



Does mining alleviate or exacerbate poverty: Are local community grievances really 'Much Ado about Nothing'?

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This study sets out to evaluate the impact of industrial mining on local economies, within a context of a developing country with a strict procurement policy on its extractive industry. It contributes empirical evidence on two main ideas on the impact of mining on local communities. The one idea is that mining has a positive impact on local communities because it creates economic activity through economic linkages with local markets; and thus contributes to local industrialisation, economic development, and poverty reduction. The other idea is that mining harms local economies through negative impacts on the environment; which hurts local agriculture and health, leading to an increase in local poverty. By evaluating a case study of a poor rural economy driven by mining and agriculture, this study measures the net average impact of the opening and expansion of mining on local income poverty. Using ward level data combined with firm data, the study essentially uses a difference-in-differences estimation procedure, by exploiting a local input demand shock from large industrial mines, as well as changes in distance to a mine, as sources of variation. The study finds that the opening of a mine is associated with poverty reduction in surrounding communities, while the impact from an expansion of a mine depends on the type of commodity mined. Unpacking these results by commodity gives insight into the concentration of labour and community unrest in the platinum and gold mining sectors in South Africa. The findings of this study remain robust to different indicators of mine expansion, and checks for alternative explanations such as selective migration and sample checks. The study uses the Limpopo Province of South Africa as a suitable case study. (JEL I32, L72, O13, O14, Q32, Q33, R11)

Keywords: Natural resources, extractive industries, poverty, economic linkages

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To my brother, Mduduzi (Aug 1975- Sep 2015), who told me I am intelligent.

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Abbreviations

ANC	African National Congress
BCC	Black Business Council
BEE	Black Economic Empowerment
BEECom	Black Economic Empowerment Commission
BMF	Black Management Forum
COSATU	Congress of South African Trade Unions
CSR	Corporate Social Responsibility
DMR	Department of Mineral Resources
IEC	Independent Electoral Commission of South Africa
MPRDA	Mineral and Petroleum Resources Development Act
NEDLAC	National Economic Development and Labour Council
PGM	Platinum Group Metals
SACP	South African Communist Party

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Chapter 1 Introducing the problem of mining

‘Gone are the days when mining contribution is measured only by its contribution to the gross domestic product, or royalties that it pays to the fiscus. Communities expect mining companies to become engines of socio-economic development of their areas’ – Susan Shabangu, Minister of Minerals (2011)¹

A CEO of a minerals mining company with assets in the Limpopo Province lamented that the opening of a mine attracts large outcries from government and communities, unlike any other form of business, such as the opening of a supermarket². In the context of one of the poorest provinces in South Africa, with a poverty rate of 74.4 percent in 2006, 78.9 percent in 2009, and 63.8 percent in 2011; compared to a national average of 57.2 percent, 56.8 percent, and 45.5 percent respectively, the opening of a mining business, which creates employment opportunities, would be expected to be a welcome development. Yet the comment by the CEO, said in mid-2016, over ten years since the introduction of the Minerals and Petroleum Resources Development Act (MPRDA) policy; a policy which sought to eliminate “enclave practices” of mining operations. Discussing history, mines, and communities in South Africa results, ironically, in a conversation about poverty. However, discussed together with post-apartheid policy and the passing of time, the conversation is directed towards an examination of progress, or perhaps the lack thereof, on reducing poverty. While the discourse on mining in pre-democracy South Africa was associated with industrialisation in the core and enclave development in the periphery (Legassick, 1977), would the discourse in post-apartheid South Africa still associate mining with industrialisation? And, would mining be linked to inclusive development?

A bird’s eye view of literature on South Africa’s history of development and industrialisation locates mining as a key cornerstone of South Africa’s economic history³. Mining changed the composition of the country through influencing factors such as migration patterns, economic and spatial planning, class development, and political trajectories. Built upon a political dispensation dividing society along racial lines, the story of mining wears two faces in South Africa according

¹ Cited from Lane et al. (2015)

² This was during a conversation between the author and the respondent, in May 2016.

³ See, for instance, Legassick, M. (1977), Bundy, C. (1977), Liebenberg, F. & Kirsten, J. (2006), and Terreblanche, S. (2002).

to which side of the line narrates. For those who were beneficiaries of racial policies spanning over a century, mining is visibly associated with industrialisation and economic development; while to the proletariat that lived in peripheries serving as labour reserves, mining has been associated at worst with poverty and underdevelopment. That there exist these two historical narratives within South Africa is important for understanding the role of natural resource wealth on communities and development. It is evidently possible to industrialise and develop at the back of natural resources, as is the case in South Africa; but it is possible to experience immiserating growth even with resource wealth, as evident in historically isolated parts of South Africa. The major difference between the experiences of those parts that industrialised and those that decayed is policy. The historical institutional arrangements made the best use of natural resources for one racial group, and created enclaves for the other racial group, where mining could not transmit local benefits.

Indeed, this paper deals with a peculiar case study of a province largely made up of historically impoverished homelands (or ‘bantustands’)⁴ that are host to large mineral deposits, predominantly of platinum group metals, coal, copper, and diamond. The disunion of these areas began before the discovery of the rich deposits in these areas, while the reintegration of these homelands came after the invention of rail and after the industrialisation of Johannesburg which industrialised around mines (Butler et al., 1978). When analysing the impact of mines on the homeland of Bophuthatswana (neighbouring the Limpopo Province), Butler et al. (1978) find that data showed extremely limited impact of mines on local incomes of homeland residents. They argued that under the then institutional arrangements, growth in the extractive sector in these areas should not be viewed as contributing in a major way to the development of the homeland, because “the genesis of income-creating forces lies outside the homelands in the private and public sectors of the Republic [of South Africa]” (Butler, Rotberg, & Adams, 1978, p. 235).

Given the background on the knowledge gap about the impact of mines on local communities, the empirical strategy of this paper mainly follows Aragón and Rud (2013), whose work is perhaps the first to *empirically* examine the impact of mining on *local communities*. The study uses a case of one of the largest gold mines in the world, Yanacocha, located near the city of Cajamarca in the Northern Highlands of Peru. According to the authors, this region is extremely poor and predominantly rural and, before Yanacocha, had no history of mining. The mine has historically

⁴ Homelands are defined and discussed in the next section of Chapter 1.

had very limited economic interactions with the local economy, being a typically export-oriented, capital-intensive operation and procuring most of its inputs outside the local economy. The most visible contribution of the mine was the revenue windfall to local governments. However, in 2000 the demand for *local inputs* increased significantly, driven partly by growth of gold production, and driven mainly by the implementation of a corporate policy directed at increasing local employment and supply linkages. The study finds that the expansion of the mine has a positive impact on the living standards of the local population, through a rise in real income, household consumption, and poverty reduction. This effect is present in the surrounding areas and decreases with distance. The study provides evidence that this effect is absent before the policy implementation.

A similar case in South Africa exists. The platinum belt in South Africa hosts approximately 80 percent of the world's platinum, making up a substantial share of the country's US\$2.5 trillion mineral reserves (Citigroup, 2011; in Minnitt, 2014). However, this area is characterised by poverty and labour unrest. The situation came into global spotlight in August 2012, when 34 mineworkers were killed by police during a mineworkers' strike in Marikana, North West Province of South Africa. The mineworkers and communities highlighted low wages, poor working conditions and poor living conditions as their main grievances. The case studied in this paper is the Limpopo Province, which is the northern most province in South Africa, and neighbours the North West Province and the Mpumalanga, three of the provinces that contain the platinum belt and other minerals such as coal and copper, and are classified as some of the poorest provinces in South Africa.

Indeed, there is high poverty in the Limpopo Province. Mining is a major economic activity, but its contribution on community livelihoods is highly contested. Some studies, such as those from the Bench Marks Foundation, find that mining harms communities in the province, and suggest that communities are worse-off as a result of having a mine. On the contrary, mining companies consistently report their positive contribution in communities, by incorporating as part of their business model the MPRDA policy requirements and the Mining Charter transformation targets. The government has in place the MPRDA, which effectively nationalised mineral rights and made government the custodian thereof, to which mining companies would need to apply for mining

licenses. Applications for licences would be granted conditional on meeting policy requirements that emphasise community-upliftment through various instruments.

Over a decade of a new policy regime in the industry has passed, yet the industry suffers protracted labour strikes, community backlash, political interference, and consistent policy changes because of either perceived slow and/or insufficient transformation within the industry, and limited impact on communities. One of the main problems faced by the mining industry is location of mines. The majority of Platinum Group Metals (PGMs) deposits, and significant deposits of coal, diamonds, and copper are located in historically poor communities. This places great pressure on mining operations to alleviate poverty at the magnitude deemed “meaningful” in surrounding communities.

The perceived lack of impact has theoretical underpinnings around the relationship between natural resource abundance and economic development. Specifically, the extractive industry has been thought to be inherently ‘enclave’, unintegrated in communities wherein it operates. Supporting this is the dependency theory, which posits that there is a core that industrialises by exploiting resource rich peripheries to no benefit of these resource-rich locations. That the extractive industry is inherently harmful to the host further complicates the relationship between mining and poverty in the host communities. By observation, the poorest provinces in South Africa are host to the largest mineral deposits and mining operations in the country, and/or are home to mine workers (labour-sending communities). On the surface, there appears to be a strong positive correlation between mine location and poverty, in support of the broad literature of the resource curse. The apparent correlation between mining and poverty raises a question on the causal impact of mining on poverty – in this case, at the local community level.

It is not empirically obvious whether communities are better-off by having a mine operation within proximity, and whether these communities are not worse-off after mine closure, as compared to before mine opening. Furthermore, the literature on the impact of the extractive industry is abundant at country-level analyses, but as argued by Aragón & Rud (2013), very little evidence currently exists at the local level. This remains the case in South Africa from an empirical perspective.

This paper sets out to estimate the impact of mining on local communities in the Limpopo Province of South Africa. The Limpopo Province offers a useful case study because of its natural resource

abundance and large mining operations. In addition, nothing much happens in Limpopo except mining, agriculture, and tourism. This allows the study to isolate the causal impact of mining with fewer confounding factors. However, before a diagnosis can be made, it is critical to understand the historical context that systematically explains the problem of poverty and the problem of mining in Limpopo, and indeed in South Africa. The top 4 (out of a total of 9) poorest provinces in South Africa consists of former homelands, which are pockets of unproductive land that were allocated to black people through forced removal from the union of South Africa. Black people were to serve as labour reserves in these homelands. These homelands were meant to be separate from South Africa, ultimately independent states. They constituted 13 percent of total South African land. At the time of allocation, it was not known that these pockets of land are rich in mineral deposits. Therefore the stark poverty in these provinces, including Limpopo, is as a result of systematic policy that created enclaves.

Mining itself, from policy design, historically created mining operations that were unintegrated in these communities⁵. Even since democracy, the impact of mines has been limited because of spatial inequality: there are limited economic benefits captured locally in host communities, while benefits are still captured in industrialised locations of the country. Therefore, poverty in these areas must be understood in a historical context. Notwithstanding, however, poverty has declined in these former homeland areas over the past 20 years, including in the Limpopo region. The question is, what is the size and direction of the impact of mine operations on local poverty?

The rigour of the study would require data on how mines impact poverty at local community level, over a period of time, with some changes in circumstances such as a before and after a mine opening/closure, and/or a policy change that influences the behaviour of mines. Given a sound model with which to isolate the impact of mine operations on local poverty, some evidence can be generated to contribute to the current discourse on the issue in South Africa and in the broader literature on extractive industries and their local impacts. This study aims to achieve such a goal – one limited to the study of mines and income poverty, using the Limpopo Province as a case study. The historical context that explains the current underdevelopment in Limpopo will allow for an

⁵ This point is demonstrated in the following section.

informed analysis of the results. The analytical framework is mainly based on Aragón & Rud (2013), Aragón & Rud (2015), and Morris et al. (2012).

The main challenge of this study will be to isolate the causal impact of mine expansion on local income poverty outcomes, during the period of study. To achieve this, the study sets out to exploit three sources of variation: the significant increase in local demand for inputs, driven by stronger local procurement and by an increase in production; the distance between a municipal ward and a nearest mine – which is a source of heterogeneous exposure to the increase in mining activity; and the opening and closure of mines.

The study finds important results with policy implications. Firstly, the results show that municipal wards that are located beyond 20 kilometres of a mine in 2001, but subsequently were within 20 kilometres between 2001 and 2011 (as a result of a mine opening locally), experienced statistically significant declines in income poverty. This means that in cases where a mine opened locally – within 20 kilometres – this brought economic relief. This is a major result, because it provides clear evidence to support the opening of mines locally, as one of the economic activities that improve incomes. Furthermore, the study could unpack the types of linkages that explain this finding. However, the second model which includes the impact of *expansion* of mining (proxied by mining expenditure and sales), revealed that income poverty worsens in wards within mining vicinity.

The second model included the expansion of mining, given that the period under study was a time of commodity boom; not only evidenced by prices, but also evidenced by investment in establishing new mines. In addition, a specific strategy of this paper is capturing an increase in local demand (in close vicinity of mines) driven by the MPRDA policy, which encouraged local procurement of inputs. This meant mining booms would not simply be felt in the developed locations of the country, but also where mines are located. The introduction of the MPRDA policy is clearly an exogenous shock. The result shows that the expansion of mine worsens poverty in local wards. This is a big puzzle, and quite contradictory to the first results. After running various checks to understand what is driving these results, the study found that disaggregating the impact of mines by different commodities reveals very interesting patterns that are driving the puzzle. It appears that the expansion of coal mining improves local economies, while on the other extreme, the expansion of platinum mines potentially worsens poverty – evidenced by a statistically

significant result. In more appropriate statistical language, there is no evidence to suggest that the expansion of platinum mines alleviates poverty, as compared to coal mines. For other commodities, such as copper and iron ore, the coefficients are not statistically significant.

These findings firstly cautioned on an over simplistic view that mines are good or mines are bad, vis-à-vis their local impacts. Certainly, in such a poor region that has a long history of exclusion through *Bantustan* policy, one that has highlighted concerns about mining, and one that has very recently experienced the killing of lives by the State to stop labour strikes; the existence of mines in these spaces is complex. That social, historical, political, cultural, and environmental dynamic has economic consequences. That is, it impacts of the dependent variable of this study. This was the finding from the results, which called for a more comprehensive approach to investigating mining impacts. As such, this draft is a re-written version that has applied a more informed approach.

Specifically, this paper applied the linkage approach to study how coal mines operate in local communities as distinct from platinum mining, specifically in the Limpopo/Platinum Belt. The insights from research led to the inclusion of mining impacts on the environment – as it became obvious that the introduction of a mine is not just an economic demand shock, but it is also an environmental shock, together with other consequential factors covered in the literature review chapter. The paper by Aragón & Rud (2015) became particularly helpful in understanding the empirical strategy of studying mine-related economic-environmental impacts, and in building a theoretical framework that captures the net impact of mining.

In summary, the study contributes a set of findings some of which are summarised as follows:

- (1) The problem of poverty in the Limpopo Province is partly explained by the history of homeland policy. Homeland policy created a systematic relationship in which mining developed enclaves in these areas, without cause or intention to contribute economic benefit to local surroundings. This finding is supported by statistics presented from primary sources and secondary sources analysed within the conceptual framework of economic linkages (Chapter 3).
- (2) The *opening* of mines alleviates poverty in close-by communities.
- (3) The impact of the *expansion* of mines varies by commodity. This is explained by how long the commodity has been mined (contextual linkages), the type of commodity and how it is

mined (intrinsic linkages), and therefore how locally embedded it is. This determines the net impacts between the positive economic benefits, and the negative environmental and social benefits.

- (4) To achieve the most out of mining activity locally, economic linkages have to be created and deepened. This means that provincial and local municipalities must be effective in addressing underdevelopment in these areas, and mines have to explore opportunities to hire locally and procure goods and services locally, as is practically possible.

In addition, some of the specific and unique contributions of this paper are as follows:

- (1) The paper shows that impacts of mine expansion differ by commodity, which helps us understand some of the current issues in the South African mining industry: why it is that labour strikes are more visibly frequent in specific sub-sectors (i.e. platinum and gold sub-sectors).
- (2) This project creates a new dataset by collecting firm data from company annual reports, and merges it with Stats SA census 2001 and 2011, together with community survey 2007. The study also creates a variable of distance between mines and municipal wards by exploiting the Independent Electoral Commission (IEC) of South Africa's *voting station finder*.
- (3) The study provides an historical overview of the Limpopo case study, which explains the origins of the problem of income poverty.
- (4) As far as the author knows, no such empirical work has been done to estimate the impact of mining on local communities in South Africa, except a forthcoming publication by Axbard, Poulsen, & Tolonen (2015) on its effects on criminality

The rest of the paper proceeds as follows:

The next section of chapter 1 provides an historical analysis of the creation of poverty in the Limpopo Province. It looks at the use of systematic policies that created enclaves by isolating a group of people into pockets of non-productive land; this enforced together with race and labour discrimination policies. This analysis also provides perspective on the behaviour of the mining industry within and around the Limpopo region. Chapter 2 is a literature review which summarises

the main literature on the impact of mining on local communities, including empirical methods published. Chapter 3 then explores qualitative evidence of change in the mining industry over time, and how mining has been increasingly integrating with local communities within which they operate. The overarching conceptual framework within which the analysis will be done is global value chains and linkages, as presented by Morris et al. (2012). Change over time is a necessary condition for the empirical study of this paper. Chapter 4 firstly outlines the framework that brings together the economic and environmental impacts of mines, upon which to build a suitable empirical model. Secondly, the chapter provides testable predictions which will be empirically estimated. Thirdly, the chapter outlines the empirical strategy, which exploits changes in distance to mine and in mining policy as sources of variation. Fourthly, the chapter presents the empirical results. Fifthly, the chapter analyses the results using extensive literature. Finally, the chapter undertakes robustness checks to rule out alternative drivers of results. Chapter 5 closes with a summary of findings and policy implications.

Building Enclaves: the development of poverty and mining in the Limpopo Province

In present-day Limpopo, poverty persists; in the context of large platinum, coal, copper, diamond, and other mineral mining operations. This observation is not a statement that mining operations are responsible to reduce or eliminate poverty as a mandate, but rather, it is to highlight that industrial mines in this area are relatively large, and their presence brings potential to make a measurable impact on the welfare of local hosting communities⁶. In addition, mining is a major economic activity in the province as a percentage of GDP, contributing 25 percent in 2011 (Statistics South Africa, 2011). The two other important industries are agriculture and tourism. Therefore, mining in Limpopo is an important industry because of its size, because the old South Africa partly industrialised at the back of mining, and because persistent poverty is a problem for communities and is a threat to the sustainability of the industry.

To understand the poverty and the impact of mining on the local communities in Limpopo, it is necessary to analyse this relationship from a historical perspective. The review of history from

⁶ This paper will specifically deal with hosting communities, as opposed to labour-sending communities.

early 1990s will establish a strong case for the enclave thesis of mining in Limpopo, which will allow for an investigation of the extent of progress – over time – in integrating mining into the economic development of local communities. Thus, this section explains the origins of the dependent variable (poverty), and the formation of the mining-community relationship in Limpopo.

The Limpopo Province is the northernmost province of South Africa and borders Botswana to the west, Zimbabwe to the north and Mozambique to the east. Limpopo was not a province before 1994. It was a collection of separate “homelands” or “Bantustans” that were meant to be independent states, separate from the Republic of South Africa⁷. These were less valued areas in the margins reserved for black people after land dispossession; and were meant for the permanent removal of the Black population in White South Africa (Manson, 2013). This development was one of the major events that created enclaves within South Africa.

The homelands that consist the Limpopo Province were economically dependent on the then Republic of South Africa, as a result of underdevelopment and lack of opportunities within the homelands. The majority of income was generated from migrants who worked in the Republic, while production within the homelands typically constituted less than one-quarter of total area income. The homeland government was also heavily reliant on the funds from the Republic, as it lacked a tax base, and was barred from taxing white businesses or mines operating within homelands (Butler, Rotberg, & Adams, 1978).

