The Financialization of Gold and Its Impact on Gold Company Stocks

Yue Zhang
DeGroote School of Business
McMaster University
E-mail: zhangy57@mcmaster.ca

April 2014

Abstract

We study the market impact of a very successful financial innovation – the SPDR Gold Trust exchange-traded fund (GLD). GLD holds physical gold, and provides traders with a convenient and cost-effective way to gain exposure to gold. We find that the introduction of GLD caused the liquidity of gold company stocks to decline, and their adverse-selection risk to increase. Over the two-month period after GLD's introduction, the stocks' relative effective bid-ask spreads increased by over 15%, while their adverse-selection cost, as measured by the price impact of trades, went up by more than 30%. Gold stocks also experienced significant negative abnormal returns (−12% on average) in the month after GLD started trading. Our findings indicate that GLD attracted traders, especially uninformed traders, away from gold company stocks. The migration of traders caused negative demand shocks to the stocks and a decrease in their liquidity, both of which, in turn, caused their prices to decline. Our results suggest that existing securities can be seriously adversely affected when a new security enters the market.

JEL classification: G10; G12; G14

Keywords: Financial innovation; Financialization; Market impact; Gold; Exchange-traded funds
1. Introduction

In this paper, we study the market impact of a very successful financial innovation. The innovation is the SPDR Gold Trust exchange-traded fund (Tic: GLD), which is the first bullion-backed exchange-traded fund introduced in the US market. GLD was introduced in November 2004 and has since grown to become one of the largest exchange-traded funds (ETFs) in terms of assets under management ($72 billion as of the end of December 2012).\(^1\) The fund holds physical gold and so its net asset values are almost perfectly correlated with the movements of gold price (except for fees and expenses). As an ETF, GLD can be traded during regular trading hours. In effect, GLD is a financialization of gold, and provides traders with a convenient and cost-effective way to invest in gold.

Our main objective is to examine the effect of GLD's introduction on the trading characteristics and the prices of stocks of gold companies. The existing literature offers several reasons why the introduction of a new security can affect existing securities, especially closely related ones. These include improved risk sharing (e.g., Detemple and Selden, 1991; Calvet et al., 2004), rebalancing of investor portfolios (e.g., Braun and Larrain, 2009), changes in the composition of investor clientele (e.g., Subrahmanyam, 1991; Gorton and Pennacchi, 1993), and greater opportunities for arbitrage trades (e.g., Dow, 1998; Rahi and Zigrand, 2009). The introduction of GLD provides us with a good opportunity to investigate empirically the impact of a new security. An opportunity like this is rare in the study of financial innovation because most new securities did not become as hugely popular as GLD, and thus their impacts on the markets were typically negligible.

Using a sample of gold company stocks traded in the US market when GLD was introduced, we find that various measures of the stocks' liquidity deteriorated after GLD started trading. For example, on average, the stocks' relative effective bid-ask spreads increased by over 15% in the two-month period following GLD's introduction. During the same period, their

---

\(^1\) As a comparison, the largest ETF in the US market (i.e., the SPDR S&P 500) had assets of $123 billion at the end of 2012.
adverse-selection cost, as measured by the price impact of trades, went up by more than 30%. Their trading volume (both in terms of shares and dollars) also significantly declined. These findings support the adverse-selection argument, which predicts that uninformed traders will migrate away from information-sensitive securities once a less information-sensitive alternative is introduced (Subrahmanyam, 1991). GLD is less information-sensitive than gold company stocks because the performance of GLD depends only on the movements of gold prices while the performance of gold stocks also depends on firm-specific factors such as management ability and cost structures. The migration caused the liquidity of gold stocks to deteriorate, and their adverse-selection risk to increase.²

With respect to the price effects of GLD, we find that gold company stocks significantly underperformed the benchmark after GLD started trading. On average, gold stocks experienced a negative abnormal return of −1.90% on GLD's introduction day, and a cumulative abnormal return of approximately −12% during the first month. One explanation for the decline is that the demand for gold stocks was not perfectly elastic due to lack of close substitutes (e.g., Scholes, 1972; Wurgler and Zhuravskaya, 2002). Rather, the stocks' demand curves were downward-sloping. The migration of trading activities to GLD represented negative demand shocks to the stocks, which caused their demand curves to shift inward and their prices to decline. Another possible explanation is that gold stocks became less liquid and thus were more costly to trade (i.e., due to higher bid-ask spreads). Therefore, investors required higher expected returns to compensate themselves for the higher costs (e.g., Amihud and Mendelson, 1986). Our further test provides support for both explanations with respect to the immediate price effects (i.e., the abnormal return on GLD's introduction day). For longer-term price effects (i.e., the cumulative abnormal return over the first month), however, the imperfect-substitutes argument is more significant and dominant.

Our results indicate that the introduction of a new security can have a serious adverse impact on the trading characteristics and prices of existing, related securities. The results are

² A migration of traders from gold company stocks to GLD has also been mentioned in the media. See, for example, "Heard on the Street: Gold Miners Lost Midas Touch" in the February 24, 2012 edition of the Wall Street Journal.
related primarily to studies that investigate the market impact of financial innovation. Typically, these studies concentrate on futures contracts and options and their impacts on the underlying securities (See Mayhew, 2000, for a review). This concentration is due mainly to the fact that futures contracts and options are very successful innovations and thus their presence can have a noticeable influence on related securities. It is much less common in the literature to find evidence based on other types of securities. There are, however, some exceptions. For example, a few studies report that the introduction of index ETFs increased the liquidity of constituent stocks (Hegde and McDermott, 2004; Richie and Madura, 2007; Madura and Ngo, 2008). Our results are in contrast to these findings. We believe that this is due to the fact that although index ETFs can attract some traders away from their constituent stocks, the ETFs themselves have to trade the stocks, and also create arbitrage opportunities with the stocks. The net effect is that the stocks' liquidity is improved. On the other hand, GLD competes with gold company stocks, and its arbitrage linkage with gold stocks is not as strong.

More recently, there is an emerging literature on the financialization of commodities (i.e., commodity investment through securities such as commodity futures contracts and commodity-linked instruments). A few papers in this literature look at the effects of the financialization on the prices and return dynamics of other related assets. For example, Henderson et al. (2012) find that investor flows into commodity-linked notes significantly increased commodity futures prices on the notes' issuance dates through hedging trades executed by the notes' issuers. That is, commodity-linked notes attract investors whose demand for commodity exposure gets passed through to the futures market. Our paper shows that the financialization of commodities can have a negative effect on the stocks of commodity companies if the new securities attract investors away from the stocks.

Finally, in a wider context, our results on the price effects are related to studies on the effect of demand on asset prices. Evidence that asset prices can be affected by their demand is typically found in studies on stock inclusions into, or removals from, major stock indices. These studies find that stocks that were newly included into (removed from) a major stock index earned significant positive (negative) abnormal returns during the adjustment periods (e.g., Shliefer,
1986; Goetzmann and Garry, 1986; and Dhillon and Johnson, 1991). They interpret the results as being consistent with the hypothesis that demand curves for stocks slope down due to limits to arbitrage. For the same reason, Braun and Larraín (2009) report that new IPO securities caused the demand and prices of existing securities that were positively correlated with them to decline. Also, Garleanu et al. (2009) show that option demand can affect option prices when market makers cannot completely hedge their inventories. Our results provide evidence from a different context to support these findings.

The paper is organized as follows. In the next section, we describe the background of GLD and other trading vehicles that enable traders to gain exposure to gold. In Section 3, we discuss theoretical predictions on the effects of GLD on the trading characteristics of gold stocks. We then present the empirical findings. Section 4 examines the price effects of GLD. Finally, Section 5 concludes.

2. Background of GLD and Other Bullion-Backed Securities

The SPDR Gold Trust was formed in November 2004 as an investment trust. The trust is sponsored by World Gold Trust Services, a wholly owned subsidiary of the World Gold Council, whose members are leading gold mining companies such as Barrick Gold and Newmont Mining Corp. The trust's objective is to promote investment in gold by providing investors with a secure and cost-effective access to the gold market. To do so, the trust holds gold bars and issues shares which represent ownership of the trust. The shares started trading on the New York Stock Exchange (NYSE) on November 18, 2004 under the tic symbol GLD.

At its inception, each share of GLD corresponded to 0.10 ounces of gold. Over time, the trust has gradually sold gold to pay the trust's expenses such as operating costs, custodian fees (i.e., storage costs) and marketing expenses. Therefore, the number of ounces per share has gradually declined over time (to 0.09684 ounces per share as of the end of 2012). So far throughout its life, the trust's expense ratio has been kept at 0.40% per year of the trust's net asset
value (NAV). For most investors (especially retail ones), this rate of expenses makes investing in gold through GLD less costly than buying/selling, storing and insuring physical gold.

Similar to other exchange-traded funds, shares of GLD can be created and redeemed directly with the trust in large lots (multiples of 100,000 shares) by authorized participants, typically designated brokers and market makers. Creation and redemption are done in kind; i.e., by exchanging shares with a specified amount of gold. The process helps to provide liquidity to GLD trading as market makers can, if needed, create or redeem shares in order to execute investor orders. The creation/redemption provision also establishes an arbitrage relationship between market price and NAV, helping to keep them in line with each other. As with conventional ETFs, GLD can be bought on margin or sold short.

Prior to the introduction of GLD, investors typically obtained exposure to gold price movements using three major approaches. First, they could buy and store physical gold (i.e., bars and coins). The problem with this approach was that at the retail level, the physical market was not very liquid, and prices could vary from one vendor to the next. The storage and insurance costs could also be expensive. In addition, certain institutional investors such as pension funds and mutual funds were prohibited by their charters from holding physical commodities. Secondly, investors could hold stocks of gold-mining companies. While the markets for these stocks were generally liquid, investors did not get a pure play on gold because the performance of these stocks depended not only on gold price movements but also on firm-specific factors such as management ability, exploration and production costs, hedging policies, and size and grade of the companies' reserves. Finally, investors could use gold futures contracts. However, this approach was more appropriate for sophisticated investors due to the leverage that futures contracts provided, the need to roll over the contracts as they expired, and the margin requirements.

When GLD was introduced, there were a few bullion-backed, exchange-listed securities in existence outside the US market but accessible to US investors, the prime example of which was the Central Gold Trust (listed on the Toronto Stock Exchange). However, at the time, these securities as a group did not attract significant investment attention. According to a survey by
Gold Field Mineral Services, an independent precious metals consulting firm, the combined gold demand from these securities in the whole of 2003 (the year before GLD was introduced) was only approximately 39 tonnes or 1.25 million ounces (worth approximately $520 million based on gold price at the end of 2003).³ By comparison, after only a week in its existence, GLD was holding over 3 million ounces of gold (worth approximately $1.46 billion). The holdings grew to over 7 million ounces after a year (worth approximately $3.46 billion). This suggests that the introduction of GLD created significant interest and awareness among investors.

