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Stock market response to potash mine disasters

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Abstract

We examine the stock market reaction to disasters in potash mines. We use a sample of 55 mining accidents – natural and man-made - worldwide over the period 1986-2019. On average, the affected mining firms experience a cumulative drop in their market value of 1.15% in the first two days day of a disaster. We show also that the accidents impact stocks of the current and future (greenfield) competitors of the affected firms. The direction and size of the effect is determined by the relative strength of the negative risk effect and positive price and supply effects.

Keywords: potash mine, disasters, event study, working accident, catastrophe

JEL classification: G14, Q27, Q51

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Abstract

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Introduction

A dwindling supply of arable land worldwide coupled with population growth requires increased food production, and as a result, potash-bearing fertilizer, which allows larger and more frequent crops to be produced per acre (Magen, 2010), is in demand. Potash is the common term for nutrient forms of the element potassium, and along with nitrogen and phosphate, is absolutely essential for food production; in fact, there is no direct substitute. The increase in demand for potash has driven its price from US\$96 per ton at the end of 1990 to a record high of US\$1050 in 2008. Today, the prediction is that its price will stay in the US\$200-300 range for the next several years. Jenny (2012) argues that the increase in potash prices over the last two decades has been the result of the formation of an international export cartel for fertilizer. The development of the cartel can be explained by geographical concentration of potash resources, as potash resources exist in select countries mined by only a few firms. Indeed, the largest 10 potash mining companies control over 90% of the market, and the top three firms hold more than a 50% share.

Most potash extraction is through conventional shaft mines, with the remainder extracted using solution and brine mining from land-locked water bodies. Underground evaporite mines are subject to a high risk of catastrophic failures (Whyatt and Varley, 2006). Furthermore, conventional potash mines are prone to flooding caused by uncontrollable brine inflow. As a result, potash production is permanently exposed to a serious threat of mine accidents. Over the last 60 years the industry experienced seven catastrophic events that lead to a permanent or long-term closure of a mine (Gnutzmann et al., 2019) and dozens smaller-scale accidents. Such disasters are clearly likely to be reflected in stock prices of the affected companies, but we may also expect a firm's stock to react strongly to smaller mining accident as any news raises fear of a

catastrophic mine disaster. One may expect disaster to have an even stronger impact given the high market concentration in the industry, though as a recent study shows (Gnutzmann et al., 2019), the arrangements of the global potash cartel lead to excess capacity, which mitigates the impact of such events. Thus, while in an industry without spare capacity, a mining accident is likely to generate a supply shock and a transfer of potash surplus from the company negatively affected to companies unaffected by the disaster, this may not be the case for the potash industry.

The existing literature on the effects of industry accidents in general on firms' stock provides ambiguous results that may be attributable to the heterogeneity of the events analyzed.¹ Capelle-Blancard and Laguna (2010) find that petrochemical firms experience, on average, a decline in market value of 1.3% over the two days immediately following a disaster, and they show that this loss is significantly related to the seriousness of the accident measured by the number of casualties and chemical pollution. Carpentier and Suret (2015) analyze the stock market reaction to major environmental and non-environmental accidents. They report that, on average, the market reacts negatively and enduringly to the announcement of an accident, yet they also find that the effect is mainly driven by two subsamples of events, namely, the airline industry and events that prompt a government reaction. Consequently, we should expect a stock market reaction to potash mining accidents with the strength of the reaction driven by its seriousness measured by casualties and production losses.

On the externalities of a disaster, Shelor, Anderson, and Cross (1990) analyze the effects of an earthquake on the stock of real estate related firms in California. They find significantly negative abnormal returns for real estate firms exposed to losses in the

¹ Capelle-Blancard and Laguna (2010) and Carpentier and Suret (2015) present a review of the results of the studies analyzing the impact of natural and industrial accident announcements on stock markets using an event study approach.

earthquake area, while firms operating in other areas of California are generally unaffected by the earthquake. Shelor, Anderson, and Cross (1992) extended the scope of their initial study by examining the market response of property and casualty insurers. They find that insurance company stock prices move up by 1.66% after an earthquake. The positive stock price movement following earthquakes suggests that investor expectations of higher demand for insurance more than compensates for any potential claim losses. Aiuppa, Carney, and Krueger (1993) also extended this research and examined a sample of firms divided into those that underwrite insurance premiums for earthquakes and those that do not. They report that earthquake insurers show a significant positive stock price reaction, whereas, non-earthquake insurers are generally not affected.

The main aim of our study is to provide empirical evidence on the stock market reaction to natural disaster and man-made accidents to commodity production facilities². A disaster in a potash mine is likely to impact both the stock of the companies directly affected by an accident as well as their competitors on the potash market, though in the opposite direction. Production disruptions experienced by one producer are likely to benefit other firms on the market. Furthermore, we assume that the impact of the disaster on stock price will strongly depend on the direct costs, such as damage to infrastructure or injury to workers, and indirect costs such as loss of production.

Accordingly, we examine the stock market reaction to 55 disasters in potash mines during the years 1986-2019. We distinguish between two main types of events, namely, natural disasters and man-made accidents. Our results show that the largest losses are reported for natural disasters, which result, on average, in cumulative

² Throughout the paper, we use the terms ‘disaster’ and ‘accident’ interchangeably, yet it should be underlined that we differentiate between ‘natural disasters’ and ‘man-made accidents’ in our study. We provide a definition of the different types of events used in the study in the section 4.2.

abnormal returns up to 2.34% over the two days immediately following the event. Furthermore, we identify two subcategories of natural disasters – mine flooding’s and mine collapses, and two subcategories of man-made accidents – fire outbursts and other work accidents. A closer analysis shows that the decline in stock prices is mainly related to inflow (flooding) in the potash mines. After an inflow the stock declines, on average, up to 5.06% over the two days immediately following the event. Those types of natural disasters are however very rare, while man-made accidents are the most frequent.

Indeed, we are able to document that investors distinguish between different types of potash mine disasters and their consequences. We further extend our study to examine the impact of the disaster on the stock of both direct and indirect competitors, i.e. greenfield firms that expect to start mining potash in the future, as developing a conventional underground potash mine requires a minimum of five to seven years (Cocker and Orris, 2012). We assume a stronger reaction to an accident in the stock of direct competitors who are producing potash, and therefore, may be directly affected by their competitors’ disasters. We find, however, evidence that the stock of these two direct competitors reacts differently to a natural disaster following the event. In our opinion, those differences can be attributed to the oligopolistic structure of the potash market. On the other hand, the stock of both direct and indirect competitors reacts negatively to the news of a man-made accident in a potash mine. The reaction of the stock to man-made accidents is significantly stronger for potash producing companies than for greenfield firms. We attribute the overall negative results to investor concerns regarding potential new regulation in the industry that would affect production costs of all potash producing companies. While, greenfield firms are still in the process of development of a potash mine and consequently will not be affected immediately by any new potential regulation following a man-made accident.

Using multivariate analysis, we further assess the effects of the type of accident on abnormal returns. We also investigate whether other factors, such as the financial situation of the company, the potash market situation, or the severity of the accident represented by news and social media coverage as well as number of injuries and fatalities caused by the accident, determine the abnormal returns following a potash mine disaster. The results of the regression confirm that the stock market reaction is mainly determined by the type of accident. Moreover, controlling for type of accident, we find strong relationship between the firm-level control variables and the stock of the affected company following a potash mining disaster. While, we find that the stock of direct competitors is positively and significantly affected by market-level control variables as well negative information about the affected company following the disaster. In our opinion, the results documents that stock markets react rationally to the disaster information and its consequences for all companies in the potash mining industry.

This study contributes to the existing literature in several ways. To the best of our knowledge, this is the first study that examines the impact of mine disasters on stock prices of competitors of the affected mining companies and on greenfield mining companies. Through our investigation of the reaction of the stock of the affected company and its competitors, our study contributes to the literature on the contagion effect of disasters. Indeed, we provide evidence on the reaction of the stock of mature and developing (greenfield) potash producers to information about a potash mining disaster. We show that not only the type of disaster but also the type of company determine the stock price reaction following the accident. Last, our study presents new evidence on the information content effect on the investor decision-making process. We find a strong association between accident type and the magnitude of the event's effects

on the company. Namely, the strongest association is found for inflow accidents, which can result in the closure of a potash mine. In contrast, smaller disasters or accidents do not result in a significant decline in stock prices. Moreover, the results are not determined by potash market situation, accident characteristics, or media coverage. Hence, we present robust evidence that in the case of potash mining accidents investors react rationally to the event information.

The paper proceeds as follows. In Section 2, we briefly present the institutional background of the study, which determines the hypotheses tested in this paper. Section 3 describes our data and our methodological approach. The empirical results are presented and discussed in Section 4, and Section 5 concludes the paper.

2. Background and hypotheses

2.1 Institutional background

Potash mineral resources are scarcely spread over a handful of geographical regions. Limited geographical distribution of deposits, large capital investment, and the lengthy time needed to develop a potash mine have all created significant market entry barriers. As a result, the industry of the potash market today is an oligopoly³. The seven largest companies produce around 80% of the total world potash output (K+S, 2016).

The de facto level of concentration in the market is even higher as the potash industry is organized into two syndicates, one in Northern America and one in Eastern Europe. The fringe players, control only about 20% of the market. In North America, the association Canpotex controls export sales of Agrium, PotashCorp (the two firms merged in 2018 to form Nutrien) and Mosaic. Similar associations among Russian

³ Industry sources reveal that it takes at least seven years and around \$4B to develop a potash mine of 2 mln mt capacity (i.e., about 5% of global potash capacity).

(Uralkali and Silvinit acquired by Uralkali in 2012) and Belarussian (Belaruskali) producers, namely, the Belarussian Potash Company (BPC), existed between 2005 and 2013.

The important feature of the potash syndicates is a prorationing mechanism. Each syndicate decides on quantities to be sold to the global market, while each syndicate member is assigned sales quota proportionally to her productive capacity. This prorationing mechanism promotes excess capacity as described in detail by Gnutzmann et al. (2019). Indeed, the capacity utilization rates among the largest producers are low, between 64% and 75%, which allows the producers to respond to production stoppages at the affected mines with increased output at other production facilities.

The alleged cooperation between the two export cartels controlling 70% of the world market is widely considered to be the main factor contributing to the potash price surge in 2007-2008 (Jenny, 2012). In this period, potash prices increased by roughly 300% and remained elevated until the collapse of the Russian-Belarusian cooperation.

The price surge in the last decade gave rise to a large number of greenfield and brownfield projects. Many of the greenfield firms sought financing for necessary feasibility studies, geological surveys, and mine engineering work via the stock market. Thus, the number of publicly traded companies related to potash mining has increased significantly in the last decade. The strategy of developing potash mine projects as independent legal entities to be acquired by large market players at or close to completion of mine development work is not new to the industry. However, it has never before occurred in such intensity. Given the long time needed to develop a mine, many of those mines are about to start and the global capacity is scheduled to grow by at least 30% in the coming years, through both green- and brownfield projects. However, the

current low potash price level makes many of the envisaged projects unfeasible, which is reflected in the stock prices of the greenfield firms and their decisions to suspend mining work.

Potash companies differ in the degree of diversification of their revenue sources. Among the large producers, all the major Northern American firms – PotashCorp, Mosaic, and Agrium – receive more than 30% to 40% of their revenues from other sources than potash production. The remaining potash producers are more dependent on potash production and hence, are likely more susceptible to events in this market. It should be noted that all major potash producers limit their activities to mining fertilizer rich rocks or brines, urea, and ammonia production and fertilizer production.⁴ Two mining giants (Vale and BHP Billiton) play a marginal role in the potash market. In 2010, BHP Billiton, after its unsuccessful hostile bid for Potash Corp, started a greenfield project with the aim to create the world's largest potash mine, which, due to unfavorable market conditions, is currently suspended. Brazilian metals and mining firm Vale, via Vale Fertilizantes, owns a relatively small potash project in Brazil.

