

The Relationship between Monetary Policy and Asset Prices

A New Approach Analyzing U.S. M&A Activity

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Abstract

This article details the relationship between asset prices and monetary policy with a specific focus on the mergers and acquisitions market. The existing literature has studied extensively the link between monetary policy and stock prices and housing prices, but has not analyzed other assets, such as MA transactions. Monetary policy theory suggest that a negative shock to monetary policy that lowers interest rates increases asset prices. A lower interest rate decreases the cost of borrowing, raises investment levels (say for firms or home-buyers), and thus raises the asset price. Using a VAR methodology, the empirical evidence in this study, however, does not find this relationship between monetary policy shocks and MA activity. The response of MA activity – measured by average EBITDA multiple and the number of transactions – does not respond inversely to shocks in monetary policy.

Black Tuesday, the infamous Wall Street Crash of 1929, triggered the Great Depression, the most severe global recession since before the Industrial Revolution. The Great Depression began with this devastating drop in the asset prices of companies. Unfortunately, the Federal Reserve made critical errors in judgment and in philosophy that severely worsened the Great Depression for years. Since then, scholars have been better able to understand monetary policy, including its relationship with asset prices. In these efforts, scholars and monetary policymakers have hoped to avoid the consequences that can result from asset price crashes and even possibly prevent such crashes in the

¹I would like to recognize several individuals who enabled me to complete this project. First, I wish to extend appreciation to Agata Rakowski and Dealogic who provided the data on U.S. M&A activity. Also, my professional experience as an investment banking analyst with Robert W. Baird & Co. developed my understanding of the M&A market. I am thankful for the constant support of the University of Notre Dame's Department of Economics, especially Professors Michael Mogavero and Mary Flannery. Finally, I owe a heartfelt thanks to Professor Timothy Fuerst. His comments and whistling were an invaluable resource in this process. Indeed, I am forever grateful for the opportunity to learn under the Whistling Professor.

first place. On Milton Friedman's 90th birthday, former Federal Reserve Chairman Ben Bernanke famously commemorated Friedman's scholarship in this field. Bernanke (2002) concluded his remarks to Friedman and the birthday party attendees stating, "Regarding the Great Depression, you're right, we [the Federal Reserve] did it. We're very sorry. But thanks to you, we won't do it again."

Just a few years later while testifying in front of Congress during his nomination to become Chairman, Bernanke falsely observed that no housing bubble existed to burst, noting that asset price increases in the housing market "largely reflect strong economic fundamentals" (Henderson 2005). Former Chairman Alan Greenspan suggested the housing price increases were merely "froth" in local markets (Henderson 2005). To the dismay of both chairmen, there was indeed a housing bubble and it collapsed. Combined with excessive risk taken by banks and financial institutions in the subprime lending market, the Great Recession resulted. Unlike the Great Depression, this time the Federal Reserve, under Bernanke's guidance, took enormous steps to provide liquidity, be a lender of last resort, and constantly strive to stabilize financial conditions. Although not perfect, most scholars would agree that the Fed's efforts were commendable and often ingenious during the Great Recession.

I provide this brief history of the two worst economic downturns in U.S. history to exemplify the important relationship between monetary policy and asset prices. In the Great Depression, falling stock prices were the trigger; in the Great Recession, housing prices took this role. It may not be practical to expect the Fed to prevent such collapses, but in the very least, an optimal response is required to minimize the potentially disastrous outcomes. However, the academic literature has so far only studied stock prices and housing prices. I argue that, just as housing prices were far off the radar of policy makers and scholars before the 2006-2007 collapse, other assets may be equally troubling in future downturns. The core aim of this paper is to extend the literature beyond stock prices and housing prices and consider the relationship between monetary policy and a third asset class – mergers and acquisitions ("M&A"). M&A activity is an enormous market, totaling more than 14,000 transactions in 2012 alone with an average transaction size over \$200 million. This is not meant to be a prediction for the next recession, although the possibility certainly exists. In the very least, understanding the relationship between monetary policy and asset prices more broadly is a critical task that can benefit schol-

ars and policymakers.

With this aim in mind, the article will progress as follows. In Section I, I present an extensive literature review covering monetary policy as it relates to asset prices. Section II presents the Asset Price Channel, a hypothesis based on existing literature that conceptually explains the potential relationship between asset prices and monetary policy. Next, Section III applies this hypothesis to M&A activity specifically and then presents a discussion on M&A valuation and why this asset type is relevant to include in the monetary policy literature. Section IV and V describe the data along with the methodology for forming a model to test the Asset Price Channel. The data includes basic Taylor rule variables, the Federal Funds Rate (“FFR”), the ten-year Treasury rate, and M&A metrics including the number of transactions and the average EBITDA multiple. Section VI presents the results from the described models, showing no evidence to support the Asset Price Channel, contradicting the existing literature that studies stock prices and the housing market.

I. Literature Review Summaries

In this literature review, I discuss several topics concerning asset prices and monetary policy. First, scholars are divided on whether optimal policy rules should include asset prices. Related to this, empirical studies have examined both whether asset prices respond to monetary policy and whether monetary policy responds to asset prices. I also briefly review articles that link foreign asset prices with domestic monetary policy. Throughout this literature review, I emphasize that economists have only studies asset prices and monetary policy with housing prices and stock prices. Economists have not linked monetary policy to other asset classes, including M&A activity which is the focus of this article.²

Cecchetti et al. (2000) outlines a scenario in which asset price misalignments create undesirable instability in inflation and employment. In other words, booms cause busts, and busts are harmful to the macroeconomy. Considering historical cases of asset booms, the authors then

²By using Google Scholar and the University of Notre Dame’s OneSearch for academic literature, I was unable to find any articles directly addressing M&A and monetary policy.

consider what steps central banks can take to avoid these pitfalls.³ The authors advocate a “lean against the wind” strategy where central banks respond to booms by increasing the interest rate in order to counter rising asset prices and dampen boom-bust cycles.⁴ This strategy includes asset prices in the policy rule to best stabilize inflation and output.

By examining forward-looking structural models of G7 economies from 1972 to 1998, Goodhart and Hofmann (2000) similarly contend that a monetary policy rule excluding asset price movements increases inflation and output gap variability because the information contained in asset prices is useful in forecasting future demand conditions. Bordo and Jeanne (2002) consider a stylized boom-bust dynamic model in stock and property prices. The thought experiment discusses the role of pre-emptive monetary policy. This sort of *ex ante* policy differs from policy rules that respond to an asset price bust only *ex post*, like an inflation-targeting rule. By compare moving averages of asset prices in OECD countries from 1970 to 2001, the analysis identified twenty-four stock booms and twenty housing booms.⁵ The authors contend that a response to asset prices restricts monetary policy during a boom and is insurance against the risk of real disruption induced by the potential for a bust or even a moderate asset price reversal. In this way, they favor a policy rule that includes asset prices in order to yield tighter monetary policy *ex ante* before a boom develops.

Several scholars, however, hold the view that policy rules including asset prices yield sub-optimal results. Bernanke and Gertler (2001) evaluate a standard new-Keynesian model while also incorporating informational friction in credit markets. The model then simulates a shock of a five-period increase in the nonfundamental component of stock prices followed by a bust in the sixth period. The results show that an aggressive inflation-targeting rule dominates accommodative approaches in reducing both inflation and output variability. Placing a weight on stock prices does help marginally, but Bernanke and Gertler conclude this is not the optimal policy because of the practical

³The cases include the 1929 stock market crash, the 1980s housing and equity bubble in Tokyo, and the late 1990s crises in Southeast Asian equity and currency markets

⁴To clarify, the authors do not recommend that central banks should burst bubbles once they form as this could still lead to disastrous outcomes. Rather, they advocate for monetary policy that works to prevent bubbles from forming in the first place.

⁵This study diverges slightly from other analyses in that they consider optimal policy not only for busts but also more moderate asset price reversals following booms.

difficulties in separating fundamental from non-fundamental movements in stock prices.⁶ Ultimately, the practical difficulties outweigh the marginal gains in policy outcomes. Carlstrom and Fuerst (2007) consider the inclusion of asset prices in monetary policy in a model with either sticky prices or sticky wages. A central bank response to share prices in the case of sticky wages does yield optimal policy because firm profits and share prices move positively with inflation. However, in a model with sticky prices, a central bank responding to share prices implicitly weakens its overall response to inflation because increases in inflation tend to lower firm profits, leading to sub-optimal monetary policy. The authors conclude that, because of the sticky price model, monetary policy rules should not include asset prices.

Gilchrist and Leahy (2002) assess large movements in asset prices in the United States and Japan from the 1970s through the 1990s. Using this data, they consider various shocks to the economy, including asset price busts. They conclude that weak inflation targets produce huge swings in output. Regardless of including asset prices in the policy rule, this empirical study concludes that aggressive inflation-targeting yields the optimal outcome. Filardo (2000) employs a framework outlined by former Bank of England member Charles Goodhart that proposed policy rules that include broad measures of housing and stock prices. He dismisses this approach, primarily because of the difficulty in identifying the signs of nonfundamental movements in asset prices. Filardo illustrates that erroneous identification of price bubbles has significant unintended consequences that harm economic outcomes.⁷ Even without this difficulty, he concludes that including asset prices has little impact in improving policy outcomes.

