ANALYSIS OF THE REACTION OF MINING STOCKS TO THE DEVELOPMENT OF COPPER PRICES

Abstract

Copper is considered as one of the most important minerals in the world; however, most of the finance literature is concentrated on determining the impact of gold spot prices on mining stock prices. To fill this literature gap, we analyze the impact of changes in copper spot and future prices on the stock returns of copper mining firms. After controlling for market returns and considering a sample of high market-cap firms, we found evidence of a positive but inelastic behavior between copper stock returns and changes in copper prices. Additionally, we determined that the 2008 Global crisis influenced investors' decisions generating a negative impact on copper stock returns; however, this effect turns out to be insignificant in developed markets (New York, Toronto and London) and significant in a less developed one (Lima). Finally, our results provide evidence to reject the hypothesis of integrated markets as copper firms are positively affected by trading in a more developed market compared to the negative effect generated by trading in a less developed one.

JEL Classifications: G11, G12

Keywords: Mining, Copper, Spot Prices, Future Prices, Segmented Markets

1 INTRODUCTION

Mining companies are some of the shaping players in many economies and have a big impact on different industries and on the global economy. For example, in 2016, 64 billion mining shares with a total value of $189 billion were traded on the Toronto Stock Exchange (TSX), making mining stocks the most frequently traded ones on that market (Toronto Stock Exchange, 2017). With an 11% share of the total market value of all stocks listed on TSX, mining is the second biggest individual industry (after energy & energy services), as of January 2017.[1]

Over the last decades many big mining companies have expanded throughout the world. Glencore, BHP Billiton and Rio Tinto are just a few examples of global players that are active in this industry (Statista, 2016). Most of the big players in the mining industry are listed on global stock exchanges. The biggest copper mining companies (measured in produced copper in 2015) are displayed in Appendix 2. To put the market capitalization into dimension, BHP Billiton, Rio Tinto and Glencore have USD 80 Billion, USD 74 Billion and USD 48 Billion, respectively. On the other hand, General Motors and Sony Corporation have market capitalizations of 55 Billion and 40 Billion, respectively.[2] This underlines the importance and growing influence of mining companies on the global economy.

The mining industry is commonly divided into three main parts: (i) gold focused companies, (ii) copper focused companies and (iii) polymetallic companies.[3] Copper itself can be considered as one of the most important minerals in the world, accounting for 13% of the volume of all global mining deals in 2013 (PwC, 2014) and 11% of all capital expenditures on minerals in 2016 (Mining Journal, 2017). The most important mineral regarding these criteria is gold but with a total global mine production far lower than the one of copper (3,100 metric tons of gold vs. 19,400 metric tons of copper[4]). These statistics provide evidence of the importance and influence of copper, as one of the most important minerals. Consequently, and given that previous research

[1] The reader is referred to Appendix 1 for details about the market value by sector in the Toronto Stock Exchange.
[2] General Motors and Sony Corporation are listed in the New York Stock Exchange. The information was obtained in Yahoo Finance for March 18th, 2017.
[3] Producing a bigger range of metals like zinc silver or lead.
[4] US Geological Survey (2016a) and US Geological Survey (2016b).

has already been focused on gold (Tufano, 1998; Blose, 1995), this paper focuses on copper as the mineral of investigation.

Previous research has been concentrated on the factors that influence investor`s decisions related with mining firm stock prices. However, it has mostly used gold as the underlying mineral and neglected the influence of futures prices. Considering the efficient market hypothesis, future copper prices form part of the available information and hence should influence investor's decisions and accordingly the stock price of mining firms. This literature gap will be addressed in this paper concluding that copper returns (spot and futures) has a positive but inelastic relationship with the returns of copper mining stocks. Furthermore, we analyze the impact of the 2008 Global crisis and found that this event only affected the returns of the copper mining stocks trading in the Peruvian market while the returns of the ones trading in more developed markets (New York, Toronto and London) were not affected. Finally, we reject the assumption of integrated markets as the returns of copper mining stocks trading in Peru have a negative impact in returns compared to the positive one exhibited by copper stocks trading in the aforementioned developed markets.

Investors have two investment options: to invest either directly in the mineral or in the stock of mining companies with focus on the corresponding mineral. Research hasn´t established yet whether a direct investment in the mineral presents a more profitable option than investing in the stock of a mining company and whether the stock's returns exhibit an elastic or inelastic behavior with respect to mineral's price changes.[5] Khoury (1984), focusing on gold, established that unstable dividends, currency exchange, political risk and unstable dividend policy weakens the influence of gold prices on mining firm stock prices. Accordingly, the author also presented evidence that stock prices present an inelastic behavior with regard to mineral prices, as changes in stock prices are smaller than changes in the underlying mineral price. Rock (1988) presents evidence that investing in mining stocks is not the best way to take advantage of gold price increases, as companies are affected by non-gold related business risks. Ozanian (1987),

[5] Current trends in the mining industry show that mining companies focus on few minerals nowadays (The Economist, 2014). Whether this results in a more elastic or inelastic behavior of mining stock returns to changes in copper prices needs to be investigated. Even though it is discussed whether mining stock returns react elastic or inelastic to changes in copper prices, all researches agree that a relationship between those two variables exist.

Panchapakesan (1993) and Rolo (1975) argue that the mining stock returns present an elastic behavior with regard to mineral price changes, as the percentage change in the mining stock price will be greater than the percentage change on the mineral price. Blose´s (1995) research considered that the forward gold price is a market´s unbiased expectation of future metal prices; his results indicate that the gold mining firm value depends on the gold price returns, the production costs, the gold reserves and the level of diversification; additionally, found evidence was found that mining stock prices present an elastic behavior with regard to mineral prices.

Tufano (1998) is a milestone paper in the analysis of mineral prices influence on mining stock prices. Tufano (1998) examined the influence of different factors on the prices of mining stocks.[6] and found that the mining stock price sensitivity to gold price decreases with increasing gold prices. The change of stock price as a reaction to a 1% change in mineral prices ranges between 2% and 10%. Tufano (1998) also addressed the impact of forward prices, which are a kind of future contract on an unregulated market, as a hedging tool; but, the signaling effect of future prices on investors decision to invest or disinvest into a stock was not studied. Zevallos and Del Carpio (2015) come to similar findings, when investigating the correlation between mining companies stock returns and changes in the prices of metal they primarily produce. They focus their analysis on Lima Stock Exchange (BVL) listed stocks and conclude that mining company stock returns are highly correlated with the prices of the main metals of production. Zevallos and Del Carpio (2015) also provided evidence of the influence of the 2008-2009 global financial crisis on Peruvian mining stocks. Nonetheless, the influence of the global crisis on global mining stocks, especially in developed countries has yet not been investigated.

Ntantamis and Zhou (2015), investigate commodity spot prices´ influence on commodity stocks, focusing on the Canadian stock market. They find that commodity prices partially explain stock price changes, but local factors, such as exchange rates, need to be taken into consideration. Other research examines the impact of commodity prices on stock returns, focusing on stock market returns rather than returns of single stocks. Jacobsen et al. (2014) find that the same kind

[6] On the one hand, gold price, gold volatility, 10-year Treasury bond rate, gold production, percent hedged (delta), and forward prices has a negative impact on gold betas. On the other hand, gold lease rate, financial leverage, cost structure and percent in mining have a positive impact on gold betas. Tufano (1998) data include 48 North American firms engaged in gold mining between January 1990 and March 1994. The reader is referred to Appendix 3 for detailed information regarding the factors affecting gold prices.

of information can have different impacts on stock returns in different economic situation, which was already indicated by McQueen and Roley (1993) and Boyd et al. (2005). While these papers generate findings for the overall stock market, they do not indicate conclusions for single stocks or the mining industry.