Panel A of Figure 1 shows the old administrative units between 1910 and 1994; a period during which South Africa was under a non-democratic political regime. Panel B shows the distribution of homelands around South Africa during this period, while panel C adds the new administrative units of democracy from 1994 interacted with the former homelands. Studying panel C shows that the Limpopo Province largely consists of homelands, namely Gazankulu (796,789 hectares), Lebowa (2,527,697 hectares), Venda (708,897 hectares), and a small part of Bophuthatswana (4,214,737 hectares). According to a census conducted in 1970, Gazankulu consisted of 731,000 citizens, Lebowa had 1,596,000 citizens, Venda has 360,000 citizens, and Bophuthatswana had 1,702,000 citizens. The total population of the homelands was 14,893,000 (South African Institute

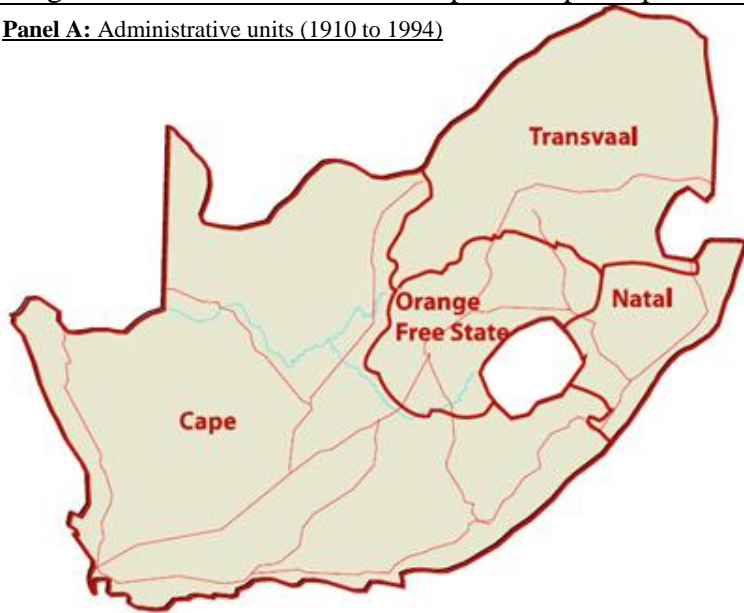
⁷ Refer to Butler, Rotberg, & Adams, 1978 for a history of homelands in South Africa.

of Race Relations, 1971; 1990)⁸. Panel D shows the Bushveld complex, largely consisting of platinum mining. This depicts a post-apartheid picture of mining in Limpopo (and the North West).

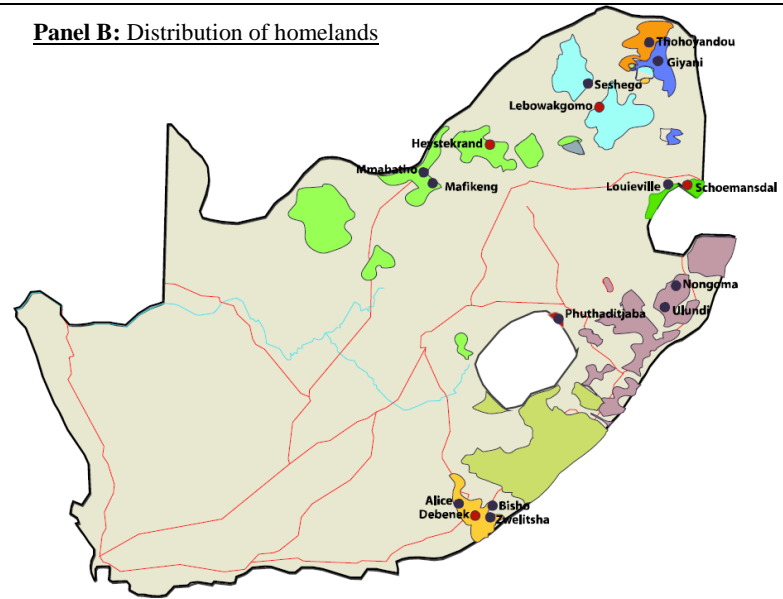
⁸ To add perspective, White South Africa had 3.8 million people in 1970, occupying well above 80 percent of total land area.

Figure 1: Administration units in pre- and post-apartheid South Africa

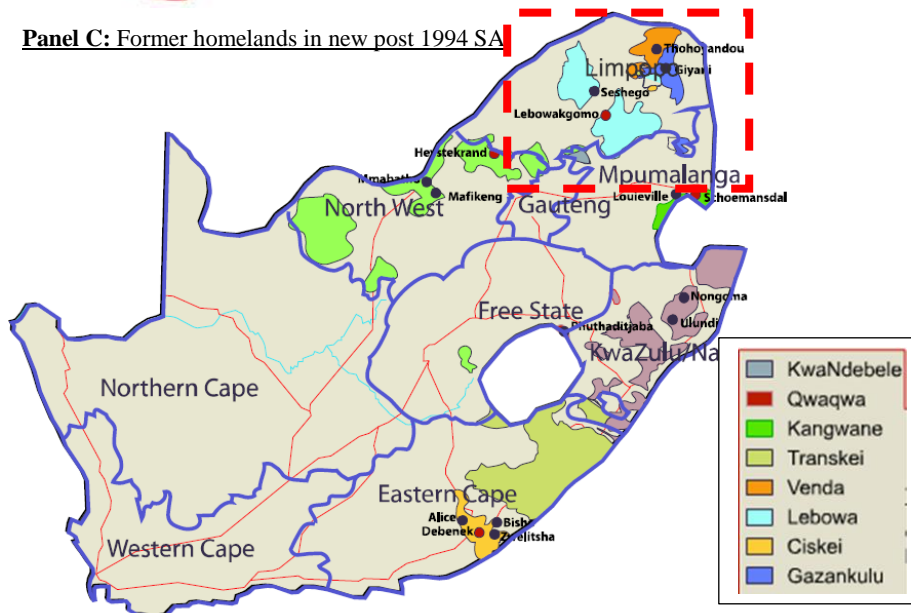
Panel A: Administrative units (1910 to 1994)



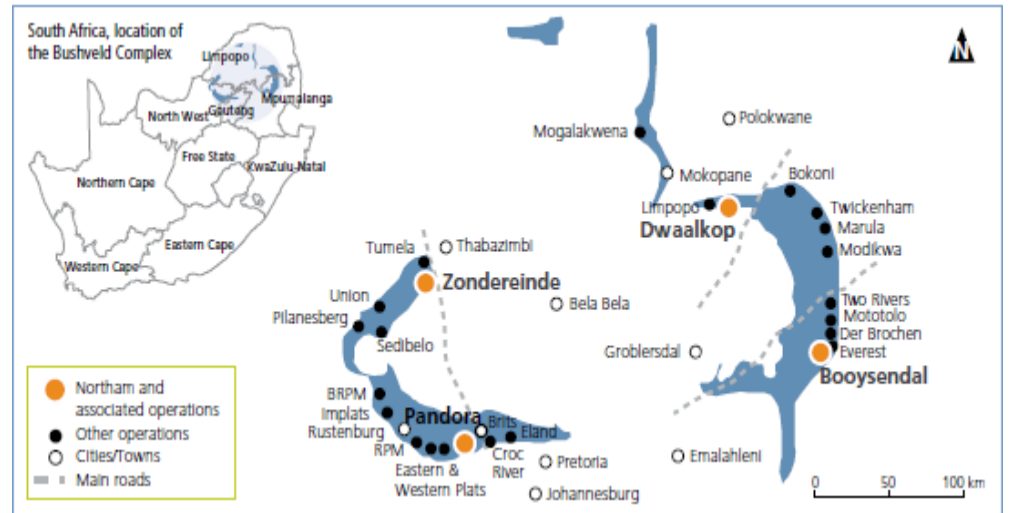
Panel B: Distribution of homelands



Panel C: Former homelands in new post 1994 SA



Panel D: Bushveld location of PGM operations



Source: Stanford University (<http://web.stanford.edu/class/history48q/Materials/maps/SouthAfricav6.html>); Chamber of Mines South Africa (<http://www.chamberofmines.org.za/sa-mining/platinum>)

It was later discovered in the 1920s that large tracts of the land allocated to homelands, including portions which were purchased by black people, (in particular, the baFokeng community), contained large deposits of platinum group metals. This area consists of the eastern and western part of the Bushveld Igneous Complex which largely lies on the Limpopo and North West provinces. However, the mining of these metals is distinguished by process of extraction that is expensive and highly specialised, with a volatile demand. Therefore this discovery of minerals could not be mined by locals who had no capital or skills. As an alternative solution, the local chiefs took advantage of the large influx of prospectors and companies seeking to cash in on the expected mining boom by selling prospecting rights (Manson, 2013).

Indeed, by the 1970s, it was becoming clear that the northern homelands were rich in mineral deposits, having not been previously systematically surveyed for mineral wealth (Butler et al.,1978). Gazankulu had gold mining, Venda had copper, Lebowa had platinum and other deposits including crocidolite, corundum, coal, iron, titanium, and vanadium. Mineral rights in these areas were held by the South African State, the Bantu Trust, tribal communities, and individual blacks⁹. During this time, the government of South Africa had granted 261 prospecting permits and 109 mining leases in African areas, but these were only granted to white companies or persons (South African Institute of Race Relations, 1971).

Table 1 shows prospecting activity statistics in the homelands during 1979. It clearly shows that there was a lot of prospecting activity concentrating in the Limpopo region by the late 1970s. Prospecting was particularly concentrated in Lebowa; given its platinum and coal deposits. Table 2 shows mines in operation, the associated black employment, and earnings. There were approximately 31 mining operations around the Limpopo region, the majority in Lebowa.

⁹ See Mason (2013) for a history of black ownership of these lands.

Table 1: Prospecting by the private sector during 1979

Homeland	Number of valid concessions	Total extent (hectares)	Expenditure R	Number of Black in employment	Black earnings R
Limpopo homelands					
Gazankulu	14	72 691	37 906	30	5 192
Lebowa	89	166 857	932 077	120	84 969
Venda	5	6 389	77 297	38	22 754
Sub-total (Limpopo)	108	245 937	1 047 280	188	112 915
Other homelands					
Ciskei	5	1 625	10 337	18	3 168
KwaZulu	53	887 027	870 761	185	235 962
KaNdwane	4	673	279 615	120	61 265
QwaQwa	1		120 000	16	12 000
KwaNdebele	2	4 713			
Total	137	1 139 975	2 327 993	527	425 310

Source: South African Institute of Race Relations (1981)

Table 2: Mining activities by private sector during 1979

Homeland	Number of mines in production	Number of Black in employment	Earnings R
Limpopo homelands			
Gazankulu	4	225	67 011
Lebowa	21	8 080	11 883 000
Venda	4	303	77 627
Mining Corporation			
Lebowa	1	458	362 148
Gazankulu	1	278	195 371
Other homelands			
Ciskei	3	78	98 036
KwaZulu	16	511	1 046 831
KaNdwane	6	1 613	1 449 733
QwaQwa	2	38	19 819
KwaNdebele	1	18	4 330
Total	59	11 602	15 203 906

Source: South African Institute of Race Relations (1981)

In order to guide the greater White and Black exploitation of homeland mineral resources, a body called the Bantu Mining Corporation was instituted. According to Butler et al. (1978), the corporation was meant to oversee existing operations and act as an agent for individual Africans and communities in their negotiations with White companies. However, the corporation only principally acted to give White mining interests access to homeland mineral deposits. The homeland governments had no authority to specify the terms of exploitation. In view of this, Butler et al. conclude that this was a classic example of enclave mining behavior in an underdeveloped setting, with very poor backward linkage effects from mines and limited employment and income multiplier effects because few locals were employed, at minimal wages, and the workers did not spend the bulk of their funds in local shops. Furthermore, there were few internal forward linkages into processing and fabrication.

By 1979, there were 59 mines operating in the homelands, majority of which were in the northern region. These mines employed approximately 12,000 black workers, of which over 80 percent were working in the north (Table 2). The largest share of the resources was dedicated to platinum mining. The royalties from the mining operations were paid into the S.A. Bantu Trust, which collected these royalties from the use of tribal land and Trust land. However, the government ministry in charge could not say what percentage of these revenues were allocated to the African tribes (South African Institute of Race Relations, 1980).

In terms of employment, a notable example is that the three large mines which had begun mining platinum in the northern homelands¹⁰ together employed 45,000 Africans (compared to 3,600 whites); however, a large majority of these were not locals, but were recruited from other parts of South Africa and neighbouring territories. Furthermore, the types of jobs that could be done by Africans were legislated under the Mines and Works Act, which did not permit Africans to do such jobs as sampling, welding underground, or driving an underground locomotive if whites were on board. The industry also applied wage discrimination, whereby the starting salary in 1979 of underground work returned R350 for a white person compared to R100 per month for an African; and R240 for surface work compared to R75 for an African. In terms of employment opportunities

¹⁰ These mines are the Union platinum, Rustenburg platinum mine, and an unnamed mine.

for locals, the White government's strategy was creating more opportunities within the Republic wherein homeland locals would travel for work.

Therefore, there are three critical "enclave effects" to be observed so far in relation to early mining in Limpopo: (1) mines were not locally owned, and royalties were not fully controlled by local representatives, (2) employment creation by mines was limited both directly and indirectly as locals were not part of the supply chain, nor were there skills transfers because of the colour bar legislation, and (3) for the employed locals, records suggest that the majority were employed outside of the homelands, where most of their expenditure from wages was spent. Thus, homelands were themselves created enclaves, while mining in these areas was enclave in nature, creating very little possibilities of local economic upliftment. It was enclaves within enclaves.

The impact on poverty was significant. A study in 1985 by the Development Bank of Southern Africa found that some 80 percent of families living in homelands earned below the minimum subsistence income level, and efforts to date by the South African government to curb this poverty had failed (South African Institute of Race Relations, 1990). A survey on household incomes undertaken by the Rural Urban Studies Unit at the University of Natal between 1982 and 1985 found that wages and remittances constituted 77% of total income, 8% from agriculture and the informal sector, and 14% from pensions and transfers.

Given the importance of wages and remittances in rural households during this time, and given that mining activity was growing during this period in the Limpopo region, Table 3 below shows that of the R672.6 million that was paid by the mining industry to mineworkers, only 0.5 percent between 1988 and 1989 accrued to the Limpopo homelands. Apart from the explanation that a lot of mining was outside this area, another part explanation is the little use of local labour living in surrounding communities, in favour of foreign migrant workers as major sources of labour – as already discussed. The major source countries of migrants were Lesotho, Mozambique, Malawi, Botswana, and Swaziland.

Table 3: Amounts paid out by Chamber of Mines Employment Bureau of Africa (TEBA)'s regional offices: 1988 and 1989

	1988	1989
	Rm	Rm
Bophuthatswana	17.2	13.2
Botswana*	20.2	19.6
Cape	7	5
Ciskei	2.9	2.9
Gazankulu#	0.8	1
KaNgwane	0.4	0.4
KwaZulu and Natal	14	15.5
Lebowa#	1.9	2
Lesotho*	347.8	408.4
Malawi*	54.8	17
Mozambique*	102.7	114.3
Orange Free State	4.7	1.2
QwaQwa	2.7	2.7
Swaziland*	15.2	16.1
Transkei	73.9	81.3
Transvaal	6	6.5
Venda#	0.4	0.6
Total	672.6	707.7

*Neighbouring countries

#Limpopo homelands

Source: South African Institute of Race Relations (1990)

The types of interventions to curb poverty during this time included the decentralisation of policies by the South Africa government, and various development projects funded through the Development Bank of South Africa, including infrastructure development and business development. In terms of economy performance, the homelands in Limpopo ranged between 1.3% and 8.2% in GNP per capita growth in real terms during 1970 and 1986, as shown in Table 4.

Table 4: GNP per capita growth rate in real terms

	1970-1980	1980-1986
Limpopo homelands		
Gazankulu	3.2%	4.1%
Lebowa	2.0%	1.3%
Venda	6.0%	8.2%
Other homelands		
Bophuthatswana	7.0%	-
Ciskei	3.6%	6.2%
KaNgwane	1.5%	-3.4%
KwaNdebele	N/A	1.2%
KwaZulu	3.7%	1.5%
QwaQwa	6.0%	2.3%
Transkei	10.4%	3.3%

Source: South African Institute of Race Relations (1990)

The efforts to curb poverty lacked political will given racial policies that underpinned the polity. Together, this system spelt the creation of poverty in the Limpopo region.

Chapter 2 Literature review – The Impact of Mines on Local Communities

The aim of this study is to measure the impact of industrial mining on income poverty in local hosting communities. The *direction* and *size* of impact is not *a priori* obvious, and this sets the context of the controversy of the issue in South Africa – with opposing narratives about the impact of mining. The main research challenge is therefore twofold. On the one hand, this is an empirical question which requires a literature survey of empirical methods used to evaluate the causal impact of mining at the micro level. On the other hand, this is a qualitative question that requires a literature survey that can unpack the complex channels of impact, give insight into theoretical predictions, give insight on how mining and communities interact socio-economically and environmentally, and thus compliment the empirical investigation. Because of the importance of context, the qualitative substance is spread throughout this paper, from the first chapter that relies on literature to investigate the historical development of poverty and the historical arrangement of the community-mining relationship in South Africa, to the empirical chapter which relies on literature to explain empirical findings, to the conclusion which also relies on literature to outline sound policy considerations. This present chapter will summarise the main literature on the impact of mining on local communities, while paying a greater focus on empirical methods published.

The impact of mines on local communities in South Africa

The related literature on the impact of mining in South Africa can generally be split between three themes. The first theme is transformation in the industry as concerning the extent of progress on meeting mining charter targets, such as employment equity, black ownership, and skills development (Mitchell G. , 2013). The second related theme is Corporate Social Responsibility (CSR), which is nuanced from Corporate Social Investment or from domestic government policy transformation targets, but is embraced by mining companies as a corporate strategy that is fundamental to doing business. CSR is increasingly an important factor for incorporation into global value chains (Morris, Kaplinsky, & Kaplan, 2012; Hamann, Mining companies' role in sustainable development: The 'why' and 'how' of corporate social responsibility from a business

perspective, 2003), improving company image (Hamann & Kapelus, 2004), and protecting investment from hostile communities (Kapelus, 2002). Finally, the third theme covers the impact of mines on local livelihoods, including job creation, the environment, and health (Akcila & Koldas, 2006; McCarthy, 2011; Corbett, et al., 2000; Campbell, 1997). This paper is not particularly concerned with unpacking whether the mining industry is complying with policy or not, or whether it has incorporated CSR into its business model. Rather, this paper is closer to the theme of local impact, resulting from mining operations. This in turn captures the two other themes because the impact of a mine is determined by how operations factor-in communities.

The most noticeable research on the impact of mining on local communities in South Africa is the Benchmarks Foundation's, which has been widely covered in the media¹¹, and actively received responses from some large mining companies. The Benchmarks Foundation concerns itself with protecting human rights and dignity of mining communities, while employing robust methods of research to highlight the lived experiences of communities in mining areas. Although the methods of research are qualitative – including tools such as focus groups, one-on-one interviews, photography of spaces, and desktop research – they are nonetheless useful to better understand the reasons behind the controversial existence of mining in South African communities. Because the report has such substantial value in so far as it has won attention of key stakeholders in the issue of local impacts of mining, the rest of this section will review literature around the Foundation's report.

The Bench Marks Foundation (“the Foundation”) (2012)'s study undertakes an investigation on the benefits of mining to surrounding communities in Rustenburg, North West Province¹². The objectives of the study include understanding the perceptions of communities about local mining operations, evaluate changes which have occurred since a previous study published by the Foundation in 2007, increase the participation of communities in monitoring local operations, and solicit views of mining operations.

Like the Limpopo Province, mining in Rustenburg is one of the district's major source of employment, both directly and indirectly, via backward and horizontal linkages. Poverty and

¹¹ Media coverage includes news sites such as polity.org.za, miningweekly.co.za, and engineeringnews.co.za. Some mining company websites also cover their responses to reports published by the organization.

¹² The North West Province neighbours the Limpopo Province.

unemployment in the region remains high, many households are headed by women, and the region lacks bulk infrastructure to support development. The mining communities are characterised by an influx of migrant workers, who are largely low-skilled poor workers seeking economic opportunities. The mines are surrounded by informal dwellings, attributed to the living-out allowance which encourages workers to live away from mine hostels and to build nearby informal housing. In terms of health, over 40 percent of reported deaths in these mining communities are attributed to HIV/AIDS.

The report suggests that there is no readily visible benefit to mining communities from operations. That is, there is a disconnect between mining firms' actual reports of substantial positive socio-economic returns to local communities, and the actual reality of impact on community wellbeing. The report contends that the extent of the problems caused by mining are larger than the benefits reported by mining operations.

The study proposes three channels through which mining impacts communities. The first channel is an economic impact through agriculture. According to the study, mines buy surrounding property and productive land, leaving these lands unproductive while causing farming to be isolated spots. The isolation exposes farms to crime, and this devaluates the property. Because the surrounding mines and mine dumps render the farms unattractive for sale, the only market left to which farms can be sold are the mine companies. These explanations are supported by empirical literature of leading scholars in the field, including Aragón & Rud (2015) who use Ghana as a case study to show causality between mining and poverty via negative impacts on agriculture; and Axbard, Poulsen, & Tolonen (2015) who show a causal impact of mining in increasing criminality in local mining communities in South Africa.