Over the years, the investment in GLD continued to grow. This coincided with a substantial rise in gold price. From the inception of GLD to the end of 2012, gold price increased by approximately 275% — from around $440/ounce to $1,650/ounce. At the end of 2012, GLD held over $72 billion worth of gold (over 43 million ounces), making it the second largest ETF in the world. Its success has spawned several other bullion-backed ETFs, both in the US market (with currently four ETFs) and abroad (e.g., Canada, the UK, Switzerland and South Africa).⁴

Because GLD holds physical gold and has low expenses, its tracking errors are very low. From its inception to the end of 2012, the correlation between the percentage changes in its NAVs and the percentage changes in gold prices is 0.9885.⁵ In addition, because of the creation/redemption provision, GLD is priced efficiently, as evidenced by the fact that its premiums/discounts (i.e., deviations of market prices from its NAVs) have been very low. From its inception to the end of 2012, the average price deviation is only 0.016% of the fund's end-of-

---

³ For a summary of gold investment demand in various years, see the prospectus of SPDR Gold Trust dated May 27, 2010.
⁴ GLD's success has also led to the introduction of other physically backed ETFs such as silver, platinum and palladium ETFs. However, except for silver ETFs, these other ETFs have not been able to attract much interest from investors.
⁵ We calculated the correlation based on the percentage changes in the NAVs and the percentage changes in the London PM fix gold prices. The London PM fix gold prices are a widely followed benchmark, and are the prices that the trust uses in determining the NAVs.
day indicative NAVs. As a result, GLD can be thought of as an extremely close substitution for physical gold.

3. The Effects of GLD on the Trading Characteristics of Gold Company Stocks

In this section, we examine the effects of the introduction of GLD on the trading of gold company stocks. We start with a few theoretical predictions. Then, we present our empirical findings.

3.1. Theoretical Predictions

The existing literature provides several reasons why the introduction of a new security can affect the trading characteristics of existing, related securities. The predictions vary depending on the setup and the assumptions of the models. Here, we mention three arguments that are relevant to the context of GLD and gold company stocks.

A. The Adverse-Selection Argument

The adverse-selection argument is due primarily to the work of Subrahmanyam (1991) and Gorton and Pennacchi (1993). Both of these studies attempt to explain the benefits of

---

6 We calculated price deviations by comparing GLD's closing prices to its closing indicative NAVs. An indicative NAV (or indicative value) is a measure of a fund's NAV at a given point in time during a trading day. During trading hours, US fund companies are required to publish the indicative values of their ETFs every 15 seconds. We used closing indicative NAVs in the calculation because, as mentioned earlier, the official NAV that the trust reports daily is based on London PM fix gold price, which comes from earlier in the day and so should not be compared with GLD's closing prices.

7 As a comparison, over the same period, the correlation between the percentage changes in the NAVs of the SPDR S&P 500 ETF and the percentage changes in the S&P 500 is 0.9996, while the average price deviation is -0.008%.
"composite" or basket securities such as index-linked funds and index-linked futures contracts. In their models, there are two types of traders – informed traders (who possess specific information about individual stocks) and liquidity traders (who trade for reasons not directly related to the stocks' payoffs). They then show that if a basket security is introduced, liquidity traders who wish to hold portfolios of stocks will migrate from individual stocks to the basket security. This is because the expected losses by liquidity traders to informed traders are lower in the basket security than in individual stocks. The reason for this is that informed traders' orders tend to offset each other in the basket security, and so firm-specific information tends to be "diversified" in it. This diversification reduces the adverse-selection costs faced by liquidity traders when they trade in the basket. Accordingly, liquidity traders have an incentive to concentrate their trades in the basket security when it is introduced.

The implication of both studies is that once an alternative security which is less information-sensitive is introduced, there will be a migration of liquidity traders to this new security. In our context, GLD is a less information-sensitive security than individual gold stocks. This is because, as mentioned earlier, the performance of GLD depends only on gold price movements, while the performance of gold company stocks depends not only on gold price movements but also on firm-specific factors such as management ability, cost structures, and hedging policies. As a result, liquidity traders have a higher chance of losing to informed traders if they trade individual gold stocks than if they trade GLD. It then follows that liquidity traders

\[8\] A similar argument is made in John, Koticha and Subrahmanyam (1993). Other studies that discuss this argument informally include Gammill and Perold (1989) and Harris (1990).
who wanted direct exposure to gold price movements would have a strong incentive to migrate to GLD when it was introduced.  

Accordingly, the adverse-selection argument predicts that gold company stocks should become less liquid after the introduction of GLD. With fewer liquidity traders remaining, the stocks' adverse-selection costs should increase, and the composition of traders in them (i.e., the mix between informed and liquidity traders) should also change, with informed traders representing a higher proportion than before.

B. The Arbitrage Argument

The introduction of a new security can have an effect on the trading of existing, related securities if it encourages arbitrage activities between them. Dow (1998) and Rahi and Zigrand (2009) argue that profiting from arbitrage trades is one of the main motivations behind the creation of new securities. In their models, arbitrageurs (e.g., investment banks and hedge funds) create new securities to open new markets. They then exploit price discrepancies between the new markets and the markets for existing, related securities. Here, the term "arbitrage" is used in a broader sense to include a speculative transaction with a high expected payoff and a

---

9 Jin and Jorion (2006, 2007) argue that many investors in certain commodity stocks such as gold and oil stocks invest in the stocks to gain exposure to gold and oil prices respectively. As a result, hedging of price risk done by these companies should not be valued by investors. Using data on gold companies' hedging activities from 1991 to 2000, Jin and Jorion (2007) report that hedging did not increase firm value, and might even have decreased it. Their findings are consistent with a widely-held view at the time among practitioners that investors of gold stocks actually wanted a pure play on gold price. In fact, there was anecdotal evidence that when some gold companies announced that they would pare down their hedging (i.e., to become more pure-play), their stock prices reacted positively (See, for example, "Gold Soars as Placer Dome Stops Hedging" in the February 5, 2000 edition of the Financial Post newspaper).

10 The traditional view of financial innovation is that innovators issue new securities to improve risk sharing by making the market more complete, reducing market imperfection costs, or circumventing regulatory constraints (e.g., Van Horne, 1985 and Miller, 1991). More recent studies, however, examine other possible motives such as to create arbitrage opportunities or to capitalize on investors' misunderstanding of the risks of the new securities (e.g., Henderson and Pearson, 2011 and Gennaioli et al., 2012)
risk that can be partially hedged (i.e., risk arbitrage). For example, an index ETF can be introduced so that the innovator can benefit from arbitrage trades between it and the stock portfolio, which may consist of a much smaller number of stocks than the whole index (and thus have a tracking-error risk).

In our context, the existence of GLD makes it easier and/or less costly for traders to implement long-short trades, which are one of the most common risk-arbitrage trading strategies that hedge funds and many portfolio managers employ (Fung and Hsieh, 2011). Traders who believe that certain gold company stocks are undervalued (overvalued) relative to the price of gold can take long (short) positions in those stocks and a short (long) position in gold. This trade enables the traders to gain exposure to company-specific factors while removing gold price risk (i.e., to make purer bets on company-specific information). Prior to the introduction of GLD, the position in gold would have to be established through gold bullions or gold futures contracts. Both approaches have their shortcomings. Gold bullions require storage, insurance and possible assay testing, all of which add costs to the position. Gold bullions also sell at a premium to the gold spot price (due to manufacturing costs and dealer overheads). While the premium is typically small for large transactions, it can vary depending on market conditions, thus creating another dimension of risk. For gold futures, they need to be rolled over regularly, and, more importantly, have basis risk. The existence of GLD provides traders with a cost-effective and more precise tool to use when implementing their long-short trades.

As Simsek (2013) argues, a new security can be used by traders to hedge their bets on existing securities, which, in turn, enables them to take greater positions on their bets. Simsek terms this effect the "hedge-more/bet-more" effect. The increase in speculative activities should add liquidity to gold company stocks. In addition, greater competition among these (informed)

---

11 Fung and Hsieh (2011) report that roughly 40% of hedge funds in the Lipper-Tass database are classified as having long-short strategies as their primary investment style (as of December 2008).
12 The use of long-short trading strategies involving gold and gold company stocks has regularly been reported and/or advocated in the press and practitioner publications. For a recent example, see "CIBC Develops Quantitative Long/Short Gold Model" in the August 14, 2013 edition of the National Post newspaper.
traders can help to reduce market makers' expected losses, and so the adverse-selection costs of gold company stocks can become lower.\textsuperscript{13}

C. The Market-Making Argument

Silber (1985) argues that if market makers can use a new security to partially hedge their inventory risk (in the existing securities), they will be able to quote narrower bid-ask spreads for the existing securities. He cites an example of block-trading desks routinely using index futures contracts to hedge their exposure to specific stocks. In our context, the existence of GLD provides market makers for gold company stocks with an alternative hedging tool to gold futures contracts. As mentioned above, as a hedging tool, GLD is more precise than gold futures because of the presence of basis risk in futures contracts. This is especially true for short-term hedging, which is what market makers typically need.\textsuperscript{14} Therefore, applied to our context, Silber's argument implies that liquidity of gold company stocks should improve after GLD was introduced.

D. Summary of Arguments

To summarize, studies from different strands of the literature offer different and conflicting predictions regarding the effects of GLD on the trading of gold company stocks. Under the adverse-selection argument, GLD should cause the liquidity of gold company stocks to decline and their adverse-selection risk to increase. The opposite is true under the arbitrage

\textsuperscript{13} The impact of an increase in the number of informed traders on the stock's liquidity and adverse-selection cost is complex and depends on the model settings. For example, Admati and Pfleiderer (1988) show that when the trading demand of liquidity traders is exogenous and all informed traders observe the same signal, liquidity will increase in the number of informed traders. See Spiegel and Subrahmanyam (1992) for a detailed discussion.

\textsuperscript{14} Figlewski (1985) examines the use of index futures contracts to hedge the systematic risk of individual stocks and stock portfolios. He shows that the price differences between the futures contracts and the underlying index can lead to substantial basis risk if the contracts are not held until maturity. Note that this basis risk is due to a maturity mismatch (between the maturity of the contracts and the hedge horizon).
and the market-making arguments. It is possible, in fact likely, that more than one of these effects occur at the same time. Therefore, the issue is an empirical question, which we will address in the following section.

Empirical studies on the effects of new securities typically examine the effects of options or futures trading on the underlying stocks' liquidity measures, particularly the bid-ask spreads (see, for example, Jegadeesh and Subrahmanyam, 1993; Kumar et al., 1998; and a review paper by Mayhew, 2000). A related strand of studies investigates the impact of the introduction of index ETFs on their portfolio securities. For example, Hegde and McDermott (2004) report that the Dow Jones Industrial Average ETF improved the liquidity of the portfolio securities and reduced the adverse-selection costs. Richie and Madura (2007) arrive at the same conclusions with the Nasdaq 100 ETF. Finally, using a sample of over 100 ETFs, Madura and Ngo (2008) report that their introduction significantly increased the trading volume of the component stocks.