Tufano (1996) developed in an earlier paper that companies hedge and minimize the risk they are exposed to by using futures contracts among other instruments. Accordingly, futures prices should have an impact on company returns and therefore on their stock prices, which has not empirically been proven yet. While a number of researchers investigated on the impact of mineral or oil prices on stock markets, they are not considering the impact of mineral futures prices on investor´s decisions.

Lastly, research in this area focuses only on individual stock exchanges, mostly from the US. When considering today´s globalized world, this research misses an international focus. Capital markets on an international level can be found to be integrated or segmented. Bekaert and Campbell (1995) define a capital market as completely integrated, "if assets with the same risk have identically expected returns irrespective of the market" (Bekeart & Campbell, 1995: 403). In case this does not hold, capital markets can be defined to be segmented. Foerster and Karolyi (1999) indicate that this market segmentation can be caused by different effects such as regulatory barriers, taxes or information constraints. Errunza and Losq (1985) find that markets are not always perfectly segmented or integrated and that a "mild segmentation" exists. As this paper analyses stocks with different locations of trade, the markets can be found to be integrated or segmented. Froot and Dabora (1999) tested international capital market integration by using "Siamese twins" (company stocks traded on different stock exchanges around the world)[7] and whether they move together, as they would in presence of integrated markets. They found that stock returns appear to be more correlated with the markets they are traded in and accordingly markets to be segmented. It can be questioned whether these results still hold after more than two decades with better communication facilities and an advancing financial and trade globalization

[7] The "Siamese twins" used are 1) Royal Dutch Petroleum (traded mostly in the US and the Netherlands) & Shell Transport and Trading (traded mostly in the UK) 2) Unilever NV (Netherlands) & Unilever plc (UK) 3) SmithKline Beecham (merged company traded in the UK and US).

(OECD, 2011). Whether global mining capital markets (i.e. different stock markets) react in a consistent way to the same set of information has not been examined.

Consequently, the following three research ideas are going to be addressed in the paper and they will cover the previously discussed research gaps:

1. Analyze the impact of changes in spot and future copper prices on stock returns of copper mining firms.
2. Study the impact of changes in spot and future copper prices on stock returns of copper mining firms vary as a consequence of the 2008-2009 global crisis
3. Investigate the impact of changes in spot and future copper prices on stock returns of copper mining firms vary across stock exchanges (i.e. New York Stock Exchange, London Stock Exchange, Toronto Stock Exchange and Bolsa de Valores de Lima)

This paper is organized as follows. The research hypotheses are elaborated and presented in Section 2, followed by the explanation of data characteristics in Section 3. Section 4 presents the research results before Section 5 summarizes the findings, provides a conclusion and proposes subjects for future research.

2 HYPOTHESES

In this section we define the research hypotheses, which will be investigated in detail in Section 4. The hypothesizes are introduced based on the previous research, they are derived from. Each hypothesis is connected to the expected outcomes of the paper.

2.1 Hypothesis 1 (H1)

"Changes in copper future prices influence the stock returns of mining firms, that have copper as their main product."

Tufano´s (1998) research indicates that gold prices are a main factor in the determination of mining companies´ stock prizes and that larger firms experience gold shocks more strongly than smaller companies. Accordingly, big market-cap stocks have been selected in this research in order to receive the most precise results possible. The idea of controlling for firm size can be addressed in future research.

Following these findings, the first hypothesis states that changes in copper future prices should influence the stock returns of mining companies, that produce copper as their main mineral. It is furthermore expected, that future prices have a bigger impact on investors decisions than spot prices, as those are a common tool, used by mining companies. To test H1 we introduce the following linear model:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} \tag{1}$$

where:

R_t^{Cu} = Return on Copper in period t

R_t^{MSCI} = Return on Morgan Stanley Corporate Index in period t

The Morgan Stanley Corporate Index (MSCI)[8] return is introduced to control for systematic risk. If H1 is true, then $\beta_1 \neq 0$ but it is expected to find that $\beta_1 < 1$, i.e., the stock returns exhibit inelastic behavior with respect to copper returns.

2.1 Hypothesis 2 (H2)

"The global financial crisis decreases the reaction of mining stock returns to changes in copper prices."

Zevallos and Del Carpio (2015) present evidence that the global financial crisis decreases the reaction of mining stock prices to changes in copper prices, as investors become more cautious. Following Foerster and Karolyi (1999) a dummy variable is used to control for the pre and post crisis periods. To test H2 we introduce the following linear model:

[8] Also known as Morgan Stanley Capital International Index.

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_3 D_{CRI} + \beta_4 D_{CRI} R_t^{CU} + \beta_5 D_{CRI} R_t^{MSCI} \quad (2)$$

where:

D_{CRI} = Dummy Variable signaling the Global Crisis

If this hypothesis holds, β_3 and β_4 should present a significant negative sign. As the global crisis of 2008 had varying effects among the developing countries (Willem et. al., 2010), it cannot be forecasted, whether the effect (with regard to this research) on less developed countries (Lima) will be higher or lower than in developed countries.

2.3 Hypothesis 3 (H3)

"Capital markets (with respect to mining companies) of developed countries are more integrated than the ones of less developed countries."

Given the improvements in communication facilities and global capital flow (especially across developed markets), developed stock exchanges are expected to be more integrated than less developed ones. Even though the capital flows to developing countries increased after the global crisis (OECD, 2011), the developed markets are still expected to be more integrated. Following this idea, the third hypothesis of this paper states, that the capital markets (with regard to mining companies) of developed countries tend to be integrated. The capital markets of less developed countries are expected to be less integrated. If this hypothesis holds, stock returns of less developed markets should present a different behavior than the ones of developed markets. Stock returns of developed markets should indicate a similar behavior among different places of trade.

To test this hypothesis, dummy variables to control for the New York (NYSE), London (LSE), Toronto (TSX) and Lima (BVL) stock exchanges are introduced. To avoid the dummy trap (Gujarati, 2008), BVL will act as the base and therefore not be represented by a dummy. To avoid biases due to the determination of BVL as the base dummy, the model will also be tested considering NYSE as the base dummy. Consequently, to test H3 we introduce the following linear model:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_6 D_{NYSE} + \beta_7 D_{LSE} + \beta_8 D_{TSX} \quad (3)$$

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_{12} D_{BVL} + \beta_7 D_{LSE} + \beta_8 D_{TSX} \quad (4)$$

where:

D_{NYSE} = Dummy Variable representing the New York Stock Exchange (NYSE)

D_{LSE} = Dummy Variable representing the London Stock Exchange (LSE)

D_{TSX} = Dummy Variable representing the Toronto Stock Exchange (TSX)

To test for the differences between less developed and fully developed capital markets, the Lima Stock Exchange, as a less developed one, will be excluded from the model, using NYSE as the base.

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_7 D_{LSE} + \beta_8 D_{TSX} \quad (5)$$

Model (5) should reveal no significant differences among these stock exchanges, as they are assumed to be integrated. Following hypothesis' two rationality, another set of dummy variables is introduced to check, in addition to the impact on the intercept, also for the impact on the slope of the model.

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_6 D_{NYSE} + \beta_9 D_{NYSE} R_t^{CU} + \beta_7 D_{LSE} + \beta_{10} D_{LSE} R_t^{CU} + \beta_8 D_{TSX} + \beta_{11} D_{TSX} R_t^{CU} \quad (6)$$

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_{12} D_{BVL} + \beta_{13} D_{BVL} R_t^{CU} + \beta_7 D_{LSE} + \beta_{10} D_{LSE} R_t^{CU} + \beta_8 D_{TSX} + \beta_{11} D_{TSX} R_t^{CU} \quad (7)$$

where:

D_{NYSE} = Dummy variable representing the Peruvian stock market (BVL)

If this hypothesis holds, variables β_6, β_7, β_8, β_9, β_{10} and β_{11}, representing developed markets, should reveal no significant impact on the stock returns, as those markets are expected to be integrated. Variables β_{12} and β_{13}, representing the Lima Stock exchange, should have a significant influence, as the capital markets of less developed markets are expected to be segmented.