Potash mines are relatively free of the hazards of underground mining due to the non-gassy salt deposits in which the ore is located (Hustrulid and Bullock, 2001). Nevertheless, accidents involving mining machines, fire, and gas do occur and may result in human losses and temporary mine closures.

The largest risk factor for potash mines is, however, water from underground sources that may flood the mine. Most mines around the world experience uncontrolled brine inflow. Efforts to stop this leakage can disturb regular mining operations, temporarily decreasing mining capacity. Failure to block the inflow may result in mine flooding, resulting in permanent mine closure. Furthermore, flooding of a shallow

⁴ Some potash firms are involved in exploration of other minerals contained in the same rock or brine as potash, i.e., lithium, magnesium, or salt (sodium chloride).

potash mine with thick deposits (typical in the Perm region in Russia) may result in the opening of a sinkhole, making mine recovery nearly impossible. In the last four decades, seven mines have been closed permanently or for an extended period due to water related accidents (Whyatt and Varley, 2006).

The negative impact of mine accidents is mitigated by the fact that part of the damage is covered by insurance. Annual reports of the main potash producers reveal that they spend, on average, 2% to 3% of their annual revenues on insurance premiums. While detailed information about insurance coverage is not available, public statements made by potash producers imply that a large part of the risk from anthropogenic disasters remains uninsured.⁵

Despite the prorationing syndicates on the market, potash producers are sensitive not only to accidents that affect them directly, but also to those impacting their competitors due to the leverage effect and the competition for market share. Investment in commodity producing firms provides a leveraged investment into those commodities. A share in a commodity producing firm not only offers access to one unit of the commodity, but also provides a share in the total future production of the firm (Tufano, 1998). Therefore, adverse events affecting potash prices are changing the value of future production of all firms in the market. The leverage embedded in real options held by resource owners depends on the production costs and those vary significantly within the industry. The costs are driven by mining technology (shaft vs. solution mining), potash concentration, and, in the case of traditional shaft mining, deposit depths and shape. The convenient location of potash deposits of just 300 to 400 meters below the

⁵ In its 2015 Annual Report, Uralkali states that it “generally enters into insurance agreements when it is required by statutory legislation. [...] The insurance agreements do not cover the risks of damage to third parties’ property resulting from the Group’s underground activities.” In its 2015 Annual Report, the Potash Corp wrote that the risk of underground water inflows, as with most other underground risks, is currently not insured.

surface are favorites of Russian and Belarussian potash producers and result in estimated operating costs of US\$60 to US\$80 per ton. The cost advantage comes, however, at the expense of a higher risk of mine collapse. In contrast, Canadian deposits in the Saskatchewan area are deeper, at approximately 1000 meters below the surface, which increases the costs to about US\$120 per ton. German potash deposits are not as deep, but the geological structure of the deposits increases the costs to US\$150 per ton. Finally, solution mines in Israel, Jordan, Chile, and the US operate at the cost of US\$150 to US\$200 per ton.

2.2. Hypotheses development

Mine disasters are likely to impact stock prices of not only the firms directly affected but also their direct competitors and greenfield mining projects due to start production in the future. The impact, however, is likely to be different and depend on a number of factors described in detail below.

Impact of mine disasters on the affected companies.

Accidents are always associated with costs to the affected companies. Those consist of a few components due to lost revenues caused by production stoppages (*supply effect*). On many markets this effect may be mitigated by a *price effect* if the competitors are unable to increase their output to fill the supply gap. As described in the previous section, this is unlikely to be the case on the potash market. Furthermore, the affected firms suffer from costs due to capital expenditure required to restore the mining capacity and to replace the affected equipment or fines imposed by the authorities and compensations to the affected workers and their families. Thus, unsurprisingly, we expect the stock prices in this group of companies to be affected the most. The impact is likely to depend on the size and financial condition of the affected company with

smaller companies with lower profit margins and lower liquidity to be affected the most (Kaplanski and Levy, 2010).

Impact of mine disasters on direct competitors

The disaster-driven supply shortages are quickly filled by increased output of the competing firms or if they lack spare capacity through an increase commodity prices. Thus, we expect to observe *positive price* or *supply effect*. Furthermore, as the potash market is dominated by long term contracts, the inability to meet the contractual obligations may lead to a permanent switch to a different supplier, or a *positive market share effect*. However, as already mentioned, the two effects are likely to be weaker than on other commodity markets due to excess capacity. Furthermore, we expect to observe a *negative (discounting) risk effect* that works in the opposite direction, though investors in existing mining operations should be aware of the risks. The described effects work in opposite directions and, a priori, we are unable to determine which one dominates. In contrast to the affected companies, we do not expect the financial characteristics to be a key variable.

Impact of mine disasters on greenfield potash firms

News about the potash mine disaster may affect also greenfield mining companies that proliferated after the commodity boom of the late 2000s. These listed financial vehicles are designed to gather resources for an implementation of risky mining projects, which success depends on new geological data collected and the success of new investment rounds (Clements and Li, 2017). The supply impact of mine disasters is likely to be transient and disappear by the time the greenfield projects successfully start production; thus, we do not expect to observe *price* or *supply effects* and the price changes are likely to be driven by the *negative (discounting) risk effect*. For the same reason, we do not expect the financial characteristics of these companies to play any role. However, news on mine accidents provides new information about the risks associated with the industry, which may negatively affect the valuation of such

companies, bringing even more volatility to the already very risky sector (Ferguson et al., 2013). Indeed, in a large number of the greenfield potash companies the largest shareholders are private equity firms, which aim to exit from the investment by selling it to a mining company. One reason for such acquisition could be a disaster in the existing mine and the need to safeguard the future production capacity of the company⁶. We may, therefore, expect an increase of the stock price of greenfield firms following an information about a natural disaster in a potash mine.

4. Data and methodology

As stated, the main aim of our study is to provide empirical evidence on the stock market reaction to potash mining disasters. We also attempt to establish whether the magnitude of the reaction is determined by the type of event, firm-level characteristics, or macro data. Accordingly, we combine three sets of data in the study: a list of publicly traded potash mining and exploration companies, a list of potash mine accidents, and a set of control variables describing the firm and accident characteristics. Due to data availability, the study covers the period 1986-2019.

4.1. Stock prices

The first dataset presents the daily closing prices of the stocks of the potash mining and exploration companies in local currencies and their market capitalization in US dollars. We retrieved the closing prices from the stock market indices of the exchanges where the companies were listed. Using the closing data, we calculate logarithmic returns for each company and the exchange indices, such as $r_t = \log(p_t/p_{t-1}) \times 100$, where p_t and p_{t-1} represent the closing price at time t and $t-1$, respectively. If a

⁶ As an example in 2008 the company BHP Billiton acquired the control of the Anglo Potash, a Canadian greenfield potash firm and announced that this acquisition will further enhances the company's position in the world's major potash basin by adding flexibility for future growth (see <https://www.bhp.com/media-and-insights/news-releases/2008/07/bhp-billiton-completes-acquisition-of-anglo-potash-ltd>)

company was listed on two or more exchanges, we use only the information on the stock prices and main stock index from the country where the company is headquartered and/or incorporated. We obtained all the data from Reuters.

The companies are divided into two categories: producers and greenfield firms. Producers are firms that report potash production in the given year, while greenfield firms are in the process of starting potash production in the future. Greenfield firms vary in their stage of advancement. Some only possess exploration licenses for potash salt rich brines, and some have completed geological investigations and feasibility studies and are preparing for engineering work, while some are already in an advanced construction stage. The names of the listed companies with basic information are presented in Appendix Table A1.

[Table A1]

4.2. Natural disasters and man-made accidents

A potash mining disaster may simply be defined as an accident that occurs in the process of mining potash above or beneath the surface of the earth. There are various causes for potash mining accidents, including collapsing of mine stopes, flooding, followed often by earthquakes, leaks of poisonous gases, or consequences from incorrectly used or malfunctioning mining equipment. There is no publicly available list of potash mining disasters that discloses the type of each disaster and the name of the company affected. Hence, to identify the disasters, we created a database by using the software Factiva, Bloomberg, and the Google news search engine. The Factiva software covers all major newspapers and publications in the world, including dailies such as the Wall Street Journal or the Financial Times. The search was carried out using keywords such as “potash mine” and “disaster,” “accidents,” “inflow,” or “disruption,” for the years 1986-2019. Similarly, we used Google News in the countries with potash mines to

identify additional events of interest. On the one hand, Google News includes additional Internet news sites. On the other, it covers mostly news only from the last decade, whereas information prior to 2000 is relatively scarce. Last, we checked information on disasters using Bloomberg and Reuters news for each company, which provides extensive information mainly for listed companies. Our sample, however, includes potash mine accidents operated by listed and non-listed companies. Using this approach, we were able to identify 55 potash mining disasters in the years 1986-2019. Of this 55 potash mining accidents 44 affected listed companies. The list of the disasters and their classifications are presented in the Appendix Table A2.

As the disasters differ from each other, they may, therefore, have a different impact on the stock of the affected company and its competitors. In order to examine the impact of the different types of disasters, we divided the group of events first as *natural disasters* and *man-made accidents*; these represent 35% and 65% of the total events in the sample, respectively. Next, we decided to classify each of the two main types of mining disasters into further subgroupings. In the case of a natural disaster, we distinguished the two most common: (i) water inflows (*Inflow*) and (ii) earthquakes and/or mine collapse (*Collapse*). These two events can result in the largest losses for the potash companies including closures of potash mines. These events are, however, quite rare in practice and represent only 11% and 24% of total events in the sample, respectively. Moreover, these disasters do not get much attention in the news as they are less spectacular than man-made accidents. As an example, on 9th of March 2018 the stocks of potash companies as Interpid Potash (+3.2%), Nutrien (+3.1%) or Mosaic (+3.3%) increased within an hour following a government report informing that the ceiling of a potash mine in Belarus had collapsed more than half a kilometer underground a day before, killing two workers and putting the future production. The

information, however, made headlines in some of the business services only when the stock price of potash companies soared on speculation that this disaster could knock out a large chunk of global production capacity. While, prior to the surge of the stock price the disaster was only covered only by one small, local newspaper even as it killed two workers. It should be noted that injuries and fatalities are seldom related the natural disasters in potash mines. In our sample human casualties were reported in only 3 out of 19 natural disasters.

In contrast, man-made accidents are more common and more spectacular. They may take the form of (iii) fire and/or gas in the mine (*Fire*) and (iv) a work accident (*Work*). Accidents related to fire or gas represent 22% of the total events in the sample. They are the most spectacular events and are most likely to receive the most attention from the press as they often involve a large number of mine workers. It should be noted, however, that in recent years, the safety in the mines has improved. Hence, the number of injuries or deaths related to this type of accident is relatively low. As an example on the morning of 19th of December 2016 a loader caught fire and has left 114 miners trapped underground at Allan potash mine. By midnight of the same day all the miners were out without any injury and the mine resumed operations the next morning. In contrast, however, to the prior described natural disaster the information about this man-made accident was covered by most regional and national newspapers.

Workplace accidents are the most common events in practice and represent 44% of all the events in the sample. We follow the European Statistics on Accidents at Work (ESAW) methodology and define work accident as a discrete occurrence in the course of work leading to physical or mental injury. However, we expand the definition and include occurrences that are caused by human error and lead to a stop in mining production, for example, a collapse of a crane.

