Economic Modelling 60 (2017) 402–407

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/econmod

Is the price of gold to gold mining stocks asymmetric?

Jonathan A. Batten[a,*], Cetin Ciner[b], Arman Kosedag[c], Brian M. Lucey[d]

[a] Monash Business School, Monash University, Clayton, Victoria 3145, Australia
[b] Cameron School of Business, University of North Carolina Wilmington, Wilmington, NC 28403, USA
[c] Campbell School of Business, Berry College, Mount Berry, GA 30149, USA
[d] School of Business and Institute for International Integration Studies, Trinity College, Dublin, Ireland

ARTICLE INFO

Keywords:
Asymmetric relation
Gold price
Gold mining firms
Real options
Corporate valuation

ABSTRACT

If an asymmetric relation exists between the prices of gold and gold mining stocks, then these firms possess real option characteristics, and therefore, a premium should be added to their valuation. This article examines this proposition, by firstly, using quantile regressions, which are ideally suited to examine asymmetries, and secondly, by accounting for endogenously determined structural breaks in the data. Our findings provide no support for an asymmetric relation. Furthermore, we also show that out-of-sample forecasting shows there is no causality from the gold price to the prices of those gold mining shares used in the sample.

1. Introduction

Under a flexible production model, gold mining firms should hold embedded real option characteristics, which increase their value. This proposition was originally suggested by Brennan and Schwartz (1985), and subsequently supported in empirical work initially by Blose and Shieh (1995) and Tufano (1998) amongst many others. If real option characteristics are indeed important for gold mining firms, then an asymmetric relation should be detected between share prices of these firms and the price of gold. This is due to management increasing production as the gold price increases, specifically when the price is greater than the marginal production cost, while decreasing production when the gold price declines. O'Connor et al. (2016) also show that these real options enable gold mining firms to adjust production costs conditional on the gold price, which in turn is consistent with production costs following gold prices.

Historically, investors have been attracted to gold mining firms since they provide a leveraged investment opportunity to the total expected future production of the gold mine. Thus, the gold exposure coefficients of gold mining shares, or gold "betas", tend to be greater than one, as initially found by Tufano (1998). One key contribution of this paper is that we provide evidence on whether these dynamics have been affected in the era of U.S. Exchange Traded Funds (ETFs), which provide an alternate method for investors to take leveraged positions on gold. In particular over the previous decade financial markets have witnessed an increase in popularity of physically backed gold ETFs, with the SPDR Gold Trust (GLD)[1] now the largest gold ETFs traded globally.[2]

We argue that the introduction and subsequent success of the GLD may have impacted the relation between the price of gold and gold mining company shares. That is in the period before the GLD, gold mining shares provided the primary vehicle for investors to be exposed to the price of gold. However, a share of the GLD represents 1/10 of an ounce of gold and is traded each day like a stock. Hence, owning this financial instrument erodes the need to own gold mining stocks when the primary purpose is exposure to the gold market. It is noteworthy that Baur (2014) also considers this hypothesis and tests it in the Australian context.[3]

Our second contribution stems from the fact that we explicitly account for structural breaks in the relation between the variables using the method developed by Bai and Perron (1998, 2003). Structural breaks are expected in our analysis given the sample period spans the global financial crisis of 2007–2009, as well as a significant run up and then, decline in the price of gold. The primary advantage of

* Corresponding author.
E-mail addresses: jabatten@gmail.com (J.A. Batten), cinerc@uncw.edu (C. Ciner), akosedag@berry.edu (A. Kosedag), blucey@tcd.ie (B.M. Lucey).

[1] SPDR funds are a family of exchange-traded funds (ETFs) traded in the United States, Europe, and Asia-Pacific and managed by State Street Global Advisors (SSGA). Informally, they are also known as Spyders or Spiders. SPDR is a trademark of Standard and Poor's Financial Services LLC, a subsidiary of McGraw Hill Financial. Also see Białkowski et al. (2015) investigation of the gold price during crisis and their discussion of Gold ETFs.

[2] As of July 31, 2015, the trust had 21,628,064 ounces of vaulted gold in its custody, representing an asset value of $23,747,009,589. SPDR Gold Shares is one of the top ten largest holders of gold in the world. See http://www.spdrgoldshares.com/#home.

[3] Similarly, for gold mining firms, there is a liquid ETF, the Market Vectors Gold Miners ETF (GDX), which replicates the NYSE/ARCA gold miners' index and is used in the present study, as discussed further below.

http://dx.doi.org/10.1016/j.econmod.2016.10.007
Received 25 April 2016; Received in revised form 13 October 2016; Accepted 22 October 2016
Available online 12 November 2016
0264-9993/

Table 1
Descriptive Statistics.

	Mean	Standard Deviation	Skewness	Kurtosis
RGDX	−.027	2.762	.129	5.574
RGDL	.024	1.304	−.328	5.642
RSPY	.030	1.337	−.085	13.270
ROIL	−.051	2.136	−.249	2.671

Note: This table provides the summary statistics of the variables in the data set. RGDX, RGDL, RSPY and ROIL denote returns of the ETFS for gold mining stocks, price of gold, the S & P 500 index and the crude oil price. Returns are calculated as log price differences and the sample covers the period between May 22, 2006 and May 29, 2015.

the Bai and Perron method is that structural breaks are endogenously determined and hence, researchers do not have to impose ad hoc break dates. Thus, it is more likely that our analysis will capture these inherent instabilities in the gold price relation. Importantly, it is one of the few papers to apply this technique to the precious metals literature.