2.4 Hypothesis 4

"The impacts of the global financial crisis and market segmentation/integration are observable simultaneously."

The combined impacts of the global crisis and segmented markets and the consistency of the previous hypotheses will be tested. This 4th hypothesis states, that the global financial crisis and market segmentation/integration are observable at the same time, checking for cross-influences. It is expected that the stock reaction to changes in copper prices reduces after the financial crisis started and that stock markets of less developed countries become more segmented and stock markets of developed countries become more integrated. To test H2 we introduce the following linear model:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_3 D_{CRI} + \beta_4 D_{CRI} R_t^{CU} + \beta_5 D_{CRI} R_t^{MSCI} + \beta_6 D_{NYSE} + \beta_7 D_{LSE} + \beta_8 D_{TSX} \quad (8)$$

If this hypothesis holds, variables β_3, β_4 and β_5, representing the global financial crisis, should have a significant negative sign, while the variables representing the developed stock exchanges (β_6, β_7, β_8) should have no significant impact, as those markets are expected to be integrated.

3 DATA

This section presents the applied methodology as well as the data and variables used during the research. Sources and details are presented in order to give the reader a clear understanding of the way of investigation. A variance–covariance matrix will be used to demonstrate relationships among the used variables.

The four hypotheses of Section 2 will be tested by using minimum squared regression analyses. Following Foerster and Karoly (1999), Gomes and Chaibi (2014) and Zevallos and Del Carpio (2015), weekly data will be used to mitigate the lack of synchronicity between the different stock exchanges and metal exchanges as well as overcome missing data due to different national holidays. Collected research data correspond to the period January 2005 to December 2015,[9] and arithmetic stock returns, considering price changes and dividends paid, will act as the dependent variable.

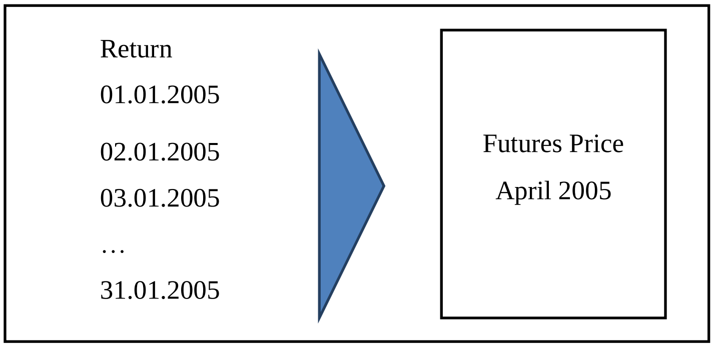
The following independent variables are used in the paper: Copper spot prices, Copper 90-day Future prices, Copper 180-day Future prices, Global crisis, Morgan Stanley Corporate Index (MSCI), S&P 500 Index, Trade venue (NYSE, LSE, TSX, BVL). All price data is converted into arithmetic returns. Copper spot prices were obtained from the London Metal Exchange (LME), using the Bloomberg data base and Futures price data was obtained from Chicago Mercantile Exchange (COMEX) and retrieved from quandl.com. As futures are always traded for a month, a total set of 132 contracts will be included (11 years x 12 month) for both 90-day and 180-day futures. The weekly stock return for January 2005 for instance will be related to 90-day future contract ending in April 2005 and the 180-day future contract ending in July 2005. This is exemplified in Figure 1.

Stock returns are collected for 23 companies from four different stock exchanges: New York, as the leading global stock exchange, Toronto, as the leading global mining stock exchange, London, as a second leading stock exchange in the world with many mining companies listed on it, as well as Lima, as a mining focused stock exchanges from a less developed country. This research is limited to those four stock exchanges. The Santiago stock exchange (Chile) has not been considered, even though mining has a big influence in the Chilean economy, as most of those companies are state owned and just few companies are stock listed. The Australian stock exchange can be considered in future research. The selected companies are a random choice of big companies, focusing on copper, traded on the respective stock exchange. The selected companies have been considered most relevant, as they are mainly the biggest firms, that are

[9] The data for November 2014 and the first week of December 2014 have been removed due to abnormally high changes in the 90-day future prices.

listed on the respective stock exchanges with regard to market capitalization. Those companies are presented in Appendix 4.

Figure 2 Data Mapping (Future Price)



To account for the 2008 financial crisis, a dummy variable will be included. The Morgan Stanley Corporate Index (MSCI) will be used to control for general economic situation and systematic risk. The place of trade will be considered, using another set of dummy variables, to detect different reactions of less developed (BVL) and developed (NYSE, LSE, TSX) markets. The correlations across the different variables (refer to Appendix 5), show a high value among copper prices (spot, 90-day and 180-day).

4 RESEARCH FINDINGS

This section presents the research´s findings. The results are summarized and interpreted for each hypothesis. The hypotheses will be tested including and excluding the BVL, as this venue represents a less developed market. Furthermore, hypotheses three and four are tested using the BVL and NYSE as the base in separate regressions, in order to control for biases according to the determination of the base stock exchange. Selected regression results are presented in this chapter, further detailed results can be found in the corresponding appendices.

4.1. Hypothesis 1

As expected, spot and future copper prices are relevant to explain mining stock returns (refer to Table 1 and Appendix 6 – Table A.6.). Copper prices show a positive influence on stock price returns of copper mining firms. Spot prices and future prices are of similar relevance, which is consistent with the strong correlation between both variables. The stock price returns present an inelastic behavior ($\beta_1^{Price} < 1$) with regard to copper returns, which is in line with Khoury´s (1984) and Rock´s (1988) findings. A value of around 0.5 for β_1^{Price} indicates that stock returns will rise by 0.5% for every 1% change in copper prices. This is consistent throughout all hypotheses. The MSCI and S&P500 prove significance, with the MSCI presenting a higher significance and more robustness, indicated by a greater Adjusted R^2. Accordingly, the MSCI is included in the subsequent models to control for systematic risk and economic conditions.

Table 1: *Hypothesis 1 - Including BVL and MSCI*

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI}$$

R_t represents the stock returns relative to the previous week. Data for stocks, which are not traded during a certain period, are excluded from the analysis. All stocks, traded on NYSE, LSE, TSX and BVL are considered. R_t^{CU} represent the price change in copper prices, relative to the previous period. The different price sets are considered: Spot prices, 90-day future prices and 180-day future prices. R_t^{MSCI} represents the relative change in the trading price of the Morgan Stanley Corporate Index relative to the previous week.

	α	β_1^{Price}	β_2^{MSCI}	Adj. R^2	F-Test
Spotprice	0.004	0.534	1.262	34.70%	3,355.923
	0.073	32.666 **	47.919 **		
90D Futures Price	0.012	0.553	1.229	35.10%	3,365.636
	0.212	33.552 **	45.994 **		
180D Futures Price	0.004	0.565	1.222	35.20%	3,417.262
	0.068	34.025 **	45.950 **		

*** significant on the 5% level*

The results are consistent among less developed and developed stock markets. Considering the model for developed capital markets (stock exchanges in developed countries) presents more robust results, as the Adjusted R^2 coefficient increases (refer to Appendix 6 – Table A.7.). Furthermore, the reaction to price changes, represented by β^{Price}, is slightly higher in developed markets than in less developed ones, showing that those markets include price information more strongly. The copper spot prices and future prices remain of equal relevance. As β^{MSCI} presents values about 0.2 greater in developed than in less developed countries, this indicates that mining stocks in developed markets are more affected by systematic risk, as the market has a greater influence on stock price developments. It furthermore indicates, that developed markets are more integrated, as stock market returns of mining firms are more affected by global economic developments.