Summarizing, we decided to control for the different types of accidents as it allows us to control for the impact of the event on the affected company and its competitors. Natural disasters are less spectacular but may result in significant costs for the affected company, e.g., closing of a mine and influence the potash market. In contrast, man-made accidents, especially fires, are likely to receive more media attention, but, in most cases, they do not have a big impact on the current production. Working accidents are however investigated by authorities and companies can be fined if the authority establishes that the safety of workers was neglected by the company. As an example, in November of 2018 the company Agrium has been fined 500 thousand USD for failing to ensure the health, safety, and welfare of an employee after a worker was struck in the abdomen by an unsecured cable in August of 2016. The example shows that there is a significant time gap between the event and the outcome of the investigation following a man-made accident. Additionally, the fines and compensations for working accidents are relatively low taking into account the profit and size of the average potash mining company.

4.3. Control variables

We employ a number of control variables, which may determine the effects of the disaster on the potash mine companies. The control variables are divided in three main categories and control for a) firm-specific characteristics; b) condition of the potash market; and, c) accident characteristics and its media exposure. A detailed description of all the variables used in the study is provided in the Appendix Table A3.

The firm characteristics and financial performance variables that might influence investor reaction to unanticipated environmental information include firm size, leverage, liquidity and profitability. Larger firms, as indicated by the market capitalization (*Mkt cap*), are likely to draw greater attention from investors and

therefore incur larger negative changes in market value (Khanna, Quimio, and Bojilova, 1998). On the other hand, we may expect that larger firms are more diversified and more able to absorb losses incurred due to a mining disaster. A higher debt to total assets ratio (*Leverage*) and a lower quick ratio (*Liquidity*) may cause investors to view a firm unfavorably as it indicates that the firm is more risky. Similarly, less profitable firms, measured by gross margin (*Profitability*), may be seen as more risky investments and also less likely to absorb any losses. Kaplanski and Levy (2010) indicate that the effects of larger market losses in comparison to actual losses are more likely to be found among smaller and riskier stocks. Based on this, we expect that these four variables just referenced will negatively determine stock prices following a mining disaster.

One of the key characteristics of the potash industry is its oligopolistic structure, which is why we expect a mining disaster to have an impact on other companies in the industry, even though the impact of such events on competitors is mixed in the literature. Bosch et al. (1998) find positive stock return bumps for competing airline carriers in the wake of a crash as well as market-wide downturns. Key in their study is whether competitors actually serve the same market and therefore provide alternatives for potential customers in the aftermath of a crash. In our study, all the firms serve the same market, thus, we may expect to see a stock market response for the other companies to a mining disaster. As mine accidents cause temporary mine work disruptions, the possible impact of those disruptions on the company affected and the market at large clearly depends on the size of the mine. Therefore, we control for the size of the mine (*Mine*), measured as the average extraction of potash in the affected mine in the year prior to the accident. We assume that the larger the size of the mine, the stronger the impact of the accident on the affected company and its competitors. Henceforth, in our robustness check we employed alternatively the share of the affected

mine output to the total world output in the year of the accident, yet our results remained unchanged.

Tufano (1998) documented that a gold mining firm's valuation is positively related to the level of the resource's price; however, firm exposure varies over time and across firms. We assume, therefore, that the current potash price as well as the market trend embedded in annual potash price changes, may determine the level of the stock price response following a potash mine disaster. In the regression, we control for the exposure to potash prices using the year-to-year change of the potash prices ($\Delta Potash$), which is calculated using monthly data till the month prior to the event. Henceforth, the variable is not influenced by the current accident and can be interpreted as a measure of market tightness in the time of the accident. Additionally, we calculate the expected change on the potash prices ($\Delta Potash_{exp}$) using the expected monthly price of potash prior to the accident. We estimated the expected price of potash employing the constant mean model. We assume that the higher return on potash, or the stronger the positive trend, the more pronounced the effect of the accident will be on the stock market.

One of the elements that may determine the level of the stock market reaction is the announcement of the number of fatalities caused by the accident. Capelle-Blancard and Laguna (2010) presented that market loss following an accident is significantly related to the number of casualties. In this study, we control for the human casualties using two control variables. The variable *Injuries* that takes the value of casualties if there are any injuries related to the mining disaster. Similarly, the variable *Death* takes the value of fatalities if there are any deaths related to the mining disaster. We assume that human casualties may not only result in larger publicity, but also lead to investigations, and consequently, a temporary closure of the mine.

As investors are not always fully rational, we could expect them to react irrationally to news on a potash mining disaster (Chen, Joslin, and Tran, 2012). We expect that investor behavior will strongly depend on the extent of the coverage of the mining accident in the mass media (*News*) and social media (*Twitter*). We control for this by introducing variables that control for the number of articles in the press and twitter mentions of the name of the company. What matters to investors is not only the quantity but also the content of the media reports. Therefore, we also control for negative media coverage of the companies in the sample (*Neg. News* and *Neg. Twitter*).

Table 1 summarizes the descriptive statistics of the variables for the entire sample, and the pairwise correlations among the variables are shown in Table 2. The variables presenting cumulative abnormal returns (CAR) for two days following the accident show large variation across the companies. Indeed, we find that the variable representing CAR for the period for all the firms is negatively related to the change in potash price in the year of the accident as well as to the size of the affected mine. The remaining variables also show noticeable variation across the different types of companies in the sample.

[Table 1]

[Table 2]

4.4. Methodology

4.4.1 Event study

We examine the stock price behavior of the affected company and its competitors using a daily event study, following MacKinlay (1997). We measure the stock price reaction to potash mining disasters by estimating abnormal returns ($AR_{i,t}$), which are defined as the difference between the actual daily return $R_{t,i}$ of stock i and the expected return $\hat{R}_{t,i}$ on a given date t . We employ the standard market model to estimate

the expected stock returns, which corresponds to the return if the event has not yet taken place. The market model is estimated using ordinary least square (OLS) and assumes a stable linear relation between the market return and the individual stock return:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \quad (1)$$

where $R_{i,t}$ and $R_{m,t}$ are the returns of the firm i and of the market m , respectively, in period t . We estimate the parameters α and β using the mining company's daily log returns (as the dependent variable) and daily log returns of a broad market index (as the regressor) for each listed potash mining company during an estimation period prior to the event window. We follow Capelle-Blancard and Laguna (2010) and employ an estimation window of 190 trading days before the event day in order to examine the impact of the mining disaster. We end the estimation period two weeks (10 trading days) prior to the event day in order to shield the estimate from the effect of the disaster announcement and to ensure that any changes in the estimates are not an issue. The Day 0 is the date of the accident; the information about the accident is sometimes published the day after. If the disaster happens either on a non-trading day or after the close of the trading day, the subsequent trading day is treated as Day 0.

We calculate the average abnormal daily return for all accidents in the sample, AAR_t , by summing $AR_{i,t}$ for each firm i of N number of firms in the sample, at each relative event time. We also compute the cumulative average abnormal returns (CAAR) since the accident date, $CAAR_t$, which is an aggregation of multiple-day abnormal returns for the post-estimation window. We decided to choose a post-estimation window of ten days after the disaster event. In Table 3, however, we present a summation of the abnormal returns for all the post-event windows between t_0 and t_1 . Additionally, in the robustness analysis, we employ as an alternative dependent variable the absolute loss incurred by shareholders ($SL_{i,t}$) for company i on day t . The variable is

computed by multiplying the market value of firm i on the day before the event with the CAR up to t days after the accident.

A time series t-test is conducted to determine if the CAARs are significantly different from zero over various intervals, according to the test described in MacKinlay (1997). Brown and Warner (1985) show that the market model performs at least as well as more complex models; we calculate, in addition, the parameters using the average return model and the two-factor model. The results from these two models do not differ significantly from the market models; thus, this shows that our results are not biased by the method used to calculate the ARs.

3.4.2 Cross-section regression

Next, we follow Khanna, Quimio, and Bojilova (1998) and perform OLS regressions for estimated $CAR_{[0;1]}$ to shed light on the cross-sectional determinants of the stock market's reaction to mining disaster announcements. In the regression, we try to establish the impact of various factors that describe the accident, firm characteristics, and the market on the $CAR_{[0;1]}$ following the accident using the regression as follows:

$$CAR_{[0;1];i} = \alpha_i + \beta X_i + \varepsilon_i \quad (2)$$

where $CAR_{[0;1]}$ is the cumulative abnormal return for a period of two days following the event for firm i , X_i is a vector of factors that describe the event, its news coverage, the impact on the potash market, and finally, firm characteristics.

We estimated the regressions using different CARs calculated over periods starting with $[0,1]$ and ending with $[0,5]$ trading days following an accident to examine both the immediate and subsequent stock price reactions to an accident announcement. We find that the results do not differ significantly across the different periods for the CAR results. We decided to follow Capelle-Blancard and Laguna (2010) and present only the results for the $CAR_{[0;1]}$ calculated for one day following the accident.

We ensure that all of the findings are robust by conducting additional tests changing the specifications and exogenous variables. The main results of this study remain unaffected throughout all of these robustness checks, but are not shown for brevity but are available upon request⁷. We show, however, in the Appendix the results of the regression were we add year fixed-effects that capture the influence of aggregate year trends that are common to all companies. Once again the main results remain unaffected with the exception of the changes in potash prices. It is not surprising as the changes in potash prices are common to all the companies, which are now controlled by the year dummies. Henceforth, we have decided to present in the first place the specification without year dummies.

5. Results

5.1 Event study

Table 3 presents the results for the event study, and in the first two columns, we present the AARs and CAARs for all the potash mining accidents. We divide the events into two main categories based on the cause of the potash mine disaster, as discussed in the previous sections.

In columns 2-4 and 5-7 of Table 3, we show the results for AARs and CAARs for natural disasters and for man-made accidents, respectively. In column 2 and 5 we present the results for all the natural disasters and man-made accidents, respectively. While, in columns 3-4 and 6-7 we present the results based on the subcategories of the events.

In Panel A of Table 3 and Figure 1, we present the AARs and associated statistics for the affected companies (the firms directly affected by the disaster). In the

⁷ The results of all the sensitivity test are available on the webpage of the FINEXCA project <http://www.finexca.eu/>.

following two panels, we distinguish two groups of competitors. In Panel B and Figure 2, we show the results for all direct competitors in the potash producing industry. In Panel C and Figure 3, we present the results for the greenfield firms, the companies developing new potash mines but not producing potash on the day of the accident. Fields and Janjigian (1989) investigated US public electric-utility stock price reactions to the Chernobyl nuclear-power accident and found that, on average, the price of the stocks declined almost 3% during the three days following the accident. In addition, they show that firms using nuclear power experienced greater losses than nonnuclear firms. Similarly, we expect a different stock reaction in the stock of direct and indirect competitors after receiving the information on a potash mine accident of the affected company.

Figure 1 and Panel A of Table 3 shows that the bulk of the reaction to the mining accidents occurs in the first two days. On average, shareholders of the affected company suffer a significant loss of 0.69% on the day of the disaster, and of 0.80% the following day. Cumulatively, the negative reaction may be observed over a period of zero to one day. The abnormal losses continue to accumulate, reaching -1.15% on day one, and slowly decreasing day by day. This implies that the market reaction is immediate and not prolonged. All these estimates are statistically significant for CAARs at the 1% level.

[Figure 1]

Our results are in line with the literature analyzing the impact of disasters on company stocks. Kaplanski and Levy (2010) show that the stock market effects of an aviation disaster begin one day after it has occurred and lasts for two days. They show that on the third day, a market correction process begins and this process continues for several days. Carpentier and Suret (2015), based on a survey of a number of studies,

document that the estimated average cumulative abnormal return for the two days following an industrial accident is between 1% and 5%.

