eunomix™ research

Production, prices and mineral rents in Zambia between 1970 and 2017

A performance analysis

June 2019

Eunomix Research (Pty) Ltd.
2 Waterford Avenue
Parkview, 2103
South Africa
tk@eunomix.com
www.eunomix.com

Eunomix Research is a specialised division of consultancy Eunomix. It is dedicated to contributing to public policy and corporate practices that impact the growth and development of countries and their communities. Eunomix Research does this by conducting and distributing research that has public value, is original and of the highest standard.

Mineral Policy Impact on South Africa's Mining. An Economic Analysis

Eunomix Research completed an independent empirical analysis of the impact mineral policy has had on the performance and socioeconomic contribution of the mining sector in South Africa over the past twenty years. South Africa's mineral policy interventions over the past two decades have had a detrimental effect on the economic contribution and performance of the sector. Furthermore, these interventions have failed to deliver some of its key socioeconomic objectives. The overall efficacy of South Africa's mineral policy has been low.

Reviewing the UNCTAD 2016 report on trade misinvoicing

Eunomix Research conducted an independent review of an UNCTAD report which accused the South African mining industry of smuggling over USD 100 billion out of the country over 10 years. We determined that the UNCTAD report displayed deep flaws invalidating its conclusions. The report received widespread attention and led UNCTAD to significantly revise its findings on South Africa. Our report also shed light on the inadequacy of methods used by several institutions to quantify illicit financial flows.

Evaluating the socioeconomic impact of platinum mining in Rustenburg

Eunomix Research documented the impact of platinum mining in Rustenburg in South Africa. It looked at the three main platinum companies' direct and indirect economic role and the impact of their social investments. The study found that while their impact has been extensive, there remains space for more strategic directions in responding to underlying socio-economic problems that plague the area. The study was the subject of a full-page article in The Mail & Guardian.

About Eunomix

Eunomix is a trailblazing consultancy delivering resilient solutions in the face of uncertainty and disruption. Our offering enhances risk management, strategy and responsible growth.

CONTENTS

1. INTRODUCTION

1.1. Context – 2012 Eunomix Research Africa mineral rents study

The present report is an update of a 2012 analysis conducted by Eunomix Research on the relationship between mineral rents, mineral prices and economic growth in Sub-Saharan Africa between 1970 and 2010. The report focuses principally on Zambia, a country whose dependency on mining has remained pronounced since independence, and which – like many other resource-rich countries – has experienced pronounced changes in policy.

Our 2012 study received significant attention after its release:

- Its key findings and conclusions were presented at a number of events, including: i) the 2013 Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development's Annual General Meeting in Geneva; ii) the 2013 Summit of the US Corporate Council on Africa in Chicago; and, iii) the 2014 Investing in Mining Indaba in Cape Town.
- A number of media quoted the analysis.

The study provided aggregate data analysis for forty-eight Sub-Saharan countries. It also contained three brief case studies: the Democratic Republic of Congo, South Africa and Zambia. These case studies assessed how over the period 1970-2010 these countries' mineral rents fared in relation to commodity prices, and how each country's rent behaved in relation to economic growth. A key objective of the case studies was to determine whether the countries studied had performed better or worse than the region in the creation of mineral rents and economic growth.

The 2012 report is available for download on https://www.eunomix.com/our-work.php under the Eunomix Research heading.

1.2. 2012 report conclusion

The report offered several conclusions. Its main conclusion from the empirical work was – quote:

- Following the commodity boom of the 1960s, most African governments took steps to increase government intervention in the sector– including through expropriation and nationalisation of mining companies and ore bodies.
- This led to significant production declines throughout the 1970s, 1980s and 1990s. The rent followed suit, naturally. The wealth generated by mineral production decreased well below the performance of prices.
- The decline in the mineral rent had a significant knock-on effect on growth and standards of living. GDP growth averaged 2 percent in the two "lost decades", and because of rapid population growth, per capita income declined dramatically.
- For resource-rich countries, the link between economic crisis and the poor performance of the resource sector was particularly pronounced. The cases of the Democratic Republic of the Congo and Zambia are demonstrative of this (read case studies in report).
- Africa also missed opportunities to better exploit its mineral rent in 1980s and 1990s. Though commodity prices were lower than in the previous decade, the policy choices made in the 1970s meant that the region could not maximise its rent opportunities.
- Poor policy choices therefore gravely exaggerated the impact of the commodity bust by effectively sterilising a large part of the natural resource endowment. This sterilisation was thus only partially the product of market forces.
- The economic opportunity cost of poor policy was extremely high.

1.3. Zambia 2012 findings

The Zambia case study attracted significant attention because of its findings, which affirmed the general conclusion, but also added an estimate of the economic opportunity cost of adverse policy decisions. These were the findings on Zambia:

- We determined that Zambia's performance had been worse than that of the region – in the particularly for the period 1970-2000. During that time Zambia's mineral rents steadily declined and were abnormally low in the 1980s and around 2000.
- Copper prices played a role in this, but minimal. The key causal factor was the steep, continuous decline in copper production from its peak in the early 1970s to its bottoming out in 2000. In 1972, Zambia's copper production peaked at 717,000 tons. In 2000, the year of lowest production, that figure was a paltry 250,000 tons – a massive 65 percent decline.
- The year 2000 marked a profound turnaround for the country. Production started increasing rapidly and continuously, whereby in 2007 it topped the 1972 record to 767,000 tons, and then 800,000 tons in 2017. This turnaround occurred in parallel with the sudden massive increase in copper prices, which shot up from around USD2,000 a ton (2010 constant value) in 2001-2002 to a staggering USD 8,000 a ton in 2011.
- Our analysis determined that Zambia's poor performance during the 1970-2000 period was largely caused by the nationalisation and ensuing poor management of its copper industry post-1970. Like so many countries at the time, Zambia's nationalisation was poorly executed, which resulted in a slow, steady drop in production. Mineral rents followed suit to a point in the early 2000s where Zambia produced zero rents. This means that during these years, after paying for the production costs, there was no surplus and therefore no contribution of copper mining to GDP.
- As a counter-factual to the analysis, we assessed the potential mineral rent that would have been generated under a different production scenario. The question we asked was: if Zambia had maintained copper production through 2010 to its early 1970s level of about 700,000 per annum, how much mineral rents would have been generated over and above those that were generated? The simulation returned a figure of USD45 billion (2000 constant value) of mineral rents that could have been generated in Zambia.

1.4. Objective and methodology

The report focuses on Zambia. The objective of the update is to bring the period analysed up from 2010 to 2017.

The update has been conducted using the same initial methodology, data sets, sourced from the World Bank and the British Geological Survey, and the same Excel workbook.

The 2012 study compared Zambia with the DRC and South Africa. In this report comparison has been made with Chile, a leading producer and exporter of copper.

The update incorporates new analytic elements, in addition to the inclusion of Chile as the comparator country:

- Nominal copper prices in addition to real prices
- Copper production
- Copper revenues
- Mineral rents yields

The analysis conducts comparative and correlation analysis to understand the countries' respective performance, and to identify plausible drivers of performance. On this basis, it what-if simulations to determine what key outputs – production, revenues and mineral rents – may have been under different performance trajectories.

