March 2017

WORKING PAPER SERIES

2017-ACF-02

Stock market response to potash mine disasters

Oskar Kowalewski
IESEG School of Management (LEM-CNRS - UMR 9221)

Piotr Śpiewanowski
Institute of Economics of the Polish Academy of Science, Poland

IESEG School of Management
Lille Catholic University
3, rue de la Digue
F-59000 Lille
www.ieseg.fr

Stock market response to potash mine disasters

Oskar Kowalewski[a,b,*]

Piotr Śpiewanowski[b]

[a] *IÉSEG School of Management and LEM CNRS (UMR 9221), France*

[b] *Institute of Economics of the Polish Academy of Science, Poland*

Abstract

We examine the stock market reaction to natural and man-made disasters in potash mines. We use a sample of 44 mining accidents worldwide over the period 1995-2016. A quarter of the accidents were the result of a natural disaster, such as flooding, that often ended in the closure of the potash mine. The remaining accidents were caused mainly by human error, and almost 50% were work accidents often associated with serious injury or death. On average, mining firms experience a drop in their market value of 0.89% on the day of a disaster. However, we observe a significantly stronger response of the stock market to natural events. Indeed, the regression analysis confirms that the firm's market loss is significantly related to the seriousness of the accident. On the other hand, we do not find any other micro- or macro-level factors that determine the stock market reaction following a disaster.

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

JEL classification: G14, Q27, Q51

[*] Corresponding author. Oskar Kowalewski (email: o.kowalewski@ieseg.fr); Piotr Śpiewanowski (email: piotr.spiewanowski@gmail.com)

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. Gnutzmann and Śpiewanowski (2015) argue 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. According to them, the cartel played an important role in the recent food crisis when prices rose, on average, by 45% from 2007 to 2008. Their results indicate that 40% of the cost of fertilizers is passed on to food prices. The development of the cartel can be explained by a lack of competition in the fertilizer industry, 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. All these companies are mining companies, but they also are fertilizer producers.

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. Thus, on the one hand, we may expect a firm's stock to react strongly to a potash mining accident in such a highly concentrated industry. However, on the other, 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.[2]

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 causalities and production losses.

A potash mining accident may generate a supply shock and a transfer of potash surplus from the company negatively affected to companies unaffected by the 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 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

[2] 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.

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. Consequently, a disaster in a potash mine may impact the stock of the companies affected and unaffected in opposite directions. 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.

The main aim of our study is to provide empirical evidence on the stock market reaction to potash mining disasters. Accordingly, we examine the stock market reaction to 44 disasters in potash mines during the years 1995-2016. 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 abnormal returns up to 4.8% over the two days immediately following the event. Moreover, a closer analysis shows that the decline in stock prices is mainly related to inflow (flooding) in the potash mines. Hence, 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 of the affected company. For indirect competitors, we identify greenfield firms that expect to be 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. However, we find weak evidence that the stock of these direct competitors reacts positively to a natural disaster a day following the event. 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 greenfield firms than for potash producing companies. We attribute the overall negative results to investor concerns regarding potential new regulation in the industry that would affect all companies; and attribute the greenfield results to the fact that greenfield firms are smaller and financially weaker than affected companies and their direct competitors.

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 news coverage, 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. We see a negative and significant reaction in the affected company's stock only to information about inflow in a potash mine. However, the stock of direct and indirect competitors is negatively and significantly affected by information about work accidents. Controlling for type of accident, we find only a weak relationship between the firm- and market-level control variables and the stock reaction following a potash mining disaster. In our opinion, the results confirm that investors 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 how the stock market responds to a potash mine disaster. Moreover, in the study, we distinguish between four types of accidents and three types of potash mining companies that may be affected by the disasters. 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 disaster's psychological 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 the size of the company, 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. 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. 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 oligopoly.[3] The seven largest companies produce around 80% of the total world potash output.[4]

The de facto level of concentration in the market is even higher as the largest Canadian producers sell potash through the export cartel Canpotex (an export association of Canadian potash producers allocating sales among the members based on production capacity). Similar associations among Russian (Uralkali and Silvinit acquired by Uralkali in 2012) and Belarussian (Belaruskali) producers, namely, the Belarussian Potash Company (BPC), existed between 2005 and 2013. The alleged cooperation between the two export groups 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.