The corollary question asks whether asset prices respond to monetary policy. Bernanke and Kuttner (2005) conducted an event-study analysis by looking at daily data from FOMC decisions from 1989 to 2002 and tracking the movement in stock prices in response to monetary policy shocks. Using several modeling techniques, such as VAR forecasts, Bernanke and Kuttner conclude that an unexpected 25-basis-point cut to the Federal Funds Rate leads to a 1% increase in stock indexes on that same day. Rigobon and Sack (2004) use a VAR model

⁶This is the same critique that Cecchetti et al. considered, but then dismissed.

⁷As many of the critics have noted, identifying bubbles is no easy task. Recall that, even as late as 2005, Bernanke and the majority of central bankers did not realize the existence or extent of the housing bubble.

that employs an identification technique through heteroskedasticity. Examining the Dow Jones Industrial Average, SP 500, the Nasdaq, and the Wilshire 5000 from 1994 to 2001, these authors find very similar results to the Bernanke and Kuttner analysis. For example, an unanticipated 25-basis point increase in the short-term interest rate results in a 1.7% decline in the S&P 500.

Laevan and Tong (2012) take a deeper look at this question by examining varying responses by different types of firms. There should be variance among firms – those more dependent on external financing should have larger swings in stock prices due to a monetary policy shock. The data examines 20,121 firms across forty-four countries, with the average response of stock prices roughly 4:1 from an unexpected change in interest rates.⁸ Firms are then classified as either dependent or (relatively) independent on external financing, interacting this variable with the monetary policy shock. Indeed, firms more dependent on external financing are disproportionately affected.

Prior to the housing price collapse beginning in 2006 that triggered the Great Recession, economists did not consider the damage that could be caused or triggered by a housing bubble. Several scholars and commentators have criticized that then-Chairman Alan Greenspan kept interest rates too low for too long leading up to the collapse of the bubble, allowing for easy lending and an increased demand for housing. According to this reason, the low interest rates fueled the bubble and allowed the housing market to overheat before eventually collapsing. From 2002 to 2006, the Federal Funds Rate was roughly 200 basis points below what the Taylor rule would have prescribed for policy makers. However, Bernanke (2010) has since argued that this thinking is flawed for several reasons. First, he states that the applicable Taylor rule looks at expected future inflation, not current inflation. The interest rates were on par with this revised monetary policy rule and were not too low. Bernanke also observes that the surge in housing prices began in 1998, implying that the timing of the start of the housing bubble rules out the period when interest rates were arguably too low (first in 2002 through 2006). Iacoviello (2005) similarly estimated a monetary business cycle that includes the housing market. By imposing collateral and borrowing constraints and simulating demand shocks on the housing market of nominal loans, he finds that “allowing the monetary authority to respond to asset prices

⁸It is generally assumed that the current inflation target of the Fed is approximately 2%.

yields negligible gains in terms of output and inflation stabilization.” Other scholars disagree and believe the Fed should have acted otherwise. Taylor (2007) observes that monetary policy responded more effectively to inflation in the 1980s and 1990s and reduced boom-bust cycles in the housing market. He then claims that the Federal Reserve deviated from this previous action beginning in 2002. Using a counterfactual model of the housing market, he contends that the loose monetary policy failed to minimize the housing bubble and may have been a causal force in the rise of the housing bubble.

Just as they answered whether asset prices respond to monetary policy, Rigobon and Sack (2003) also study the reverse – the reaction of monetary policy to stock markets. According to the authors, stock markets have a significant impact on the macroeconomy primarily through the influence on aggregate consumption and the cost of financing to businesses. These effects play into the calculus of central bankers. Using the same VAR model from before, Rigobon and Sack establish an identification technique based on the heteroskedasticity of stock market returns. They conclude that a five percent rise in the S&P 500 increases the likelihood of a 25 basis point tightening by about one half. Bohl et al. (2007) study this same question by looking at the Bundesbank, tracking stock prices and interest rates in Germany from 1985 to 1998. Contrary to the evidence that Rigobon and Sack found in the U.S., the results in this study show that the Bundesbank did not respond to movements in stock prices, with one possible exception to the stock market crash of 1987. Bohl et al. states that “the theoretical rationale linking central bank reactions to asset prices is not yet sufficiently well developed to provide definite guidance.”

Erlor et al. (2013) analyze the real estate boom leading up to the Great Recession to determine if monetary policy responds to real estate asset prices. They set up a GMM model using real estate market data from 1980 to 2007 and then approximate both a Taylor rule and a Taylor-type rule with asset prices as possible monetary policy responses. The authors found a statistically significant negative response to real estate asset prices including a real estate dummy variable. In other words, the Fed actually lowered interest rates in the presence of a real estate boom, contrary to a “lean against the wind” strategy.

A related topic that several scholars have addressed is the relationship between domestic monetary policy and foreign asset prices, both if foreign asset prices respond to domestic policy and vice versa. Ida

(2011) examines a theoretical New Keynesian model to determine optimal monetary policy rules in an open economy. For simplicity, the model illustrates a two-country sticky price world. In this scenario, a positive foreign productivity shock leads to an increase in foreign asset prices. Assuming an open economy, this leads to increases in both foreign and domestic consumption. Ida argues that this increased consumption raises domestic asset prices despite no change to the fundamental values of domestic producers, creating a price bubble. This creates an opportunity for central bankers to consider this type of bubble when setting interest rates. Wongswan (2008) addresses this question using empirical evidence from fifteen foreign equity indexes in Asia, Europe, and Latin America with respect to movements in U.S. monetary policy. By observing high-frequency intra-day data on dates of FOMC announcements, he employs a model similar to that of Bernanke and Kuttner. The stock indexes increase between 0.5% and 2.5% with a 25-basis-point cut in the federal funds target rate. This reinforces the inverse relationship between asset prices movements and monetary policy shocks

II. Theoretical Outline of Monetary Policy Effects on Asset Prices

The Fed sets the money supply to a level that achieves a certain interest rate. But, how does the Fed determine the optimal interest rate? According to the Federal Reserve Act, the Fed has a dual mandate to stabilize prices and minimize unemployment (Carlstrom and Fuerst 2012). This simplifies to the objective of limiting the variability of inflation and output. John Taylor famously proposed an econometric model where the interest rate is a function of changes in the price level and changes in output. This has led to the development of various monetary policy rules, known as “Taylor rules.” The most basic Taylor rule is an OLS regression depicted by Equation 1 below (Ball 2011):

$$r = r^n + a_Y \cdot (Y - Y^*) + a_\pi(\pi - \pi^T) \quad (1)$$

where $(Y - Y^*)$ is the output gap with Y being actual output and Y^* is potential output and $(\pi - \pi^T)$ is the inflation gap with π^T being the target inflation.⁹ An important component of the Taylor rule is the

⁹It is generally assumed that the current inflation target of the Fed is approximately 2%.

Taylor Principle, which states that the coefficient α_π should be greater than 1.0. This changes the nominal interest by more than the inflation rate, ensuring that the real interest rate actually adjusts to affect the real economy (David and Leeper 2007).¹⁰

One additional feature regarding the interest rate worth noting is the zero-lower bound on the nominal interest rate set by the Fed. That is, no person would save in exchange for a negative nominal return, but would rather simply hold money. So, the Fed cannot lower the nominal interest rate below zero. The Taylor rule, however, may still imply a negative interest rate. Consider monetary policy with the Taylor rule from Equation 1. Say, actual inflation equals the inflation target so the inflation gap is zero. Then, take $r^n = 1.0$ and $\gamma = 0.5$. If the output gap is large enough (say -3.0), then the Taylor rule will suggest a negative nominal interest rate. Once a central bank reaches the ZLB in this scenario, it may lead to a liquidity trap. The model computes that the interest rate should be further lowered, but this is impossible due to the ZLB. Even worse, monetary policy is now too tight given the optimal response according to the Taylor rule. This further fuels a lack of liquidity and slows down the economy. A vicious circle—known as a liquidity trap—can develop, characterized by low levels of nominal interest rates, economic stagnation and potential deflationary periods (Bullard 2013).

Several examples exist of this ZLB scenario. Japan has been in a liquidity trap at the ZLB for most of the 1990s and is still facing this issue today. Since 2008, the U.S. and several other countries reached the ZLB during the Great Recession and are still challenged by strategies to exist these liquidity traps. As will be discussed later, this makes the FFR irrelevant because an econometric model based on a Taylor rule does not understand the ZLB constraint. Several policies are available to central banks to escape a liquidity trap. These policies including quantitative easing, purchasing long-term assets, and fiscal expansion (Bullard 2007). As an example of recent U.S. policy, the Fed has practiced quantitative easing, or buying long-term assets like mortgage-backed securities, at a rate of \$85B per month. These policy options are often aimed at lowering the long-term real interest rate to provide greater liquidity and induce a robust recovery when the Fed can no longer lower short-term interest rates. For this reason, I contend that

¹⁰Recall the Fisher Equation where the real rate is the difference between the nominal rate and the inflation rate. Thus, to move the real rate, the nominal rate needs to move by a larger amount than the inflation rate movement.

including long-term interest rates in empirical analyses is relevant because the Fed’s policy is no longer solely aimed at the FFR but is also targeting long-term rates such as the 10-year Treasury rate.