4.2. Hypothesis 2

Model (2), considering developed and less developed markets, reveals a negative impact of the crisis, expressed by the negative value of β_3 (refer to Table 2 for detailed information), which is consistent with the findings of Zevallos and Del Carpio (2015). Accordingly, the mining stock returns decreased over the post global crisis period. Interestingly, the impact on the slope (expressed by β_4) is not significant.

When considering just the developed markets for this model (refer to Table 3), the results become more robust, as the Adjusted R^2 increases. They further show, that the crisis does not have any significant effect on the investor's behavior as β_3 is not significant. Consistently with hypothesis one, β^{MSCI} increases by about 0.2, which indicates that developed markets are more integrated and more exposed to systematic risk.

Table 2: ***Hypothesis 2 - Including BVL***

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_3 D_{CRI} + \beta_4 D_{CRI} R_t^{CU} + \beta_5 D_{CRI} R_t^{MSCI}$$

All stocks, traded on NYSE, LSE, TSX and BVL are considered. Dummy variable β_3 represents the impact of the global crisis

	α	β_1 Price	β_2 MSCI	β_3 Crisis	β_4 D(crisis) R(Copper Price)	β_5 D(crisis) R(MSCI)	Adj. R^2	F-Test
	0.218	0.546	1.248	-0.323	-0.028	-0.029	34.80%	1,344.504
Spotprice	2.178 **	22.251 **	21.362 **	-2.649 **	-0.851	0.439		
	0.244	0.567	1.214	-0.322	-0.032	0.031	35.10%	1,348.438
90D Future Price	2.228 **	22.711 **	20.629 **	-2.624 **	-0.962	0.468		
	0.202	0.588	1.210	-0.304	0.047	0.033	35.20%	1,369.251
180D Future Price	2.021 **	23.245 **	20.654 **	-2.494 **	-1.394	0.495		

*** significant on the 5% level*

Table 3: ***Hypothesis 2 - Excluding BVL***

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_3 D_{CRI} + \beta_4 D_{CRI} R_t^{CU} + \beta_5 D_{CRI} R_t^{MSCI}$$

Just the stocks traded on stock exchanges of developed markets (NYSE, LSE and TSX) are considered. Dummy variable β_3 represents the impact of the global crisis

	α	β_1 Price	β_2 MSCI	β_3 Crisis	β_4 D(crisis) R(Price)	β_5 D(crisis) R(MSCI)	Adj. R^2	F-Test
Spotprice	0.129	0.540	1.457	-0.184	0.046	-0.002	41.00%	1,289.033
	1.118	19.114 **	21.676 **	-1.312	1.222	-0.031		
90D Future Price	0.161	0.563	1.424	-0.219	0.032	0.003	41.30%	1,288.129
	1.386	19.572 **	21.062 **	-1.549	0.827	0.034		
180D Future Price	0.121	0.584	1.416	-0.17	0.020	0.007	41.40%	1,307.207
	1.050	20.056 **	20.990 **	-1.219	0.511	0.088		

*** significant on the 5% level*

4.3. Hypothesis 3

Including the trade venue shows, as expected, no significant impact on the intercept as $\beta_{6,}$ β_7 and β_8 are insignificant (refer to Appendix 6 – Table A.8.). The values for β^{Price} and β^{MSCI} are consistent with the previous results. To test for a possible impact of the Lima stock exchange as the base, the model is run with the New York stock exchange acting as base variable, which leads to similar conclusions (refer to Appendix 6 – Table A.9.). Coefficients β_7, β_8 and β_{12} present insignificant results and β^{Price} and β^{MSCI} are consistent with the results of hypothesis one. The base has accordingly no influence on the results.

To test further for segmented markets, the exchanges´ impact on the slope of the model is tested (refer to Table 4). It proves an impact of the place of trade on the slope of the model, as $\beta_{9,}$ β_{10} and β_{11} are significant. The positive values indicate, that the developed markets achieve higher returns than the less developed markets (BVL acts as base). It is furthermore reasonable, that TSX, as the most important mining stock exchange in the world, reveals the highest returns, indicated by the highest β. LSE, as the second strongest mining stock exchange, presents the second highest β and NYSE, as the biggest stock exchange in the world, presents a higher β than BVL, as a less developed stock exchange and the smallest one in the sample.

Table 4: *Hypothesis 3 (II) - Including BVL (base: BVL)*

The following regression model is used:

$$Rt = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_6 D_{NYSE} + \beta_9 D_{NYSE} R_t^{CU} + \beta_7 D_{LSE} + \beta_{10} D_{LSE} R_t^{CU} + \beta_8 D_{TSX} + \beta_{11} D_{TSX} R_t^{CU}$$

All stocks, traded on NYSE, LSE, TSX and BVL are considered. Dummy variables β_6, β_7 and β_8 represent the indicated stock exchanges' impact on the intercept of the model. BVL acts as base dummy. Dummy variables β_9, β_{10} and β_{11} represent the stock exchanges impact on the slope of the model.

	α	β_1 Price	β_2 MSCI	β_6 NYSE	rice)	β_7 LSE	10 (LSE)*(Price)	β_8 TSX	11 (TSX)*(Price)	Adj. R^2	F-Test
Spotprice	-0.009	0.270	1.262	-0.049	0.254	-0.013	0.343	0.097	0.466	35.50%	869.906
	-0.078	9.617 **	48.205 **	-0.301	6.393 **	-0.077	8.611 **	0.633	12.341 **		
90D Future Price	-0.005	0.291	1.228	-0.040	0.251	-0.009	0.338	0.103	0.463	35.90%	872.204
	-0.045	10.368 **	46.266 **	-0.247	6.342 **	-0.054	8.526 **	0.670	12.291 **		
180D Future Price	-0.020	0.297	1.222	-0.028	0.260	0.006	0.343	0.104	0.476	36.00%	886.394
	-0.179	10.485 **	46.230 **	-0.172	6.539 **	0.035	8.599 **	0.683	12.571 **		

*** significant on the 5% level*

The results therefore propose the assumption of segmented markets, which is unexpected and contrary to hypothesis two. Replacing BVL with NYSE as the base leads to similar result, accordingly the base has no influence on the result (refer to Appendix 6 – Table A.10.).

Lastly, the Lima stock exchange is excluded from the analysis to focus solely on developed markets (refer to Appendix 6 – Tables A.11. and A.12.). The data get more robust, but the conclusion of more segmented markets remains, as the place of trade again has a significant impact on the slope of the model (β_{10} and β_{11}). β^{Price} and β^{MSCI} are again consistent with previous findings.

4.4. Hypothesis 4

H4 shows consistency with the previous results. The copper price (β1) as well as the MSCI (β_2 and β_5) present a significant positive impact on stock returns. The crisis (β_3 and β_4) has a significant negative impact on stock returns for less developed markets but a mostly insignificant impact on developed markets. The places of trade (β_6 – β_{13}) have no significant impact on the intercept of the model, but on the slope and therefore suggest different behaviors among the markets. The choice of the base (NYSE or BVL) does not impact the results. Excluding BVL, as a less developed stock exchange, and solely focusing on developed stock exchanges increases the robustness (Adjusted R^2) of the results and the impact of the MSCI once again. (Refer to Table 5 and Appendix 6 – Tables A.13. and A.14.).

Table 5: *Hypothesis 4 (II) - Including BVL (base: BVL)*

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_3 D_{CRI} + \beta_4 D_{CRI} R_t^{CU} + \beta_5 D_{CRI} R_t^{MSCI} + \beta_6 D_{NYSE} + \beta_9 D_{NYSE} R_t^{CU} + \beta_7 D_{LSE} + \beta_{10} D_{LSE} R_t^{CU} + \beta_8 D_{TSX} + \beta_{11} D_{TSX} R_t^{CU}$$

All stocks, traded on NYSE, LSE, TSX and BVL are considered. Dummy variable β_3 represents the impact of the global crisis Dummy variables β_6, β_7 and β_8 represent the indicated stock exchanges' impact on the intercept of the model. BVL acts as base dummy. Dummy variables β_9, β_{10} and β_{11} represent the stock exchanges impact on the slope of the model.

