Productivity at the mine face: Pointing the way forward

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With insights from the MineLens Productivity Index

Ajay Lala
Mukani Moyo
Stefan Rehbach
Richard Sellschop

Productivity at the mine face: Pointing the way forward

Many mine operators could learn from industry leaders that are pursuing productivity-enhancing approaches.

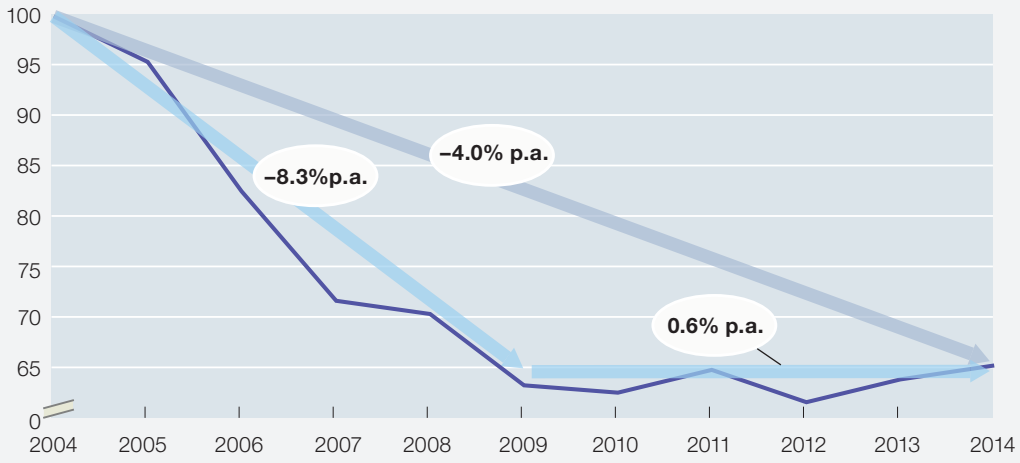
The global mining industry has started to show some signs of life after three dire years. Prices and equity valuations have risen—albeit from low levels—for commodities including copper, gold, iron ore, and zinc. But the industry's fundamentals remain challenged in the short to medium term because of slower demand growth and overcapacity in certain commodities.

As mining-company leaders work to rebuild profitability, improving productivity is high on the agenda. Why does productivity matter so much? It's helpful to go back to basics: "doing more with less" is the foundation of improving performance in mining and leads directly to raising shareholder returns.

So it's clearly good news that the industry in aggregate has stabilized the trend and even marginally improved its productivity from 2012 to year-end 2014, according to McKinsey's latest MineLens Productivity Index (MPI) analysis (Exhibit 1). At the individual mine level, however, the story is more nuanced: some mines are boosting productivity significantly, while others continue to decline. In this article, we look at the different strategies mines are employing, the results, and the steps they can take to further improve productivity.

Exhibit 1 **Mining productivity performance industry-wide has stabilized since 2009 and started to show a small improvement, but is still far below where it was a decade ago.**

MineLens Productivity Index,
indexed to 2004 = 100



Source: McKinsey analysis

The productivity scorecard: A story of leaders and laggards

Over the past year, we've expanded the scope of our research on mining-industry productivity in breadth and depth, increasing the number of mines in the sample and extending the data series to the end of 2014 (see sidebar "The MineLens Productivity Index: What an expanded set of data shows us about mining-productivity trends"). The latest data have established that the industry in aggregate has stabilized its productivity performance since 2009, albeit at a level 30 percent below that of a decade ago.

But looking at the performance of individual mines offers a different and revealing perspective: many mining companies are failing to capture productivity improvements.

Detailed study of a subset[1] of mining companies shows that just under half of that sample were able to improve productivity between 2010 and 2014. Exhibit 2 shows the MPI performance of this subset; mines are ranked alphabetically based on the evolution of their MPI performance over the period. The gains registered by mines A through L were offset by the continuing deteriorating performance of the other companies in the sample.