The second channel is an environmental impact. According to the Foundation, the impact on the environment has worsened since its report of 2007. The report explains that the expansion of mining since the 2007 report has led to more slime dams being built adjacent to farmers and to other properties. This in turn has impacted on the quality of surface water. The polluting of local rivers means farmers downstream can no longer use that water. Mines also claim the majority use of local dams, which are earmarked for agriculture. In addition, air pollution is a substantial problem to the farms, especially in times of high winds. The extent of the situation has farmers

preferring that mines buy up the rest of the small surrounding farms and use the local dams for industrial mining purposes.

The channel of environmental impact has been widely studied in South Africa. For example, Naicker, Cukrowska, & McCarthy (2003) scientifically investigated soil composition and underground water in the Witwatersrand mining district¹³. The study revealed that the ground water within the mining district is heavily contaminated and acidified as a result of oxidation of pyrite (FeS₂) contained within mine tailings dumps, and has elevated concentrations of heavy metals. Similarly, as study by Durand (2012) on the Witwatersrand finds that despite the development, employment and wealth brought about by mining in the region, there is evidence of pollution caused by acid mine drainage which bears serious consequences for health and the environment. The extent of possible health consequences is exposted by Davies & Mundalamo (2010), who suggest that studies of medical geology can show a link between polluted water from mines and nutrient deficiency and contamination in soil, which is transmitted into the food chain, which in turn has causal impacts on osteoarthritic disease that afflicts two-thirds of the women in Maputaland (Kwa-Zulu Natal), for instance. Furthermore, the generally low Selenium status of agricultural soils could represent an important co-factor in the relatively high diffusion rates of HIV-AIDS in the country.

Indeed, the Foundation's 2012 report suggests that the *expansion* of mining activity is positively correlated with the expansion of greenhouse gas emissions and other forms of pollution. In one instance, the study states that for a certain local mine, "greenhouse gas emissions increased by 12 percent as production levels rose" (Bench Marks Foundation, 2012, p. 84). This narrative directly addresses the theoretical and empirical framework of this present study on Limpopo. It sets the context of the complex effects of mining operations, which on the one hand provide economic activity that can potentially improve local livelihoods, and on the other hand undermine local development. The suggestion is not that there is a critical point beyond which the expansion of mining operations hurts livelihoods – that would be contrary to the linkages story where deepening of economic linkages requires scale. What this does suggest, however, is the important role of deepening economic linkages so that the rate and scale of local development rises faster and

¹³ The Witwatersrand is about 300 kilometres from Limpopo, in the city of Johannesburg.

substantially to limit as much as possible the negative impacts on society. Part of this development involves better spatial planning and better mining practices.

The third channel of impact nuanced by the Foundation is a social impact. The establishment of squatter camps on unproductive land owned by mines increases crime, rape and prostitution, social disintegration, and communicable diseases such as TB and HIV/AIDS. The sleeping-out allowance is used for remittance and/or entertainment in the form of alcohol and women. Other social issues pertain to a perceived lack of proper consultation before the exploration of farm land. Where consultation is reported as having been done, these reports are usually carried out by consultants from Johannesburg who are said to report dishonestly on matters affecting farm land.

Examining the rest of the study, there are twelve substantial claims about the impact of mining on local communities in Rustenburg area, most of which can be viewed as hypotheses of mining impacts on communities. The claims are as follows:

1. Mining contributes to the spread of HIV/AIDS.
2. There are causal links between HIV/AIDS, Tuberculosis, and the reliance of mining on a highly mobile migrant labour system. Literature establishes a link between a stable (non-migrant), locally recruited, properly housed labour force and lower HIV/AIDS infection rates.
3. Women suffer livelihood losses, marginalisation and loss of identity as a direct and indirect consequence of mining operations.
4. Mining damages water quality which in turn causes health and livelihood problems.
5. Mining causes air quality issues that lead to respiratory problems.
6. Mining leads to overall development problems of communities in whose land they operate.
7. Despite the great value extracted from platinum mining in the North West, there are harmful social, economic, and environmental impacts on local communities.
8. Mining communities in the Rustenburg area are yet to benefit from mining operations, as unemployment and poverty levels remain high.
9. Lack of job opportunities result from use of migrant labour instead of training workers from local communities.
10. The policies of subcontracting and outsourcing are not resulting in local procurement and economic development.

11. There's a strong gender bias in the industry, with a lack of employment opportunities for women.
12. The mining corporations do not provide levels of environmental, income, health and safety standards equal to that of their operations in the developed world.

These are substantial claims which frame the narrative of the impact of mines at community level. This present paper contributes empirical evidence of the socio-economic impact of mining, supported by insightful qualitative analysis of the subject.

The impact of policy on the mining-community relationship in South Africa

Another important element in studying mining impact on communities in South Africa is policy. The role of policy in fostering transformation in the industry is central, in so far as it has been used to change how mining companies do business in communities. For example, a study by Rawashdeh, Campbell, & Titi (2016) investigates the impact of mining on local communities by comparing socioeconomic indicators in mining and non-mining regions in the Jordan, and exploiting before and after mining outcomes. The study provides suggestive evidence that mining communities do not fare better than non-mining communities partly because there is no legislation guiding mining companies' responsibility on local communities in 'giving back' to compensate for the negative impacts disproportionately borne by communities. The correlations support a hypothesis that mining activity involves a higher social cost on community in the absence of "compensation policies" to offset local costs of mining.

Because this present study relies on the introduction of policy in the industry as an exogenous shock to mining behavior and therefore to mining impacts, it is useful to understand literature in South Africa that has investigated the impact of policy on mining.

A study by Morris and Baartjes (2010) examines the extent to which the South African mining charter legislation has been effective in influencing diamond mining firms to implement local economic development strategies. The study specifically looks at the period between 2004 and 2009, which was the time during which the mining industry was converting to the new mineral

rights dispensation¹⁴. The study is motivated by the observation that large industrial diamond mining appears to have negligible positive impact on the livelihood of local communities during active mine operational life, while the closure of mines may leave communities worse-off because of loss of jobs and loss of mine-linked activities at the local communities. While diamond mining may not be associated with armed conflict in South Africa as in countries such as Sierra Leone, Angola, and the Democratic Republic of Congo, the authors suggest that the failure of diamond mines to impact meaningfully on the livelihoods of communities close to the location of operations has led to increased resentment and a different type of non-violent but more socio-politically driven tension. This tension, the authors explain, is a result of local communities' view that they are excluded from the business of mining - from the extraction of the diamonds to the final sale – therefore they do not have any material benefits that should accrue to them from mining.

The study uses the mining charter scorecard, which is an assessment tool to evaluate the extent to which mining firms comply with the mining charter and are socially responsible; and to evaluate the extent of progress of the diamond mining industry towards becoming more community uplifting. The objectives within the scorecard include human resource development, employment equity, non-discrimination of migrant workers, increased procurement from historically disadvantaged South African (HDSA) communities, mine community and rural development, improvement of housing and living conditions, ownership stakes of mines by HDSAs, and increased beneficiation. The study finds that there is a delay by the diamond mining industry in implementing their local development strategies, while the failure of the legislation to impose stricter measures means that communities are left destitute.

Similarly to the study above, Mitchell et al. (2012) examine how the MPRDA has transformed the historical relationship between mines and communities and how this has impacted community livelihoods. The authors liken the historical relationship between mining and communities in South Africa to the story told in the film *Avatar*, whereby mining firms have simply sought to enrich themselves without taking into account the interest and concerns of the communities whose lives are affected by mining operations. This relationship, they argue, was further exacerbated by the institutional arrangement of the country, including the Black Land Act 27 of 1913 and the

¹⁴ See Badenhorst, P. J. (2011). The Make-Up of Transitional Rights to Minerals: Something Old, Something New, Something Borrowed, Something Blue...? *South African Law Journal*. Vol.128 (4), 763-784

Development Land and Trust Act of 1936 that are argued to have deprived black people of rights to own land. With the introduction of the MPRDA in 2002, the article contends, contrary to Morris and Baartjes (2010), that this policy effectively transformed the relationship between mining firms and communities, through requirements by government that firms must undertake consultations with affected communities, submit a comprehensive social and labour plan that focuses on how the operation will uplift the community, and incorporate communities in joint ventures with the mine operations.

While mining communities articulate poor benefits from local mine operations, the mining industry has reported difficulties in implementing mining charter legislation, particularly given constant changes in legislation, with ever stricter requirements. A study by Moraka & van Rensburg (2015) conducts a qualitative study including interview surveys of 10 mining executives to assess the challenges faced by the industry to transform, given the government's perception that the industry is slow to transform because there is lack of buy-in to do so (also see Mitchell, 2013). The study finds that skills shortages is a key constraint that limits employment opportunities for communities; and this impacts on the industry's ability to achieve employment equity. Other issues involve different interpretations of the charter requirements between government and industry, which leads to different measurements of progress. Furthermore, Lane, Guzek, & van Antwerpen (2015) present a view that government is increasingly expecting mining companies to fulfil social needs typically addressed by government, such as the provision of basic services, education, and health care. Provision of such public goods is not only outside the core competencies of mining, but it is not the business function of mining companies. This problem may suggest that a better model on usage of fiscal linkages (tax and royalties) from mining is needed, while communities make the most of mining operations through exploiting production and consumption linkages (see Chapter 3 for further discussion on linkages).

Review of empirical studies on estimating the impact of mining on local communities

Empirical studies on the impact of large mines on local communities are scant (Aragón & Rud, 2013). However, since 2013, this question has been receiving increasing attention from an empirical perspective, largely inspired by the work of Aragón & Rud. This section reviews some

of this literature, with a view to understand empirical methods applied to the issue, as well as findings.

Aragón and Rud (2013) examine the local economic impact of a large golden mine in Northern Peru using annual household data over a period of ten years. The authors use a difference-in-differences analysis by exploiting a local demand shock resulting from an introduction of procurement policy by the mine in 2001, as well as variation of distance from the mine. The study finds evidence of a positive effect of the mine's demand for local inputs on real income; diminishing with distance. This finding is supported by a similar study by the World Bank which uses a new district-level database on Peru, and finds evidence that producing districts have better average living standards than otherwise similar districts: larger household consumption, lower poverty rate, and higher literacy; diminishing with distance. However, this study finds that district level consumption inequality increases in all districts belonging to a producing province; a result which may explain the social discontent with mining activities in the country (Loayza et al., 2013).

While Aragón and Rud (2013) focus on the economic impact of mines on local communities, Kotsadam and Tolonen (2015) undertake a similar investigation, only focusing on female employment. The authors explain that it is theoretically ambiguous whether mines increase or decrease female employment, because mining may possibly reinforce gender disparities in economic opportunities at the detriment of women. The authors expect that although overall employment emanating from mines should increase for both genders, they expect to find gender segregation; whereby female employment increases in the services and sales sectors, while male employment is concentrated in manual labour. The study uses a longitudinal dataset of 874 industrial mines in 29 countries in Sub-Saharan Africa (years 1975 and 1984 to 2010) and use spatial information to match 275 large mines to Demographic and Health household survey data for women aged 15 to 49. It exploits both spatial and temporal variation in the data (by using mine openings and closures, and distance from a mine at household level) to compare people living close to a mine with those living farther away. The study also distinguishes between active mines, closed mines, and planned mines in order to investigate before and after mine activity effects.

The study finds support for a structural shift resulting from an opening of a mine, whereby women shift from agriculture work to the service sector, or out of the labour force. The increase in employment for females in the services sector increases by 50 percent. This effect diminishes with

distance to an active mine, and is statistically insignificant beyond 50 kilometres. The overall impact of a mine opening causes a decrease in work force participation, whereby there is a 5.4 percentage points decrease in participation by women, and a 3.2 percentage point participation decrease by men: these results are stronger during commodity price booms. Therefore, this paper provides evidence that woman could potentially be empowered through horizontal economic linkages that are stimulated by mining, but it is not necessarily the case that the overall impact of mining empowers women, given the decline in overall labour force participation by women.

Another study by Axbard, Poulsen, & Tolonen (2015) essentially uses the same empirical strategy that exploits spatial variation to investigate the role of mine operations on levels of local criminality in South Africa. The study finds that the start of natural resource extraction is not linked to higher levels of crime. However, the closure of a mine leads to a large and significant increase in both property and violent crime. The study shows that migration flows and income opportunities created by the mining industry are two important channels through which mining affects criminality. Therefore, this study supports the view that mining could potentially threaten local social stability and security.

Aragón & Rud (2015) empirically investigate the impact of mine operations on the environment, on agricultural productivity and on poverty in Ghana, using spatial variation between farmers located near mines and those farther away. The study finds that pollution from mines decreases agricultural factor productivity by almost 40 percent between 1997 and 2005. Therefore, the study provides evidence of negative environmental and socio-economic externalities that affect living conditions in rural areas, particularly in the absence of policy to mitigate such externalities.

Overall, a fuller view on the literature covering the impact of extractive industries on poverty is provided by a study by Gamu et al. (2015) who survey fifty-two empirical studies they distinguish by mode of resource extraction. They find that industrial mining is frequently associated with poverty exacerbation, while artisanal mining is associated with poverty reduction. The former is concluded from studies that use aggregate level data, while the latter uses sub-national census-based data. This confirms the motivation for more granular data level studies to understand the impact of industrial mining at the local level, which will be the focus of this paper (Nxele, 2015).

The next chapter builds on this literature review by discussing a conceptual framework to understand how mining operations economically link to local communities, and therefore how

these links can be amplified to create positive spillovers from mining. The chapter will also give further insight on how South Africa's mining-community relationship has changed, and how, from a policy-implication perspective, it can continue to change towards a positive direction.

Chapter 3 From a ‘leakages’ model to a ‘linkages’ model

Chapter 1 provided a historical context under which the mining industry has been operating in the Limpopo Province. The chapter provided evidence of causal, structural, and systematic factors that largely created the problem of poverty and enclave practices of mining in the Province. This chapter progresses from the historical, pre-democracy structural arrangements to an analysis of the mining industry under a new national political regime, with a new mining industry policy, operating under the era of global value chains which have changed dynamics of how mining firms interact with communities. Therefore, this chapter explores qualitative evidence of change in the mining industry over time, and how mining has been increasingly integrating with local communities within which they operate. The overarching conceptual framework within which the analysis will be done is one of global value chains and linkages, as presented by Morris et al. (2012). The analysis is limited to the economic dimension, and leaves the environmental issues to the next chapters.

The ‘Leakages’ model

The point of departure is the premise that mining is a productive activity that is both a market and a source of raw materials, as stated by Harris (1954). If the supply chain is localised, the demand shock resulting from an opening of a mine will create multipliers (direct and indirect) that will filter locally by creating new sources of employment (Moretti, 2010). The rise in employment as a result of new (and amplified pre-existing) economic activities provides a source of income for local households who are producers and suppliers of labour. This leads to a rise in real income for benefiting households (Aragón & Rud, 2013), which then lifts local beneficiaries out of income poverty. The extent of the impact, as noted by Moretti, will be partially offset by general equilibrium effects induced by changes in local wages and prices of local services. In short, the existence of local linkages is a necessary condition for economic multipliers to be captured locally.

Given that mining is an economic activity that requires natural conditions, which includes the existence of profitably extractable deposits, it cannot physically move closer to suppliers. Suppliers, however, are mobile, and the mobility of suppliers is necessary to creating localised economic activity around mines. As an example, Harris (1954) observed that before the

development of mining in Britain, the highest population densities were in southern England; but after the Industrial Revolution, there was a strong development of industry around the coal-mining districts in order to be close to the source of power. Therefore, there was a change in the composition of the mining areas by a process of localisation of inputs and downstream industries, based on a commercial imperative.

However, Harris observed that this pattern of suppliers moving to the location of natural resources did not replicate in the United States. Specifically, the coal-mining districts in southern West Virginia and in south-eastern and western Kentucky were devoid of manufacturing activities, while in Illinois mines were in the south, and manufacturing concentrated in the north. Therefore, the mobile nature of mining-linked economic activities did not, in this case, mean that these activities will move close to mines.

This divergence from the pattern in Britain, according to Harris, is explained by the fact that mining in the United States occurred after the development of railroad and therefore “power thus could be brought from rugged mining districts to existing industrial areas or to points with a favourable combination of terrain, market, labour, transportation, and other conditions” (Harris, 1954, p. 24). Therefore the emergence of railroad changed the location relationship between manufacturing and mining, whereby the location of manufacturing attached less weight to the location of natural resources.

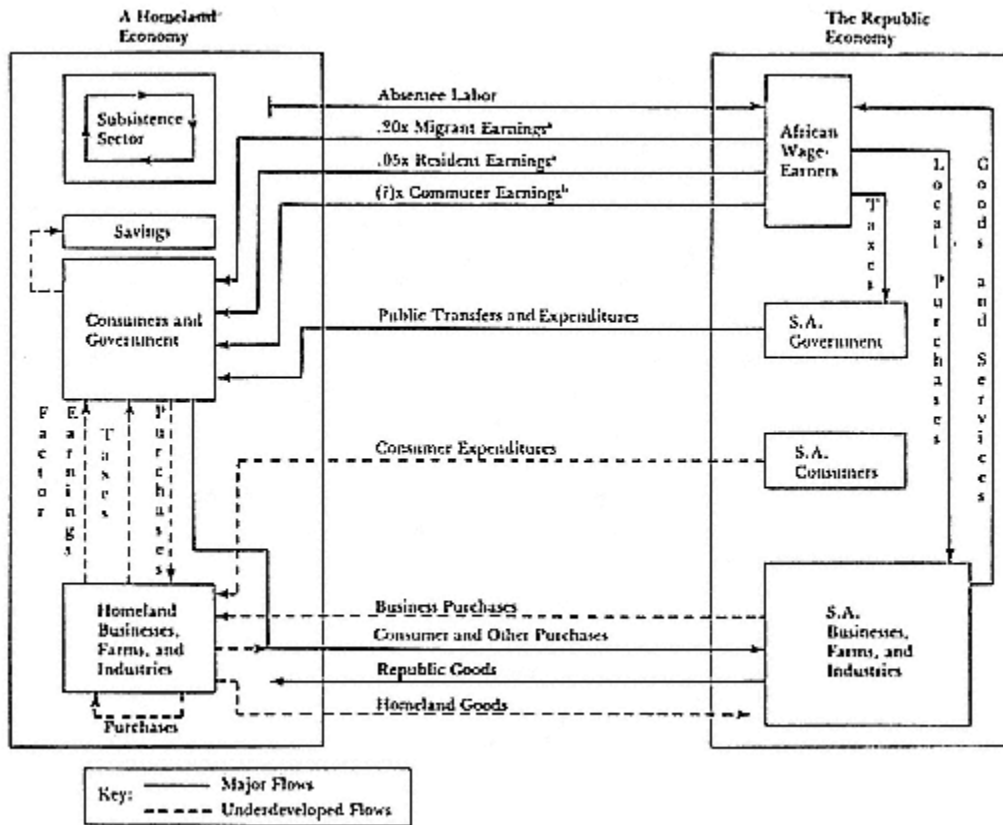
This development of transportation and communication infrastructure makes possible an “enclave” behaviour of mines, where inputs can be sourced from established locations and downstream activities can be done in those favourable locations. In fact, the enclave thesis argues that the development of mining will have weak local linkages because commodities intrinsically have little scope for linkages and technological spillovers, and because resource-rich low-income economies have limited linkages; while the benefits are captured by high-income home economies of the lead commodity firms (Singer, 1950: cited in Morris, Kaplinsky, & Kaplan, 2012).

Indeed, this paper deals with a peculiar case study of a province largely made up of historically impoverished independent homelands that are host to large mineral deposits, predominantly of platinum group metals, coal, copper, and diamond. The disunion of these areas began before the discovery of the rich deposits in these areas, while the reintegration of these homelands came after the invention of rail and after the industrialisation of Johannesburg which industrialised around

mines (Butler et al., 1978). When analysing the impact of mines on the homeland of Bophuthatswana (neighbouring the Limpopo Province), Butler, Rotberg, & Adams (1978) find that data showed extremely limited impact of mines on local incomes of homeland residents. They argued that under the then institutional arrangements, growth in the extractive sector in these areas should not be viewed as contributing in a major way to the development of the homeland, because “the genesis of income-creating forces lies outside the homelands in the private and public sectors of the Republic [of South Africa]” (Butler et al., 1978, p. 235).

This apparent core versus periphery set-up led to an analysis of the underdevelopment of the homelands that was called the “leakages” model, which encapsulated the idea that “public spending and private investment in the homelands will “leak” back into the [South African] White economy, which would itself then experience the multiplied effects on income, consumption, savings, and employment, rather than the homelands” (p. 138). From their data, the authors constructed a flow chart depicted in Figure 2, where major flows are shown as solid lines, and weak, underdeveloped linkages are shown as dashed lines. The essence of the diagram demonstrates that the major export from the homelands was labour, which in turn spent a large portion of their earnings in White and Asian stores. Therefore there were no “secondary multiplicative or cumulative effects because they ‘leak’ away immediately to non-African businesses and industries as ‘consumption expenditures’” (p. 140). In addition, virtually all capital expenditure was made outside the homeland, and any funds that were in circulation did not stimulate local enterprise and employment.