Before analyzing the potential effects of monetary policy on asset prices, it is necessary to understand how asset prices are determined. The classical theory of asset prices states that the price of an asset equals the present value of expected asset income (Ball 2011). The “expected” income derives from the rational expectations assumption, that is, people’s expectations of future variables are the best possible forecasts based on all available information. Thus, two variables determine the present value: forecasts of future income and the interest rate to determine present values. Looking at stock price valuation, one can better understand the valuation method of asset prices. The future earnings of a firm flow to stockholders through dividends. Thus, the price of a stock is given by:

$$stockprice = \frac{D_1}{(1+i)} + \frac{D_2}{(1+i)^2} + \frac{D_3}{(1+i)^3} + \dots \quad (2)$$

If the dividends are assumed to be constant, then this becomes a perpetuity valuation where the present value of the stock is:

$$stockprice = \frac{D}{i} \quad (3)$$

Or, as proposed by Myron Gordon, the Gordon growth model theorizes that a stock is determined by an initial expected dividend that is then expected to grow at a constant rate. In this case, the price of a stock is given by:

$$stockprice = \frac{D}{(i-g)} \quad (4)$$

Finally, it is important to understand the relevant interest rate, as it does not necessarily match the FFR, or the interest rate set by the Fed. Rather, $i = i^{safe} + \phi$ where i^{safe} is the risk-free rate, such as the rate on a ten-year Treasury bond, and ϕ is the risk premium of the asset that the owner receives as compensation for bearing the additional risk. Together, i is known as the risk-adjusted interest rate.

Continuing with the valuation of stock prices, it is clear how monetary policy could affect asset prices. Using the Gordon Growth Model,

say $D = \$2$, $i = 0.05$, and $g = 0.01$. The price of the stock equals \$50. Now, let's say the Federal Reserve lowers the interest rate. This can have several transmission effects on the price of this stock. For one, the risk-free rate may decrease. As discussed earlier, the Federal Reserve controls the short-term, nominal rate. However, according to the expectations theory of the term structure, the long-term nominal rate is just the average of expected short term rates. Thus, assume the Fed lowers the interest rate such that the risk-adjusted i decreases to 0.04. In this case, the stock price would rise from \$50 to \$66.67.

Monetary policy could also affect the actual prospects of the firm's future earnings as well. The function for forecasting a firm's future earnings can take on several forms. Parameters may include management ability (M), historical performance (H), projected competitors (C), investments (I), and any number of other factors influencing production (P). Think of this forecast function in the general form of Equation 5 where any number of parameters could be used, but certainly investment is a critical variable.

$$\text{Future Income} = F(M, H, C, I, P) \quad (5)$$

Importantly in this function, investment has a positive effect on future income. Now, consider the function for investment, which includes parameters such as current capital accumulation (K), a productivity factor (Z), and the interest rate (i), given by Equation 6.

$$I = F(K, Z, i) \quad (6)$$

Again, assume the Federal Reserve lowers the interest rate. This in turn makes it cheaper for firms to borrow, thus increasing the firm's level of investment. Feeding Equation 6 into Equation 5, a lower interest rate that increases investment will also increase future income. According to the rational expectations assumption, market participants would include new information such as the Fed's decision to lower the interest rate in forecasting a firm's future earnings. Returning to the stock price example, this could increase D , g , or both. Let's say D increase to \$2.25 and g increases to 0.015 with i still lowered at 0.04. Now, the price of the stock increases further from \$66.67 to \$90. This general example helps illustrate the potential effects of monetary policy on asset prices, a mechanism I will refer to as the Asset Price Channel throughout this essay.

In summary, the Asset Price Channel suggests that a negative shock to the interest rate makes borrowing cheaper. This induces a higher level of investment, raising the growth prospects and, thus, the potential earnings for assets. Because assets have earnings potential over a long-period of time, a cut in the interest rate may also raise asset prices by decreasing the discount rate when determining present values of future earnings. The Asset Price Channel dictates an inverse relationship between shocks in monetary policy and movements in asset prices. Thus, the Asset Price Channel aligns with much of the literature. As Bernanke and Kuttner found, a 25 basis-points cut in the funds rate increased stock prices by about 1%. Likewise, many scholars such as Taylor believe low interest rates can fuel increases in housing prices.

However, the Asset Price Channel may not always hold for several reasons. First, the interest rate set by the Fed may not be a relevant interest rate in the valuation of assets. Above, we assumed that the short-term nominal rate – the FFR – influences both the risk-free rate and the rate at which firms borrow for investment projects. This may not necessarily be true. Again, assume the risk-free rate is the 10-year rate. This is determined by the average of the current 1-year nominal rate and the expectations for the 1-year nominal rates over the next nine years. If this holds, then the current monetary policy decisions of the Fed would only affect the current 1-year nominal rate. In averaging with the next nine years of short-term rates, it is plausible that this has an insignificant effect on the 10-year nominal rate. Likewise, if firms borrow at a rate other than the short-term nominal rate, then monetary policy shock would not necessarily influence firms' growth prospects. By the same reasoning, it is likely that the Fed's control of this short-term nominal rate does not transmit to the rate at which firms' borrow. In this event, the Fed's current monetary policy would not affect the valuation of stocks. Finally, the same could be said for the relevant interest rate at which households borrow in determining mortgage rates and housing prices.

In addition to potential flaws in the Asset Price Channel, I contend that both stock prices and house prices are not ideal assets for testing this theory with empirical evidence. Beginning with stock prices, it is very difficult to determine causality in the fluctuations of stock prices because price movements are virtually constant given the continual inclusion of new information. Empirical research, such as Bernanke and Kuttner, is limited to analyzing one-day movements in

stock prices on days in which monetary policy shocks occur. Although effective in determining one-day movements in stock prices, this may not be at all relevant if stock prices absorb this news and reverse the fluctuation over the course of days and weeks. It is nearly impossible to filter out any type of a reverse fluctuation (if one occurs) from the inclusion of other new information. Beyond one-day movements, stock prices cannot provide a testable experiment for lasting changes in asset prices from monetary policy shocks. Similar difficulties exist for the housing market where countless variables affect prices over a much longer period of time. One can observe broad movements in housing prices, but it is difficult to associate such long-term changes in housing prices with a one-day monetary policy shock. Thus, it is a daunting empirical challenge to observe the specific impact of monetary policy shocks both on housing prices and stock prices. For these reasons, I consider a third type of asset prices: M&A activity.

III. A New Approach: Mergers and Acquisitions

To begin this section, I emphasize that M&A activity has not been studied in relation to the effects of monetary policy on asset prices.¹¹ The only two types of assets considered in the literature have been stock prices and housing prices, even though M&A transactions are ideal for several reasons. First, M&A activity involves the equity prices of companies, just as stock prices reflect the equity value of public companies.¹² It follows that, if stock prices are relevant to study the effects of monetary policy on asset prices, then M&A activity must be relevant as well because they both measure the same type of asset. However, M&A transactions involve a multi-month process. Contrary to only observing one-day movements in stock prices, M&A processes have the time to absorb shocks in monetary policy and respond accordingly. This allows empirical research to more consistently observe the effects of shocks. Unlike investing in a house that covers multiple decades or the perpetuity nature of stock valuations, M&A investments often cover a three to seven year window. This is more

¹¹The outline of the MA market and valuation methods follows the M&A investment banking guides by Breaking into Wall Street. (“Equity Value and Enterprise Value Questions Answers” 2012, “Valuation Questions Answers” 2012, “DCF Questions Answers” 2012, “LBO Model Questions Answers” 2012).

¹²Note that M&A activity can include either public or private companies. Public companies can be acquired either through divestitures of specific divisions or through a private takeover.

likely to reflect the effect of monetary policy, which controls the short-term nominal rate. In the very least, M&A activity is a relevant asset class due to its enormous market size. In 2012 alone, over 14,000 M&A transactions were completed with an average value above \$200 million. This empirical analysis of the effects of monetary policy on M&A activity provides an original approach to this literature and helps further understand the relationship between asset prices and monetary policy.

M&A transactions are either the merger of or purchase of companies, generally involving the sale of a majority stake or the entirety of a company. Broadly speaking, M&A involves two classes of acquirers: 1) a company acquiring or merging with another company; or 2) an investment institution, primarily a private equity firm, that acquires companies to include in an investment portfolio. The latter sort of acquisitions often involve a large portion of debt with only a minority of the acquisition being funded with equity. To understand this process, consider a typical private equity firm. The firm will raise capital in an investment fund and then acquire a group of companies, financing the acquisitions with debt. Each portfolio company has two primary goals: 1) use the investment from the acquisition to grow the company; and 2) generate profits that are used to pay down the debt. As the companies grow and the debt paid down, the private equity firm re-sells each company hopefully at a higher price due to growth. What is more, the firm receives a quantity worth the entire value of the company, which is sizably more than the original investment that was financed only partially with equity and mostly with debt. Even if only some of the portfolio companies grow and not all the debt paid down, the portfolio can post remarkable returns. Harris et al. (2013) has found that the average U.S. private equity fund outperformed the S&P 500 by over 3% annually. The next sections discuss more fully the elements of this market.