3.2. Sample Description

To study the impact of the introduction of GLD on gold company stocks, we use a sample of firms that satisfy the following requirements. First, they were classified as belonging to the gold ores industry (SIC four-digit code: 1041) at the time of the introduction of GLD. Companies in this industry are gold producers, and thus their stocks should be directly affected by GLD's introduction. Secondly, the companies in the sample were listed on either the New York Stock Exchange (NYSE) or the American Stock Exchange (AMEX), and were included in the CRSP database. We do not include companies listed on NASDAQ because the market structure of NASDAQ is different (i.e., a dealer market as opposed to an auction market in the

---

15 The description of companies with this SIC code is "Establishments primarily engaged in mining gold ores from lode deposits or in the recovery of gold from placer deposits by any method. In addition to ore dressing methods such as crushing, grinding, gravity concentration, and froth flotation, this industry includes amalgamation, cyanidation and the production of bullion at the mine, mill or dredge site." (Source: The United States Department of Labor's web site)
case of NYSE and AMEX). The difference in market structure was shown to cause trading costs
to be different (Huang and Stoll, 1996), which would make comparison across firms difficult.
Thirdly, to ensure reliable estimates, we require that the stocks be traded every day in the sample
period. Finally, the companies were not involved in a major confounding event during the
sample period such as a merger/acquisition, a lawsuit, or a stock split/reverse stock split.

The sample period consists of a period of two months prior to the introduction of GLD
(the pre-GLD period) and two months after the introduction (the post-GLD period). The
relatively short sample period minimizes the possibility of confounding events. As GLD quickly
gained popularity after its introduction, we believe that the sample period is long enough to
capture the effects of GLD on the trading of gold company stocks. To ensure that the effects are
accurately captured, we omit ten trading days immediately before and ten trading days
immediately after the GLD introduction day. This is due to the possibility that during this period,
traders may liquidate their holdings of gold stocks in order to move to GLD, and thus the trading
activity of gold stocks during this period could be unusually high and not reflective of a normal
condition. The results in this section still hold even if this period is included in the analysis, and
are available upon request. We obtain transactions data from the New York Stock Exchange's
Transactions and Quotes (TAQ) database. Price data and data used to calculate abnormal returns
are from CRSP, while daily gold prices are obtained from Bloomberg.

In total, there are thirty-six companies in our sample.\textsuperscript{16} Their summary statistics are
reported in Table 1. In terms of size, the sample is considerably diverse. The market
capitalizations (as of November 1, 2004) range from $51.7 million to $11.6 billion with a mean
of $1.4 billion and a median of $653.9 million. This reflects the nature of the gold-mining
industry, which consists of a few large companies and many smaller companies. To put the

\textsuperscript{16}The number of companies in our sample is slightly smaller than that in other studies on gold mining companies.
For example, there are forty-eight companies in Tufano (1996, 1998) and forty-four companies in Jin and Jorion
(2007). This is due mainly to the criteria that we set for our sample. Two companies were omitted because they
were listed on NASDAQ, while three others were excluded because they did not trade every day during the sample
period. In addition, three more companies were omitted because of a major confounding event (a lawsuit), a reverse
stock split and suspected irregularities in the data, respectively.
companies' market capitalizations in perspective relative to the size of GLD, recall from Section 2 that the assets under management of GLD after only a week in existence was approximately $1.46 billion (i.e., close to the 75th percentile of the market capitalization of gold company stocks). Accordingly, the introduction of GLD was a major event that could potentially affect the demand for gold company stocks.

[Insert Table 1 here]

To get an idea about how these stocks co-move with gold prices, we calculate the correlation coefficients between the stocks' returns and gold returns over the period of three months ending ten trading days before our sample period. As expected, all correlation coefficients are positive. They range from 0.30 to 0.68, with a mean (median) of 0.52 (0.51). This suggests that gold company stocks respond positively to gold price movements, but, on average, they do not provide a pure play on gold. This is consistent with the fact that the performance of gold stocks depends not only on gold price, but also on other factors such as hedging policies, production costs and management ability.

The correlations between the stocks' returns and the returns on the market (as proxied by the CRSP value-weighted market index) are low on average, with a mean (and median) of 0.26. This average is comparable to the number reported in Jaffe (1989) for the period between 1971 and 1987 (i.e., 0.30). The wide range of the correlation values (i.e., from –0.06 to 0.66) suggests that gold companies are diverse in their response to market factors.

Table 1 also provides a snapshot of the trading activity of the stocks of companies in the sample. The information on the numbers of trades and trading volume are from November 1, 2004. As with market capitalization, the trading activity varies substantially across firms in the sample. The average number of shares traded that day is 768,194 shares, while the standard deviation (876,685 shares) is larger than the mean.
3.3. Basic Results – Liquidity Measures

As a first step in our investigation of the effects of the introduction of GLD on the trading characteristics of gold company stocks, we compare the stocks' measures of trading activity and liquidity between the pre-GLD and the post-GLD periods. The trading-activity measures that we examine are as follows:

1. Number of trades
2. Trading volume (in both shares and dollar values)
3. Relative trading volume, defined as the ratio between (i) the stock's normalized trading volume (i.e., number of shares traded divided by the stock's number of shares outstanding) and (ii) the equally-weighted normalized trading volume of all stocks traded on the NYSE and AMEX on the same day (see the Appendix for a formal description). As defined, relative trading volume takes into account a possible market-wide trend in trading volume.
4. Sell-vs-buy volume ratio, calculated as the ratio between seller-initiated trading volume and buyer-initiated trading volume, where trades are classified as sells or buys using the techniques developed by Lee and Ready (1991), which is standard in the market microstructure literature (see the Appendix for a description of the technique).

For liquidity measures, we examine bid-ask spreads and trade depths. We use two definitions of bid-ask spreads. They are effective spread (ES) and relative effective spread (RES). Effective spread is defined as twice the absolute difference between the trade price and mid-point of the bid-ask quote at the time of the trade. This measure takes into account the fact that trades often occur at prices inside the posted spreads, and so a measure of spreads based on quoted bid and ask prices may not accurately reflect market liquidity and transaction costs faced by investors (Petersen and Fialkowski, 1994). Relative effective spread is effective spread expressed as a percentage of the mid-point of the quote. For each day, we volume-weight
effective spreads and relative effective spreads, where the weights are the number of shares in each trade during the day (see formal descriptions in the Appendix).

Trade depth is the amount of trade that can be done at the quoted bid and ask prices. It captures the quantity dimension of liquidity, which is another piece of information that liquidity providers (e.g., market makers) use to manage information risk (e.g., Lee et al., 1993). We measure trade depth both in terms of number of shares and in dollar values (see the Appendix for formal descriptions).

The bid-ask spreads and trade depth are calculated using TAQ data. We delete all quotes and transactions data outside the NYSE trading hours (9:30 A.M to 4:00 P.M.), and disregard the first trade of each day to remove the overnight demand and news effects. Commonly used filters are applied to the data to remove observations that can be subject to errors or related to irregular transactions. For example, only quotes that were eligible for inclusion in the National Best Bid or Offer (NBBO) calculation (i.e., those with quote conditions of 01, 02, 06, 12 and 23) are considered. Only trades that were not corrected, changed, or signified as cancel or error (i.e., correction indicator = 0) are included. Other filters include removing observations with negative bid, ask or transaction prices, and those with bid prices greater than ask prices, etc.

To match trades with quotes, we use the Lee and Ready’s (1991) five-second rule (where each trade is matched with the most recent quote that occurred at least five seconds before the trade timestamp on the same day). More recent studies argue that the improvement in technology and information transmission has reduced the time delay between the submission of quotes data and the submission of transactions data. For example, Henker and Wang (2006) propose a one-second rule, and show that it outperforms the five-second rule in the estimation of components of bid-ask spreads. For robustness, we also perform our tests and estimation using the one-second rule. The results are qualitatively similar to those obtained by the five-second rule. Hence, to save space, we will only present the results under the five-second rule.

For each day in the sample period (i.e., thirty-four trading days in the pre-GLD period and thirty-four trading days in the post-GLD period), we calculate the trading-activity measures and the liquidity measures for each stock. We then take the average of each measure at the
company level for the pre-GLD period and the post-GLD period. Next, we calculate the "Post/Pre ratio" for each variable as follows:

\[
\text{Post/Pre Ratio}_i = \frac{X_{i,\text{post}}}{X_{i,\text{pre}}}
\]

where \(X_{i,\text{pre}}\) and \(X_{i,\text{post}}\) are the variable of interest for stock \(i\) in pre-GLD and post-GLD periods respectively. We perform a Student's \(t\)-test on the Post/Pre ratio to determine whether the sample mean of the ratio is significantly different from unity. Since the normal distribution assumption of the \(t\)-test may be violated, we also employ a signed rank test.

Table 2 reports the estimates of the trading-activity measures (Panel A) and the liquidity measures (Panel B). In Panel A, the number of trades and all three measures of trading volume show a decline (i.e., Post/Pre ratio < 1) after the introduction of GLD. All the declines are significant, especially for relative trading volume, which accounts for the market-wide trend in trading volume. The Post/Pre ratios suggest that, on average, trading volume declines by approximately 15% in dollar term and 19% in relative term. In addition, the decline occurs in most of the firms, as only about 28% (14%) of the firms have an increase in dollar trading volume (relative trading volume).

The sell-vs-buy volume ratio increases significantly in the post-GLD period. The mean (median) of its Post/Pre ratio is 1.095 (1.111), indicating that, on average, the sell activity (as normalized by the buy activity) increases by about 10%. The increase occurs in two-thirds (i.e., 67%) of the firms in our sample. We interpret this result as being consistent with the prediction that the demand for gold company stocks would drop after the introduction of GLD.

[Insert Table 2 here]
(median) Post/Pre ratio of relative effective spread is 1.157 (1.174). In other words, the relative bid-ask spread increases by over 15% on average. The proportion of the sample that experiences an increase in bid-ask spread measures is also high – about 72% in the case of effective spread and 81% in the case of relative effective spread.

As for trade depth, in terms of shares, both the mean and median of its Post/Pre ratios are smaller than, but not significantly different from, unity. However, trade depth in terms of dollars, which is arguably a more economically meaningful measure of depth, declined significantly. The mean (median) of its Post/Pre ratios is 0.925 (0.870), both of which are significantly different from 1. For both measures of depth, the proportion of the sample with ratio greater than unity is less than 40%, suggesting that the decline in trade depth happens to the majority of the companies in the sample.

In summary, the results in Table 2 indicate that the majority of the gold companies in the sample experience significant deterioration in trading activity and liquidity after the introduction of GLD. In particular, their bid-ask spreads increase, while trade depth declines. The findings are consistent with the adverse-selection argument, which predicts a migration of traders to GLD. The findings do not support the arbitrage argument or the market-making argument.

Finally, we note that prior studies have shown that bid-ask spreads depend on return volatility, price levels and trading volume (e.g., Lee et al, 1993; Jegadeesh and Subrahmanyam, 1993; Boehmer and Boehmer, 2003). To rule out the possibility that changes in these three factors, rather than the introduction of GLD, cause the observed changes in the spreads, we follow Jegadeesh and Subrahmanyam (1993) and run a log-linear regression of bid-ask spreads on the three factors and a dummy variable. We want to know whether the observed increase in spreads still exists after controlling for the changes in these factors.

