# Fool's Gold: The Return on Investment in Global Mining, 1869-1969

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Abstract

In this paper, we study the return on investments in mining for a whole century, starting in the "Golden Age" of resource exploitation in the late nineteenth century. We use a sample of more than 1,000 mining companies, registered on the London Stock Exchange 1869-1969, but operating on all continents of the world. Our results suggest that the return on investments in mining was lower than for a comparable portfolio of all equity on the London Stock Exchange. Our results also suggest substantial differences in return depending on the type of resource mined – with diamond-stocks being particularly lucrative for investors and gold-stocks underperforming in the long run. At the same time, mining was a risky investment, when measured as volatility. Hence, our results fits badly with standard financial market theories of the relationship between risk and return. Instead, a combination of information asymmetries and a recurrent overoptimistic risk-appetite should be sought as potential explanations for investors' decisions and the return on investment in global mining.

## Introduction

Many have sought Eldorado, and the hunt for gold and other precious and base metals have taken explorers all over the world. Although some explorers really struck gold or some other precious metal, and eventually became fabulously rich, many others never did so, but wasted both time and resources in fruitless searches for minerals or other resources that could be mined profitably.

The period from 1870 to 1914 is commonly regarded in economic historiography as a "Golden Age" of resource based development.[1] New mining companies were critical in this period for exploiting the global mining resource frontiers. The mining investment "rush" was driven by the second industrial revolution centered on electrification, and the 1870s monetary reforms that led to the progressive adoption of the Gold standard by a number of important economies. The demand for precious metals such as gold but also for base non-ferrous metals such as copper, lead, tin and zinc increased tremendously after the 1870s and stimulated the exploitation of new mining frontiers all around the world.[2]

Although early domestic mining in Britain may have not required large amounts of capital, following the second Industrial Revolution, developing and operating a mine internationally required large capital investments. The mining sector thereby became intimately connected to the financial sector. Being the global leader for international investments during our period of study, the London Stock Exchange became an important outlet for a majority of these mining ventures. From the latter part of the nineteenth century, mining companies consequently constituted a growing share of the market capitalization on the London stock exchange.[3] Mining was considered an investment of high risk and this fitted well into the London market. Since the late nineteenth century, investments in mining supplemented popular and safer investment objects like government and railway bonds.

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[1] Edward B. Barbier, *Scarcity and Frontiers: How Economies Have Developed Through Natural Resource Exploitation*, Cambridge, 2011.

[2] J.J. Van Helten, "Mining, Share Manias and Speculation: British Investment in Overseas Mining, 1880-1913", in J.J. Van Helten and Y. Cassis (eds.), *Capitalism in a Mature Economy: Financial Institutions, Capital Exports and British Industry, 1870-1939*, England, 1990, chap. 8; R. Declercq, "Red Fever: Natural Resource Companies and the Global Copper Mining Frontier 1890-1939", in S. Joseph (eds.), *Commodity Frontiers and Global Capitalist Expansion: Social, Ecological and Political Implications from the Nineteenth Century to the Present Day, Palgrave Studies in Economic History*, Cham, 2019, p. 215

[3] R. Burt, "The London Mining Exchange 1850-1900", in *Business History*, no. 2, 1972, pp. 124-143.

Many of the mining ventures floated on financial markets during the mining booms of the nineteenth and early twentieth centuries never managed to initiate real mining operations, let alone deliver any returns to its investors. At the same time there were many well-known success stories, where mining companies (often with a mining tycoon as public figure) delivered handsome returns to its investors for shorter or longer periods of time.[4] So while Cecil Rhodes and others made it clear for contemporary market participants that there were riches to be made from recurrent mining booms, how profitable was it really to invest in mining in general? Although there have been studies focusing on particular metals and investments in specific countries, the long run return on investment in a diversified mining portfolio have, so far, remained an open question.

In this study, we study investments in the mining sector using the financial sector as our lens of focus. We estimate the average return on investments in mining for a number of different types of resources mined, starting around the mining booms of the late nineteenth century and early twentieth century. We use data from the London Stock Exchange on mining companies mining for six different resources – copper, gold, silver, tin, lead and diamonds – around the globe. We show that the mining of one resource – diamonds – stand out as particularly profitable investment opportunities over the whole period that we study, while the return on investment in for example gold was remarkably low. Some other resources – most notably copper, silver and tin – were extraordinarily profitable investment opportunities during certain periods, though the long run rate of return over the whole period was also comparatively low. All that glittered was, in essence, not always very profitable to mine.

We conclude, therefore, that our results fits badly with stylized financial market theories of the relationship between risk and return. We argue instead that issues of asymmetric information and the role

[4] C. Harvey and J. Press, "The City and International Mining, 1870-1914", in *Business History*, no. 3, 1990, pp. 98-119.

of recurrent overoptimistic risk-appetite needs to be taken into account in order to explain investors' behavior and the return on investment in global mining during the period under study.

## Theory and previous research

The "Golden Age" of resource based development during the late nineteenth century marked the beginning of what has been termed the second Industrial Revolution. The demand for base metals, precious metals and gems rose steadily during this period and well into the 20th century. Several factors drove this increasing demand. Mineral resources were inputs for new industrial processes, such as electrification driving the global surge in copper demand. Concomitant processes of economic growth and wealth accumulation also raised the demand for precious metals and gems – gold was particularly important in this respect because it was also the backbone of the international payment system. We know from earlier research that the expanding mining market around the turn of the century 1900 also meant that mining stocks gradually were acquiring a more significant position in the portfolios of investors in both London and on stock exchanges throughout the world. Hence, this secular trend of rising demand for minerals during the second industrial revolution begs the question: Did investments in mining stocks in general (and in specific minerals in particular) result in high return on investment? On the face of it, this is what one would expect. However, if the mining sector expanded rapidly enough then of course falling prices could have acted as a countervailing force on the level of return.

There have been a number of studies of the historical rate of return on various portfolios of investments. Classic studies such as the research by Michael Edelstein researched how high the return on foreign investments was relative to the return on domestic investments in Britain.[5] Lance Davis and Robert Huttenback focused their

[5] M. Edelstein, "The Rate of Return to U.K. Home and Foreign Investment, 1870-1913",

similar research more specifically upon comparing the profitability of investments in British colonies with the return on domestic investments in Britain, in order to analyze the political economy of British imperialism.[6] In more recent years, a number of studies have attempted to take an even more global approach, studying the return on investments in various places around the world. Elroy Dimson, Paul Marsh and Mike Staunton for example studied the return on investments during the whole of the twentieth century, in a number of countries around the world.[7] Frans Buelens and Stefaan Marysse used the same methodology to estimate the return on investments in Belgian Congo.[8] Frans Buelens and Ewout Frankema similarly studied the return on investments in the Dutch Indies, current-day Indonesia.[9] Most recently, Klas Rönnbäck and Oskar Broberg have studied the return on British investments in Africa for a century, starting in the late nineteenth century[10] The same authors, together with Stefania Galli, have also studied the return on investments in colonial Malaya.[11] Overall, the research from recent years shows that

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Ph.d. Dissertation, Pennsylvania, 1970; M. Edelstein, "Realized Rates of Return on UK Home and Overseas Portfolio Investment in the Age of High Imperialism", in *Explorations in Economic History*, no. 3, 1976, pp. 283-329; M. Edelstein, *Overseas Investment in the Age of High Imperialism?: The United Kingdom, 1850-1914*, London, 1982.

[6] L. Davis and R. Huttenback, "The Political Economy of British Imperialism: Measures of Benefits and Support", in *The Journal of Economic History*, no. 1, 1982, pp. 119-130; L. Davis and R. Huttenback, *Mammon and the Pursuit of Empire?: The Political Economy of British Imperialism, 1860-1912*, Cambridge, 1986; L. Davis and R. Huttenback, *Mammon and the Pursuit of Empire: The Economics of British Imperialism*, Abridged Edition, Cambridge, 1988.

[7] E. Dimson, P. Marsh, and M. Staunton, *Triumph of the Optimists?: 101 Years of Global Investment Returns*, Princeton, N.J., 2002.