1.5. Report structure

The report is structured as follows:

1. **Section 1 – Copper prices**

   This section summarises the trajectory of copper prices between 1970 and 2017.

2. **Section 2 – Comparative performance analysis**

   This section presents the performance trajectories of Chile and Zambia in copper production, revenues, mineral rents and GDP growth during the period

3. **Section 3 – Performance analysis and findings**

   This section analyses and compares the two countries performances along key variable interaction:

   - Prices and production
   - Production, revenues and mineral rents

   It conducts correlation analyses and, based on the results, proposes a hypothesis for the two countries' differential performances.

4. **Section 4 – Simulation: potential opportunity cost of Zambia's performance**

   This section simulates what production, revenues and mineral rents may have been under scenarios derived from the findings of sections 1 to 3.

1.6. Additional analysis required

- Impact of Chile and Zambia's copper industries' trajectories and economic growth and diversification
- Correlation of performance analysis with key internal country economic, political and policy developments

1.7. Important notice

The 2012 study conducted by Eunomix Research was funded internally and independently.

The update presented in this report has been commissioned by Vedanta Resources. The update has been conducted independently and in the same manner the 2012 study was. Eunomix Research and the client agreed in writing over the broad objectives of the research. The client did not contribute to the approach and methodology, did not have sight of the data, the results and the final report until it was communicated to the client. The client was provided this report as is, and was not given opportunity to review nor make comments.

As stated in the methodology section above, Eunomix Research conducted the update using the same methodology, the same Excel workbook and the same data sets as the 2012 study, sourced from the World Bank and the British Geological Survey.

2. EXECUTIVE SUMMARY

Production, revenues and rents

- In 1970, Chile and Zambia produced the same tonnage of copper at about 700,000 per year.
- By mid-1970s the countries' production trajectories significantly diverged. Production in Chile increased and Zambia's decreased. By 2017 Chile was producing eight times more copper than in 1970, and seven times Zambia's production.
- Both countries produced about 10 percent each of global production in 1970. In 2000 Chile's share was 35 percent and Zambia 2 percent. In 2017 Chile's share had declined to 27 percent and Zambia's had increased to 4 percent.
- Revenues followed suit. Between 1970 and 2017 Chile's production resulted in over USD 650 billion of revenues to Zambia's USD 112 billion
- Mineral rents experienced dramatic differential trajectories. Chile's rents ranged in the 4-12 percent to GDP band from 1970 to 2004, rising past 15 percent between 2006 and 2012, and reverting to the below 12 percent mark since. Zambia's rents peaked in the early 1970s past 30 percent, then turned highly volatile to between 15 percent and 0 percent in the late 1990s. Rents rose again from 2004, and started tracking closely those of Chile as a proportion of GDP.

Key finding

- Production has been the key driver in the country's differential performances.
- Contrary to an often-repeated explanation for the poor economic performance of Zambia's copper industry between 1970 and 2010, prices were not the determinant factor.
- Zambia's collapse in production was accompanied by a collapse in the economic efficiency of that production, demonstrated by the dramatic gap between mineral rents and revenues in the early 1980s and the late 1970s.
- The momentary improvement in rents in the late 1980s-early 1990s is likely explained by improvement in efficiency, made possible by the increases in prices. However, this proved short-lived: as prices lowered efficiency collapsed.
- The dramatic turnaround in mineral rents post 2000s, as in the case of Chile in the mid-1970s, is likely to have been made possible by the rise of production, and not by that of prices. This would explain the subsequent increase in mineral rents yields, as with increased production came improvements in productivity.
- This supports the proposition that nationalisation of the copper industry in the early 1970s and its privatisation in the late 1990s was the primary cause for the decline in production and efficiency – productivity – in the period 1970-2000, and for the dramatic recovery in production and efficiency that came after 2000. The temporary improvement of the mid-1980s supports this notion, as it likely points to moderate and short-lived investment in production and productivity, which could not be sustained when prices decreased again.
- Zambia undoubtedly lost production, revenues and mineral rents between 1970 and 2017. And with these, all the attendant benefits and costs: investment, value added, tax revenues, export dollars, employment and so on.

Simulation outcomes

- Scenario 1 simulates the effects of Zambia had maintained average early 1970s production of 685,000 tons from 1970 to 2017 at a mineral rents to revenues ratio of 0.5.
- Scenario 2 simulates the effects of an annual increase in production of 2 percent per annum between 1970 and 2017, with constant mineral rents yield of 0.5.
- *Under scenario 1*, the loss would have as follows: over 6 million tons of production, USD 18 billion of real revenues (USD 15 billion nominal), and USD 6 billion of mineral rents (USD 3 billion nominal).

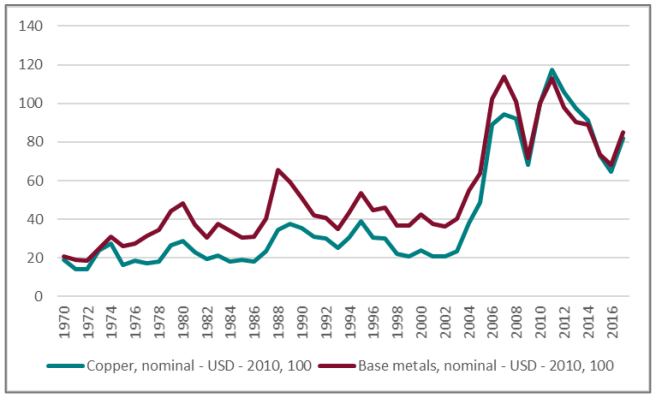
- It must be noted that this scenario would have been the least likely in a situation where the country would have found an adequate copper industry governance approach. Indeed, under such a system, production would have likely increased. This makes scenario 2 a more likely scenario, as it postulates a realistic increase of production by an annual average of 2 percent during the period 1970-2017.
- *Under scenario* 2, therefore, the calculated loss is a plausible 28 million tons of production, USD 117 billion of real revenues (USD 108 billion nominal), and USD 62 billion of mineral rents (USD 55 billion nominal).
- With these significant losses came all the attendant benefits: investment, value added, tax revenues, export dollars, employment and so on. And the costs: environmental damage, natural capital depletion, and the likes.