Asymmetric information is especially of concern in the M&A market. As noted earlier, over 14,000 M&A transactions occurred in 2012. Although this is a large market due to the size of each transaction, the frequency of transactions pales in comparison, say, to the thousands of stocks traded daily. The market value of a stock is readily available because of the high frequency of transactions that signal the price to market participants. In contrast, there may only be a few transactions each year that are similar in terms of size, sector, maturity, geography, etc. This asymmetry is further compounded when consider-

ing reporting requirements. Public companies are required to publish quarterly and annual financial reports. What is more, these reports include sections of management discussion, providing deeper insight into the prospects and growth of the companies. However, because many M&A transactions deal with private companies, this information is often not available. For this very reason, investment banks are hired to advise M&A transactions, gather and present company information to potential buyers, and provide a credible reputation to stand behind the company information, thus removing the asymmetry problem. Posing even more of a challenge for empirical research such as this, not all M&A deals are required to disclose the transaction price or valuation multiples. Therefore, particularly when assessing the aggregate market, one must be prudent in selecting relevant variables that are still reliable and consistent despite this lack of information.

When analyzing aggregate data on M&A, four variables reflect the overall market activity: 1) the aggregate value of all disclosed deals, 2) the average size of each deal, 3) the number of deals in each period, and 4) the average valuation multiple of each deal. I argue that the first two are inconsistent metrics due to reporting requirements. Because information is only available on disclosed transactions, the aggregate value of all deals does not represent the entire market and can fluctuate from period to period simply if more or fewer firms disclose deal information. Similarly, the average size of each deal can also fluctuate from period to period as this average size comes from only the sample of deals that are disclosed. For these variables, there is the potential for inconsistency from one period to the next based only on fluctuations in reporting.

The next two variables, however, account for these issues. The total number of M&A transactions represents both disclosed and non-disclosed deals, thus removing the disclosure problem altogether. Looking at the final variable, valuation multiples are disclosed for only a portion of transactions. However, unlike the average deal size, multiples are independent of the size of a company and reflect the real price of the company. If a company with \$100 million in revenue is sold for \$200 million, the enterprise value (EV) to its revenue, or the revenue multiple, would be 2.0x.¹³ If a company with \$1 billion in revenue is sold for \$2 billion, the revenue multiple would still be 2.0x. Regardless of company size, the average multiple is not distorted. Several

¹³The enterprise value of a company is the price for which the actual company is sold, combining equity and debt less any cash that the company holds.

common multiples are a ratio of EV to revenue, EBIT (earnings before interest and taxes), and EBITDA (earnings before interest, taxes, depreciation, and amortization). Without digging deeply into the accounting for each multiple, this study looks at the EBITDA multiple which is the most commonly used multiple in the investment banking industry. EBITDA indicates a company's operational profitability. In other words, it reflects how much a company can earn with its present assets and operations on the products it manufactures or sells. This multiple is comparable across companies regardless of size, gross margin levels, debt-capital structures, or any one time costs that affect net income. EBITDA is generally considered the truest accounting metric for the health and profitability of a company. Thus, the EBITDA multiple is an excellent pricing metric to determine the value of a company relative both across time and to other companies of varying sizes. When assessing aggregate data, the average EBITDA multiple is a proxy for the average real price of transactions. With these metrics in mind, I now discuss common valuation methods.

Valuation methods can be broken into two main categories: 1) Relative methods that value the company in comparison to similar companies; and 2) Intrinsic methods that value the company based on its own performance. Two types of relative methods are precedent transactions and comparable public companies ("comps"). Precedent transactions look at the financial metrics of similar M&A deals and then apply those multiples and ratios to the target company. Similarly, comps analysis examines the trading multiples of a group of similar public companies and applies them to the financials of the company. In each method, the sample is based on criteria such as industry, financial metrics, geography, and maturity. An analysis will take the multiples of the group of companies, say the EBITDA multiple, and then apply it to the company at hand. As an example, if the average EBITDA multiple of the precedent transactions or comps is 10.0x and the EBITDA of the company is \$20 million, the relative methods imply a value of \$200 million.

In addition to relative methods, intrinsic methods value a company based solely on its individual financials. Discounted cash flow ("DCF") analysis is the present value of a company's future cash flow, as the real worth of a company is determined by how much cash (income) it can generate in the future. This mirrors the basic asset price valuations discussed previously. A DCF is usually split into two parts. The first component of a DCF is the forecast of a company's free cash

flow over a five to ten year period that is then divided by a discount rate to yield a present value. The most commonly used discount rate is the WACC which is broken into components based on a firm's capital structure. Debt and preferred stock are easy to calculate as they are based on the interest rate of debt or the effective yield of preferred stock. The cost of equity is determined using the Capital Asset Pricing Model ("CAPM") by taking the risk-free rate, i^{safe} , and adding the product of the market risk premium, ϕ , and a company-specific risk-factor, β .¹⁴ Within the CAPM, the risk-free rate is often a 10-year Treasury bond whereas the market risk premium is generally the percentage that stocks are expected to outperform the riskless rate. The CAPM is given by Equation 7:

$$CAPM = i^{safe} + \phi \cdot \beta \quad (7)$$

The three components must be added back together to determine one discount rate, usually calculated by the Weighted Average Cost of Capital ("WACC"). Depicted in Equation 8 below, WACC multiplies each cost by that component's percentage of the total capital structure.

$$WACC = Cost\ of\ Equity \cdot \%Equity + Interest\ rate \cdot \%Debt \\ + Effective\ yield \cdot \%Preferred\ Stock \quad (8)$$

The last part of the DCF is a terminal value to reflect the earnings of the company that are generated beyond the projection period. The Gordon Growth Method, a common terminal value, takes the final year of projected free cash flow, multiplied by a projected annual growth rate of the company and then divided by the difference between the discount rate and the growth rate.¹⁵ Adding the discounted free cash flows and the terminal value, the total DCF with a five-year projection period is the following:

¹⁴A risk-neutral company has a beta of 1. Thus, this company is as risky as the entire market so the risk premium is simply that of the market's risk premium. However, emerging, fast-growth companies may face more risk in getting established. Thus, its beta may be 1.5. Then, investors demand even a higher return on equity to account for this additional risk that is above the market premium.

¹⁵Note that the annual growth rate of the company must be below the approximate growth rate of the entire economy. If it is not, then the parameter assumes that, in the limit, the company would be larger than the entire economy, which is not a practical assumption.

$$DCF = \frac{FCF_1}{(1 + WACC)^1} + \dots + \frac{FCF_5}{(1 + WACC)^5} + \frac{FCF_5 \cdot (1 + g)}{(WACC - g)} \quad (9)$$

The DCF, although one of the most common valuation methods, is highly sensitive to assumptions, particularly for the projected growth of the company, the beta risk-factor, and the terminal value. This creates asymmetric information where the seller will inevitably have more information than the buyer. Adverse selection may even arise where all sellers, whether performing well or not, will present favorable assumptions as buyers do not have the same insight to whether or not such projections are realistic and probable. For this reason, transactions rely on the credibility of investment banks and the use of multiple valuation methods to minimize asymmetric information.

Another intrinsic method is the leveraged buyout model (“LBO”), a more advanced valuation method that is relevant to acquisitions that involve a large amount of debt such as private equity acquisitions. An LBO works for three key reasons:

1. Up-front cash payment on the part of the acquirer is reduced by issuing debt;
2. The cash flows generated by the company can be used to pay down the debt;
3. The return on the future re-sale totals the initial funds spent, the amount of debt paid down, and any additional value from the company’s growth.¹⁶

Briefly, I illustrate these three points in an example. Consider a private equity firm that acquires a \$300 million portfolio company with \$100 million of its own equity and finances the rest of the acquisition by issuing \$200 million in debt. Over the course of several years, the investment in the company allows it to grow while also using its profits to pay down the \$200 million in debt. Then, the private equity firm can re-sell the company at a higher price, earning a substantial return

¹⁶To understand this concept of leverage, literally picture a lever that has a shorter side and a longer side separated by a fulcrum. The larger side of course allows for greater force to be created. Likewise, the larger amount of debt allows for a greater return from a smaller portion of equity.

on the original equity investment. Although highly stylized, this illustrates how the more advanced LBO can yield above-market returns, as found in the Harris et al. study.

By applying the Asset Price Channel from the previous section to M&A activity, the potential effects of monetary policy are very similar to those of stock prices. For simplicity, let's only look at the DCF as an example. If the Fed raises the interest rate, the DCF could lower for several reasons. This could increase the interest rate on debt and *i^{safe}*.¹⁷ What is more, this increase in the interest rates may discourage borrowing by the firm to fund additional investment projects. As a result, the projected annual growth in cash flows may decrease. In addition to these two issues, the WACC may be affected as well. The monetary policy shock is likely to make output more volatile, including the risk of the entire market and the firm, causing β to increase. A higher β results in a higher WACC. All of these components would result in a lower valuation of a firm. This DCF analysis illustrates the Asset Price Channel. If this theory holds, then one would expect the data to show that an increase in the interest rate by the Fed leads to a decrease in the number of M&A transactions and in the average EBITDA multiple.

