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Mining activities and housing price nexus: evidence from South Africa

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Abstract

Purpose – Several studies have examined the impact of market fundamentals on house prices. However, the effect of economic sectors on housing prices is limited despite the existence of two-speed economies in some countries, such as South Africa. Therefore, this study aims to examine the impact of mining activities on house prices. This intends to understand the direction of house price spreads and their duration so policymakers can provide remediation to the housing market disturbance swiftly.

Design/methodology/approach – This study investigated the effect of mining activities on house prices in South Africa, using quarterly data from 2000Q1 to 2019Q1 and deploying an auto-regressive distributed lag model.

Findings – In the short run, we found that changes in mining activities, as measured by the contribution of this sector to gross domestic product, impact the housing price of mining towns directly after the first quarter and after the second quarter in the non-mining cities. Second, we found that inflationary pressure is instantaneous and impacts house prices in mining towns only in the short run but not in the long run, while increasing housing supply will help cushion house prices in both submarkets. This study extended the analysis by examining a possible spillover in house prices between mining and non-mining towns. This study found evidence of spillover in housing prices from mining towns to non-mining towns without any reciprocity. In the long run, a mortgage lending rate and housing supply are significant, while all the explanatory variables in the non-mining towns are insignificant.

Originality/value – These results reveal that enhanced mining activities will increase housing prices in mining towns after the first quarter, which is expected to spill over to non-mining towns in the next quarter. These findings will inform housing policymakers about stabilising the housing market in mining and non-mining towns. To the best of the authors' knowledge, this study is the first to measure the contribution of mining to house price spillover.

Keywords Africa, South Africa, ARDL model, House prices, Mining activities, Spatial residential analysis

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1. Introduction

House prices have been used to monitor the economic and financial sectors' performance in a country (Gupta and Hartley, 2011). Studies on house pricing and transaction dynamics are necessary due to the importance of home equity and housing to national wealth and regional economies. Lee and Chien (2011), report that regional housing prices have gained attention from academics and government policy-makers due to changes in asset prices, significantly impacting affordable homes. Changes in house prices within a local market, which sometimes spill over to other markets do not occur without triggers. The occurrence of house price spillover may be caused by changes in the business cycle, money market, mortgage lending rate and real estate sector. Spillover effects on house prices are well documented (Alexander and Barrow, 1994; Pollakowski and Ray, 1997; Stevenson, 2004; Luo, Liu and Picken, 2007; Lee and Chien, 2011; Grigoryeva and Ley, 2019; Bangura and Lee, 2019; González-Pampillón, 2022; Vizek, Stojčić and Mikulić, 2023; Bangura and Lee, 2023). However, findings on house price spillovers vary across different regions due to buyer behavioural enigma and contextual settings. Theoretical details for these phenomena are also insufficient, making previous studies in similar or other contexts unimplementable without considering current economic and social dynamics.

A thorough analysis of a nation's current economic and social conditions can help understand the potential spillover effects of house prices across different regions. While this is true, Bangura and Lee (2019) emphasise the importance of understanding economic linkages between regional housing markets, recommending that housing submarkets are the preferred option for analytical robustness. Thus, utilising housing submarkets to analyse house price patterns offers the following benefits. Firstly, it reveals important information about residential asset wealth distribution (Teye, Haan and Elsinga, 2018; Bangura and Lee, 2019). Secondly, it provides a better platform for analysing housing market dynamics (Meen, 2002; Bangura and Lee, 2019). Thirdly, policymakers, households, local and institutional investors and mortgage lenders could use the information to analyse house price movement for thorough planning and decision-making (Teng *et al.*, 2017; Teye *et al.*, 2018; Bangura and Lee, 2019; Bangura and Lee, 2023). The literature on the relationship between economic sectors and house price spillover at the submarket level is still exploratory, despite the significant role of economic activities in the housing market.

Accordingly, the Republic of South Africa, a developing nation in Africa offers an ideal case study. Sectoral contributions to the South African gross domestic product (GDP) are well documented (Boshoff and Fourie, 2020). However, a careful study of the economic dynamics of these sectors reveals a huge contribution of mining to the GDP, leading to a spiralling effect on the housing sector (Kane-Berman, 2018). For instance, there was a steady growth in house prices from 2000–2010, with structural breaks from 2008–2009, which coincided with the Global Financial Crisis (GFC) debacle. Delmendo (2022) also revealed that house prices increased by 51% from 2011–2019, but the growth was negatively affected by inflation. Balcilar *et al.* (2013), Simo-Kengne, Gupta and Aye (2014) and Gupta and Sun (2020) are known South African studies that examined regional house price interrelationships. However, these analyses of house prices did not consider specific shocks from the mining boom and bust that could assist policymakers in decision-making.

The South African housing markets are characterised by gentrification and uneven distribution of population across the different income strata (Beier, 2023; Karuri-Sebina and Beckley, 2023). Additionally, the insufficient analysis of South Africa's house price spread may probably be the reason for developers' investment in housing development, providing a short-term advantage (Ingwani *et al.*, 2023). Therefore, studying the dynamics surrounding mining and its influence on the South African housing markets relative to changes in volatility across the country is imperative. We used the house price index of mining and non-mining towns to create submarkets in this study. The rationale for defining housing submarkets, using South African mining and non-mining towns, is predicated on the fact that within a mining conglomerate lies a response towards external stimuli considered "price instigator". Thus, the objective of this study is to evaluate whether house price spillovers across different regions in the Republic of South Africa are interrelated in terms of the scale of mining operations.

