Using Media-Based Emotion to Predict Commodity Price

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***Abstract*— Emotion plays a significant role in consumer decision making. We recently conducted a study to explore how media-based information of aggregated market emotion influences consumers' expected demand of commodities, and how businesses can use media-based emotion indices to predict commodities' price. We implemented time series econometrics by analyzing a fourteen year daily observations of twelve major energy and material commodities prices and five market-level emotion indices (buzz, sentiment, optimism, fear and joy). The empirical results suggest that high-arousal emotion from all groups of individuals tend to reach consensus at the market level in its effect on commodity price. The study also provides evidence that there is a short term predictive relationship between the media-based emotion indices and the following five days' commodity prices.**

Keywords—market emotion; time series econometrics; social media

I. INTRODUCTION

Media plays an essential role to diffuse information in the business world. Recently, academic researchers and industrial practitioners have adopted content analysis and data mining algorithms to detect aggregated business and financial markets' sentiment and emotions manifested on news media and social media [1, 7, 11]. A literature search found quite a few studies discussing the effects of positive and negative online customer reviews on product sales, brand strength, and converting site visitors into paying customers (conversion rates) [6, 9]. However, there is no published study focusing on how managers from companies in high energy and material consuming sector utilize information of market emotion manifested on news media and social media to predict commodity price. Thus, we conducted a study to explore how media-based information of aggregated market emotion influences consumers' expected demand of commodities, and how businesses can use media-based emotion indices to predict commodities' price. We implemented time series econometrics by analyzing a fourteen year daily observations of twelve major energy and material commodities prices and five market-level emotion indices (buzz, sentiment, optimism, fear and joy).

Emotion is considered as one of the major influences on consumer behaviors, such as purchase decision making, and customer satisfaction [12]. Di Muro and Murray [2] investigated how consumers' purchasing preferences are affected by the level of arousal and the valence of their affective state and they proposed a hypothesis that consumers in a pleasant mood tend to choose products that are congruent with their level of arousal at that moment, while those in an unpleasant mood are more likely to choose products that are incongruent with their level of arousal at the moment. Zeelenberg and Pieters [13] empirically showed that emotions have a direct impact on dissatisfied consumers' responses on a product, such as complaining to customer service, switching to the other products, and talking about their dissatisfaction with others. While many consumer behaviors have documented evidences that emotions influence consumers' purchase decision making and post-purchase responses, there is still lack of research to examine how market-level emotion affects commodity pricing, and whether managers can utilize collective media emotion indices to predict commodity prices.

II. DATA AND METHODOLOGY

In this study, we mainly incorporate twelve energy and material commodities' price data and five dimensions of their market-level emotion data. The twelve energy and material commodities are Aluminum, Copper, Crude Oil, Gold, Heating Oil, Jet Fuel, Gasoline, Natural Gas, Nickel, Palladium, Platinum and Silver and they are considered critical to world economy. The five dimensions of market emotion are buzz, sentiment, optimism, fear and joy. We retrieved our daily commodity data from Bloomberg Commodity Database and Global Financial Database. Bloomberg Database is a leading business commercial data powerhouse encompassing both current and historical financial information on individual equities, stock market indices, fixed-income securities, currencies, commodities, and futures for both US and international markets. Global

Financial Database Provides an extensive collection of financial and economic data covering more than 200 countries extending back to centuries ago. We obtain our daily commodity emotion data from Thomson Reuters MarketPsych Indices (TRMI). TRMI's entire content set includes millions of articles and posts each day from various sources such as news wires, internet news sources, and social media. TRMI utilizes contents derived both from news and social media to reflect market emotion from a group of customers, analysts, journalists, and economists, and so on. A collection of MarketPsych sources covers The New York Times, The Wall Street Journal, Financial Times, Seeking Alpha, Google News among other major business news channels and over 2 million social media sites. MarketPsych employs lexical analysis to extract market-level emotion indices by sweeping through all sources minutely, which includes over 2 million news articles and posts every day [10]. TRMI emotion measures provide the 24 hour rolling average score of total references in news and social media. The scores are normalized so that their value ranges from -1 to 1. In the empirical analysis, we employ a time series study of the fourteen years' daily observations among twelve energy and material commodities. We then implement the Ordinary Least Squares (OLS) model and the Generalized Auto Regressive Conditional Heteroskedasticity (GARCH) model to measure the relationship between the commodities' price and market emotion (buzz, sentiment, optimism, fear, and joy) as in (1).