Uralkali left the BPC in June 2013, creating a shift from a price-over-quantity to a quantity-over-price strategy, which was reflected in a gradual price decrease. On the day of the collapse of the BPC, all stock prices of all major potash producers plunged by 20-30%. Canpotex continues to operate today, explicitly stating in its mission statement the objective to "deliver value by responsibly exporting Canadian potash." However, without the support of the Russian and Belarussian companies, Canpotex alone has a more limited impact on world prices.

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

---

[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).
[4] Source: www.k-plus-s.com/en/pdf/2016/2016_01_Compendium.pdf.

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 seven to 10 years needed to develop a mine, many of those mines are about to start operations soon 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.[5] 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).

[5] 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).

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 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.[6]

The oligopolistic structure of the potash market makes it likely that 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

[6] 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.

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 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.

Oligopolistic producers operate usually with excess capacity (Benoit and Krishna, 1987). On one hand, this enables operating firms to be ready to compensate production losses from a temporary stoppage at one site with increased production at another. On the other, spare capacity also enables the market players to be ready at any time to capture a competitor's market share if it fails to deliver the contracted quantities. Temporary production stoppages caused by mine accidents are likely to invoke "force majeure" clauses in long-term contracts, meaning, in such cases, the companies would no longer be liable for failure to perform to the contract obligations. However, such failures may encourage the contracting parties to switch to another supplier, which could result in market share loss.

3. 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 1995-2016.

3.1. Stock prices

The first dataset presents the daily closing prices of the stocks of the potash mining and exploration companies and their market capitalization in local currencies. 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 $r_t = \log(p_t/p_{t-1})x100$, where p_t and p_{t-1} represent the closing price at time t and t-1, respectively. If a 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 Bloomberg.

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 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]

3.2. Disasters

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 1990-2016. 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 for the 1990s is relatively scarce. Last, we checked information on disasters using Bloomberg 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 44 potash mining disasters in the years 1995-2016. 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 manmade accidents (*Accident*); these represent 34% and 66% 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 including closures of potash mines. These events are, however, quite rare in practice and represent only 14% and 20% of total events in the sample, respectively. Human caused accidents are more common and 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 23% 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.

Workplace accidents are the most common events in practice and represent 41% 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. Although the definition used in this study is very broad, we remain tightly focused on the direct and indirect costs of potash mining disasters. We do, however, exclude any working accident related to a greenfield project. We classify these as *Greenfield*, and as there is only one such an accident in our sample, we do not investigate this type of event further.

3.3. 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 accident characteristics; and, c) the media exposure of the accident. A detailed description of all the variables used in the study is provided in the Appendix Table 2A.

The firm characteristics and financial performance variables that might influence investor reaction to unanticipated environmental information include firm size, leverage, and profitability. Larger firms, as indicated by 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 three 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 size*), measured as the share of the affected mine output to the total world output in the year of 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.

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 log of the average annual potash price in the year of the accident (*Potash price*) and the year-to-year change of the potash price (*ΔPotash price*). We assume that the higher the potash price, 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 a dummy variable that takes the value of one if there are any deaths (*Death*) related to the mining disaster and zero otherwise. 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 (*Sentiment)*.

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]

3.4. Methodology

3.4.1 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:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t}$$

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 five 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_5. 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 form 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 CARs 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 following the accident using the regression as follows:

$$CAR_{i,t;t} = \alpha_i + \beta X_i + \varepsilon_i$$

where CAR is the cumulative abnormal return for firm i for the period $t;t$, X_i is a vector of factors that describe the mining disaster, 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. Consequently, we decided to follow Capelle-Blancard and Laguna (2010) and present only the results for the CARs calculated for two days following the accident. The results for the other periods are not presented for brevity but are available upon request.[7]

4. Results

4.1 Event study

Table 3 presents the results for the event study, and in the first two columns, we present the AAR and CAAR 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 3 and 4 and 5 and 6 of Table 3, we show the results for AAR and CAAR for natural disasters and for accidents caused by human errors, respectively. To allow for comparisons between the potash mining firms, we distinguish among three groups of companies and present the results for these separately.

In Panel A of Table 3, we present the ARs and associated statistics for the affected companies (the firms directly affected by the disaster). In the following two

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

panels, we distinguish two groups of competitors. In Panel B, we show the results for all direct competitors in the potash producing industry. In Panel C, 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.