The primary motivation, among others, is to assist in unravelling the origin of house price shocks between mining and non-mining towns, so that policymakers could swiftly respond to prevent disturbances (Balcilar *et al.*, 2013) and uneven house planning and development patterns in the housing market. Thus, the likelihood of spillovers in house prices between South African mining and non-mining towns can relatively be linked to one or more of household behavioural drivers and spillover theoretical frameworks including migration or replaced demand, equity transfer or displaced demand, spatial arbitrage and spatial patterns in the determinants of house prices earlier suggested in (Meen, 2002; Grigoryeva and Ley, 2019; Bangura and Lee, 2019). Despite the contribution of mining activities to the economies of many nations including the Republic of South Africa, no study has examined the impact of this economic sector on the behaviour of house prices. Our study is the first to investigate the correlation between house prices in mining and non-mining towns. Using mining and non-mining towns to define housing submarkets in the Republic of South Africa, we documented the following findings.

First, we found that rising mining activities directly impact house prices in mining towns, as increased demand for skilled and unskilled employees will trigger migration which leads to higher house prices. Second, the study revealed a one-directional relationship between house prices in mining and non-mining towns, with mining towns' prices spilled over to non-mining towns in the second quarter. This is intuitively appealing as some residents in the mining towns may tend to buy houses in the non-mining towns when their income improves. Some mining workers may also shuttle between mining and nearby non-mining towns with better amenities. This is consistent with economic theory which states that as household income increases (from mining operations in this case), household spending will increase relative to different housing types with attendant facilities (Nelson, 1988). Third, we found mortgage lending rate and housing supply to be significant drivers of house prices in the mining towns over time, while all the explanatory variables in the non-mining towns are insignificant. The study provides insights into the one-way house price spillover between mining and non-mining towns, aiding housing policymakers in stabilizing the housing market. This could also inform the decisions of housing investors about house price activities in the market.

This paper is organised as follows. Section 2 is a review of related literature, including the South African housing market. The methodology and data used in this study are discussed in Section 3. The results and discussion are in Section 4, whereas the concluding statements are in Section 5.

2. Literature review

Past works on determining house prices are vast (Brzezicka, 2021; Herath and Maier, 2010). There is a wide range of authors and a plethora of work that discusses and develops models to understand the dynamics of house prices (Zulkifley *et al.*, 2020; Herath and Maier, 2010). Some of these authors examine the dynamics of house prices across different countries. For example, Holly *et al.* (2011) illustrate how region-specific and spatial effects from a dominant region such as London impact other regions in the UK. London house prices thereafter are impacted by international housing markets, as the authors show that New York house prices have a direct effect on London house prices. Pijnenburg (2017) examines heterogeneity across time and space in spatial house price spillovers and heterogeneity in the effect of fundamentals on house price dynamics in the USA. Using 319 metropolitan statistical areas, results show that house prices in neighbouring regions spillover more in times of increasing neighbouring house prices. Furthermore, real per capita disposable income and the unemployment rate have a homogeneous effect across time and space. Xu and Zhang (2023a, 2023b) examine the impact of house price information flows in 12 major cities in China from 2010 to 2019. Using a wavelet analysis that considers time and frequency domains, the authors find that the housing prices of all cities significantly affect each other beyond 16 months of the frequency domain. Xu and Zhang (2023a, 2023b) investigate the cointegration between monthly house prices in 100 Chinese cities from 2010 to 2019 using time-invariant and time-varying approaches using wavelet transformations. The findings show different price relationships across different pairs of cities, and the housing price information of certain cities could be reflected in that of other cities at a relatively large magnitude.

Despite the benefits of utilising housing submarkets in house price analysis, Bangura and Lee (2019), observed that few scholars consider house price spillovers in housing submarkets. In Hong Kong, Ho, Ma and Haurin (2008), used a four quality-tiered definition of submarkets. Wilson *et al.* (2011) segregated the Aberdeen housing market into three submarkets. Teye *et al.* (2018) used 15 officially designated submarkets in Amsterdam, The Netherlands. Bangura and Lee (2019) used a price disparity (low-priced and high-priced), in their definition of housing submarkets in Greater Sydney, Australia. Zhang *et al.* (2020) used the constrained clustering technique within the Markov chain to detect 16 submarkets in Beijing, China. Also, Hu *et al.* (2020) used the average house prices and merged 194 subdistricts into 25 submarkets in Shanghai, China. The work of Holly *et al.* (2011), Pijnenburg (2017) and Xu and Zhang (2023a, 2023b) focuses on the impact of housing spillovers from one housing market to another; Bangura and Lee (2019) consider house price spillover in submarkets; whilst this is an essential attribute in determining house prices, the authors fail to consider other critical macro-economic variables that explain house prices.