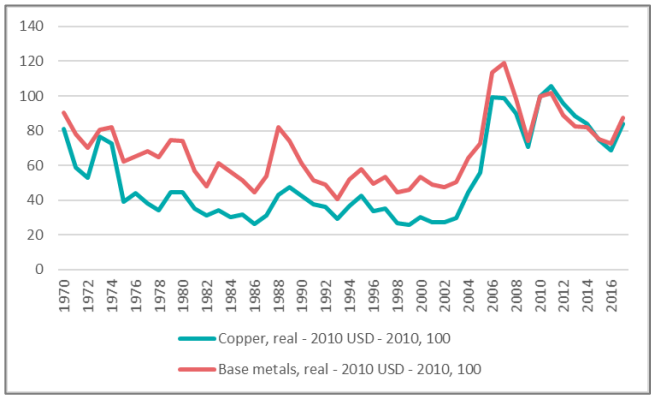
3. SECTION 1 – COPPER PRICES

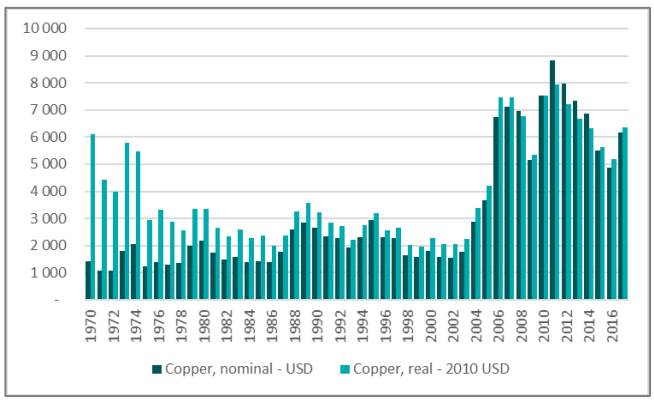
The analysis was conducted using real US dollar prices at 2010 value to provide an accurate measure and retrospective perspective – *ex post*. However, nominal prices offer a useful perspective from the prospective standpoint – *ex ante*. In the fraught debate about natural resource governance both perspectives are essential. *Ex ante* offers clue on the decisions of the past while *ex post* provides an empirical evaluation of these decisions.

Copper prices between 1970 and 2017 closely tracked the prices of base metals:

- In nominal terms (Chart 1, index prices based on 100 in 2010), copper prices remain relatively stable through the 1970s, increased a factor of nearly two in the 1990s, reverted to their 1970s around the year 2000, and rose extraordinarily rapidly to their 2011 peak – by which time they were six times higher than in 2002. They then declined by half, but have remained higher than their historical average – 41 on the 2010 index scale.
- In real terms (Chart 2), copper prices experienced a less dramatic cycle of increases and declines. They were relatively high in the early 1970s – index 80 in 1970 – and declined during the rest of the decade to stabilise during the 1980s, remaining subdued through their spectacular rise of 2003. At their 2011 peak, they were only 20 points over the 1970 price.





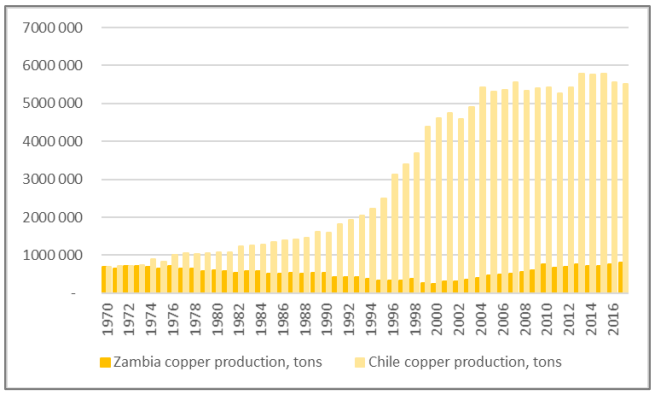


4. SECTION 2 – COMPARATIVE PERFORMANCE ANALYSIS

4.1. Copper production

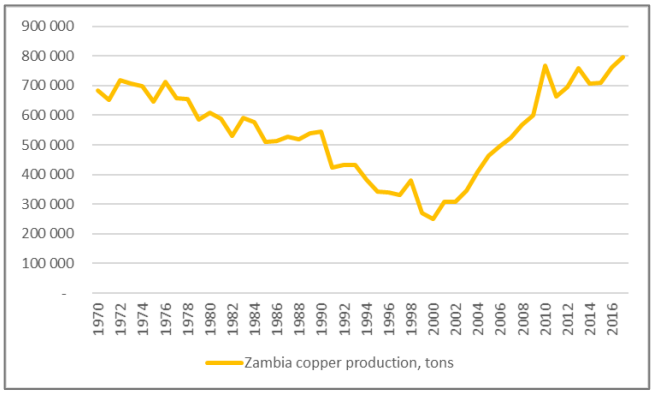
British Geological Survey 2019 – No Eunomix Research calculations

The copper production trajectories of Zambia and Chile experienced dramatic variation in the period 1970-2017.

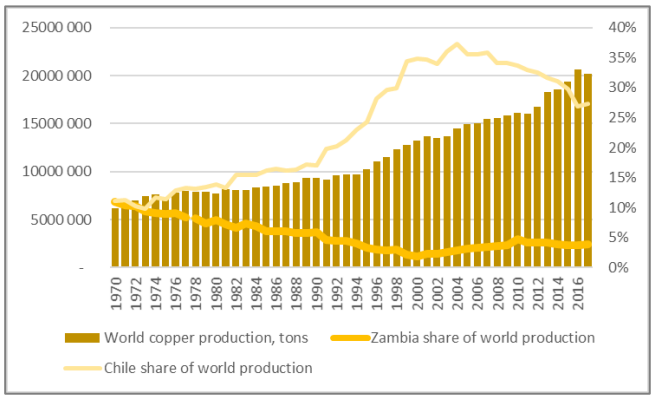


Both were set at the same level in 1970, with Zambia producing 684,000 tons and Chile 685,000 tons. The two countries production curves began diverging in the mid-1970s, as Zambia's production started a long decline that would continue unabated until 2000, while Chile's progressively increased.

By the early 1980s, Chile was producing twice as much as Zambia, past the 1 million tons mark. Chile's production growth expanded rapidly from the early 1990s and faster still from the middle of that decade. Having reached 2 million tons in 1993, it sailed past 3 million in 1996, 4 million in 1999 and 5 million in 2004. Its production has since hovered between 5 and 6 million tons. Zambia's passed in 1972 record of 717,000 tons. In 2017 it for the first time produced 800,000 tons of copper – a mark passed by Chile in 1974.



Zambia's copper production's decline was continuous through the late 1970s to the year 2000, expect for a brief period of stabilisation in the mid-1980s at around 500,000. At that time, Chile was producing around 1 million tons. From 1990 the decline in production was precipitous, reaching 250,000 tons in 2000. That year, Chile produced 4.6 million tons of copper – eighteen times more than what Zambia produced.



In terms of shares of global copper production, Chile's production increase outpaced that of global production from the mid-1970s to 2000. Its share of global production peaked at 37 percent in 2004, and has declined since to 27 percent– the product of a plateau in its production and of continued global production growth. Zambia's share, equal to that of Chile in 1970 progressively declined as global production grew. From 11 percent in 1970, it represented a meagre from 1999 to 2002. Though production has since more than doubled (from 250,000 tons in 2000 to 800,000 in 2017), it only amounts to 4 percent of global production.