Figures 2 and 3 report the average abnormal returns and cumulative abnormal returns for natural disaster and man-made accidents, respectively. The Figures document that the announcement of a natural disaster in a potash mine has a larger effect on the stock price of the affected company than a man-made accident. In the case of the natural disasters, on the first day, the stock declines by 1.99% and is statistically significant at the 5% level. The following day, the stock further declines by 2.34%. After two days from the natural disaster, the cumulative abnormal losses reach a maximum value of -4.47%.

[Figure 2]

The effect of the man-made accidents on the stock of the affected companies is significantly lower. The stock declines only on the day of the accident by 0.31% and rebounds on the second day. Consequently, the cumulative abnormal losses reach their maximum value the day following the accident with a value of -0.65%. The results are, however, statistically significant only for the day of accident at 5% level.

[Figure 3]

Panel B of Table 3 shows that the stock of existing potash producers reacts negatively to disasters and accident only on the day of the event. The average abnormal losses with a value of 0.06% are small for the competitors on the event day. Moreover, we find that the effect of the natural disaster on the stock of the direct competitors is negative only on the day of the event. Indeed, on the following three days competitor stock increases and the cumulative abnormal returns reach the maximum gain of 0.55% on the third day; however, the results are not statistically significant.

Panel C of Table 3 documents that the stock of the greenfield companies are more sensitive to the information on a disaster than existing potash companies and are more likely to respond with a price decrease. This is in line with our hypotheses – greenfield companies do not benefit directly from potential prices changes. We find that the stock of greenfield companies declines more following a man-made accident than a natural one; moreover, the results for man-made accidents are statistically significant. The decline after the man-made accident may be a result of investor concerns that this kind of event could result in new government regulation or an increase in insurance premiums in the industry. We find that the decline of the stock is significantly stronger for a greenfield firm than for existing potash companies. On average, the cumulative abnormal losses for a greenfield firm reach the value of -0.65% at the second day and CAARs are statistically significant at 5% level. We attribute the differences in the results to the fact that greenfield companies are smaller, often more leveraged, and less diversified than existing potash producers (and thereby potentially prone to greater risk after an event in the industry). The possible difference between the stock price reactions depending on the type of firm is analyzed further in the following section.

[Table 3]

5.2 Main results

Table 4 reports the OLS regression results using the firms' $CAR_{[0;1]}$ as dependent variable. In the regression we control for accident type distinguishing at the beginning between natural disasters and man-made accidents. In the next regression, we further control for different subgroups of accidents, which we outlined in the previous section. As we try to identify differences in market reaction for different producer classes, we present again the results for the affected company, the competitors, and the greenfield firms separately.

The specifications (1) and (2) in Table 4 show the results for the affected company. In the first specification, the coefficient for the dummy variable natural disasters is negative and significant at the 1% level. The second specification documents that the result is mainly driven by inflow disasters as only the coefficient for the dummy variable inflow is negative and significant at the 1% level. The coefficients for collapse and accidents, whereas it is mainly determined by work accidents, are also negative, but are statistically insignificant. The results confirm the rational behavior of investors as a disaster related to brine inflow can result in significant losses for the company, which are likely uninsured by the affected company.

Interestingly, the results also confirm that a working accident at a firm affects the stock of the direct and indirect competitors. These results are shown in Table 4 in the specifications (3) for the competitors and (5) for the greenfield firms.

We find that for the competitor specifications, the coefficient for the dummy variable man-made accident is negative and statically significant at 1% level. For the greenfield firms, the dummy variable for working accidents is negative, yet statistical significant at 10% level. One of the explanations for the results is that following this kind of accident, investors are wary of possible future safety and regulatory costs.

Blacconiere and Patten (1994) show that the news of a chemical leak in Bhopal, India, caused an overall negative market reaction among firms with chemical operations. Moreover, they found that firms with more extensive environmental and safeguard disclosures prior to the disaster experienced less negative market reaction. We assume that most of the greenfield firms disclose only limited information on future risk related to potash mining disasters. The limited disclosure may explain the stronger investor reaction to man-made accidents as these investors recognize additional risk related to potash mining and to future regulatory costs because of a work accident. We

may assume that the immediately impact of man-made accident is stronger for competitors than greenfield firms, what would explain why the results are weaker for the latter.

As we expected, we find inflows in the affected companies have to some extent positive impact on direct and indirect competitors. The coefficient for the inflow dummy is positive in the specification for competitors and greenfield firms, yet statistical insignificant. One explanation of the results could be that investors are aware that the affected potash firm has a surplus of capacities. Consequently, a disaster that leads to an immediately closing of a potash mine does not need to influence the supply of the competitors as the company affected by the disaster either has other potash mines or is part of a cartel that can fill the gap in the market (Gnutzmann et al., 2019).

[Table 4]

5.3 Sensitivity analysis

Our results show that stock prices, on average, decline following a potash mining disaster. Capelle-Blancard and Laguna (2010), Kaplanski and Levy (2010), and Ho, Qiu, and Tang (2013) show that the characteristics of the firm and the accident may explain the differences between the abnormal returns across events following the announcement. In this subsection, we analyze other potential effects that may be related to the mining disaster and the observed event effects on rates of return. All of the regression include four dummy variables as proxy for the different subgroups of accidents, namely two for each of the natural disasters categories and two for each of the man-made accidents as in specification (2) in Table 4, but are not shown for brevity. We find that adding additional control variables does not change the sign or the statistical significance of the coefficients for the proxy variables for the type of accident. Consequently, the sensitivity analysis confirms that the type of accident

determines the largest shift in the stock market response following an event and these results are robust.

5.3.1 Company and market characteristics

Table 5 reports the regression where we add firm-level variables controlling for size, leverage, liquidity, and profitability of the companies. Moreover, in Table 5 we control for the price of the potash using the current and expected year to year return. Lastly, we also control for the size of the mine that was affected by the disaster. Panel A of Table 5 shows the results for the affected companies by the disaster. Panel B of Table 5 presents the results for the not affected potash producers by any of the disasters in a potash mine. Panel C of Table 5 shows the results for companies with greenfield potash firms following any the disasters in a potash mine.

In the specifications for the affected companies, we find that the coefficients for all the financial variables are negative and only the coefficient for leverage is statistically insignificant. On one hand as expected, we find that the liquidity ratio is negatively related to the abnormal returns and is statistically significant at the 5% level. Consequently, the results indicate that the stock of more risky companies are more likely to respond to the announcement of an accident. On the other hand, we find that larger and more profitable companies faces a stronger reaction to the adverse events. Our results are in contrast to Carpentier and Suret (2015), who find a positive association between return on equity and long run abnormal performance. Conversely, Capelle-Blancard and Laguna (2010) and Carpentier and Suret (2015) report a negative association between firm size and abnormal performance, yet in their specification the coefficient is insignificant. Similarly, we find a negative association but our results are statistically significant at the 5% level. Indeed, we repeated the estimation using the

company's total assets rather than market capitalization and the results remain unchanged.

An explanation for our results can be that investors of larger and more profitable firms are overly optimistic and an accident results in a short-term change in sentiments. Another explanation is that investor may anticipate that such firms will pay a significant fine should the company be responsible for the occurred accident.

As the event does not directly affect the competitors we do not expect their financial characteristics to have an impact on the market reaction. Similarly, we do not expect any effect of financial characteristics on greenfield companies as they only incur mine development costs and their revenues only begin once the exploration of mineral resources start at a later date. The lack of revenues is the reason the number of observation drop when we employ as control variable profitability in the regression. In fact, the regression analysis confirms that no financial variable is statistically significant for the competitors as well greenfield firms. Moreover, in the specification for the greenfield firms the coefficients for all the variables are close to zero.

Commodity prices experience periods of both boom and bust. Given the direct link between commodity prices and mining firms' valuations, the general state of the market could influence the market reaction to mine accidents. Another important factors possibly affecting investor reactions is the impact of the accident on the potash supply described by the size of the affected mine. The impact of mine size is rather self-evident – the larger the affected mine, the larger are the potential losses, the effect of the potash price changes comes from the fact that the potash producers, typically, operate multiple mines. Consequently, production loss from one mine can be partially compensated by an increase in potash prices in the aftermath of the disaster. This may happen only when the market is tight, i.e. prices were increasing in the previous 12 months.

Contrary to initial expectation, we find however that the coefficient for potash price changes and mine size for the affected companies are statically insignificant. Similarly, we find that the coefficients for potash price changes and mine size are statically insignificant for greenfield firms. Indeed, the coefficient for mine size is insignificant in all the specifications. One of the explanation for the insignificant result is that most investors are not able to associate the affected mine name that is presented in the news with its size, especially in the first days following the event. Indeed, most of the news reports provide information mainly about the characteristics of the accident without providing any specific information how this event will affect the potash market.

In contrast, we find that the coefficient for year to year potash price change is negative and statically significant only for direct competitors at 1% level. It means that the abnormal returns for the competitors are positively related to the potash prices following an accident in a competing mine. Additionally, we find that the coefficient for expected price change of potash is also negative and statistically significant at 1% level

In a sensitivity analysis we interacted the changes of potash prices with different accident types. Our sensitivity analysis reveals that the interaction term is negative and statistical significant when the accident type is natural disaster or inflow. In other words, competitor's positive abnormal returns following a natural disaster are strongly related to the current and expected potash prices. An explanation of the results could be that investors hope for an increase of potash prices following an accident in a potash mine. It also explains why the results are significant for natural disasters. In a tight market an increase of potash prices should in the first place benefit the competitors whose mining capacity was not affected by the accident.

[Table 5]

5.3.3 Accident severity and media exposure

Market reaction is triggered by information about the accident, which naturally comes through various media channels. Indeed, a large number of studies show that as the number of fatalities increase, companies experience larger negative abnormal returns following an accident (Capelle-Blancard and Laguna. 2010). In addition, Ho, Qiu, and Tang (2013) find that the stock prices of rival airlines suffer in large-scale disasters, yet benefit from the disasters when the fatalities are small. Hence, we examine stock market reaction by controlling for accidents severity as described by the number of injuries and fatalities related to the accident.

More media exposure implies that more investors have information about the accident. At the same time, a large number of recorded media reports is likely to be correlated with greater accident damage, as only more dramatic events are likely to attract the attention of the general audience rather than local ones. When a topic gains a certain level of attention in the media, it is more likely to become newsworthy and attract more attention from other outlets. Vasterman, Yzermans, and Dirkzwager (2005) report that media hype after a disaster has a tendency to take on a life of its own when a shocking story unfolds. Moreover, the media can have a huge impact on the way a disaster and the risk issues involved are perceived by the public and authorities.

We assess the impact of accidents media coverage by taking into account both aspects of exposure: quantitative, the number of media reports and Twitter tweets; and qualitative, the negative sentiment in those texts.

Table 6 confirms that more fatalities amplify the negative market reaction to the accident for the affected companies. On one hand, we find that none of the coefficients for the control variables for injuries or death are statistically significant. On the other hand, we run the same regression using only a subsample of firms affected by a

mankind accident. The results for the subsamples periods are not presented for brevity but are available upon request. In fact, when we use the subsample for mankind accidents the coefficients for injuries and death are statistical significant at least at 5% level. In our opinion, it means that market reaction to man-made accidents is conditional on human fatalities, which show that they act very rational.

Surprisingly, the results show no significant relation between the media coverage on the event day and the day following the accident and the abnormal returns. As reported in Table 6, coefficients denoting the impact of media variables on companies directly affected by the disaster and greenfield firms are all insignificant. Interestingly, we do not observe any significant differential direction of the impact of the proxy variables for news coverage on affected, competitors and greenfield firms. All coefficients have the same sign for both groups.