Hossain and Latif (2009) identify the determinants of housing price volatility in Canada; the authors examine the role of house price volatility and key macro-economic variables. Results show that house price volatility is impacted by GDP growth rate, house price appreciation rate and inflation. The work of Ozus *et al.* (2007) extends beyond the role of macroeconomic variables in explaining house prices as the authors examine the spatial distribution of house prices at the metropolitan and district level in Istanbul, Turkey. There was a difference in variables which impact house prices in district and metropolitan levels. For instance, for metropolitan levels, variables that impact house prices include sub-market, floor area and sea view, whilst at the district level house prices vary based on location, socio-economic and property characteristics. Hossain and Latif's (2009) and Ozus *et al.*'s (2007) papers differ in results, as the latter uses micro-economic variables while the former uses macro-economic variables in explaining house prices.

In further understanding the dynamics of house prices, other authors have examined the significance of market fundamentals in explaining house prices. Plakandaras *et al.* (2020), for example, examined the role of macroeconomic shocks in determining house prices focusing on the UK and the US housing markets. Beltratti and Morana (2010) investigated the linkages between general macroeconomic conditions and the housing market for the G-7 countries, and they found that the USA is an important source of global fluctuations for real house prices. The importance of macroeconomic variables in explaining house prices remains essential in the understanding of house prices, however, these papers fail to consider the role of specific economic attributes in understanding house prices.

Earlier, the Productivity Commission Inquiry Report (2004) of Australia documented the increasing importance of income improvement in entering the housing market, especially for first homebuyers. This is reiterated in the study by Bangura and Lee (2023) who found income to be a critical factor in the pursuit of homeownership. Yates (2008) and Worthington and Higgs (2013) each found housing supply boost to have a favourable effect on house prices due to the sluggish response of supply to the competing housing demand. Migration also plays an important role in the housing market. According to Lee's (1966) push–pull migration theory, the decision to migrate is often determined by a set of push and pull factors. Lee (1966) defined the push factors as adverse economic and non-economic situations in the community where people live before migrating, while the pull factors are the attractions in the destination area including job opportunities, better housing, standard of living and educational facilities. Other authors have explored the determinants of house prices through micro-economic indicators such as the role crime rates play in explaining house prices such as Lynch and Rasmussen (2001), Ihlanfeldt and Mayock (2010); the role of good quality schools in the dynamics of house prices as seen in Kane *et al.* (2006) and Turnbull *et al.* (2018).

There exists sparse literature on house price spillover effects in the South African housing markets but with variegated focus. Das *et al.* (2011) concentrated on the influence of house price spillover on the South African consumption. The study used a 40-year house price quarterly data (1969:Q2 to 2009:Q3) built on the unit root test across different segments (aggregate, large, medium and small-medium) of the housing markets. The purpose was to use house price movements to discover their role in influencing the consumption decisions of the household. The study found that an increase in house price would trigger either way – upward or downward movement in consumer expenditures. Gil-Alana *et al.* (2013) also used different segments of the housing markets (affordable, luxury, middle segment) of different sizes to test for the existence of persistence in house price movement. The quarterly house price data was used with staggered periods for different middle-segment (1966:Q1 to 2012:Q1); luxury segment (1966:Q3 to 2012:Q1) and affordable segment (1969:Q4 to 2012:Q1), aided by the fractional integration model. In all the results show transitory shocks in affordable and luxury segments which disappear in the long run, while the middle segment demonstrate permanent shocks.

Balcilar *et al.* (2013) also segregated the South African housing markets into large, medium and small sizes to test for spillover effects in house prices in five metropolitan areas (Cape Town, Durban Unicity, Greater Johannesburg, Port Elizabeth/Uitenhage and Pretoria). The study covers a 44-year period spanning 1966:Q1 to 2010:Q1 and found that the large housing segment in the city of Cape Town is the point of origin of spillover and medium- and small-sized houses in Durban.

Simo-Kengne *et al.* (2014) examine the economic rationale behind the house price co-movement using 37 year-quarterly data, from 1974:Q1 to 2011:Q4. The result shows that all macroeconomic shocks are responsible for house price movements. Thus, overwhelming evidence of house price spillovers was found between the cities and the national house prices in the South African housing market. Still, the direction of flow and magnitude were not captured. Gupta and Sun (2020) evaluate the existence of house price spillovers using quarterly data covering 44 years from 1971:Q1 to 2015:Q3, in South Africa. Inferences from the study suggest the presence of spillovers in house prices triggered by house preference and technology shocks in the consumption sector coupled with a flexible exchange rate policy and activities of the Reserve Bank. There is an enormous literature on the determinants of house prices in South Africa; while some authors focus on spillover effects such as Das *et al.* (2011), some focus on house price movements in different real estate market segments such as Gil-Alana *et al.* (2013). Some authors go on further to understand determinants of housing consumption such as Gupta and Sun (2020).