[8] F. Buelens and S. Marysse, "Returns on Investments during the Colonial Era: The Case of the Belgian Congo", in *The Economic History Review*, no 6, 2009, pp. 135-166.

[9] F. Buelens and E. Frankema, "Colonial Adventures in Tropical Agriculture: New Estimates of Returns to Investment in the Netherlands Indies, 1919-1938", in *Cliometrica*, 2015, pp. 1-28.

[10] K. Rönnbäck and O. Broberg, *Capital and Colonialism – the Return on British Investments in Africa 1869-1969*, London, 2019; K. Rönnbäck and O. Broberg, "All That Glitters Is Not Gold: The Return on British Investments in South Africa, 1869-1969", in *Studies in Economics and Econometrics*, no. 2 2018, pp. 61-79.

[11] K. Rönnbäck, O. Broberg, and S. Galli, "A Colonial Cash Cow: The Return on Investments in British Malaya, 1889-1969", in *Cliometrica*, 2021.

the return on investments varied substantially between regions of investment, and over time.

As for studies of the average rate of return on investments in mining, there have been some studies focusing on particular metals and geographic regions such as for instance the work by Frankel on South African Gold mining, Harvey and Taylor on British mining companies in Spain and Burt on British investments in American mining, which have suggested that mining in general may have not been a particularly profitable investment.[12]

What is clear from earlier research is that the average return of a diversified portfolio of mining investments hides large variations within that portfolio. That is to say that although mining investments may have on average yielded a low return, there were many context-specific factors that resulted in large variations within an investment portfolio. The use of inside information via corporate control (founders shares), the use of political and military means to safeguard investments (Boer War), the use of local state power (Rio Tinto in Spain), the use of cartels (diamonds), the use of coercive labour laws (South Africa) are all examples of different events and corporate strategies that have had direct implications on the return of investment for all or some share holders of specific mining companies. Those (few) investors situated in the right type of informational networks had good opportunities in both the short and the long run to extract large fortunes from mining. To our knowledge, there is however only one study which attempts to decompose the analysis of return on investments by studying specific sectors, rather than comparing countries. Klas Rönnbäck and Oskar Broberg dedi-

[12] S. Herbert Frankel, "Return to Capital Invested in the Witwatersrand Gold-Mining Industry, 1887-1932", in *The Economic Journal*, no. 177, 1935, pp. 67-76; S. Herbert Frankel, *Investment and the Return to Equity to Capital in the South African Gold Mining Industry 1887-1965?: An International Comparison*, Oxford, 1967; C. Harvey and P. Taylor, "Mineral Wealth and Economic Development: Foreign Direct Investment in Spain, 1851-1913", in *The Economic History Review*, no. 2, 1987, pp. 185–207; R. Burt, "British Investment in the American Mining Frontier", in *Business and Economic History*, no. 2, 1997, pp. 515-525.

cate one chapter of their book on British overseas investments to a particular study of global mining investments.[13] However, with the exception of the continent of Africa it stops short of analyzing the return on investments in mining by type of resource mined. There are no comprehensive reliable indices of the mining industry stocks that would allow to estimate the relative return on investment between different types of mining activities. To undertake such a study is therefore the aim of the present paper.

One factor that might influence the return on investment is the level of competition in a sector. On the one hand prices have been formed directly by producers' prices and on the other hand by the commodity exchange market prices established at the London Metal Exchange.[14] Cartels have historically been one measure used to create the conditions for monopolistic or oligopolistic market structures on several mining markets. This could have the effect of increasing the rate of return on investment in the sectors involved. Cartels in the mining industry have historically often aimed at manipulating market prices either directly through common agreements among the producers or indirectly through a coordinated curtailing of metals supply. Historically examples of such processes can been traced in the case of copper and tin mining such as for instance the International Copper Cartel (ICC) and the International Tin Committee (ITC), both established in the interwar period, the International Tin Council of the post-war era (established in 1956) and the efforts to establish the international Zinc and Lead Cartel between 1945 and 1975.[15] The literature that has examined these cartelization attempts

[13] K. Rönnbäck and O. Broberg, *Capital and Colonialism - the Return on British Investments in Africa 1869-1969*, chap. 14, London, 2019.

[14] The London Metal Exchange, founded in 1877, was one of the most important commodity exchange markets in the world with copper, tin and lead being some of its key trading commodities. Copper was the first mineral to be traded in the London metal Exchange market while lead and tin started to be effectively traded only after the 1920s (for more on the London Metal Exchange see R. Gibson-Jarvie, *The London Metal Exchange: A Commodity Market*, Cambridge, 1983; R. Wolff, *Wolff's Guide to the London Metal Exchange*, England, 1991).

[15] for some recent examples see J.I. Guzmán, "The International Copper Cartel, 1935-

has been inconclusive as to their effectiveness on price levels in the long run.[16]

When foreign investors consider entering new markets, the expected return is only one side of the coin. The flip side is the anticipated level of risk.[17] We know from existing research that these risks have often been very large, both in the short and in the long run. We also know that the diversity of these risks has forced investors to adopt multi-faceted strategies.[18] Mark Casson and Teresa da Silva Lopes have used a historical approach to identify six different types of risks in overseas investment: unfamiliarity, political, social, business, financial, climactic, and geological risk.[19] We know that building up a long-term successful mining venture in the late 19th and early 20th century entailed all of the uncertainties that Casson and Lopes capture in their categorization of risk. In the present study we analyze empirically financial risk as we believe that from the point of an investor this type of risk encapsulates to a great extend the effects from the remaining five risk-factors.

Hence, we focus in this paper on financial risk and in financial theory the variability of return over time – i.e. volatility – is often used as a key proxy for this. The notion behind this is that riskier, more volatile, investments ought to be compensated by a higher return on investments and the most commonly used measurement for

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1939: The Good Cartel?", in *Mineral Economics*, no. 1, 2018, pp. 113-125; R. Declercq, "Forging Cartels. A Transatlantic Perspective on Business Collusion and the Interwar Copper Industry (1918-1940)", in *Scandinavian Economic History Review*, 2019, pp. 1-18.

[16] C. Schmitz, "The Rise of Big Business in the World Copper Industry 1870-1930", in *The Economic History Review*, no. 3, 1986, pp. 392-410; K. Tsokhas, "The Rise and Decline of an International Zinc and Lead Cartel, 1945-75", in *Australian Economic History Review*, no. 3, 2000, pp. 263-286; J. Hillman, "The Impact of the International Tin Restriction Schemes on the Return to Equity of Tin Mining Companies, 1927-39", in *Business History*, no. 3, 1997, pp. 65-80.

[17] D.A. MacKenzie, *An Engine, Not a Camera?: How Financial Models Shape Markets*, Cambridge, 2006.

[18] K. Rönnbäck and O. Broberg, *Capital and Colonialism - the Return on British Investments in Africa 1869-1969*, London, 2019, p. 143.

[19] M. Casson and T. da Silva Lopes, "Foreign Direct Investment in High-Risk Environments: An Historical Perspective", in *Business History*, 55, no. 3, 2013, pp. 375-404.

this is the standard deviation of returns.[20] Such a relationship between risk and return has, however, been difficult to find support for empirically, and empirical studies have challenged the theoretically positive relationship between stock performance and levels of risk. For instance, the classical study by Fama and French (1992), based on evidence from the US stock market, did not find support for the hypothesized positive relationship between stock returns and volatility levels (as a measure of risk). More recent studies, such as the one from Blitz et al. (2013) focusing on emerging equity markets, have found that the empirical relation between levels of risk and return is either flat or even negative. This stream of research has recently led other scholars to take a step further and describe this consistently observed empirical pattern as a "low-risk anomaly" that reflects market inefficiencies (Baker et al., 2011, 2014).