Panel A 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 loss of 0.81% on the day of the accident, and of 0.64% the following day. Cumulatively, the negative reaction may be observed over a period of zero to four days. The abnormal losses may continue to accumulate, reaching -1.45% on day one, and slowly decreasing day by day. The estimates are statistically significant at the 5% level, but only for the day of the accident.

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%.

We find 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 human caused accident. In the case of the natural disasters, on the first day, the stock declines by 1.94% and is statistical significant at the 10% level. Over the following two days, the stock further declines by 2.52% and 0.35%, respectively. After two days from the natural disaster, the cumulate abnormal losses reach a maximum value of -4.81%. The effect of the news of human caused accidents on the stock of the affected companies is significantly lower. The stock declines only on the day of the accident by 0.41% and rebounds after that. Consequently, the cumulative abnormal losses reach their maximum value the day of the accident; however, the results are not statistical significant.

Panel B of Table 3 shows that the stock of existing potash producers reacts negatively to the accident, and the cumulative abnormal losses reach the maximum value of -0.35% on the second day. We find that the effect of the natural accident 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 statistical significant.

Panel C of Table 3 documents that the stock of the greenfield companies is much more sensitive to the information on a disaster than existing potash companies. We find that the stock of greenfield companies declines more following a man-made accident than a natural one; moreover, the results for human caused accidents are statistically significant. The decline after the man-made disaster 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. Moreover, we find that the decline of the stock is significantly stronger for a greenfield firm than for existing potash companies; additionally, the cumulative abnormal losses reach the maximum value of -1.83% at day five and are statistically significant. 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]

4.2 Main results

Table 4 reports CAARs in the first five days after a disaster while we control for accident type. 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 first four specifications of Table 4 show the results for the affected company. In all the specifications, the coefficient for the dummy variable inflow is negative and significant at the 1% level. The coefficients for work accidents and collapse are also negative in the first two days following the accident, but are insignificant in all the specifications. 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.

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 the first eight specifications on Table 4; the first four specifications show the results for the competitors and the next four the greenfield firms. We find that in all the competitor specifications, the coefficient for the dummy variable man-made accident is negative and statically significant up to two days following the event. For the greenfield firms, the dummy variable is negative and statistical significant at least at the 5% level from day one to day five. 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.

[Table 4]

4.3 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 proxy variables for the type of accident are as in Table 4, but 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.

4.3.1 Company characteristics

Table 5 reports the regression where we add firm-level variables controlling for size, leverage, liquidity, and profitability of the companies. In the specifications for the affected companies, we find only the coefficient for profitability to be statistically significant at the 5% level. Contrary to initial expectations, the sign of the coefficient is negative, which means that the stock of 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. An explanation for the results can be that investors in more profitable firms are overly optimistic and an accident results in a short-term change in sentiments.

As expected, we find that the liquidity ratio is negatively related to the abnormal returns and is statistically significant at the 5% level, but only in the specification for the competitors. Consequently, the results indicate that the stock of more risky companies is more likely to respond to the announcement of an accident.

We find that the affected company and its competitor firms with higher market capitalization and lower debt to asset ratios are less sensitive to information on mining accidents, with the size of the coefficients lower for the competitor firms. The coefficient for leverage is, however, statistically insignificant in all specifications. Similarly, we do not find any evidence that firm size is related to the abnormal returns. In contrast to Capelle-Blancard and Laguna (2010), we find that the coefficient for size is negative and insignificant in all specifications. Indeed, we repeated the estimation using the log of total assets rather than market capitalization and the results remain unchanged.

Since greenfield companies only incur mine development costs and their revenues only begin once the exploration of mineral resources start at a later date, we do not expect their financial characteristics to have an impact on the market reaction. Indeed, the regression analysis reveals that no financial variable is statistically significant for the sample of greenfield firms and the coefficients for all the variables are close to zero.

[Table 5]

4.3.2 Market and accident characteristics

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. Other important factors possibly affecting investor reactions are the characteristics of the accident as described by the size of the affected mine and the number of fatalities related to the accident. 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.

Table 5 confirms that higher potash prices, both in terms of level and growth, larger size of the affected mines, and more fatalities amplify the negative market reaction to the accident for the affected companies. We find, however, that none of the coefficients for the control variables are statistically significant.