However, none of these factored in the contribution of mining to house price shocks and the likelihood of transmission to non-mining regions and possibly recursive ripple to mining towns. Thus, it is argued that a robust economic linkage (in-house purchases) occurs between mining and non-mining towns in South Africa. Relative to house price linkages between regional housing markets, several studies have evaluated the magnitude of house price spread, from one market to another (Luo *et al.*, 2007; Lee and Chien, 2011; Taltavull de La Paz *et al.*, 2017; Chen and Chiang, 2019). Our current work attempts to understand the impact of mining activities in understanding the dynamics of house prices in South Africa. Prior work on housing literature has examined how macro-economic indicators such as GDP, real GDP and GDP growth rate can significantly explain house prices (Xu, 2017), however, there is a dearth of literature on how mining activities can explain house prices in mining areas. Therefore, this study examines this and uses unique data from South Africa to explore the role of mining activities in explaining house prices.

3. Data and Methodology

3.1 Mining activities, mining towns in South Africa

The Department of Mineral Resources and Energy in South Africa, as of 2022, lists 2004 operating mines in South Africa. These operating mines are spread across 225 mining towns within 9 provinces (Eastern Cape, Free State, Gauteng, Kwazulu-Natal, Limpopo, Mpumalanga, Northern Cape and the Northwest) in South Africa. The Eastern Cape province of South Africa has the most towns with mining activities in South Africa, with a total of 44 mining towns, while the north-west province has the lowest number of mining towns with mining activities, with a total of 15 mining towns. Figure 1 displays mineral mines in nine South African provinces, with mining towns arranged across commodity symbols. Barkly West, a mining town in the Northern Cape province of South Africa, has the most operating mines in South Africa, with 91 operating mines as of 2022.

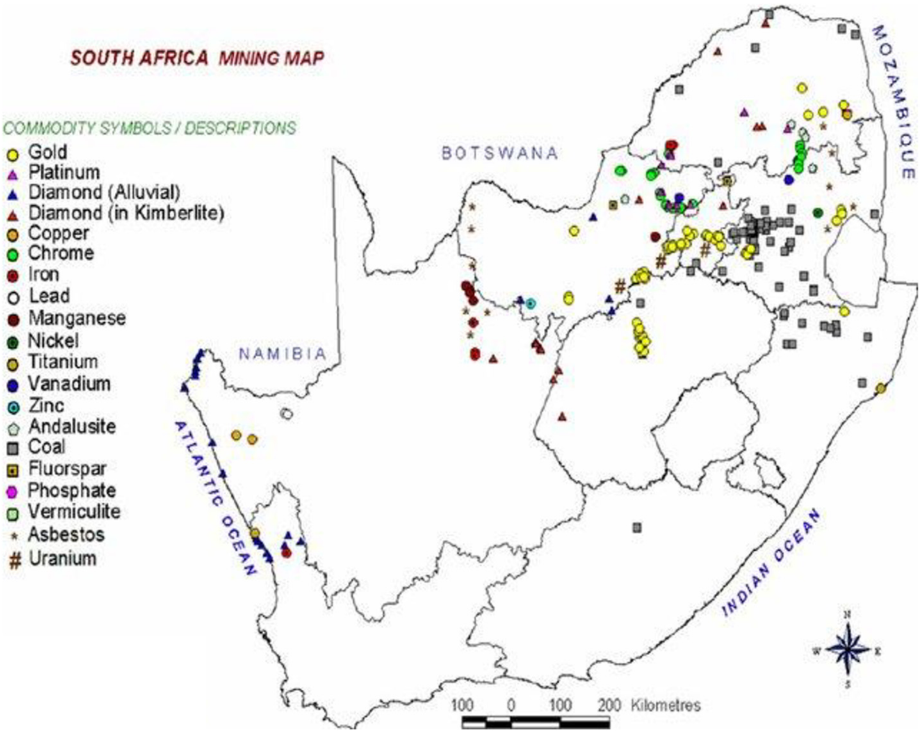
As of 2022, the value of mining production in South Africa was ZAR1.2tn (US$71.5bn), contributing ZAR483.3bn (US$28.4bn) and providing for 469,353 jobs (Minerals Council South Africa, 2022).

3.2 Data

The First National Bank (FNB) housing index for mining and non-mining towns is retrieved from INET BFA McGregor database. These are quarterly data from January 2000 to March 2019. Economic indicators such as the percentage of mining production to GDP, the proportion of total employees in mining, housing supply, inflation and interest rates were retrieved from Quantec database.

The FNB house price index is a repeat sales house price index [1] that is based on the Case–Shiller methodology which is used when calculating the Standard and Poor's Case–Shiller Home indices in the USA. The FNB house price index used in this paper is compiled by the FNB in-house valuation team and based on the residential properties financed by FNB. There are certain cut-offs to the data- the maximum price cut-off is R15m (US$794,000) and the minimum price cut-off is R20,000 (US$1,058). The FNB mining Towns index is compiled from deeds office data, and this data involves transactions by individuals.

3.2.1 Descriptive statistics. Table 1 summarizes the mining and non-mining housing index and economic variables such as the percentage of mining production to GDP, the proportion of total employees in mining, housing supply, inflation and interest rates. The data is from 2002 to 2019 and shows the mean, median, standard deviation, minimum and maximum of the data. The economic variables used are represented in Table 1.