	α	β_1 Price	β_2 MSCI	β_3 Crisis	β_4 D(crisis)*R(Price)	β_5 D(crisis)*R(MSCI)	β_6 NYSE	β_9 (NYSE)*(Price)	β_7 LSE	β_{10} (LSE)*(Price)	β_8 TSX	β_{11} (TSX)*(Price)	Adj. R^2	F-Test
Spotprice	0.202	0.283	1.247	-0.323	-0.030	0.030	-0.047	0.254	-0.008	0.343	0.104	0.466	35.60%	633.674
	1.481	8.484 **	21.490 **	-2.668 **	-0.925	0.452	-0.289	6.394 **	-0.047	8.617 **	0.678	12.344 **		
90D Future Price	0.204	0.307	1.213	-0.323	-0.034	0.032	-0.038	0.251	-0.004	0.339	0.110	0.463	36.00%	635.373
	1.485	9.123 **	20.750 **	-2.644 **	-1.039	0.481	-0.235	6.343 **	-0.025	8.533 **	0.714	12.296 **		
180D Future Price	0.175	0.321	1.209	-0.304	-0.049	0.034	-0.026	0.261	0.010	0.343	0.110	0.476	36.00%	645.781
	1.289	9.443 **	20.771 **	-2.514 **	-1.478	0.509	-0.160	6.542 **	0.064	8.608 **	0.725	12.579 **		

*** significant on the 5% level*

5 CONCLUSIONS AND RECOMMENDATIONS

The literature review revealed some gaps with regard to the impact of copper prices on investor`s decisions and accordingly on the stock returns of mining companies. It furthermore lagged an investigation on market characteristics (capital market integration vs. segmentation) among developed and less developed countries as well as the influence of the global financial crisis. We stated four (04) hypothesis regarding the effect of copper prices in the return of mining stocks.

Hypothesis 1 (H1) states that copper future prices have a significant impact on the returns of mining stocks. This hypothesis was confirmed, as spot and future prices prove a similar impact. Stock returns reaction to changes in copper prices was proven to be inelastic, with a β of around 0.5. This is consistent with findings of Khoury (1984) and Rock (1988), who focused their research on gold. Furthermore, the Morgan Stanley Corporate Index (MSCI) was proven to have a more significant impact on stock price returns than the Standard & Poor´s 500. It furthermore has a stronger impact on developed markets than on less developed ones, which indicates that those developed markets are stronger exposed to systematic risk.

Hypothesis 2 (H2) presents evidence that the global financial crisis influenced investors decisions and has a negative impact on mining companies´ stock returns. This hypothesis could just partially be confirmed, as the results show, that it has a strong negative impact in less developed countries, but no significant impact in developed ones. In conclusion, the global financial crisis has no impact on mining companies´ stock returns in developed markets.

Hypothesis 3 (H3) states that capital markets of developed countries are expected to be more integrated than those of less developed ones. This hypothesis was rejected, as all capital markets turned out to be segmented. While the trade venue´s impact on the intercept of the models is insignificant, its impact on the slope proved significance. The conclusion of Froot and Dabora (1999), that capital markets rely on national characteristics and developments, apparently still holds. The chosen base trade venue has no impact on the results, as they remain the same for different bases.

Hypothesis 4 (H4) is confirmed as the impacts of the trade venue and the crisis are observable at the same time. The results of a joint impact of the global financial crisis and the trade venue are consistent with the results of individual tests. Even though these results are different than expected, the impact of the global financial crisis remains insignificant for developed markets and significant for less developed ones. The markets furthermore remain to be segmented.

The findings of this paper suggest further research on the reasons behind the non-significant impact of the global financial crisis (on developed markets) as well as the segmented capital markets in developed countries. The global financial crisis of 2008 had a big impact on the global economy. Surprisingly, it turned out to have no significant impact on returns of mining stocks in developed markets. An explanation for this would need to be given in future research. Capital markets of developed countries have been expected to be integrated, which was disproved during this research. Whether this is a unique for mining stocks or a general condition, needs to be further analyzed.

Lastly, previous research has found a relationship between stock price and trading volume (Karpoff, 1987; Bessembinder & Seguin, 1993; Gulia, 2011). This is explained by the impact of information on both variables. Furthermore, Karpoff (1988), finds additionally that positive information and increasing prices have a bigger impact on trading volume, than do negative information and decreasing prices. This is explained with the high costs of short selling, which mitigate investors motivation to invest into stocks and benefit from falling prices. Future research would need to analyze, whether this paper´s findings also hold with regard to traded volume. In this context, it has to be considered, that while changes in stock returns can be positive or negative, traded volume is always represented by a positive value. Accordingly, absolute values are recommended to be used in this research.

APPENDICES

I. Market value by sector on Toronto Stock Exchange

Table A.1: Market Value by Sector on Toronto Stock Exchange

The following table presents the market value by sector on the Toronto Stock Exchange
The sector clustering is adopted from the Toronto Stock Exchange

Sector	Market Value	%
Mining	292,947,499,631	11%
Clean Technology	34,635,030,888	1%
Energy & Energy Services	295,657,740,911	11%
Technology	81,692,899,415	3%
Life Sciences	18,798,776,399	1%
Real Estate	94,579,215,601	3%
Diversified Industries	1,900,800,686,249	70%
TOTAL	2,719,111,849,094	100%

Source: Toronto Stock Exchange, 2017

II. Biggest copper mining companies world wide

Table A.2. Biggest copper mining companies world wide

The following table presents the biggest copper producing companies worldwide. In case stocks are traded on different stock exchanges, this table lists the stock exchanges with the biggest market capitalization (among NYSE, LSE and TSX).Stock Exchanges: NYSE = New York Stock Exchange; LSE = London Stock Exchange; TSX = Toronto Stock Exchange; F = Frankfurt Market capitalization is as of 7th March 2017.The average daily traded volume relates to the period December 2016 – February 2017. Returns are given as stock price changes between March 2016 and March 2017.

Company Name	Produced Copper Volume (2015) in 000 t	Stock Exchange	Market Cap (in B USD)	Avg daily Traded Volume (in M shares)	Returns
Codelco	1,893	State Owned (Chile)			
Freeport McMoRan	1,547	NYSE	18.88	29.96	46.10%
Glencore	1,259	LSE	48.13	46.86	134.90%
BHP Billiton	1,178	NYSE	80.35	1.89	30.48%
Southern Copper	745	NYSE	28.46	1.21	41.06%
KGHM Polska Miedz	562	F	5.86	0.654	84.10%
Rio Tinto PLC	555	NYSE	73.77	3.85	42,71%
Anglo American	472	LSE	17.84	6.41	139.59%
Antofagasta	472	LSE	8.08	3.47	61.45%
First Quantum Minerals	366	TSX	10.33	3.45	121.99%

Sources: Thomson Reuters, 2016; Yahoo Finance.

III. Gold price influencing factors according to Tufano

Table A.3. Gold price influencing factors according to Tufano

The following table presents the influencing factors on gold price developments, found by Tufano (1998).

Description of Data Describing Potential Factors Affecting Gold Price Exposures

Panel A reports descriptive statistics for the sample of 48 North American gold mining firms from 1990 through March 1994. The gold price, volatility, and interest rates are market-wide variables. The remainder of the variables are firm-specific and the summary statistics reflect the average over the panel for all periods. Panel B shows the correlations between the variables affecting the gold betas. Because some of the variables are reported quarterly and some are reported yearly, quarterly vs. yearly variable correlations are computed by first averaging the quarterly variable over the year. The shaded area in Panel B corresponds to variables where quarterly data are averaged over a year. V represents the market value of the firm, which equals the average market value of the firm's equity plus the book value of its debt. The last row shows the correlations of the gold betas with the variables affecting the gold betas (β).