4.2. Revenues

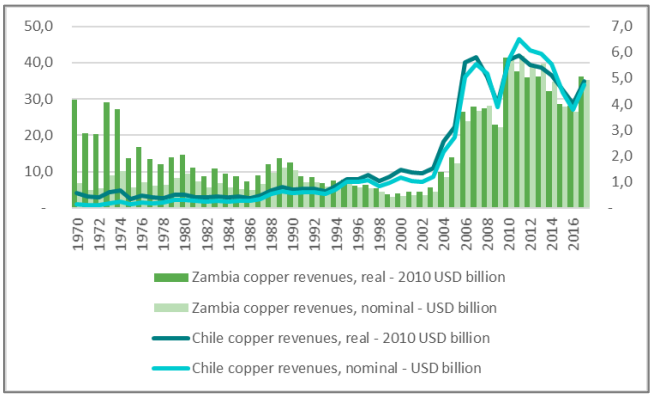
Data source: World Bank, 2019; British Geological Survey 2019 – Eunomix Research revenues estimates based on production and price data

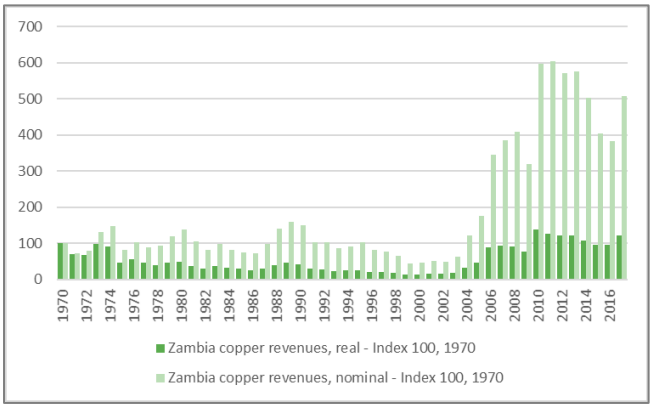
Copper revenues for both countries followed the evolution of production and prices.

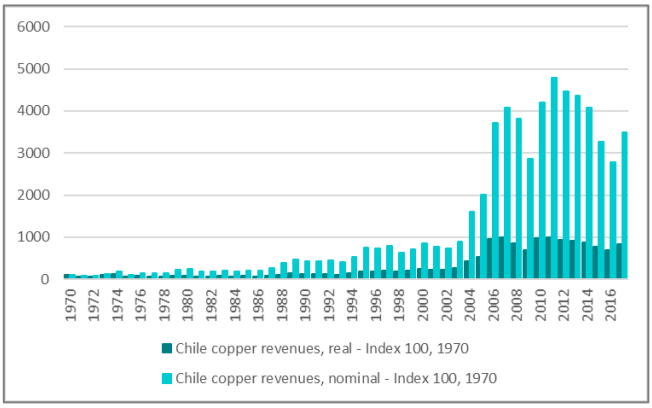
Both countries' revenues were equal until the mid-1970s, as production started its long decline in Zambia while it increased in Chile.

The revenue curve is significantly impacted by the reference currency. In nominal terms, Zambia's revenues fluctuated from USD 500 million to USD 1.5 billion between 1970 and 2004. In 2005, revenues began to rapidly increase as production recovered from its thirty-year decline and prices rose. That year, revenues passed the USD 1.5 billion mark, and expanded rapidly after that. Between 1970 and 2017, total copper revenues in Zambia amounted to an estimated USD 88 billion, nominal. The real terms curve was significantly more subdued, but total real USD revenues for the period amounted to USD 112 billion.

Chile's estimated revenues for the period dwarfed those of Zambia, and increased progressively as production grew. In nominal terms, they rose past USD 2 billion in 1974, USD 4 billion in 1989, USD 5 billion in 1994 and USD 10 billion in 2004. Total revenues for the period 1970-2017 amounted to an estimated USD 607 billion in nominal terms, and USD 688 billion in real terms.



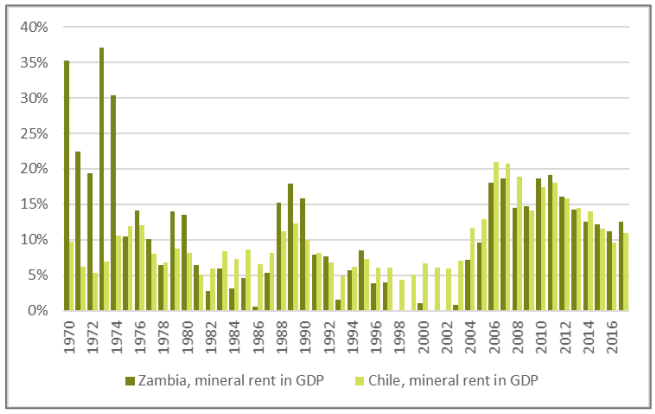




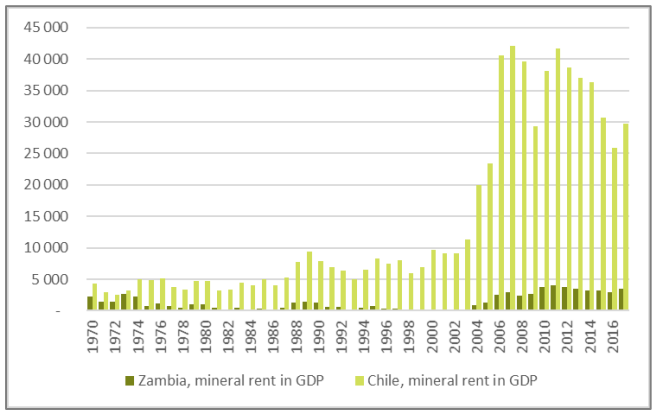
4.3. Mineral rents

Data source: World Bank, 2019 – No Eunomix Research calculations

Mineral rents represent the difference between total revenues *per annum* from the sale of the natural resource and the cost of producing that resource, including normal returns on capital. Mineral rents are the surplus extracted from the resource, and are sometimes called super-profits. Rents are measured both as a share of GDP and a gross figure – here in USD 2010 constant value.

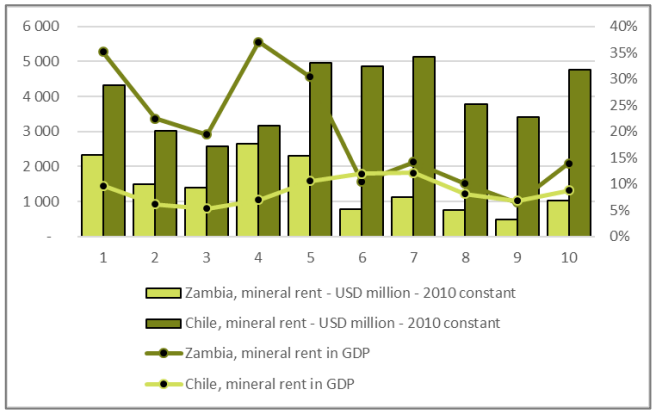


Zambia's mineral rents peaked in the early 1970s past 30 percent of GDP, a proportion representative of high resource dependency – resource-rich countries are generally defined as having resource rents over 5 percent of GDP. Declining to below 15 percent after 1975, the country's rents varied widely from year to year, some years to near zero, rebounding to around 15 percent in the late 1980s, then declining to near extinction in the late 1990s. Rents rose again from 2004, and started tracking closely those of Chile – as a proportion of GDP.