Source: Council for Geoscience, South Africa

Figure 1.
South African mining map

Table 1.
Summary statistics of the variables

Statistic	Mining	Non-mining	Mining % production GDP	Mining % total employee	Housing supply	CPI	Interest rates
Mean	357.52	356.83	8.00	5.5	55.91	59.25	11.43
Median	392.34	391.34	7.00	5.66	55.51	57.1	10.5
Max.	566.45	576.17	10.00	6.23	61.98	88.70	17
Min.	90.09	90.17	5.90	4.43	52.94	37.55	8.5
Std. Dev.	158.39	158.41	1.40	0.52	1.96	15.70	2.41

Source: Authors

The standard deviation of the variables ranges from 1.4% for the contribution of mining production to GDP and 158.41 for the non-mining housing indexes. The sample mean of the variables ranges from 8% for the contribution of mining production to GDP to 356.83 for the non-mining housing index. The interest rate in South Africa averaged around 11.43% in the study period but increased to 17% and a minimum rate of 8.5%. The mean of inflation rates in South Africa represented by the consumer price index (CPI) is 59.25, while the mean of the housing supply index stands at 55.91.

3.3 Methodology

We used the auto-regressive dynamic lag (ARDL) model developed by Pesaran *et al.* (2001). According to Pesaran *et al.* (2001), the ARDL model was developed because the dependent variable often responds to the explanatory variables with a lapse of time. As housing decisions are in most cases not instantaneous, it is appropriate to introduce lagged values of variables in its regression model. Additionally, the ARDL model exhibits the following advantages: it does not require the variables to have the same level of stationarity; it produces a valid estimate even with a small sample size; it examines the short and long-run relationships between a set of time series variables; and it has inherent features that can correct any potential endogeneity and unbiased issues in the model. However, the model does not accommodate a variable with a second difference stationarity (Pattak *et al.*, 2023; Li *et al.*, 2022). As there is no variable with a second difference stationarity, we, therefore, used the ARDL model to examine the effects of mining activities and other variables on house prices in mining and non-mining towns of South Africa. As a precursor to the ARDL estimation, we conducted a unit root test using the Augmented Dickey–Fuller (ADF) and an ARDL bounds test developed by Pesaran *et al.* (2001) to check for cointegration of the variables. Following Pesaran *et al.* (2001), the ARDL model of our study becomes:

$$\Delta LnHPT_t = \alpha_0 + \alpha_{1i}LnHPT_{t-1} + \alpha_{2i}LnMPGDP_{t-1} + \alpha_{3i}LnTE_{t-1} + \alpha_{4i}LnHS_{t-1} + \alpha_{5i}LnCPI_{t-1} + \alpha_6 LnHLR_{t-1} + \sum_1^k \beta_{1i}\Delta LnHPT_{t-i} + \sum_0^k \beta_{2i}\Delta LnMPGDP_{t-i} + \sum_0^k \beta_{3i}\Delta LnTE_{t-i} + \sum_0^k \beta_{4i}\Delta LnHS_{t-i} + \sum_0^k \beta_{5i}\Delta LnCPI + \sum_0^k \beta_{6i}\Delta LnHLR + \varepsilon_t \quad (1)$$

From equation (1), HPT denotes the housing price of a given town (mining or non-mining town), MPGDP denotes the monetary value of mining production as a percentage of the country's GDP, TE denotes the proportion of employees in the mining sector; HS denotes housing supply in a given town, CPI is the consumer price index and HLR denotes housing lending rate. The parameters α_0 is a constant, $\alpha_{1\text{-}6}$ are the long-run parameters because the sum of these slope coefficients gives the total change in the mean value of housing price of a given housing market given a unit change in the explanatory variables at time t, $\beta_{1\text{-}6}$ are the short-run parameters, as they measure the change in the mean value of the housing price of a given market, following a unit change in a given explanatory variable at the same time, and k denotes the optimal number of lags of the variables in difference. From equation (1), the error correction model of the cointegration test is defined as follows:

$$\Delta \mathrm{LnHPT}_{it} = {}_{\theta\tau t-1} + \sum_1^k \beta_{1i}\Delta LnHPT_{t-i} + \sum_0^k \beta_{2i}\Delta LnMPGDP_{t-i} + \sum_0^k \beta_{3i}\Delta \mathrm{LnT}E_{t-i} + \sum_0^k \beta_{4i}\Delta \mathrm{LnHS}_{t-i} + \sum_0^k \beta_{5i}\Delta LnCPI_{t-i} + \sum_0^k \beta_{6i}\Delta LnHLR_{t-i} + \varepsilon_t \quad (2)$$

From equation (2), $\Theta_{\tau\, t\text{-}1}$ is the error correction term, $_\Theta$ is the cointegration parameter, while Δ is the difference factor and it denotes the short-run effects. The null hypothesis of no cointegration states *H0*: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0$ against the alternative hypothesis of cointegration *H1*: $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq \alpha_6 \neq 0$. We use the F-test to show the joint significance of these coefficients. This is compared with the critical values of the upper and lower bounds that are generated. We reject the null hypothesis if the F-statistic is greater than the upper bound, showing there is cointegration, while a rejection of the null hypothesis is when the F-statistic is below the lower bound, suggesting the lack of cointegration between the variables. If the F-statistic lies between these two bounds, the results are undefined (Pesaran *et al.*, 2001). We determine the optimal lag k by using the Akaike information criterion, Schwarz information criteria and Hannan–Quinn information criteria. We introduce logs in the variables to reduce spread.

