Volume in Redundant Assets

by

Richard Roll, Eduardo Schwartz, and Avanidhar Subrahmanyam

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Contacts

	Roll	**Schwartz**	**Subrahmanyam**
Voice:	1-310-825-6118	1-310-825-2873	1-310-825-5355
Fax:	1-310-206-8404	1-310-206-5455	1-310-206-5455
E-mail:	Rroll@anderson.ucla.edu	Eschwart@anderson.ucla.edu	Asubrahm@anderson.ucla.edu
Address:	Anderson School UCLA Los Angeles, CA 90095-1481	Anderson School UCLA Los Angeles, CA 90095-1481	Anderson School UCLA Los Angeles, CA 90095-1481

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Abstract

Multiple contingent claims on the same asset are common in financial markets, but little is known about the joint time-series of trading activity in these claims. We empirically analyze volume on the S&P 500 index and three contingent claims on the index, namely, the options, the futures, and the ETF over a long time-period of more than 3000 trading days. All series are highly cross-correlated but do not share calendar regularities; for example, an increase in volume in January occurs only in the cash index market. Vector autoregressions indicate that all series are jointly determined, though volume innovations in contingent claims lead those in the cash market. Consistent with the informational role of markets for contingent claims, there is evidence that trading activity in these markets predicts shifts in the term structure and the credit spread, as well as signed and absolute returns around macroeconomic announcements.

Introduction

Financial markets are often characterized by multiple contingent claims on the same underlying asset. Financial economists have made notable progress on how these claims should be priced relative to each other but their comparative trading activity is less well understood. How correlated are the joint time-series of volume across contingent claims? Does trading volume in one market lead other markets? How do the various markets contribute to price discovery? A comprehensive answer to these questions for all existing contingent claims is a daunting task, but we hope to take a first step by examining three contingent claims on the S&P 500 index: futures, options, and exchange traded funds.

Volume plays a fairly limited role in theories of contingent claims pricing. For example, Black and Scholes (1973) treat options as securities that are redundant and can be replicated in continuous time by investments in stocks and bonds. In this paradigm, there is no role for options volume. But, options are not replicable with stocks and bonds when the process for the underlying stock involves stochastic discontinuities (see Naik and Lee, 1990, and Pan and Liu, 2003). In general, when markets are incomplete, options cannot be replicated by trading in simple equity or fixed income securities (see Ross, 1976, Hakansson, 1982, and Detemple and Selden, 1991). But, even though options markets are quite active, models of options markets do not explicitly allow for trading activity related to market completion.

Options markets may also alter the incentives to trade on private information about the underlying asset. Cao (1999) argues that informed agents should be able to trade more effectively in options that span more contingencies. In addition, informed traders may prefer to trade options rather than stock, because of increased leverage (Back, 1992).[1] Cao and Wei (2010) find evidence that information asymmetry is greater for options than for the underlying stock, implying that informed agents prefer options. This finding is supported by Easley, O'Hara, and Srinivas (1998), Chakravarty, Gulen,

[1]Figlewski and Webb (1993), Danielsen and Sorescu (2001), and Ofek, Richardson, and Whitelaw (2004) explore the role of options in alleviating short-selling constraints.

and Mayhew (2004), and Pan and Poteshman (2006), who find that options orders contain information about future stock prices. Ni, Pan, and Poteshman (2008) show that options order flows forecast stock volatility. Cao, Chen, and Griffin (2005) show that options volume predicts returns around takeover announcements, suggesting the presence of informed traders in the options market prior to corporate events.

In sum, the literature suggests that options markets stimulate informed trading. It also is well known that options are used for hedging positions in other options as well as in the underlying stock.[2] Thus, the literature suggests that options volume could arise both for informational as well as risk-sharing reasons. Since volume in the underlying stock could also arise for similar reasons, the question arises as to what factors explain the trading activity in options markets relative to the stock market. Motivated by this observation, in a recent study, Roll, Schwartz, and Subrahmanyam (2010) analyze whether the ratio of equity options volume relative to the underlying stock volume is related to hedging and informational proxies. However, no studies have analyzed options volume in relation to *other* claims on the stock market such as index futures and ETFs.

Some research has looked at the relation between futures and the cash market. In a frictionless world, these securities would also be redundant, but Gorton and Pennachi (1993) and Subrahmanyam (1991) indicate that index futures may provide a preferred venue for uninformed traders by removing sensitivity to firm-specific informational asymmetries. Along these lines, Daigler and Wiley (1999) find that futures volatility is primarily caused by (presumably uninformed) members of the general public. Roll, Schwartz, and Subrahmanyam (2007) find that the liquidity of the underlying index influences the pricing gap between the theoretical and observed basis, but they do not analyze volume. Allaying concerns that derivatives may attract too many uninformed agents and cause volatility spillovers to the stock market, Bessembinder and Seguin (1992) find that futures volume only has a limited impact on stock volatility. To the best

[2]Lakonishok, Lee, Pearson, and Poteshman (2007) show that covered call writing, a form of hedging, is one of the most commonly used strategies in options markets.

of our knowledge, no studies have considered the relation between futures markets and other contingent claims on equities.

With regard to exchange-traded funds (ETFs), the third type of contingent claim we analyze, there has been *no* analysis of volume in ETFs vis-à-vis the underlying index, nor in relation to other contingent claims such as futures and options. However, Hasbrouck (2003) analyzes price formation in ETFs and finds that they are an important source of price discovery about the underlying index. Yet the price discovery role of ETFs incremental to other contingent claims remains an open issue.