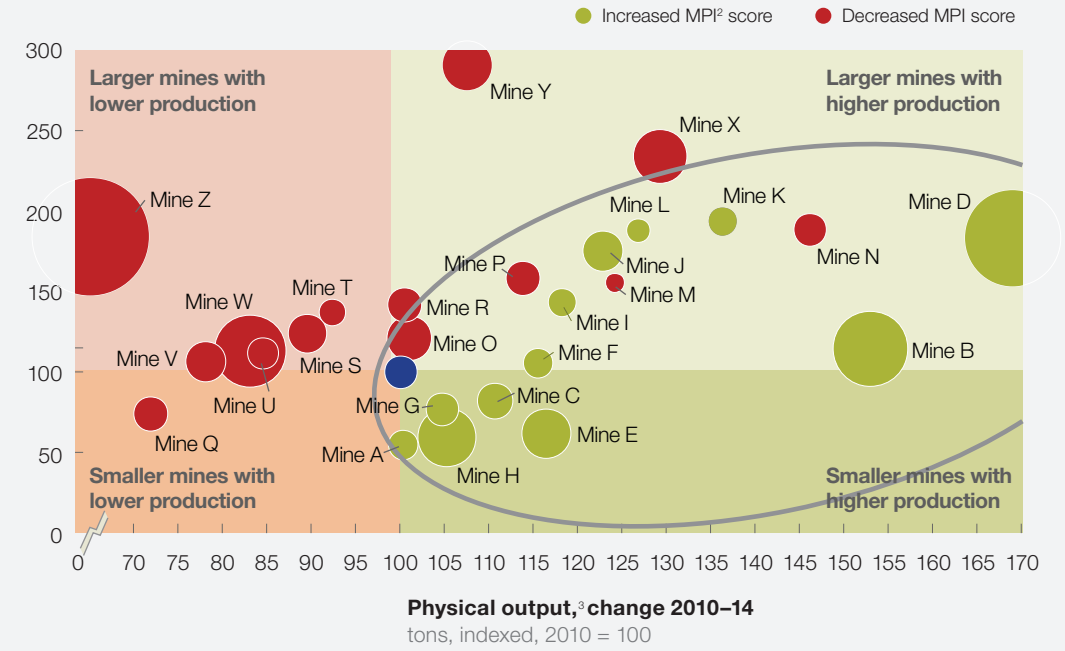
Choosing the right moves: Looking at individual mine performance

Pursuing a higher level of productivity confronts mining-company leaders with many difficult choices.

Exhibit 2 **These 26 mines have seen diverging performance in productivity between 2010 and 2014.**

Source: McKinsey analysis

Exhibit 3 **Mines that have raised output have had greater success improving productivity.**



[1]Value in real 2012 dollars (adjusted for inflation).
[2]MineLens Productivity Index.
[3]Bubble size represents the sum of operating expenditures multiplied by total labor head count, divided by production (measured as physical output); indexed to 2010.

Source: McKinsey analysis

Should a mine reduce its workforce? Should it increase capital spending to improve equipment? Should it increase output at all costs? How will each of these initiatives affect the others? For example, how will reducing the labor force affect output, and how much additional output will a capital-spending program produce?

We used our sample of 26 companies to explore strategies and outcomes. The results of the analysis covering 2010 to 2014 are shown in Exhibit 3. (For an explanation of the methodology used, see sidebar "A mine-by-mine assessment of productivity moves: Interpreting the bubble chart.")

How mines improved productivity

Increasing output makes a major contribution to productivity improvements, but the process has to be managed correctly. The analysis shows that all mines that improved MPI performance also increased

A mine-by-mine assessment of productivity moves: Interpreting the bubble chart

In Exhibit 3, the four quadrants represent the evolution of performance (from a base in 2010), measured by production and asset value. The horizontal axis shows changes in the production volume of each mine site from 2010 to 2014; production in 2010 is indexed as 100. Mines that increased production through 2014 move to the right, while mines where production fell slid to the left. The vertical axis shows changes in asset value, also indexed as 100 in 2010. Those mines that invested capital and increased the value of their assets at the site will have moved up on the chart, while mines where asset values fell move down. The value of mining assets depreciates constantly if investments are not made, and so a decline in asset value is a typical indicator of a mine that is not making capital expenditures.