4. Results and discussion

4.1 Presentation of results

The ADF unit root results are reported in Table 2. The housing price of mining town, housing price of non-mining town, monetary value of mining production as a percentage of the country's GDP, housing supply and housing lending rate are stationary on level at the relevant significance levels. These variables are I(0) stationary. The proportion of employees in the mining sector, and consumer price index are stationary on first difference, suggesting they are I (1) stationary. These different levels of stationarity in the model shows the appropriateness of using the Bounds cointegration test. The results of this cointegration test are presented in Tables 3 and 4.

From Table 3, there is evidence of cointegration between the housing price of mining towns and the explanatory variables as the F-statistic of 7.24 is above all the upper bound levels of significance including the 1%. As reported in Table 4, similar evidence of cointegration is found between the housing price of non-mining towns and the explanatory variables as the F-statistic of 10.61 is greater than all the upper bound levels of significance.

	Level		First difference	
Variable	Lag length	*t*-statistics	Lag length	*t*-statistics
Housing price of mining town	4	−2.76*		
Housing price of non-mining town	1	−3.21**		
Mining production as a % of GDP	7	−2.90***		
Employees in the mining sector	0	−0.47	0	−7.86***
Housing supply	1	−2.95**		
Consumer price index	1	0.50	0	−5.50***
Housing lending rate	1	−2.63*		

Note: *; ** and *** denote the rejection of the tested hypothesis of no unit root at the 10, 5 and 1% significance level respectively
Source: Authors

Table 2. Results of the ADF unit root

ARDL equation	F-statistic	Bounds	1%	2.5%	5%	10%
$LnHPT_m = F$(LnMPGDP,	7.24***	Lower bound	3.06	2.70	2.39	2.08
LnTE, LnHS, LnCPI, LnHLR)	7.24***	Upper bound	4.15	3.73	3.38	3.00

Notes: ***; ** and * denote there is cointegration at 1, 5 and 10% significance level respectively; subscript m denotes mining town
Source: Authors

Table 3. ARDL bounds cointegration results for mining town

These results are a confirmation of the existence of a long-run relationship between the housing price of each of the towns under study and the set of explanatory variables. Our diagnostic results also reveal no serial correlation and there is homoskedasticity in each equation as the *p*-value for both tests are above the critical value of 0.5 for mining and non-mining towns each. Overall, our model is a good fit. The short-run and long-run ARDL results for mining and non-mining towns are reported in Tables 5 and 6, respectively. We define short-run in terms of the quarterly change in the variables in a year, while long-run is the effect of the change in the explanatory variables on the dependent variable over the entire study period. The use of a log-log model means our results represent elasticities.

4.1.1 Results of mining towns. From Table 5, the results show that the variable of interest in the model, the monetary value of mining production as a percentage of the country's GDP, does not instantly impact house prices in mining towns. It shows that the effect of mining

ARDL equation	F-statistic	Bounds	1%	2.5%	5%	10%
$LnHPT_{nm}$ = F(LnMPGDP,	10.61***	Lower bound	3.06	2.70	2.39	2.08
LnTE, LnHS, LnCPI, LnHLR)	10.61***	Upper bound	4.15	3.73	3.38	3.00

Notes: ***; ** and * denote there is cointegration at 1, 5 and 10% significance level; respectively; subscript nm denotes non-mining town
Source: Authors

Table 4.
ARDL bounds cointegration results for non-mining town

Short-run estimates	Coefficient	*p*-value
$lnHPT_m$ (−1)	2.96	0.00***
$lnHPT_m$ (−2)	3.51	0.00***
$lnHPT_m$ (−3)	2.01	0.00***
$lnHPT_m$ (−4)	−0.46	0.00***
lnMPGDP	0.45	0.34
lnMPGDP (−1)	1.68	0.00***
lnMPGDP (−2)	1.07	0.03**
lnTE	0.53	0.03**
LnTE (−1)	−0.51	0.02**
LnHS	−0.03	0.00***
LnCPI	0.08	0.03**
LnCPI (−1)	0.02	0.65
LnCPI (−2)	−0.09	0.00***
LnHLR	−0.02	0.00***
LnHLR (−1)	0.01	0.08*
C	0.10	0.02
Long-run estimates		
lnMPGDP	79.85	0.17
lnTE	2.84	0.92
lnHS	−6.59	0.07*
lnCPI	1.76	0.21
LnHLR	−2.62	0.07*
C	25.06	0.07*

Notes: ***; ** and * denote that variable is statistically significant at the 1, 5 and 10% significance level, respectively
Source: Authors