With regard to cash volume, there have been previous time-series studies of equity trading activity, many of which have focused on short-term patterns in volume or on the contemporaneous links between volume and other variables such as return volatility. For example, a number of empirical papers have documented a positive correlation between volume and absolute price changes (see Karpoff, 1987, Schwert, 1989, and Gallant, Rossi, and Tauchen, 1992). Other papers document time-series regularities. Thus, Amihud and Mendelson (1987, 1991) find that volume is higher at the market's open, while Foster and Viswanathan (1993) demonstrate a U-shaped intraday volume pattern and also find that trading volume is lower on Mondays. In another stream of research, Campbell, Grossman, and Wang (1993) and Llorente, Michaely, Saar, and Wang (2002) analyze the dynamic relation between returns and volume levels. Chordia, Roll, and Subrahmanyam (2010) consider the causes of the recent trend in trading activity and conclude that it is mainly due to a rise in institutional trading, but they do not consider trends in contingent claims volume.

In contrast to previous work on trading activity, which has mostly analyzed volume in equities or in the context of a single contingent claim, we conduct an empirical study of the joint time-series of volume in the underlying S&P 500 index, an associated ETF, and index futures and options. Our data span a long (twelve-year) period and thereby allow us to uncover reliable patterns in these time-series. To the best of our knowledge, our paper represents the first attempt to jointly analyze trading activity that spans the cash equity market as well as multiple contingent claims on equities.

We find that all time-series (cash as well as contingent claims volume) fluctuate significantly from day to day, but fluctuations in derivatives markets are higher than those in the cash market. While daily changes in futures, cash, and ETF volumes are strongly and positively correlated, changes in options volume exhibit only weak correlations with the other series, suggesting that non-linear option payoffs attract a different clientele than the other markets.

We next consider the time-series properties of trading activity across the four contingent claims. While options, cash index, and ETF volumes have trended upward, futures volume has trended downward, indicating that other markets have acted as substitutes for the futures contract. Our analysis indicates that regularities are not common to all series. For example, there is a reliable January seasonal in cash index volume, but not in the other series, providing support for the notion that year-end cash inflows stimulate equity investments (Ogden, 1990). However, all series exhibit lower volumes at the beginning of the week.

We conduct a vector autoregression to examine the dynamics of the four volume series. This provides reliable evidence of joint determination: contemporaneous correlations in VAR innovations are strongly positive across the cash, futures, and ETF markets, and ETF and futures volume Granger-cause cash volume. Further, the accompanying impulse response functions reveal that the series are jointly determined, and confirm volume innovations in futures and ETF predict those in cash volume. This suggests that informed traders may prefer to trade first in contingent claims markets due to low transaction costs and additional leverage.

Following the vector autoregression, we perform additional tests to ascertain the informational role of contingent claims volume. Specifically, we consider how trading activity in the three derivatives and the cash market is related to equity price formation and shifts in the macroeconomy. We uncover evidence that contingent claims volume predicts changes in the term structure and the credit spread, as well as returns and volatility around major macroeconomic announcements. The role of cash index volume in predicting shifts in macroeconomic variables and returns around macroeconomic news releases is quite limited. This underscores the notion that derivatives, owing to their lower trading costs and enhanced leverage, play a key role in price discovery.

The remainder of this paper is organized as follows. Section I describes the data. Section II presents the regressions intended to address calendar regularities and trends. Section III describes vector autoregressions. Section IV describes the role of the volume series in predicting shifts in macroeconomic variables and returns around macroeconomic announcements. Section V concludes.

I. Data

The data are obtained from several sources. First, price-data.com provides data on index futures. Second, CRSP has volume data for the S&P 500 the S&P 500 ETF (SPDR). Third, index options data are from OptionMetrics (we simply use the sum of volume in calls and puts on the S&P 500 during a trading day[3]). Given that index options data are only available from 1996 onward, the sample spans the years 1996 to 2007, i.e., more than 3000 trading days.

The S&P500 index (or cash) volume series is created by value-weighting individual stock volume for all stocks in the index every day, using value weights as of the end of the previous day. In creating this volume series, an important issue is the treatment of Nasdaq volume. Atkins and Dyl (1997) indicate that Nasdaq volume is overstated because of double counting of interdealer trading. However, Dyl and Anderson (2005) argue that in recent times, due to the rise of public limit orders and ECN trades reported on Nasdaq, the double-counting problem has been mitigated. They examine the trading of firms that switched from the NASDAQ to the NYSE in the 1997-

[3] In part of the analysis we also examine options volume from calls and puts separately.

2002 time period and find that median volume drops by about 37%, which is less than the 50% number found by Atkins and Dyl (1997). We therefore scale Nasdaq volume by the implied adjustment factor of 1.59 (=100/63) prior to its inclusion in aggregated S&P500 cash volume.

The index futures volume series is constructed by starting with a contract having three months to maturity and rolling over every third Friday of March, June, September, and December into a successive contract with the same original time to maturity.[4] This method of construction implies possibly discrete changes around the expiration dates of the futures contracts. As discussed in the next section, in our empirical analysis we adjust the series for various time-series regularities, and include indicator variables for expiration days to address this issue.

Volume numbers are those reported by the data source. Here, it is worth noting that each contract has a different associated multiplier. Thus, ETFs (SPDRs) trade in units of one-tenth of the index, options trade in units of $100 times the index, and futures trade in units of $500 times the index. These scale factors need to be borne in mind while comparing the levels of volume across the different contracts.