One way to explain this deviation from standard economic theory is to focus on the bounded rationality of investors, for example through information asymmetries and herding behaviour. As shown by Mishkin an asymmetric information approach can explain volatility patterns in historical data throughout the 20th century and Baskin makes a similar argument for herding behaviour in a historical setting.[21] The underlying logic in both of these historical studies is that participants in financial markets where information dissemination is slow and incomplete makes the assumptions of rational investors incomplete. Information asymmetries lead to misconceptions on the part of the investors regarding the real risk-return relationship. Instead, what emerges are patterns of over-optimism and situations where information asymmetries, rather than well-performing underlying assets, are key to understanding the return on investment.

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[20] E. Dimson, P. Marsh, and M. Staunton, *Triumph of the Optimists?: 101 Years of Global Investment Return*s, Princeton, N.J., 2002, p. 54.

[21] F.S. Mishkin, "Asymmetric Information and Financial Crises: A Historical Perspective", in R.G. Hubbard (eds.), *Financial Markets and Financial Crises*, Chicago, pp. 34-35; J.B. Baskin, "The Development of Corporate Financial Markets in Britain and the United States, 1600-1914: Overcoming Asymmetric Information", in *The Business History Review*, 1988, p. 237.

However, such findings arenot confined to studies examining the distant past, but they continue to be important explanatory factors even today. Recent financial research claims that issues of asymmetric information and herding behaviour are still important explanatory variables in contemporary financial markets.[22]

Our point of departure in this study is that the mining sector was a well-integrated part of the London financial market from the latter half of the 19th century. Therefore, we would argue, investors in mining were of all kinds. We know that short-term speculation (and outright fraud) thrived alongside an increased global demand for metals and long-term investment in actual mining capacity. It is beyond the scope of this paper to study the relative importance of each investors' profile. What earlier research has shown, however, is that historical mining booms were prone to serious issues of asymmetric information, where short-term gains of insiders outweighed the long-term gains of outsiders.[23] One the most illustrative examples is the development of the largest gold mining company around the turn of the century, the Rand Mines Limited. The outside investor received an average return of merely 1 per cent, between its IPO in 1895 and the First World War. At the same public figures like Cecil Rhodes or Alfred Beit made fortunes on their respective interests in the Rand Mines (and connected companies). These insider profits could be made from a multitude of financial instruments and techniques – such as founders' shares, vendor's interests and the specific timing of the IPO. However, the stories widely distributed

[22] T.C. Chiang and D. Zheng, "An Empirical Analysis of Herd Behavior in Global Stock Markets", *Journal of Banking & Finance*, no. 8, 2010, pp. 1911-1921; S. Bekiros et al., "Herding Behavior, Market Sentiment and Volatility: Will the Bubble Resume?", in *The North American Journal of Economics and Finance*, 42, 2017, pp. 107-131.

[23] Helten, "Mining, Share Manias and Speculation: British Investment in Overseas Mining, 1880-1913", pp. 163-168; L. Hannah, "Pioneering Modern Corporate Governance: A View from London in 1900", in *Enterprise and Society*, no. 3, 2007, pp. 23-24; R. Dumett, *Mining Tycoons in the Age of Empire, 1870-1945?: Entrepreneurship, High Finance, Politics and Territorial Expansion*, Farnham, 2009, pp. 17-18; K. Rönnbäck and O. Broberg, "The Crumble in the Jungle: The London Financial Press and the Boom-and-Bust Cycles of the Ashanti Goldfields Corporation, 1895-1914", in *Enterprise & Society*, 2020, pp. 1-27.

to the investing public through the press was more often as narratives on the wealth created by global mining and more seldom as problems of asymmetric information.[24]

The most important strategy to handle risk is to diversify the portfolio and to include assets which are not highly correlated in terms of valuation. Though risk diversification was not formally modelled in financial theory until the 1950s and 1960s, economic historians have shown that diversification was used by investors in varying degree long before.[25] Investing in mining might thus to some extent have attracted particularly risk-prone investors. Other investors might, however, have been invested in mining to broaden their portfolios in order to diversify the risk.

## Materials and Methods

In this article, we are interested in the total return on investment in mining from the perspective of the financial investor. We measure the return by combining the capital gains/losses due to changing share prices and the dividends paid out to shareholders. This method has in recent years become standard in the studies of financial history, and applied in a number of different settings.[26] The total return on investment is thus an estimate of how profitable it was to invest in a particular company (or, if aggregated, for example in a portfolio of companies, such as all companies operating in a certain sector or

[24] K. Rönnbäck and O. Broberg, *Capital and Colonialism - the Return on British Investments in Africa 1869-1969*, London, 2019, pp. 306-307.
[25] See for example J. Rutterford and J. Maltby, "'The Nesting Instinct': Women and Investment Risk in a Historical Context", in *Accounting History*, no. 3, 2007, pp. 305-327; A.M. Carlos, E. Fletcher, and L. Neal, "Share Portfolios in the Early Years of Financial Capitalism: London, 1690-1730", in *The Economic History Review*, no. 2, 2015, pp. 574-599; D. P. Sotiropoulos and J. Rutterford, "Individual Investors and Portfolio Diversification in Late Victorian Britain: How Diversified Were Victorian Financial Portfolios?", in *The Journal of Economic History*, no. 2, 2018, pp. 435-471.
[26] Dimson, Marsh, and Staunton, *Triumph of the Optimists*; Buelens and Marysse, "Returns on Investments during the Colonial Era"; Rönnbäck and Broberg, *Capital and Colonialism - the Return on British Investments in Africa 1869-1969*.

country of operation) for an average investor on the stock market. Whether the estimated return on investment that an investor experienced was a good proxy for the economic performance of the ventures underlying the financial assets will not be in focus in this study.

The study will be based on the return on investments in stocks of publicly traded companies mining copper, gold, silver, tin, lead and diamonds. As mining companies in general required substantial capital investments, most of the major companies were undoubtedly turning towards stock markets for capital and there is no reason to suspect a bias across the different mining activities and the number of companies that were raising capital publicly. This study will furthermore be limited to mining companies registered on the London Stock Exchange during the period 1869 to 1969.

As a consequence of this research design, the sample does not capture investments in all mining companies operating around the world during the period under study. Firstly, during the twentieth century, a number of state-owned mining companies, such as the Norilsk Combine in the USSR, were started.[27] Such state-owned companies were not necessarily traded on any stock exchange. Secondly, some companies might have been wholly-owned subsidiaries of other companies, or privately held mining companies that were not registered on a stock exchange either. Thirdly, some mining companies were simply not registered on the London Stock Exchange. During the nineteenth century, London was certainly the unrivalled center of the global financial markets. By the early twentieth century, London experienced competition from several new competing financial centers, most importantly New York. London did nonetheless remain a most important center for world finance throughout the period under study.[28] Previous research has also shown that

[27] V.V. Strishkov, *The Copper Industry of the U.S.S.R.: Problems, Issues, and Outlook*, U.S. Department of the Interior, Bureau of Mines, 1984.
[28] R.C. Michie, *The London Stock Exchange?: A History*, Oxford, 2001; M. Flandreau and F. Zumer, *The Making of Global Finance 1880-1913*, Paris, 2004; R.C. Michie, *The Global Securities Market a History*, Oxford, 2006; Y. Cassis, *Capitals of Capital?: The Rise and Fall of International Financial Centres, 1780-2009*, Cambridge, 2010.

there was a comparatively high degree of integration between the financial markets for listings that operated internationally already during the nineteenth century.[29]

In order to estimate the total return, we need information on the price of the shares, and on dividends paid out to the shareholders. The historical prices of stocks listed on the London Stock Exchange can be gathered from the Investors' Monthly Manual (IMM), a source that has been exploited in much previous research.[30] The source began publication in 1864, and was one of the most important channels of information for investors in London from this time onward. Originally, it covered more or less all companies operating on the London Stock Exchange, but as the number of companies listed on the London Stock Exchange increased, the IMM's coverage gradually decreased to only include the major companies because of the page constraints of the publication.[31] The data from this source has since been collected by Global Financial Data (GFD) in digital form. GFD has further complemented the data from IMM with similar primary data from *The Times* of London. For this article, we have acquired data from the GFD on all mining companies listed on the London Stock Exchange, and included in either of these primary sources, during the period under study. The selection does not include iron- or coal-mining companies, as these were categorized in the IMM under another heading (together with companies operating furnaces and similar ventures). Both common and preferred stocks have been included in the sample, but the common stocks clearly