Table 5.
Short- and long-run ARDL results for mining town

Short-run estimates	Coefficients	p-value
$\ln HPT_{nm}$ (−1)	0.59	0.00***
$\ln HPT_{nm}$ (−2)	0.20	0.21
$\ln HPT_{nm}$ (−3)	0.21	0.11
lnMPGDP	−9.01	0.26
lnMPGDP (−1)	1.05	0.87
lnMPGDP (−2)	2.04	0.00***
lnMPGDP (−3)	1.95	0.02**
LnMPGDP (−4)	1.70	0.02**
LnTE	3.91	0.17
LnTE (−1)	0.04	0.99
LnTE (−2)	1.43	0.68
LnTE (−3)	−1.89	0.58
LnTE (−4)	−5.08	0.08*
LnHS	−0.31	0.01**
LnCPI	0.15	0.71
LnCPI (−1)	0.57	0.39
LnCPI (−2)	0.92	0.17
LnCPI (−3)	−1.29	0.01**
LnHLR	−0.16	0.00***
C	1.14	0.11
Long-run estimates		
lnMPGDP	−93.29	0.83
lnTE	3.04	0.85
lnHS	60.65	0.84
lnCPI	−9.20	0.82
LnHLR	30.84	0.84
C	−218.85	0.85

Note: ***; ** and * denote that variable is statistically significant at the 1, 5 and 10% significance level, respectively
Source: Authors

Table 6. Short- and long-run ARDL results for non-mining town

boost on house prices begins in the first quarter and continues in the following quarter. This is a cyclical pattern that is supported by the significance of the variable's first and second lags at the 1% and 5% significance levels, respectively. We found that a percentage increase in the monetary value of mining production will increase the housing price of mining towns by 1.68% in the next quarter, holding everything else constant. This is supported by the immediate, positive and statistically significant relationship at the 5% level between the proportion of employees in the mining sector and house prices in mining towns. However, the coefficient of the first lag of the proportion of employees in the mining sector is negative and statistically significant, indicating a cooling period in house prices in mining towns after the immediate reaction of workers migrating to mining towns when there is a mining boom.

As expected, increasing the supply of housing could reduce house prices in mining towns, while inflationary pressure could raise house prices. The reactions of both housing supply and inflation are instantaneous and statistically significant at 1% and 5%, respectively. Holding all other variables constant, a percentage increase in housing supply is expected to reduce house prices in the mining towns by 0.03%, while inflationary pressure is expected to increase the house prices in the mining towns by 0.08%. The housing lending rate, a measure of the cost of a home loan, is negative and statistically significant at the 1% level. Owing to the immediate effect of inflation, raising the cost of borrowing will adversely affect households' purchasing power, and this may slow down the demand for housing and, by extension, the house prices in mining towns. The results further reveal that, over time, housing supply and housing lending rate are the only statistically significant variables at 10% each. This shows the critical role of these variables in shaping the supply side and demand side of the housing market in mining towns in South Africa.

4.1.2 Results of non-mining towns. The results in Table 6 show that the monetary value of mining production as a percentage of the country's GDP does not instantaneously impact house prices in non-mining towns until the second quarter and then through to the fourth quarter. The coefficients of the second and third lags of this variable are statistically significant at the 1% and 5% levels, respectively. Holding all other variables constant, a percentage increase in the monetary value of mining production will increase the housing price of mining towns by 2.04% and 1.95% in the second and third quarters, respectively. The delay in the reaction of house prices in non-mining towns to the mining boom suggests the possible existence of a conduit through which the impact is channelled. The effect of a rise in the proportion of employees in the mining sector on house prices in non-mining towns is only felt after four quarters and at the 10% significance level. This shows that employment activities in the mining sector do not have an immediate effect on house prices in non-mining towns. Similar to mining towns, increasing housing supply is expected to lower house prices in non-mining towns at the 5% significance level, while the direct impact of inflation will only be realised after three quarters. The housing lending rate also has an immediate and statistically significant effect at the 5% level on house prices in the non-mining towns. This means the high cost of borrowing could limit households' access to home loans, and this could slow down housing demand and house prices in non-mining towns. In non-mining towns, all of the explanatory variables are statistically insignificant over time, which suggests that these variables only have an impact on house prices during the four quarters of the year.

Overall, a closer look into the housing markets of mining and non-mining towns reveals significant differences in the effect of the demand-side explanatory variables of the market. However, on the supply side, the effects are similar in both housing markets. These discrepancies on the demand side of the market trigger the next stage of our analysis, which explores any possible spillover in house prices between mining and non-mining towns. As argued by Bangura and Lee (2020), an understanding of house price movements would provide important information that could be used for better market analysis and prediction in the housing market. We begin the spillover analysis by testing for cointegration between house prices in mining and non-mining towns to examine any possible long-run relationship between these housing markets. From the ARDL bounds cointegration results in Tables 3 and 4, both results rejected the null hypothesis of no cointegration at the 1% significance level. This is followed by a causality test to explore any spillover effect using the pairwise Granger causality reported in Table 7.

Null hypothesis	F-statistic	*p*-value
House prices of mining towns do not Granger cause house prices of non-mining towns	24.89	0.00***
House prices of non-mining towns do not Granger cause house prices of mining towns	1.40	0.24

Notes: House prices of mining and non-mining towns are stationary on level at the 10 and 5% significance level; ***denotes a rejection of the tested hypothesis at the 1% significance level; **is a rejection of the null hypothesis at 5% significance level and *is a rejection of the tested hypothesis at 10% significance level
Source: Authors

Table 7. Results of pairwise Granger causality

The results from Table 7 show evidence of spillover in house prices from mining towns to non-mining towns without any reciprocity. These results reveal that rising mining activities will increase house prices in mining towns after the first quarter and this is expected to spillover to non-mining towns in the next quarter. These findings have enhanced our understanding of the housing markets of mining and non-mining towns, and this will inform housing policymakers in stabilising the housing market of these towns.