Table 1 provides summary statistics on the data. The means are fairly close to the medians indicating little skewness, except for the ETF series. Panel B of Table 1 provides summary statistics for absolute proportional changes in volume. Options volume fluctuates the most from day to day while cash volume fluctuates the least. The percentage daily changes in volume are quite large, ranging from 13.2% per day for the cash market to 39.4% for the options market. The large fluctuations in derivatives volume relative to the cash market are consistent with informational flows being reflected in derivatives markets. Specifically, if volume arises due to information arrival (as Andersen, 1986, suggests) and trading on this information is reflected in derivatives markets, one would expect these markets to be more sensitive to changes in informational

[4]Our exploratory investigation revealed that longer-maturity contracts are not very active, indicating that futures volume series with a longer time to maturity would not add much additional insight to our study.

flows, and therefore exhibit more volatile volume. Note that the median absolute change is lower than the mean for each of the volume series, suggesting some days with very large positive changes; this notion is confirmed by the consistently positive skewness statistic for each of the four series.

Figure 1 presents the time-series plots of the four series. As can be seen, the futures series exhibits a slight downward trend in the later years, and a slight up-trend in earlier years. The downward trend in futures volume is at odds with the strong increase in stock trading activity documented elsewhere (e.g., Chordia, Roll, and Subrahmanyam, 2010). However, the other three volume series exhibit marginal to strong up-trends, with the Spider (ETF) volume growing the most dramatically. It is worth noting that minimum transaction size restrictions are less onerous in the ETF market; (as pointed out earlier, the S&P500 ETF trades in units of one-tenth of the index whereas the multiplying factor for index futures is 500). This aspect possibly adds to the attractiveness of ETF markets for small investors and has contributed to the strong up-trend in conjunction with other innovations like online brokerage that have facilitated trading by small investors. It also appears that other contingent claims as well as the cash index have been crowding out futures markets as alternative avenues for trading equities. All series are highly volatile, thus confirming the patterns in Panel B of Table 1.

In Table 2, we present the correlation matrix for levels as well as percentage changes. The futures volume levels (Panel A) are negatively correlated with other volume series, presumably because futures volume has trended downwards whereas the other series have trended upwards. The negative futures pattern disappears in Panel B, which reports correlations in percentage daily changes. Percentage changes in volume are strongly positively correlated among cash index, futures, and the ETF, while options volume changes exhibit only weak correlations with the other three series. Perhaps the non-linear nature of option payoffs and the leverage afforded by options attracts a clientele with unique information, whose trades are, by definition, less correlated with those in the cash market and in other contingent claims with linear payoffs.

II. Time-Series Regularities

One of our primary goals is to analyze the joint dynamics of the time-series. For this exercise, the preferred method is a vector autoregression (VAR). For such an estimation, however, it is desirable to first remove common regularities and trends from the time-series in order to mitigate the possibility of spurious conclusions. Specifically, series with secular trends or other common time-series regularities may betray evidence of joint dynamics simply because of these commonalities. In fact, prior research (Chordia, Roll, and Subrahmanyam, 2001) finds that market-wide bid-ask spreads do indeed exhibit time-trends and calendar regularities. It seems plausible that the volume series could also exhibit such phenomena. Thus, after log-transforming the series (to address the skewness documented in Table 1), we adjust them for deterministic variation; (see Gallant, Rossi, and Tauchen, 1992 for a similar approach to adjusting the series of equity volume). Since little is known about seasonalities or regularities in contingent claims volume, this adjustment analysis is of independent interest. In Section III, innovations (residuals) from the adjustment regressions are related with each other in a VAR.

The following variables are used to account for time-series regularities: (i) Four weekday dummies for Tuesday through Friday, (ii) 11 calendar month dummies for February through December, (iii) for the options and futures series, a dummy for the four days prior to expiration (the third Fridays in March, June, September, and December) to control for any maturity-related effects, (iv) a time index to account for any long-term trends.

Rebalancing trades by agents in response to major informational announcements (Kim and Verrecchia, 1991) suggests another set of dates that may influence volume, namely, those following the releases of material macroeconomic data. We thus include dummy variables for macroeconomic announcements about GDP, the unemployment rate, and the Consumer Price Index. For GDP we include advance, preliminary, and final release dates, whereas for unemployment announcements we include the day of as well as the four days following the announcement dates, on the basis of prior evidence that trading activity and liquidity change most strongly around this announcement (Fleming and Remolona, 1999, Chordia, Roll, and Subrahmanyam, 2001).

In Table 3 we report the results of regressing the natural logarithms of the four volume series on the preceding adjustment variables. There is a large number of coefficients reported in the table. For parsimony, in the following discussion of the results, we do not focus on all of the coefficients, but only those significant at the 5% level or less.

First, confirming the results observed in Figure 1, the trend in volume is positive for the cash index, the options and the ETF, but negative for the futures. Further, the trend in ETF volume is by far the most strongly significant amongst all of the volume series. The cash S&P 500 has a strong January seasonal in volume, which is largely attenuated in its contingent claims. This suggests that the January cash market volume increase is driven by individual stock trading activity, rather than by a common influence. Our finding is consistent with stock investment surges at the beginning of the calendar year due to cash inflows to some retail investors in the form of year-end bonuses (Ogden, 1990). It is also consistent with re-investments following tax loss motivated selling just prior to the end of the previous year (Roll, 1983). Since these activities have no fundamental information content, the derivatives volume series do not respond as much.[5]

Among other regularities, we find that options volume increases in the last four months of the year,[6] and volume in all series is statistically lower on Mondays relative to other days of the week. These are results with no obvious explanation, and deserve analysis in future research. Specifically, it may be worth examining if these regularities are common to contingent claims on other assets such as bonds and foreign currencies, and if so, to ascertain causes for the phenomena.

[5] The monthly coefficients for futures are entirely negative for February through December, though only a few are significant when considered alone. As a group, they also indicate a larger volume in January but the effect is much smaller than in the cash (spot) market.

[6] The monthly options volume coefficients are all positive, thereby revealing that January volume is unusually low.