In contrast, the coefficient for potash price growth is negative and statically significant for competitors and greenfield firms at 1% and 10%, respectively. Indeed, the stock of greenfield companies reacts in a similar manner as that of the affected companies in relation to the variable representing affected mine size. However, the values of the coefficient for mine size are larger (in terms of absolute value) and statistical significant at the 5% level only for the sample of greenfield firms. Surprisingly, the results show a positive relation between the accident fatalities and the abnormal returns of a competitor's stock. The coefficient for the dummy variable death is positive and statistical significant at the 5% level. One explanation would be that investors relate fatalities to a possible halt of production at the affected company, which in turn could positively influence the revenues of a competitor.

[Table 6]

4.3.3 Media exposure

Market reaction is triggered by information, which naturally comes through various media channels. 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 media coverage by taking into account both aspects of exposure: quantitative, the number of media reports and Twitter tweets; and qualitative, the sentiment in those texts. As reported in Table 7, coefficients denoting the impact of those variables on companies directly affected by the disaster are almost all insignificant and qualitatively close to zero in all specifications. As in the regression showing the impact of market and accident characteristics on stock market response, we do not observe any differential direction of the impact of the proxy variables for news coverage on affected and competitor firms. All coefficients have the same sign for both groups.

We find, however, that the coefficient on news sentiment is negative and significant at the 5% level for the competitor firms. The result means that if there were fewer negative articles about the competitive firms following the disaster, their stock price 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, we find that the coefficient for the variable for Twitter information is negative and statistical significant at the 5% level. Greenfield firms are less likely to be covered by the conventional press than potash producing companies, which may explain the difference in the results. Therefore, shareholders of greenfield firms may pay greater attention to information on social media, which may determine their investment sentiments. Surprisingly, we find that the coefficient for the variable representing the amount of news with negative sentiments on Twitter is positively and significantly related to the stock return for greenfield firms.

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 four years. Thus, the results are available for a significantly smaller number of accidents than in the previous regressions.

[Table 7]

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.

5. 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, accidents caused by human error 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.

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.

Acknowledgment

The authors would like to thank Luc Bauwens, Hinnerk Gntuzmann, and the participants of the following conferences: 3L Finance Research Workshop at

HUB/Brussels, and the 2nd FINEXCA Workshop on Competition and Finance in Natural Resource Markets at the Leibniz University in Hannover for their valuable comments and suggestions.

The authors acknowledge the financial support of the National Science Center (NCN), Poland under research project number DEC-2014/15/G/HS4/03629.

References

Aiuppa, Thomas, Robert J. Carney, and Thomas M. Krueger, 1993, An Examination of Insurance Stock Prices Following the 1989 Loma Prieta Earthquake, *Journal of Insurance Issues* 16, 1–14.

Benoit, Jean-Pierre, and Vijay Krishna, 1987, Dynamic Duopoly : Prices and Quantities, *Review of Economic Studies* 54, 23–35.

Blacconiere, Walter G., and Dennis M. Patten, 1994, Environmental disclosures, regulatory costs, and changes in firm value, *Journal of Accounting and Economics* 18, 357–377.

Brown, Stephen J., and Jerold B. Warner, 1985, Using Daily Stock Returns, *Journal of Financial Economics* 14, 3–31.

Capelle-Blancard, Gunther, and Marie Aude Laguna, 2010, How does the stock market respond to chemical disasters?, *Journal of Environmental Economics and Management* 59, 192–205.

Capelle-Blancard, Gunther, and Marie Aude Laguna, 2010, How does the stock market respond to chemical disasters?, *Journal of Environmental Economics and Management* 59, 192–205.

Carpentier, Cécile, and Jean Marc Suret, 2015, Stock market and deterrence effect: A mid-run analysis of major environmental and non-environmental accidents, *Journal of Environmental Economics and Management* 71, 1–18.

Chen, Hui, Scott Joslin, and Ngoc Khanh Tran, 2012, Rare disasters and risk sharing with heterogeneous beliefs, *Review of Financial Studies* 25, 2189–2224.

Cocker, Mark D., and Greta J. Orris, 2012, World Potash Developments, *48th Annual Forum on the Geology of Industrial Minerals Arizona Geological Survey*.

Fields, M. Andrew, and Vahan Janjigian, 1989, The effect of Chernobyl on electric-utility stock prices, *Journal of Business Research* 18, 81–87.

Gnutzmann, Hinnerk, and Piotr Śpiewanowski, 2015, Did the Fertilizer Cartel Cause the Food Crisis ? INE PAN Working Paper.