4.1.3 Discussion of results. Our study on the nexus between mining activities and the house prices of mining and non-mining towns reveals some fascinating findings. First, we found a direct link between mining activities and house prices in mining towns after the first quarter, and then in non-mining towns after the second quarter. This result revealed that the expansion of mining operations is expected to attract employees into the area which could drive housing demand and in turn cause house prices to increase. Additionally, an increase in the monetary value of mining production may likely raise the income level of people in these towns and this may increase their purchasing power for housing products. This is espoused by the findings of the Productivity Commission Inquiry Report (2004) of Australia, which documented that an improvement in income could boost the chances of entering the housing market. Similar findings were reported by Bangura and Lee (2023) on the importance of income in the pursuit of homeownership. As such, linking mining activities and housing market is a key finding that illuminates the effect of rising operational activities in a given economic sector on house prices, an aspect of the literature on house price behaviour that has not been examined.

Second, as more workers migrate to the mining towns, it creates an immediate increase in house prices in these towns but the market cools down after the first quarter. This cooling period is extended to the non-mining housing market in the fourth quarter. This result implies mining boom could be a pull factor that attracts the working population to mining towns, supporting Lee (1966), who theorised that job opportunities are a pull factor that attracts people to migrate to the area. The immediate and indirect effect of the housing lending rate on house prices in mining and non-mining towns is consistent with the previous findings of Worthington and Higgs (2013) and Yates (2008). As a measure of the cost of borrowed funds in the capital market, a high lending rate could affect households' financial capacity to enter the housing market, a situation that could lower housing demand and by extension house prices especially in the mining towns where inflation has an immediate effect which could exacerbate pressure on households' expenditure.

Third, from the supply side of the market, we found that increasing housing supply will reduce house prices in both towns, highlighting the critical role of increasing housing stock in the market to slow down house prices. This result supports the findings of Bangura and Lee (2023) who also reported the importance of increasing housing supply to help reduce the pressure of rising house prices on households. This result is also consistent with the findings of Lee and Reed (2014) who reported that an increase in housing supply is expected to cushion the effect of rising house prices, especially for first homebuyers.

Fourth, using mining and non-mining towns to define housing submarkets in the Republic of South Africa, our study showed that house prices of these towns are not disconnected. We found a one-way-directional relationship in house prices between mining and non-mining towns, flowing from the mining towns to the non-mining towns in the second quarter. Factors such as the increase in household income and the growing dis-amenities in the mining towns, over time, may trigger some residents in the mining towns to buy houses in the non-mining towns. Improved transport systems may also cause some mining workers to live in nearby non-mining towns and shuttle to work in the mining towns.

Finally, market fundamentals such as mortgage lending rate and housing supply are critical drivers of house prices in the mining towns in the long run, while all the explanatory variables in the non-mining towns are insignificant. The results generally showed that changes in macroeconomic variables such as mortgage lending rate, housing supply and mining operations could prompt changes in house prices in mining towns which is expected to spillover to the non-mining towns in the second quarter.

5. Conclusion

The rising global house prices including developing nations has become topical in many housing research and policy discussions. Previous studies have examined house price dynamics from a range of perspectives including its determinants, spatialization of housing markets, co-movements and the spillover between various housing markets including submarkets. From the scope of these studies, the missing piece in the literature is the role of sector-specific in influencing house prices. One sector that continues to impact the economies of many nations, especially in the developing world is the mining sector. It is therefore critical to examine the impact of mining activities on house prices. To fill this gap in the literature, we examined the effect of mining activities on house prices in the Republic of South Africa, using quarterly data from 2000Q1 to 2019Q1, deploying an ARDL and modelling both demand-and-supply-side variables such as the percentage of mining production to GDP, the proportion of total employees in mining, housing supply, inflation and housing lending rate.

The ARDL estimation is preceded by a unit root and cointegration analysis. This is followed by a Granger causality analysis to determine possible spillover between mining and non-mining housing markets. This cascading study design generated the following findings. Enhanced mining activities will increase house prices in the mining towns after the first quarter, suggesting that mining activities are a pull factor for working classes who migrate in search of the resulting job opportunities. This is a cyclical effect that is expected to snowball to non-mining towns in the second quarter. Over time, housing supply and housing lending rate remain critical in both markets. The study generally shows mining and non-mining housing markets are connected through house prices, a mechanism in which the resulting house prices increase from the expanded mining activities could flow to non-mining towns without any reciprocity.

These findings will inform housing policymakers in stabilising the housing market of mining and non-mining towns. Lending institutions and residential property developers may also use these findings to better inform their respective activities in the housing market.

Note

1. The repeat sales approach is based on the measure of the rate of change in the prices of individual houses between 2 points in time based on when the individual houses are transacted. Each house prices in any month's sample is compared with its previous transaction value.

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Further reading

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