Figure 2: The Flows of Labour, Money, and Goods Between Homelands and the Republic



Source: Butler, Rotberg, & Adams, 1978

The spatial arrangement of industries in South Africa was heavily concentrated in four regions: Pretoria-Witwatersrand-Vereeniging, the southwestern Cape, Durban-Pinetown, and Port Elizabeth-Uitenhage. The cumulative area covered by these regions was 4 percent of the land area, but contained 75 percent of all manufacturing enterprises and generated 80 percent of total industrial production. Half the industrial output of the country arose in the first region alone (Butler et al., 1978). Naturally, the poverty in homelands led to Black labour moving (as close as possible) to these industrial hubs; posing a problem for the South African government. A commission was tasked with tackling this problem, and this commission identified creating a large number of job opportunities in mining, commerce, and industry *within* homelands as the solution. The commission's report suggested that there be investment of White capital in homelands, but this report was rejected, with an alternative proposal to create industrial centres close to homeland borders (Butler et al., 1978).

The committee that was formed during 1960 to induce industry to locate closer to homelands failed to affect private business location-decisions. According to Butler et al., scholars found no evidence of substantial industrial relocation. Most importantly for this study, the limited industrial relocation was in Kwa-Zulu Natal, while the Northern Transvaal (where Limpopo is located) was ignored. For those locations that did somewhat benefit from industrial relocation, labour still had to commute to White South Africa, thus continuing to spend most of their incomes in White shopping areas. In addition, the new firms were not necessarily linked to the mineral, agricultural, or secondary industrial bases of the homeland economies, but rather presented a threat to the homelands as the most skilled workers were enticed away to border areas. Therefore this arrangement still perpetuated the leaking away of multipliers that could have moved across to local underdeveloped communities and potentially contributed to the development of these areas (Butler et al., 1978).

The new policy framework in the minerals industry: the MPRDA and the mining charter

This section bridges the gap between the historical ‘leakages model’ and a potential move towards a ‘linkages model’. The bridge is the change in the political dispensation in South Africa, which necessitated elimination of the homelands system and a review of enclave business practices via government policy intervention. The main policy governing the mining industry is the Minerals and Petroleum Resources Development Act (MPRDA), which is changing how mining firms operate in local communities in South Africa.

The starting point in crafting the MPRDA was the Freedom Charter of 1955, from which the African National Congress (ANC)¹⁵ drafted its Mineral and Energy Policy document in 1990. Following this document, in November 1997, the Black Management Forum (BMF) held a National Conference in Stellenbosch, where the idea of the Black Economic Empowerment Commission (BEECom) was conceived. The aim of the BEECom was to facilitate the entrance of black capital into business through creation of state policies that would serve this purpose. The

¹⁵ The ANC is a ‘liberation’ movement which became the ruling political party in South Africa since 1994 to date of this publication.

prevailing view was that black people should direct and take charge of a new vision for Black Economic Empowerment (BEE); a process that, until then, had been conceptualised, controlled and driven by the private sector. The commission, chaired by Cyril Ramaphosa, was formally established in May 1998 under the auspices of the Black Business Council (BBC), an umbrella body representing 11 black business organisations (Maharaj, 2001). It consulted with a wide range of stakeholders. These included financial institutions, black business people, the ANC, the SACP, COSATU, NEDLAC, and the Parliamentary Committee of Trade and Industry. The commission reported on the status of participation of black people in the private sector, to which the mining sector was reported to have only 4% black people in management (BEECom Report, 2001).

The limited transformation in the mining sector was attributed to barriers such as the capital-intensive nature of the industry, the limited life span of mines, the lack of exploration of beneficiation opportunities, and the difficulty in sourcing funding for mining ventures. As a result, one of the main outcomes of the commission was a resolution to be adopted by the State, worded in the following way in the commission's report: "the State is seeking the return of private mineral rights to the government, in line with the rest of the world. Government's long-term objective is for all mineral rights to vest in the State for the benefit of and on behalf of all the people in South Africa; Government will promote minerals development by applying the "use-it or lose it"/ "use-it and keep-it" principle. The right to prospect and to mine for all minerals will vest in the State provision will be made for: guaranteeing the continuation of current prospecting and mining operations in accordance with the "use-it and keep-it" principle" (BEECom Report, 2001).

Then in 1998, Cabinet approved the White Paper on Minerals and Mining Policy for South Africa. This new development would see the overhaul of the system of old order rights that underpinned the relationship between [platinum] mining houses and traditional authority, with minimal involvement by the State, and therefore minimal need by mining houses to form strong political ties for the sake of credible commitment. The policy would repeal the Minerals Act of 1991 that empowered the mining houses to secure mineral rights with traditional authority. In essence, the State was nationalising the mineral rights and setting out new rules of the game about securing and re-securing mining rights. The system imposed by the MPRDA includes the requirement to submit a Social and Labour Plan (SLP) by a mineral right holder that is acceptable to the DMR in order to be granted new order mining or production rights. The SLP must demonstrate a comprehensive

human resource development programme, a local economic development programme, and processes to preserve jobs and manage mine downscaling and closure. Specifically, the SLP must have contents that include skills development, career progression, employment equity, poverty eradication projects, housing and living, procurement, and retrenchment (Goode & Granville, 2006; Claassens & Boyle, 2015). The MPRDA was supplemented with the Mining Charter in 2004 and a reviewed version in 2009, with the objective to accelerate transformation in the industry. The pillars of the charter include human resource development, employment equity, migrant labour, mine community development, housing and living conditions, procurement, ownership and joint ventures, beneficiation, and reporting. All pillars have targets agreed upon by industry stakeholders, to be reviewed after 10 years from 2004¹⁶ (Mitchell G. , 2013).

The ‘Linkages’ model

Chapter 1 together with the preceding sections of the present chapter provided a historical account and analysis on the missing linkages between the mining industry and the local communities in the Limpopo region. However, the change in policy in South Africa and in the mining industry has presented an opportunity for the creation of an economic relationship between mining and local communities in Limpopo. The introduction of mining policy presents an empirical opportunity to evaluate the short-term impact of this exogenous change in how mining does business. This change presents an opportunity to study whether the application of the enclave theory as an explanation of the current economic relationship between mining and local economies in Limpopo still applies or is outdated. This gap highlights the importance of this present study, whose results may provide new insights on the role of mining in local communities in South Africa.

Having identified policy change as one critical development in the mining-community relationship, another important development is the rapid change in corporate strategies that focus on specialisation on core competencies; which has changed the way businesses link with local communities. With the deepening of globalisation after 1970 that led to intensified competition, corporate strategy moved towards focusing on core competencies, outsourcing non-core

¹⁶ As is the case at the time of writing this paper, with a new draft charter (2015) released for public comments.

competencies to local and/or global suppliers – leading to the development of Global Value Chains. The resources sector too has begun specialising, resulting in an expansion of local linkages driven by outsourcing by core lead firms in the commodity value chain (Morris, et al., 2012). This development is crucial, as explained by Morris et al. (2012), because it provides opportunities for the creation of locally-owned firms, extends business opportunities to existing local firms, and spreads these benefits across local industries. Therefore, outsourcing is an important concept in explaining the emergence and expansion of local linkages, which has consequences on how mining operations are integrating locally, and hence impacting on local livelihoods.

The imperative of Global Value Chains as a driver of local linkage development is further nuanced by Morris et al. (2012) by distinguishing between vertically-specialised GVCs and additive value chains. Vertically specialised chains characterise the manufacturing industry, and are a result of the fracturing of value chains, resulting from firms increasingly specialising in their core competences and outsourcing non-core competencies. Typically, these production activities can be undertaken in parallel because there is little processing loss in production, and there is no degradation of inputs; and therefore there is no intrinsic need for various stages to be co-located (Kaplinsky and Morris, 2015). In contrast, additive value chains involve a process of sequentially adding value to each stage of the chain, as options to fracture the chain are characteristically limited. As such, additive value chains generally characterise the resources sector.

The above distinction means that while the manufacturing sector adds value by combining raw materials and processing to the final product, “mining operations aim to minimise value attrition from the moment the ore is first handled to the final product to capture as much value as possible from the ore body, for the effort, time, and money invested” (Claassen, 2016a, p. 141). Therefore in mining, there is a close geology-mining-plant interrelationship. This interrelationship encourages local linkages which are further bolstered by adequate local capabilities. The necessity to develop a mine locally and acquire local capabilities provides an opportunity for local supply firms to be incorporated into the supply chain.

Morris et al. (2012) also discuss what they call ‘intrinsic’ determinants of linkage development. As the name suggests, intrinsic determinants of linkage development are innate to the resources sector. The first intrinsic determinant is lean production in the supply chain, whereby the chain prioritises keeping low inventories, rapid response, and flexible production. As a result, this

promotes near sourcing (domestic linkages), subject to imperatives of cost, quality, and delivery. The second intrinsic determinant is the specificity of the resource deposit. Because resources are location-specific, and no two deposits are identical, there is, by necessity, a need for local skills and knowledge, which in turn leads to localisation of input supply. This produces local technological spill-overs, or horizontal linkages (Morris et al., 2012). Classen (2016b) refers to this local specificity as spatial heterogeneity; and adds that there is also heterogeneity that occurs over time within a mining operation, resulting from variable ore composition. Some examples of variability include variable roof and floor condition, variable in-seam parting thickness and composition, and variable ore seam thickness; which require equipment that is optimally matched with the geological environment, sufficiently staffed support functions, and adaptable work teams. Classen therefore argues that this places emphasis on the value of the necessity for local knowledge and skills, and proximity of skills and inputs, to support changing production constraints.

The third intrinsic determinant is the technological intensity required to extract and process a resource. This depends on the resource in question, and the local capabilities available. Given multiple points of production in a single country, this may lead to specialised suppliers who benefit from economies of scope (Morris et al., 2012).

Finally, there are four ‘contextual’ determinants of the development of local linkages that are discussed by Morris et al. (2012). The first is policy, which provides an enabling context for local linkages to develop. This determinant is empirically tested in this study. The second contextual determinant is ownership, which is important because if lead firms are locally owned, they will be more deeply embedded in the local economy, have greater familiarity with local suppliers, and be more committed to local development. Therefore, tied to the first determinant, policy should support local ownership and build relationships with foreign firms that have preference for long-term investment and developing host communities (Morris et al., 2012; Staritz and Morris, 2015). Infrastructure is the third contextual determinant. On one hand, the nature of the commodity in question has a significant impact on infrastructure (e.g. commodities exported in bulk require large scale transport infrastructure), while on the other hand the nature of infrastructure has important implications for the development of linkages, in so far as whether the infrastructure only caters to a specific commodity or is usable by other commodities and industries, and is accessible location-wise. The fourth and final contextual determinant is domestic capabilities and systems of

innovation. Policy should promote local skills and enhance technological capacities of commodity producers, in order to expand linkages.

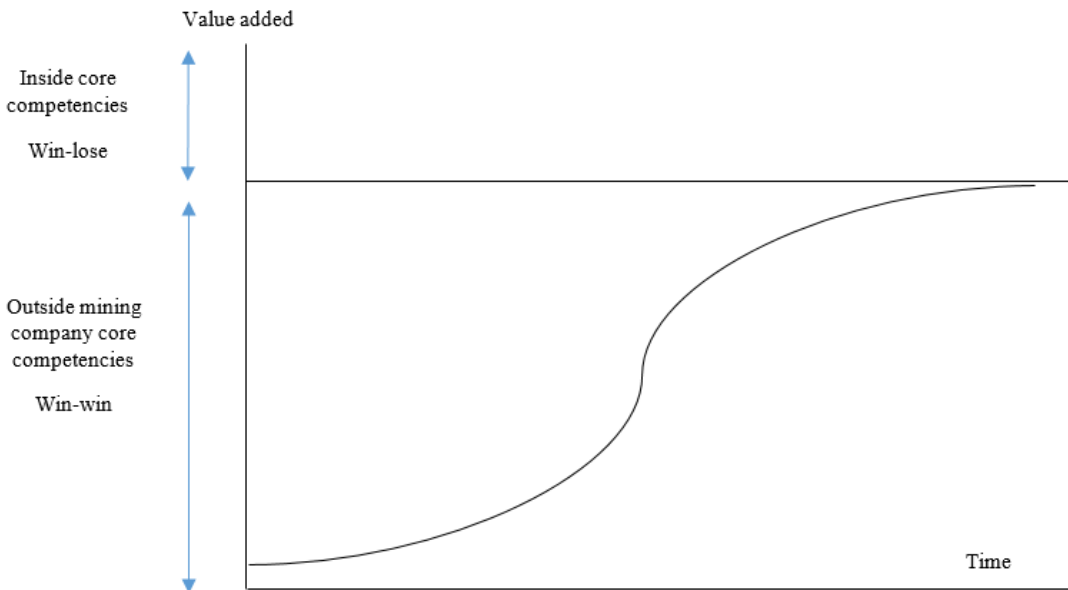
The above concepts provide a path to viewing the role of natural resources on local communities in light of new developments (e.g. GVCs), and with a nuanced understanding of how localities develop from natural resources (i.e. linkages). Taking account of these concepts and developments means that simply applying the enclave theory to understand the relationship between mining and local communities in South Africa would potentially be ignorant of new data. As argued by Morris et al. (2012), since the development of the enclave theory, there has been a significant accretion of capabilities in very many low-income economies, with evidence of growing linkages even in high technology products.

The typology of linkages according to Hirschman

Hirschman (1981) identifies three sets of linkages from the commodities sector that provide a path for industrial development. The first is fiscal linkages, which consist of corporate taxes, royalties, and taxes on the incomes of employees, which together, if used well, could promote industrial development in other sectors. The second type is consumption linkages, arising from income earned in the resources sector, increasing demand for output in other sectors. The third type is production linkages, which consist of forward, backward, and horizontal linkages. Forward linkages link to industries downstream (e.g. processing); and are increasingly part of the debate around Africa beneficiating its mineral resources in order to capture more of the value added. The key constraint has historically been the structural arrangement of most resource sectors in Africa¹⁷, as well as high commodity prices that local downstream firms cannot afford. Regarding backward linkages, these link to upstream industries. They are crucial linkages that are perhaps under-emphasised in policy. These linkages involve production processes that are more familiar with local agents, and provide a push for technological learning and industrial development (see Morris et al., 2012, for concrete examples). Horizontal linkages link to other industries outside the resources chain – important for diversification. In conclusion, therefore, this existence of interlinkages between the resources sector and other industries proves that “development is essentially the record of how one thing leads to another” (Hirschman, 1981; in Morris, et al., 2012).

¹⁷ An example is mining geared for primary (unprocessed) commodity exports.

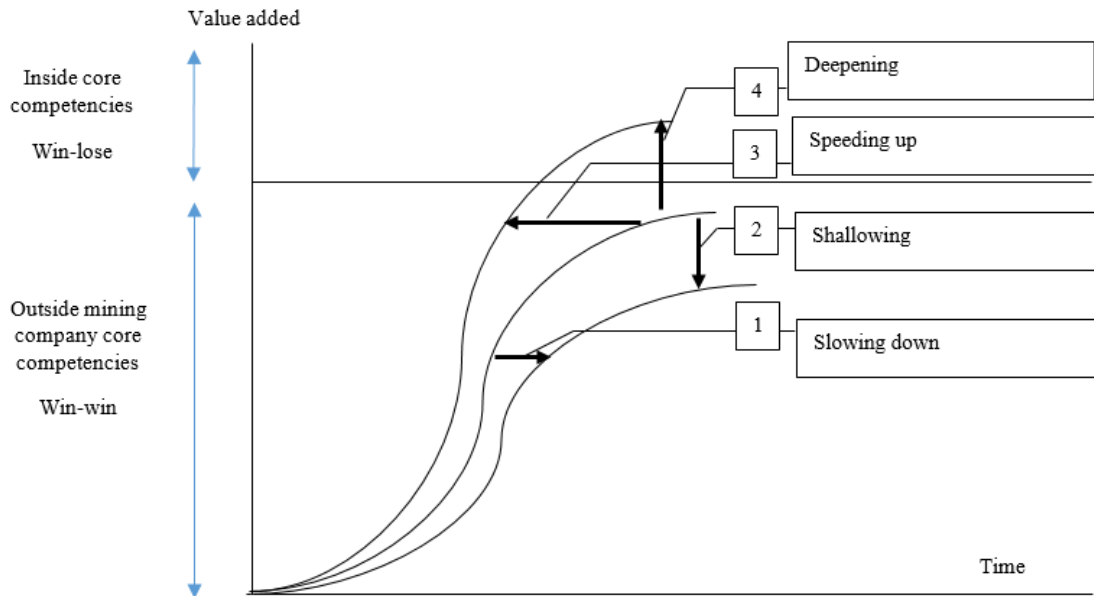
Figure 3: Market driven linkages over time



Source: Morris et al. (2012)

The main idea is that economic linkages from the resources sector can be created and developed. Figure 3 is taken from Morris et al. (2012), who show that as a consequence of outsourcing, there is a market-driven process of linkage development. Initially, the pace of outsourcing is low and confined to basic commodities. This would be typical in an underdeveloped region such as Limpopo, where the mines would target ‘low-hanging fruits’ for outsourcing, such as catering and security. These are non-core mining competencies, and therefore present a win-win situation. This rate of outsourcing tails off as technological and scale requirements become demanding. Beyond the non-core competencies, there are no opportunities to outsource high-value adding, mining core-competencies. Mining firms create high barriers around these, including ‘natural’ barriers such as high capital requirements. Any competition in these competencies would create win-lose situations.

Figure 4: Different trajectories of linkage development



Source: Morris et al. (2012)

Figure 3 can be extended to incorporate determinants of linkages, in order to observe different trajectories of linkage development. This is represented by Figure 4. Linkages can be developed, and accelerated; and they can be destroyed. Where contextual factors are inappropriate, this could lead to the slowing down and shallowing of linkages: shown by (1) and (2) on Figure 4. Where contextual factors are appropriate, this could speed-up and deepen linkages: shown by (3) and (4). The possibility to create and develop linkages provides an essential policy implication around getting the contextual determinants of linkages right.

Linkages in the Limpopo Province

The conceptual framework about the existence of linkages directs this chapter towards an investigation of the status quo of linkages and the business practice of outsourcing in the Limpopo Province in recent years.

A helpful paper is one by Goode and Granville (2006), who wrote a report on mining in the Sekhukhune municipality of the Limpopo Province. According to the authors, the increase in the use of contract services in South African mining of what had hitherto been considered core mining

operations began in the late 1980s. This trend began particularly in underground gold mining, where labour-only brokers and full scale contract mining service companies were employed to reduce costs. This practice spread over to platinum mining where the industry was dominated by leaders such as SAN Contracting and JIC Mining Services (Goode & Granville, 2006). The authors argue that “Noting that at a minimum mining operations involve the following range of services mining, engineering, technical, electrical, equipment maintenance, drilling and explosives, transport, rail yard, medical, security, training, and cleaning services, there exists a strong business case for outsourcing” (Goode & Granville, 2006, p. 23).

The evidence of the practice of outsourcing is captured in the authors’ report, where some respondents reported that their business model is based on outsourcing services and will continue to follow this established practice. Outsourcing remains favoured for specialist contractors for expansion projects and mine development, and in cases where mechanised mining takes place (Goode & Granville, 2006). Chadwick (2012) surveys some of the South African mining support services that have global influence, offering goods and services such as design, procurement, logistics, infrastructure works, caterpillar dealership, dump trucks, explosives, and various equipment. The study shows that the practice of outsourcing in South Africa has led to the development of some of the major global suppliers into mining services.

Indeed, Solomon (2011) argues that whether communities in Africa benefit from natural resources largely depends on the behaviour of companies “on the ground” (p. 475). He argues that management of mining should focus on the development of linkages which enhance economic diversification, and mitigates the resource curse syndrome. The opening of a mine, the author suggests, could create local market for supplies of agricultural produce, while creating opportunities for the expansion of agriculture to broader markets through transport and communication infrastructure that comes with mining. For example, the suppliers of goods and services to a mining operation could provide transport services to farmers on their return journey back to cities. The author makes an important point that the bulk of economic benefit from mining activity do not take place locally, but in cities.