IV. Data

The data considered in this study is broken into three groups: 1) M&A metrics, 2) interest rates, and 3) Taylor rule variables. The M&A data was made available by Dealogic, a research firm that specializes in providing information to investment banks and brokerage firms. The data gathered by Dealogic covers over 99% of all M&A activity across the globe. This dataset includes quarterly data from 2003 through 2013 on the total number of transactions in each period, the total value of all disclosed transactions, the average deal value of disclosed transactions, and average EBITDA multiple of disclosed transactions.¹⁸

As discussed in the previous M&A sections, the analysis below does not include the total value of all disclosed transactions or the average deal value of disclosed transactions because of inconsistencies

¹⁷This is a stylized example. Again, the Fed raising the short-term federal funds rate would realistically not have this one-to-one effect on debt interest rates and risk-free rates. However, this provides a high-level analysis of how the theory would affect the prices of M&A transactions.

¹⁸To be more precise, this data only goes through Q2 of 2013. Also, the number of disclosed and non-disclosed transactions in each period was not available.

in the sample of what deals are disclosed from one period to the next. Therefore, I focus on the number of total transactions which represents disclosed and non-disclosed deals and the average EBITDA multiple which is consistent regardless of sampling. Over this time period, the average EBITDA multiple was 11.12x and the average number of transactions per quarter was 2,793.

Below, Figure 1 displays the quarterly data for average EBITDA and number of transactions from 2003:Q1 to 2013:Q2. First, notice the steep decline in both price and activity in 2008 and 2009 as the financial crisis created great uncertainty and panic in the M&A market, causing investment activity to stagnate. A rebound followed that eventually led to record highs in number of transactions in 2011 and 2012. Also, this time series illustration shows the close relationship between these variables. Like any market, when the demand goes up and the quantity of transactions increases, this is accompanied by an increase in price. The M&A market is no different as the number of transactions and the average EBITDA multiple trend together.



Figure 1: Average EBITDA and Number of Transactions from 2003:Q1 to 2013:Q2

The remaining variables were gathered from the Federal Reserve

Economic Data (“FRED”). In selecting an interest rate, the choice consistent with previous empirical studies is the federal funds rate (“FFR”). As discussed previously, the FFR is subject to a zero lower bound which was reached in 2009. The data on this will depict inaccurate results from 2009 to 2013 because the linear model would no longer hold. Thus, the dataset is cut-off in 2008. Because of this limited timeframe, this empirical study also includes the ten-year Treasury rate. As the study will show later, this still provides a consistent depiction of monetary policy transmission when modeling the Taylor rule. Because the ten-year rate never reaches its zero lower bound, this second interest rate allows the empirical analysis to consider the full MA dataset from 2003 through 2013. What is more, much of recent monetary policy actions have aimed to also affect long-term interest rates. Even from a monetary policy perspective beyond logistics with the data, the ten-year rate is natural to include in this analysis alongside the FFR.

For both the FFR and the ten-year, the end of period values are used, implying that the Federal Reserve responds to the macroeconomic variables in that current period whereas a change in the interest rate is likely to have a delayed effect on the macroeconomic variables. Thus, although the end of period is used for the interest rates, the average of the quarterly period is used for the Taylor rule variables. Finally, in order to analyze alongside the following Taylor rule variables, the data for both interest rates begin in 1990 with the FFR ending in 2008 and the ten-year ending in 2013. From 1990 through 2008, the average FFR was 4.23%. From 1990 through 2013, the average ten-year rate was 5.05%. Figure 2 highlights several key points concerning the FFR and the ten-year rates. First, this shows the ZLB that the FFR reached in late 2008, a bound that it has stayed at through 2013.

Secondly, this time series graph illustrates that the ten-year rate is a good proxy for the FFR as the two interest rates move together, reaching peaks and troughs at roughly the same time periods. The FFR moves more extremely, yet more smoothly than the ten-year rate. Because it is controlled by the Fed, the FFR changes in a disciplined, gradual manner whereas the ten-year rate faces more frequent fluctuations due to other market forces. However, the FFR also moves more extremely, particularly for cuts in the FFR. This is evident from 1992 to 1993, 2001 to 2004, and from 2008 to the present. In each case, the Fed cut rates aggressively in efforts to adequately respond to a slumping

economy. Even though the ten-year rate decreases during these periods, the troughs are less severe.¹⁹

The final group of variables are the Taylor rule parameters which includes real GDP and inflation. The metric for GDP is the seasonally adjusted, quarterly average of the natural log of billions of chained 2009 dollars. Similarly, inflation is measured by the quarterly average of the natural log of the seasonally adjusted personal consumption index. The inflation rate is simply the difference of these natural logs. Again, the data for both variables is quarterly from 1990 through 2013. The average log of GDP and of the price level during this time period was 9.4 and 4.5, respectively. Figure 3 displays the difference of natural log for GDP and of the price level from 1990 to 2013.²⁰

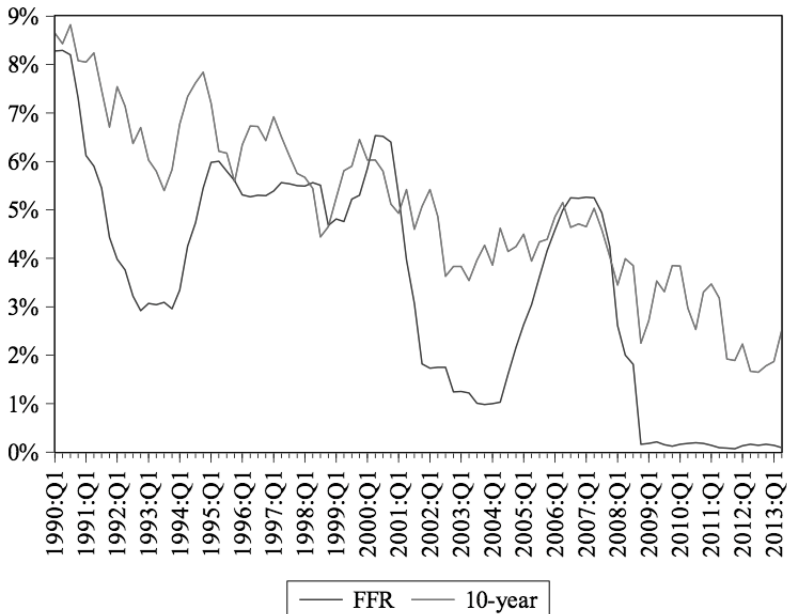


Figure 2: Federal Funds Rate and 10-year Treasury Rate from 1990:Q1 to 2013:Q2

Inflation has been remarkably stable over this time period, remaining steady around 0.5% per quarterly, or roughly 2% annually. This

¹⁹Recall that the ten-year rate will decrease (although less sharply) with cuts in the FFR because of the Expectations Hypothesis.

²⁰In the actual model, the natural logs are used; however, the difference of natural logs better illustrates the GDP growth rate and the inflation rate.

reflects the Fed’s success in maintaining its target inflation rate. The one noticeable exception is the sharp deflation of 1.4% in 2008:Q4, which was in the heart of the Great Recession. Secondly, the late 1990s saw steady GDP growth as the quarterly growth rate increases significantly from 1996 through 2000. This line also shows the true impact of the Great Recession on the economy where GDP growth decreases severely and is negative for most of 2007 to 2010.

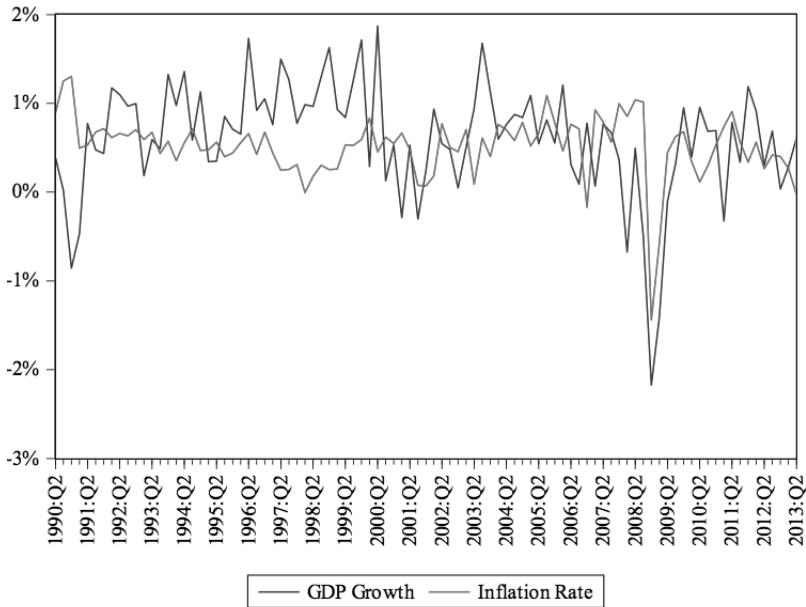


Figure 3: Quarterly GDP Growth Rate and Inflation rate from 1990:Q2 to 2013:Q2²¹

Below is a table of all the descriptive statistics of all the variables. EBITDA is presented as a multiple representing the total value of the transaction divided by the EBITDA. Also, the minimum of the FFR is 0.16%, which occurs in 2008, signaling the ZLB. Finally, as mentioned above, both GDP and inflation are reported as the differences of natural logs, which is the quarterly growth rate. The levels of GDP and PCE are not of importance, but only the natural logs which reflect the GDP growth rate and the inflation rate. In the actual model, the natural log is used rather than the difference in natural logs.

