakhstan, Kiribati, Kuwait, Libya, Mauritania, Mexico, Norway, Oman, Qatar, Russian Federation, Saudi Arabia, Trinidad and Tobago, Turkmenistan, United Arab Emirates, United States, Venezuela.

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