The bubbles represent individual mines, ranked from A to Z by MPI performance, as shown in Exhibit 2. The color of the bubble captures the overall MPI trend for the mine: mines that raised their MPI performance are green, and mines where performance fell are red. The size of the bubbles is derived from the mines' operating costs and labor head count relative to mine output. Changes in these inputs relative to 2010 levels are shown by changes in the bubble size compared with the dark-blue bubble. These changes are based on calculating the product of the mine's operating costs multiplied by the labor head count and then dividing that figure by production volume. Bubbles that have become larger than the dark-blue bubble indicate that the product of the operating costs and head count have risen faster than output.

production. This correlation may not seem surprising at first glance, given that the most basic definition of productivity improvement implies being able to do more with less. A closer look, however, shows the following approaches at work to improve productivity:

- *Big projects.* The first approach is a classic investment-led strategy, making major capital investments that led to increases in production on such a large scale that they also translated to productivity performance gains. A good example is Mine D, an iron-ore producer which increased output substantially and registered among the highest MPI improvement scores.

- *Steady steps.* Companies that have made modest capital investments have also raised productivity significantly. Mine B, an African copper producer, has delivered a 50 percent output increase with minimal investment, resulting in an MPI performance increase of 30 percent. A number of other mines,

such as the West Asian copper producer Mine I, followed a route to limit capital spending and increase output, and succeeded in improving their MPI performance.

- *Tight fist.* A third approach is to neither make significant investments nor significantly increase production. Companies that took this route instead pursued a path of rigorous cost control and focus on production efficiencies, enabling them to squeeze more output from their existing mine setup or from a smaller asset base. A decline in asset value is a typical indicator of a mine taking this approach, since the value of mining assets depreciates constantly if investments are not made. The Americas copper player Mine C followed this approach, increasing production by 12 percent while its asset value decreased by 15 percent; its MPI score rose by over 25 percent. Similarly, the Americas silver and zinc producer Mine E raised output while its asset value declined, and improved MPI performance by about 15 percent. The African platinum-group-metals (PGM) producer Mine G and the Americas silver producer Mine H also followed this path, and both mines saw MPI improvements of about 10 percent.

  There are two important variants of the tight-fist approach. The first is shown by the Asia–Pacific coal producer Mine F. This mine increased its output by 15 percent while also focusing on controlling and reducing operating expenses and labor costs (indicated by the reduction in its bubble size); its capital-spending-to-asset value remained more or less flat. Through this approach, the mine achieved an MPI improvement of well above 10 percent.

  The second variant is an even tighter focus on spending: squeezing investment, and maintaining, rather than increasing, output, while pushing through higher productivity. Mine A, which registered the highest productivity increase shown in Exhibit 2, took this approach. This Americas copper, lead, and zinc producer maintained its output at a constant level while its net asset value declined significantly; its MPI performance rose by more than 30 percent.

What happened at the mines where MPI performance declined?

During the boom years, there were two major contributors to the decline in the mining industry's productivity: high capital spending and high operating expenses. In the postboom years, capital spending continues to bedevil many companies in the industry, our analysis suggests.

Capital-spending bleed. Poorly applied capital spending appears to have been an important contributor to declining productivity at most of the mines where MPI performance fell. All but one of these mines experienced an increase in their asset value. This is hardly surprising, considering how rapidly capital spending in the mining industry grew during the boom years of 2003 to 2012. For many companies, the heavy outlays have not yet translated to the amount of additional output necessary to improve their productivity scores. For example, the Americas iron-ore miner Mine Y and the African PGM producer Mine X both invested heavily and did raise output. But the output increase was not enough to offset the huge increase in capital spending. These mines saw their MPI score fall 35 percent and 25 percent, respectively.

Shrinking output. Declining production appears to be the second important contributor to declining productivity (there are no green bubbles on the left-hand side of Exhibit 3). Mine V is an Americas gold mine confronting

challenging geological conditions. It saw its production fall over 20 percent despite investments that held up its asset value; its MPI performance fell over 20 percent. The worst performer in Exhibit 2 is the African gold producer Mine Z, which is in the middle of a change in mining strategy. It has invested heavily and added workers, but its output has declined; its MPI performance dropped almost 50 percent.

Roads not yet traveled

Mines might also have to adopt another approach: if production decreases, they can cut costs, labor, and capital to a level where their productivity still increases. We see few mines able to achieve this (there are no green bubbles on the left-hand side of Exhibit 3). Mining's relatively high fixed-cost base means the cuts would have to be deep to lead to higher productivity. Nevertheless, given overcapacity and price declines, many mines may need to consider this course of action.