Thirdly, we utilize quantile regressions, in addition to conventional ordinary least squares (OLS), to examine the gold price exposure of gold mining shares. While OLS regressions are useful to specify the conditional mean response of a dependent variable to an independent variable, quantile regressions can help to determine whether there is a relation at the conditional median, or other conditional quantiles. This can be particularly useful for the primary purpose of the present study. If there is indeed an asymmetric relation between the price of gold and gold mining shares, then, as will be explained later, then different coefficient estimates should be obtained at highly negative and highly positive quantiles of the distribution of the regression coefficient.

Finally, we consider the price of oil as an additional explanatory factor in the analysis. There are several reasons to expect that gold mining stocks should have exposure to the oil price. Gold and oil are both considered strategic commodities as reflected by central bank holdings of physical gold and the strategic oil reserves held by most developed countries (e.g. the Strategic Petroleum Reserve of the U.S. is currently 695 million barrels[4] or US$33.4 billion). Several researchers have also found that the two prices have significant linkages, for example Antonakakis and Kizys (2015), Ewing and Malik (2013), Ciner et al. (2013) and Zhang and Wei (2010). On the other hand, there is also an extensive literature on the impact of oil on the overall stock market, especially stock market volatility (see Kilian and Park (2009), Ciner (2013), Broadstock and Filis (2014), Kang and Ratti (2013), Mensi et al., 2015, Chkili et al. (2014) and Ftiti et al. (2016) as some recent examples), while there are also a number of papers that demonstrate the ability of the oil price to forecast stock returns (see Phan et al., 2015a, 2015b). These papers further motivate the use of oil price changes as a potential risk factor. In addition to contemporaneous relations, we also examine whether there are lagged relations between the risk factors in our model and gold mining shares, which would indicate potential forecasting ability. We therefore investigate the predictive power of the gold price for gold mining shares in an out-of-sample causality analysis.

Our primary findings can be summarized as follows: We show that there are three significant structural breaks in the regression specifying the gold price exposure of gold mining equities. Consistent with prior work, in each of the subperiods, the gold price exposure coefficient is greater than one and statistically significant. However, with regards to the asymmetry in the gold betas, we find no evidence for an asymmetric response in gold mining shares to the price of gold. This finding is contrary to the conclusions of prior work and furthermore, is inconsistent with the view that gold mining stocks have an embedded real option. Hence, it is questionable whether a real option premium should be included in gold mining firm valuations. Finally, there is some evidence to suggest that in the latter part of the sample, the price of gold could be useful to forecast gold mining share returns. As this could be evidence against market efficiency, we also formally investigate causality from gold prices to gold mining shares in an out-of-sample forecasting analysis. Our results suggest no evidence for predictive power consistent with efficiency in these markets.

We organize the rest of the paper as follows: In the next section, we present the data set. In Section 3, we discuss the econometric method and the results of the empirical analysis. We offer the concluding remarks of the paper in the final section.

2. Data

Our data set includes the daily closing (adjusted for dividends) of four ETFs traded on the NYSE/ARCA for the period between May 22, 2006 and May 29, 2015. Note that while GLD ETFs were initially listed on the New York Stock Exchange in November 2004, we begin our sample from May 22, 2006, when other ETFs were also listed, including the key Market Vectors Gold Miners ETF (GDX) on the NYSEArca. The value of this ETF in effect represents in index terms the listed value of the world's leading gold mining firms. The listing of this ETF provides a convenient starting point for our analysis.

We use the GDX for gold mining stock prices, which is a value-weighted average of companies included in the NYSE/ARCA gold mining index. As mentioned above, for the price of gold, we use the GLD and the SPDR Standard & Poor's 500 ETF (SPY) to control for systematic factors that impact the overall stock market. The oil price data are from United States Oil ETF (USO), which replicates the spot price of West Texas Intermediate light, sweet crude oil. We calculate daily returns as $100*\log(P_t/P_{t-1})$ on the series and report summary statistics in Table 1. There is nothing controversial about these statistics, which display some evidence of complexity due to the presence of slight kurtosis and skewness that characterize other financial series, with the mean close to one and time varying volatility.

3. Empirical findings

3.1. Structural breaks

We first construct the following regression model, similar to several papers in prior work such as Baur (2014) as a recent example, to examine the sensitivity of gold mining stocks to gold price movements by controlling for the overall stock market and the price of oil:

$$RGDX_t = a_0 + a_1 RSPY_t + a_2 RGDL_t + a_3 ROIL_t + \varepsilon_t \quad (1)$$

in which *RSPY, ROIL, RGDX* and *RGDL* represent daily returns on the respective ETFs discussed above and *t* denotes the time subscript. Note that a test for cointegration between the variables was undertaken as part of the preliminary investigation, since the presence of cointegration requires the inclusion of an error-correction mechanism in Eq. (1). The full information maximum likelihood method of Johansen and the test statistics, which for brevity are not reported (but are available upon request), point to the somewhat unexpected conclusion that no cointegration is detected between the variables.

With respect to Eq. (1), we expect a_2 to be positive and statistically significant. However, we do not have any *prior* expectation for a_3. An oil price increase could be good news for gold mining stocks as it could indicate greater global economic demand, represented by an increase in retail demand for gold via jewelry purchases. Furthermore, an oil price increase could also be inflationary and it is frequently argued that higher inflation leads to higher gold prices, which again should provide a positive impact. On the other hand, an increase in the oil price could also be bad news for gold mining stocks since it increases energy costs, which are typically very important in this sector. Therefore, we do not form any *ex-ante* expectation for the oil variable.

As mentioned above, an important contribution of the present

[4] See http://www.spr.doe.gov/dir/dir.html.