[29] G. Campbell and M. Rogers, "Integration between the London and New York Stock Exchanges, 1825-1925", *The Economic History Review*, no. 4, 2017, pp. 1185-1218.
[30] Edelstein, "The Rate of Return to U.K. Home and Foreign Investment, 1870-1913"; Edelstein, "Realized Rates of Return on UK Home and Overseas Portfolio Investment in the Age of High Imperialism"; Edelstein, *Overseas Investment in the Age of High Imperialism*; B.R. Chabot and C.J. Kurz, "That's Where the Money Was: Foreign Bias and English Investment Abroad, 1866-1907", in *The Economic Journal*, no. 547, 2010, pp. 1056-1079; O. Jordà et al., "The Rate of Return on Everything, 1870-2015", Federal Reserve Bank of San Fransisco Working Paper 2017-25, San Fransisco, 2017.
[31] L. Hannah, "The London Stock Exchange, 1869-1929: New Statistics for Old?", in *Economic History Review*, no. 4, 2018, pp. 1349-1356.

dominate both in terms of number and in terms of market capitalization.

In order to test the reliability of GFD's data, the authors of this paper have assembled the corresponding data directly from primary sources, for three different sub-samples drawn from the data from GFD: all share price observations for one of the largest and longest-standing companies in the sample (DeBeers Consolidated); a random selection of share price observations for another company in the sample (British South Africa Company); and a smaller random selection of observations from among all the companies in the sample. In all three of these sub-samples, the correlation between the data on share prices gathered from GFD:s database and the data gathered directly by us from the primary sources was higher than 99 per cent. We are therefore confident that GFD:s dataset is reliable enough for our purposes on this variable. GFD's data on other necessary variables, including the number of shares of the companies, and the dividends paid out, is in contrast unreliable.[32] For this paper, the data on these variables have therefore been assembled directly from the primary source, the London Stock Exchange Yearbooks.

The London Stock Exchange Yearbooks – in combination with a search of scholarly articles, historical websites (museums, local historical associations) and contemporary press (Financial Times and The Economist) – have also been consulted in order to categorize the mining ventures according to what type of resources that they primarily were mining (see table 1). For simplicity, we have here categorized them according to what is described as the main resource mined. In many cases, this is very straightforward, as the venture primarily will be dependent upon one type of resource, such as gold, copper or diamonds. In some cases, however, several resources were mined in a single mine, so that a company might extract for example both silver, lead and zinc from the same mine. In other cases, a company might own and operate several different mines, on occasion in

[32] Rönnbäck and Broberg, *Capital and Colonialism - the Return on British Investments in Africa 1869-1969*, chap. 5.

different parts of the world. We have in such cases attempted to make a qualitative judgement concerning the main mineral/metal mined. In some cases, it was however not possible to do so with any reasonable degree of certainty. These companies (included the category of "Other" companies in table 1 together with some companies focusing on some other, specific metals or minerals) have henceforth been left out of the analysis.

Table 1 also summarizes the number of companies, and company-months observations, of our sample. As can be seen, the sample is dominated by companies operating in Africa – and then most importantly in South Africa. More than half of the ventures in the sample were also primarily described as primarily mining for gold.

**Table 1**
Description of the sample of companies

| | Companies | Company-month observations |
|---|---|---|
| *Total* | *1,034* | *178,243* |
| *By continent* | | |
| Africa | 518 | 98,684 |
| Asia | 88 | 18,093 |
| Europe | 144 | 22,541 |
| South America | 59 | 8,677 |
| North America | 84 | 9,492 |
| Oceania | 141 | 20,756 |
| *By resource mined* | | |
| Copper | 118 | 20,245 |
| Diamonds | 34 | 5,581 |
| Gold | 583 | 102,298 |
| Lead | 42 | 5,994 |
| Silver | 46 | 8,179 |
| Tin | 117 | 18,648 |
| Other | 94 | 17,298 |

Source: Global Mining Equities Database, see Rönnbäck & Broberg 2019, chapter 14.

Note: "Other" resources include asbestos, manganese, nickel, platinum, zinc and some other minor resources, as well as some companies with mixed activities that we were unable to classify with any certainty.

It is important to note that the uneven geographical and sectoral distribution of the sample most probably does not constitute a bias in the sample, but is representative of the sectors and regions that London investors favored investing in, due to the even geographical nature of economically viable resources to mine.

There is quite some attrition of the sample, so that only a smaller number of the companies are still in operation at the end of the period under study. The attrition is due to a number of factors, including most importantly mergers and acquisitions, but also bankruptcies or companies winding down their operations and repaying the capital invested.

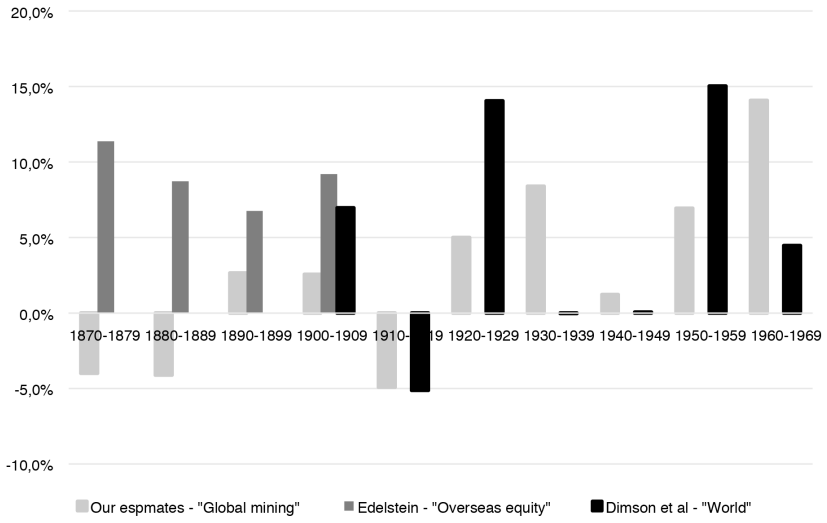
The share-price data is at least available on a monthly basis, allowing us to calculate a month-by-month return on investments. We thus calculate the return on investment by month for each individual company in the sample. The monthly return on investments are then aggregated into different portfolios, by country, continent or by resource mined, weighted by the market capitalization of each venture (the number of shares times the prevailing market price of a single share) in the previous month. The most important ventures in terms of their market capitalization are thereby having the largest influence on our estimated return on investments in portfolios of investments. The annualized nominal return on investment have then been used for estimates of the real rate of return, using data on historical inflation in Britain.[33]

## Results

Figure 1 shows our estimates for the return on investments in mining globally during the period under study, and puts this into comparison with estimates from previous research on the return on investments in other portfolios of equity. We have here only included

[33] J. O'Donoghue, L. Goulding, and G. Allen, "Consumer Price Inflation Since 1750", in *Economic Trends*, No. 604, 2004.