We find, however, that the coefficient on news sentiment is positive and significant at the 5% level for the competitor firms. The result means that if there were more negative articles about the affected firms following the disaster, the stock price of the competitor moved higher. An explanation for the result is that media hype generates news waves repeatedly reinforcing one specific sentiment while ignoring other perspectives. Vasterman, Yzermans, and Dirkzwager (2005) report that such news waves can fuel fear and anxiety among people in the aftermath of a disaster, which may determine the reaction of investors in competing firms.

Interestingly, the results are not confirmed when we employ as control variable the number of negative information on Twitter. The coefficient for the variable for Twitter information is however negative but statistical insignificant. It looks like shareholders pay greater attention to information on traditional news than social media, which may determine their investment sentiments. In our interpretation of the results for

media coverage, we need, however, to be very careful as the proxy variables representing traditional and social media news are available only for the last six years. Thus, the results are available for a significantly smaller number of accidents than in the previous regressions.

[Table 6]

In summary, the empirical analysis reveals that for the wide set of accident types in the sample, characteristics of the company or accident, current level of potash prices and its trend, as well media coverage of the company following the accident provide only a weak explanation of the stock market reaction to potash mine disasters for all types of firms.

6. Conclusion

The highly concentrated oligopolistic structure of the market makes the potash industry an ideal object of study to assess the impact of adverse events on a given firm and on its competitors. We show that news about a mining accident affects the stock of the competitors of the affected company as well the greenfield potash firms. Moreover, the impact of the accident on the stock of the competitors and greenfield firms strongly depends on the type of mining disaster.

The stock of the affected companies responds the most to information on brine inflow in potash mines. Inflows of water into a potash mine can result in its closure, which can lead to significant losses at the company, as this type of accident is often uninsured. In contrast, man-made accidents result in only a small reaction of the stock of the affected companies. In most cases, such accidents do not have a negative impact on potash production and potential losses related to the event are insured. The stock of competing companies and greenfield firms reacts, however, negatively to information on work accidents in the affected companies. We attribute these results to the wariness

of investors to potential new regulation following such accidents, which could result in higher production costs for all mining companies.

As expected, we find that the stock of competing companies is not affected by natural disasters. We attribute it to the oligopolistic structure of the market controlled by cartels, which have a surplus of capacity. Consequently, the affected company can probably use its existing capacities to compensate a loss of a mine as a result of an inflow. Interestingly, we find however, that the stock prices of greenfield firms react positively to the information of an inflow in an existing potash mine. In our opinion, the increase of the stock of greenfield firms could reflect the potential demand for new potash fields by affected companies, which are interested in preserving their excess capacity in the long run.

Mine accidents are not extraordinary in the potash mining industry. In the last five years, there were, on average, five accidents per year that attracted the attention of media outlets around the world. The relatively high frequency of such events prepares investors for such information. We document that as long as the accident does not result in a long-term mine closure, news on the accidents have, at most, a modest impact on the stock of the affected firms. We find that potash mine disasters are followed by negative rates of return in the stock market accompanied by a reversal effect. The magnitude and timing of the reversal depends strongly on the type of accident.

In our opinion, there is more than one possible interpretation of investor reaction to potash mining disasters. First, the ability to mitigate the impact of negative news could be explained by excess capacity typical in this industry. Most of the potash producers can, at little cost, compensate for production losses at the accident site with increased output from other mines. Second, damages to mining equipment resulting from accidents do not result in losses as they are typically covered by insurance. Last, as

potash firms do not serve individual customers, tastes and preferences that could be affected by negative news do not play a role.

In the study, we analyzed the impact of firm financial performance, market characteristics, and accident media coverage on investor reaction to adverse events. We find that the additional control variables play only a minor role in determining investor reaction to the information on the mining disaster. In our opinion, this shows that potash mine investors are mostly rational as we observe a significant reaction only to accidents that may result in considerable economic losses, whereas we find that other factors do not influence the event effect.

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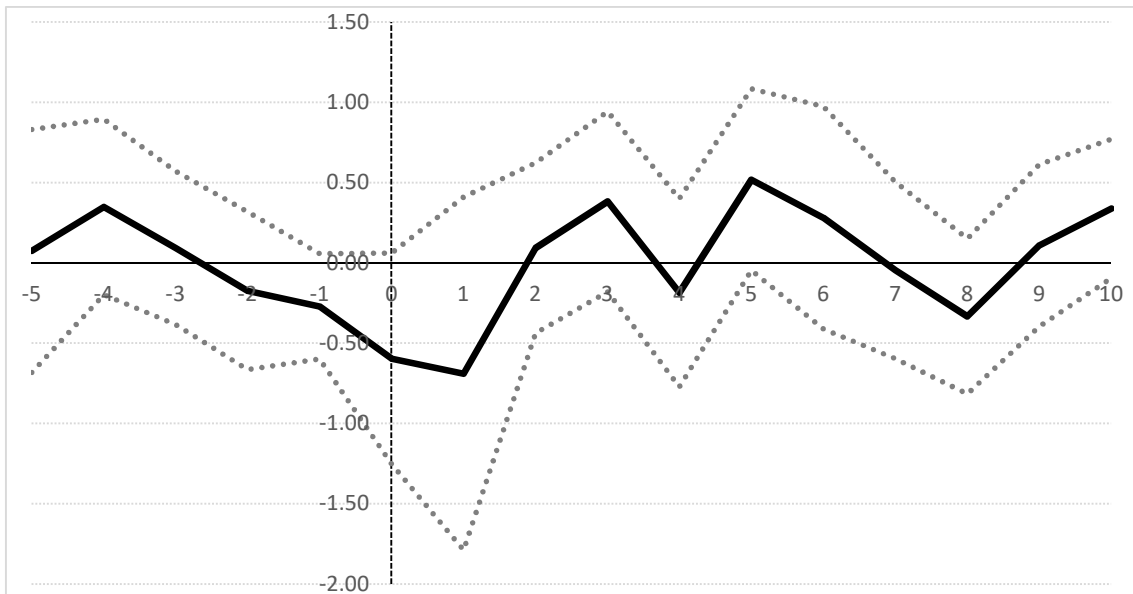
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Figure 1. **Abnormal returns for affected potash companies (all disasters)**

The figures present average abnormal returns and cumulative average abnormal return for companies affected by the disaster in the period -5 to 10 days to the event time. Event time is days relative to the disaster date [0]. Abnormal returns are computed given the market model parameters estimated with OLS through the period [-190;-10]. The sample is composed of 44 disasters in the potash mine over the period 1986-2019.

- a) Average abnormal returns for all disasters in potash mines (in %) with confidence intervals at the 5% level



- b) Cumulative average abnormal returns for all disasters in potash mines (in %) with confidence intervals at the 5% level

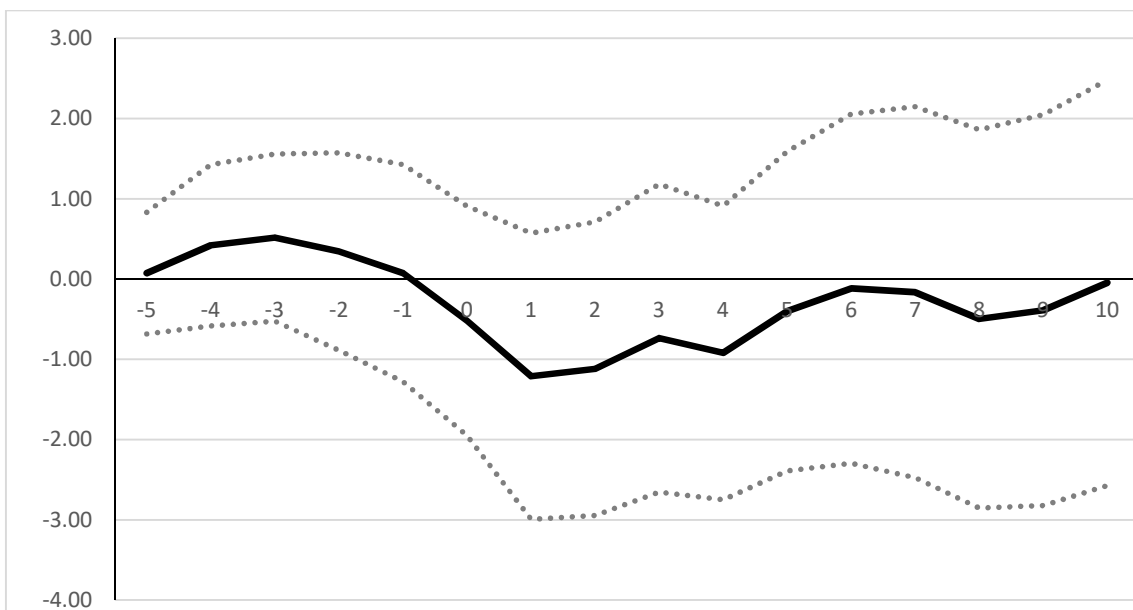
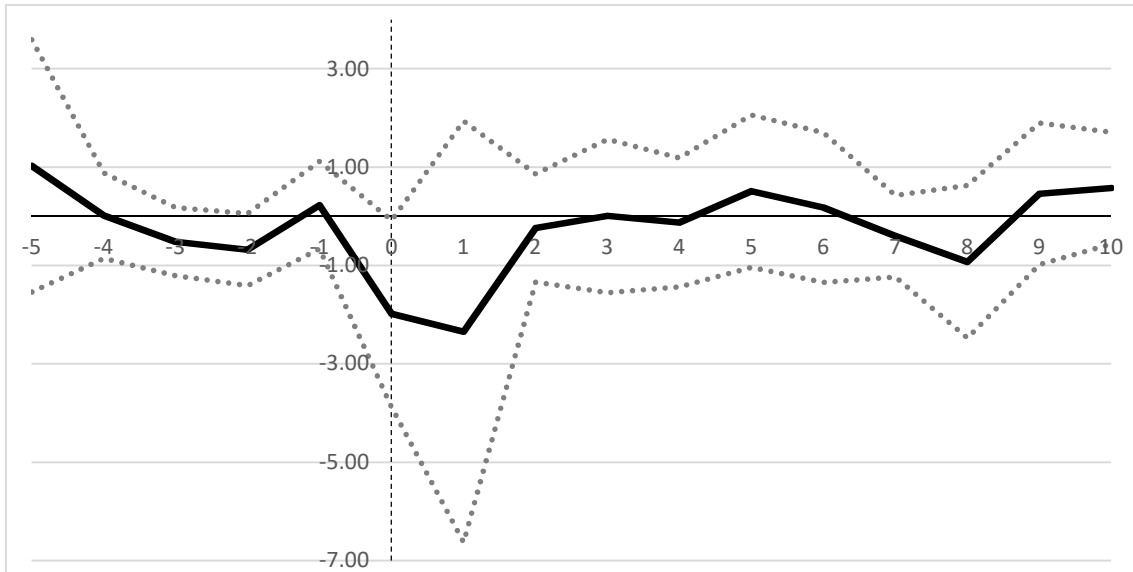


Figure 2. **Abnormal returns for affected potash companies (natural disasters)**

The figures present average abnormal returns and cumulative average abnormal return for companies affected by the disaster in the period -5 to 10 days to the event time. Event time is days relative to the disaster date. Abnormal returns are computed given the market model parameters estimated with OLS through the period [-190;-10]. The sample is composed of 10 natural disasters in the potash mine over the period 1986-2019. Average abnormal returns with confidence intervals at 5% level.