Panel A: Description of Variables

Factor	Effect on Gold Beta	Observed Variable	Definition and Source of Data	Mean Std. Dev. Median
Gold price (P)	−	Average gold price over quarter	Average of daily COMEX closing prices, in US$ per ounce, as of 2:30 p.m. EST. (ReuterLink)	Mean: $361 SD: $16 Med: $360
Volatility (σ)	−	90-day annualized gold return volatility	90-day annualized volatility of gold returns. (Calculated from ReuterLink)	Mean: 0.13 SD: 0.04 Med: 0.14
Interest rates	+	Gold lease rate (GLR)	Quarterly average of daily gold lease rates. (Commodity dealers)	Mean: 1.02% SD: 0.52% Med: 0.79%
	−	10 year Treasury bond rate (10YR)	Quarterly average of daily 10-year T-bond rates. (Datastream)	Mean: 7.17% SD: 1.08% Med: 7.31%
Production quantity (Q)	−	Production in millions of oz.	Production in millions of ounces. (Annual reports)	Mean: 0.37 SD: 0.51 Med: 0.15
Financial leverage (F)	+	Debt to equity ratio	(Year-end long-term debt + current portion)/Year-end market value of firm. (Compustat)	Mean: 0.30 SD: 0.59 Med: 0.15
Cost structure	+	Yearly cash costs (C)	Yearly cash costs in $/oz. (Annual reports)	Mean: $237 SD: $58 Med: $223
		Proxies for potential economies of scale (firm size)	Reserves in millions of ounces. (Annual reports) (R)	Mean: 5.18 SD: 6.80 Med: 2.28
			Year-end market value of firm in millions. (COMPUSTAT) (V)	Mean: 749 SD: 1159 Med: 210
Percent hedged	−	Delta-percentage-of-production ($D\%P$)	Delta of risk management portfolio/estimated production. (Reeve reports, market data)	Mean: 0.27 SD: 0.33 Med: 0.20
		Delta-percentage-of-reserves ($D\%R$)	Delta of risk management portfolio/total reserves. (Reeve reports, market data)	Mean: 0.05 SD: 0.07 Med: 0.02
Forward prices	−	Average-forward-contract-price (W_1)	Sum of quarterly forward price times quarterly hedged amount, divided by sum of hedged amount. (Reeve reports)*	Mean: $419 SD: $37 Med: $419
		Average-delta-contract-price (W_2)	Average contract price, weighted by ounce, where options included at delta-equivalent at spot. (Reeve report)*	Mean: $418 SD: $174 Med: $401
Percent in mining	+	Percent of firm assets in mining ($\%M$)	Yearly percent of firm assets in mining. (COMPUSTAT)	Mean: 92 SD: 22 Med: 100

Source: Tufano, 1998: 1028 + 1029

IV. List of selected companies

Table A.4. List of selected companies

The following table presents the companies, selected for this research.
Market capitalization is as of 13th March 2017
Revenue is as reported for the last Business Year

	Headquarters	Market Cap (in B USD)	Revenue (last BY) (in B USD)
New York Stock Exchange			
Alcoa Inc. (AA)	New York	6.42	9.32
BHP Billiton (BHP)	Melbourne	97.82	34.69
Freeport McMoRan (FCX)	Phoenix	18.07	14.83
Rio Tinto (RIO)	London	71.52	33.78
Southern Copper (SCCO)	Phoenix	27.43	5.38
London Stock Exchange			
Anglo Americano (AAL.L)	London	16.64	21.38
Antofagasta (ANTO.L)	London	7.73	3.07
KAZ Minerals (KAZ.L)	London	2.14	0.77
Rio Tinto (RIO.L)	London	59.45	33.78
BHP Billiton (BLT.L)	London	67.89	34.69
Toronto Stock Exchange			
First Quantum Minerals (FM.TO)	Vancouver	9.33	2.67
Imperial Minerals (III.TO)	Vancouver	0.588	0.42
Ivanhoe mines (IVN.TO)	Vancouver	3.2	/
HudBay Minerals (HBM.TO)	Toronto	2.24	1.13
Lundin Mining Corporation (LUN.TO)	Toronto	5.63	1.55
Nevsun Resources (NSU.TO)	Vancouver	1.01	0.23
Teck Resources Limited (Teck-A.TO)	Vancouver	16.05	9.30
Bolsa de Valores Lima – Lima Stock Exchange (BVL)			
Sociedad Minera Cerro Verde SAA (CVE.LM)	Arequipa	7.6	2.31
Sociedad Mineral El Brocal SAA (BRO.LM)	Lima	1.434	0.26
Minsur (MINi.LM)	Lima	1.278	0.46
Milpo (MIL.LM)	Lima	4.475	0.69
Southern Copper (SPC.LM)	Phoenix	27.172	5.38
Volcan Compania Minera SAA (VOL_pb.LM)	Lima	5.417	0.80

Sources: YahooFinance, 2017c & Reuters, 2017

V. Covariance Matrix

Table A.5. Covariance Matrix

The following table presents the variance-covariance matrix for the selected variables

	Stock Price Return	Spot Price Copper	Future Price Copper (90D)	Future Price Copper (180D)	Return MSCI	Return S&P500
Stock Price Return	1.000	0.478	0.491	0.493	0.541	0.482
Spot Price Copper		1.000	0.976	0.975	0.510	0.434
Future Price Copper (90D)			1.000	0.996	0.526	0.442
Future Price Copper (180D)				1.000	0.530	0.445
Return MSCI					1.000	0.955
Return S&P500						1.000

VI. Further Regression Results

Table A.6. Hypothesis 1 - Including BVL - S&P500

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{S\&P500}$$

R_t represents the stock returns relative to the previous week. Data for stocks, which are not traded during a certain period, are excluded from the analysis. All stocks, traded on NYSE, LSE, TSX and BVL are considered. R_t^{CU} represent the price change in copper prices, relative to the previous period. The different price sets are considered: Spot prices, 90-day future prices and 180-day future prices. $R_t^{S\&P500}$ represents the relative change in the trading price of the Standard & Poor´s 500 Index relative to the previous week.

	α	β_1^{Price}	$\beta_2^{S\&P500}$	Adj. R^2	F Test
Spotprice	-0.026	0.648	1.082	32.10%	2,981.869
	-0.455	40.767 **	41.462 **		
90D Futures Price	-0.17	0.669	1.055	32.80%	3,035.992
	-0.285	42.119 **	40.185 **		
180D Futures Price	-0.027	0.683	1.048	32.90%	3,086.157
	-0.463	42.710 **	40.128 **		

*** significant on the 5% level*

Table A.7. Hypothesis 1 - Excluding BVL – MSCI

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI}$$

R_t represents the stock returns relative to the previous week. Data for stocks, which are not traded during a certain period, are excluded from the analysis. Just stocks traded on stock exchanges of developed markets (NYSE, LSE, TSX) are considered. R_t^{CU} represent the price change in copper prices, relative to the previous period. The different price sets are considered: Spot prices, 90-day future prices and 180-day future prices. R_t^{MSCI} represents the relative change in the trading price of the Morgan Stanley Corporate Index relative to the previous week.

	α	β_1^{Price}	β_2^{MSCI}	Adj. R^2	F-Test
Spotprice	-0.001	0.567	1.464	41.00%	3,220.877
	-0.019	30.235 **	48.531 **		
90D Futures Price	0.009	0.583	1.432	41.30%	3,218.780
	0.142	30.837 **	47.798 **		
180D Futures Price	0.003	0.597	1.424	41.40%	3,267.585
	0.048	31.329 **	46.729 **		

*** significant on the 5% level*

Table A.8. Hypothesis 3 (I) - Including BVL (base: BVL)

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_6 D_{NYSE} + \beta_7 D_{LSE} + \beta_8 D_{TSX}$$

All stocks, traded on NYSE, LSE, TSX and BVL are considered. Dummy variables β_6, β_7 and β_8 represent the indicated stock exchanges' impact on the intercept of the model. BVL acts as base dummy.