**Figure 1**
**Return on investments in mining in comparison with the return on investments in other portfolios of equity, decadal averages, 1869-1969**




Sources: for our estimates, see table 1; other data from Dimson et al 2002; Edelstein 1970; 1976; 1982.

data from the studies that match our methodological approach the closest, i.e. the studies by Dimson et al, and by Edelstein.[34] As Dimson et al's data only is reported by decade, we have here aggregated our data in the same way to enable a comparison. As can be seen in the figure, our estimates for the return on investments in mining is quite substantially lower than the Edelstein's estimates for the return on all equity traded on the London Stock Exchange. This was particularly the case during the first two decades when the data can be compared, the 1870s and the 1880s: at this time, the difference between the two portfolios was more than ten percentage points. Comparing our results to the estimates of Dimson et al, the results suggest that the estimates are much more closely correlated in total:

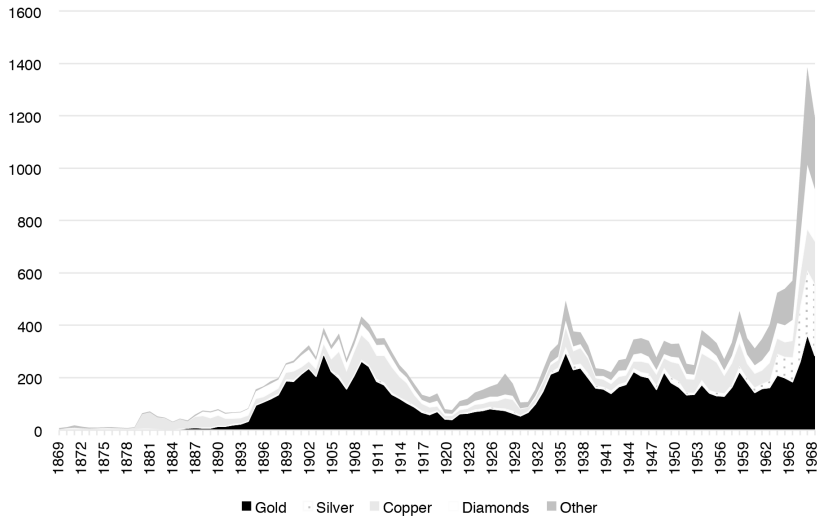
[34] see Rönnbäck and Broberg, *Capital and Colonialism - the Return on British Investments in Africa 1869-1969,* chap. 4 for a discussion of methodological problems in several previous studies in the field.

the average for the whole period (1900-1969) in their "World"-portfolio of equity was 4.8 per cent per year. The corresponding figure for our sample of global mining companies was 4.6 per cent per year during the same period. In total, our results suggest that investing in mining stocks does not seem to have been particularly profitable compared to other alternatives.

There were, however, huge differences between the different resources that were mined. Figure 2 shows how market capitalization of the companies in our sample changed over time in terms of resources mined. This sheds light on what resources London investors primarily were interested in investing in.

During the first decades of our study, investments in mining for base metals such as lead or tin are important in our sample in terms of the market capitalization of the companies involved. Copper is

**Figure 2**
Market capitalization of global mining ventures listed on the London Stock Exchange, by main resource mined, 1869-1969 (£ million, 1868 constant prices)




Sources: see table 1.
Note: the category of "Other" in this figure includes all resources listed in table 1 other than gold, silver, copper or diamonds (including ventures where the resource mined is unknown).

from an early date also an important target for investors. These developments in lead, tin and copper mining capitalization reflected the rising demand for such base non-ferrous metals triggered by the second wave of industrialization during the late nineteenth century. Following the diamond- and gold rushes in South Africa, which came to attract British investors primarily from the 1880s, the market capitalization of ventures mining for these resources also increased drastically. Gold then continue to dominate our sample for most of the remaining period of the study.

Table 2 shows that average (geometric mean) annual real return of investments in portfolios based on the different types of resources mined over the whole period for which we have data, as well as broken down by different sub-periods: before the First World War, the interwar period (including the years of war), and the post-war period. In parenthesis is the standard deviation of returns, i.e. volatility.

**Table 2**
Annual return on investments in different portfolios of global mining companies, 1869-1969

| Main resource mined | Pre-World War I (1869-1913) | World Wars and interwar period (1914-1945) | Post-war period (1946-1969) | Whole period (1869-1969) |
|---|---|---|---|---|
| Diamonds | +8.7 | +3.2 | +19.5 | +9.5 |
| | (35.3) | (34.7) | (33.2) | (35.1) |
| Gold | -2.4 | +5.9 | +2.2 | +1.3 |
| | (25.8) | (21.8) | (22.5) | (24.0) |
| Silver | -7.3 | +2.6 | +16.6 | +1.1 |
| | (35.6) | (28.3) | (32.0) | (33.7) |
| Copper | +2.4 | -4.8 | +17.0 | +3.3 |
| | (31.9) | (33.2) | (36.8) | (34.3) |
| Lead | -8.3 | -0.4 | +1.4 | -3.6 |
| | (24.7) | (92.9) | (53.0) | (62.2) |
| Tin | -3.6 | +1.5 | +12.4 | +1.6 |
| | (37.8) | (31.2) | (23.9) | (33.3) |
| All mining | -1.0 | +3.8 | +8.3 | +2.7 |
| | (18.6) | (21.7) | (23.8) | (21.3) |

Sources: see table 1.
Real return per cent per year, geometric mean with standard deviation of return in parenthesis.

The average return on investment in a portfolio of mining stocks was thus comparatively low, as was shown in figure 1, at least compared to what an investor on the London Stock Exchange could earn from investing in other portfolios. This is to a large extent the result of low – even negative in real terms – return on investment before the First World War, paradoxically during a period when resource based development and mining worldwide was booming. Once the mining sector became more mature, however, the average return on a diversified mining portfolio investment does seem to have converged toward the return on other comparable investment opportunities.

In terms of risk and return, however, the pattern is not as straightforward as suggested by standard financial theory. Our results do represent the mirror-image of what (Baker et al. 2018a, 2018b) have recently described as a "low-risk anomaly". The risks were high for all types of mining operations shown in table 2, especially during the mining booms in the late nineteenth and early twentieth century; as a point of comparison, long-term volatility for mature financial markets during the 20th century was around 20 per cent.[35] To the extent that mining was, and continued to be, associated with a comparatively high degree of risk and uncertainty (or at least often was perceived that way), little or no compensation for this risk was forthcoming to the investors. This lack of a positive association between risk and compensation is also evident by looking at volatility and return on investment levels across the various mining sectors. It is noteworthy, for instance, that lead mining which demonstrated the highest volatility over the whole period had a strikingly negative real return on investment.

The most profitable investment portfolio over the whole period were the companies operating diamonds mines, with an average real return of 9.5 per cent per year for a whole century. Volatility in diamond shares were, at the same time, comparatively high – and

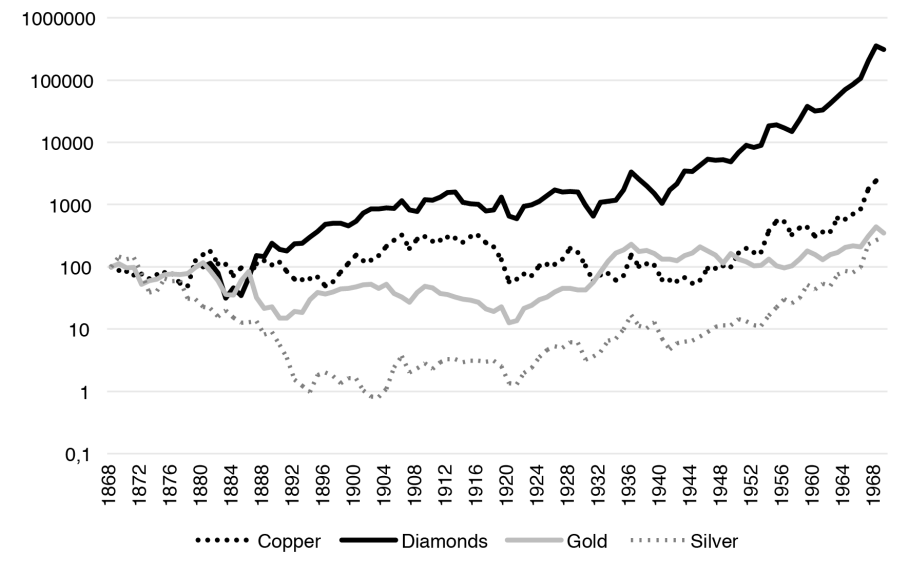
[35] Dimson, Marsh, and Staunton, *Triumph of the Optimists*, 60.