a) Average abnormal returns for natural disasters in potash mines (in %)



b) Cumulative average abnormal returns for natural disasters in potash mines (in %)

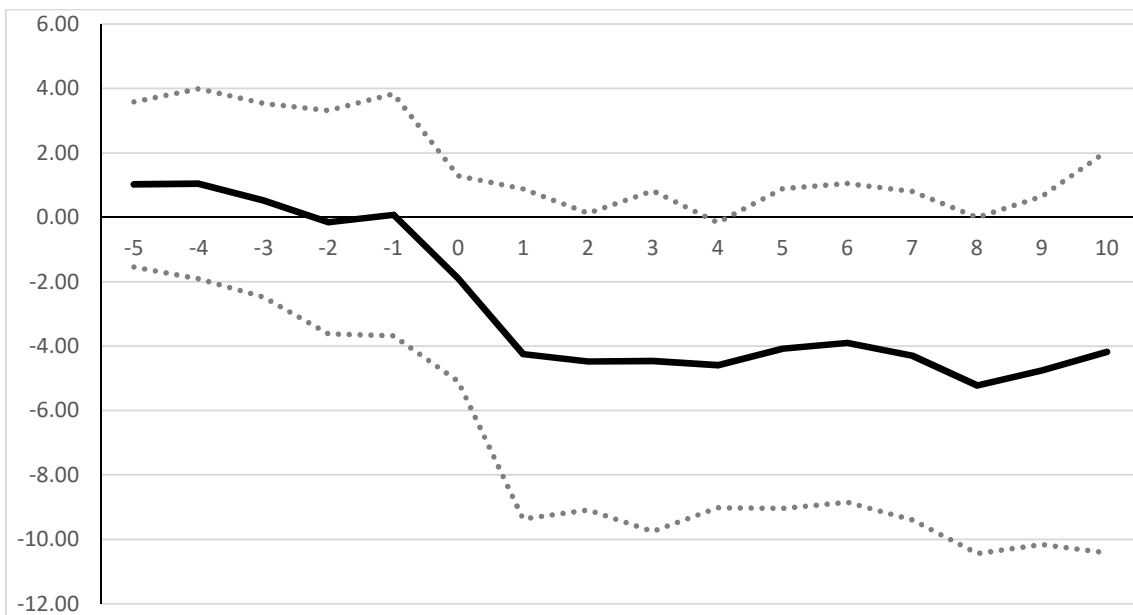
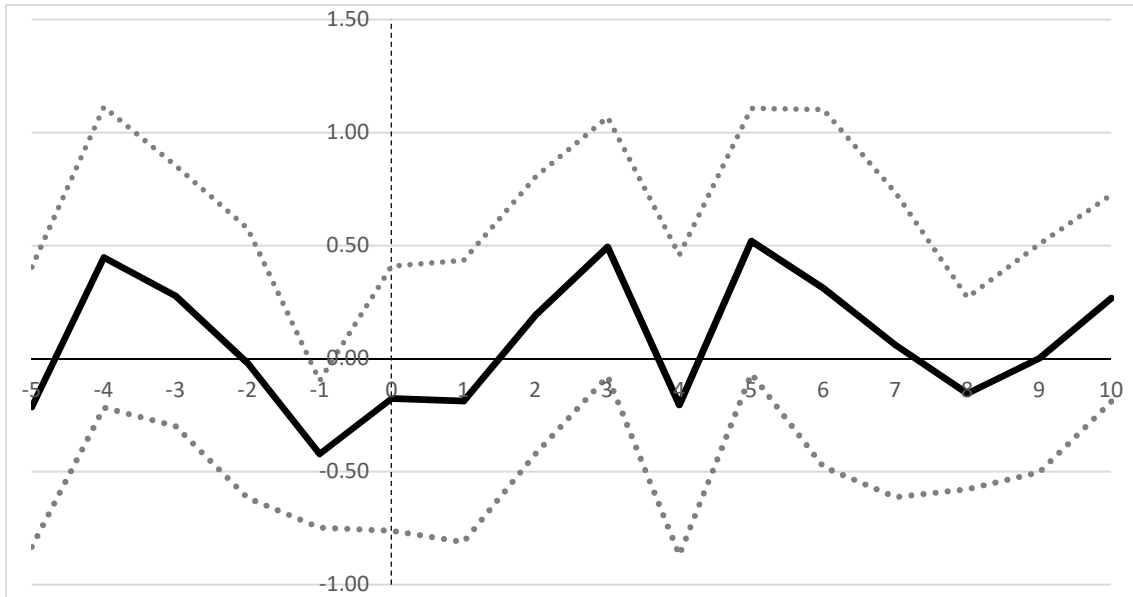


Figure 3. **Abnormal returns for affected potash companies (man-made accidents)**

The figures present average abnormal returns and cumulative average abnormal return for companies affected by the disaster in the period -5 to 10 days to the event time. Event time is days relative to the disaster date. Abnormal returns are computed given the market model parameters estimated with OLS through the period [-190;-10]. The sample is composed of 34 man-made accidents over the period 1986-2019. Average abnormal returns with confidence intervals at 5% level.

a) Average abnormal returns for accidents in potash mines (in %)



b) Cumulative average abnormal returns for accidents in potash mines (in %)

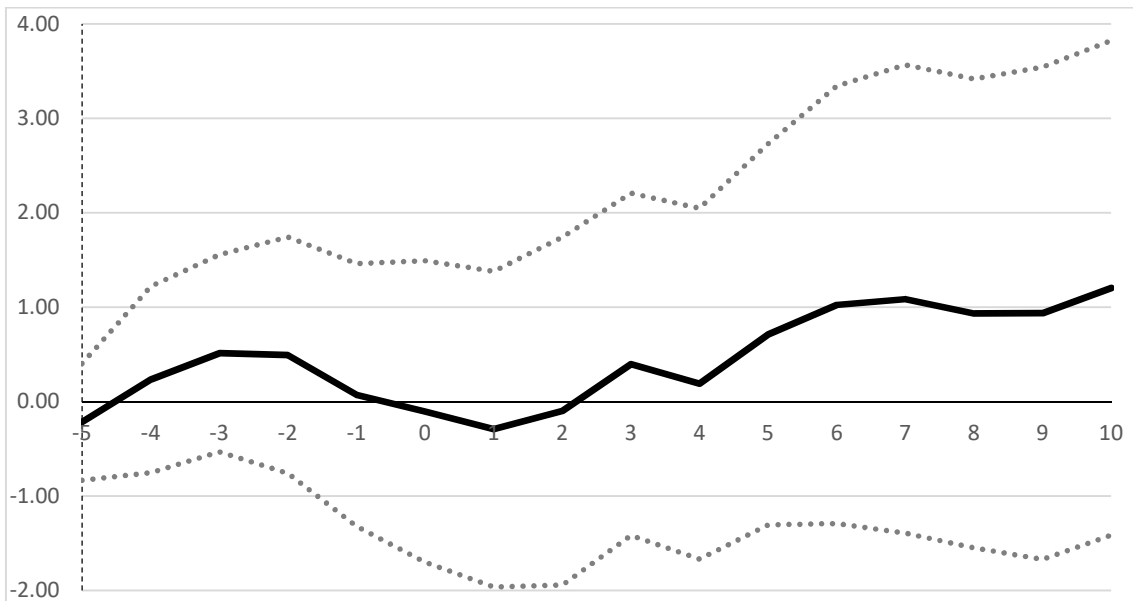


Table 1. Descriptive statistics

The sample data is for the years 1986-2019. Variables definitions are in Appendix in Table A3.

Statistic	All Firms			Affected companies			Competitors			Greenfields		
	Obs.	Mean	Std. Dev.	Obs.	Mean	St. Dev.	Obs.	Mean	St. Dev.	Obs.	Mean	St. Dev.
CAR _[0; 1]	2,679	-0.39	11.28	44	-1.22	5.36	579	-0.01	2.58	2,043	-0.44	12.79
Inflow	2,679	0.09	0.29	44	0.09	0.29	579	0.11	0.31	2,043	0.09	0.28
Collapse	2,679	0.17	0.38	44	0.14	0.35	579	0.19	0.40	2,043	0.17	0.37
Fire	2,679	0.26	0.44	44	0.27	0.45	579	0.24	0.43	2,043	0.26	0.44
Work	2,679	0.48	0.50	44	0.50	0.51	579	0.46	0.50	2,043	0.48	0.50
Mkt cap	2,061	140.20	829.52	41	92.58	178.75	499	533	1612.32	1,508	9.54	35.44
Leverage	2,103	15.11	39.06	42	28.47	15.07	527	27.84	17.18	1,521	10.29	43.77
Profitability	745	30.72	29.60	42	36.69	19.87	529	33.94	17.32	161	17.01	51.92
Liquidity	2,172	10.57	30.50	42	1.85	0.92	519	2.50	1.52	1,598	13.48	35.09
Δ Potash	2,679	5.07	41.10	44	11.57	21.70	579	9.20	22.39	2,043	5.39	40.50
Δ Potash _{exp}	2,679	-3.41	18.12	44	-6.16	11.22	579	-5.02	11.47	2,043	-3.55	17.91
Mine	2,679	1.57	0.68	44	1.51	0.65	579	1.52	0.65	2,043	1.58	0.68
Injury	2,679	0.94	4.11	44	1.02	4.31	579	0.92	4.08	2,043	0.95	4.13
Death	2,679	0.74	1.48	44	0.70	1.47	579	0.69	1.41	2,043	0.76	1.51
News	1,760	18.96	29.51	29	18.21	29.72	348	18.21	29.25	1,383	19.17	29.59
Neg. News	1,633	1.24	1.93	27	1.19	1.94	324	1.19	1.91	1,282	1.25	1.93
Twitter	1,277	5.67	9.88	21	5.43	9.95	252	5.43	9.73	1,004	5.74	9.92
Neg. Twitter	1,087	1.23	2.36	18	1.17	2.38	216	1.17	2.32	853	1.24	2.37

Table 2. Pairwise correlations

The sample data is for the years 1986-2019. Variables definitions are in Appendix in Table A3.

	CAR	Mkt cap	Leverage	Profit.	Liq.	Δ Pot.	Δ Pot. _{exp}	Mine	Injury	Death	News	Neg. News	Twitter	Neg. Twitter.
CAR _[0; 1]	1													
Mkt cap	0.00	1												
Leverage	-0.01	0.10 ^{***}	1											
Profitability	-0.07 [*]	0.05	0.25 ^{***}	1										
Liquidity	-0.01	-0.04 [*]	-0.11 ^{***}	-0.18 ^{***}	1									
Δ Potash	0.02	0.00	0.00	-0.13 ^{***}	0.02	1								
Δ Potash _{exp}	-0.01	0.00	0.00	0.13 ^{***}	-0.04 [*]	-0.97 ^{***}	1							
Mine size	-0.03	-0.01	0.00	-0.05	0.00	-0.18 ^{***}	0.12 ^{***}	1						
Injury	0.01	0.00	0.02	0.04	0.00	0.04 [*]	0.00	-0.21 ^{***}	1					
Death	0.01	0.01	0.03	0.00	-0.02	-0.11 ^{***}	0.14 ^{***}	0.17 ^{***}	0.04 [*]	1				
News	-0.03	0.01	-0.01	-0.13 ^{***}	-0.01	-0.16 ^{***}	0.22 ^{***}	0.28 ^{***}	-0.13 ^{***}	0.57 ^{***}	1			
Neg. news	-0.03	0.00	-0.02	-0.17 ^{***}	0.01	0.05 [*]	0.06 ^{**}	0.08 ^{***}	-0.10 ^{***}	0.17 ^{***}	0.78 ^{***}	1		
Twitter	-0.05	0.00	-0.02	-0.11 ^{**}	0.03	0.29 ^{***}	-0.26 ^{***}	0.23 ^{***}	-0.15 ^{***}	0.15 ^{***}	0.58 ^{***}	0.66 ^{***}	1	
Neg. twitter	-0.03	0.00	-0.02	-0.12 ^{**}	0.04	0.46 ^{***}	-0.43 ^{***}	0.17 ^{***}	-0.16 ^{***}	-0.04	0.49 ^{***}	0.58 ^{***}	0.93 ^{***}	1

Note: ***, **, * denote statistically significance at 1%, 5% and 10%, respectively

Table 3. Average daily abnormal returns and cumulative abnormal returns

This table reports the average abnormal returns (AAR) and cumulative average abnormal return (CAAR) from the disaster date [0] to one day following [1] the disaster (in %). We distinguish between the natural disasters and man-made accidents. In each of the group of disasters we distinguish two kind of events: inflow and collapse for natural disasters; fire and working accidents for man-made accidents. Abnormal returns are computed given the market model parameters which are estimated with OLS through the period [-190;-10] in event time. Panel A and D shows the results for the affected companies by the disaster; Panel B and E for potash producing companies that are not affected by the accident; Panel C and F for greenfield potash firms.