We also find evidence that cash index and futures volumes tend to be higher on days of macroeconomic announcements (for GDP, around the second release). Due to the use of logarithms, the regression coefficients have the usual proportional change interpretation; thus, for example, the coefficients imply cash index and futures volumes are higher by 10% and 13%, respectively, on the day of the second GDP release. Volume is also an estimated 18% higher in the ETF on the day of the unemployment announcement. All of these findings are consistent with the notion that information-endowed traders adjust their holdings in response to the new macroeconomic information conveyed by the announcements (Kim and Verrecchia, 1991).

Interestingly, we find that index options exhibit *decreased* volume around the CPI and unemployment announcements. This may indicate that sophisticated uninformed agents stay away from these markets prior to macroeconomic announcements as they are apprehensive about trading against truly informed traders or against better-informed dealers or market makers. We shed more light on this phenomenon in Section IV by examining whether the volume predicts shifts in macroeconomic variables or in signed and absolute equity returns around macroeconomic announcements.

III. Vector Autoregression

The regressions of the previous section yield four residual series that we now analyze with a vector autoregression (VAR). This VAR seems desirable because the four volumes might exhibit heterogeneous time-series behavior. For example, some informed agents might prefer the venue with lower transactions costs while others may trade on the same information sequentially in one or more contingent claims.[7] Alternatively, asset allocation trades between equities and bonds as a reaction to new public information may be conducted in cash markets as well as with contingent claims. This could result in the four volume series being jointly determined or to innovations in some series leading others.

[7] See Chakravarty, Gulen, and Mayhew (2004) and Hirshleifer, Subrahmanyam, and Titman (1994).

To address these possibilities, a VAR is the natural tool. In applying the VAR, we determine the number of lags by the Akaike and Schwarz information criteria. When these criteria indicate different lag lengths, the lesser lag length is chosen for the sake of parsimony. Typically, the slopes of the information criteria as a function of lag length are quite flat for longer lags, so the choice of shorter lag lengths is further justified. The criteria indicate a lag length of six for the VAR.

Correlations in VAR innovations and Granger causality tests are reported in Table 4 (in Panels A and B, respectively). The correlation patterns generally confirm those in Table 1; specifically, all series except the options volume are strongly and positively cross-correlated, and the options series exhibits very weak correlation with the other series. The correlation between the cash market and ETF is the largest amongst all of the numbers reported in the table, perhaps indicating that both of these markets, with lower minimum transaction size requirements (as discussed in the previous section) attract a common clientele of small investors. Overall, these findings indicate that the volume series are jointly determined and that the clientele attracted by options (with non-linear payoffs) is different from that which prefers to trade in the other three markets.

We now turn to a discussion of the Granger causality tests in Panel B of Table 4. It can be seen that innovations to the options and ETF volume series are Granger-caused by the other series. In addition, the futures and ETF series Granger-cause the index while the options series Granger-causes the futures series. Further, we also observe that innovations in futures volume Granger-cause those in cash volume but the reverse is not true, suggesting that futures volume innovations lead those in the cash market. While there is bivariate Granger-causality between the ETF and the cash market, the p-value for the lead from the cash to the ETF is higher than for the reverse case. Overall, the evidence supports the joint determination of the four volume series, as suggested by Panel A of Table 4. Thus, volume innovations in the three contingent claims and the cash market do not occur independently but in a coordinated fashion, suggesting that agents who trade in these markets are not random noise traders but arbitrageurs or hedgers whose trades naturally lend themselves to joint determination across the four markets. Further, the broad evidence is consistent with the notion that contingent claims volume leads cash volume.

However, Granger causality is based on bivariate comparisons. A clearer picture can potentially be provided by impulse response functions (IRFs), which account for the full dynamics of the VAR system. An IRF traces the impact of a one-time, unit standard deviation, positive shock to one variable (henceforth termed simply a ”shock” or “innovation” for expositional convenience) on the current and future values of the endogenous variables. Since the innovations are correlated, they need to be orthogonalized, so we use the inverse of the Cholesky decomposition of the residual covariance matrix to orthogonalize the impulses.

Figure 2 shows the response of each volume to a unit standard deviation shock in the other volumes traced forward over a period of ten days. Monte Carlo two-standard-error bands (based on 1000 replications) are provided to gauge the statistical significance of the responses. Period 1 in the IRFs represents the contemporaneous response, whereas subsequent periods represent lagged responses. The vertical axes are scaled to the measurement units of the responding variable. We focus our discussions largely on the IRFs that demonstrate evidence of significance at least in part, i.e., those whose standard error bands lie wholly above or below zero for at least one lag.

First note that the auto-responses are strong and persistent for all three derivative volumes and for cash volume. In each case, an initial volume shock for a variable is followed by significant volume in the same variable for at least ten days.

The cross-responses in general are less significant. However, innovations to futures volume are useful in forecasting volume in the ETF and in the cash index. Volume innovations in the ETF significantly forecast those in the cash index. The forecasting ability of futures and ETF volume innovations for cash volume is persistent and the statistical significance lasts for at least ten days. There also is a curious delayed (fifth lag) response of options to innovations in the other volume series, which suggests a weekly seasonal that deserves analysis in future research. Overall, however, the picture is again that the time-series of volume are jointly determined.

Figure 2 also indicates that except for the already-mentioned fifth lag response for options, innovations in cash index volume are not useful in forecasting other volume series (though ETF and futures innovations forecast cash index volume), suggesting that volume in contingent claims leads that in the cash index at daily horizons. Overall, the impulse responses suggest that contingent claims, by offering lower transactions and higher leverage, are preferred by informed agents, and trading activity in the cash market therefore follows innovations in contingent claims volume.