higher than the average for the London Stock Exchange – so the high return for this particular sector could to some extent be associated with this elevated market risk. But most importantly, the high return for diamonds was undoubtedly associated with the market structure of the global diamond industry. The development of investments in diamond mining was strong in the late nineteenth and early twentieth century, as is shown in greater detail in figure 3: from 1885 to 1913, the average real return on investments in mining was 8.7 per cent per year. The key player in the industry from its establishment in 1889 onwards was DeBeers Consolidated. Even though DeBeers attempted to acquire a monopoly position on the market, it never managed to do so since new-comers kept being established. In the 1890s, when DeBeers Consolidated just had been established, one key competitor was the Griqualand West Diamond Mining company. From the early twentieth century, and into the mid-1920s, Premier Diamond Mine became an important competitor. From this time, until the 1940s, Consolidated Diamond Mines of South-West Africa (largely controlled by The Anglo-American Corporation) was another competitor. From the 1940s, finally, the Selection Trust and its diamond-mining subsidiaries (including the Consolidated African Selection Trust) was yet another rival to DeBeers position. Noteworthy is that all of these companies based their diamond-mining operations in Africa. As DeBeers failed to acquire a monopoly on the mining of diamonds, the alternative was to attempt to cartel for the wholesale buying and the retailing of the diamonds mined. As is well-known from previous research, this was first attempted via the London Diamond Syndicate, but eventually led to the establishment of the Central Selling Organization.[36] The Anglo-American Corporation, controlling some of the competitors, would initially choose to not participate in this diamond cartel, but would aggressively compete with DeBeers Consolidated until Anglo-American

[36] C. Newbury, "The Origins and Function of the London Diamond Syndicate, 1889-1914", in *Business History*, no. 1, 1987, pp. 5-26; C. Newbury, *The Diamond Ring?: Business, Politics and Precious Stones in South Africa, 1867-1947*, Oxford, 1989.

managed to acquire a controlling interest in DeBeers. These events are seemingly also reflected in the return on investments in diamond-mining during this period, as the interwar period exhibit, for the sector, comparatively low average real return on investments of only 3.2 per cent per year. During the post-war period, the cartel had effectively been resumed, and only occasionally did the new competitor (Selection Trust) try to challenge the cartel agreements. The post-war period would therefore exhibit an enormously profitable period for investments in diamond mining, with an average real return on investments from 1946 to 1969 of 19.5 per cent per year. The fact that the market for diamonds largely was operated under a comparatively successful cartel throughout much of the period undoubtedly explains the very high average rate of return on investment to a very large extent.

**Figure 3**
Accumulated total return on investments in companies mining for diamonds and precious metals, 1869-1969 (index, 1868 = 100, logarithmic scale)




Sources: see table 1.

Investors in gold experienced moderate volatility and low return on investment. Gold-mining companies dominate our sample for most of the period under study, but they exhibit comparatively low return on investment, only 1.3 per cent per year in real terms on average. Many of the investments undertaken in the 1880s, for example in Witwatersrand in South Africa, seem to have incurred great losses for the investors, as can be seen in figure 3, with the index of total return on investments in gold-mining declining by 85 per cent. After this, gold mining experienced a shorter period of positive returns, followed by renewed losses in the early twentieth century. Only during the 1920s and 1930s – particularly following the abandoning of the Gold Standard in the early 1930s did gold-mining really turn highly profitable, but only for a short while. In total, many of the investors in gold-mining ventures would thus have profited more from investing elsewhere than in this portfolio, suggesting that the hunt for Eldorado, and all the investments that went into this hunt, led to substantial overinvestments in this particular portfolio.[37] One hypothetical interpretation of these figures is that gold-mining firstly suffered from the government-regulated price under the Gold Standard. Once these regulations were lifted, the return on investment increased somewhat. A second reason for the low return on gold-mining investments might be that this sector, in contrast to diamond-mining, faced much greater competition between the actors, potentially overcrowding the market. Even when the price of gold was left to the market, the large number of competing gold-mining companies – in several different parts of the world – might have put a downward-pressure on the price of the output, such that only the most productive gold-mines could turn profitable.

Silver-mining experienced an even more drastic slump during the first decades under study, followed by a long, substantial recovery and later boom, as can be seen in figure 3. During the early decades of the period under study in this paper, the investors in sev-

[37] Similar to the results in Rönnbäck and Broberg, "All That Glitters Is Not Gold: The Return on British Investments in South Africa, 1869-1969".

eral of the silver-mining companies – many of them operating in the Americas – thus experienced great losses. Virtually all of the early investments in silver-mining thus lost their value almost completely. This begs the question of why investors kept investing in silver-mining, even though the prospects at this time must have seen bleak. We believe the reason is to be found in the great uncertainties involved in mining, and what we have called the Klondike-mentality: the hope, many times despite substantial setbacks, of eventually striking it rich. One of the most important silver-mining ventures was, for example, the Emma Silver Mining Company, which operated silver mines in Utah in the United States, but soon came to experience major setbacks and eventually had to cease operations.[38] When the company was introduced on the London Stock Exchange, it accounted for more than half of the market capitalization of silver-mining companies listed in London. The losses that this particular company experienced would therefore weigh heavily in the silver-mining portfolio of companies. The hope of finding a rich vein of silver-bearing ore at Emma Hill did, however, take more than two decades to completely dissipate.[39] In the meanwhile, some investors held on to their shares, even when the company started to exhibit losses, in the vain hope that their luck might change to the better.

The average return on silver-mining investments for the period from 1869 to 1913 on average was thus a remarkable -7.3 per cent per year. In total, the portfolio index of accumulated total return on investment decreased by 99 per cent from 1869 to the early twentieth century. Once several of these loss-making companies had ceased operations (and therefore disappear from our sample), silver-mining did, however, turn into a highly profitable investment. In the period after the Second World War, in particular, investments in silver-mining were highly profitable, with an average real return on invest-

[38] Rönnbäck and Broberg, *Capital and Colonialism - the Return on British Investments in Africa 1869-1969*, pp. 360-361.
[39] C. Spence, *British Investments and the American Mining Frontier, 1860-1901*, London, 2000, pp. 180-181.

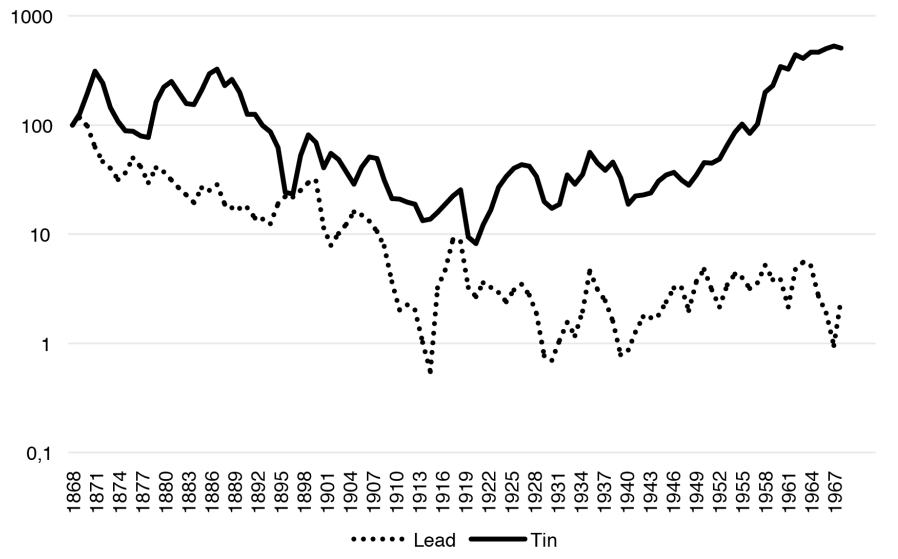
ments of 16.6 per cent per year. The Klondike-mentality eventually paid off.