Exhibit 3 also illustrates that trying to improve all four elements of MPI simultaneously is difficult. Such performance would show up as a smaller green bubble in the lower-right quadrant—and is, as yet, not observed.

First, mining companies find it challenging to execute any of these improvements, let alone four at the same time. Also, let's recall the trade-offs between productivity-improvement levers. For example, running old equipment instead of buying new assets saves capital costs but may result in higher operating costs for maintenance. Similarly, installing autonomous or semiautonomous equipment may reduce labor and other operating costs but requires capital.

How to improve productivity performance

Productivity improvement is challenging, as the discussion above suggests. But miners can take several steps to achieve short-term gains, thus setting their operations on the right course for higher productivity performance in the long run.

Mines should aggressively lower their operating-cost base. As mines following the tight-fist and steady-steps routes are showing, this will require deep and targeted cuts in areas of excess spending. Big areas of opportunity include reducing external spending through smarter procurement and streamlining support functions. One Americas precious-metals producer expanded staffing at its headquarters when profits rose during the boom years. Following an efficiency study, it reduced head-office staffing while maintaining the level and quality of support provided to mining sites and delegating more accountability to sites for some activities.

For mines choosing to take the big-projects route, the way forward on productivity improvement will require holding down capital-expansion cost overruns and minimizing delays in starting new production. The first step is to improve the design and engineering of projects, in particular through scrutiny of project plans to cut waste. Next is rigorous project execution: mines must get the right organizational structure in place to eliminate silos in project teams and impose a disciplined process for monitoring and control of capital projects.

Improving the productivity of their asset base is imperative. This means digging and hauling more dirt with each shovel and truck as well as debottlenecking the downstream logistics chain. For example, one

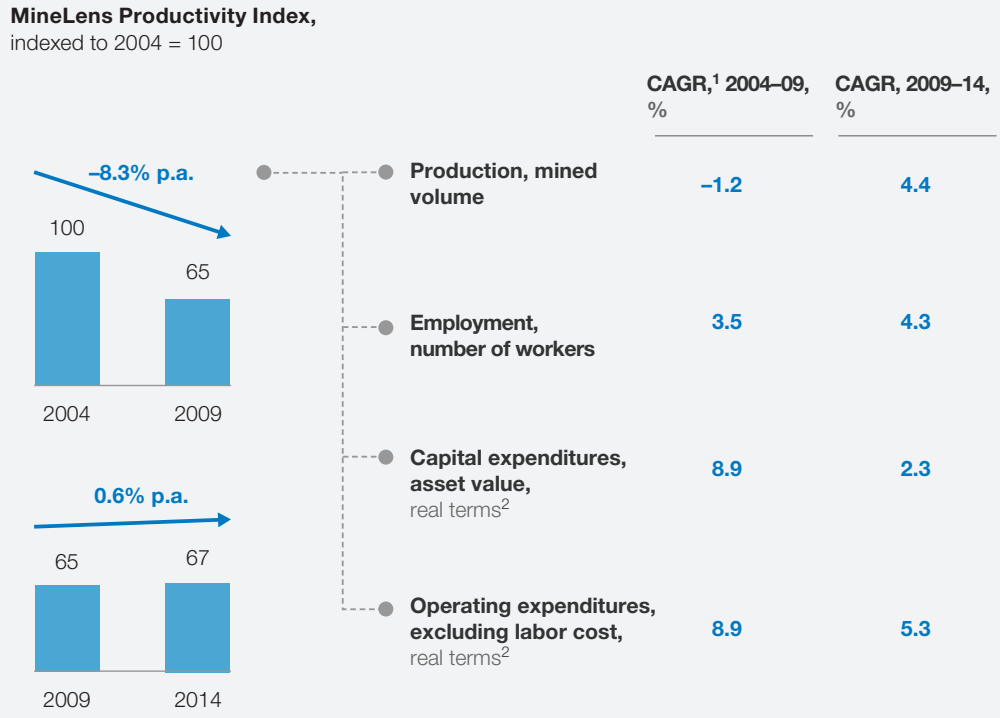
The MineLens Productivity Index: What an expanded set of data shows us about mining-productivity trends