IV. Volume and Price Formation

The volume series are worth examining in their own right, but this does not shed much light about the role, if any, they play in price formation. If it is costly to obtain timely data on volume, then volume is not public information, and return predictability based on volume would not violate semi-strong market efficiency (Grossman and Stiglitz, 1980).

By its very nature, total volume does not reveal whether the trade is initiated by a buyer or a seller, which presumably limits the ability of volume to predict signed returns. Nonetheless, if volume represents trading on information, then it could predict absolute returns, especially around informational announcements, because high absolute returns would signify a strong informational signal and thus higher volume prior to the announcement.

In addition, if futures and options trading can be used to get around cumbersome short-sales constraints in the cash market and thus enable more effective trading on negative information, high volume in contingent claims prior to informational announcements may signal negative information and thus predict signed returns. In other words, high volume in contingent claims might be negatively associated with future returns.

To test these hypotheses, we first take an empirical look at relation between volume and daily shifts in common macroeconomic indicators. We then also explore the behavior of volume around major announcements to ascertain the predictive ability of different volume series for signed and absolute returns around the release of macroeconomic data.

A. Volume and the Macroeconomy

We consider four macroeconomic variables; the term spread, the default spread, the short-term interest rate, and the return on a broad stock market index. While other variables could also be proposed, the advantage of these variables is that they are available on a daily basis that matches the interval of our volume series. The use of daily data, of course, promises better power in testing the predictive ability of volume for shifts in macroeconomic indicators.

Here, the short-term interest rate is the yield on three-month Treasury Bills. The term spread is the yield differential between Treasury bonds with more than ten years to maturity and T-bills that mature in three months. The default spread as the yield differential between bonds rated BAA and AAA by Moody's. The S&P 500 is the broad stock market index.

Panel A of Table 5 presents a daily contemporaneous correlation matrix between the logged volume series (calls and puts are included separately) and the absolute values of the first differences in the macroeconomic variables, and the absolute value of the S&P 500 return. The correlations of all of the volume series with shifts in macro variables are positive. The highest correlations are observed between the short-term interest rate and options as well as cash index volume, and between options volume and the credit spread.

The positive correlations suggest that volume and macroeconomic indicators are related, but does not directly show that volume conveys information about the macroeconomy.

Panel B of Table 5 presents *predictive* regressions where the dependent variables are the absolute values of the first differences in the macroeconomic variables, and the absolute value of the S&P 500 return. The right-hand volume variables represent the sum of the natural logarithms of volumes on the three lags of each of the five volume series (calls and puts are included separately). In addition, we control for the average three-day lag of the dependent variable (labeled "LagDepVar").

The results indicate that option (put) volume positively predicts shifts in three of the four macroeconomic variables. Since the right-hand variables are expressed in natural logarithms, the coefficients can be interpreted in terms of proportional change in the independent variable. Thus, for example, a put volume shift in the amount of the mean daily options volume shift change documented in Table 1 (i.e., 0.394) is associated with a 0.15% shift in the term spread. We also find that futures volume positively predicts absolute shifts in the credit spread as well as the stock market. Interestingly, ETF volume is negatively related to the absolute movement in the short-term interest rate and the term spread. However, just as in the futures market, large ETF volume predicts a large shift in the credit spread.

The two most significant observations from Table 5 are the strong and positive predictive ability of put option volume for shifts in three of four macroeconomic variables, and the negative and significant predictive relation between ETF volume and future shifts in these macroeconomic variables. These results are consistent with informed traders becoming more active in options markets prior to large absolute shifts in macroeconomic variables, and uninformed traders becoming reluctant to trade with informed agents in the ETF market prior to large macro shifts in one direction or another (e.g., prior to major announcements of the consumer sentiment index or corporate profitability data). Overall, there is reliable evidence that four volume series contain information about shifts in the macroeconomic variables considered in Table 5, with the (put) option market playing a particularly material role.

B. Predictive Role of Volume Around Macroeconomic Announcements

Fleming and Remolona (1999) as well as Chordia, Roll, and Subrahmanyam (2001) suggest that GDP, CPI, and unemployment announcements influence equity market liquidity, indicating information-based trading prior to these announcements. Based on these findings, one would expect volume (which partially reflects information-based trading) to affect price formation around these announcements. We thus consider whether trading activity in the contingent claims predicts returns on the day of the macroeconomic news releases.

Table 6 presents two predictive return regressions, where the dependent variable is the signed index return on the day of the macroeconomic announcement in the first regression, and the absolute value of the return in the second regression.[8] These variables are regressed on the sum of logged volumes on the three days preceding the announcement for each of the volume series. In addition, controls are included for the compound index return and the average absolute return over the past three days in the first and second regressions, respectively.

With regard to coefficients for the signed return regressions in Panel A of Table 6, it is again worth observing that without information about trade initiation, the signs of the coefficients do not lend themselves to an obviously intuitive explanation. Specifically, volume could be influenced by information, and hedging of large cash index or derivative positions, as well as circumvention of short-sale constraints using contingent claims. With this caveat in mind, and focusing on the significant coefficients, we find that cash index and ETF volumes predict returns prior to the CPI announcement, and options and futures volumes predict the return on the day of the GDP announcement.

[8] Using signed shifts in macroeconomic variables as dependent variables (i.e., using signed as opposed to absolute changes in the context of Table 5) yields no significance for the volume variables; we therefore omit these regressions for brevity.

Regarding the coefficient signs, note that the hypothesis that contingent claims are used to circumvent short-selling constraints is supported for calls and futures prior to GDP announcements, because these coefficients are negative. This hypothesis is not supported for puts because the coefficient on put volume is positive. Further, greater returns on the day of the CPI announcement are associated with lower cash index volume and higher ETF volume. The negative coefficient on cash index volume prior to CPI announcements suggests either a volume decrease prior to positive releases or a volume increase prior to negative releases. Similarly, the positive coefficient on ETF volume suggests either a volume surge prior to positive CPI releases or a volume decrease prior to adverse CPI releases. We will shed more light on these possibilities when we discuss regression with the absolute return as the dependent variable.