Chile's rents in GDP were less volatile. They varied within the 4-12 percent band from 1970 to 2004, rising past 15 percent between 2006 and 2012, and reverting to the below 12 percent mark since.

In US dollar terms, Zambia's mineral rents have been dwarfed by those of Chile since the mid-1970s. While rents in US dollars were converging between 1970 and 1973 – Zambia's almost equalling that of Chile (USD million 2,600 against USD million 3,200), they started diverging in 1974. By 1979 Chile's rents stood seven times those of Zambia's. The margin continued to grow through the 1980s, 1990s, and the 2000s as Chile's rents continue to grow, and then exploded from 2005. During that period, Zambia's rents nearly disappeared. While Chile's rents peaked at USD 42 billion in 2007, Zambia's reached its *apex* at USD 4 billion in 2011.



4.4. GDP growth

Data source: World Bank, 2019 – No Eunomix Research calculations

The two countries gross domestic products (USD dollar 2010 constant) experienced wide divergence in their GDP trajectories between 1970 and 2017.

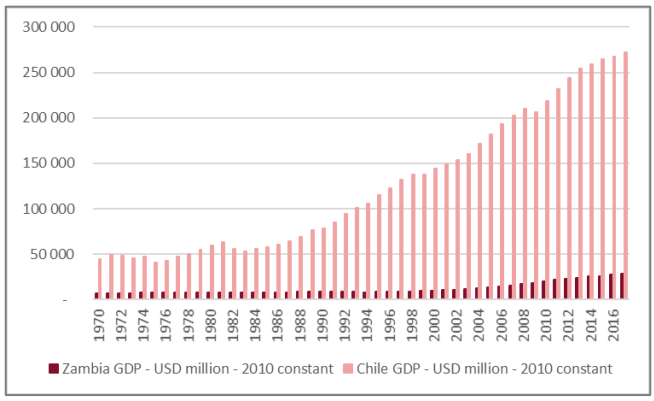
In 1970 Chile's GDP stood at USD 44.5 billion to Zambia's at USD 6.6 billion. Through the 1970s they remained relatively constant, though annual GDP growth was volatile. This was particularly so for Chile, whose growth fluctuated from -13 percent to +10 percent. In 1978 Chile's economy started to expand more rapidly while Zambia's remained stagnant – hovering between USD 7.4 and USD 9.9 billion throughout the 1980s and 1990s. After a brief slowdown in the early to mid-1980s, Chile's economy expanded rapidly and consistently from 1986. Zambia's economic growth started in 2001, when it grew past USD 10 billion.

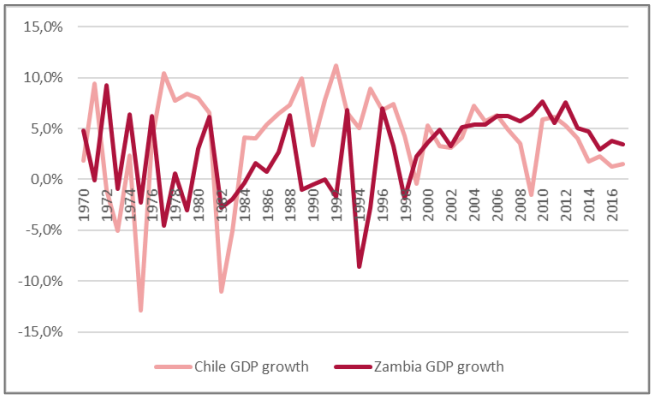
Average growth for the period was 2.6 percent for Zambia and 4 percent for Chile. However, average growth for Zambia was a mere 1.1 percent between 1970 and 1999, while it was 4.1 percent for Chile. Between 2000 and 2017 Zambia's GDP growth outpace that of Zambia at 5.2 percent per annum to Zambia 3.9 percent. In 2017 Zambia's GDP reached its highest ever at USD 28 billion. Chile's GDP also reached its highest, at USD 272 billion.

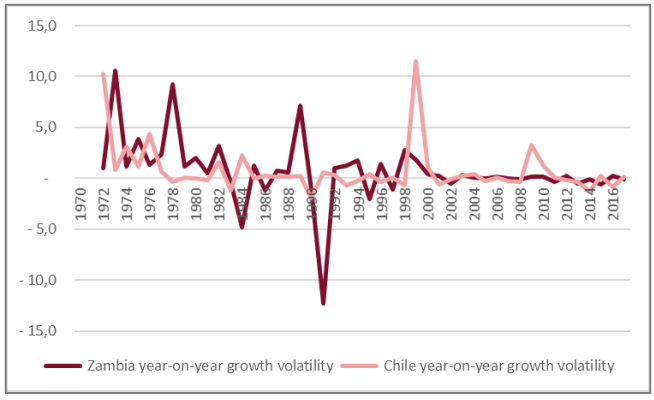
Zambia GDP growth was highly volatile until 2000, with a volatility measure (standard deviation) of 10.4 to Chile's 2.8.

Zambia's growth volatility significantly decreased between 2000 and 2017 to a very low 0.3, while Chile's stood at 1.

Post Zambia thus managed to stabilise its GDP growth at around 5 percent per annum. This explains the near tripling of that GDP between 2000 and 2017. This has represented a remarkable achievement considering the near absence of growth in the previous three decades.







4.5. Summary

In the early 1970s Zambia and Chile displayed a relatively similar copper production profile, both producing around 700,000 *per annum*. By the mid-1970s, the two countries' production trajectories began to greatly diverge:

	1970-2017	1970-2000	2000-2017
Chile			
Production - 1,000 tons	144 273	53 195	95 680
Revenues - USD billion, nominal	607	103	512
Mineral rents - USD billion, nominal	615	119	504
Revenues - USD billion, constant 2010	658	147	521
Mineral rents - USD billion, constant 2010	673	170	512
Zambia			
Production - 1,000 tons	26 239	16 348	10 141
Revenues - USD billion, nominal	88	29	59
Mineral rents - USD billion, nominal	55	13	41
Revenues - USD billion, constant 2010	112	53	59
Mineral rents - USD billion, constant 2010	66	25	41

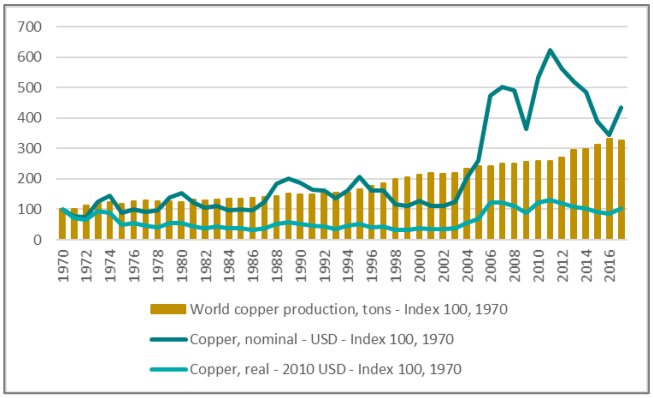
- Chile's production started to expand on a regular, continuous basis up to the mid-2010s. In 2017 its production was 800 percent larger than in 1970. Between 1970 and 2017 the country had produced a total of 144 million tons of copper, resulting in over USD 650 billion of real revenues, and USD 600 of nominal revenues. Note that the rents figure for Chile includes other minerals produced in the country – which explains that they are higher than copper revenues.
- In contrast, Zambia's production started to contract in the mid-1970s, bottoming out in 2000 at 35 percent of its 1972 record. It then took ten years for production to reach its 1972 production figure, reached in 2010. Annual production has since hovered around 700,000 tons. Between 1970 and 2017 the country had produced a total of 26 million tons – 5.5 times less than Chile. Revenues were thus limited to USD 112 billion real, and 88 billion nominal. Mineral rents creation followed suit, though the production/rent yield rapidly increased after 2000.