Natural disasters and man-made accidents							
	All	Natural			Man-made		
t	(1)	All	Inflow	Collapse	All	Fire	Work
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average Abnormal Returns (AAR)							
<i>Panel A: Affected companies by the disaster</i>							
0	-0.69***	-1.99***	-3.35	-1.08	-0.31	0.19	-0.06
1	-0.80	-2.34	-5.06	-0.05	-0.34	0.35	-0.07
N	44	10	4	6	34	12	22
<i>Panel B: Competitors</i>							
0	-0.06	-0.07	0.15	-0.19	-0.06	0.10	-0.15
1	0.06	0.37***	0.51**	0.29*	-0.07	-0.09	-0.06
N	580	174	62	112	406	139	267
<i>Panel C: Greenfields</i>							
0	-0.25	-0.02	0.11	-0.09	-0.32	-0.49	-0.22
1	-0.28	-0.11	0.32	-0.35	-0.34	0.06	-0.57**
N	2,203	579	206	373	1,589	571	1,018
Cumulative Average Abnormal Return (CAAR)							
<i>Panel D: Affected companies by the disaster</i>							
0	-0.69***	-1.99***	-3.35	-1.08	-0.32**	0.19	-0.06
1	-1.15***	-4.33	-8.41	-1.61	-0.65	0.54	-0.13
N	44	10	4	6	34	12	22
<i>Panel E: Competitors</i>							
0	-0.06	-0.07	0.15	-0.19	-0.06	0.10	-0.15
1	0.00	0.30	0.66	0.10	-0.13	0.01	-0.21
N	580	174	124	224	406	139	267
<i>Panel F: Greenfields</i>							
0	-0.25	-0.02	0.11	-0.09	-0.32	-0.49	-0.22
1	-0.53**	-0.13	0.42	-0.44	-0.65**	-0.43	-0.79*
N	2,203	579	206	373	1,589	571	1,018

Note: ***, **, * denote statistically significance at 1%, 5% and 10%, respectively.

Table 4. Impact of accident type on cumulative abnormal returns

This table report results from OLS regressions. The dependent variable is the cumulative abnormal return $CAR_{[0, 1]}$ to the first day following the disaster. In all specification we use as dummy variables to control for different disasters types. Their definitions are presented in Appendix in Table A3. The sample is composed of 55 potash mining disasters over the period 1986-2019. In columns (1)-(2) we shows the results for the affected companies by the disaster; (3)-(4) for all potash producing companies that are not affected by the disaster and (5)-(6) for greenfield potash firms .

	Affected companies		Competitor		Greenfield	
	(1)	(2)	(3)	(4)	(5)	(6)
Natural	-4.327** (1.625)		0.046 (0.236)		0.069 (0.562)	
Man-made	-0.309 (0.881)		-0.352** (0.150)		-0.608* (0.328)	
Inflow		-8.406*** (2.481)		0.113 (0.393)		0.772 (0.954)
Collapse		-1.609 (2.025)		0.009 (0.294)		-0.304 (0.695)
Fire		0.539 (1.432)		0.055 (0.260)		-0.452 (0.552)
Work		-0.771 (1.058)		-0.556*** (0.184)		-0.693* (0.408)
N	44	44	636	636	2043	2043
R ²	0.147	0.242	0.009	0.014	0.002	0.002
Adj. R ²	0.106	0.166	0.006	0.008	0.001	0.000

Note: Standard errors are presented in parentheses. ***, **, * denote statistical significance at 1%, 5% and 10%, respectively

Table 5. Impact of firm and market characteristics on cumulative abnormal returns

This table report results from OLS regressions. The dependent variable is the cumulative average abnormal return $CAR_{[0;1]}$ to the first day following the disaster. The sample is composed of 55 potash mining disasters over the period 1986-2019. Panel A shows the results for the affected companies by the disaster; Panel B for potash producing companies that are not affected by the disaster; Panel C for greenfield potash firms. In the columns we present the results of a regression where the independent variables that are market capitalization (*Mkt cap*), total debt to total assets (*Leverage*), gross margin (*Profit.*), year over year change in potash prices ($\Delta Potash$), expected changes in potash prices ($\Delta Pot.exp$) and the mine size affected by the accident (*Mine*). In all specification we use as dummy variables to control for the four disasters types, yet not reported for brevity. Variables definitions are in Appendix in Table A3.

	Mkt cap ^a	Leverage	Profit.	Liquidity	$\Delta Potash$	$\Delta Pot.exp$	Mine ^a
<i>Panel A: Affected companies by the disaster</i>							
Variable	-1.345** (0.635)	-0.079 (0.054)	-0.087** (0.040)	-1.976** (0.839)	-0.042 (0.035)	-0.074 (0.068)	-2.357 (1.742)
N	41	42	42	42	44	44	44
R ²	0.326	0.283	0.328	0.341	0.269	0.264	0.276
Adj. R ²	0.232	0.187	0.238	0.252	0.175	0.170	0.183
<i>Panel B: Competitors</i>							
Variable	-0.083 (0.053)	-0.004 (0.008)	-0.008 (0.008)	-0.052 (0.091)	-0.021*** (0.003)	-0.044*** (0.007)	-0.169 (0.266)
N	553	582	584	574	636	636	636
R ²	0.020	0.018	0.019	0.020	0.089	0.079	0.015
Adj. R ²	0.011	0.009	0.011	0.011	0.082	0.072	0.007
<i>Panel C: Greenfield firms</i>							
Variable	-0.062 (0.087)	-0.004 (0.006)	-0.009 (0.006)	-0.002 (0.007)	0.000 (0.007)	0.004 (0.016)	-0.358 (0.627)
N	1508	1521	161	1598	2043	2043	2043
R ²	0.003	0.005	0.057	0.006	0.002	0.002	0.002
Adj. R ²	0.001	0.002	0.027	0.003	0.000	0.000	0.000

Note: Standard errors are presented in parentheses. ***, **, * denote statistical significance at 1%, 5% and 10%, respectively. ^aIn the regression, this variable is included as $\log(\text{variable})$.

Table 6. Impact of accident characteristics and media coverage on cumulative abnormal returns

This table report results from OLS regressions. The dependent variable is the cumulative average abnormal return $CAR_{[0;1]}$ to the first day following the disaster. The sample is composed of 55 potash mining disasters over the period 1986-2019. Panel A shows the results for the affected companies by the disaster; Panel B: for all potash producing companies that are not affected by the accident; Panel C: for greenfield potash firms. In the columns we present the results of a regression where the independent variables that are number of injuries (*Injuries*), number of deaths (*Deaths*), number of news (*News*), number of negative news (*Neg. News*), number of tweets (*Tweets*), and number of negative tweets. In all specification we use as dummy variables to control for the four disasters types, yet not reported for brevity. Variables definitions are in Appendix in Table A3.

	Injuries	Deaths	News	Neg. News	Tweets	Neg. Tweet
<i>Panel A: Affected companies by disaster</i>						
Variable	0.948 (1.257)	-1.078 (1.604)	-0.174 (0.555)	1.271 (2.306)	0.410 (1.151)	2.472 (2.510)
N	44	44	29	10	21	18
R ²	0.253	0.251	0.388	0.321	0.426	0.470
Adj. R ²	0.157	0.155	0.261	0.031	0.246	0.266
<i>Panel B: Competitors</i>						
Variable	0.110 (0.224)	-0.084 (0.273)	-0.151* (0.086)	1.501** (0.718)	0.085 (0.162)	0.313 (0.351)
N	636	636	377	130	273	234
R ²	0.015	0.015	0.012	0.057	0.016	0.017
Adj. R ²	0.007	0.007	-0.001	0.035	-0.003	-0.004
<i>Panel C: Greenfield firms</i>						
Variable	0.311 (0.486)	0.472 (0.575)	-0.223 (0.194)	2.660 (2.121)	-0.519 (0.369)	-0.710 (0.784)
N	2043	2043	1383	504	1004	853
R ²	0.002	0.002	0.008	0.015	0.010	0.013
Adj. R ²	-0.000	0.000	0.005	0.009	0.005	0.008

Note: Standard errors are presented in parentheses. ***, **, * denote statistically significance at 1%, 5% and 10%, respectively

Appendix

Table A1. List of the potash mining companies in the event study sample

Id	Company name	Country	Greenfield
1	Potash Corp of Saskatchewan	Canada	No
2	Mosaic	United States	No
3	Sociedad Quimica y Minera de Chile	Chile	No
4	K+S	Germany	No
5	Israel Chemicals	Israel	No
6	Agrium	Canada	No
7	UralKali	Russia	No
8	Arab Potash	Jordan	No
9	Acron	Russia	Yes
10	Compass Minerals International	United States	No
11	Intrepid Potash	United States	No
12	Western Potash	Canada	Yes
13	Encanto Potash	Canada	Yes
14	IC Potash	Canada	Yes
15	Gensource Potash Corporation	Canada	Yes
16	Karnalyte Resources	Canada	Yes
17	Kore Potash	Australia	Yes
18	Qinghai Salt Lake Potash	China	No
19	Yanzhou Coal	China	Yes
20	Vale	Brazil	No
21	Prospect Global Resources	United States	Yes
22	African Potash	United Kingdom	Yes
23	Sirius Minerals	United Kingdom	Yes
24	Galaxy Resources	Australia	Yes
25	Activex	Australia	Yes
26	Toro Energy	Australia	Yes
27	Rum Jungle Resources	Australia	Yes
28	Agrimin	Australia	Yes
29	Plymouth Minerals	Australia	Yes
30	Danakali	Australia	Yes
31	Highfield Resources	Australia	Yes
32	Kazakhstan Potash Corporation	Australia	Yes
33	Parkway Minerals NL	Australia	Yes
34	Reward Minerals	Australia	Yes
35	Red Metal	Australia	Yes
36	BHP Billiton	Australia	Yes
37	FYI Resources	Australia	Yes
38	Australian Potash	Australia	Yes