Solomon’s (2011) study helps shed light on the existence and nature of linkages in the Limpopo region. His study assessed the local impact of a large precious metal underground mine operation

in the North West Province¹⁸ of South Africa. The study analysed 41,784 procurement transactions categorized by origin of manufactured goods, home office of services provided (in order to assess commissions or margins taken by local or regional branch offices or agencies), and Standard Industry Codes (in order to assess cross sectoral benefits). The author also accessed records of 5,996 employees that enabled for the analysis of net earnings, discretionary incomes, labour supplying area, local family versus rural family commitments, level of dependencies, and years of service. In addition, the author had access to fiscal data and a survey on mineworkers giving information on spending and remittances to rural and urban families. The study finds that around 5% of the mine's expenditure is spent locally, while 20% is spent regionally (around the North West and the Limpopo provinces) and close to 70% of the mine's expenditure flows into the industrial, financial services, and corporate administrative districts in Gauteng. Of the total expenditure captured locally, it is salaries and wages that consist the largest share. This suggests that the reality is that there is very limited expenditure captured locally around mine operations¹⁹. The study also finds that the expenditure spent locally is heavily skewed towards wholesale and retail trade, while the expenditure captured in the Gauteng Province²⁰ buys mining intermediate inputs, machinery, and equipment. Overall, the reality suggests that the impact from mining operations is still leaking from local economic systems, as a result of historical spatial arrangements.

The evidence found in the above study is supported by Farooki, Perkins, Fessahie, & Malden (2016), who undertake a study to assess domestic procurement challenges in the domestic sector within Southern Africa. The study finds that there are still limited local linkages from mining operations in South (and Southern) Africa, as a result of practical challenges linked to industry structure locally and globally. The overarching challenge for local linkage development is the high standards of input products and services required by mining companies, which local firms in mining communities (local defined as 30 km to 70 km) scarcely have capability to meet. More specifically, the main issues concerning the procurement of consumables include meeting input demand at short notice. Small businesses struggle to deliver on time compared to more established, often international suppliers. Small businesses are often not able to hold large stocks because of

¹⁸ The North West Province neighbours the Limpopo Province, as shares a similar history and mineral wealth.

¹⁹ Although this study is investigating the North West Province of South Africa, its neighbouring province, the Limpopo Province, is similarly affected, if not more severely, due to the extent of its underdevelopment.

²⁰ The province consists of Johannesburg, Sandton, Pretoria, and the East and West Rand.

cost implications, nor are they able to offer the product range required by mines. The issues with engineering related services procurement include sufficient expertise and innovation. What is seen as a potential opportunity is the local production of smaller equipment and spare parts. The study finds that the procurement of personal protective equipment is already being localised, but this is limited to simple stitching together of fabric. More sophisticated products are still being procured outside of local mining communities.

Another local procurement opportunity identified by the above study involves environmental related services, throughout the lifetime of a mine operation. Given the serious environmental impact of operations, and the increasingly stringent legislation to reduce these negative impacts, mine operations are outsourcing this function, such as the management of hazardous waste. The main challenge is that this is a highly technical area, which needs certified businesses – which are currently scarce locally. However, the authors argue that this is a substantial opportunity for communities to participate in mining activity.

Given this evidence, what suggests that a study on local linkages from mines in Limpopo will find any different results that generate useful evidence and new insights?

The usefulness of the study lies in the fact that although poverty remains high, it has declined during the period of the study, 2001 to 2011. Given that mining is a major economic activity, the controversy around its contribution needs empirical investigation, beyond descriptive statistics. Firstly, the new insights involve understanding the impact of the MPRDA policy in enhancing the economic integration of mining operations on local economies. The second important insight is the role of corporate strategy that has changed focus to core-competencies, and thus has relied on outsourcing and near-sourcing. This direction in strategy has meant that local communities stand to benefit from outsourced functions from mining operations. The third insight is the concept of additive value chains, as characterising business in the natural resources industry. The nature of business in resources requires localised activities. Tied with the unique nature of deposits in each locality, this requires local knowledge that thus opens opportunity for local procurement of expertise. Together, these are major changes that give reason to believe that something is happening in mining at the local level that is having an impact on poverty. The issue of the extent of impact and what can be done to amplify it will be dealt with in the next two chapters.

Chapter 4 Estimating the impact of mines on local economies

This first section of chapter 4 provides a framework upon which to build an empirical model in the next section. It also provides testable predictions which will be empirically estimated.

The framework follows three papers. The first paper is by Aragón & Rud (2013). The authors build a framework to assess the impact of an expansion of a mine on local communities, driven by the growth of gold production and an introduction of a new policy to increase local employment and localise supply linkages. These linkages are explained by the work of Morris et al. (2012), who provide a conceptual framework to understand the types of economic linkages from mine operations. The third paper is by Aragón & Rud (2015), who build a framework to assess the impact of mine expansion on local agricultural total factor productivity and local livelihoods, given the environmental impacts of mines.

Bringing the work of these three papers provides an opportunity to develop a framework that addresses as close as possible the impact of mines on local livelihoods. The economic activity stimulated by mine operations, in the presence of local economic linkages, has the potential to create positive economic multipliers on local economies and therefore help reduce poverty. However, because industrial mines are substantial polluting entities, their effects on the environment and health could exacerbate local poverty. Therefore, estimating the impact of mine operations on local income poverty would be capturing the net average effect; both the negative impacts, and the positive impacts.

Aragón & Rud (2013) use the framework of local labour demand shocks developed by Moretti (2010). Moretti builds on the premise that the opening of a new business generates a new job in the local economy, which may generate additional jobs through increased demand for local goods and services. With this framework in mind, the communities surrounding the mines in Limpopo Province can be considered a local economy²¹, while those farther away as another.

²¹ These communities will be defined as those that are within 20 kilometres around a mine, by road.

The opening or expansion of a mine introduces a local demand shock for inputs. The direct impact is the procurement of inputs by mining operations including the wage bill paid to local workers. Using the typology of linkages from Morris et al. (2012), the direct impact consists of production linkages, which are linkages with the local market and can proxied by the value of local purchases; and consumption linkages, which arise from the disposable income proxied by the wage bill paid by mines. As already established, the extent to which these linkages are local depends on the degree to which local markets are developed.

The indirect impact includes spillover effects or local multipliers. These consist of fiscal linkages (such as tax and royalties paid to government and local authorities), and horizontal linkages (such as demand for financial auditing services).

The local demand shock will then increase nominal wages in the local services sector (around mining areas) relative to locations farther away. Given labour mobility between sectors, the increase in wages will increase for other workers not directly linked to mining. This will then lead to an increase in demand and price of local goods, such as locally traded agricultural produce; thus benefiting agriculture. Given low levels of inter-regional mobility and an upward-sloping supply of local goods, this would have a positive effect on individuals' real income (Aragón & Rud, 2013). As a result, some individuals will be lifted out of income poverty.

The framework has to also take into account that mining presents interplay between traditional agricultural activities and modern industry, following Aragón & Rud (2015).

The Limpopo Province is predominantly rural (89 percent), and both commercial and subsistence agriculture is a large source of local livelihood (Limpopo Dept. of Agriculture and Rural Development, 2012). Close to agricultural commercial farms and backyard farms are industrial mines, whose operations release pollutants that accumulate in the surrounding areas and can travel some distance.



Figure 5: Land used for agriculture in Limpopo.
Source: Nxele (2015)

As demonstrated by Aragón & Rud (2015), such a spatial arrangement has implications on agricultural factor productivity, where pollution-related effects reduce agricultural productivity which in turn exacerbate local poverty in a context where agriculture is an important source of income in the local economy.

In particular, the authors use a consumer-producer household framework from Benjamin (1992) and Bardhan and Udry (1999); where households are both farmers and consumers of an agricultural good with a given price. The households have endowments of labour and land, which can be used in their farms or sold in the local markets at given prices. The presence of mine could increase demand for local inputs and thus create input competition, which leads to an increase in input prices and therefore reduces input use and agricultural output. This is one channel of impact.

The second channel is that pollution from mining may affect agriculture through 3 possible mechanisms. The first is that pollution could directly affect health and yields of crops. Secondly, pollution could deteriorate the quality of key inputs, such as soil. Third, through its effect on health, pollution could affect labour productivity. The overall impact from pollution would be a reduction of agricultural output and household consumption, and potentially a reduction of input use as well.

Given the importance of the agricultural sector in Limpopo and the impact of mines on this sector as described in the fieldwork report of the Bench Marks Foundation, the reduction in agricultural

productivity and output has a knock-on effect on local living standards. Specifically, the negative effect on the environment by mine operations exacerbates income poverty and other forms of socio-economic ills in the local economy. This means that the opening and subsequent expansion of a mine proxies for the introduction and expansion of pollutants into the atmosphere.

Apart from the economic channels such as labour moving away from agriculture to mining (which itself can reduce agricultural productivity), the reality of an undesirable change in the environment means that those who heavily rely on the agricultural sector lose. The size of the impact of negative effects of mining can exceed that of the generalised benefits of local mining activity. This will be the case when the economic linkages are weak. As suggested by Aragón & Rud (2015), mining companies would have to counter these negative impacts by deepening localisation such as employing local residents, procuring locally, and/or compensating local residents. This highlights the importance of policy such as the MPRDA in encouraging local linkages. Furthermore, the work of Morris et al. (2012) discussed in the preceding chapter on creating and deepening linkages is particularly important to understanding how to make the most of commodities for local development.

Therefore the construction of a framework to capture the impact of industrial mines on local communities has to take into account both the negative and positive impacts that arise from mining activity. The impacts discussed above are not exhaustive, as mines could also impact on other aspects such as local crime levels (Axbard, Poulsen, & Tolonen, 2015), gender norms (Kotsadam & Tolonen, 2016), and infant mortality (Tolonen, 2016). What is important to highlight is that mining presents both positive and negative impacts, therefore the estimate on local poverty is a *net benefit* of local mining activity.

The next section uses the above framework to build a model which will be used to estimate the impact of mining on local communities in Limpopo Province.

Estimating the impact of mines at ward level in the Limpopo Province

The preceding section lays out a foundation for building a model to empirically test the impact of mines on local surrounding communities. To successfully test for the competing effects of mining on local communities, there is need for local micro-level data and case study that allows a community-level study. This paper created such a database, which includes mine location and production data that allows for the investigation of the local impact of mining. The study also identified a suitable case study that inherently possesses the DNA of mining, agriculture, and poverty.

More specifically, isolating the Limpopo Province as a case study on the impact of natural resources is useful because of the following reasons. The first reason is that the province is the poorest in South Africa, with an official headcount of 74.4 percent in 2006, 78.9 percent in 2009, and 63.8 percent in 2011; against a national average of 57.2 percent, 56.8 percent, and 45.5 percent respectively (Lehohla, 2014). The large poverty headcount provides a strong context for a study on poverty, and the gradual decline in poverty provides an opportunity to understand part of the cause of this gain.

The second reason is that the province is predominantly rural (89 percent). This characteristic provides two main advantages for the present study. First, because the Limpopo Province is rural, there is very scarce economic activity in the area, which allows the study to isolate the mining industry and evaluate its impact. Second, the heavy reliance on agriculture, which has to compete with mining, provides an opportunity to investigate the impact of mining on local livelihoods in a largely rural, agricultural economy.

The third reason is that the province is endowed with an abundance of mineral resources, which contribute on average 22 percent of the province's Gross Domestic Product. Total mineral sales of Limpopo constituted 15 percent on average of South Africa's total mineral sales between 2001 and 2011. The deposits in the province include platinum, copper, coal, iron ore, and diamond (Department of Mineral Resources, 2014). Therefore, this sector is large enough to explain part of the socio-economic wellbeing of the province.

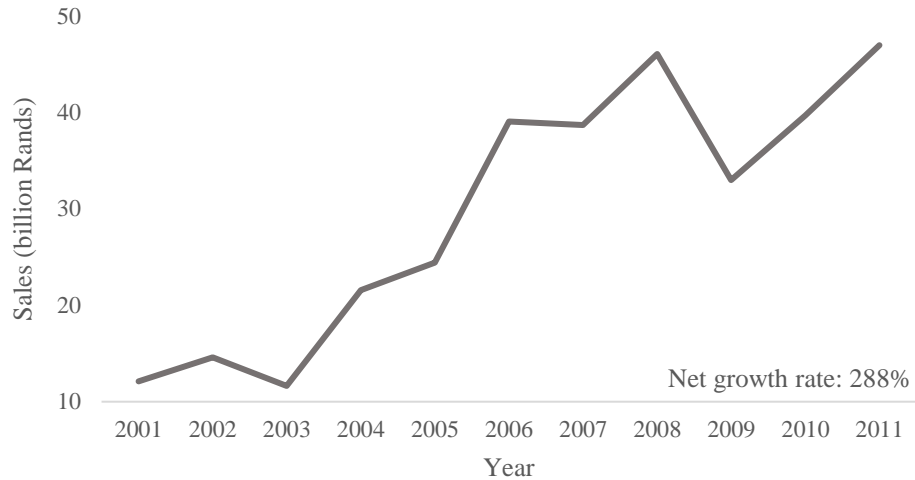


Figure 6: Limpopo Province Estimated Primary Mineral Total Sales.

(Source: Author. Data from the Department of Mineral Resources). Note that it is not clear whether the prices are nominal or real.

Finally, the province has experienced a significant increase in both the intensity of mining (the number of mines) and the size of mining (see Figure 6). This feature is critical for the success of the empirical strategy of this paper, which uses this increase in mine activity as a treatment, and therefore allows comparison with communities that are not exposed to the demand shock.

Data and Main Variables

Ward data

The empirical analysis uses three waves of data consisting of a stratified municipal ward sample, combined with firm data, for the years 2001, 2007, and 2011. The ward data is available through the South African Local Government Association (SALGA)'s *municipal barometer*, and is sourced from Statistics South Africa's *population census* waves 2001 and 2011, together with its *community survey 2007*.

The analysis focuses on the Limpopo Province, which consists of 453 wards per wave for the period under study. Wards are determined by the *Municipal Demarcation Board*, mainly based on

population size²². The variable of interest is the share of individuals living in income poverty per ward per year. The poverty lines used are the food poverty line below which one lives in extreme poverty and cannot afford sufficient nutrition, and the upper-bound poverty line describing those who are able to afford sufficient nutrition and non-food items²³.

Because this paper deals with one province, data at municipal ward level provides an advantage for a large-enough sample size and heterogeneity to do an empirical study. It also allows for the investigation of smaller units than municipalities, to understand the impact of mining at a granular level possible. However, the major limitation is that business decisions, particularly related to employment and goods and service procurement, do not consider wards as a definition of local. On the contrary, a local municipality is practically considered the lowest “local” level. Therefore, the modelling essentially assumes that if a particular mine employs 1000 people, for example, that figure is assigned to every ward closest to the mine. This means that the results may overstate the actual impact of the mine. At worst, the results show the average potential poverty-reducing impact of that particular mine in that particular ward when employing 1000 people.

Firm data

The firm data is collected from firms’ annual reports, and consists of a total of 20 large mines employing above 1000 workers on average per annum²⁴; each owned by publicly listed entities. There are two main reasons for restricting analysis to these. The first reason is that a mine has to be large enough to observe a communitywide impact. The second reason is that in general, only publicly listed companies publish publicly accessible annual reports, which are audited by accredited external parties²⁵. To measure activity of a mine, the study collects data on mine production volumes per commodity, wage bill, purchases, revenue, and number of workers employed per year. This study adjusts the purchases variable to restrict it to preferential procurement by firm per year, which increases confidence that this fraction represents local

²² See more information on ward delimitation here: <http://www.elections.org.za/content/Voters-Roll/About-voting-districts-and-stations/> and here: <http://www.demarcation.org.za/site/>

²³ The poverty lines are sourced from Statistics South Africa and are inflation-adjusted. See Lehohla (2014).

²⁴ The exception is diamond mines in this study, which hire below 300 employees on average per annum.

²⁵ There are 27 listed mines shown on the Department of Mineral Resources (DMR) mine register. The majority of mines listed in the register are farmland registered under individuals and small companies, with no evidence of mining activity. Generally, companies that are not publicly listed are small and do not publish operations data publicly.

purchases^{26,27}. The wage bill ordinarily includes bonuses and profits distributed to employees. The sum of the wage bill and local purchases is used as a main measure of a mine's demand for local inputs. Table 5 below presents the summary statistics for the three waves.

To measure the impact of mine activity on local communities, the study constructs a measure of distance between a ward and its nearest mine during a given wave. This variable varies per year with the development of new mines or closure of old mines; whereby the opening of a new, closer mine changes the distance variable for the affected wards. Specifically, distance is the shortest route from a ward's central voting station to the nearest mine using existing road network. This method takes into account that voting stations are chosen based on communitywide accessibility. The study uses the Independent Electoral Commission of South Africa (IEC)'s *Voting Station finder* to locate the precise gps coordinates, and then uses the AfriGIS Map data via the Google Maps tool, to obtain distance approximations. The distance variable varies from 1 to 248 km, with an average of 87.9 kilometres (see Table 5 for summary statistics).

²⁶ The reader must keep in mind that this study has already established that there is very little 'local' procurement in the Limpopo Province; therefore this variable is not entirely captured locally.

²⁷ The procurement variable is the share HDSA procurement reported by each company, per wave year. For those companies who report at company group level (but do not specify at the asset/mine level), the study applies that average at mine operation level.

Table 5: Summary Statistics

Variables	Mean $N = 1606$	Standard Error		
Ward level				
Ratio upper-bound poverty	0.768	0.003		
Ratio food poverty	0.738	0.003		
Ratio employed	0.520	0.005		
Ratio dependency ratio	0.773	0.006		
Ratio sanitation	0.292	0.007		
Ratio electricity	0.356	0.007		
Ratio sewerage system	0.156	0.008		
Ratio migration	0.097	0.004		
Ratio primary education	0.283	0.003		
Ratio secondary education	0.240	0.003		
Ratio tertiary education	0.036	0.001		
Total Population	9789.577	117.2		
Distance to mine	87.856	1.142		
Firm data $N = 20$ mines \times 3 waves				
	Mean	Standard deviation	Minimum	Maximum
Wage bill (Rm)	314.922	127.251	191.067	445.317
BEE purchases (Rm)	825.357	535.184	264.265	1330.188
Capital Expenditure (Rm)	547.035	218.660	265.369	789.724
Percent BEE Procurement	29.654	18.014	12.292	48.256
Percent HDSA management	31.101	8.624	22.150	39.355
PGM (ounces)	328,481.4	41,437.2	298,294.9	375,724.7
Coal (tons)	2,519,926	170,717.3	2,323,467	2,632,200
Copper (tons)	28,274.63	4,982.461	22,669.29	32,199.81
Diamond (carats)	2,419,625	3,009,840	301,103	5,864,895
Iron Ore (tons)	2,033,333	986,576.6	900,000	2,700,000
Employees	2060.888	152.957	1937.242	2231.934

Empirical Strategy

The empirical challenge is isolating the causal impact of mining activity on the poverty rate of local communities. The three waves in this study provide the following quasi-experimental set up. In 2001 data is collected, providing information on ward poverty rates, characteristics, and mining activity. During 2001 and 2007, there is an expansion of mining by intensity (more mines) and increased local demand. The survey in 2007 collects the short-term data, and the process is the same for the 2011 wave. Therefore, it is possible to compare those wards that are treated and those that are not. For the pre-existing mines, treatment is strictly the expansion of mines. For wards wherein new mines open, the additional treatment is the opening of these mines, where the first year of production is considered the start of the treatment. Therefore, the true counterfactual of

this study is wards both with no mines and outside of the 20-kilometre mining exposure threshold – for the period of the study.

The study therefore exploits two sources of variation. First, the study uses the significant increase in local demand for inputs, driven by stronger local procurement and by an increase in production. The stronger local procurement is driven by policy, and can be seen in Figure 7 where purchases from BEE firms are increasing by year, the wage bill (and number of employees) is increasing, and the mines are employing a greater share of persons defined as HDSA²⁸. The increase in production was driven by the opening of new mines and favourable mineral prices (see Figure 6). Specifically, the study starts with 12 operating mines in 2001, then 6 additional mines open between 2001 and 2007 giving 18 operating mines, then 2 mines close and 2 mines open between 2007 and 2011²⁹, keeping the sample with 18 operating mines.

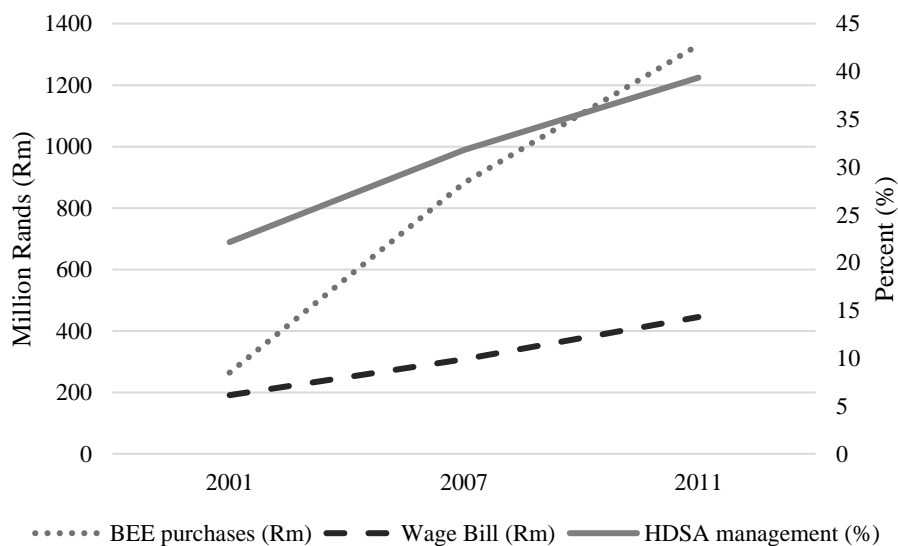


Figure 7: Procurement and transformation by mines in Limpopo

The second source of variation is the changes in distance to a nearest mine driven mainly by mine openings (and less by mine closures). Figure 8 shows mine locations by wards in 2001, which

²⁸ These indicators imply a greater tendency by mining firms to procure locally, while acknowledging that evidence in this study suggests that there is still very limited ‘local’ procurement in the Limpopo Province.