Note that many of the preceding patterns on predictability of signed returns are lost when aggregating across all announcements, in which case only the cash index volume predicts returns. Importantly, the lagged index return itself is never significant in predicting the return on the day of the announcement, which underscores the role of trading activity in price formation around macroeconomic announcements.

Turning now to the absolute return regressions in Panel B of Table 6, and focusing again on the significant coefficients, we find that high ETF volume predicts lower absolute returns on the day of the CPI announcement, indicating again, as in Table 5, that agents back away from ETF trading prior to an announcement with a large anticipated price move. The result in Panel A indicates that this phenomenon occurs primarily prior to adverse CPI releases. The cash index volume is positively related to absolute returns around the CPI announcement (albeit only at the 10% level), indicating that the negative coefficient in Panel A arises from volume surges prior to negative announcements. This suggests that the cash market receives some of the reduced ETF volume around adverse CPI announcements. Panel B also indicates that high put and futures volume indicate high absolute returns on the day of the GDP announcements, and this result is consistent with the results for signed returns in Panel A.[9] These patterns are all reflected in the regression that combines the macroeconomic announcements.

Overall, the results indicate the contingent claims aid in price discovery around informational announcements. Indeed, futures and options volumes predict returns on the day of GDP releases, and ETF volume predicts returns on the day of the CPI release. Nonetheless, several issues remain intriguing. First, futures and options volume positively predict absolute returns on the day of the GDP announcement, which is consistent with the notion that agents trade intensely on GDP that has a material impact on prices. However, ETF volume negatively predicts absolute returns on the day of the CPI announcement. This could be due to the fact that ETF markets have a lower minimum trade size requirement (as mentioned in Section II), and thus may attract small investors who refrain from trading prior to a material announcement.[10] Second, put and call volumes positively and negatively predict returns, respectively, on the day of the GDP announcement. One may speculate on an explanation for this finding—thus, for example, selling puts (calls) prior to positive (negative) announcements yields an immediate cash inflow but requires no cash outlay and thus may be preferred by informed agents. However, a full explanation of this finding deserves attention in future research.

IV. Conclusion

When agents trade, they incur both opportunity costs and direct transfers to intermediaries. It therefore becomes interesting to examine the joint time-series of trading activity in assets that would be redundant in a frictionless world. Finance textbooks are filled with knowledge about how these claims should be priced relative to

[9] Again, the coefficients can be interpreted in terms of proportional changes in the volume variable; thus, the coefficient of 0.11 for put volume in the case of GDP announcements (Panel B), implies that a shift in put volume equal to the mean options volume shift of 0.394 in Table 1 implies an extra absolute return of 4.3%. We leave it for the reader to perform other such illustrative calculations on economic significance.

[10] While such small traders may know the sign of the announcement from the popular press, they are likely to not know the precise magnitude of its impact on prices, thus causing them to back away from trading.

each other,[11] but comparatively little is known about the relative extent of volume in these claims.

To the best of our knowledge, this paper contains the first analysis of the joint time-series of trading activity on multiple and mutually "redundant" derivative assets. We study trading volume in three contingent claims, index options, index futures, and the ETF, as well as volume in the underlying cash index, the S&P 500. This provides some empirical information about the degree to which trading activity in contingent claims is jointly determined and the extent to which it plays a role in price formation. The data used here span a long time-period of twelve years (more than 3000 trading days), thereby providing some assurance of reliability. We are not aware of another study that has analyzed the joint time-series of trading activity in multiple contingent claims and on the underlying asset over such a long time-period.

The volumes on S&P index options, the ETF, and on the cash index itself have trended upward over recent years but futures volume has trended downward. This suggests that other markets have acted as substitutes for the futures market. Trading activity innovations in all series except options are strongly and positively autocorrelated. Options volume is only weakly correlated with the other volume series, suggesting that non-linear options payoffs attract a different clientele. Calendar regularities also differ across contracts; for example, there is a January volume seasonal in the cash index but none in its contingent claims, which reveals trading in individual stocks at the turn of the year.

Vector autoregressions and Granger causality tests indicate that the time-series are jointly determined. However, at daily horizons, impulse responses indicate that while ETF and futures volume innovations forecast cash index volume, innovations in the underlying cash index volume are not useful in forecasting volume in any of the contingent claims; this suggests that informed investors are trading contingent claims first and the cash market later.

[11] See, for example, Bodie, Kane, and Marcus (2009), Chapters 21 to 23.

Options and futures volume predict shifts in the term structure and in the credit spread, respectively. These volume series also predict signed returns on the day of the GDP announcement, suggesting that agents trade on private information in derivative markets, possibly to circumvent short-selling constraints in cash markets. Options and ETF volumes also predict volatility on the days of these announcements. The predictive ability of cash volume is quite limited, indicating that contingent claims (futures, options, and ETFs), with likely lower trading costs and enhanced leverage relative to the cash market, play a material role in price formation.

Our study, being the first on the topic, is exploratory in nature. We believe that much more needs to be done to relate how these series contribute to price formation around other announcements such as shifts in the stance of the Federal Reserve, as well their relation as other macroeconomic variables such as credit and term spreads. Further, an investigation into what types of clientele (individuals versus institutions) these markets attract would also be of considerable interest. Finally, the joint analysis of the time-series of multiple contingent claims in other markets (e.g., bonds, foreign exchange, and commodities) also remains an un-addressed issue.