Ho, Jerry C., Mei Qiu, and Xiaojun Tang, 2013, Do airlines always suffer from crashes?, *Economics Letters* 118, 113–117.

Hustrulid, W. A., and Richard C. Bullock, 2001, *Underground Mining Methods : Engineering Fundamentals and International Case Studies* (Society for Mining, Metallurgy, and Exploration).

Jenny, Frederic, 2012, Export Cartels in Primary Products: The Potash Case in Perspective, *Trade, Competition and the Pricing of Commodities*, 99–132.

Kaplanski, Guy, and Haim Levy, 2010, Sentiment and stock prices: The case of aviation disasters, *Journal of Financial Economics* 95, 174–201.

Khanna, Madhu, Wilma Rose H. Quimio, and Dora Bojilova, 1998, Toxics Release Information: A Policy Tool for Environmental Protection, *Journal of Environmental Economics and Management* 36, 243–266.

MacKinlay, Archie Craig, 1997, Event Studies in Economics and Finance, *Journal of Economic Literature* 35, 13–39.

Shelor, R., D. Anderson, and M. Cross, 1992, Gaining from loss: Property-liability insurer stock values in the aftermath of the 1989 California earthquake, *Journal of Risk and Insurance* 59.

Shelor, Roger, Dwight Anderson, and Mark Cross, 1990, The Impact of the California Earthquake on Real Estate Firms' Stock Value, *Journal of Real Estate Research* 5, 335–340.

Tufano, Peter, 1998, The Determinants of Stock Price Exposure: Financial Engineering and the Gold Mining Industry, *The Journal of Finance* 53, 1015–1052.

Vasterman, Peter, C. Joris Yzermans, and Anja J E Dirkzwager, 2005, The role of the media and media hypes in the aftermath of disasters, *Epidemiologic Reviews* 27, 107–114.

Whyatt, Jeff, and Floyd Varley, 2006, Catastrophic Failures of Underground Evaporite Mines, *Proceedings of the 27th International Conference on Ground Control in Mining*.

Table A1 **List of the potash mining companies in the 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
39	Centrex Metals	Australia	Yes

id	Company name	Country	Greenfield
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

Table A2 **Identified natural events and human caused disasters in potash mines in the period 1990-2016**

Date	Mine	Owner	Accident type
5-Jan-1995	Solikamsk-2	UralKali	Collapse
11-Sep-1996	Teutschenthal	KALIMAG	Collapse
30-Oct-1996	Corry	Potash Corporation of Saskatchewan	Working Accident
18-Jun-1997	Cassidy Lake	Potash Corp of Canada	Inflow
29-Jan-2006	K2 Esterhazy	Mosaic Company	Fire/Gas
31-Aug-2006	Vanscoy	Agrium	Working Accident
17-Oct-2006	Berezniki	UralKali	Inflow
24-Jan-2007	K2 Esterhazy	Mosaic Company	Inflow
19-Apr-2007	Boulby	Isreal Chemical	Working Accident
28-Jul-2007	Berezniki	UralKali	Collapse
7-Sep-2008	Lanigan	Potash Corporation of Saskatchewan	Working Accident
21-Nov-2009	Sussex New Brunswick	Potash Corporation of Saskatchewan	Working Accident
28-Nov-2009	K2 Esterhazy	Mosaic Company	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 Company	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 Corporation of Saskatchewan	Working Accident
12-Sep-2012	Berezniki	UralKali	Working Accident
25-Sep-2012	Rocanville	Potash Corporation of Saskatchewan	Fire/Gas
11-Feb-2013	Colonsay	Mosaic Company	Collapse
13-Jul-2013	Vanscoy	Agrium	Working Accident
1-Oct-2013	Unterbreizbach	K+S	Fire/Gas

Date	Mine	Owner	Accident type
27-Oct-2013	K2 Esterhazy	Mosaic Company	Fire/Gas
9-Jan-2014	Boulby mine	Isreal Chemical	Collapse
14-Feb-2014	Vanscoy Mine	Agrium	Fire/Gas
17-Feb-2014	Corry	Potash Corporation of Saskatchewan	Working Accident
22-Jul-2014	Corry	Potash Corporation of Saskatchewan	Working Accident
10-Sep-2014	Allan	Potash Corporation 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 Company	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	Accident
5-Sep-2016	Allan	Potash Corporation of Saskatchewan	Collapse
19-Dec-2016	Allan	Potash Corporation of Saskatchewan	Fire/Gas
21-Dec-2016	Boulby mine	Isreal Chemical	Inflow