McKinsey has developed the MineLens Productivity Index (MPI) to measure aspects of productivity that operational managers can control.[1]

The basis for MPI is the well-established Cobb-Douglas production function used to measure productivity in national economies. We have adjusted the function so that we can measure productivity in mining operations. MPI comprises four elements: physical mining output, employment at the mine site, the value of assets at the site, and nonlabor costs. Physical mining output is measured as total material moved so that MPI performance is not affected by changes in ore grade, stripping ratio, or commodity prices. Since introducing MPI a year ago, we have enlarged the data series to 94 mines, covering all major mining geographies, commodities, and types of players. The data set runs from 2004 to the end of 2014; for each mine, detailed data have been gathered from publicly available sources.

The extent to which 2009 marks a watershed in industry productivity performance is shown by our expanded data series (Exhibit A). From 2004 to 2009, producers had to quickly increase production to meet demand

Exhibit A **Escalating capital and operating expenditures were the biggest drivers of declining productivity.**



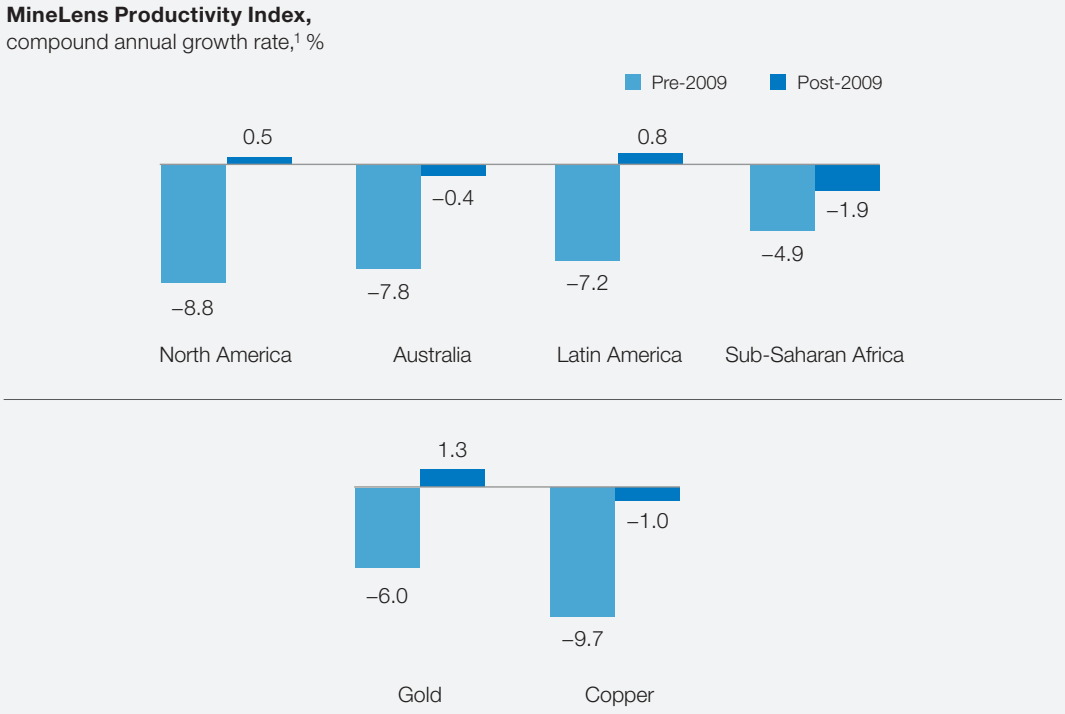
[1]Compound annual growth rate.
[2]Capital and operating expenditures adjusted for mine cost.

Source: McKinsey analysis

growth in a time of rapidly rising prices. Control of operating costs was weak, and much of the production expansion was not efficiently executed. As a result, higher operating costs and capital spending contributed most to the decline in productivity before 2009.

Commodity prices fell sharply in 2009 during the financial crisis and then rebounded; the latest analysis shows clearly that despite the price recovery, there was a major shift in the industry's attitude about productivity. Between 2009 and 2014, operating and labor spending continued to rise, but slower growth in capital spending, combined with expanding output, led to a halt in the productivity decline. Analysis by geography and commodity shows a generally similar pattern (Exhibit B).