5. SECTION 3 – PERFORMANCE ANALYSIS AND FINDINGS

5.1. Copper prices and production

5.1.1. Global level

Correlation between copper prices and global copper production is affected by the unit of measurement and by the time period examined:



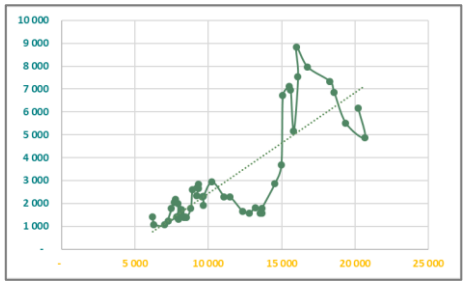
- For the entire period, in US dollar current/nominal the correlation is a high 80 percent, indicating a opossible causal relationship between the two.
- It is much less significant in US dollar constant 2010 value, lowering to 56 percent, indicating a possible diluted causal relationship.
- Correlation decreased significantly for the period 1970-2000, and even more for 2004-2017 – to 40 percent and 0 percent respectively. For the former period, correlation in constant dollar was significantly negative.

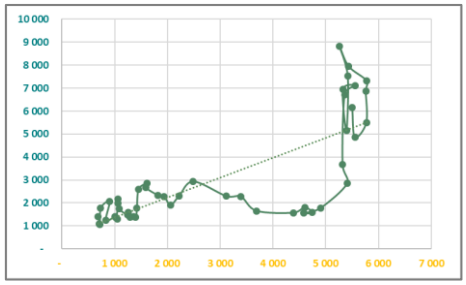
	1970-2017	1970-2000	2004-2017
Correlation production/copper prices, nominal	0,80	0,40	0,06
Correlation production/copper prices, real	0,56	- 0,57	0,00

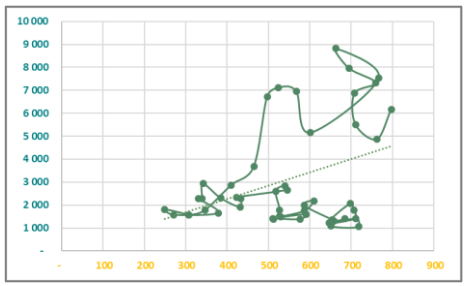
		1 year lag	2 year lag	3 year lag
Correlation production/copper prices, nominal	1970-2017	0,80	0,81	0,82
Correlation production/copper prices, real		0,62	0,64	0,66
Correlation production/copper prices, nominal	2001-2017	0,13	0,18	0,19
Correlation production/copper prices, real		- 0,22	0,14	0,12

- The introduction of lags between production and prices – based on the reasonable hypothesis that prices should drive increases in production –increases correlation for real prices slightly over the 1970-2017 period, but not for nominal prices. It slightly increases correlation for both real and nominal prices for the period 2001-2017.

The strong correlation between production and nominal prices confirms the connection between the two. However, this is only the case over long periods, and correlation may be weak during shorter periods. Overall, production has steadily increased since 1970 at an annual rate of 2.4 percent. Nominal prices have increased at a lower rate of 0.5 percent. As a result, the standard deviation of production has been 65, while that of nominal prices has been 158. Conversely, the standard deviation of real prices has only been 30. Nominal prices, which are those that tend to influence behaviour, have been more than twice as volatile as production.







5.1.2. Chile and Zambia

The two countries production profiles in relation with prices are very different. Chile's follow the broad pattern of global production/prices (first scatterplot for global and second scatterplot for Chile). Per the strong correlation, prices and production have tracked each other overall, with periodic variance. Zambia's (third scatterplot) does not follow this path. Instead, its production/prices pattern is non-linear. This is confirmed by a low overall correlation between production and prices in Zambia during the period – at 40 percent versus 76 percent for Chile, and 80 percent for global production. Importantly, correlation between Zambia's production and prices was negative 50 percent in the 1970-200 period. Correlation then surpassed overall global correlation and Chile's at 80 percent between 2000-2017.

	1970-2017	1970-2000	2000-2017
Correlation global production/nominal prices	0,80	0,46	0,54
Correlation global production/real prices	0,80	0,46	0,54
Correlation Zambia production/nominal prices	0,38	-0,50	0,81
Correlation Zambia production/real prices	0,62	0,60	0,78
Correlation Chile production/nominal prices	0,76	0,35	0,73
Correlation Chile production/real prices	0,50	-0,51	0,74

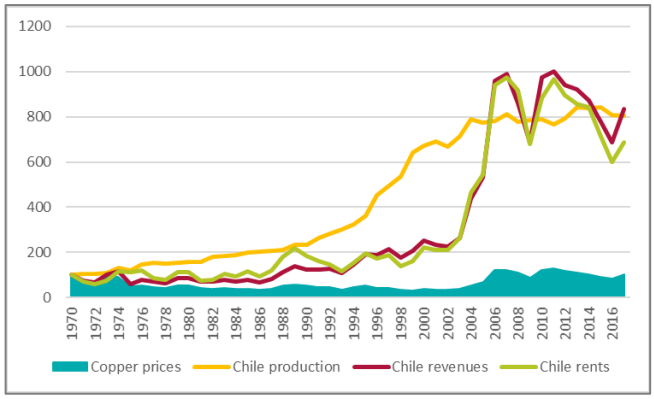
5.2. Production, revenues and mineral rents

Correlation between production, revenues and mineral rents provide crucial perspective on the production and economic efficiency of the industry.

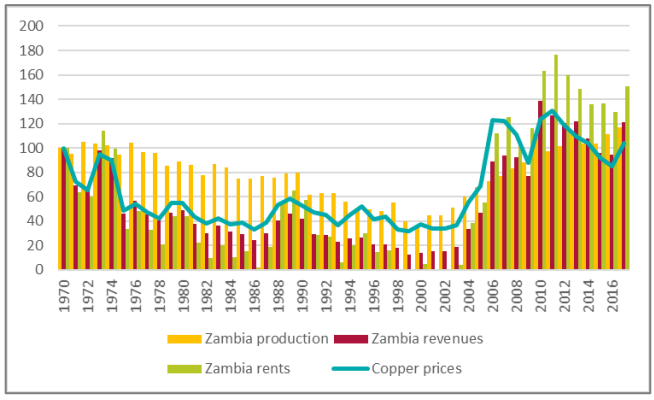
The contrast between the performances of Chile and Zambia is highlighted by this correlation. The Chart to the right illustrates the differential growth paths of both countries – showing their copper respective productions, revenues and rents between 1970 and 2017. Considering that both countries produced the same tonnage of copper in 1970, their differential growth paths are all remarkable.