Global copper-mining was – after diamonds – the second-best investment opportunity in global mining over the whole period studied, with an average real return on investment over the period of study of 3.3 per cent per year (figure 3). The world-wide electrification process that intensified after the 1890s meant that new copper frontiers were sought after. After 1900 new mining technologies became instrumental for the exploitation of lower grade copper mines and marked what has been termed as the "second generation" of copper mining.[40] Investments in copper mining were during this time to a large extent heading to European ventures, most importantly the Rio Tinto Ltd company, and from the early 1900s also several ventures in the United States, including some of the world-leading copper producers at the time, such as the Anaconda Copper, Amalgamated Copper or Utah Copper companies.[41] Several of the latter were, however, eventually delisted from the London Stock Exchange, not necessarily because they were unprofitable but in many cases because they were amalgamated with or taken over by other companies in the sector. London investors in copper did, in turn, have to find new ventures to invest their capital in. That new region was Africa. From the 1920s, onwards, investments channeled via the London Stock Exchange into global copper mining was increasingly targeting mining ventures in Africa, most importantly in a couple of companies operating in the Copperbelt in current-day Zambia (including Rhodesian Anglo-American, Rhodesian Selection Trust and the Rhokana Corporation) and Tanganyika Concessions, a major investor in UMHK operating in neighbouring Katanga in Belgian Congo.[42] By the end of the 1920s, Belgian Congo produced

[40] Declercq, "Red Fever".
[41] Rönnbäck and Broberg, *Capital and Colonialism - the Return on British Investments in Africa 1869-1969*, chap. 14; Declercq, "Red Fever".
[42] Rönnbäck and Broberg, *Capital and Colonialism - the Return on British Investments in Africa 1869-1969*, chap. 10.

5.7% of the world copper production. Northern Rhodesia set off somewhat later, but claimed a global market share of 9.4% on average between 1930 and 1939.[43] It did, however, take some time before these new mining ventures started to become really profitable for the investors. It was thus only in the post-war period that the return on British investments in copper-mining would really become profitable. By this time, however, the return was on the other hand extraordinarily high, with a real average return of 17.0 per cent per year from 1946 to the end of the 1960s. The comparatively rich copper findings in the Copperbelt, in combination with the low labour costs in no small part attributable to the colonial institutions imposed in the colonies, would seem to be important components in explaining the extraordinarily high post-war return on London investments in copper mining.

**FIGURE 4**
Accumulated total return on investments in companies mining for lead and tin, 1869-1969 (index, 1868 = 100, logarithmic scale)




Sources: see table 1.

[43] Declercq, "Red Fever", p. 215.

Investments in the mining of base metals were on average considerably less profitable for the investors, as can be seen in figure 4. The mining of lead, initially to a large extent dominated by European mines, experienced two drastic periods of collapse: one in the 1870s, and another in the decade prior to the First World War. After this, investments never really recovered, leading to a negative average return on investments of -3.6 per cent per year. Specifically the lead mining industry in the UK marked a significant saturation during the pre-World World I period. Since 1865 domestic lead mining in the UK had started to decline while by 1885 the domestic lead mining industry had more than halved.[44] The demand for lead was thus satisfied by increasing lead imports which from the 1870s until the First World War increased by almost four times. The portfolio of lead-mining companies also suffered from the highest volatility of all the sectors studied in this paper, particularly during its protracted demise with low/negative return on investment. The investors in this sector would thus have faced both very high risk and a negative return on investment. Unsurprisingly, there were very only a handful new lead-mining ventures successfully floated on the London Stock Exchange after the turn of the century.

Tin-mining shifted geographically from Europe to Asia, most importantly current-day Malaysia (and later also partly to Nigeria in West Africa). The tin-mining industry performed much better than the lead-mining industry did, but was with an average total return on investments of 1.6 per cent per year nonetheless in total a worse investments opportunity than many other alternatives would have been. Like silver-mining, tin-mining would however experience very different trends over time: in the case of tin-mining, investors faced major losses from the 1890s to the years just after the end of the First World War. It was mainly from the 1920s onwards that global tin demand expanded significantly stimulating a short-

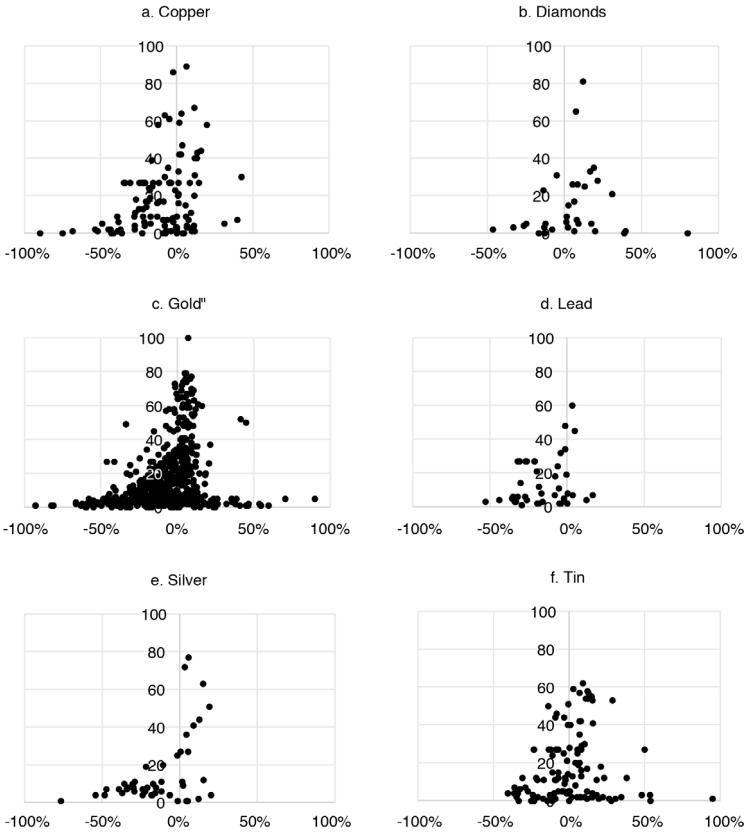
[44] C.G. Flynn, "The Decline and End of the Lead Mining Industry in the Northern Pennines 1865-1914: A Socio-Economic Comparison between Wensleydale, Swaledale and Teesdale", Durham, 1999, http://etheses.dur.ac.uk/4569/.

age of supply and a fuzz on an "impending tin famine".[45] The period after the Second World War saw the tin-mining industry booming, with an average real return on investments of 12.4 per cent per year, as strategic demand for tin continued, to a large extent driven by the United States' involvement in the Korean War, and its continued stockpiling of tin well after the war. This eventually became favorable not the least for investors in the Malayan tin-mining industry.[46]

A certain rationality of the Klondike-mentality can be shown in our quantitative figures. In figures 5a-f the average annual return on investments and longevity of the individual mining companies in our sample is presented, by sector. It becomes evident that for the mining sector as a whole, a company's return on investment and its longevity are associated. Most of the companies exhibiting negative average return on investments are short-lived. This is in itself unsurprising: companies that failed to make any positive return for years would eventually be wound up or acquired. The majority of companies that survived for a certain period of time therefore exhibited a positive return on average. The pattern is clearly evident in gold-, diamond-, silver- and copper mining and to a lesser extent also in tin- and lead mining. A closer look on the performance of the companies does, however, reveal a more important differences between the mining sectors: as shown in figures 5b, c and f, in the cases of diamond, gold and tin mining, some companies had an outstanding performance with an average annual return on investment of more than 50 per cent. In all these three sectors, there are also a number of outliers exhibiting a return on investment of more than 100 per cent for one or at most two years (not shown in figures, as these have been truncated at +100%), before they disappear from our sample. This performance was in the particular case of diamonds also combined with an exceptionally low failure rate, i.e. companies that

[45] Hillman, "The Impact of the International Tin Restriction Schemes on the Return to Equity of Tin Mining Companies, 1927-39".
[46] Rönnbäck, Broberg, and Galli, "A Colonial Cash Cow: The Return on Investments in British Malaya, 1889-1969".

**Figure 5a-f**
Average annual nominal return on investments (per cent per year, geometric mean) and longevity (years) of mining companies globally, by sector, 1869-1969




Note: Average return on investment (per cent per year) on x-axis. Longevity (years) on y-axis. A handful of extreme outliers (all exhibiting a return on investment exceeding 100 per cent, but only stay in the sample for one year) have been excluded from the figures.