Specifically, we run the following regression:

\[
\text{Ln Spread}_{i,t} = \beta_0 + \beta_1 \times \text{Dummy} + \beta_2 \times \text{Ln Volume}_{i,t} + \beta_3 \times \text{Ln Std}_{i,t} + \beta_4 \times \text{Ln Price}_{i,t} + \epsilon_{i,t}, \quad (2)
\]
where the index $i$ represents the firms in the sample ($i = 1, 2, \ldots, 36$) and the index $t$ represents the days in the pre-GLD and post-GLD periods ($t = 1, 2, \ldots, 68$). $\text{Ln Spread}_{it}$ is the natural log of effective spread or relative effective spread, as the case may be. $\text{Dummy}$ takes a value of 1 in the post-GLD period and 0 in the pre-GLD period. $\text{Ln Volume}_{it}$ is the natural log of the daily trading volume (in shares), and $\text{Ln Std}_{it}$ is the natural log of the daily return standard deviation estimated by the extreme value method of Parkinson (1980).\footnote{According to Parkinson (1980), the standard deviation of daily returns is estimated as:}

$$\text{Std} = \sqrt{\frac{\left[ \ln(\text{Price\_High}) - \ln(\text{Price\_Low}) \right]^2}{4 \times \ln(2)}},$$

where $\text{Price\_High}$ and $\text{Price\_Low}$ are the daily highest and lowest transaction prices, respectively.

To correct for the autocorrelation and heteroscedasticity in standard errors, we use the Newey-West (1987) procedure. However, since our sample firms are from the same industry, we also account for possible correlation of regression disturbances between companies by using two other approaches. First, we allow for cross sectional correlation of standard errors by using the approach proposed in Kmenta (1986). Secondly, we adjust the standard errors by using the approach in Driscoll and Kraay (1998), which is expected to eliminate some deficiencies of the Kmenta approach.\footnote{Beck and Katz (1995) point out that in some cases, the Kmenta standard error estimates can be unacceptably low.}

The regression results are presented in Table 3.\footnote{Under the Newey-West and the Driscoll and Kraay approaches, there are 2,438 firm-day observations in the regressions. This number is 10 fewer than the full complement (i.e., 36 firms x 68 days). The 10 missing firm-day observations come from three companies. Under the Kmenta approach, there are 2,244 firm-day observations in the regressions. This is because the Kmenta approach required balanced data, which are not possible for the three companies. As a result, the three companies were removed from the Kmenta regressions.} The results are similar across the three standard error approaches. The coefficient for $\text{Dummy}$ is positive and significant for both definitions of dependent variables. The coefficients for the three control variables are significant.
and have the anticipated signs.\footnote{The literature on bid-ask spreads posits that spreads are determined by three different costs of market makers – order-processing cost, inventory cost and adverse-selection cost (i.e., losses to informed traders). Spreads should decline in trading volume because it allows market makers’ fixed costs to be spread over a larger base, and also provides market makers with more flexibility in managing their inventory imbalances. Spreads should increase in return volatility because higher volatility increases inventory risk and also the potential losses to informed traders. As for the expected relationship between spreads and price, the relationship depends on whether spreads are measured in dollar term or percentage term. In dollar term, high-price stocks should have higher spreads because the inventory cost and the amounts of potential losses to informed traders are larger. In percentage term, however, high-price stocks should have lower percentage spreads because, for a given number of shares traded, a higher price means a higher dollar trading volume, which allows fixed cost to be spread over a larger base. For a discussion on spread components, see, for example, Stoll (1978), Glosten and Milgrom (1985) and Huang and Stoll (1997). For a discussion on the relationship between spreads and trading volume, volatility and price, see, for example, Copeland and Galai (1983) and Jegadeesh and Subrahmanyam (1993).} This confirms that gold company stocks have higher bid-ask spreads in the post-GLD period after controlling for changes in trading volume, return volatility and share prices.

[Insert Table 3 here]

### 3.4. Estimation of the Adverse-Selection Component

The adverse-selection argument predicts that the introduction of GLD would attract uninformed traders away from gold company stocks. As a result, the stocks' bid-ask spreads should increase due, in particular, to an increase in the adverse-selection cost that market makers face. In this section, we investigate whether the increase in the bid-ask spreads reported in the previous section can be attributed to higher adverse-selection cost. To do so, we employ two approaches that have been used in the literature to estimate the adverse-selection component of bid-ask spreads. The first approach is proposed by Madhavan et al. (1997), while the second approach is from Huang and Stoll (1996).
Under the Madhavan et al. (1997) approach (henceforth referred to as "MRR"), bid-ask spreads are decomposed into a non-information component (which includes order-processing cost and inventory cost) and an information component (adverse-selection cost). In their model, price changes because market makers continuously revise their beliefs about the stock's fundamental value based on new public information and observed order flows (which may reflect traders' private information). Accordingly, one can estimate the adverse-selection cost that market makers face by using a time series of changes in transaction prices. Formally, changes in price are modeled as:

\[ P_t - P_{t-1} = \alpha + (\phi + \theta) x_t - (\phi + \rho \theta) x_{t-1} + \epsilon_t + \xi_t - \xi_{t-1}, \]  

(3)

where \( P_t \) is the transaction price at time \( t \), \( \alpha \) is a constant drift (if any) in price, \( \phi \) is the order-processing cost parameter, and \( \theta \) is the adverse-selection cost parameter. \( x_t \) is an indicator variable for trade initiation, which takes the value of +1 if trade at time \( t \) is buyer-initiated, −1 if seller-initiated and 0 otherwise (e.g., a mid-quote transaction). \( \rho \) is the first-order autocorrelation of the trade initiation variable, while \( \epsilon_t \) denotes the innovation in beliefs between time \( t - 1 \) and time \( t \) because of new public information, and \( \xi_t \) is the error term that captures the effect of errors induced by price discreteness or possibly time-varying returns.

Our parameters of interest are the two cost parameters, \( \phi \) and \( \theta \), in the pre-GLD and post-GLD periods. To estimate them, we use the methodology in Armstrong et al. (2011), where the dependent variable is deflated by lagged price (i.e., \( P_{t-1} \)) to allow for cross-sectional comparability (and thus the estimated \( \phi \) and \( \theta \) will be in percentage term). The estimation is done using OLS. To determine trade initiation, we match trades and quotes using the Lee and Ready (1991) method with the 5-second rule.\(^2\) A trade is classified as a buy order (i.e., \( x_t = +1 \)) if it occurs at a price above the quote mid-point, and a sell order (i.e., \( x_t = -1 \)) if it occurs at a price below the quote mid-point. For transactions taking place at the quote mid-point, we assign

\(^2\) As before, we also use the 1-second rule. The results are qualitatively similar.
0 to $x_t$. As a by-product of the estimation procedure, we also obtain the estimate for effective spread. This estimate is based only on transaction prices, and so it is different from the commonly used definition, which is with respect to the mid-quote (See Section 3.3). For this reason, we will refer to this estimate as MRR effective spread.\footnote{The MRR effective spread is equal to $\left(1-\lambda\right)\left(2\phi + \theta\right)$, where $\lambda$ is the probability that a transaction occurs at the quote mid-point.}

The second approach that we use to estimate the adverse-selection component of bid-ask spreads is from Huang and Stoll (1996). This approach decomposes effective spread into realized spread and price impact. Huang and Stoll argue that due to the existence of informed traders, prices usually move against market makers after a trade, falling after a seller-initiated transaction (i.e., a market maker purchase) and rising after a buyer-initiated transaction (i.e., a market maker sale). As a result, market makers usually do not realize the effective spread because of losses to informed traders. The profit (loss) of market maker is actually the difference between the initial transaction price and the subsequent transaction price at which the trade is liquidated. They define this difference as realized spread, which measures the actual post-trade revenues earned by the market maker, and define the difference between effective spread and realized spread as price impact, which estimates the amount that market makers lose to informed traders (i.e., adverse-selection cost).

Based on this premise, we define relative realized spread as:

$$RRS_t = 2I_t \frac{(P_t - P_{t+n})}{M_t},$$

where $I_t$ is an indicator variable whose value equals +1 if the trade at time $t$ is buyer-initiated and −1 if seller-initiated, $P_t$ is the transaction price at time $t$, $P_{t+n}$ is the first transaction price observed at least $n$ minutes after time $t$ within the same trading day, and $M_t$ is the mid-quote at time $t$ (i.e., the half-way point between the best bid and ask at time $t$). Subtracting relative
realized spread from relative effective spread (as previously defined), we obtain relative price impact (in percentage term) as:  

$$PRCIMPACT_t = 2I_t \left( \frac{P_{t+n} - M_t}{M_t} \right).$$

(5)

Following Huang and Stoll, we estimate relative realized spread with $n$ equal to 5 and 30 minutes. Since the two cases provide similar and consistent results, we only present the results with $n$ of 5 minutes. Volume-weighted relative realized spread and relative price impact are calculated on a daily basis for each stock. Then, for each stock, these daily values are averaged for the pre-GLD period and the post-GLD period.

Table 4 reports the estimates of bid-ask spread components before and after the introduction of GLD, and the results of the tests whether those components change significantly between the two periods. Panel A presents the results based on the MRR approach. The MRR effective spread (in percentage term) increases significantly in the post-GLD period, with mean (median) Post/Pre ratio of 1.069 (1.092). The Post/Pre ratio is greater than 1 for about 70% of the companies in the sample. This increase is consistent with the results in Table 2, where relative effective spread is calculated based on the commonly used definition. The estimates of the non-information and the adverse-selection costs (i.e., $\phi$ and $\theta$) show that the increase in bid-ask spreads is due mainly to the increase in the adverse-selection cost. The mean and median Post/Pre ratio of $\theta$ are 1.097 and 1.099, both of which are significantly different from unity. On the other hand, we do not observe any significant changes in the non-information component. The mean and median Post/Pre ratio of $\phi$ are not significantly different from 1 under either the $t$-test or the signed rank test.

---

As defined in Section 3.3 and also in the Appendix, relative effective spread is equal to twice the absolute value of the difference between the trade price and the mid-quote at the time of trade, expressed as a percentage of the mid-quote. For the purpose of this section, that definition is equivalent to: $RES_t = 2I_t (P_t - M_t)/M_t$.
Panel B of Table 4 shows that the results under the Huang and Stoll’s (1996) approach are consistent with the results under the MRR approach. The price impact (i.e., adverse-selection cost) rises significantly after the introduction of GLD. The mean (median) its Post/Pre ratio is 1.334 (1.230), both of which are significantly different from unity at the 1% level. The price impact is higher for two-thirds of the firms in the sample. On the other hand, the relative realized spreads do not change significantly, indicating that the actual profit of market makers does not change significantly. In other words, the widening of bid-ask spreads is primarily the result of market makers requiring more compensation for greater information risk.

In summary, the results in Table 4 are consistent with the adverse-selection argument, which suggests that uninformed traders migrate to GLD due to its low adverse-selection risk and the pure-play on gold that it offers. This migration leads to a larger proportion of informed traders in gold company stocks and thus higher adverse-selection compensation required by market makers. This causes the bid-ask spreads of gold company stocks to widen in the post-GLD period.

### 3.5. Comparison between GLD and Gold Company Stocks

In this section, we present evidence that traders in GLD indeed face lower transaction cost and, in particular, lower adverse-selection cost than traders in gold company stocks. The lower adverse-selection risk is what attracts uninformed/liquidity traders away from the stocks.