Id	Company name	Country	Greenfield
39	Centrex Metals	Australia	Yes
40	Harvest Minerals	Australia	Yes
41	Lithium Americas	Canada	Yes
42	Lara Exploration	Canada	Yes
43	American Lithium	Canada	Yes
44	Pacific Potash	Canada	Yes
45	Passport Potash	Canada	Yes
46	Potash Ridge	Canada	Yes
47	Crystal Peak Minerals	Canada	Yes
48	Marifil Mines	Canada	Yes
49	Great Quest Fertilizer	Canada	Yes
50	Grizzly Discoveries	Canada	Yes
51	Sennen Potash	Canada	Yes
52	Channel Resources	Canada	Yes
53	Mesa Exploration	Canada	Yes
54	North American Potash Developments	Canada	Yes
55	Anglo Potash	Canada	Yes
56	AgriMinco	Canada	Yes
57	GrowMax Resources	Canada	Yes
58	Red Moon Potash	Canada	Yes
59	Allana Resources	Canada	Yes
60	Talon Metals	Canada	Yes
61	Migao	Canada	Yes
62	Potash One	Canada	Yes
63	Rio Verde Minerals Development	Canada	Yes
64	MagIndustries	Canada	Yes
65	Potash America	United States	Yes
66	IMC Global	United States	No
67	Orocobre	Australia	Yes
68	Nutrien	Canada	No

Table A2. Identified natural disasters and man-made accidents in potash mines in the period 1986-2019

Date	Mine	Owner	Accident type
25 Jul. 1986	3 rd Berezniki	UralKali	Collapse
1 Jan. 1987	Patience Lake	Potash Corp. of Saskatchewan	Collapse
13 Mar. 1989	Merkers	Kalibetrieb Werra	Collapse
5 Jan. 1995	Solikamsk-2	UralKali	Collapse
11 Sep. 1996	Teutschenthal	KALIMAG	Collapse
30 Oct. 1996	Corry	Potash Corp. of Saskatchewan	Working Accident
18 Jun. 1997	Cassidy Lake	Potash Corp. of Saskatchewan	Inflow
29 Jan. 2006	K2 Esterhazy	Mosaic	Fire/Gas
31 Aug. 2006	Vanscoy	Agrium	Working Accident
17 Oct. 2006	Berezniki	UralKali	Inflow
24 Jan. 2007	K2 Esterhazy	Mosaic	Inflow
19 Apr. 2007	Boulby	Isreal Chemical	Working Accident
28 Jul. 2007	Berezniki	UralKali	Collapse
7 Sep. 2008	Lanigan	Potash Corp. of Saskatchewan	Working Accident
21 Nov. 2009	Sussex New Brunswick	Potash Corp. of Saskatchewan	Working Accident
28 Nov. 2009	K2 Esterhazy	Mosaic	Working Accident
18 Feb. 2010	BKPRU-2	UralKali	Collapse
11 May. 2010	Vanscoy	Agrium	Working Accident
25 Nov. 2010	Berezniki	UralKali	Collapse
16 Jun. 2011	Colonsay	Mosaic	Working Accident
24 Jun. 2011	Complex 2	Belaruskali	Inflow
4 Dec. 2011	Berezniki	UralKali	Collapse
18 Jan. 2012	Boulby	Isreal Chemical	Working Accident
5 Apr. 2012	Sigmundshall	K+S	Fire/Gas
25 Jun. 2012	Allan	Potash Corp. of Saskatchewan	Working Accident
12 Sep. 2012	Berezniki	UralKali	Working Accident
25 Sep. 2012	Rocanville	Potash Corp. of Saskatchewan	Fire/Gas
11 Feb. 2013	Colonsay	Mosaic	Collapse
13 Jul. 2013	Vanscoy	Agrium	Working

Date	Mine	Owner	Accident type
			Accident
1 Oct. 2013	Unterebreizbach	K+S	Fire/Gas
27 Oct. 2013	K2 Esterhazy	Mosaic	Fire/Gas
9 Jan. 2014	Boulby mine	Isreal Chemical	Collapse
14 Feb. 2014	Vanscoy Mine	Agrium	Fire/Gas
17 Feb. 2014	Corry	Potash Corp. of Saskatchewan	Working Accident
22 Jul. 2014	Corry	Potash Corp. of Saskatchewan	Working Accident
10 Sep. 2014	Allan	Potash Corp. of Saskatchewan	Fire/Gas
18 Nov. 2014	Solikamsk-2	UralKali	Inflow
15 Mar. 2015	Berezniki-4	UralKali	Working Accident
26 Oct. 2015	K2 Esterhazy	Mosaic	Working Accident
13 Apr. 2016	Boulby mine	Isreal Chemical	Fire/Gas
17 Jun. 2016	Boulby mine	Isreal Chemical	Fire/Gas
17 Jul. 2016	Legacy mine	K+S	Greenfield
8 Aug. 2016	Vanscoy Mine	Agrium	Working Accident
24 Aug. 2016	Vanscoy Mine	Agrium	Working Accident
5 Sep. 2016	Allan	Potash Corp. of Saskatchewan	Collapse
19 Dec. 2016	Allan	Potash Corp. of Saskatchewan	Fire/Gas
21 Dec. 2016	Boulby	Isreal Chemical	Inflow
26 Oct. 2017	K2 Esterhazy	Mosaic	Working Accident
8 Mar. 2018	Soligorsk	Belaruskali	Collapse
8 Nov. 2018	Boulby	Isreal Chemical	Working Accident
10 Nov. 2018	Moab	Interpid Potash	Working Accident
22 Dec. 2018	Solikamsk-2	UralKali	Fire/Gas
14 May 2019	Allan	Nutrien	Fire/Gas
2 Jun. 2019	Complex 4	Belaruskali	Working Accident
2 Jul. 2019	Corry	Nutrien	Working Accident

Table A3. Variable description

Variable	Description	Sources
AR	Daily abnormal return for the potash mining company affected by the disaster and its direct and indirect competitors	Based on daily data on stock prices from Reuters
CAR	Cumulative abnormal return for the potash mining company involved in the disaster and its competitors	
Inflow	A dummy variable that takes the value 1 if the disaster resulted in mine flooding or zero otherwise.	Based on information from Factiva, Bloomberg, Google News, Company reports
Collapse	A dummy variable that takes the value 1 if the disaster resulted in mine collapsing or zero otherwise.	
Work	A dummy variable that takes the value 1 if the accident was work related or zero otherwise.	
Fire	A dummy variable that takes the value 1 if the disaster was fire or gas related or zero otherwise.	
Mkt cap	Stock market capitalization of the company on the day of accident (in million USD).	Reuters
Leverage	Total debt to total asset ratio at the end of the accounting year proceeding the accident (in %).	Orbis
Profitability	Gross profit margin at the end of the accounting year proceeding the accident (in %).	
Liquidity	Ratio of liquid assets to current liabilities at the end of the accounting year proceeding the accident (in %).	
Δ Potash	A year to year percentage change in the potash price (in %).	Reuters
Δ Potash _{exp}	A year to year percentage change in the expected potash price. The expected potash price was calculated employing the constant mean model and monthly potash prices prior to the disaster (in %).	
Mine	The capacity of the affected potash mine in million ton	Companies reports and annual statements
Injury	The total number of deaths of employees involved in the accident plus one.	
Death	The total number of deaths of employees involved in the accident plus one.	
News	The total number of news articles mentioning the company affected within the event days plus one.	
Twitter	The total number of tweets mentioning the company affected within the event days plus one.	Bloomberg
Neg. News	A measure of negative sentiment in the news articles mentioning the company affected within the event days of the accident. Higher negative score, more negative sentiment. It equals one plus the logarithm of the value measure	
Neg. Twitter	A measure of negative sentiment in tweets mentioning the company affected within the event days of the accident. Higher negative score, more negative sentiment. It equals one plus the logarithm of the value measure.	

Table A4 Impact of firm and market characteristics on cumulative abnormal returns

This table report results from OLS regressions. The dependent variable is the cumulative average abnormal return $CAR_{[0; 1]}$ to the first day following the disaster. The sample is composed of 55 potash mining disasters over the period 1986-2019. Panel A shows the results for the affected companies by the disaster; Panel B for potash producing companies that are not affected by the disaster; Panel C for greenfield potash firms. In the column we present the results of a regression where the independent variables are companies market capitalization (*Mkt cap*), total debt to total assets (*Leverage*), gross margin (*Profit.*), year to year change in potash prices ($\Delta Potash$), expected changes in potash prices ($\Delta Pot.exp$) and mine size affected by the accident (*Mine*). In all specification we use as dummy variables to control for the four disasters types and year dummies, yet not reported for brevity. Variables definitions are in Appendix in Table A3.

	Mkt cap ^a	Leverage	Profit.	Liquidity	$\Delta Potash$	$\Delta Pot.exp$	Mine ^a
<i>Panel A: Affected companies by the disaster</i>							
Variable	-0.911 (0.907)	-0.083 (0.068)	-0.071 (0.053)	-1.909* (1.084)	-0.042 (0.076)	-0.207 (0.218)	-2.127 (1.975)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	41	42	42	42	44	44	44
R ²	0.523	0.531	0.537	0.559	0.509	0.521	0.526
Adj. R ²	0.149	0.180	0.190	0.229	0.137	0.157	0.165
<i>Panel B: Competitors</i>							
Variable	-0.083* (0.050)	-0.009 (0.008)	-0.002 (0.008)	-0.070 (0.088)	0.011 (0.012)	0.053 (0.034)	0.387 (0.313)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	553	582	584	574	636	636	636
R ²	0.171	0.138	0.136	0.136	0.148	0.151	0.149
Adj. R ²	0.135	0.107	0.105	0.105	0.115	0.117	0.116
<i>Panel C: Greenfield firms</i>							
Variable	-0.060 (0.088)	-0.004 (0.006)	-0.010 (0.006)	-0.002 (0.007)	-0.009 (0.029)	0.045 (0.082)	-1.062 (0.726)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1508	1521	161	1598	2043	2043	2043
R ²	0.011	0.013	0.207	0.015	0.011	0.011	0.012
Adj. R ²	-0.003	0.000	0.107	0.002	0.001	0.001	0.002

Note: Standard errors are presented in parentheses. ***, **, * denote statistical significance at 1%, 5% and 10%, respectively. ^aIn the regression, this variable is included as log(variable).

Table A5. Impact of accident characteristics and media coverage on cumulative abnormal returns

This table report results from OLS regressions. The dependent variable is the cumulative average abnormal return $CAR_{[0;1]}$ to the first day following the disaster. The sample is composed of 55 potash mining disasters over the period 1986-2019. Panel A shows the results for all potash producing companies that are not affected by the accident; Panel B for greenfield potash firms. In the columns we present the results of a regression where the independent variables are the number of injuries (*Injuries*), the number of deaths (*Deaths*), the number of news (*News*), the number of negative news (*Neg. News*), the number of tweets (*Tweets*), and the number of negative tweets. In the regression, the variables are included as $\log(1+variable)$. In all specification we use as dummy variables to control for the four disasters types, yet not reported for brevity. Variables definitions are in Appendix in Table A3.

	Injuries	Deaths	News	Neg. News	Tweets	Neg. Tweet
<i>Panel A: Competitors</i>						
Variable	-0.137 (0.225)	0.378 (0.329)	0.325 (0.239)	2.606*** (0.862)	0.188 (0.233)	0.264 (0.471)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	636	636	377	130	273	234
R ²	0.148	0.149	0.035	0.148	0.035	0.033
Adj. R ²	0.114	0.116	0.004	0.100	0.006	0.010
<i>Panel B: Greenfield firms</i>						
Variable	0.518 (0.516)	-0.039 (0.736)	-0.329 (0.529)	1.654 (2.636)	-0.427 (0.523)	-0.654 (1.038)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	2043	2043	1383	504	1004	853
R ²	0.012	0.011	0.015	0.017	0.015	0.016
Adj. R ²	0.001	0.001	0.006	0.003	0.004	0.004

Note: Standard errors are presented in parentheses. ***, **, * denote statistical significance at 1%, 5% and 10%, respectively.