Source: see table 1.

demonstrated a negative return on investment in the long run, explaining the comparatively high return on average in the sector.

The extraordinary performance of a select number of companies in diamonds, gold and tin, may not have had any large impact upon the average return of a market-capitalization weighted portfolio of investments in the sector, as these companies as a rule were compar-

atively small and quickly disappear from our sample – presumably taken over by or merged with some other company. Their performance might, however, have fueled the Klondike-mentality, showing that the lucky (or well-informed) investor indeed could strike it enormously rich particularly in these sectors.

The performance of some of these outliers might thereby have attracted more investments into these sectors, but they might also have had spillover effects on investments in other mining sectors. The structure of the sector would, then, make a crucial difference for the effect such over-optimistic expectations would get. In diamond-mining, the market became highly concentrated at an early date, and few new competitors were established. The comparatively successful diamond-cartel, in combination with the nature of new diamond deposits, possibly thus led many potential investors in the sector to invest their money in already established companies. This would have had the effect of driving up the share prices of these companies, which eventually shows up in our estimated return on investments in these companies. In the case of gold mining, in contrast, investments did to a large extent target newly established ventures; thousands of new companies were established and floated (out of which only a smaller fraction of 583 turn up in our sample of companies). While the leading diamond-mining companies in general seem to have met investors' expectations, turning up a high, positive real return over the long run, many of the newly established gold-mining companies failed to ever make a positive return. The tin-mining sector would exhibit a slightly different pattern: many of the early tin-mining ventures were operating in Europe. A new mining frontier was however established internationally. One of the most important new tin-mining regions was then Malaysia, and this became the recipient of much new British investments during the period under study. Tin also came into high demand particularly following the end of World War II, as it became a strategic commodity at this time.[47] The mining of lead, and copper do not exhibit the same ex-

[47] Rönnbäck, Broberg, and Galli.

traordinarily profitable companies. At least, in the cases of both silver and copper, there were a quite large number of comparatively successful companies established in a second wave of investments during the twentieth century, explaining the impressive comeback shown in table 2 above.

The chance to strike it rich by investing in extraordinarily high-yielding companies did, however, furthermore diminish over time. Table 3 shows the change over time of the between-company standard deviation of the annual return on investments.

**Table 3**
Change in standard deviation of return on investment in individual companies over time, per sector, 1869-1969

| | |
|---|---|
| Copper | -1.423*** |
| | (0.290) |
| Diamonds | 0.041 |
| | (0.317) |
| Gold | -0.738*** |
| | (0.236) |
| Lead | -0.570 |
| | (0.482) |
| Silver | -0.626*** |
| | (0.160) |
| Tin | -0.758*** |
| | (0.175) |

Note: Standard errors in parenthesis. *** = statistically significant at the 5 per cent confidence level.

Source: see table 1.

As can be seen in the table, the standard deviation clearly decreased over time for several of the sectors studied, including copper, gold, silver and tin (the coefficient for lead is also negative, but not statistically significant at conventional levels of confidence). What these figures show is that the return on investment to a decreasing extent varied between companies in the sample. Development of geology and mining engineering presumably created a

situation where investors could gain access to more complete information over time. The development of communication technologies also increased the flow of information globally, potentially making investors less reliant only on the information provided by the company. The performance of individual companies would thereby increasingly depend upon more generic factors, including most importantly the demand for the mining output on global markets. For the investors, the development also implied a problem, as the companies increasingly faced similar risks. Diversifying a portfolio to include companies operating within the same sector of mining thereby became less of a solution in order to spread risks.

## Discussion

The second Industrial Revolution translated into a secular increase in the demand for base metals, precious metals and gems. We also know that mining stocks were gradually acquiring a more significant position in the portfolios of investors from the latter half of the 19th century onwards. Investments in mining were risky investment objects since it as a rule was highly uncertain how rich any particular mine was, and how effective the extraction of valuable resources really could become. The rapid development of geological science and engineering changed the conditions for mineral extraction throughout our period of study – opening up new possibilities but also aggravating market uncertainties from an investor point of view. We know that mining stocks also were at the center of several boom and busts cycles at the London Stock Exchange during this period. Hence, given the long-term development of demand and the short-term volatility involved, one could expect mining stocks to generate high return to its investors. However, in our empirical examination the findings indicate quite the opposite.

We have studied the return on investments in mining, starting in the "Golden Age" of resource exploitation during the late nineteenth century. We thus study the performance of the mining sector

through the lens of the financial sector. We estimate how the return on investments developed during a whole century, from 1869 to 1969. We use monthly data on investments in more than 1,000 companies operating worldwide, channeled via the London Stock Exchange, the most important global financial hub for most of the period under study.

Our results show that the return on investment in mining was comparatively low during the period under study. The average rate of return on investment in mining was lower than the rate of return of a diversified portfolio of investments on the London Stock Exchange. The low average return can, largely, be attributed to substantial losses experienced in the early mining booms during the last decades of the 19th century. Once the mining market had matured, in tandem with a development in engineering science, the return on investments in mining converged upon the return on other investments while the volatility remained largely unchanged across the mining sectors.

The return on investment furthermore differed substantially between the different metals or minerals mined. The highest return on investment came from investments in diamond-mining. We attribute this result to the fact that the diamond market throughout much of the period under study was dominated by a successful cartel. The mining of other metals – including the precious metals – were far from as profitable for the investors: the average return on investments in such mining all yielded an average return on investment well below the average for a diversified portfolio of investments on the London Stock Exchange. This is, however, largely, due to the fact that investments in all these sectors experienced drastic losses at some point in time (primarily during the late nineteenth or early twentieth centuries). In some cases – such as in the mining of silver, copper or tin – the early losses were great, but a very high return on investment during the latter part of the period under study could to a large extent counterbalance these early losses, so that the average return at least turned positive over the whole period. In some other cases, such as in the case of lead, the market never recovered from

the early losses, leading to a negative average return over the whole period under study.

The low return on investments in global mining is notable considering that mining was regarded as a comparatively risky investment. That the actual market risk of mining investments was high is also confirmed by our data, where the volatility of the estimated annual return on investment was substantially higher than the volatility of, for example, a portfolio of all stocks on the London Stock Exchange. To the extent that volatility is an effective measure of investments' risk, theories of risk premium do therefore not seem to fit well with our empirical results. Our results rather suggest that investments in mining in general might have suffered from a "high-risk anomaly" – the mirror image of the "low-risk anomaly" shown in some previous historical research – with high risks compared with the risk of investing in other sectors than mining, but comparatively low average return on investment. Although this suggests that investments in mining may have suffered from a high risk-low ROI anomaly, this does not necessarily imply that volatility in mining determined investor's overall portfolio performance per se. From the investors' perspective, the level of risk that they experienced was conditional upon their diversification strategies. Investors that held diversified portfolios may have had a greater potential to ameliorate this anomaly. Future research that would examine the degree of diversification of investors that invested in mining may shed more light in this direction.

What the results in our paper can demonstrate is that this high-risk anomaly potentially can be explained by information asymmetries in combination with a recurrent over-optimism among investors. A prerequisite for such an over-optimism to have any impact is is many investors have imperfect information about the business ventures they were investing in. Issues of asymmetric information are not easily captured in our kind of data, but while there existed investors making more informed choices, there at the same time existed a substantial group of investors who had little access to information concerning the ventures they were investing in. The latter group's investment decisions were thus to a large extent

colored by their hopes and dreams of what their investments might yield. Such hopes and dreams were, we have argued in this paper, in no small degree fueled by the performance of some outstanding companies. Some of the mining sectors studied in this paper, most importantly diamond-, gold- and tin mining include some companies that were extraordinarily successful, exhibiting a rate of return on investment exceeding 50 per cent per year for some time. Even though these generally were small companies, and present in the sample only during shorter periods of time, we have here argued that they contributed to shaping the perceptions of what the lucky investor could gain from investing in mining. They thereby helped fuel over-optimistic expectations on investments in the global mining economy – both in general, but perhaps most importantly for the mining of gold.

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