	α	β_1^{Price}	β_2^{MSCI}	β_6^{NYSE}	β_7^{LSE}	β_8^{TSX}	Adj. R^2	F-Test
Spotprice	-0.050	0.534	1.262	-0.009	0.040	0.165	34.70%	1,342.544
	-0.451	32.668 **	47.913 **	-0.055	0.248	1.074		
90D Future Price	-0.052	0.553	1.229	0.004	0.050	0.181	35.10%	1,346.474
	-0.463	33.555 **	45.989 **	0.027	0.306	1.167		
180D Future Price	-0.066	0.565	1.222	0.017	0.064	0.181	35.20%	1,367.100
	-0.598	34.028 **	45.944 **	0.106	0.393	1.182		

*** significant on the 5% level*

Table A.9. Hypothesis 3 (I) - Including BVL (base: NYSE)

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_{12} D_{BVL} + \beta_7 D_{LSE} + \beta_8 D_{TSX}$$

All stocks, traded on NYSE, LSE, TSX and BVL are considered. Dummy variables β_7, β_8 and β_{12} represent the indicated stock exchanges' impact on the intercept of the model. NYSE acts as base dummy.

	α	β_1^{Price}	β_2^{MSCI}	β_{12}^{BVL}	β_7^{LSE}	β_8^{TSX}	Adj. R^2	F-Test
Spotprice	-0.049	0.565	1.222	-0.017	0.047	0.164	35.20%	1,367.100
	-0.408	34.028 **	45.944 **	-0.106	0.277	1.024		
90D Future Price	-0.047	0.553	1.229	-0.004	0.046	0.176	35.10%	1,346.473
	-0.390	33.555 **	45.989 **	-0.027	0.269	1.091		
180D Future Price	-0.059	0.534	1.262	0.009	0.050	0.174	34.70%	1,342.544
	-0.492	32.668 **	47.913 **	0.055	0.291	1.085		

*** significant on the 5% level*

Table A.10. Hypothesis 3 (II) - Including BVL (base: NYSE)

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_{12} D_{BVL} + \beta_{13} D_{BVL} R_t^{CU} + \beta_7 D_{LSE} + \beta_{10} D_{LSE} R_t^{CU} + \beta_8 D_{TSX} + \beta_{11} D_{TSX} R_t^{CU}$$

All stocks, traded on NYSE, LSE, TSX and BVL are considered. Dummy variables β_7, β_8 and β_{12} represent the indicated stock exchanges' impact on the intercept of the model. NYSE acts as base dummy. Dummy variables β_{10}, β_{11} and β_{13} represent the stock exchanges impact on the slope of the model.

	α	β_1 Price	β_2 MSCI	β_{12} BVL	β_{13} (BVL)*(Price)	β_7 LSE	β_{10} (LSE)*(Price)	β_8 TSX	β_{11} (TSX)*(Price)	Adj. R^2	F-Test
Spotprice	-0.057	0.524	1.262	0.049	-0.254	0.036	0.089	0.145	0.212	35.50%	869.906
	-0.481	17.211 **	48.205 **	0.301	-6.393 **	0.215	2.139 **	0.912	5.361 **		
90D Future Price	-0.045	0.543	1.228	0.040	-0.251	0.031	0.087	0.144	0.211	35.90%	872.204
	-0.377	17.820 **	46.266 **	0.247	-6.342 **	0.184	2.107 **	0.892	5.365 **		
180D Future Price	-0.047	0.557	1.222	0.028	-0.260	0.033	0.083	0.132	0.215	36.00%	886.394
	-0.399	18.182 **	46.230 **	0.172	-6.539 **	0.199	1.987 **	0.829	5.433 **		

*** significant on the 5% level*

Table A.11. Hypothesis 3 (I) - Excluding BVL (base: NYSE)

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_7 D_{LSE} + \beta_8 D_{TSX}$$

Just the stocks traded on stock exchanges of developed markets (NYSE, LSE and TSX) are considered. Dummy variables β_7 and β_8 represent the indicated stock exchanges' impact on the intercept of the model. NYSE acts as base dummy.

	α	β_1 Price	β_2 MSCI	β_7 LSE	β_8 TSX	Adj. R^2	F-Test
Spotprice	-0.084	0.567	1.464	0.050	0.174	41.00%	1,610.656
	-0.714	30.237 **	48.549 **	0.299	1.106		
90D Future Price	-0.073	0.584	1.432	0.047	0.177	41.30%	1,609.620
	-0.618	30.839 **	46.794 **	0.277	1.112		
180D Future Price	-0.075	0.597	1.424	0.047	0.164	41.40%	1,644.945
	-0.639	31.331 **	46.724 **	0.285	1.044		

*** significant on the 5% level*

Table A.12. Hypothesis 3 (II) - Excluding BVL (base: NYSE)

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_7 D_{LSE} + \beta_{10} D_{LSE} R_t^{CU} + \beta_8 D_{TSX} + \beta_{11} D_{TSX} R_t^{CU}$$

Just the stocks traded on stock exchanges of developed markets (NYSE, LSE and TSX) are considered. Dummy variables β_7 and β_8 represent the indicated stock exchanges' impact on the intercept of the model. NYSE acts as base dummy. Dummy variables β_{10} and β_{11} represent the stock exchanges impact on the slope of the model.

	α	β_1^{Price}	β_2^{MSCI}	β_7^{LSE}	$\beta_{10}^{(LSE)*(Price)}$	β_8^{TSX}	$\beta_{11}^{(TSX)*(Price)}$	Adj. R^2	F-Test
Spotprice	-0.067	0.459	1.464	0.036	0.088	0.143	0.212	41.20%	1,082.102
	-0.571	15.107 **	48.631 **	0.215	2.160 **	0.911	5.444 **		
90D Future Price	-0.054	0.476	1.432	0.031	0.087	0.141	0.212	41.50%	1,081.482
	-0.459	15.634 **	46.876 **	0.185	2.127 **	0.891	5.448 **		
180D Future Price	-0.057	0.490	1.424	0.033	0.082	0.130	0.216	41.60%	1,098.022
	-0.482	15.979 **	46.809 **	0.199	2.006 **	0.825	5.516 **		

*** significant on the 5% level*

Table A.13. Hypothesis 4 (1) - Including BVL (base: BVL)

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_3 D_{CRI} + \beta_4 D_{CRI} R_t^{CU} + \beta_5 D_{CRI} R_t^{MSCI} + \beta_6 D_{NYSE} + \beta_7 D_{LSE} + \beta_8 D_{TSX}$$

All stocks, traded on NYSE, LSE, TSX and BVL are considered. Dummy variable β_3 represents the impact of the global crisis Dummy variables β_6, β_7 and β_8 represent the indicated stock exchanges' impact on the intercept of the model. BVL acts as base dummy.