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Table 1: Summary statistics

Here are summary statistics for daily volume on the S&P 500 index (Cash), and on S&P 500 options, futures, and ETF. In Panel A, all numbers are in millions of contracts or shares except the number of observations, skewness, and kurtosis. SPDRs trade in units of one-tenth of the index, options trade in units of $100 times the index, and futures trade in units of $500 times the index. The time-period is 1996 to 2007.

Panel A: Levels

Statistic	Cash	Options	Futures	ETF
Observations	3014	3012	3020	3020
Mean	48.845	3.380	0.063	37.176
Median	46.260	2.283	0.061	18.747
Standard deviation	24.533	4.203	0.030	51.254
Mean absolute deviation	17.878	2.231	0.024	33.061
Skewness	1.29	4.94	0.72	3.42
Kurtosis	3.09	34.75	0.83	17.27

Panel B: Daily absolute (proportional) changes

Statistic	Cash	Options	Futures	ETF
Observations	3013	3009	3018	3018
Mean	0.132	0.394	0.228	0.327
Median	0.096	0.306	0.168	0.255
Standard deviation	0.142	0.350	0.288	0.307
Mean absolute deviation	0.092	0.260	0.156	0.212
Skewness	3.31	1.82	10.38	4.12
Kurtosis	16.75	5.09	196.76	44.50

Table 2: Correlation matrix

Here are correlation matrices for daily volume in the S&P 500 (cash) Index, and S&P 500 options, futures, and ETF. The time-period is 1996 to 2007. Volume is in number of contracts.

Panel A: Levels

Variable	Cash	Options	Futures
Options	0.609		
Futures	-0.228	-0.173	
ETF	0.817	0.704	-0.268

Panel B: Daily Percentage Changes

Variable	Cash	Options	Futures
Options	0.036		
Futures	0.567	-0.006	
ETF	0.532	0.018	0.437

Table 3: Time-Series Regressions of Volume

Log Volume in the S&P 500 (cash) Index and in S&P 500 Options, Futures, and ETF are regressed on variables intended to remove calendar regularities and trends. The macroeconomic announcement dates are the day of the announcement except for the unemployment dummy, covers the announcement day and four days following the announcement. The GDP numbers cover the advance, preliminary, and corrected announcements. The Remtrm dummy for options and futures is unity for the four days prior to expiration of the contracts (the third Fridays in March, June, September, and December). The time-period is 1996 to 2007.

Variable	Cash		Options		Futures		ETF	
	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.
Unempl 0	0.0257	1.64	-0.1971	-4.46	0.1371	4.50	0.1804	4.80
Unempl+1	0.0450	2.36	-0.0965	-1.87	0.1099	3.07	0.0048	0.11
Unempl+2	0.0686	3.45	-0.1024	-1.93	0.1072	2.89	0.0483	1.05
Unempl+3	0.0748	4.02	-0.1129	-2.23	0.1009	2.87	0.0254	0.58
Unempl+4	0.0997	6.03	-0.0917	-1.95	0.1099	3.39	0.0747	1.88
CPI	0.0090	0.80	-0.0732	-2.27	0.0598	2.68	0.0067	0.25
GDP#1	-0.0053	-0.26	0.0904	1.63	0.0145	0.38	0.0074	0.16
GDP#2	0.0980	4.91	0.0334	0.60	0.1316	3.43	0.0811	1.71
GDP#3	0.0369	1.90	0.0920	1.69	-0.0280	-0.75	0.0437	0.94
Trend	1.4730	25.65	1.7130	21.07	-0.9375	-15.52	4.8830	57.64
Tuesday	0.0998	12.62	0.1378	5.91	0.1371	8.59	0.1414	7.27
Wednesday	0.1392	14.16	0.1732	6.07	0.1560	7.96	0.1674	6.99
Thursday	0.1153	11.51	0.1963	6.76	0.0887	4.45	0.1843	7.55
Friday	0.0752	8.51	0.0995	3.78	0.0347	1.92	0.1099	5.09
February	-0.1420	-3.33	0.0635	0.68	-0.0711	-1.07	-0.1020	-1.18
March	-0.1449	-2.91	0.1997	2.04	-0.0093	-0.13	-0.0293	-0.31
April	-0.1339	-2.55	0.1021	1.03	-0.1033	-1.44	-0.0089	-0.09
May	-0.2127	-3.98	0.1186	1.19	-0.1334	-1.85	-0.0784	-0.81
June	-0.1869	-3.47	0.0837	0.84	-0.0051	-0.07	-0.0182	-0.19
July	-0.3477	-6.45	0.0878	0.89	-0.1941	-2.71	-0.1483	-1.54
August	-0.3549	-6.59	0.1517	1.53	-0.1591	-2.22	-0.0396	-0.41
September	-0.2700	-5.02	0.2498	2.49	-0.0054	-0.07	0.0134	0.14
October	-0.2629	-5.03	0.2065	2.11	-0.1242	-1.75	0.0529	0.56
November	-0.3832	-7.61	0.2268	2.29	-0.2001	-2.79	-0.1428	-1.50
December	-0.2603	-6.05	0.2949	3.21	-0.1327	-2.01	-0.1386	-1.60
Remtrm			0.0804	1.48	-0.1092	-2.89		
Intercept	3.2230	348.20	4.955	161.30	3.873	185.90	4.2200	169.40
Adjusted R^2	0.264		0.161		0.126		0.536	

Table 4: Correlations Between VAR Innovations and Granger Causality Tests

Correlations in the innovations from a vector autoregression (Panel A) and Granger causality tests (Panel B) for daily residuals obtained by regressing the natural logarithms of trading volume of the S&P 500 Index, and of S&P 500 options, futures, and ETF against calendar regularities and macroeconomic announcements as reported in Table 3. The time-period is 1996 to 2007. Volume is in number of contracts.