OLS model:

$$Price_i = \alpha + \beta_1 * BUZZ_i + \beta_2 * SNTMENT_i + \beta_3 * OPTIMSM_i + \beta 4 * FEAR_i + \beta 5 * JOY_i + \varepsilon_i \quad (1)$$

where $Price_i$ is the daily log commodity *i*'s price, BUZZ is the daily media attention of this commodity, SNTMENT is the daily market sentiment level, OPTIMSM is the daily optimism level of this commodity, FEAR is the daily fear level of this commodity, and JOY measures the daily joy level of this commodity.

Next, we use GARCH model to capture the lagged effects with a few parameters. The reason we use this model is to deal with the variance changes over time and it comes from the Auto Regressive Conditional Heteroskedasticity (ARCH). GARCH models have become important tools in the analysis of time series data in academic research. These models are especially useful when the goal of the study is to analyze and forecast volatility. GARCH model:

$$y_t = \beta + \varepsilon_t$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \beta_1 h_{t-1} \quad (2)$$

where ht is the error variance for time t. The variance in the current period is a function of a constant term and the lagged squared error and lags of the conditional variance. This is a well-developed model to deal with historical price volatility's effect on current price.

The last method we use is the vector autoregressive (VAR) model, which is a general framework used to describe the dynamic interrelationship among variables. The VAR model here is used to capture the spillover effects of one commodity's market emotion to other ones. In addition, this model is also employed to test the predictive power of market emotions to the future commodity price.

VAR(p) model:

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + \varepsilon_t \quad (3)$$

where each y_t is a vector of length k and each A_i is a k × k matrix. k is the number of variable in this analysis. Clearly, the model tests how one variable, yi, is influenced by the historical value of itself and the historical values of other variables. In addition, this can be used to test the predictive power of other variables on this one.

III. EMPIRICAL RESULTS

Figure 1 shows that there are fairly high co-movements among all commodities' price during January 1998 to December 2011. However, the correlation is not strong during economic expansion as Figure 1 shows. On the other hand, all commodities' prices went down together during 07-09 financial crises.

To further test the prediction power of the market emotion, we conduct an out-of-sample analysis to predict future one-week commodity price for all twelve commodities. The results are shown in Figure 2. The x-axis represents the subsequent number of days (e.g. T+5 indicate the fifth following day), while the y-axis represents the percentage change of the commodity prices. We compare the predicted price and real price, along with the 95% confidence boundary. The result confirms the strong predictive power of the market emotion on commodity price. Based on our analysis, we find that market emotion model can provide a robust forecasting on following days' commodity prices. The forecasting of our model would even be more accurate if there is less new information adjusted into the price. As Figure 2 shows, the model fits very well to forecast the price of heating oil, natural gas, and platinum, which commodities with less volatility in the prediction period. On the other hand, commodities with high volatility have a higher diversion between the real price and the predicted price.

The empirical results confirmed the short term predictive power of media-based emotion indices on the following five days' commodity prices, consistent with short term predictive model of media-based sentiment on the next five days' stock return [11]. Compared with previous time series studies of media-based sentiment, we expand the single dimension of consumer or investor sentiment index to multiple dimensions of emotion indices. More importantly, our emotion indices are built on a collection of media sources covered from news wires, internet news sources, and social media, which includes over two million news articles and posts every day [10], where most of the prior textual analysis studies of media contents exclusively rely on a single source.

IV. DISCUSSION AND IMPLICATIONS

Comparing to previous marketing research of emotion on an individual customer level, we utilized an established market-level emotion manifested in a collective sources of news wires, internet news sources, and social media to examine the market emotion predictive power in commodity price. Through a time series studies of twelve energy and material commodities' price on five market-level emotion (buzz, sentiment, optimism, fear and joy), we found evidence that market emotion indices are relative reliable and persistent indicators to explain commodity price dynamic changes. The effects of buzz, sentiment, optimism and fear on commodity price are generally consistent with the evaluation of emotion effect in appraisal-tendency hypothesis [4, 8], whereas the effect of joy on commodity price is rather confounding. Additionally, we provide evidence that our market emotion model provides a relative accurate forecast of future commodity price up to five days, and the model fits better to forecast commodities' price with less volatile changes over time. From another major mainstream perspective, valence-arousal framework [3], to looked at our emotion indices, we can group our emotion indicators into high-arousal indicators (buzz, sentiment, optimism, fear) and low-arousal measure (joy) based on intensity of the emotion. The high-arousal emotion tends to reach a market consensus in their effects on commodity pricing, whereas the low-arousal emotion, such as joy, is more difficult to cause an information consensus in the market to influence commodity price that could be a possible explanation for the confounding effect of joy on commodity price. The summary of the empirical results also indicates that high-arousal emotion, such as buzz, sentiment, optimism, fear tend have a stronger predictive power in future commodity price that last longer as well, whereas the low-arousal emotion, such as joy, has a weaker prediction effect on future commodity price that also last shorter. This paper provided evidence of the existence of relationship between market-level emotion fluctuation and commodity price change and demonstrated the value of media-based information including news media and social media in affecting business performance.