Table 1: Descriptive Statistics

Variable	Average	Minimum	Maximum	St. Dev.
EBITDA	11.12x	7.23x	14.89x	1.55x
Number of Transactions	2793	1927	3745	488
FFR	4.23%	0.16%	8.29%	1.90%
Ten-year	5.05%	1.65%	8.82%	1.76%
GDP growth rate	0.60%	-2.18%	1.87%	0.64%
Inflation rate	0.51%	-1.44%	1.30%	0.35%

Figure 4: Descriptive Statistics

V. Method

A vector autoregression (“VAR”) is an estimation technique that captures linear interdependence among multiple time series by including the lags of variables. In such a model, each variable has its own equation that includes its own lags and the lags of other variables in a model. Together, the entire VAR model has simultaneous equations that provide a model for how variables affect each other intertemporally. Bernanke and Mihov (1998) famously argue that such VAR-based methods can be applied to monetary policy because VAR innovations to the FFR can be interpreted as innovations in the Fed’s policy. Thus, a VAR model can be created using the current FFR and its lags alongside the current and lagged values of other macroeconomic variables. This allows empirical analysis to then determine the effects of innovations in monetary policy on other variables. In this study, because the M&A data overlaps the monetary interest rates, GDP, and inflation for a limited sample, I am using a modified VAR technique. Think of this model as establishing a Taylor rule using inflation and real GDP. The residuals in this equation are exogenous monetary shocks, that is, deviations from the Taylor rule. A second step then inputs these shocks – the residuals – into another VAR with the MA data.

In the results below, I include a VAR of the FFR and the ten-year rate with the Taylor rule variables. This illustrates the basics of the VAR technique and the intertemporal relationships between monetary policy innovations and macroeconomic variables. It is also important

to include a word on the ordering of variables. By including the interest rate last, it suggests that monetary policy responds immediately to the current levels of GDP and inflation whereas the effects of the current interest rate really only have lagged effects on the macroeconomy.²² When ordering a VAR, an implicit assumption is being made about the timing of the intertemporal responses. Together, Equations 10-12 create a VAR model portraying a form of the Taylor rule

$$\begin{aligned}
 GDP_q = & \beta + \beta_1 \cdot GDP_{(q-1)} + \beta_2 \cdot GDP_{(q-2)} + \beta_3 \cdot GDP_{(q-3)} \\
 + & \beta_4 \cdot GDP_{(q-4)} + \beta_5 \cdot Inflation_q + \beta_6 \cdot Inflation_{(q-1)} + \beta_7 \cdot Inflation_{(q-2)} \\
 & + \beta_8 \cdot Inflation_{(q-3)} + \beta_9 \cdot Inflation_{(q-4)} + \beta_{10} \cdot Interest\ rate_q \\
 + & \beta_{11} \cdot Interest\ rate_{(q-1)} + \beta_{12} \cdot Interest\ rate_{(q-2)} + \beta_{13} \cdot Interest\ rate_{(q-3)} \\
 & + \beta_{14} \cdot Interest\ rate_{(q-4)} \quad (10)
 \end{aligned}$$

$$\begin{aligned}
 Inflation_q = & \beta + \beta_1 \cdot Inflation_{(q-1)} + \beta_2 \cdot Inflation_{(q-2)} \\
 & + \beta_3 \cdot Inflation_{(q-3)} + \beta_4 \cdot Inflation_{(q-4)} + \beta_5 \cdot GDP_q \\
 & + \beta_6 \cdot GDP_{(q-1)} + \beta_7 \cdot GDP_{(q-2)} + \beta_8 \cdot GDP_{(q-3)} + \beta_9 \cdot GDP_{(q-4)} \\
 + & \beta_{10} \cdot Interest\ rate_q + \beta_{11} \cdot Interest\ rate_{(q-1)} + \beta_{12} \cdot Interest\ rate_{(q-2)} \\
 & + \beta_{13} \cdot Interest\ rate_{(q-3)} + \beta_{14} \cdot Interest\ rate_{(q-4)} \quad (11)
 \end{aligned}$$

$$\begin{aligned}
 Interest\ rate_q = & \beta + \beta_1 \cdot Interest\ rate_{(q-1)} + \beta_2 \cdot Interest\ rate_{(q-2)} \\
 & + \beta_3 \cdot Interest\ rate_{(q-3)} + \beta_4 \cdot Interest\ rate_{(q-4)} + \beta_5 \cdot GDP_q \\
 + & \beta_6 \cdot GDP_{(q-1)} + \beta_7 \cdot GDP_{(q-2)} + \beta_8 \cdot GDP_{(q-3)} + \beta_9 \cdot GDP_{(q-4)} \\
 & + \beta_{10} \cdot Inflation_q + \beta_{11} \cdot Inflation_{(q-1)} + \beta_{12} \cdot Inflation_{(q-2)} \\
 & + \beta_{13} \cdot Inflation_{(q-3)} + \beta_{14} \cdot Inflation_{(q-4)} \quad (12)
 \end{aligned}$$

In an ideal case, one would run the same VAR above while including a fourth variable that measures MA activity. However, given

²²This means that a statistical software program will order Equations 10-12 in that order. The ordering of the coefficients within each equation is not of concern for this timing assumption.

the limited data set with the ZLB, I employ the two-step VAR technique described above to assess the effects of monetary policy shocks on MA activity. Using Equations 10-12 for both the FFR and the ten-year Treasury rate, I find the fitted values for the interest rate given the parameters of the model. The residuals of the interest rates from the VAR model can then be calculated using Equation 13 where i is the actual value of the interest rate, \hat{i} is the estimated value of the interest rate, and e_i is the residual.

$$e_i = i - \hat{i} \quad (13)$$

The residuals reflect monetary policy that differs from the Taylor rule, or shocks to monetary policy. By using this historical data in this way, the model extracts exogenous shocks in monetary policy for the period covering the M&A data.

The next step in this technique is to take these residuals and create another VAR model, this time using the current and lagged values of the residual shocks and the M&A data.²³ This model is given by Equation 14:

$$\begin{aligned} M\&A\ Metric_q = & \\ & \beta + \beta_1 \cdot M\&A\ Metric_{(q-1)} + \beta_2 \cdot M\&A\ Metric_{(q-2)} + \\ & \beta_3 \cdot M\&A\ Metric_{(q-3)} + \beta_4 \cdot M\&A\ Metric_{(q-4)} + \beta_5 \cdot e_{(i,q)} \\ & + \beta_6 \cdot e_{(i,q-1)} + \beta_7 \cdot e_{(i,q-2)} + \beta_8 \cdot e_{(i,q-3)} + \beta_9 \cdot e_{(i,q-4)} \quad (14) \end{aligned}$$

This VAR model will then allow for the same sort of impulse response functions that were discussed previously for illustrating the Taylor rule. However, in this case, the impulse is an actual change in the residual, or monetary policy shock. If the Asset Price Channel holds, M&A activity will decrease when the interest rate increases. Thus, a positive impulse to the residual would cause the average EBITDA multiple and the number of transactions to decrease.

²³For consistency, I again use four lags of the data. Also, the interest rate shock is again ordered second as monetary policy would not respond immediately to M&A activity whereas the asset-price channel suggests that M&A asset prices would respond immediately.

VI. Results

From Equations 10-12 the first VARs presented are linear, inertial Taylor rules using the lagged and contemporaneous values of the interest rate, GDP, and the price level.²⁴ The first and primary purpose of this VAR is to take the residuals between the fitted FFR values and the actual FFR values. Applying Equation 13, this creates the exogenous shocks, or innovations, in the FFR that cannot be explained by the model. Over the period from 2003 to 2008, these residuals serve as the monetary policy shocks that will be used to analyze M&A activity. This VAR has an F-statistic of 120.35 and an R-squared value is 0.967. Next, I repeat this process using the 10-year rate in a VAR alongside GDP and inflation. In this VAR, the R-square is even stronger with a value of 0.999, and the F-statistic is 8102.57. The residuals are thus statistically significant and can be used as proxies for exogenous innovations in monetary policy.

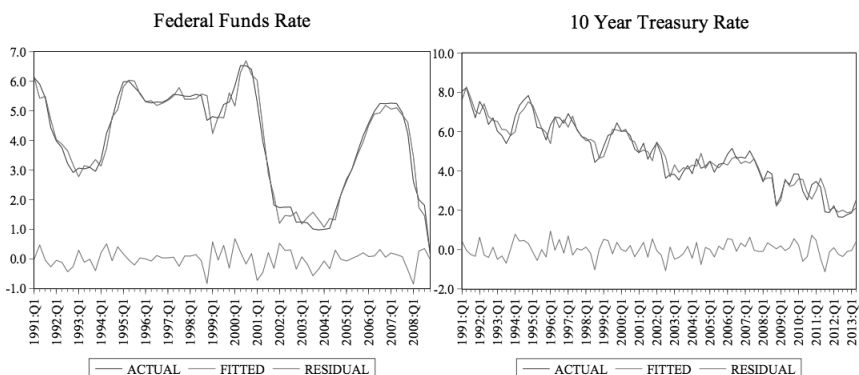


Figure 5: Actual Interest Rate vs. Taylor-Rule Estimation

Another way to confirm the validity of this VAR Taylor rule is to compare the actual interest rate values to the fitted values from the VARs. As Figure 5 illustrates, the fitted values mirror the actual values very closely. The difference between the actual and fitted values are

²⁴Note that earlier I described the GDP growth rate and inflation rate. From here on out, the terms GDP and inflation refer to the actual levels of output and prices, respectively. Also note that trends in these two variables are still captured by using levels because of the nature of a VAR which incorporates lagged values, thus structurally incorporating trends.

movements in the interest rate where the Fed is not responding to output and inflation, representing shocks that can be placed into a second VAR with the M&A data.