²⁹ The two mines that close are a platinum mine and a diamond mine; while the two mines that open are a coal and platinum mine.

largely consist of large industrial mines that were established before the new democratic South Africa. This sample of mines represents mining before the introduction of preferential policy.

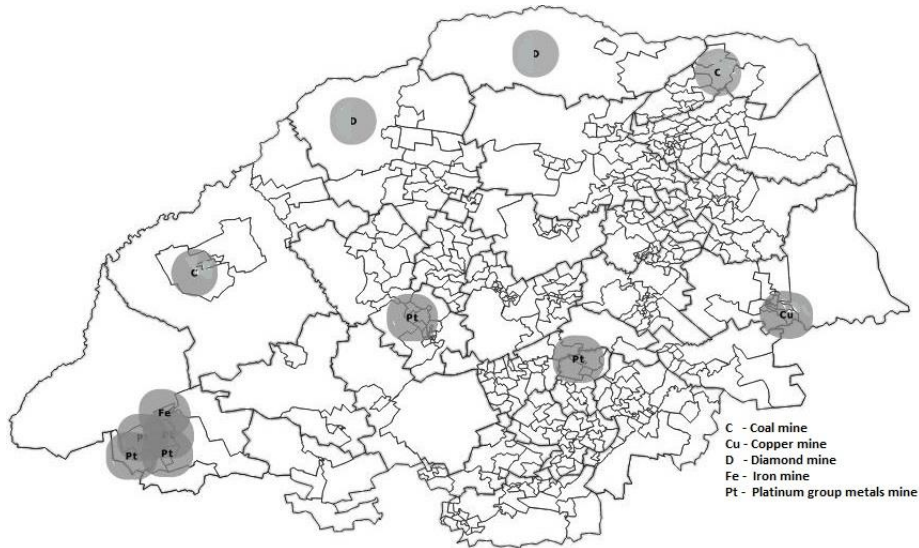


Figure 8: Mines (12 in total) in 2001 by commodity mined in Limpopo.

(Shading is not meant to imply scale, but only to enhance visibility). (Source: Author. GIS data from the South African Municipal Demarcation Board)

Figure 9 shows that by 2011, the province had new mines that had opened and a few closed. As a result, an increasing number of wards were now located closer to mines than before, and mining activity had increased in the region. In other words, a number of wards were ‘treated’ during the period between 2001 and 2011, where ‘treatment’ is defined as the opening of new mines.

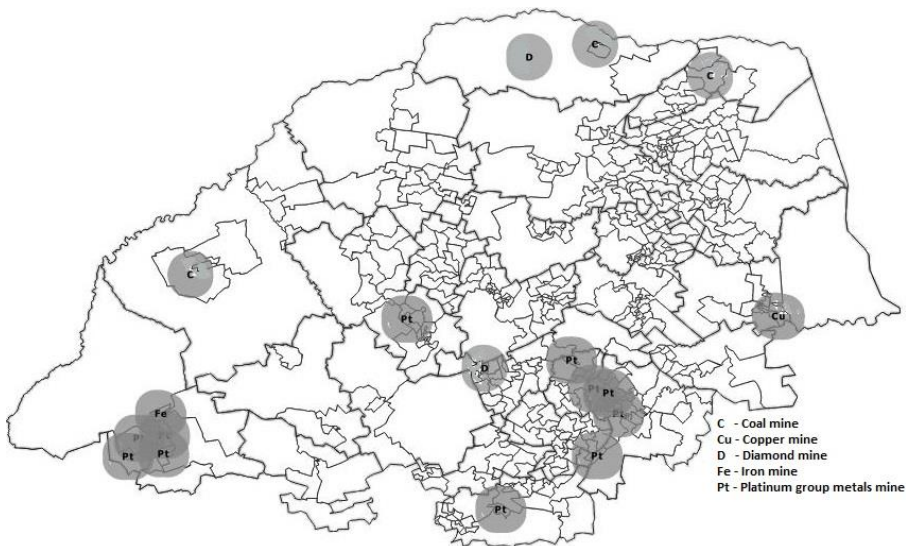


Figure 9: Mines (18 in total) in 2011 by commodity mined in Limpopo.

(Shading is not meant to imply scale, but only to enhance visibility). (Source: Author. GIS data from the South African Municipal Demarcation Board)

Thus, distance is a source of heterogeneous exposure to the increase in mining activity. The study uses 20 kilometres as a threshold to divide wards into two groups – close to mine and far from mine. Figure 10 shows β estimates for wards located at distance intervals of 10 kilometres. The impact of mine opening is significant and poverty-reducing for wards located within 20 kilometres of a mine, but becomes insignificant the farther away a mine opens. This result supports the assumption that the effect of mine activity is localised around close wards, and declines by distance. This also validates the empirical strategy of exploiting variation in distance to measure the causal impact of mining on ward income poverty.

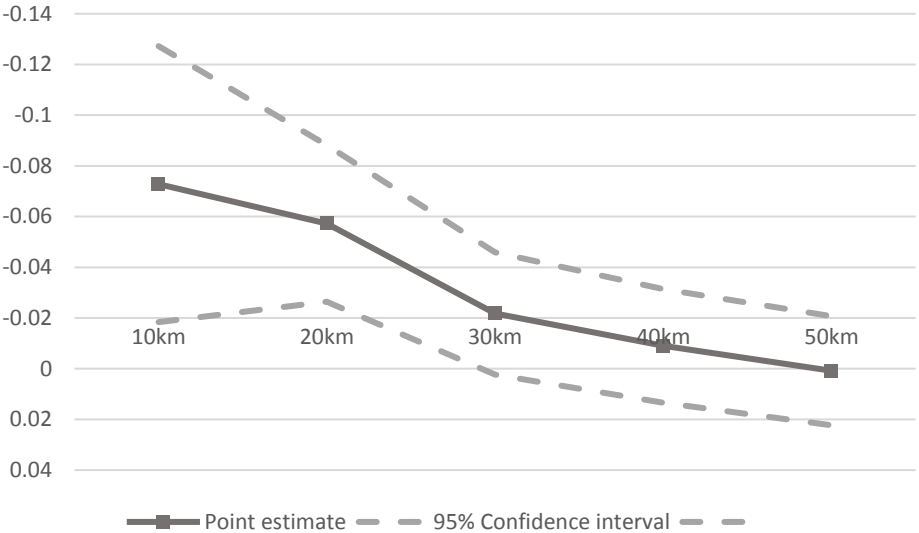


Figure 10: Effect of mine openings on income poverty, by distance

A priori, this study does not know the correct distance threshold. The choice of distance is important to correctly estimate the effects (Tolonen, 2014). To choose the distance, the study ran multiple regressions to determine at which threshold the opening/expansion of mining becomes statistically insignificant³⁰. Ensuring the correctness of this threshold is also important for this study to maintain the true counterfactual. Moreover, this threshold is in line with the range of distance (20 kilometres to 100 kilometres) from previous studies that examine local impacts. These

³⁰ This exercise is not included in this study.

studies include (as cited in Tolonen, 2014): Aragón and Rud (2013), Aragón and Rud (2012) where they use 20 kilometres in a study on agricultural productivity in Ghana close to gold mines, and 20 kilometres for labour market effects across Africa (Kotsadam and Tolonen, 2013; in Tolonen 2014).

The study is essentially a difference-in-differences procedure that uses the opening and closing of mines, as well as the expansion of mining activity, as the treatment, and compares wards located close to mines, to those that are far from mines. In order for the study to be valid, the parallel trend assumption must hold. That is, the study assumes that the impact of mining activity declines with distance, and that wards close and far from mines would have performed similarly in the absence of an opening of a mine nearby or an increase in pre-existing mining activity.

A major drawback is the lack of data before 2001, in order to gain better insight on the poverty trend between wards close to mines and far from mines. Figure 11 below isolates wards that are located within 20 kilometres in 2001 and farther than 20 kilometres from a mine (the control group), and evaluates the change in mean poverty on those wards that get ‘treated’ by the opening of a mine nearby. The figure shows similar starting trends between the control group and those wards that eventually get treated. Furthermore, the figure shows that those located within mining communities in 2001 start off poorer than those farther away, but this changes beyond 2007. Therefore, this figure addresses the concern that wards located close to mines were *a priori* faring better than non-mining wards.

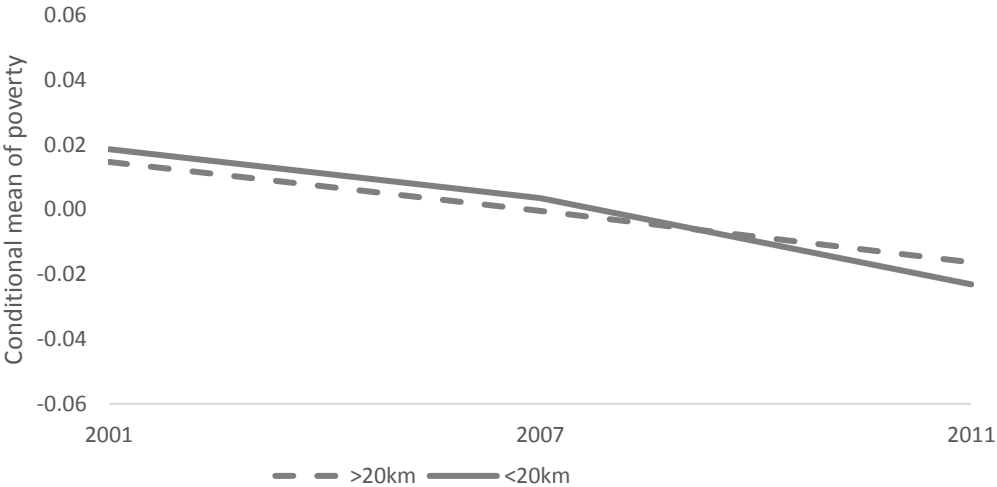


Figure 11: Conditional mean of income poverty

Baseline Specification

To evaluate the impact of mining activity on ward-level income poverty rate, the following regressions are estimated:

$$y_{w,t} = \beta_0 + \beta_1 distance_{w,t} + \beta_2 X_{w,t} + \beta_3 \alpha_w + \beta_4 \delta_t + \varepsilon_{w,t} \quad (1)$$

$$y_{w,t} = \beta_0 + \beta_1 distance_{w,t} + \beta_2 (\ln M_{w,t} \times distance_{w,t}) + \beta_3 X_{w,t} + \beta_4 \alpha_w + \beta_5 \delta_t + \varepsilon_{w,t} \quad (2)$$

where $y_{w,t}$ is the outcome variable measuring share of population living in income poverty in ward w in year t . $M_{w,t}$ is the measure of mining activity in ward w at time t . The main measure of mine activity is the sum of a mine's preferential procurement³¹ and its wage costs. However, other measures of activity are used, including sales revenue, and number of mine workers employed. $distance_{w,t}$ is a dummy variable, which is equal to one if a ward is located within 20 kilometres to a mine. Both variables vary with time due to opening and closure of mines. The study also uses alternative specifications of distance, such as continuous distance. The specification also includes a vector of ward-level controls $X_{w,t}$ ³², ward-level fixed effects α_w and time fixed effects δ_t .

The main parameters of interest are β_1 and β_2 , which capture the size of impact on ward income poverty due to changes in distance and due to an increase in demand for local inputs by mines, respectively.

Threats to identification

This study seeks to convincingly isolate the causal impact of industrial mining on local economic wellbeing, as measured by income poverty. The validity of the empirical strategy, however, relies on assumptions that may be violated. The main assumption is that the timing, the choice of location of mine, and the level of production, is exogenous to local population characteristics and local labour market participation (Tolonen, 2014). However, mine location and production may depend on local characteristics. The necessary condition for establishing a mine is the existence of a deposit. Access to and costs of inputs could also have an influence, as well as institutions – which determine the rules of ownership, revenue sharing, and environmental demands (Tolonen, 2014).

³¹ Preferential procurement refers to the percentage of a mine's total expenditure devoted to companies that comply with Black Economic Empowerment policies.

³² See Appendix A for a full list of controls.

For this study, variation in these institutions is not expected at the ward level. Therefore, differences in mine location and production levels are not expected to be driven by ward level characteristics.

Another concern is the choice of mine opening or location based on infrastructure, including road and rail network, and access to water and electricity. Tolonen (2014) notes that if mining operations create new infrastructure, then the treatment will simply include infrastructure. This will not harm the identification strategy, because interest is on the total effect of industrial mining. The threat is only when mines open or expand as a result of infrastructure. This affects the interpretation of the estimates, as they no longer provide the general equilibrium effects of a large-scale mining shock (Tolonen, 2014). Indeed, the type of minerals in this study, such as coal, iron ore, and platinum group metals, heavily rely on good infrastructure. Industrial mines partly create the needed infrastructure (included in companies' capital expenditure budget), but government remains the main provider of major infrastructure investment. In this study, the development of new mines is concentrated around pre-existing mines – which necessarily have better infrastructure for mining in particular – but this location decision is strongly influenced by the location of mineral deposits concentrated regionally. At this point, this study does not find a solution to rule out this concern.

Selective migration could also threaten the identification strategy, if it alters the population characteristics in a way that influences the outcome variable of interest. For instance, if more productive people move closer to communities anticipated to open mines, this increase in average productivity may significantly exert downward pressure on poverty. Therefore, although the study is interested in the general equilibrium effects of mining on the local economy – how it affects economic opportunities of new and old community members – it is crucial to isolate the treatment effect from the selection effect (Tolonen, 2014).

In addition, Aragón and Rud (2013) flag tax revenue windfall as a possible threat to identification. Because mines are taxed at the federal level, it is possible that the estimates of impact are simply capturing this channel. If this is the case, it means it is public expenditure that matters for poverty reduction, rather than backward linkages from mining activity. This possibility is considered unlikely in this study. However, to establish confidence on the robustness of the empirical results, the above concerns will be tested towards the close of this chapter.

Finally, to mitigate the concern of endogeneity relating to mine opening and location, the empirical strategy includes ward fixed effects as well as year fixed effects.

Main Results

This section reports the empirical results of the model specification. The main outcome variable is the upper-bound income poverty rate, which is the share of people who are just able to afford sufficiently nutritious food and basic non-food items. The results will also use the food poverty definition, which describes the share of people who can barely afford sufficient food. The main measure of mine activity, or expansion, is the local demand for inputs by mines, measured by the sum of preferential procurement and wages expense. The development of new mines and mine expansion is expected to increase nominal income of workers in affected sectors, as well as increase the price of goods traded locally (Aragón and Rud, 2013). This latter outcome cannot be examined in this study due to unavailability of data.

The other possibility pertains to the impact of mining on communities in Limpopo through impact on agriculture. As discussed in the preceding chapter, there are two main channels in this regard. First, the presence of a mine could increase demand for local inputs and thus create input competition, which leads to an increase in input prices and therefore reduce input use and agricultural output. Second, pollution from mining could either directly affect health and yield of crops, deteriorate the quality of key inputs such as soil, or affect labour productivity through its effect on health. The fall in agricultural output due to reduced factor productivity, closure of commercial farms, and reduced subsistence farming activity could exert downward pressure on incomes, or escalate health costs; effects which could exacerbate income poverty.

Overall, the direction of impact of mining on local poverty will depend on the strength of economic linkages versus the intensity of harmful spillovers from mining. It should be noted that because of the short period of years of the data sample, the results are only indicative of short-term impacts.

Table 6: The impact of mines on ward-level income poverty

	Upper Poverty	Upper Poverty	Upper Poverty	Food Poverty	Upper Poverty	Upper Poverty
	(1)	(2)	(3)	(4)	(5)	(6)
Distance ≤ 20 km	-0.0573*** (0.0157)	-0.1196*** (0.0287)	-0.1393*** (0.0310)	-0.0014 (0.0016)	-0.1174** (0.0577)	
Mine activity \times distance ≤ 20 km		0.0073*** (0.0028)			0.0104 (0.0082)	
Copper \times Mine activity \times distance ≤ 20 km			0.0137 (0.0010)			
PGM \times Mine activity \times distance ≤ 20 km			0.0090*** (0.0030)			
Diamond \times Mine activity \times distance ≤ 20 km			0.0254 (0.0162)			
Coal \times Mine activity \times distance ≤ 20 km			-0.0255** (0.0125)			
Mine activity \times continuous distance						-0.0010 (0.0008)
Measure of activity [#]		Procurement	Procurement	Procurement	Sales	Procurement
Observations	1445	1445	1445	1445	1444	1445
Number of groups	533	533	533	533	533	533
R ²	0.5826	0.5990	0.5354	0.6357	0.6281	0.6210

Note: All regressions include year and ward fixed effects. The set of control variables include municipal ward population characteristics, municipal ward services, employment, and education (See Appendix). Purchases is the sum of a mine's wage bill and local purchases. Standard errors in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Measure of activity is in logarithm.

Table 6 presents the estimates of β . The baseline specification measuring the impact of a mine opening (column 1) shows that wards that are located within 20 kilometres of a new mine experience a statistically significant decline of 0.06 percentage points in income poverty levels. This means that on average, 557 people per ward are lifted out of income poverty as a result of a mine opening within 20 kilometres. This result suggests that there has been some level of progress from the 'enclave effect' of mine openings, where mines had very limited economic linkages into local communities. The size of impact is relatively small; as expected, given studies that suggest that most of the benefits of procurement from mining are captured outside the Limpopo Province. Therefore, improving local linkages in the mining sector could strengthen the poverty-reducing impact of mine operations.

However, the benefit of a mine opening does not extend to the extremely poor, as shown in column 4 of Table 6. That is, when using the food poverty line as the dependent variable, the study finds that the opening of mine locally is not associated with a fall in income poverty for the extremely

poor. This could suggest that those in extreme poverty experience barriers to accessing economic opportunities arising from mine opening. These barriers could include transport and communication costs, disabling health problems, and extreme illiteracy.

Once a new mine opens, what is the additional impact of its expansion? Column 2 of Table 6 estimates this effect, measured by an increase in the demand of local inputs. Similar to Aragón and Rud (2013), procurement is the preferred measure of mine activity, as it captures better the interaction between the mine and the local economy. The results show that *when controlling for the expansion of a mine*, the impact of having a mine locally is twice as strong: income poverty drops by a ratio of 0.12 per ward. Once this effect is captured, the expansion of a mine is not associated with additional poverty reduction. This finding is elaborated by column 3, which unpacks this result by type of commodity mined in the locality. Column 3 includes the expansion of mines by different commodities. These are PGM, coal, diamond, and copper; while iron ore is assumed to be the dummy variable commodity. The study finds that the expansion of a PGM mine has a significantly lower impact on poverty reduction compared to the expansion of an iron ore mine. In fact, of all the types of mines in the dataset, it is specifically the expansion of coal mines that significantly reduces income poverty.

These results suggest that the poverty-reducing impact of mine expansion is driven primarily by coal mining. That is, communities in the coal mining region may be benefiting more than others from mining activity. This result is robust to alternative baseline commodity dummies. It is unlikely that this result is driven by the overrepresentation of coal mines in the sample, as there are only three coal mines in the sample; whereas platinum mines consist the majority of the sample.

Indeed, there is reason to believe that there are differences in impact by commodity because of the following reasons. First, different commodity types were discovered at different periods. Generally, coal and copper mining in the area has existed for many decades, while PGM mining is comparatively recent. This essentially means that the benefit of the expansion of coal mines is better captured locally because of better established local linkages compared to other commodity mines. Second, the extent of local embeddedness may intrinsically differ by commodity mined. For instance, coal is the primary source of domestic electricity generation in South Africa and is also largely used for the production of the country's liquid fuels (Hancox & Götz, 2014), and

therefore has more local embeddedness. In addition, the coal field includes small scale miners who are likely boosting economic activity in the area; as opposed to more capital intensive, high-barrier-to-entry isolated commodities such as PGM mining. Thirdly, the mining process may require differing amounts of capital expenditure, local knowledge, and various inputs. This determines not only the level of investment, but the extent of local procurement versus ‘outside’ procurement. Fourth, the wave of mining strikes particularly during 2012 were concentrated on PGM and gold mining sectors (Els, 2012), which may highlight some level of heterogeneity of socio-economic impact between commodity sectors.