Table A3 **Variable description**

Variable	Description
AR	Daily abnormal return for the potash mining company involved in the disaster (Target) and its competitors
CAR	Cumulative abnormal return for the potash mining company involved in the disaster (Target) and its competitors
Inflow	A dummy variable that takes the value 1 if the disaster resulted in mine flooding or zero otherwise.
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	Log of market capitalization on the day of accident (in mln US$).
Leverage	Total debt to total asset ratio at the end of the accounting year proceeding the accident.
Profitability	Gross profit margin at the end of the accounting year proceeding the accident.
Liquidity	Ratio of liquid assets to current liabilities at the end of the accounting year proceeding the accident.
Potash price	Log of average annual potash price in the year of the accident.
ΔPotash price	A year to year percentage change in the potash price.
Mine size	A percentage of the world capacity the involved potash mine in the disaster was supplying.
Death	A dummy variable that takes the value 1 if the accident involved death of an employee and zero otherwise.
News count	A total number of news articles mentioning the company affected within 7 days after the accident as reported by Bloomberg
Twitter count	A total number of tweets mentioning the company affected within 7 days after the accident as reported by Bloomberg
News sentiment	A measure of negative sentiment in the news articles mentioning the company affected within 7 days after the accident as reported by Bloomberg. More negative score, more negative sentiment.
Twitter sentiment	A measure of negative sentiment in tweets mentioning the company affected within 7 days after the accident as reported by Bloomberg. More negative score, more negative sentiment.

Table 1. **Descriptive statistics**

	All Firms			Target			Competitors			Greenfields		
Statistic	N	Mean	St. Dev.	N	Mean	St. Dev.	N	Mean	St. Dev.	N	Mean	St. Dev.
CAR	1294	-0.01	0.08	37	-0.01	0.06	386	-0.001	0.04	871	-0.01	0.10
Inflow	1294	0.09	0.28	37	0.11	0.31	386	0.1	0.3	871	0.08	0.27
Collapse	1294	0.17	0.38	37	0.16	0.37	386	0.16	0.37	871	0.18	0.39
Fire	1294	0.27	0.45	37	0.27	0.45	386	0.27	0.45	871	0.28	0.45
Work	1294	0.47	0.50	37	0.46	0.51	386	0.47	0.5	871	0.46	0.5
Mkt cap	1279	9.08	29.03	37	16.34	11.17	384	14.27	23.92	858	6.45	31.21
Leverage	894	13.65	33.89	26	23.57	10.74	235	26.65	15.31	633	8.42	37.91
Profitability	403	29.54	93.01	30	41.3	19.48	302	37.77	16.13	71	-10.44	215.49
Liquidity	895	8.57	19.86	26	1.21	0.78	235	1.3	0.77	634	11.57	22.93
Potash price	1294	339.16	119.63	37	330.24	130.02	386	335.97	125.79	871	340.95	116.44
ΔPotash price	1294	-14.03	30.58	37	-11.91	31.82	386	-13.21	30.74	871	-14.48	30.47
Mine size	1294	0.05	0.02	37	0.49	0.65	386	0.51	0.64	871	0.49	0.64
Death	1294	0.50	0.64	37	0.68	0.47	386	0.13	0.34	871	0.34	0.47
News count	869	75.35	127.85	23	78.09	131.22	251	75.69	127.7	595	75.1	127.99
Twitter count	591	19.64	41.63	16	19.88	42.28	172	20.59	42.66	403	19.23	41.27
News sentiment	869	-3.19	6.52	23	-3.39	6.77	251	-3.23	6.55	595	-3.17	6.51
Twitter sentiment	591	-3.45	6.56	16	-3.5	6.67	172	-3.59	6.72	403	-3.38	6.5