Equation 14 is modeled with the number of transactions responding to the FFR shocks, or residuals from the above graphs. The R-squared is 0.67 with an F-statistic of only 2.74. This is in larger part due to the limited data range from 2003 to 2008 that is further restricted by the inclusion of lagged values. Figure 5 illustrates the simulation of a shock of one standard deviation to the FFR residual in this VAR model on the number of transactions. This simulates a roughly exogenous 30 basis-point increase in the FFR. The response of the number of transactions has an initial positive increase of roughly fifty to two hundred transaction per quarter. The accumulated response levels off at roughly 575 transactions after six quarters. Multiplying the quarterly average by six, this number of transactions is a 3.4% increase in the number of transactions. This is in the direction opposite of what would be predicted by the Asset Price Channel. Most importantly, the standard error bands in the graph indicate that the response is not statistically significant.²⁵ This not only provides evidence against the Asset Price Channel, but it also contradicts the hypothesis.

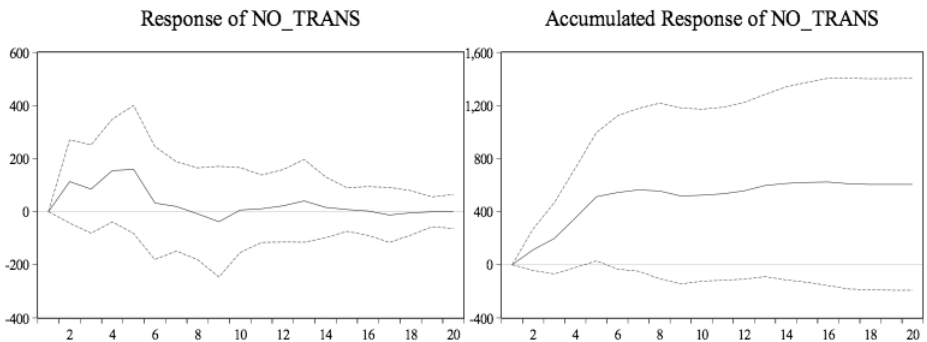


Figure 6: Response of Number of Transactions to a One S.D. Shock in the FFR Residual $\pm 2S.E.$

This process is repeated using the FFR residuals and EBITDA. The R-squared is 0.67 with an F-statistic of 2.82. As Figure 7 highlights, the EBITDA response to a simulated one standard deviation shock to

²⁵The red bands, as with all of these illustrations, reflect the values plus/minus two analytic standard errors.

the FFR residual is not statistically significant. Only a limited portion of this projection period is relevant. For example, in quarter 14, the accumulated response is roughly 4x which is not even a realistic response given that the average EBITDA is only 11x. This suggests that this particular model may not be reflecting the relationship correctly. Again, I stress that this is in large part be due to the limited data as this only covers 2003 to 2008 before the FFR reached the zero lower bound. Over the course of the first three years, the accumulated response of EBITDA fluctuates between 1 and 3x. 2x is roughly 20% of the average EBITDA so the magnitude of the response is considerable given the shock to the FFR is only 40 basis-points. Given the volatility of both EBITDA, the standard error bands confirm that this is not a statistically significant impulse response. It remains that there is no evidence to support the Asset Price Channel and actually limited evidence to contradict the explanation.

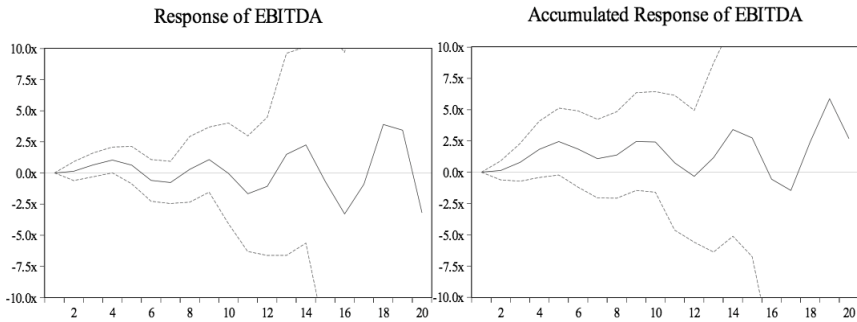


Figure 7: Response of EBITDA to a One S.D. Shock in the FFR Residual $\pm 2S.E.$

The above two VAR models are replicated using the residuals of the ten-year rate with an approximate 40 basis-points shock. Beginning with the number of transactions, this VAR has an R-squared of 0.60 with a stronger F-statistic of 5.4. The response of the number of transactions is not statistically significant, but is again positive. Looking at the accumulated response in Figure 8, the response flattens out around two hundred transactions by the end of the first projected year, or roughly 2% annually. A continuing theme exists in this VAR setup with no evidence supporting the Asset Price Channel and even slight

evidence contradicting it.

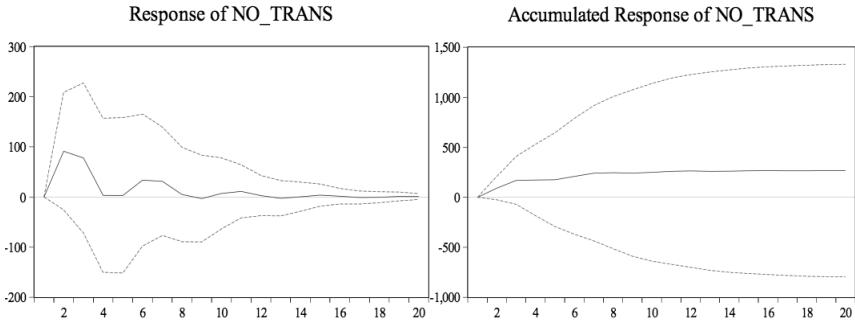


Figure 8: Response of Number of Transactions to a One S.D. Shock in the 10-year Rate Residual $\pm 2S.E.$

The final VAR model repeats the process using EBITDA with the residuals of the ten-year rate. This time, the R-squared is only 0.48 with an F-statistic of 3.34. Figure 9 illustrates the accumulated response of EBITDA to an approximate 40 basis-points shock to the ten-year rate residual. The response does not statistically differ from zero and peaks at 0.4x, or roughly 3.5%, in the second projected year. Like the other VAR models, this model provides no evidence in support of the Asset Price Channel and limited evidence against it.

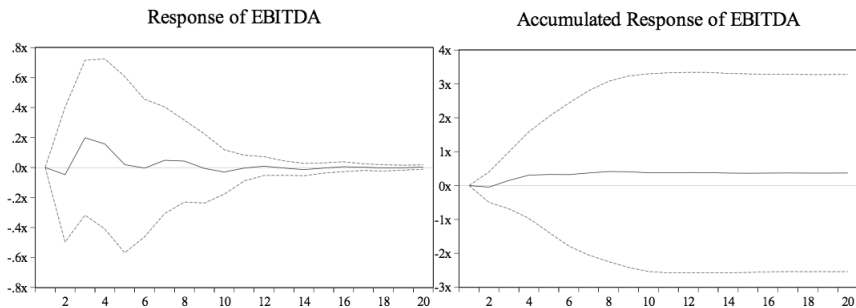


Figure 9: Response of EBITDA to a One S.D. Shock in the 10-year Rate Residual $\pm 2S.E.$

An alternative explanation places GDP as the primary driver of movements in asset prices. I hypothesize that the main concern of both investors and bankers is inevitably output – the production of

the firm, of its industry, and of the entire economy. Thus, a positive shock to GDP should result in increases in M&A prices and activity. By extracting the GDP residuals, exogenous shocks to GDP are identified that can then be modeled with the M&A data to determine the effect of output on M&A activity. I repeat the previous process by running Equations 10-14 using GDP, inflation, and the ten-year rate.²⁶ This time, Equations 13 and 14 take the residuals of GDP to identify GDP shocks that are then modeled in a VAR with the M&A metrics.

In the VAR with GDP residuals and the number of transactions, a 0.6% quarterly shock to GDP has a statistically significant shock on the number of transactions. The accumulated response reaches a level around 900 transactions, or roughly 8% of the annual average number of transactions. This is strong evidence that GDP explains movements in M&A activity.