Each country's growth trajectory is represented in the two ensuing Charts, which highlight:

- The continuous expansion of Chile's production throughout the period until the mid-2000s, irrespective of the trajectory of copper prices – real terms.



- The fact that Zambia's revenues and mineral rents generation were undermined by the collapse in production pre-2000 irrespective of prices, and that the post-2000 recovery was not primarily tied to prices but to a very well-timed (lucky?) recovery in production.

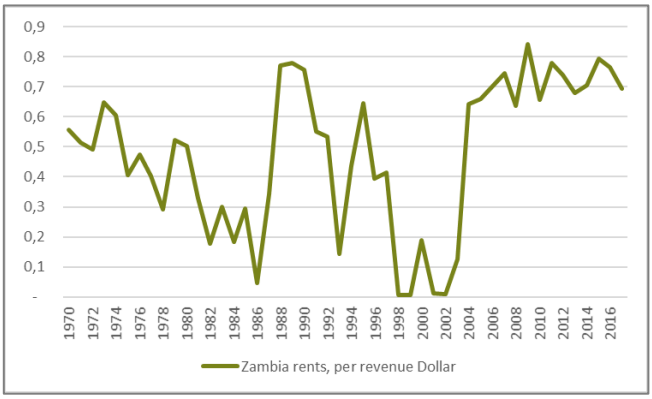


In the case of Chile, one must conclude that it is the growth of production which served as the foundation for the extraordinary growth in revenues and mineral rents post 2004 – and not the other way around. This is a crucial fact.

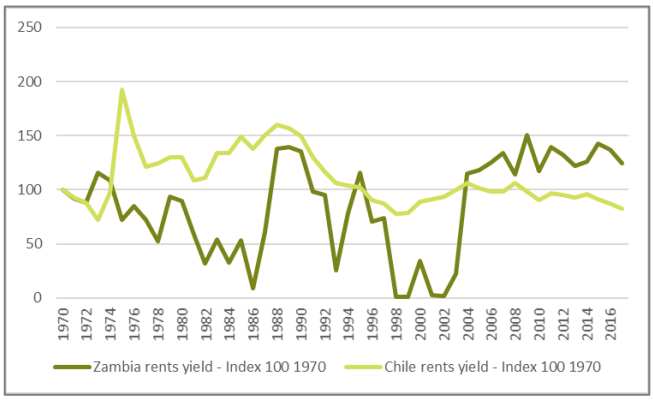
In the case of Zambia, on must conclude that the collapse in production was the key driver in the collapse and near erasure of mineral rents in the mid-1980s and again in the early 2000s. But the trajectory of production alone cannot explain the dramatic fate of mineral rents then. Something else must have been at play.

5.3. Mineral rents as a marker of economic efficiency

Mineral rents yields in Zambia fluctuated widely across the 1970-2017 period. Measured in relation to revenues, they ranged from 0 to slightly above 0.8 per revenue USD. Set at about 0.5 in 1970, they declined rapidly and continuously from 1974 to less than 0.1 in 1986. They spectacularly increased in the late 1980s, fluctuating widely until collapsing in the late 1990s. In 2004, yields spectacularly increased again, and stabilised around the 0.7 range thereafter. Over the period, the rents yield averaged 0.5.



Chile's rents yield followed a different path. It was much less volatile over the period, and progressively increased through the 1980s. It then declined through the 1990s and stabilised at its 1970 level thereafter.

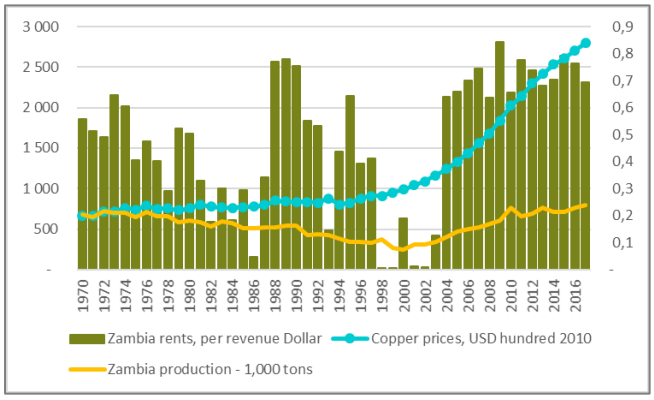


Correlation analysis provides a crucial perspective:

- *Rents yield/copper prices* shows a moderate correlation between 1970 and 2017, at 50 percent. For the period 1970-2000 that correlation is negative 30 percent. However, it stands at a high 70 percent for the period 2000-2017.

	1970-2017	1970-2000	2000-2017
Zambia correlation, rents yields/copper prices	0,5	-0,3	0,7
Zambia correlation, rents yields/production	0,6	0,3	0,8
Zambia correlation, rents yields/revenues	0,7	0,5	0,8

- *Rents yield/production* shows a greater correlation for 1970-2017 of 60 percent, a lower correlation of 30 percent for 1970-2000, and a very high correlation of 80 percent for 2000-2017.
- *Rents yields/revenues* shows a high correlation for 1970-2017 of 70 percent, a lower correlation of 50 percent for 1970-2000, and a very high correlation of 80 percent for 2000-2017.



5.4. Key finding

The critical finding here is the moderate/negative/high correlation with prices. Paired with the higher correlations with production and revenues, this points to an explanatory hypothesis for Zambia's overall performance:

1. Production has been the key driver in the decline of mineral rents.
2. The collapse in production was accompanied by a collapse in the economic efficiency of that production, demonstrated by the dramatic gap between mineral rents and revenues in the early 1980s and the late 1970s.
3. The momentary improvement in mineral rents in the late 1980s-early 1990s is likely explained by improvement in efficiency, made possible by the temporary increases in prices then. However, this proved short-lived: as prices lowered efficiency collapsed.
4. The dramatic turnaround in mineral rents post 2000s, as in the case of Chile in the mid-1970s, is likely to have been made possible by the rise of production, and not by that of prices. This would explain the subsequent increase in mineral rents yields, as with increased production came improvements in productivity.
5. Contrary to an often-repeated explanation for the poor economic performance of Zambia's copper industry between 1970 and 2010, prices were not the determinant factor.
6. This supports the proposition that nationalisation of the copper industry in the early 1970s and its privatisation in the late 1990s was the primary cause for the decline in production and efficiency – productivity – in the period 1970-2000, and for the dramatic recovery in production and efficiency that came after 2000. The temporary improvement of the mid-1980s supports this notion, as it likely points to moderate and short-lived investment in production and productivity, which could not be sustained when prices decreased again.