First, we compare trading-activity and liquidity measures between GLD and gold company stocks during the post-GLD period. We calculate the differences in those measures on a daily basis for the 34 trading days in the post-GLD period, and test whether their mean and median are significantly different from zero based on the 34 observations. The results are reported in Table 5. In Panel A, the three measures of trading activity show that GLD gained popularity immediately after its introduction. The number of trades and trading volume in both
share term and dollar term far exceed the averages for the stocks. For example, the mean daily number of trades of GLD is close to twice the average of gold company stocks (i.e., 1,241 vs. 755), while the trading volume (in dollar term) of GLD is about eleven times as high.24

The estimates of the liquidity measures in Panel B show that GLD is a much more liquid security than an average gold stock. Effective bid-ask spreads, in both dollar term and particularly percentage term, are significantly lower for GLD than for an average gold stock. This suggests that trading in GLD involves much less transaction costs than trading in gold stocks. We also find that the market of gold company stocks is, on average, shallower than that of GLD. The quoted depth (in dollar term) of gold company stocks on average is about seven times smaller than that of GLD. The quoted depth (in share term), however, is higher for gold stocks. We attribute this to the fact that GLD has a higher price than an average gold stock. The average price of GLD during the post-GLD period is around $43, while the average price of an average gold stock during the same period is around $8.

Next, we show that trading in GLD entails lower adverse-selection risk than trading in gold company stocks. Table 6 presents the comparison of spread components between GLD and gold company stocks based on the MRR (1997) and the Huang and Stoll (1996) approaches. We use the data on GLD trading during the post-GLD period in the estimation. As before, all the variables are in percentage term.

24 Note that the median values for all the measures for gold company stocks in Table 5 are not the same as the median values in the post-GLD period in Table 2. This is because in Table 5, we calculate the median by first averaging the values of each measure across firms within a day, and then ranking the daily values. That is, the median is calculated based on 34 observations. We calculate the median this way because there are also 34 daily observations for GLD, with which we want to compare. On the other hand, the median values in Table 2 are calculated by first averaging across days for each firm, and then ranking those individual firms.
In Panel A, the spread components are estimated using the MRR approach. Both the non-information component ($\phi$) and the adverse-selection component ($\theta$) of GLD's spreads are significantly smaller than their gold stocks' counterparts. The results based on the Huang and Stoll approach are similar and are reported in Panel B. The mean (median) relative realized spread of GLD is much smaller than that of gold company stocks (a difference of 0.31% (0.29%)), both of which are significant at the 1% level. Similarly, the mean (median) relative price impact of GLD is significantly lower than that of gold company stocks (a difference of 0.42% (0.41%)). The magnitude of the differences in both the realized spread and price impact is significant both statically and economically.

In summary, the results in this section suggest that GLD is a much more liquid and less information-sensitive security than gold company stocks. Therefore, traders who migrate to GLD benefit by lowering their transaction cost and minimizing their losses to informed traders.

4. The Effects of GLD on the Prices of Gold Company Stocks

We now examine the effects of the introduction of GLD on the prices of gold company stocks. We will first discuss a few theoretical predictions. Then, we will present the empirical results.

4.1. Theoretical Predictions

The results in the previous sections suggest that the introduction of GLD attracted traders, especially uninformed traders, from gold company stocks. In other words, GLD caused the demand for gold stocks to decline. To predict the effects of this demand shock on their prices, we rely on a few arguments that have been put forth in the literature.
A. The Imperfect-Substitutes Argument

In a frictionless market where assets have perfect substitutes, their prices are not affected by changes in their demand or supply (Scholes, 1972). This is because the market will price assets such that the expected returns on assets of similar risk are equal. If a change in demand or supply of an asset causes it to sell at a price that yields a different expected return, arbitrageurs can take advantage of this opportunity by buying (or selling) this asset and taking an opposite position in its substitute. As a result, demand curves for stocks are kept flat by arbitrage forces.

In actual markets, however, perfect substitutes do not exist. Therefore, the type of arbitrage transaction described above is not without risk. Wurgler and Zhuravskaya (2002) formally develop a model to show that when there is arbitrage risk, demand curves for stocks will be downward-sloping. When a demand shock occurs, the stock's demand curve will shift (inward or outward) while its supply curve remains the same. As a result, the price of the stock will change. The magnitude of the change depends on the slope of the demand curve and the size of its shift. The steeper the demand curve and/or the larger the shift, the stronger the price effect is. Stocks that have steeper demand curves are those with no close substitutes, which make arbitrage more risky.

Along the same line, Greenwood (2005) shows that the price effect is proportional to the contribution of the demand shock to the risk of the arbitrage portfolio. When demand shocks occur simultaneously to a group of stocks, the price effect is stronger if the stocks in the group co-move with one another (and thus cannot be used as a hedge against each other to reduce the risk of the arbitrage portfolio).

In the literature, this line of reasoning is typically referred to as the imperfect-substitutes argument. The argument implies that the price effect will be permanent as the new price reflects a new equilibrium distribution of security holders (Harris and Gurel, 1986). Adapted to our context, the introduction of GLD attracted traders away from gold company stocks, causing a negative demand shock. Prices of these stocks would decline, and the decline would be

---

25 Supply of shares is fixed in the short run, and so the supply curve is vertical.
permanent. In addition, since GLD affected all gold stocks, arbitrage risk was higher and the price effect should, on average, be strong.

B. The Price-Pressure Argument

The price-pressure argument states that demand shocks are absorbed by traders who agree to immediately buy or sell securities that they normally would not trade (Scholes, 1972). Therefore, even if the fundamental value of the stock does not change, its price has to decline (increase) when there is a large sale (purchase) in order to attract these traders. Then shortly afterwards, the price will revert to its fundamental level. The initial price change and the subsequent reversal compensate these traders for the service that they provide and the risk that they bear.

A similar argument is made in Campbell et al. (1993), who show that risk-averse utility-maximizing traders will be willing to accommodate the fluctuations in demand for stock from liquidity or non-informational traders only if they are rewarded for it. As in Scholes (1972), the reward demanded by traders who accommodate the selling pressure is in the form of a lower transaction price. The reward is realized when the price of the stock returns to its fundamental value.

Accordingly, applied to our context, the price pressure argument predicts that the introduction of GLD would cause the prices of gold company stocks to decline, but the decline would be temporary.

C. The Liquidity-Premium Argument

Amihud and Mendelson (1986) show that the expected return on a stock is an increasing function of its relative (i.e., percentage) bid-ask spreads. This positive relationship reflects the fact that investors require compensation for transaction costs. The relationship implies that if there is a change in the relative bid-ask spreads of a stock, the stock's expected return will change. It follows that its price will change, and the change will be permanent. In our context, we report
in Section 3 that the relative spreads of gold company stocks increased significantly after the introduction of GLD. As a result, the liquidity-premium argument suggests that the stocks' expected returns should increase and their prices should decline in the post-GLD period.

D. Summary of Arguments

All of the above arguments predict that the prices of gold company stocks should decline after the introduction of GLD. One important difference among them is that the decline will be permanent under the imperfect-substitutes and the liquidity-premium arguments, but will be temporary under the price-pressure argument.

A number of prior studies have empirically tested the imperfect-substitutes argument and the price-pressure argument, particularly in the context of stock inclusions into, or removals from, major stock indices. Most of these studies concentrate on inclusions (which raise the demand for the included stocks), and ignore removals (which reduce the demand for the removed stocks, and which are closer in spirit to our study). For studies that examine removals, their results are not entirely conclusive. For example, Harris and Gurel (1986) and Chen et al. (2004) study stock removals from the S&P 500 index, and report significant price drops around the removal dates which subsequently were almost completely reversed (i.e., cumulative abnormal returns becoming insignificantly different from zero) after 11 and 20 trading days respectively. Since the price effects were temporary, these results appeared to support the price-pressure hypothesis rather than the imperfect-substitutes hypothesis. On the other hand, Lynch and Mendenhall (1997) study the same index, but report that the price reversal was only partial, and conclude that their results support both hypotheses.

Madura and Ngo (2008) examine the price effects of ETFs on their component stocks. They find that the price effects were positive and significant, especially for large ETFs. We interpret their results as being consistent with positive demand shocks to the component stocks as these ETFs have to hold those stocks. Madura and Ngo do not, however, examine whether the price effects were subsequently reversed.
As for the liquidity-premium argument, the positive relationship between expected returns and bid-ask spreads has been empirically verified in several studies including Amihud and Mendelson (1991), Datar et al. (1998) and Hasbrouck (2009).

4.2. Price Effects

To measure the price effects of GLD on gold company stocks, we estimate the stocks' abnormal returns (ARs) and cumulative abnormal returns (CARs) during the period surrounding GLD's introduction day. Since all the firms in our sample come from the same industry and we want to examine the effects of a common event on them, it is likely that their returns will be cross-sectionally correlated. As a result, the traditional event-study methodology introduced by Fama et al. (1969) is not appropriate. Instead, we will use the event-parameter approach discussed in, for example, Schipper and Thompson (1983) and Binder (1985), and commonly used in studies that examine the impact of common events, such as regulatory changes, across firms (e.g., Karpoff and Malatesta, 1995; Akhigbe and Martin, 2006; Doidge et al, 2010). The approach involves constructing an equally-weighted portfolio of the stocks under investigation, and regressing the portfolio's returns on a constant, event indicator variables and benchmark return-generating factors.

Our benchmark return-generating factors are the four factors in Carhart's (1997) model, which are the three factors in Fama and French's (1993) model (i.e., market risk, size, and book-to-market) plus the momentum factor. In addition, following Tufano (1998), we include gold returns as a factor in order to capture the impact of gold price movements on gold stock returns.26 To account for the possibility of non-synchronous trading, we use the Dimson (1979) approach and include one lagged and one leading terms for the market risk factor and gold returns. Accordingly, the regression equation is:

---

26 As reported in Table 1, returns on gold stocks are positively correlated with gold returns (average correlation = 0.52).
\[ R_{p,t} = \alpha + \sum_{j=-1}^{1} \beta_j^M R_{m,t+j} + \gamma_1 \times SMB_t + \gamma_2 \times HML_t + \gamma_3 \times UMD_t + \sum_{j=-1}^{1} \beta_j^G R_{g,t+j} + \sum_{i=10}^{22} \lambda_{i} D_{i}, \tag{6} \]

where

\[ R_{p,t} \] = return on day \( t \) on the equally-weighted portfolio of gold company stocks;
\[ R_{m,t} \] = market return on day \( t \), as proxied by CRSP value-weighted market index;
\[ SMB_t \] = return differential between the average small-cap and the average large-cap portfolios on day \( t \);
\[ HML_t \] = return differential between the average value and the average growth portfolios on day \( t \);
\[ UMD_t \] = return differential between the highest and the lowest prior-return portfolios on day \( t \);
\[ R_{g,t} \] = gold return on day \( t \); and
\[ D_{i} \] = a dummy variable set to be one if day \( i = t \), and zero otherwise

The estimated coefficient for each dummy variable, \( \lambda_{i} \), measures the abnormal return on the portfolio on day \( i \). The summed value of \( \lambda_{i} \)'s over a certain interval is therefore the cumulative abnormal return on the portfolio over that interval. We estimate \( \lambda_{i} \) for each day during the period from ten trading days (i.e., two weeks) before GLD's introduction to twenty-two trading days (i.e., one month) after. This period is intended to account for the possibility that traders may have anticipated the issuance of GLD and so started to sell their holdings of gold stocks before GLD's introduction day.\(^{27}\) The period also accounts for the possibility that the migration from gold stocks to GLD could be gradual, and so the effects on gold stock prices may

\[ ^{27} \text{GLD went through a long (18 months) approval process at the US Securities and Exchange Commission (SEC). It was only about a week or two before GLD's introduction day that reports started to appear that the approval was imminent. See "SEC Close to Backing New Gold Product" in the November 8, 2004 edition of the Financial Times newspaper).} \]
have lasted longer than a few days after GLD's introduction. In addition, the period allows us to observe whether a reversal of the price effects would occur within that time.