Table 2. **Pairwise correlations**

	CAR	Market Cap	Leverage	Prof.	Liquid.	Potash price	ΔPotash price	Mine size	Death	News count	Twitter count	News sentiment
CAR	1											
Mkt cap	0.02	1										
Leverage	-0.05	0.08**	1									
Profitability	-0.02	0.09	-0.13*	1								
Liquidity	0.05	-0.10***	-0.11***	0.14**	1							
Potash price	-0.05	0.07**	-0.04	0.04	0.07*	1						
ΔPotash price	-0.09***	0.04	0.03	0.04	0.05	0.54***	1					
Mine size	-0.05*	-0.02	0.04	-0.05	-0.03	-0.02	0.05*	1				
Death	-0.01	0.02	0.00	-0.04	0.00	0.32***	0.13***	0.17***	1			
News count	-0.06	-0.06*	-0.04	0.00	-0.07*	-0.55***	-0.23***	0.16***	-0.15***	1		
Twitter count	-0.08	-0.05	-0.04	0.01	-0.04	-0.55***	-0.38***	0.11***	-0.01	0.50***	1	
News sentiment	0.04	0.05	0.02	0.00	0.07*	0.40***	0.05	0.01	-0.09***	-0.68***	-0.76***	1
Twitter sentiment	0.07	0.05	0.05	-0.01	0.05	0.59***	0.38***	-0.07*	-0.04	-0.67***	-0.95***	0.81***

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 abnormal return (CAARt) up to the specified day *t* in event time (in %). Event time is days relative to the potash mining disaster date, whereas in addition we distinguish between the natural disasters and accidents caused by human errors. Abnormal returns are computed given the market model parameters which are estimated with OLS through the period [-190;-10] in event time. 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 companies with greenfields potash projects.

Days	Disasters		Natural		Accidents	
	AAR	CAAR	AAR	CAAR	AAR	CAAR
Panel A: Target companies						
0	-0.81	-0.81**	-1.94	-1.94*	-0.41	-0.41
1	-0.64	-1.45	-2.52	-4.45	0.03	-0.38
2	0.03	-1.43	-0.35	-4.81	0.17	-0.21
3	0.46	-0.97	0.28	-4.53	0.53	0.31
4	0.29	-0.67	0.18	-4.35	0.34	0.65
5	0.71	0.04	0.27	-4.08	0.86	1.51*
Panel B: Competitors						
0	-0.16	-0.16**	-0.07	-0.07	-0.20	-0.20*
1	0.02	-0.14	0.37	0.30	-0.15	-0.35**
2	0.12	-0.02	0.07	0.38	0.14	-0.21
3	0.12	0.10	0.17	0.55	0.10	-0.10
4	0.03	0.14	-0.31	0.23	0.20	0.10
5	0.16	0.29	-0.16	0.07	0.30	0.40
Panel D: Greenfields projects						
0	-0.42	-0.42**	0.01	0.01	-0.60	-0.60***
1	-0.19	-0.61***	-0.07	-0.06	-0.24	-0.84***
2	-0.46	-1.07***	-0.84	-0.90	-0.29	-1.13***
3	-0.16	-1.23***	-0.13	-1.03	-0.17	-1.31***
4	0.00	-1.23***	0.23	-0.80	-0.10	-1.41***
5	-0.47	-1.70***	-0.58	-1.37	-0.43	-1.83***

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 regression, whereas the dependent variable is the CAR up to *t* days following the disaster. The sample is composed of 44 potash mining disasters over the period 1995-2005. In all the specification the dummy variables for accident types are included as in Table 4, yet not reported for brevity. Variables definitions are in Appendix in Table A3.

	Target				Competitor				Greenfield			
	t = 0	t = 1	t = 2	t = 5	t = 0	t = 1	t = 2	t = 5	t = 0	t = 1	t = 2	t = 5
Work	-0.008	-0.008	-0.008	0.012	-0.004**	-0.006**	-0.005*	-0.004	-0.003	-0.012**	-0.015***	-0.025***
	(0.005)	(0.013)	(0.014)	(0.016)	(0.001)	(0.002)	(0.003)	(0.004)	(0.003)	(0.005)	(0.005)	(0.007)
Collapse	-0.010	-0.015	-0.019	0.003	-0.004	-0.002	-0.002	-0.005	-0.001	-0.003	0.001	-0.006
	(0.009)	(0.023)	(0.023)	(0.028)	(0.003)	(0.004)	(0.005)	(0.006)	(0.005)	(0.007)	(0.008)	(0.010)
Fire	0.002	0.003	0.009	0.024	-0.001	-0.002	0.001	0.014***	-0.010**	-0.007	-0.005	0.002
	(0.007)	(0.018)	(0.018)	(0.020)	(0.002)	(0.003)	(0.004)	(0.005)	(0.004)	(0.006)	(0.006)	(0.009)
Inflow	-0.033***	-0.089***	-0.091***	-0.087***	0.001	0.006	0.008	-0.007	0.006	0.009	-0.005	-0.002
	(0.011)	(0.028)	(0.029)	(0.031)	(0.003)	(0.005)	(0.006)	(0.008)	(0.008)	(0.011)	(0.012)	(0.018)
Obs.	38	38	37	35	391	386	386	381	991	919	871	741
R^2	0.277	0.241	0.259	0.239	0.022	0.022	0.012	0.028	0.008	0.010	0.011	0.020
Adjusted R^2	0.192	0.152	0.169	0.141	0.012	0.012	0.002	0.018	0.004	0.005	0.007	0.014