6. SECTION 4 – SIMULATION: POTENTIAL OPPORTUNITY COST OF ZAMBIA'S PERFORMANCE

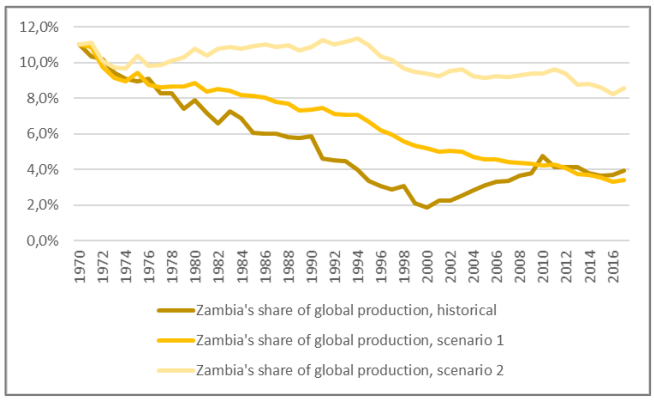
6.1. Methodology, assumptions and scenarios

The 2012 Eunomix Research analysis estimated the potential cost of loss production and associated economic benefits through mineral rents and prices. The present update uses production and prices to provide a more accurate assessment.

The assessment estimates the revenues and mineral rents that would have been generated had Zambia been able to produce more copper than it did. Two scenarios are provided, based on differing assumptions regarding production.

The two key assumptions:

- Zambia's increased production would have had no impact on copper prices, because it under no scenario does Zambia maintain a share of global production greater than 10 percent on average over the period.
- Mineral rents remained constant as a proportion of revenues per revenues generated – the rent/ revenue yield per ton.



The two scenarios:

- Scenario 1 simulates the effects of Zambia had maintained average early 1970s production of 685,000 tons from 1970 to 2017 at a mineral rents to revenues ratio of 0.5.
- Scenario 2 simulates the effects of an annual increase in production of 2 percent per annum between 1970 and 2017, with constant mineral rents yield of 0.5.

6.2. Scenarios outcome

Zambia's historical performance between 1970 and 2017 consisted of a total production of over 26 million tons, with revenues in nominal terms of USD 88 billion, and in real terms of USD 112 billion. Mineral rents amounted to USD 55 billion nominal, and 66 billion real. The mineral rent yield increased significantly post 2000, indicating improvements in the efficiency of the industry.

	1970-2017	1970-2000	2000-2017
Historical			
Production - 1,000 tons	26 239	16 348	10 141
Revenues - USD billion, nominal	88	29	59
Mineral rents - USD billion, nominal	55	13	41
Revenues - USD billion, constant 2010	112	53	59
Mineral rents - USD billion, constant 2010	66	25	41
Scenario 1			
Production - 1,000 tons	32 880	21 235	12 330
Revenues - USD billion, nominal	102	39	65
Mineral rents - USD billion, nominal	57	22	36
Revenues - USD billion, constant 2010	130	66	66
Mineral rents - USD billion, constant 2010	72	37	37
Scenario 2			
Production - 1,000 tons	54 278	28 988	26 529
Revenues - USD billion, nominal	196	55	143
Mineral rents - USD billion, nominal	109	31	80
Revenues - USD billion, constant 2010	229	86	145
Mineral rents - USD billion, constant 2010	128	48	81

6.2.1. Production, revenues and rents

Scenario 1, assuming stable production of 685,000 tons between 1970 and 2017 results in total production of 32 million tons, and revenues of USD 130 billion real, and USD 100 nominal. Mineral rents are USD 72 billion real, and USD 57 billion nominal.

Scenario 2, assuming an annual average increase in production of 2 percent, results in a total production of 54 million tons, revenues of USD 230 billion real, and USD 196 billion nominal. Mineral rents amount to USD billion 128 real, and USD 110 billion nominal.

6.2.2. The opportunity cost of lost production

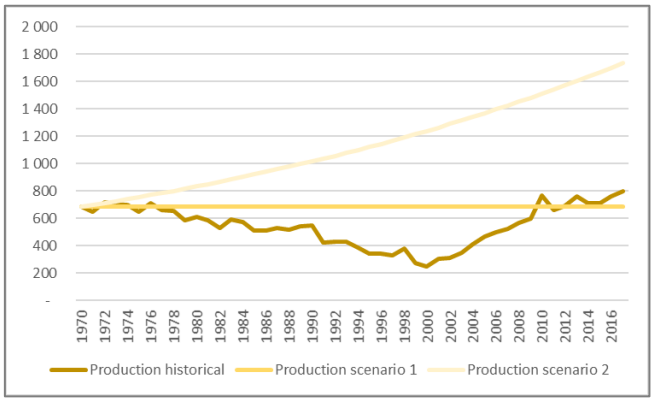
Zambia undoubtedly lost production, revenues and mineral rents between 1970 and 2017. And with these, all the attendant benefits and costs: investment, value added, tax revenues, export dollars, employment and so on.

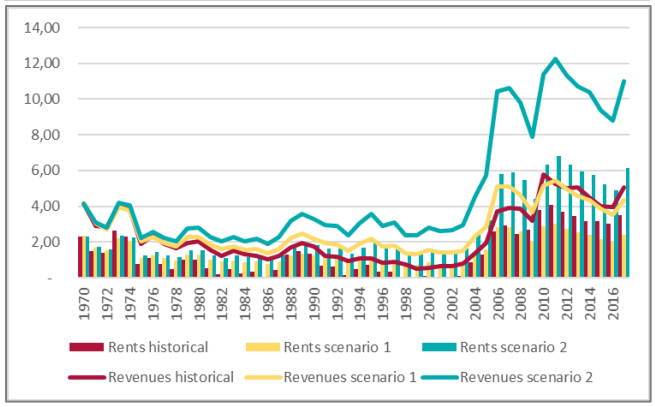
Under scenario 1, the loss would have as follows: over 6 million tons of production, USD 18 billion of real revenues (USD 15 billion nominal), and USD 6 billion of mineral rents (USD 3 billion nominal).

It must be noted that this scenario would have been the least likely in a situation where the country would have found an adequate copper industry governance approach. Indeed, under such a system, production would have likely increased. This makes scenario 2 a more likely scenario, as it postulates a realistic increase of production by an annual average of 2 percent during the period 1970-2017.

Under scenario 2, therefore, the calculated loss is a plausible 28 million tons of production, USD 117 billion of real revenues (USD 108 billion nominal), and USD 62 billion of mineral rents (USD 55 billion nominal).

With these significant losses came all the attendant benefits: investment, value added, tax revenues, export dollars, employment and so on. And the costs: environmental damage, natural capital depletion, and the likes.





	1970-2017	1970-2000	2000-2017
Scenario 1			
Production - 1,000 tons	6 641	4 887	2 189
Revenues - USD billion, nominal	15	10	5
Mineral rents - USD billion, nominal	3	8	- 5
Revenues - USD billion, constant 2010	18	13	7
Mineral rents - USD billion, constant 2010	6	11	- 4
Scenario 2			
Production - 1,000 tons	28 039	12 640	16 389
Revenues - USD billion, nominal	108	26	84
Mineral rents - USD billion, nominal	55	17	39
Revenues - USD billion, constant 2010	117	33	86
Mineral rents - USD billion, constant 2010	62	23	40