The above regression is run using daily observations over the period of six months centering on the GLD's introduction day. As Tufano (1998) shows, the sensitivity of gold stocks to market returns and gold returns (i.e., the stocks' market betas and gold betas) varies across time (and even from quarter to quarter). Therefore, it is not appropriate to use a long period in the estimation, as betas can change over that period.

The estimated CARs of the portfolio are presented in Table 7 and Figure 1. In Figure 1, we plot the portfolio's CARs from day -10 to day +22 relative to the listing date of GLD (i.e., day 0). A casual glance at the plot suggests that the prices of gold stocks were relatively stable during the ten trading days before the introduction of GLD (i.e., the CAR appeared to be close to zero). After the introduction of GLD, the CAR became negative and increasingly so for two weeks (i.e., ten trading days), before bouncing back slightly thereafter.

[Insert Figure 1 here]

In Table 7 the estimation results show that during the two weeks preceding GLD's introduction, the cumulative abnormal return, CAR (-10, -1), is 0.9%, which is not significantly different from zero. On the introduction day of GLD (i.e., day 0), the portfolio of gold stocks experienced a negative abnormal return of -1.90% (i.e., the estimated coefficient of the dummy variable D0), which is significantly different from zero. This suggests that traders started to migrate from gold stocks to GLD immediately after GLD became available. Then, over the following two weeks, the CAR became increasingly negative, with CAR (0, 10) of -12.5%. It thus appears that the migration continued to occur during this period. Finally, in the subsequent two weeks, the CAR became stable, with CAR (0, 22) of -12.3%. This result indicates that the migration activity may already be over during this period.

[Insert Table 7 here]
In summary, the introduction and trading of GLD had a serious adverse effect on gold company stocks. The stocks significantly underperformed the benchmark on GLD's listing date. The underperformance became more severe during the following two weeks. After two weeks, however, there did not appear to be any further significant negative effect.\(^{28}\)

4.3. Analysis of the Price Effects

The observed decline in the prices of gold stocks in the days (and weeks) after GLD was introduced is consistent with the imperfect-substitutes argument and the liquidity-premium argument. It does not, however, lend support to the price-pressure argument because there was no significant price reversal, even after a period of a month.\(^{29}\) In this section, we attempt to confirm the imperfect-substitutes and/or the liquidity-premium arguments as the source of the price effects. To do so, we run a (cross-sectional) regression of firm-level abnormal returns on several variables that are related to the two arguments.

We use two measures of firm-level abnormal returns (i.e., the dependent variable of the cross-sectional regression). They are (i) the stocks' abnormal returns on the day of GLD's introduction (AR (0)); and (ii) the stocks' cumulative abnormal returns over the one-month period from GLD's introduction (CAR (0, 22)). These two measures allow us to investigate the factors that can explain immediate and longer-term price effects respectively. For each stock, the

---

\(^{28}\) The negative abnormal returns on the portfolio are not due to some outliers or small companies in the sample. Over the same period (i.e., from day 0 to day 22), the HUI Gold index, which is a modified equally-weighted index of approximately fifteen large gold companies that do not hedge their long-term production (roughly similar to the top half of the companies in our sample), declined by 9.67% while gold price remained approximately the same and the market (as proxied by the CRSP value-weighted market index) increased by 2.44%. That is, the negative abnormal returns occurred across the board.

\(^{29}\) It is impossible to rule out completely the price-pressure argument. This is because there is no theoretical guidance regarding when price reversals should occur. Prior tests of the price-pressure argument commonly limit their observations to one month after the event day. The risk of using a longer observation period is that there may be confounding events that subsequently occur.
two measures are estimated using the regression in equation (6) at the company level over the same estimation period as in the previous section.

To test for the effect of the imperfect-substitutes argument, we use, as independent variables of the cross-sectional regression, two variables that are predicted to determine the size of the price effects. The first variable is the stocks' arbitrage risk (which determines the slopes of the demand curves), while the second variable is the size of the demand shocks. The stocks' arbitrage risk is calculated using the approach in Wurgler and Zhuravskaya (2002). Under this approach, the arbitrage risk of a stock depends on whether or not the stock has a close substitute, and can be measured by the variance of a zero-net-investment portfolio which holds $1 long (short) in the stock and $1 short (long) in a portfolio of substitutes. Wurgler and Zhuravskaya consider two potential substitutes. One is the market portfolio, and the other is a portfolio of three stocks that match the subject stock on industry and as closely as possible on size and book-to-market ratios. Their results indicate that the two substitutes yield similar and highly correlated (about 0.98) measures of arbitrage risk. Due to the fact that the introduction of GLD affected all firms in our sample at the same time, we cannot use a portfolio matched on industry as a substitute. Accordingly, we use the market portfolio as a substitute for all gold company stocks in the calculation of their arbitrage risk measures (ARMs). As for the size of the demand shocks, we use the Post/Pre ratio of the sell-vs-buy volume ratio (as defined in Section 3.3). A larger Post/Pre ratio of sell-vs-buy volume ratio indicates a larger seller-initiated transaction proportion in the post-GLD period relative to the pre-GLD period (i.e., a greater negative demand shock). If the imperfect-substitutes argument can explain the observed price effects, the coefficients of the arbitrage risk and the size of the demand shocks should be negative and significant.

30 Specifically, to get each stock's ARM, we first regress the stock's daily excess returns on the daily CRSP value-weighted market index excess returns over the 3-month period ending 10 trading days before the GLD introduction day. We then define ARM as the standard deviation of the residuals from the regression. Note that for this calculation, one company was dropped from the sample because of incomplete data over the period.
The liquidity-premium argument suggests that the price of a stock will decline (increase) if its liquidity decreases (increases). To test for the effect of this argument, we use two proxies for liquidity as the independent variables of the cross-sectional regression. The first proxy is the Post/Pre ratio of relative effective spread, while the second proxy is the Post/Pre ratio of the MRR adverse-selection cost (i.e., \( \theta \)). Since these two proxies are highly correlated, only one of them will appear in the regression at a time. If the liquidity argument can explain the observed price effects, the coefficient of each proxy should be negative and significant.

We run four versions of the regression. The coefficient estimates, together with their White's heteroscedasticity-consistent standard errors are presented in Table 8. Columns (1) and (2) contain the results where the abnormal return on GLD's introduction day (i.e., AR (0)) is the dependent variable. In column (1), the independent variables are ARM, the Post/Pre ratio of sell-vs-buy volume ratio, and the Post/Pre ratio of relative effective spread, while in column (2), the Post/Pre ratio of \( \theta \) is used as the proxy for liquidity instead of the Post/Pre ratio of relative effective spread. In column (1), all the independent variables are significantly negatively related to abnormal returns of gold stocks. In column (2), the coefficient of ARM is not significant but the Post/Pre ratio of sell-vs-buy volume ratio is still significant. The Post/Pre ratio of \( \theta \) is also significant. These results suggest that the abnormal returns on gold stocks on GLD's introduction day (i.e., AR(0)) can be explained by both the imperfect-substitutes argument and the liquidity-premium argument.

[Insert Table 8 here]

Columns (3) and (4) contain the results where CAR (0, 22) is the dependent variable. In column (3), the proxy for liquidity is the Post/Pre ratio of relative effective spread, while in column (4), the proxy for liquidity is the Post/Pre ratio of \( \theta \). For both regressions, only the Post/Pre ratio of sell-vs-buy volume ratio is significant. This indicates that the longer-term price effects are associated with the negative shock to the demand of gold stocks, and not with the changes in the stocks' liquidity costs. This is not unexpected because the magnitude of the
stock's longer-term cumulative abnormal returns (i.e., CAR (0, 22)) is large compared to the magnitude of the changes in the liquidity costs. As a result, the effect of the negative demand shock dominates the effect of the changes in liquidity costs in explaining longer-term cumulative abnormal returns.

In summary, the results in columns (1) and (2) show that the negative abnormal returns on gold company stocks on GLD's listing date are associated with both the decline in liquidity and the negative demand shocks. The results provide support for both the imperfect-substitutes argument and the liquidity-premium argument as the causes for the observed immediate price effects. For longer-term price effects, however, the results in columns (3) and (4) indicate that the imperfect-substitutes argument is more significant and dominant.

5. Conclusions

In this paper, we study the market impact of a very successful financial innovation. The innovation is the SPDR Gold Trust exchange-traded fund (Tic: GLD), which is the first bullion-backed exchange-traded fund introduced in the US market. GLD holds physical gold, and provides traders with a convenient and cost-effective way to gain exposure to gold. Using a sample of gold company stocks traded in the US market when GLD was introduced, we find that the introduction of GLD caused the liquidity of gold company stocks to decline, and their adverse-selection risk to increase. Over the two-month period after GLD's introduction, the stocks' relative effective bid-ask spreads increased by more than 15%, while their adverse-selection cost, as measured by the price impact of trades, went up by over 30%. Their trading volume (both in terms of shares and dollars) also significantly declined. The findings support the argument that GLD, being a less information-sensitive security, attracted traders, especially uninformed traders, away from gold company stocks.

We also find that gold company stocks significantly underperformed the benchmark after GLD started trading. On average, the stocks' abnormal returns were about –12% during the first
month. The findings are consistent with the argument that the stocks\' demand curves are downward-sloping. The migration of trading activities to GLD represented negative demand shocks to the stocks, which caused their demand curves to shift inward and prices to decline. The findings are also consistent with the argument that as gold stocks became less liquid and thus were more costly to trade (due to higher bid-ask spreads), investors required higher expected returns to compensate themselves for the higher costs. Our further test provides support for both explanations, but especially the former.

Taken together, our results indicate that the introduction of a new security can have a serious adverse impact on related existing securities. Our findings provide evidence from a new context to the empirical literature on the market impact of financial innovation, which typically concentrates on the effects of options and futures contracts on their underlying securities.

The observed decrease in gold stocks' liquidity is in contrast to the results reported in studies on the effects of index ETFs on their constituent stocks. We believe that this is due to the fact that GLD attracted traders away from gold company stocks, while index ETFs needed to trade the constituent stocks.

Our results also contribute to the recently emerging literature on the financialization of commodities. So far, there are a few studies in this literature that look at the effects of the financialization on the prices and return dynamics of other related assets. Our findings show that the financialization of commodities can have a negative effect on the stocks of commodity companies if the new securities attract investors away from the stocks.