The findings of this research provide significant managerial implications, specifically highlighting the value of media-based emotion in reflecting and forecasting commodity price. Researchers and managers should pay more attention to the valuable information contained in media-based information [5]. Since the market-level emotion has proven to be effective in predicting short term commodity price changes, business managers from high energy and material commodity consuming sector should implement emotion content analysis tools or subscribe established market-level emotion indices to track longitudinal reactions of public opinions and emotions toward a commodity price changes. Based on collective media-based emotion data, managers from those companies can construct strategies to store resources in low prices, or use financial futures to hedge the emotion based bias in commodity pricing. Furthermore, companies from high commodity consuming sector are recommended to deploy real time surveillance and analytics techniques to analyze various media sources and examine how market-level emotion fluctuation influences real time commodity price change. Companies should monitor and respond quickly to messages with high-arousal emotion by taking corrective actions to mitigate the potential adverse effects on future performance.

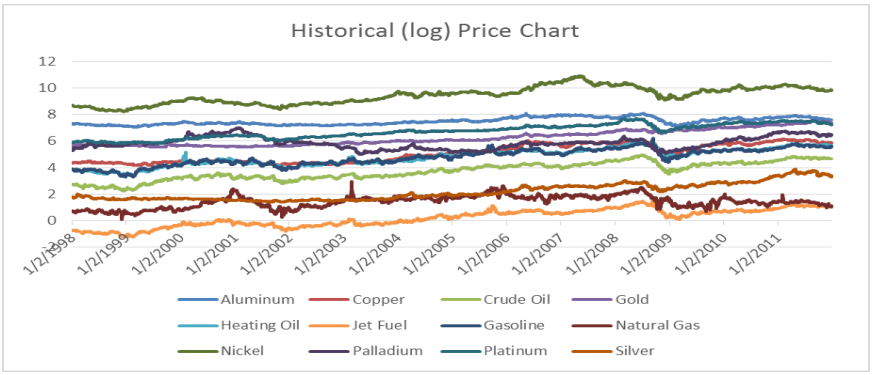
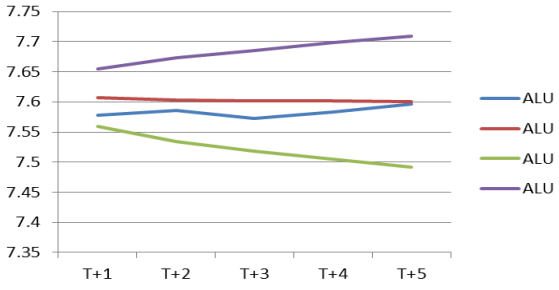
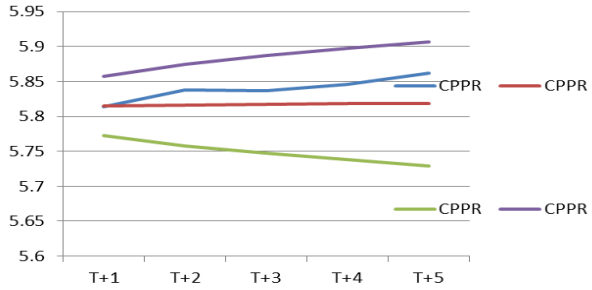
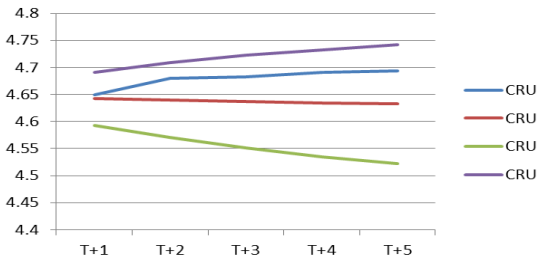
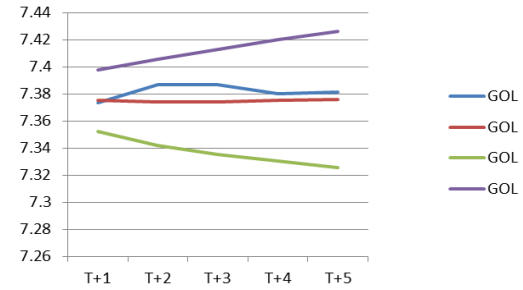


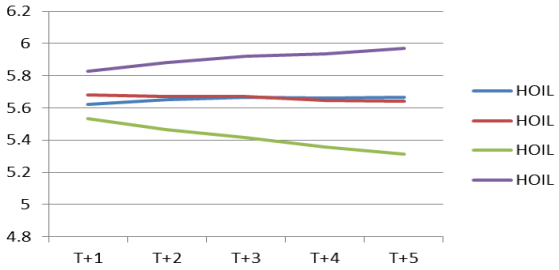
Figure 1: 12 Energy and Material Commodities' Prices during January 1998 to December 2011