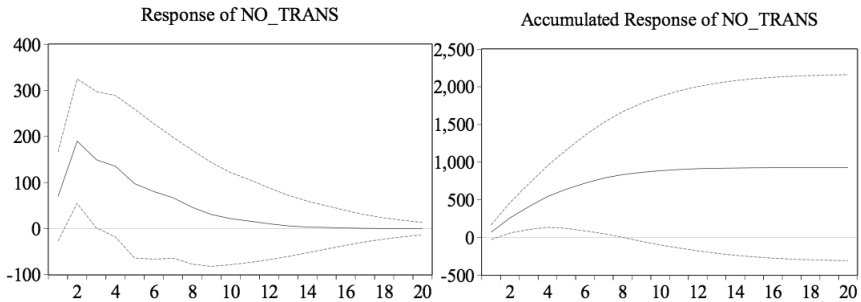


Figure 10: Response of Number of Transactions to a One S.D. Shock in the GDP Residual $\pm 2S.E.$

In the VAR with GDP residuals and the EBITDA multiple, a shock to GDP again leads to a positive response in the M&A metric. The GDP shock is approximately 0.5%. Despite being statistically insignificant, the magnitude of the shock reaches 1.4x, or roughly 12.5% of the average EBITDA multiple. This impulse response function is additional evidence supporting the explanation that GDP is a fundamental driver of movements in M&A activity.

²⁶I use the ten-year interest rate instead of the VAR so as to use the entire dataset with the M&A metrics. In the impulse response functions, I order inflation before GDP, suggesting that inflation contemporaneously respond to GDP, but GDP does not contemporaneously respond to inflation. This depicts a model where prices are sticky. For robustness, I re-ran the model ordering GDP before inflation and the results were qualitatively the same both in the Taylor rule VAR and with the M&A data.

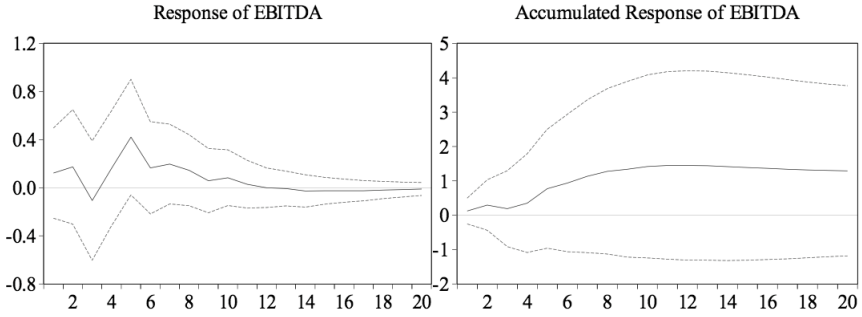


Figure 11: Response of EBITDA to a One S.D. Shock in the GDP Residual $\pm 2S.E.$

VII. Conclusion

When considering this alternative explanation, there is strong evidence in support of GDP as the primary explanation for movements in M&A prices and activity. A shock to GDP produces positive responses in both EBITDA and the number of transactions. I conclude that output is ultimately the primary driver of movements in the asset prices of M&A transactions. This is not a surprising result. At its fundamental level, the output of the firm, its industry, and the broader market drives M&A prices. Despite the persuasiveness of the Asset Price Channel, the data does not support this theory, but instead presents a simpler picture of movements in asset prices dependent solely on output.

This empirical study is an important addition to the monetary policy literature by considering a new asset class in M&A activity. Unlike the studies analyzing monetary policy with stock prices and housing prices, the Asset Price Channel does not hold with the number of M&A transactions and the average EBITDA multiple, reflecting both M&A activity and prices. Rather, the critical component in explaining movements in M&A activity is output. Although this empirical study does not find evidence of a relationship with monetary policy, it is still conceivable that an implicit relationship exists between monetary policy influencing output which then influences the M&A market. Regardless, this article does not find any direct relationship between monetary policy and M&A activity and therefore concludes that the Asset Price Channel does not hold. This study, then, is an important expansion of the literature and provides further understand-

ing of the relationship between monetary policy and asset prices in the M&A market.

References

- [1] Ball, Laurence M. 2012. *Money, Banking, and Financial Markets*. New York: Worth Publishers.
- [2] Bernanke, Ben and Ilian Mihov. 1995. "Measuring Monetary Policy." *Quarterly Journal of Economics*. 113.3: 869-902.
- [3] Bernanke, Ben and Kenneth Kuttner. 2005. "What Explains the Stock Market's Reaction to Federal Reserve Policy?" *The Journal of Finance*. 60.3: 1221-1257.
- [4] Bernanke, Ben and Mark Gertler. 2001. "Should Central Banks Respond to Movements in Asset Prices?" *The American Economic Review*. 91.2: 253-257.
- [5] Bernanke, Ben. 2010. "Monetary Policy and the Housing Bubble." Presented at the Annual Meeting of the American Economic Association. *Board of Governors of the Federal Reserve System*. Atlanta, Georgia, January 3.
- [6] Bernanke, Ben. 2002. "On Milton Friedman's Ninetieth Birthday." Presented at the Conference to Honor Milton Friedman. *University of Chicago*. Chicago, Illinois, November 8.
- [7] Bohl, Martin, Pierre Siklos, and Thomas Werner. 2007. "Do central banks react to the stock market? The case of the Bundesbank." *Journal of Banking and Finance*. 31.2:719-733.
- [8] Bordo, Michael and Olivier Jeanne. 2002. "Monetary Policy and Asset Prices: Does 'Benign Neglect' Make Sense?" *International Finance*. 5.2: 139-164.
- [9] Bullard, James. 2013. "An Update on the Tapering Debate." *Federal Reserve Bank of St. Louis*, August 15.
- [10] Bullard, James. 2007. "Seven faces of" the peril." *Federal Reserve Bank of St. Louis Review*. 339-352.

- [11] Carlstrom, Charles and Timothy Fuerst. 2007. "Asset Prices, Nominal Rigidities, and Monetary Policy." *Review of Economic Dynamics*. 10: 256-275.
- [12] Carlstrom, Charles and Timothy Fuerst. 2012. "Gaps versus Growth Rates in the Taylor rule." *Federal Reserve Bank of Cleveland*, October.
- [13] Cecchetti, Stephen, et al. 2000. "Asset prices and Central Bank Policy." Paper presented at *The Geneva Report on the World Economy No. 2*. Geneva, Switzerland, May.
- [14] Davig, Troy and Eric Leeper. 2007. "Generalizing the Taylor Principle." *The American Economic Review*. 97.3: 607-635.
- [15] "DCF Questions Answers." 2012. *Breaking Into Wall Street: Investment Banking Interview Guide*.
- [16] "Equity Value and Enterprise Value Questions Answers." 2012. *Breaking Into Wall Street: Investment Banking Interview Guide*.
- [17] Erler, Alexander, Christian Drescher, and Damir Krizanac. 2013. "The Fed's TRAP: A Taylor-Type Rule with Asset Prices." *Journal of Economics and Finance*. 37.1: 136-149.
- [18] Filardo, Andrew. 2000. "Monetary Policy and Asset Prices." *Economic Review – Federal Reserve Bank of Kansas City*. 85.3: 11-38.
- [19] Gilchrist, Simon and John Leahy. 2002. "Monetary Policy and Asset Prices." *Journal of Monetary Economics*. 49.1: 75-97.
- [20] Goodhart, Charles and Boris Hofmann. 2000. "Asset Prices and the Conduct of Monetary Policy." Presented at *Sveriges Riksbank and Stockholm School of Economics Conference on Asset Markets and Monetary Policy*. Stockholm, Sweden, June.
- [21] Harris, Robert, et al. 2013. "Private Equity Performance: What do we know?" *National Bureau of Economic Research*. Forthcoming in *Journal of Finance*.
- [22] Henderson, Nell. 2005. "Bernanke: There's No Housing Bubble to Bust." *Washington Post*, October 27.

- [23] Iacoviello, Matteo. 2005. "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle." *The American Economic Review*. 95.3: 739-764.
- [24] Ida, Daisuke. 2011. "Monetary Policy and Asset Prices in an Open Economy." *North American Journal of Economics and Finance*. 22.2: 102-117.
- [25] Laeven, Luc and Hui Tong. 2012. "US Monetary Shocks and Global Stock Prices." *Journal of Financial Intermediation*. 21.3: 530-547.
- [26] "LBO Model Questions Answers." 2012. *Breaking Into Wall Street: Investment Banking Interview Guide*.
- [27] Rigobon, Roberto and Brian Sack. 2003. "Measuring the Reaction of Monetary Policy to the Stock Market." *The Quarterly Journal of Economics*. 118.2: 639-669.
- [28] Rigobon, Roberto and Brian Sack 2004. "The Impact of Monetary Policy on Asset Prices." *Journal of Monetary Economics*. 51.8: 1553-1575.
- [29] Taylor, John. 2007. "Housing and Monetary Policy." *Federal Reserve Bank of Kansas City*. 463-476.
- [30] Taylor, John. 1993. "Discretion versus Policy Rules in Practice." *Carnegie-Rochester Conference Series on Public Policy*. 39: 195-214.
- [31] "Valuation Questions Answers." 2012. *Breaking Into Wall Street: Investment Banking Interview Guide*.
- [32] Wongswan, Jon. 2009. "The Response of Global Equity Indexes to U.S. Monetary Policy Announcements." *Journal of International Money and Finance*. 28.2: 344-365.