Finally, our results provide supporting evidence to the hypothesis that demand curves for stocks slope down and thus changes in demand can affect asset prices.
Appendix

This appendix contains formal definitions of some of the trading-activity measures and liquidity measures used in this paper.

1. Relative Trading Volume ($RTV$):

For each day, we calculate stock $i$'s relative trading volume ($RTV_i$) as follows:

$$RTV_i = \frac{TV_i}{\sum_{i=1}^{I} \frac{1}{I} \times TV_i SHARE_i}$$

where $TV_i$ is stock $i$'s trading volume for that day and $SHARE_i$ is stock $i$'s number of shares outstanding on the same day.

2. Sell-vs-Buy Volume Ratio:

For each day, we calculate stock $i$'s sell-vs-buy volume ratio as the ratio between seller-initiated trading volume and buyer-initiated trading volume, where trades are classified as sells or buys using the algorithm developed by Lee and Ready (1991). Specifically, we match each trade with the most recent quote that occurred at least five seconds before the trade time stamp on the same day. Trades are classified as buys (sells) if they occur above (below) the mid-point of the bid and ask quotes.
3. Effective Spread (ES):

The daily effective spread (ES) is the volume-weighted average of twice the absolute difference between the trade price and mid-point of the quote at the time of the trade:

$$ES = \frac{2 \times \sum_{j=1}^{n} |P_j - Mid_j| \times Q_j}{\sum_{j=1}^{n} Q_j},$$

(A2)

where $P_j$ is the $j$th trade of the day, $Mid_j$ is the mid-point between the best bid and the best ask quotes associated with trade $j$ (i.e., $0.5 \times ASK_j + 0.5 \times BID_j$), and $Q_j$ is the number of shares traded in trade $j$.

4. Relative Effective Spread (RES):

Relative effective spread (RES) is effective spread expressed as a percentage of the mid-point of the quote. The relative effective spreads are then volume-weighted for each day.

$$RES = \frac{2 \times \sum_{j=1}^{n} |P_j - Mid_j|/Mid_j \times Q_j}{\sum_{j=1}^{n} Q_j},$$

(A3)

where $P_j$, $Mid_j$ and $Q_j$ are as defined above.

5. Trade Depth (DEP):

Trade depth (DEP) is defined as the equally weighted average of the depths during a trading day and we calculate the depths in both share term (DEP_SHARE) and dollar term (DEP_DOLLAR):
\[ \text{DEP\_SHARE} = \frac{\sum_{j=1}^{n} (\text{ASK\_SHARE}_j + \text{BID\_SHARE}_j)}{n}, \]  
(A4)

\[ \text{DEP\_DOLLAR} = \frac{\sum_{j=1}^{n} (\text{ASK}_j \times \text{ASK\_SHARE}_j + \text{BID}_j \times \text{BID\_SHARE}_j)}{n}, \]  
(A5)

where \( \text{ASK\_SHARE}_j \) is the number of shares at best \( \text{ASK}_j \) and \( \text{BID\_SHARE}_j \) is the number of shares at best \( \text{BID}_j \).
References


Table 1: Summary statistics
Table 1 provides summary statistics for sample firms. It contains the means, standard deviations, maximums, 75th percentiles, medians, 25th percentiles and minimums of the firm characteristics for sample firms. The following are firm characteristic descriptions. Market Cap is the product of the stock's closing price and number of shares outstanding. Gold Correlation is the correlation between the daily returns on gold company stocks and the daily returns on gold. Market Correlation is the correlation between the daily returns on gold company stocks and the daily returns on the CRSP value-weighted market index. The period used to calculate the correlations is three months ending ten trading days before our event window. Price is the closing prices of gold company stocks. Number of Trades is the total number of trades between 9:30 A.M. and 4:00 P.M. of the day. Trading Volume is the total number of trading volume between 9:30 A.M. and 4:00 P.M. of the day. Statistics of Market Cap, Price, Number of Trades and Trading Volume are based on data as of November 1, 2004.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std</th>
<th>Max</th>
<th>P75</th>
<th>Median</th>
<th>P25</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Cap ($ 000s)</td>
<td>1,409,895</td>
<td>2,478,716</td>
<td>11,628,214</td>
<td>1,424,578</td>
<td>653,888</td>
<td>127,598</td>
<td>51,748</td>
</tr>
<tr>
<td>Gold Correlation</td>
<td>0.516</td>
<td>0.097</td>
<td>0.680</td>
<td>0.588</td>
<td>0.507</td>
<td>0.453</td>
<td>0.297</td>
</tr>
<tr>
<td>Market Correlation</td>
<td>0.264</td>
<td>0.164</td>
<td>0.663</td>
<td>0.394</td>
<td>0.262</td>
<td>0.154</td>
<td>-0.057</td>
</tr>
<tr>
<td>Price ($)</td>
<td>8.228</td>
<td>9.649</td>
<td>36.810</td>
<td>12.775</td>
<td>3.755</td>
<td>1.575</td>
<td>0.690</td>
</tr>
<tr>
<td>Num of Trades</td>
<td>694.9</td>
<td>782.5</td>
<td>3059.0</td>
<td>1237.5</td>
<td>288.0</td>
<td>97.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Trading Volume (shares)</td>
<td>768,194</td>
<td>876,685</td>
<td>3,543,200</td>
<td>1,060,800</td>
<td>450,850</td>
<td>175,950</td>
<td>2,900</td>
</tr>
</tbody>
</table>
Table 2: Changes in trading characteristics and liquidity measures

Table 2 reports the mean (across firms) and median values of trading characteristics (Panel A) and liquidity measures (Panel B) in the pre-GLD period and the post-GLD period. It also contains the mean and median values of the Post/Pre ratios of these measures, and the Student's t and signed rank test results of whether the ratios equal unity. Relative Trading Volume is the ratio between (i) the stock's normalized trading volume (i.e., number of shares traded divided by the stock's number of shares outstanding) and (ii) the equally-weighted normalized trading volume of all stocks traded on the NYSE and AMEX on the same day; Sell-vs-Buy Volume Ratio is the ratio between seller-initiated trading volume and buyer-initiated trading volume; Effective Spread is defined as twice the absolute difference between the trade price and mid-point of the bid-ask quote at the time of the trade; Relative Effective Spread is effective spread expressed as a percentage of the mid-point of the quote. For each day, we volume-weight effective spreads and relative effective spreads, where the weights are the number of shares in each trade during the day; Trade Depth (in shares) and Trade Depth (in dollars) are the equally weighted average daily depths in share term and dollar term respectively. The symbols ***, **, and * denote significance at the 1, 5, and 10 percent levels respectively.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of Trades</th>
<th>Trading Volume (shares)</th>
<th>Trading Volume ($)</th>
<th>Relative Trading Volume</th>
<th>Sell-vs-Buy Volume Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Pre</td>
<td>778.7</td>
<td>904,398</td>
<td>10,257,464</td>
<td>1.066</td>
<td>1.398</td>
</tr>
<tr>
<td>Mean Post</td>
<td>755.0</td>
<td>792,158</td>
<td>8,695,316</td>
<td>0.817</td>
<td>1.415</td>
</tr>
<tr>
<td>Median Pre</td>
<td>341.6</td>
<td>557,184</td>
<td>2,085,137</td>
<td>0.787</td>
<td>0.983</td>
</tr>
<tr>
<td>Median Post</td>
<td>298.6</td>
<td>470,803</td>
<td>1,392,461</td>
<td>0.606</td>
<td>1.066</td>
</tr>
<tr>
<td>Post/Pre Ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.940*</td>
<td>0.881**</td>
<td>0.855**</td>
<td>0.812***</td>
<td>1.095**</td>
</tr>
<tr>
<td>Median</td>
<td>0.921**</td>
<td>0.852***</td>
<td>0.827***</td>
<td>0.785***</td>
<td>1.111**</td>
</tr>
<tr>
<td>Proportion &gt; 1</td>
<td>44.44%</td>
<td>19.44%</td>
<td>27.78%</td>
<td>13.89%</td>
<td>66.67%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Effective Spread (cents)</th>
<th>Relative Effective Spread (%)</th>
<th>Trade Depth (00 shares)</th>
<th>Trade Depth ($ 00)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Pre</td>
<td>2.117</td>
<td>0.73</td>
<td>156.78</td>
<td>540.53</td>
</tr>
<tr>
<td>Mean Post</td>
<td>2.329</td>
<td>0.77</td>
<td>165.41</td>
<td>507.98</td>
</tr>
<tr>
<td>Median Pre</td>
<td>1.886</td>
<td>0.49</td>
<td>72.97</td>
<td>408.04</td>
</tr>
<tr>
<td>Median Post</td>
<td>2.127</td>
<td>0.58</td>
<td>65.72</td>
<td>366.21</td>
</tr>
<tr>
<td>Post/Pre Ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>1.103***</td>
<td>1.157***</td>
<td>0.974</td>
<td>0.925*</td>
</tr>
<tr>
<td>Median</td>
<td>1.059***</td>
<td>1.174***</td>
<td>0.941</td>
<td>0.870**</td>
</tr>
<tr>
<td>Proportion &gt; 1</td>
<td>72.22%</td>
<td>80.56%</td>
<td>36.11%</td>
<td>33.33%</td>
</tr>
</tbody>
</table>
Table 3: Multivariate analysis of changes in the bid-ask spreads of gold company stocks

Table 3 provides the results of the multivariate analysis of changes in the bid-ask spreads of gold company stocks. The dependent variables are Ln ES and Ln RES. The independent variables are Ln Volume, Ln Std and Ln Price. The following are the variable descriptions: Ln ES and Ln RES are the natural logarithm of effective spread and relative effective spread respectively. Ln Volume is the natural logarithm of trading volume. Ln Std is the natural logarithm of standard deviation of daily returns, calculated using the approach in Parkinson (1980). Ln Price is the natural logarithm of closing price. Dummy is a dummy variable that takes a value of 1 in the post-GLD period and 0 in the pre-GLD period. The sample period is thirty-four trading days ending ten trading days before the introduction of GLD and thirty-four trading days starting ten trading days after the introduction of GLD. For each variable, the coefficient (standard error) is reported. The symbols ***, **, and * denote significance at the 1, 5, and 10 percent levels respectively.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Newey-West</th>
<th>Kmenta</th>
<th>Driscoll and Kraay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ln ES</td>
<td>Ln RES</td>
<td>Ln ES</td>
</tr>
<tr>
<td>Intercept</td>
<td>-0.552***</td>
<td>-0.535***</td>
<td>-0.836***</td>
</tr>
<tr>
<td></td>
<td>(0.110)</td>
<td>(0.109)</td>
<td>(0.063)</td>
</tr>
<tr>
<td>Dummy</td>
<td>0.060***</td>
<td>0.059***</td>
<td>0.071***</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.012)</td>
</tr>
<tr>
<td>LnVolume</td>
<td>-0.204***</td>
<td>-0.204***</td>
<td>-0.192***</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Ln Std</td>
<td>0.345***</td>
<td>0.349***</td>
<td>0.306***</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.018)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Ln Price</td>
<td>0.367***</td>
<td>-0.633***</td>
<td>0.351***</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>N</td>
<td>2438</td>
<td>2438</td>
<td>2244</td>
</tr>
</tbody>
</table>
Table 4: Changes in spread components
Table 4 provides the estimates of bid-ask spread components during the pre-GLD period and the post-GLD period. It contains the means and medians of the relevant measures, their Post/Pre ratios, and the Student’s t and signed rank test results of whether the ratios equal unity. Panel A and Panel B provide the estimates of spread components based on the Madhavan, Richardson and Romans (1997) approach and the Huang and Stoll (1996) approach respectively. The following are the variable descriptions: MRR RES is the estimated relative effective spread. $\phi$ and $\theta$ are the non-information and the adverse-selection components of spreads respectively. MRR RES, $\phi$ and $\theta$ are based on the Madhavan, Richardson and Romans (1997) approach, and are in percentage term. RRS is relative realized spread. Price impact is the difference between relative effective spread and relative realized spread. RRS and price impact are based on Huang and Stoll (1996), and are in percentage term. All other variables are as defined in Table 2. The symbols ***, **, and * denote significance at the 1, 5, and 10 percent levels respectively.