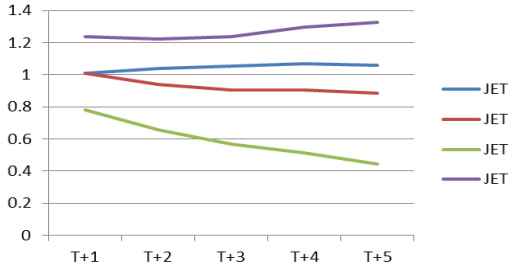












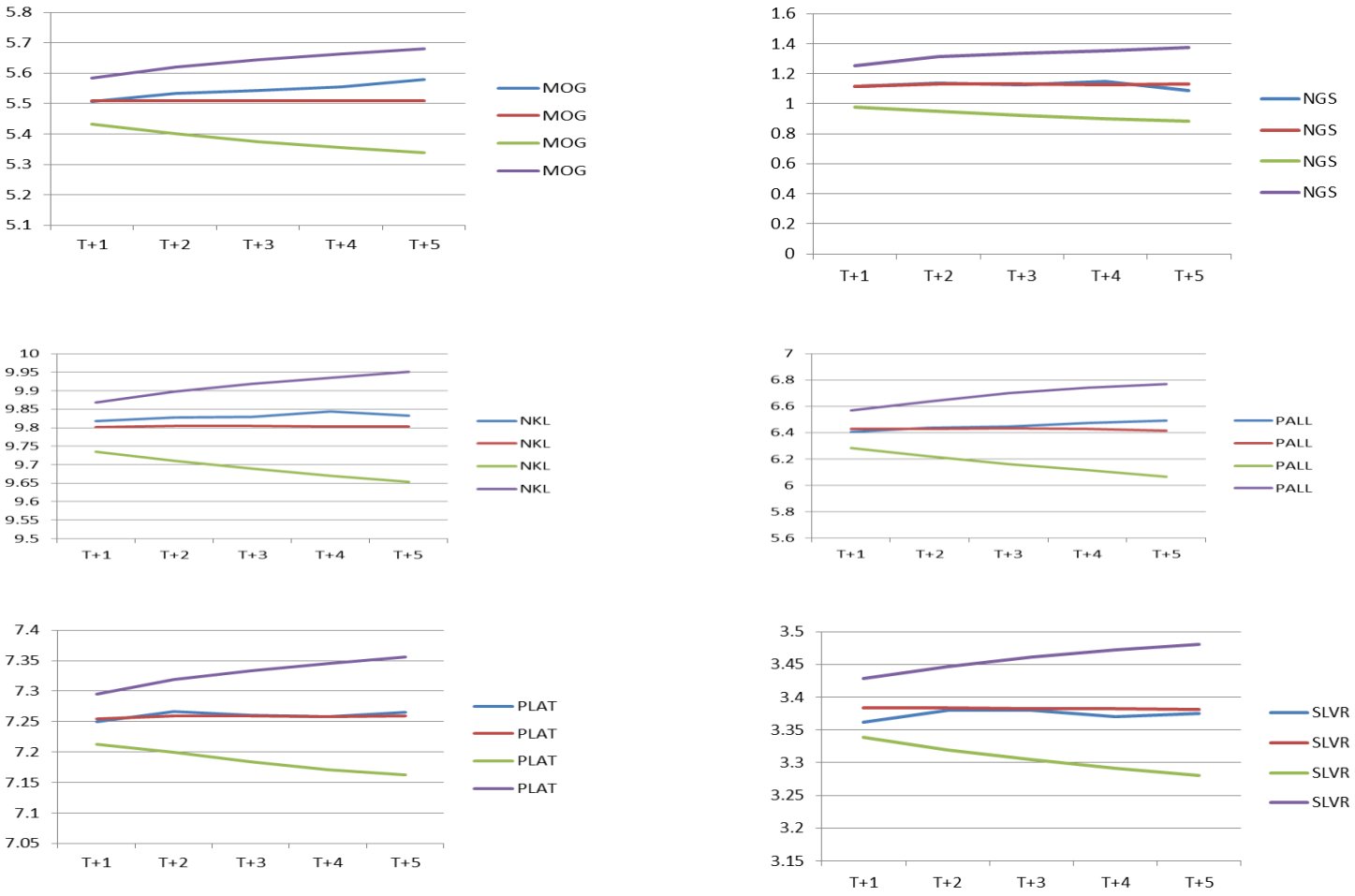


Figure 2: Forecasting Model of Market Emotion Indices on Future Commodities' Price

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