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

Table 5. **Impact of firm characteristics on cumulative abnormal returns**

This table report results from OLS regression, whereas the dependent variable is the CAR up to two days following the disaster. The sample is composed of 44 potash mining disasters over the period 1995-2005. In all the specification the dummy variables for accident types are included as in Table 4, yet not reported for brevity. Variables definitions are in Appendix in Table A3.

	Target				Competitor				Greenfield			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Mkt cap	-0.004				-0.0003				0.002			
	(0.014)				(0.001)				(0.001)			
Leverage		-0.002				-0.0001				-0.0002		
		(0.001)				(0.0002)				(0.0001)		
Profitability			-0.001**				0.0002				-0.00000	
			(0.001)				(0.0001)				(0.00004)	
Liquidity				-0.001				-0.007**				0.0003
				(0.017)				(0.003)				(0.0002)
Accident type	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	37	26	30	26	384	235	302	235	858	633	71	634
R^2	0.260	0.423	0.464	0.374	0.012	0.017	0.025	0.033	0.013	0.020	0.022	0.020
Adjusted R^2	0.145	0.286	0.357	0.225	-0.001	-0.004	0.008	0.011	0.008	0.012	-0.052	0.012

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

Table 6. **Impact of market and accident characteristics on cumulative abnormal returns**

This table report results from OLS regression, whereas the dependent variable is the CAR up to two days following the disaster. The sample is composed of 44 potash mining disasters over the period 1995-2005. In all the specification the dummy variables for accident types are included as in Table 4, yet not reported for brevity. Variables definitions are in Appendix in Table A3.

	Target				Competitor				Greenfield			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Potash price	-0.022				0.003				-0.013			
	(0.025)				(0.005)				(0.010)			
Δ Potash price		-0.00003				-0.0003***				-0.0002*		
		(0.0003)				(0.0001)				(0.0001)		
Mine size			-0.528				-0.108				-0.341**	
			(0.475)				(0.096)				(0.170)	
Death				-0.004				0.007**				-0.001
				(0.016)				(0.003)				(0.006)
Accident type	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	37	37	37	37	386	386	386	386	871	871	871	871
R^2	0.276	0.259	0.286	0.260	0.013	0.063	0.016	0.023	0.013	0.015	0.016	0.011
Adjusted R^2	0.163	0.143	0.175	0.144	0.0001	0.051	0.003	0.010	0.007	0.009	0.010	0.006

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

Table 7. **Impact of media coverage on cumulative abnormal returns**

This table report results from OLS regression, whereas the dependent variable is CAR up to two days following the disaster. The sample is composed of 44 potash mining disasters over the period 1995-2005. In all the specifications the dummy variables for accident types are included as in Table 4, yet not reported for brevity. Variables definitions are in Appendix in Table A3.

	Target				Competitor				Greenfield			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
News	-0.0002				-0.00004				-0.0001			
	(0.0001)				(0.0001)				(0.0001)			
Twitter		0.0003				0.0002				-0.0004**		
		(0.0003)				(0.0001)				(0.0002)		
News sentiment			-0.001				-0.003**				0.002	
			(0.003)				(0.001)				(0.002)	
Twitter sentiment				-0.002				-0.001				0.003**
				(0.002)				(0.001)				(0.001)
Accident type	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8	6	8	6	86	64	86	64	199	147	199	147
R^2	0.734	0.496	0.491	0.565	0.051	0.078	0.097	0.084	0.027	0.050	0.023	0.041
Adjusted R^2	0.468	-0.009	-0.018	0.130	0.004	0.033	0.053	0.039	0.007	0.031	0.003	0.021

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