	α	β_1 Price	β_2 MSCI	β_3 Crisis	β_4 D(crisis)*R(Copper Price)	β_5 D(crisis)*R(MSCI)	β_6 NYSE	β_7 LSE	β_8 TSX	Adj. R^2	F-Test
Spotprice	0.162	0.546	1.248	-0.326	-0.028	0.029	-0.007	0.045	0.172	34.80%	840.445
	1.184	22.249 **	21.361 **	-2.670 **	-0.848	0.438	-0.043	0.278	1.119		
90D Future Price	0.159	0.567	1.214	-0.325	-0.032	0.031	0.006	0.055	0.188	35.20%	842.932
	1.152	22.709 **	20.628 **	-2.646 **	-0.959	0.466	0.039	0.336	1.211		
180D Future Price	0.131	0.588	1.210	-0.306	0.047	0.033	0.019	0.069	0.188	35.20%	855.926
	0.956	23.243 **	20.644 **	-2.517 **	-1.392	0.493	0.118	0.423	1.224		

*** significant on the 5% level*

Table A.14. Hypothesis 4 (1) - Including BVL (base: NYSE)

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_3 D_{CRI} + \beta_4 D_{CRI} R_t^{CU} + \beta_5 D_{CRI} R_t^{MSCI} + \beta_{12} D_{BVL} + \beta_7 D_{LSE} + \beta_8 D_{TSX}$$

All stocks, traded on NYSE, LSE, TSX and BVL are considered. Dummy variable β_3 represents the impact of the global crisis. Dummy variables β_7, β_8 and β_{12} represent the indicated stock exchanges' impact on the intercept of the model. NYSE acts as base dummy.

	α	β_1 Price	β_2 MSCI	β_3 Crisis	β_4 D(crisis)* R(Copper Price)	β_5 D(crisis)* R(MSCI)	β_{12} BVL	β_7 LSE	β_8 TSX	Adj. R^2	F-Test
Spotprice	0.155	0.546	1.248	-0.326	-0.028	0.029	0.007	0.053	0.179	34.80%	840.445
	1.070	23.249 **	21.361 **	-2.670 **	-0.848	0.438	0.043	0.309	1.116		
90D Future Price	0.165	0.567	1.214	-0.325	-0.032	0.031	-0.006	0.049	0.181	35.20%	842.932
	1.132	22.709 **	20.628 **	-2.646 **	-0.959	0.466	-0.039	0.286	1.120		
180D Future Price	0.150	0.588	1.210	-0.047	-0.306	0.033	-0.019	0.050	0.168	35.20%	855.926
	1.035	22.243 **	20.644 **	-2.517 **	-1.392	0.493	-0.118	0.294	1.053		

*** significant on the 5% level*

Table A.15. Hypothesis 4 (II) - Including BVL (base: NYSE)

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_3 D_{CRI} + \beta_4 D_{CRI} R_t^{CU} + \beta_5 D_{CRI} R_t^{MSCI} + \beta_{12} D_{BVL} + \beta_{13} D_{BVL} R_t^{CU} + \beta_7 D_{LSE} + \beta_{10} D_{LSE} R_t^{CU} + \beta_8 D_{TSX} + \beta_{11} D_{TSX} R_t^{CU}$$

All stocks, traded on NYSE, LSE, TSX and BVL are considered. Dummy variable β_3 represents the impact of the global crisis. Dummy variables β_7, β_8 and β_{12} represent the indicated stock exchanges' impact on the intercept of the model. NYSE acts as base dummy. Dummy variables β_{10}, β_{11} and β_{13} represent the stock exchanges impact on the slope of the model.

	α	β_1 Price	β_2 MSCI	β_3 Crisis	β_4 D(crisis)* R(Copper Price)	β_5 D(crisis)* R(MSCI)	β_{12} BVL	β_{13} (BVL)*(Price)	β_7 LSE	β_{10} (LSE)*(Price)	β_8 TSX	β_{11} (TSX)*(Price)	Adj. R^2	F-Test
Spotprice	0.155	0.537	1.247	-0.323	-0.030	0.030	0.047	-0.254	0.039	0.089	0.150	0.212	35.60%	633.674
	1.075	15.168 **	21.490 **	-2.668 **	-0.925	0.452	0.289	-6.394 **	0.232	2.144 **	0.942	5.363 **		
90D Future Price	0.165	0.558	1.213	-0.323	-0.034	0.032	0.038	-0.251	0.034	0.087	0.148	0.211	36.00%	635.373
	1.139	15.655 **	20.750 **	-2.644 **	-1.039	0.481	0.235	-6.343 **	0.201	2.112 **	0.922	5.368 **		
180D Future Price	0.149	0.581	1.209	-0.304	-0.049	0.034	0.026	-0.261	0.036	0.083	0.136	0.215	36.00%	645.781
	1.038	16.157 **	20.771 **	-2.514 **	-1.478	0.509	0.160	-6.542 **	0.215	1.994 **	0.857	5.438 **		

*** significant on the 5% level*

Table A.16. Hypothesis 4 (1) - Excluding BVL (base: NYSE)

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_3 D_{CRI} + \beta_4 D_{CRI} R_t^{CU} + \beta_5 D_{CRI} R_t^{MSCI} + \beta_7 D_{LSE} + \beta_8 D_{TSX}$$

Just the stocks traded on stock exchanges of developed markets (NYSE, LSE and TSX) are considered. Dummy variable β_3 represents the impact of the global crisis Dummy variables β_7 and β_8 represent the indicated stock exchanges' impact on the intercept of the model. NYSE acts as base dummy.

	α	β_1 Price	β_2 MSCI	β_3 Crisis	β_4 D(crisis)* R(Copper Price)	β_5 D(crisis)* R(MSCI)	β_7 LSE	β_8 TSX	Adj. R^2	F-Test
Spotprice	0.046	0.540	1.457	-0.186	0.046	-0.002	0.051	0.177	41.00%	920.873
	0.304	19.113 **	21.675 **	-1.327	1.224	-0.032	0.309	1.125		
90D Future Price	0.078	0.563	1.424	-0.221	0.032	0.003	0.049	0.180	41.40%	920.235
	0.513	19.571 **	21.025 **	-1.564	0.830	0.033	0.288	1.133		
180D Future Price	0.043	0.584	1.416	-0.172	0.020	0.007	0.049	0.167	41.40%	933.815
	0.283	20.056 **	20.989 **	-1.233	0.513	0.088	0.294	1.061		

*** significant on the 5% level*

Table A.17. Hypothesis 4 (1I) - Excluding BVL (base: NYSE)

The following regression model is used:

$$R_t = \alpha + \beta_1 R_t^{CU} + \beta_2 R_t^{MSCI} + \beta_3 D_{CRI} + \beta_4 D_{CRI} R_t^{CU} + \beta_5 D_{CRI} R_t^{MSCI} + \beta_7 D_{LSE} + \beta_{10} D_{LSE} R_t^{CU} + \beta_8 D_{TSX} + \beta_{11} D_{TSX} R_t^{CU}$$

Just the stocks traded on stock exchanges of developed markets (NYSE, LSE and TSX) are considered. Dummy variable β_3 represents the impact of the global crisis Dummy variables β_7 and β_8 represent the indicated stock exchanges' impact on the intercept of the model. NYSE acts as base dummy. Dummy variables β_{10} and β_{11} represent the stock exchanges impact on the slope of the model.

	α	β_1 Price	β_2 MSCI	β_3 Crisis	β_4 D(crisis)* R(Copper Price)	β_5 D(crisis)* R(MSCI)	β_7 LSE	β_{10} (LSE)*(Price)	β_8 TSX	β_{11} (TSX)*(Price)	Adj. R^2	F-Test
Spotprice	0.062	0.432	1.457	-0.184	0.045	-0.002	0.037	0.088	0.146	0.212	41.20%	721.774
	0.411	11.710 **	21.708 **	-1.320	1.201	-0.025	0.225	2.156 **	0.930	5.437 **		
90D Future Price	0.096	0.457	1.424	-0.219	0.031	0.003	0.033	0.087	0.145	0.211	41.50%	721.328
	0.632	12.243 **	21.058 **	-1.556	0.804	0.041	0.196	2.125 **	0.913	5.442 **		
180D Future Price	0.060	0.477	1.416	-0.171	0.019	0.007	0.035	0.082	0.132	0.215	41.60%	732.108
	0.399	12.678 **	21.023 **	-1.224	0.486	0.096	0.208	2.005 **	0.842	5.511 **		

*** significant on the 5% level*

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