This heterogeneity of impact by commodity is likely not only explained by differing depths of local linkages, but by differing pollution levels, such that the expansion of mining of a particular commodity proxies for the expansion of pollutants. In order to better understand these results, the following section provides an exposition of coal and platinum mining linkages and pollution activity in the Limpopo Province.

Coal mining in Limpopo Province

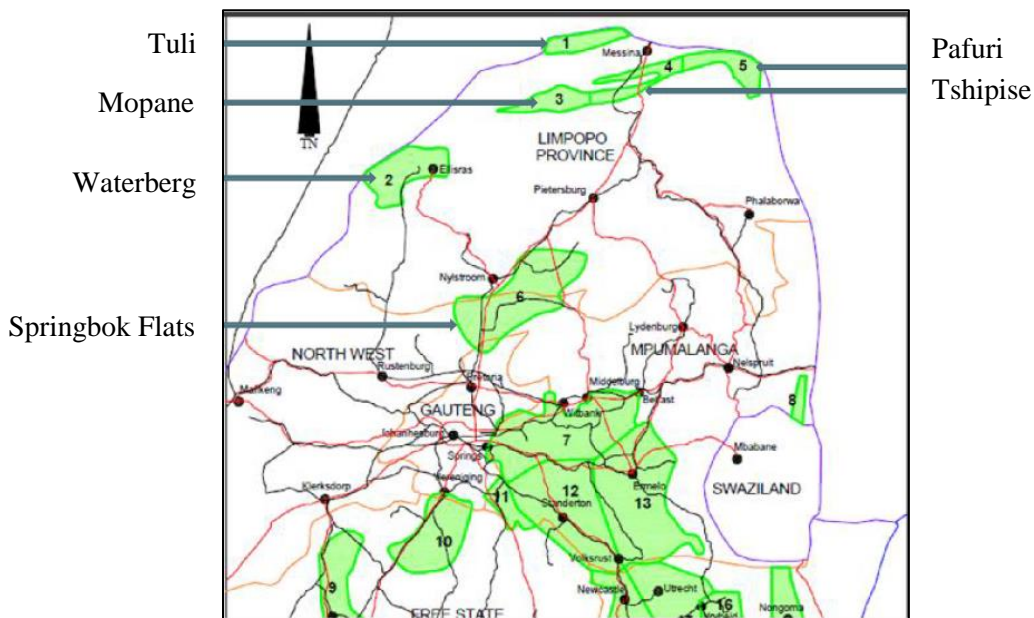
Coal is a major polluter, and this is a globally recognised problem when discussing climate change. In this respect, South Africa accounts for 1.1 percent of global greenhouse gas (GHG) emissions. The contribution is mainly driven by South Africa’s heavy reliance on coal, which generates 94% of electricity, 39% of liquid fuels and accounts for 70% of GHG emissions (Baxter, Opportunities and challenges facing the South African Mining Industry, 2011). While coal is a major GHG emitter, the next subsection will discuss the role of platinum pollution particularly in releasing harmful non-GHG emissions.

An analysis of the heterogeneity between the impact of coal mining compared to the impact of platinum mining also requires an examination of both historical context and local linkages. To do that, the analysis on coal relies on a study by Hancox & Götz (2014), which contains a detailed analysis of coalfields in South Africa.

Coal mining has existed in South Africa well over a century, and has been essential to South Africa’s electricity generation and overall economy. However, according to Hancox & Götz (2014), whilst many of the coalfields have been extensively explored and exploited, those in the

north of South Africa have until recently received much less attention. There are *four coalfields* that occur partly or wholly within the Limpopo Province (see Figure 12) and these may contain as much as 70% of South Africa’s remaining coal resources. These resources include large coking and thermal coal, as well as potential for coal bed methane. The coal value chain is well integrated, governed by few large players including Anglo, Exxaro, BHP Billiton (South32), Sasol, and Xstrata. In Limpopo, there are two large operating mines, both operated by BEE empowered Exxaro (Mayes & Prevost, 2012).

Figure 12: Coalfields in the Limpopo Province



Source: Mayes & Prevost (2012)

The study captures the mining of coal in the Waterberg Coalfield, located in the Lephalale municipality, 400 kilometres northwest of Johannesburg in Limpopo, and containing between 40 and 50 percent of South Africa’s remaining coal resources. There is one large open cast mine currently mining in the field, the Grootegeluk Mine, which is the first coal mine to open in this region, in 1980. This is the largest opencast coal mine in the world and operates the world’s largest coal beneficiation complex. Within the coalfield is also located Eskom’s Matimba Power Station,

which is the largest direct dry cooling power station in the world; and the newly built Medupi Power Station³³, with an operational life of 50 years.

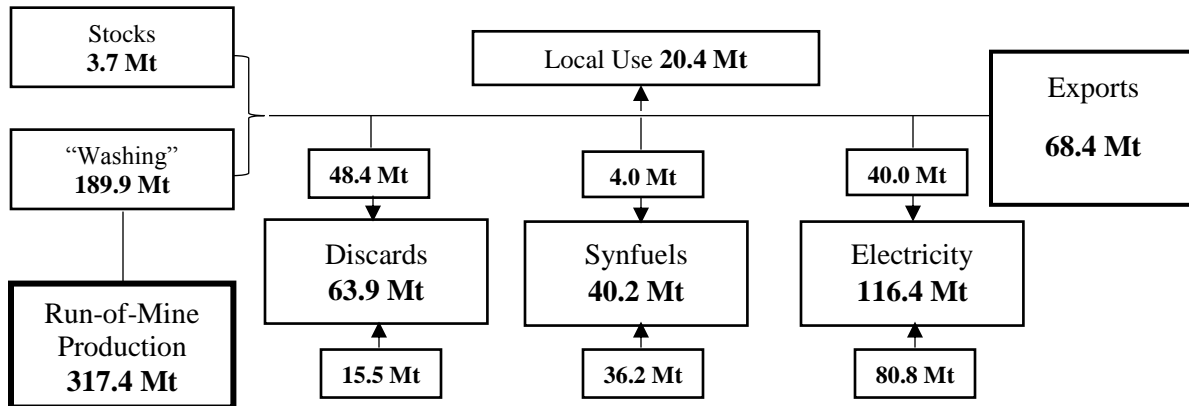
The Grootgeluk mine produces an average of 18.8 Mtpa, of which 14.8 Mt is thermal coal that is transported directly to Eskom's Matimba power station via a seven kilometres conveyor belt. An additional 1.5 Mtpa of metallurgical coal is sold domestically to the metals and other industries. The remaining output is exported via the Richards Bay Coal Terminal if not sold domestically. The rich coal resources have also attracted a number of junior miners as well into the region. This is an important feature because there is evidence to suggest that small and medium scale mining provides a sizeable number of jobs (Tolonen, 2015).

The second coalfield captured in this study is the Southpansberg coalfield, which is situated in the Southpansberg Mountain Range in the Limpopo Province. Commercial mining began as early as 1911 by an entity that was called Messina Transvaal Copper Company. In 1984, an underground mine called Tshikondeni mine, located 140 kilometres east of Musina town, began operating. It is currently the only colliery operating in this coalfield, and is operated by Exxaro. The mine produced around 316,000 tpa, and the coal is processed in a local plant which is then used by Arcelor Mittal's steel mill in Vanderbilpark.

The third coalfield is the Limpopo coalfield, situated in the northernmost extremity of the province, 70 kilometres west of Messina town. The coalfield has been known since 1985, but it only became a producer over a century later with the Coal of Africa's Vele colliery, which is in operation and captured in this study as well. Finally, the fourth coalfield is called the Springbok Flats coalfield, located in Tuinplaats, Bela-Bela, and Roedtan in the Limpopo Province. The coalfield has had various exploration projects, but no large active mine.

³³ The station started partly operating in 2015. See more information here: http://www.eskom.co.za/Whatweredoing/NewBuild/MedupiPowerStation/Pages/Medupi_Power_Station_Project.aspx

Figure 13: South Africa's Coal Chain 2011 (total coal: bituminous, anthracitic, lean and coking)



Source: Mayes & Prevost (2012)

Eskom is a major market for coal produced in South Africa, and indeed coal output from Limpopo. Not only is Eskom a major market, but it is also responsible for procuring local electricity network construction, while providing maintenance of these facilities. Figure 13 shows that the majority of coal mined in the Limpopo is used for electricity generation, with a relatively small share exported. What is also important about Eskom in the coal value chain is that it specifically procures local network construction from BEE firms that already exist locally, within each province. Firms contracted are required by Eskom to use local municipal labour (Kelman, 2008). Therefore this set-up in the coal industry further strengthens linkages to local economies.

Overall, the description of coal mining in the Limpopo Province suggests that the industry is relatively locally embedded, with a variety of linkages into the local economy. The sector uses local knowledge, local inputs into production, and evidently beneficiates locally. The theory of linkages discussed in this paper would support the view that this feature of local embeddedness enhances local economies, and therefore alleviates poverty. This analysis would therefore support the empirical results discussed in this chapter.

Platinum Group Metals mining in Limpopo Province

An article on Business Day published in December 2015 reports on the violence in the platinum mining area called Steelpoort, in Greater Tubatse Municipality, Limpopo. This area includes the major platinum mines including Northam Platinum, Anglo American Platinum, and African

Rainbow Minerals. The one explanation for the violence is the lack of service delivery. This explanation is supported by Krugell et al. (2010) who construct a service delivery index for all South African municipalities using the 2001 Census and 2007 Community Survey. The index reveals that the majority of municipalities in Limpopo are performing below average on service delivery, and these include almost all municipalities where platinum mines are located within the province. The other explanation is local contestation for supply contracts from mines. One mining executive is reported to say that the violence started as a protest for service delivery, but was captured by people who want to “get rich on the back of supply contracts with the mines and the provision of local labour” (Seccombe, 2015, p. 2). According to the article, the community is dissatisfied with black economic empowerment. Instead, the community wants only locals to benefit and to be involved, and to dictate who gets mine-supply contracts and who gets employed.

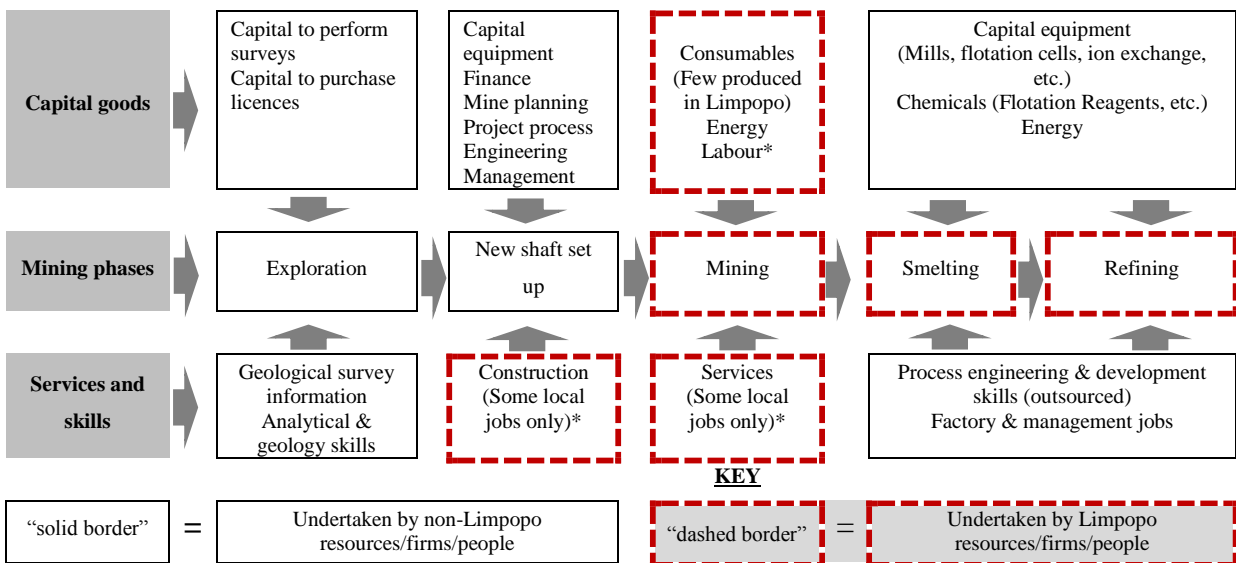
This article highlights that local communities in Limpopo, particularly in the platinum belt, are not only protesting on service delivery or wages from mines, but are protesting out of a growing awareness of potential business from mines through procurement. Indeed, the violence is challenging the ways mines will secure their investment through the imperative to localise procurement as much as is practical and possible.

As already discussed, in contrast to coal mining in Limpopo, platinum mining is a relatively recent industry in Limpopo. Together with the fact that the output is largely geared for exports both outside the immediate province and the country, it is less locally embedded as compared to coal. In addition, as a young industry, its innovation on decreasing environmental impact is yet to advance to an extent which ensures that the net benefit of its presence is positive. Specifically, throughout the mining process of platinum mining, from blasting operations, crushing and milling operations, production of concentrate, to recovering platinum from concentrate, the process (a) releases a large amount of air pollution (including dust and Sulphur dioxide), (b) consumes large amounts of water, and (c) consumes large amounts of electricity (Cainrncross, 2014). The air pollutants released cause acid drainage, as well as health and environmental problems.

Recalling that Aragón & Rud (2015) find evidence of poverty exacerbation on local communities due to pollution from gold mines, a study by Glaister & Mudd (2010) which scientifically investigates the impact of PGM mines in the platinum belt finds that unit environmental costs of PGMs are higher in greenhouse gas emissions than gold mining, higher in energy consumption

than gold mining, and slightly lower in water consumption than gold mining³⁴. Furthermore, Aragón & Rud (2015) suggest that the expansion of gold mining captured in their study in fact proxies for the stock of pollutants produced by each mine. If this is the case, and in light of the finding that PGM mining may be currently more environmentally damaging than gold mining, then the empirical findings in this study may be capturing the increase in pollution activity from PGM mining in the Limpopo, relative to weaker positive economic linkages from mine expansion.

Figure 14: Platinum Group Metals Value Chain in Limpopo



* BEE through procurement opportunities

KEY: The dashed borders means those are undertaken by Limpopo resources/firms/people

Source: Glen Steyn and Associates (2006a)

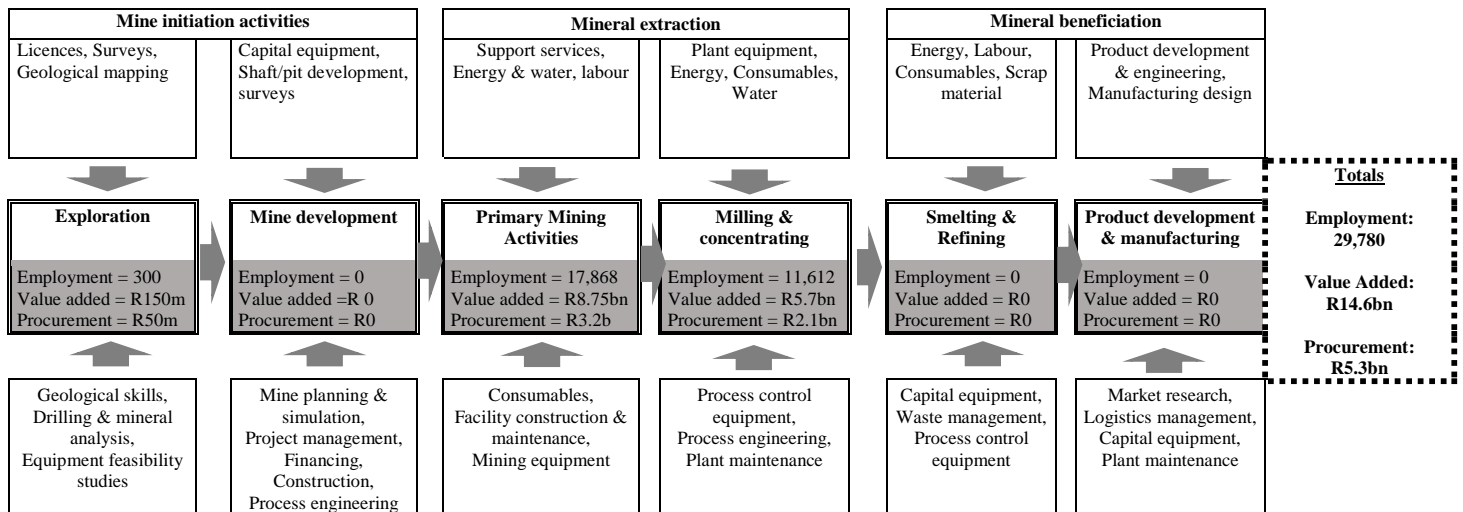
In terms of local economic linkages, there is some information to suggest that PGM mining has scarce local linkages along its mining process, and this is partly explained by underdevelopment in the platinum areas. Figure 14 shows the PGM value chain in Limpopo, developed by Glen Steyn and Associates (2006a). The diagram illustrates that the participation of communities in Limpopo is limited to mining, while the actual procurement to support the process is sourced externally. Of those goods and services that are procured locally, few consumables are produced locally, and few jobs arise from construction and services into the mining phase. Key technology and skills into mining are practically wholly sourced externally. As already discussed throughout this paper, this

³⁴ The reader should note that most of the PGM mines also produce gold as part of their annual output.

is a general state of mining in Limpopo as concerning local procurement, but there is evidently some heterogeneity in local embeddedness between commodities.

Figure 15 further illustrates the extent of local procurement from PGM mining; in this case, in the Waterberg District Municipality in Limpopo Province. Glen Steyn and Associates (2006b) show that the mining and milling phase of PGM mining creates a large number of jobs, but these are largely shared with non-local people. A procurement estimate of R5.3 billion is large for a local economy such as the Waterberg municipality, but the report states that it was the municipality’s goal to capture 20 percent of this procurement by 2010. This suggests that at the time of publishing, less than 20 percent of this indicated PGM mining procurement spend was captured locally. In addition, the figure shows that higher-end processes within the value chain are undertaken using external resources. Thus, although the MPRDA requires procurement from HDSA firms, the fact that these firms could be located in Johannesburg does not help the local mining communities. It is evident therefore that there is more local development needed in mining communities in order for these communities to start enjoying linkages with local mining operations.

Figure 15: PGM mining procurement in the Waterberg District Municipality, 2005 estimates



Source: Glen Steyn and Associates (2006b)

Alternative explanations

It may be possible that the empirical results in the preceding section are driven by factors other than mine opening and mine expansion. These are confounding factors that explain the observed

decline in income poverty in wards close to mines. There are three immediate alternative drivers of these results, which this section aims to test. These are tax revenue (fiscal linkages), selective migration, and sample bias driven by ward size.

Tax revenue explanation

Generally, local governments receive tax revenue from local operating mines; in which case the impact of mining may run through this channel. For example, there could be an expansion of public employment, which could lead to increased local wages; or a demand shock from increased public works (Aragón and Rud, 2013)³⁵. The following two reasons make it unlikely that the preceding results capture this channel. Firstly, the analysis of this study is at the ward level. Given that tax is collected at the municipal level, which has a strict government agenda to allocate tax revenue equitably, the study should not have found economic benefit from mining activity that is isolated only within the 20-kilometre distance of exposure. This is because municipalities consist of wards spreading well beyond the 20-kilometre threshold. In addition, tax allocation is meant to prioritise poorer areas, rather than localise tax to wards with mines. Secondly, the tax revenue on mining companies is exceptionally low relative to local procurement by mines. This casts doubt that tax revenue may be driving the results, and supposes a strong assumption that tax revenue has a strong social return (Nxele, 2015).

To formally evaluate this possibility, annual tax paid per mine is added as a covariate to the baseline specification, along with its interaction with mining exposure (proxied by distance of 20 kilometres), to test whether tax revenue captures explanatory power away from the impact of mines.

³⁵ Mining revenue collection in South Africa is by federal government (see PriceWaterhouseCoopers, 2012), although federal government in South Africa is not fiscally autonomous (see Calitz and Essop, 2013).

Table 7: Results Controlling for Tax

	Upper Poverty (1)	Food Poverty (2)
Distance ≤ 20 km	-0.1049*** (0.0334)	-0.0964*** (0.0351)
Mine activity x distance ≤ 20 km	0.0059* (0.0031)	0.0062* (0.0033)
Ln (Tax)	0.0016 (0.0017)	0.0014 (0.0018)
Ln (Tax) x distance ≤ 20 km	0.000008 (0.00003)	0.00001 (0.00003)
Observations	1358	1358
Number of groups	529	529
R ²	0.6151	0.6356

Note: All regressions include year and ward fixed effects. The set of control variables include municipal ward population characteristics, municipal ward services, employment, and education (See Appendix). Purchases is the sum of a mine's wage bill and local purchases. Standard errors in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Measure of activity is in logarithm.