Panel A:

<table>
<thead>
<tr>
<th>Variable</th>
<th>MRR RES (%)</th>
<th>$\phi$ (%)</th>
<th>$\theta$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Pre</td>
<td>0.40</td>
<td>0.16</td>
<td>0.09</td>
</tr>
<tr>
<td>Mean Post</td>
<td>0.42</td>
<td>0.17</td>
<td>0.10</td>
</tr>
<tr>
<td>Median Pre</td>
<td>0.32</td>
<td>0.13</td>
<td>0.05</td>
</tr>
<tr>
<td>Median Post</td>
<td>0.32</td>
<td>0.13</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Post/Pre Ratio

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Proportion &gt; 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.069***</td>
<td>1.064</td>
<td>1.097*</td>
</tr>
<tr>
<td>Median</td>
<td>1.092**</td>
<td>1.094</td>
<td>1.099*</td>
</tr>
<tr>
<td>Proportion &gt; 1</td>
<td>69.44%</td>
<td>55.56%</td>
<td>66.67%</td>
</tr>
</tbody>
</table>

Panel B:

<table>
<thead>
<tr>
<th>Variable</th>
<th>RES (%)</th>
<th>RRS (%)</th>
<th>Price Impact (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Pre</td>
<td>0.73</td>
<td>0.31</td>
<td>0.43</td>
</tr>
<tr>
<td>Mean Post</td>
<td>0.77</td>
<td>0.33</td>
<td>0.45</td>
</tr>
<tr>
<td>Median Pre</td>
<td>0.49</td>
<td>0.23</td>
<td>0.28</td>
</tr>
<tr>
<td>Median Post</td>
<td>0.58</td>
<td>0.22</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Post/Pre Ratio

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Proportion &gt; 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.157***</td>
<td>1.170</td>
<td>1.334***</td>
</tr>
<tr>
<td>Median</td>
<td>1.174***</td>
<td>1.045</td>
<td>1.230***</td>
</tr>
<tr>
<td>Proportion &gt; 1</td>
<td>80.56%</td>
<td>55.56%</td>
<td>66.67%</td>
</tr>
</tbody>
</table>
Table 5: Comparison of trading-activity and liquidity measures between GLD and gold company stocks

Table 5 provides the results of the comparison of the trading-activity and liquidity measures between GLD gold company stocks. The sample period is thirty-four trading days, starting ten trading days after the introduction of GLD. All variables are as defined in Table 2. Dif is the difference in the daily value of the measures between GLD and gold company stocks. Student’s t and signed rank test results of whether Dif equals zero are also provided. The symbols ***, **, and * denote significance at the 1, 5, and 10 percent levels respectively.

<table>
<thead>
<tr>
<th>Panel A:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>GLD</td>
<td>Stock</td>
<td>Dif</td>
</tr>
<tr>
<td>Number of Trades</td>
<td>Mean</td>
<td>1,240.6</td>
<td>755.0</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>1,013.5</td>
<td>719.1</td>
</tr>
<tr>
<td>Trading Volume (shares)</td>
<td>Mean</td>
<td>2,121,979</td>
<td>792,158</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>1,818,950</td>
<td>727,404</td>
</tr>
<tr>
<td>Trading Volume ($)</td>
<td>Mean</td>
<td>92,253,022</td>
<td>8,695,316</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>78,848,571</td>
<td>8,383,350</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>GLD</td>
<td>Stock</td>
<td>Dif</td>
</tr>
<tr>
<td>Effective Spread (cents)</td>
<td>Mean</td>
<td>2.120</td>
<td>2.330</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>2.090</td>
<td>2.240</td>
</tr>
<tr>
<td>Relative Effective Spread (%)</td>
<td>Mean</td>
<td>0.05</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>0.05</td>
<td>0.73</td>
</tr>
<tr>
<td>Trade Depth (00 shares)</td>
<td>Mean</td>
<td>77.96</td>
<td>165.41</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>73.98</td>
<td>164.55</td>
</tr>
<tr>
<td>Trade Depth ($ 00)</td>
<td>Mean</td>
<td>3,391.70</td>
<td>507.98</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>3,183.00</td>
<td>519.74</td>
</tr>
</tbody>
</table>
Table 6: Comparison of spread components between GLD and gold company stocks
Table 6 provides the results of comparison of spread components between GLD and gold company stocks. The sample period is thirty-four days starting ten trading days after the introduction of GLD. All variables are defined in Table 4. Dif is defined as the difference in the values of the variables between GLD and gold company stocks. Student’s t and signed rank test results of whether Dif equals zero are also provided. The symbols ***, **, and * denote significance at the 1, 5, and 10 percent levels respectively.

<table>
<thead>
<tr>
<th>Panel A:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>φ (%)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>θ (%)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>RRS (%)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Price Impact (%)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Table 7: Cumulative abnormal returns
Table 7 reports the regression results of equation (6) and cumulative abnormal returns computed based on the results. CAR ($T_1, T_2$) denotes the cumulative abnormal return from day $T_1$ to day $T_2$ relative to the GLD introduction day (day 0). It is the sum of the values of corresponding dummy variable coefficients obtained from the regression’s results. For the regression, $t$-test results are reported and standard deviations of the coefficients are in parentheses. For the CAR test, $F$-test results are reported and $F$-value is in parentheses. The symbols ***, **, and * denote significance at the 1, 5, and 10 percent levels respectively.

<table>
<thead>
<tr>
<th>Abnormal Return Regression</th>
<th>CAR Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
</tr>
<tr>
<td></td>
<td>Sums of $\hat{\lambda}_i$</td>
</tr>
<tr>
<td></td>
<td>CAR (-10,-1)</td>
</tr>
<tr>
<td></td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
</tr>
<tr>
<td>Contemporaneous Market Return</td>
<td>0.540**</td>
</tr>
<tr>
<td></td>
<td>(0.241)</td>
</tr>
<tr>
<td>Lagged Market Return</td>
<td>-0.384**</td>
</tr>
<tr>
<td></td>
<td>(0.190)</td>
</tr>
<tr>
<td>Leading Market Return</td>
<td>-0.007</td>
</tr>
<tr>
<td></td>
<td>(0.181)</td>
</tr>
<tr>
<td>Contemporaneous Gold Return</td>
<td>1.771***</td>
</tr>
<tr>
<td></td>
<td>(0.149)</td>
</tr>
<tr>
<td>Lagged Gold Return</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td>(0.152)</td>
</tr>
<tr>
<td>Leading Gold Return</td>
<td>0.295*</td>
</tr>
<tr>
<td></td>
<td>(0.155)</td>
</tr>
<tr>
<td>SMB</td>
<td>0.055</td>
</tr>
<tr>
<td></td>
<td>(0.343)</td>
</tr>
<tr>
<td>HML</td>
<td>0.496</td>
</tr>
<tr>
<td></td>
<td>(0.518)</td>
</tr>
<tr>
<td>UMD</td>
<td>0.679*</td>
</tr>
<tr>
<td></td>
<td>(0.354)</td>
</tr>
<tr>
<td>$D_0$</td>
<td>-0.019*</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
</tr>
<tr>
<td>$D_i$ ($i \neq 0$)</td>
<td>Yes</td>
</tr>
<tr>
<td>$N$</td>
<td>125</td>
</tr>
<tr>
<td>adj. $R^2$</td>
<td>0.695</td>
</tr>
</tbody>
</table>
Table 8: Multivariate analysis of abnormal returns
Table 8 provides the results of a multivariate analysis of gold company stocks' abnormal returns. The dependent variables are the stocks' abnormal returns on the introduction day of GLD (AR (0)) and the one-month cumulative abnormal returns since GLD’s introduction, (CAR (0, 22)). The independent variables are the arbitrage risk measure (ARM), and the Post/Pre ratios of sell-vs-buy volume ratio, RES and $\theta$. To estimate ARM, we first regress the daily excess returns of the gold company stock on the daily market excess returns over a 3-month period ending 10 trading days before the GLD introduction date. ARM is defined as the standard deviation of the residuals from the regression. All other variables are as defined in Table 2 and Table 4. For each variable, the coefficient (White's heteroscedasticity-consistent standard error) is reported. The symbols ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

<table>
<thead>
<tr>
<th></th>
<th>(1) AR (0)</th>
<th>(2) AR(0)</th>
<th>(3) CAR (0,22)</th>
<th>(4) CAR (0,22)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.130***</td>
<td>0.093***</td>
<td>-0.064</td>
<td>0.090</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.027)</td>
<td>(0.140)</td>
<td>(0.091)</td>
</tr>
<tr>
<td>ARM</td>
<td>-0.715*</td>
<td>-0.263</td>
<td>0.403</td>
<td>-0.284</td>
</tr>
<tr>
<td></td>
<td>(0.373)</td>
<td>(0.403)</td>
<td>(1.881)</td>
<td>(1.656)</td>
</tr>
<tr>
<td>Post/Pre Ratio</td>
<td>-0.029*</td>
<td>-0.049***</td>
<td>-0.123**</td>
<td>-0.123**</td>
</tr>
<tr>
<td>(sell-vs-buy volume ratio)</td>
<td>(0.017)</td>
<td>(0.016)</td>
<td>(0.056)</td>
<td>(0.052)</td>
</tr>
<tr>
<td>Post/Pre (RES)</td>
<td>-0.082***</td>
<td></td>
<td>0.055</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td></td>
<td>(0.078)</td>
<td></td>
</tr>
<tr>
<td>Post/Pre ($\theta$)</td>
<td></td>
<td>-0.047***</td>
<td>-0.066</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.017)</td>
<td>(0.069)</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>adj. $R^2$</td>
<td>0.371</td>
<td>0.288</td>
<td>0.066</td>
<td>0.094</td>
</tr>
</tbody>
</table>
Figure 1: Cumulative abnormal returns of portfolio of gold stocks

Figure 1 plots the CAR of the portfolio of gold stocks; i.e., CAR \((-10, T_2)\) for \(T_2 = -10\) to \(T_2 = +22\). The CARs are computed based on regression results of equation (6).