Exhibit B **The precipitous decline of the 2000s, followed by flattening productivity, is evident across geographies and commodities.**



[1]For North America, pre-2009 is 2006–09; for Australia, Latin America, sub-Saharan Africa, gold, and copper, it is 2004–09. For all regions and commodities, post-2009 is 2009–14.

Source: McKinsey analysis

[1] See Ajay Lala, Mukani Moyo, Stefan Rehbach, and Richard Sellschop, "Productivity in mining operations: Reversing the downward trend," May 2015, McKinsey.com.

Australian miner was able to substantially increase the overall-equipment-effectiveness performance of its pit-to-port system by improving equipment availability, raising utilization through better planning and scheduling, and accelerating the pace of port loading.

At the same time, mines could continue to address the causes of productivity decline through the following initiatives, as outlined in our previous article[2]:

- *Embed effective management operating systems at mines.* Establishing such systems will create greater transparency on operations performance and identify areas for improvement. The operating systems should also free people and resources to focus on productivity and operational excellence and should support effective performance management. This approach will help resolve what has been a long-standing challenge for many mining companies: making productivity performance (and its measurement) a priority. Operators have typically concentrated on improving one or two variables, such as reducing cost, lowering capital intensity, or increasing throughput.

- *Prioritize operational excellence and capabilities development.* Operational excellence implies a sustained focus on cost reduction and throughput improvement. This will require mining companies to shift away from the traditional approach of making occasional intensive drives for improvement, and instead embed manufacturing-type systems and continuous-improvement approaches in their organizations. This manufacturing-inspired approach focuses on standardized work and the disciplined execution of processes to improve performance over time. Particular target areas include elimination of waste, reducing variability, and improving productivity of assets through advanced reliability and maintenance approaches.

  Improving productivity requires building individual and organizational capabilities. Many mining companies still consider productivity improvement the domain of a continuous-improvement department or a handful of lean experts or Six Sigma black belts, rather than a core competence that should be embraced throughout the organization.

- *Focus on innovation.* Innovation and adoption of breakthrough technologies could also help in the productivity battle, and the mining industry has room to raise its game here. Digitization, in particular, offers several useful approaches.[3] One of the most accessible is to draw insights from the data that mining companies routinely gather and then use them to forecast when a piece of equipment may fail. Estimating the probability of failure of specific components, rather than using a traditional time-based approach for scheduling their replacement, helps reduce maintenance spending and prevents interruptions that affect production.

  At the same time, real-time data and better analytical engines are enhancing scheduling and processing approaches that can help maximize equipment utilization and yields. In the mine pit, combining traditional dispatching with smart algorithms can optimize the efficiency of machine movements. In processing plants, applying new mathematical techniques that look for hidden relationships between second- and third-order variables can improve yields by 3 to 10 percent within months.

Digitization also facilitates increased automation and mechanization. Automated haulage and drilling have now been commercialized, while other technologies, such as automated blasting and shoveling, are in testing, making it possible not only to reduce labor costs but also to reduce the number of people working in the most dangerous areas.

Improving mining productivity is essential to turning around the industry's fortunes. A number of mines have adopted approaches that are offering major productivity performance enhancements, and other mines could benefit from following a similar path. Given overcapacity, volatile prices, and uncertainty about demand, productivity initiatives provide mining companies with the means to regain control of their destiny.

[1] A sample of 26 mines for which it was possible to obtain data covering the 2010–14 period was analyzed in detail. The sample includes mines representing all regions of the world, all major mining commodities, and a range of company sizes.

[2] Ajay Lala, Mukani Moyo, Stefan Rehbach, and Richard Sellschop, "Productivity in mining operations: Reversing the downward trend," May 2015, McKinsey.com.

[3] For a more extensive discussion of how digitization can help mining productivity, see Hugh Durrant-Whyte, Ryan Geraghty, Ferran Pujol, and Richard Sellschop, "How digital innovation can improve mining productivity," November 2015, McKinsey.com.

Ajay Lala is an analyst in McKinsey's Belgian Knowledge Center, **Mukani Moyo** is a senior expert in the Toronto office, **Stefan Rehbach** is a senior expert in the Düsseldorf office, and **Richard Sellschop** is a partner in the Stamford office.

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