The results in Table 7 show that the opening of a mine within 20 kilometres of a ward remains an important explanation of a decline in ward income poverty, whether using the upper-bound poverty measure or food poverty measure. In contrast, the study finds no evidence that additional tax revenue is a significant cause of reduction in income poverty in the sample wards. The positive coefficient of tax on poverty is surprising, but consistent with the finding of Aragón and Rud (2013). It suggests that additional tax outside mining communities is not poverty reducing, at least in the short run. Apart from a possibility that tax revenue has low social returns, this could be because public projects take longer to mature. Alternatively, tax revenue may be funding provision of public goods, without direct income poverty gains (Aragón and Rud, 2013, in Nxele, 2015).

Selective Migration explanation

Before a mine is established, there are necessary processes concerning approvals from government and community stakeholders that are undertaken, generally taking well beyond a year to complete. The anticipation of a mine opening could alter the composition of the local population through selection. *A priori*, it is not known with certainty whether the opening of a mine leads to positive or negative migration. Nonetheless, compositional changes of the population, if significant, affect

poverty income. It could be possible that in anticipation of the opening of a mine, the poorer (and/or less educated) move closer to the mining area while the wealthier (and/or more educated) move farther away in anticipation of the negative health and migration impacts. This changes ward characteristics such as average income and average education, and biases the true size of the impact of a mine opening and/or demand shock. Alternatively, the opening of a mine or mine expansion could attract productive labour, which would exert downward pressure on income poverty (Nxele, 2015).

To test the impact of selective migration, it is necessary to identify the nature of migration and test whether this subpopulation drives the results (Aragón and Rud, 2013). The present study does not have robust migration data at the ward level; instead, migration is presently measured as the share of people per ward who report being born outside of the Limpopo Province. Using this variable, this paper makes an initial attempt to test the impact of migration by investigating whether the inflow or outflow of migrants by education level influences income poverty observed at ward level. To do this, the study interacts the migration variable with the share of the educated population. The results in Table 8, which should be taken with caution, show that the opening of a mine and the expansion thereof remain important explanations of changes in ward income poverty for both the upper-bound poverty measure and the extreme poverty measure, even when controlling for migration effects. The results show no significant impact of migration into mining areas by education level. However, wards with a larger share of migrants and/or a larger share of tertiary educated people experience declining levels of income poverty. Therefore the results suggest that the income-reducing effects of migration are not localised to mining areas, but are generalised across all wards. That is, the effect of migration into mining wards is likely not driving the results behind ward poverty changes, as shown by the robust parameters of distance and mine expansion.

Table 8: Results Controlling for Selective Migration

	Upper Poverty (1)	Food Poverty (2)
Distance ≤ 20 km	-0.1113*** (0.0294)	-0.1009*** (0.0308)
Mine activity x distance ≤ 20 km	0.0065** (0.0028)	0.0069** (0.0030)
Migration	-0.0903*** (0.0216)	-0.0942*** (0.0226)
Migration x Secondary education x distance ≤ 20 km	-0.0653 (0.2058)	-0.1126 (0.2160)
Migration x Tertiary education x distance ≤ 20 km	0.1023 (0.8226)	0.1595 (0.8633)
Secondary education	0.0732 (0.0461)	0.0645 (0.0484)
Tertiary education	-0.2616*** (.0856)	-0.2234*** (0.0899)
Observations	1443	1443
Number of groups	533	533
R ²	0.6299	0.6489

Note: All regressions include year and ward fixed effects. The set of control variables include municipal ward population characteristics, municipal ward services, employment, and education (See Appendix). Purchases is the sum of a mine's wage bill and local purchases. Standard errors in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Measure of activity is in logarithm.

Sample bias explanation

The other major concern is that the results are driven by certain wards. Therefore, to further establish confidence on the empirical results, the study undertakes sample checks to verify the robustness of the variables of interest. To do this, the study explores removing wards by local municipality and commodity then tests the base model. The results show that the *opening of a mine* (or the variation of distance to a mine) remains a highly statistically significant variable in reducing poverty, and this is specifically driven by platinum mines. This is not a surprise, as the model is a difference-in-differences and therefore captures the *variation* in distance as a result of mine opening and mine closing. Further checks on the *expansion of mines* confirms that coal mines are statistically associated with poverty reduction relative to other commodities in the sample. On the

contrary, the study finds no evidence of poverty reduction as a result of expansion of platinum mines. Therefore, these results uphold the base specification findings³⁶.

Improvements to the study

Data

The main limit to this study is the availability of data that could provide a richer set of variables, such as information on prices of local goods, health, the environment, and a richer vector of control variables at the ward level. This would allow the study to directly test for these community wellbeing variables that are associated with mining. Unfortunately, data at ward level is scarce in South Africa and to the knowledge of the author, the data used in this study is the best available data at ward level.

Instrumenting for mine location/production

In order to rule out possible endogeneity associated with mine location or mine production, a further improvement would be to identify an appropriate instrument. This instrument should explain the location of mines without having direct impact on local poverty.

³⁶ The Stata software do-file running these sample checks is available by request from the author.

Chapter 5 Conclusion and Policy Implications

The problem facing the mining industry, government, and communities is essentially that mining has long term significant impacts. These impacts, as discussed in this study, involve both positive economic benefits, and negative environmental and health impacts that ultimately have economic implications. The poverty in the Limpopo Province is a problem that needs effective redress. The challenges are complex, given the history of homelands that make up a significant part of the province. The political and policy dispensation under which the mining industry was established in South Africa encouraged racial segregation of a great number of local citizens, therefore part of the challenge is not only aligning municipal management towards creating an inclusive service delivery framework (in contrast to homeland policy), but also aligning mining behaviour towards inclusive, socially responsible business practices.

To that end, the study has explored two major themes on impacts of mines: one being the economic impact of mines via economic linkages, and the other the environmental impact. The idea is that the measure of the impact of mines is not purely capturing economic benefits such as employment and income. Mining is inextricably linked to environmental harm, and this is itself linked to welfare economics. Therefore from a policy perspective, it is important to magnify the positive economic benefits that are stimulated by mining activity, while suppressing negative impacts, particularly pollution.

Chapter 1 discussed the history of poverty in the Limpopo Province, largely explained by the creation of homelands; and the early development of the mining-community relationship. The chapter found three critical “enclave effects” that could be observed in relation to early mining in Limpopo: (1) mines were not locally owned, and royalties were not fully controlled by local representatives, (2) employment creation by mines was limited both directly and indirectly as locals were not part of the supply chain, nor were there skills transfers given the colour bar legislation, and (3) for the employed locals, records suggest that the majority were employed outside of the homelands, where most of their expenditure from wages was spent. Thus, homelands were themselves created enclaves, while mining in these areas was enclave in nature, creating very little possibilities of local economic upliftment. Thus the chapter concluded that mines were enclaves within homeland enclaves.

Chapter 2 provided a literature review to unpack the complex channels of mining impact on poverty, give insight into theoretical predictions, and give insight on how mining and communities interact socio-economically and environmentally. The chapter also provided a survey of empirical methods used to evaluate the causal impact of mining at the micro level. Chapter 3 built on the literature review by discussing a conceptual framework to understand how mining operations economically link to local communities, and therefore how these links can be amplified to create positive spillovers from mining. The chapter also gave further insight on how South Africa's mining-community relationship has changed, and how, from a policy-recommendation perspective, it can continue to change towards a positive direction.

Chapter 4 provided a framework which provided testable predictions for empirical estimation, and also framed the building of an empirical model. It also presented the empirical strategy and results.

While this study initially set out to evaluate the economic impacts of mining within the conceptual framework of linkages as presented by Morris et al. (2012), the empirical results showed surprising results from what was expected. The expectation was that, consistent with Aragón & Rud's (2013) results, mining activity will show a positive impact on income poverty reduction. However, the results showed conflicting results between the impact of the *opening* of a mine, and the impact of an *expansion* of a mine. This led to re-evaluating channels through which mines impact communities, and it was found that a wholistic picture of mining impact has to include environmental impacts. This is one of the main innovations of this study: it brings together a framework that studies economic linkages and environmental linkages within a value chain analysis and an empirical investigation.

By exploiting the significant increase in local demand for inputs (driven by policy), and exploiting the changes in distance between municipal wards and mines, the study finds that wards located within 20 kilometres of a new mine experience a statistically significant decline in income poverty; lifting just above 500 people per ward out of income poverty. Assuming that during the homeland dispensation and before the introduction of the MPRDA policy, mining had little or no positive impact on poverty – if not exacerbating poverty – this result shows that there has been some progress from the 'enclave effect' of mine operations in the Limpopo Province, as discussed in detail in Chapter 1 and Chapter 3. However, the study found that the economic benefits of a mine opening does not extend to the extremely poor, possibly because of barriers to accessing economic

opportunities. A surprising result was that once a new mine has opened, the *expansion* of a mine did not seem to be associated with additional poverty reduction. From an economic linkages perspective, literature suggests that the ‘low-hanging fruits’ are picked in the early stages of mining. These pertain to linkages such as labour employment and supply chain linkages such as services for food catering and cleaning services. More complex linkages that come with expansion, such as capital equipment and services that require scale and sophistication, are sourced outside of the Limpopo Province. From an environmental impacts perspective, the expansion of mining also proxies for the stock of pollutants produced by each mine. This has adverse effects on a heavily agricultural reliant local economy, by decreasing agricultural total factor productivity, harming community health, and other adverse effects through this channel.

Further investigation revealed that the impact of mines varies by type of commodity; and it is coal mines that are driving positive impacts of mine expansion, while PGM mines appear to be exacerbating poverty.

An historical and value chain analysis was undertaken on the coal and platinum industry in Limpopo, to better understand the results. The analysis found that coal mining in the Limpopo began earlier than platinum mining, and is more locally embedded in the local community through localised value chains. In contrast, platinum mining was found to be relatively recent, its output geared for exports, and has scarce and shallow economic linkages to the local communities. Overall, while both commodities are major polluters, coal mining appears to have a positive net impact on income poverty as a result of stronger economic linkages. These positive economic linkages ‘compensate’, to some extent, the costs borne by communities from the negative socio-environmental impacts.

That said, the policy recommendations necessarily have to focus on creating and deepening economic linkages. While there are extensive studies on limiting pollution – covered by fields such as environmental economics and mining engineering – there is less a focus on expanding economic linkages. Indeed, mining companies are increasingly reporting on their efforts to reduce emissions to acceptable levels as guided by government policy. What remains a gap in policy implementation is the creation of economic linkages at the local level. This has significant potential in making a difference on how communities experience mining operations, both in perception and in reality. An example found in this study is the impact of coal mining versus the impact of platinum mining

in the Limpopo Province. While coal mining is a major polluter, the findings of this study suggest that coal mining is relatively more locally embedded, and therefore local communities are able to participate relatively more in the economic activity around coal mining. Therefore the net positive impact from coal mining on community livelihoods is driven by this feature of localised economic activity. This contrasts with the other subsectors, particularly platinum. Thus, it is important to learn that there is a practical way to benefit from mining activity. Assuming that mining will remain a business for the long term, it is worth making the most of it.

Policy Implications: Creating and deepening linkages

The paper by Farooki, Perkins, Fessahie, & Malden (2016) discussed in chapter 3 is a very useful study to understanding the challenges of mine companies pertaining to creating economic linkages in Southern Africa; and indeed, in Limpopo. By assessing domestic procurement challenges in the domestic sector within Southern Africa, the study finds that there is still limited local linkages from mining operations in this region, as a result of practical challenges linked to industry structure locally and globally. The overarching challenge for local linkage development is the high standards of input products and services required by mining companies, which local firms in mining communities (local defined as 30 kilometres to 70 kilometres) scarcely have capability to meet. More specifically, the main issues concerning the procurement of consumables include meeting input demand at short notice. Small businesses struggle to deliver on time compared to more established, often international suppliers. Small businesses are often not able to hold large stocks because of cost implications, nor are they able to offer the product range required by mines. The issues with engineering related services procurement include sufficient expertise and innovation.

What is seen as a potential opportunity is the local production of smaller equipment and spare parts. The study finds that the procurement of personal protective equipment is already being localised, but this is limited to simple stitching together of fabric. More sophisticated products are still being procured outside of local mining communities. Another local procurement opportunity identified by the study involves environmental related services, throughout the lifetime of a mine operation. Given the serious environmental impact of operations, and the increasingly stringent legislation to reduce these negative impacts, mine operations are outsourcing this function, such as the management of hazardous waste. The main challenge is that this is a highly technical area,

which needs certified businesses – which are currently scarce locally. However, the authors argue that this is a substantial opportunity for communities to participate in mining activity.

In summary, the above captures the creation of economic linkages by mining firms in the context of underdeveloped regions – mines are targetting what can be practically outsourced locally. These are activities in the lower-end of the value chain, requiring basic skills and basic capital equipment.

The next level of linkage development concerns deepening linkages partly by localising more supply chain activities. This is where there is a disconnect between business and policy. While mines are localising what they can at the minimum risk possible, policy is increasingly pressuring mining firms to localise more supply chain activities, where local capability to reliably meet demand on time and at required quality standards is in question. Indeed, regulatory pressure on procurement is relatively high in South Africa, with the first mining charter requiring companies to procure a minimum of 40% of capital goods, 70% of services, and 50% of consumer goods from BEE companies by 2014. While this could be interpreted as reasonable policy given the discussion on the role of policy in deepening linkages, policy must be practical. Stifling business which operates within an economically underdeveloped context could potentially worsen the welfare of communities. Thus, a more targeted approach is required, one which recognises the importance of mining as an economic activity which could be leveraged for community-wide economic gain, while remaining cognisant of the profit motive of business, particularly in an industry that requires substantial investments.

One potential direction could be to learn from the automotive industry in South Africa, which faces similar challenges on meeting increasingly stringent regulation relating to BEE procurement. As a producer-driven value chain, the automotive industry is approaching the problem of localising supply chains by systemising technology and skills transfer from Original Equipment Manufacturers (OEMs) and Tier 1 multinational firms, to Tier 2 and Tier 3 firms which consist of locally owned businesses. One such initiative is the Automotive Supply Chain Competitiveness Initiative (ASCCI) established in 2013, which has a mandate of coordinating supply chain development activities within the South African automotive industry. ASCCI is a collaborative initiative between the suppliers, OEMs, government and labour, with the objectives of increasing supplier manufacturing value add, enabling local supply chain capabilities, increasing local content, growing employment and advancing transformation. ASCCI follows a value chain-centric

approach in which OEM's nominate suppliers that are of strategic importance to them. That is, through ASCCI's World Class Manufacturing (WCM) initiative, Tier 1 firms 'adopt' Tier 2 firms with the aim to develop capabilities to meet world class manufacturing standards, and therefore become competitive and sustainable businesses. Tier 2 firms can adopt Tier 3 firms, with the same aim. Through benchmarking (by ASCCI) of firm operations, 'parent' companies can understand operational and competitive deficiencies of adoptees, and better target interventions within an ASCCI supportive framework.

ASCCI is still new, and yet to be proven through official publications. However, as an employee currently working closely with the ASCCI team, the programme is making a promising difference to member companies.

A multistakeholder programme with a shared vision, such as ASCCI, could potentially transform the success rate of supplier development programs within the mining industry. Currently, mining companies have supplier development programmes focusing on Small and Medium Enterprises (SMEs). The programmes are either undertaken directly by mining companies, or outsourced to private parties. Through a tiered classification, mining companies offer various support around incubating and developing local suppliers. The aim is to locate support in close vicinity of a mine precisely as a way to uplift the local community.

However, the supplier development programmes face a range of procurement-related challenges and contradictions on supplier sustainability. The challenges include the following:

- 1) OEMs of mining equipment require much more specialised, high quality inputs for manufacturing their products³⁷, and thus there remains little scope to localise supply;
- 2) such high technology products are governed by international contracts with global equipment manufacturers who also invest in R&D and provide parts and maintenance;
- 3) related to the preceding point is while procurement of services such as food catering can be localised, other products involve issues of scalability which local suppliers are not able to meet;
- 4) large mining companies that operate in multiple jurisdictions have centralised procurement systems, which leave little opportunity to make procurement decisions at a mine plant level.

³⁷ Compared to other sectors, the specificity of ores and other mine-specific conditions may require tailoring of equipment.

- 5) Where opportunity exists at a mine level to localise procurement, mine managers have strict short-term production performance targets which encline them to rely on well established, reliable suppliers than risk dealing with local suppliers who likely have no proven record.

While suppliers may benefit from incubation, some contradictions are as follows:

- 1) Incubated local suppliers creates a dependency as these are trained to fit the standards and needs of the particular mine and therefore limits opportunities to diversify clients;
- 2) By requiring local vicinity as part of supplier development, firms' ability to service its client increases, but the ability to tap into new businesses that are not located locally will diminish
- 3) However, if such firms establish their production units in a more 'central' location, they will have to create warehouse units near their clients to ensure that they can meet their demands quickly. This introduces additional costs for the supplier firms.

There are many other complex challenges discussed in detail by Farooki, Perkins, Fessahie, & Malden (2016). The main innovation of ASCCI is its multistakeholder approach, which could carry more weight in improving cohesion in a highly fragmented, highly contested industry such as the mining industry. Such an approach exposes all parties to the common challenges of creating an industry that is locally embedded and uplifts local communities. Furthermore, sharing the same conviction that supplier development is an effective approach to increasing local participation, while commonly understanding the challenge of "giving away equity" as a more challenging path to localisation, will greatly improve relations in the industry. This part of creating economic linkages creates a path for more inclusive engagement from ordinary local citizens, contrasting the practice of equity deals which have been seen to largely benefit politically-connected elites. This approach is consistent with Hirschman (1981), Morris et al. (2012), and the empirical studies such as Aragón & Rud (2013) and the findings of this study.

An 'ASCCI' within the mining industry would have to nuance coordination by commodity type, given the findings that mining impacts differ by commodity type. Labour instability, protracted strikes, a government-instigated massacre, emergence of a militant union, and community outcries about living conditions and poverty, are issues disproportionately inclining towards

platinum mining. The degree of dispute intensity appears to decline from platinum, gold, all the way to coal mining. The underlying issues would need customised coordination. The one dimension involves economic linkages issues. Platinum mining is an exports focused industry – that is the reality. However, what can be alternated is the industry’s heavy reliance on non-local, migrant labour, and external outsourcing even on locally procureable consumer goods and services. Added to that, ‘local’ should include locally produced. These are clear findings of this research, which add important nuance about formulating a multistakeholder body which will be suitable to the specific complex needs of the mining industry.

Finally, an ‘ASCCI’ in the mining industry would have to also focus on building environmental waste management and safety services suppliers. Waste management is a specialised field that is heavily regulated in South Africa, and there is opportunity to build licenced suppliers to handle movement of waste, identify industrial symbiosis opportunities, and contribute towards making mining production more environmentally-friendly. These services are crucial not only during the lifetime of a mine as concerning compliance with the waste management act, the air quality act, the water act, etc; but beyond mine closure, where environmental and economic impacts remain a legacy in communities.

Taken together, healing the fragmented community-mining relationship in South Africa towards poverty alleviation requires a wholistic institutional approach which emphasises not only economic linkages, but also environmental and health impacts of mining – in the broadest definitions practical. Thus, a cohesive, pragmatic multistakeholder approach is the next step towards creating a less enclave, more inclusive mining industry.

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Appendix

Table 9: Model 1 & 2 of the baseline specification, showing full list of base controls

	Upper Poverty (1)	Upper Poverty (2)
Distance ≤ 20 km	-0.0573*** (0.0157)	-0.1196*** (0.0073)
Mine activity \times distance ≤ 20 km		0.0073*** (0.0028)
Ln (mine workers)	-0.0052** (0.0023)	-0.0068*** (0.0028)
Ln (municipal ward employment)	-0.0283*** (0.0068)	-0.0278*** (0.0068)
Ln (municipal ward primary education)	0.0250*** (0.0093)	0.0250*** (0.0093)
Ln (municipal ward secondary education)	-0.0087 (0.0089)	-0.0095 (0.0089)
Municipal ward share of female population	0.5123*** (0.0644)	0.5160*** (0.0642)
Ln (total population per ward)	0.0298*** (0.0050)	0.0295*** (0.0050)
Municipal ward share of access to sanitation	0.0247* (0.0154)	0.0256* (0.0153)
Municipal ward share of access to sewerage	-0.1678*** (0.0312)	-0.1692*** (0.0311)
Municipal ward share of access to electricity	-0.0048 (0.0160)	-0.0056 (0.0159)
Year 2007	-0.0420*** (0.0045)	-0.0433*** (0.0046)
Year 2011	-0.0764*** (0.0087)	-0.0782*** (0.0087)
Measure of activity [#]		
Observations	1445	1445
Number of groups	533	533
R ²	0.5826	0.5990

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.