Panel A: Correlation Matrix for VAR Innovations

Variable	Cash	Options	Futures
Options	0.001		
Futures	0.493	-0.040	
ETF	0.535	0.004	0.412

Panel B: Granger Causality Tests

Exclude	Chi-sq	df	*p*-value
Dependent variable: Cash			
Futures	15.23834	6	0.0185
Options	10.79789	6	0.0948
ETF	17.43188	6	0.0078
All	43.65616	18	0.0006
Dependent variable: Futures			
Cash	12.03045	6	0.0613
Options	5.189359	6	0.5198
ETF	19.64028	6	0.0032
All	62.6355	18	<0.0001
Dependent variable: Options			
Cash	241.1804	6	<0.0001
Futures	53.84673	6	<0.0001
ETF	46.49945	6	<0.0001
All	690.4252	18	<0.0001
Dependent variable: ETF			
Cash	13.64112	6	0.0339
Futures	13.18396	6	0.0402
Options	17.4517	6	0.0078
All	47.10534	18	0.0002

Table 5: Volume and the Macroeconomy

Panel A presents contemporaneous correlations between volume and absolute values of the daily changes in macroeconomic variables and the absolute return on the S&P 500 index. Panel B presents regressions where the dependent variable is the absolute daily change in three macroeconomic variables and the absolute return on the S&P 500 index. The three macroeconomic variables are (i) the short-term interest rate (ii) the term spread, and (iii) the credit spread. The term spread is the yield differential between constant maturity ten-year Treasury bonds and Treasury bills that mature in three months. The credit spread is the yield differential between bonds rated Baa and Aaa by Moody's. The right-hand volume variables represent the sum of three lags of logged daily volume for the S&P 500 Index (Cash), and for S&P 500 call and put options, index futures, and the ETF. The variable LagDepVar is the average three-day lag of the dependent variable. The time-period is 1996 to 2007. Volume is in number of contracts, and all volume coefficients are multiplied by 1000.

Panel A: Contemporaneous Correlations

	Short-term interest rate	Term Spread	Credit Spread	Stock Market
Cash	0.1100	0.0963	0.0853	0.0807
Call	0.1503	0.0973	0.0344	0.0130
Put	0.1827	0.1370	0.0673	0.0778
Futures	0.0550	0.0731	0.0426	0.3116
ETF	0.0564	0.0855	0.0874	0.0593

Panel B: Predictive Regressions

	Short-term interest rate		Term Spread		Credit Spread		Stock Market	
Variable	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.
Cash	1.165	1.29	0.585	0.55	0.148	0.46	7.240	0.43
Call	1.013	1.87	-0.133	-0.21	-0.143	-0.74	-26.760	-2.66
Put	3.129	5.13	4.098	5.76	0.003	0.01	61.920	5.56
Futures	0.184	0.33	0.591	0.89	0.611	3.06	80.570	6.93
ETF	-1.662	-4.75	-1.270	-3.13	0.268	2.20	-9.435	-1.48
LagDepVar	0.196	26.73	0.1424	16.80	0.086	9.15	0.098	9.91
Intercept	-0.146	-3.64	-0.126	-2.70	-0.029	-2.05	-3.466	-4.54
Adjusted R^2	0.2770		0.1256		0.0384		0.1023	

Table 6: Predictive Return Regressions Around Macroeconomic Announcements

In these regressions, the dependent variable is the signed (Panel A) and absolute S&P500 return (Panel B) on the date of the macroeconomic announcement. The right-hand volume variables represent the sum of three lags of logged daily volume for the S&P 500 Index (Cash), and for S&P 500 call and put options, index futures, and the ETF. "Cashret" represents the compounded three lags of returns on the index. The time-period is 1996 to 2007. Volume is in number of contracts.

Panel A: Signed Announcement-Day Return

	Unemployment		CPI		GDP		All	
Variable	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.
Cash	-0.0746	-0.52	-0.4670	-4.40	0.0290	0.24	-0.1742	-2.31
Call	0.1676	1.68	0.0656	1.10	-0.1465	-2.01	0.0040	0.09
Put	-0.0471	-0.52	-0.0692	-0.90	0.1986	2.40	0.0232	0.47
Futures	0.1384	1.61	-0.0587	-0.82	-0.2451	-2.93	-0.0104	-0.22
ETF	-0.0468	-0.91	0.1180	3.08	-0.0728	-1.47	0.0215	0.76
Cashret	-0.0185	-0.29	0.0522	1.05	-0.0696	-1.27	0.0110	0.33
Intercept	-3.12	-0.49	24.56	4.27	7.86	1.48	7.35	2.20
Adjusted R^2	0.0216		0.1178		0.0470		0.0032	

Panel B: Absolute Announcement-Day Return

	Unemployment		CPI		GDP		All	
Variable	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.
Cash	0.0266	0.31	0.1512	1.89	0.0130	0.17	0.0863	1.80
Call	-0.0130	-0.22	-0.0332	-0.73	-0.0379	-0.81	-0.0397	-1.41
Put	0.0537	1.00	0.0621	1.08	0.1118	2.09	0.0780	2.48
Futures	0.0672	1.17	0.0808	1.48	0.2308	3.71	0.1122	3.52
ETF	-0.0532	-1.77	-0.0698	-2.44	0.0015	0.05	-0.0472	-2.66
|Cashret|	0.1114	2.33	0.0777	1.67	-0.0410	-0.80	0.0508	1.84
Intercept	-1.98	-0.49	-8.77	-2.06	-10.51	-2.90	-6.75	-3.05
Adjusted R^2	0.1011		0.0859		0.1174		0.0936	

Figure 1: Volume for the S&P 500 and for its Options, Futures, and Spider

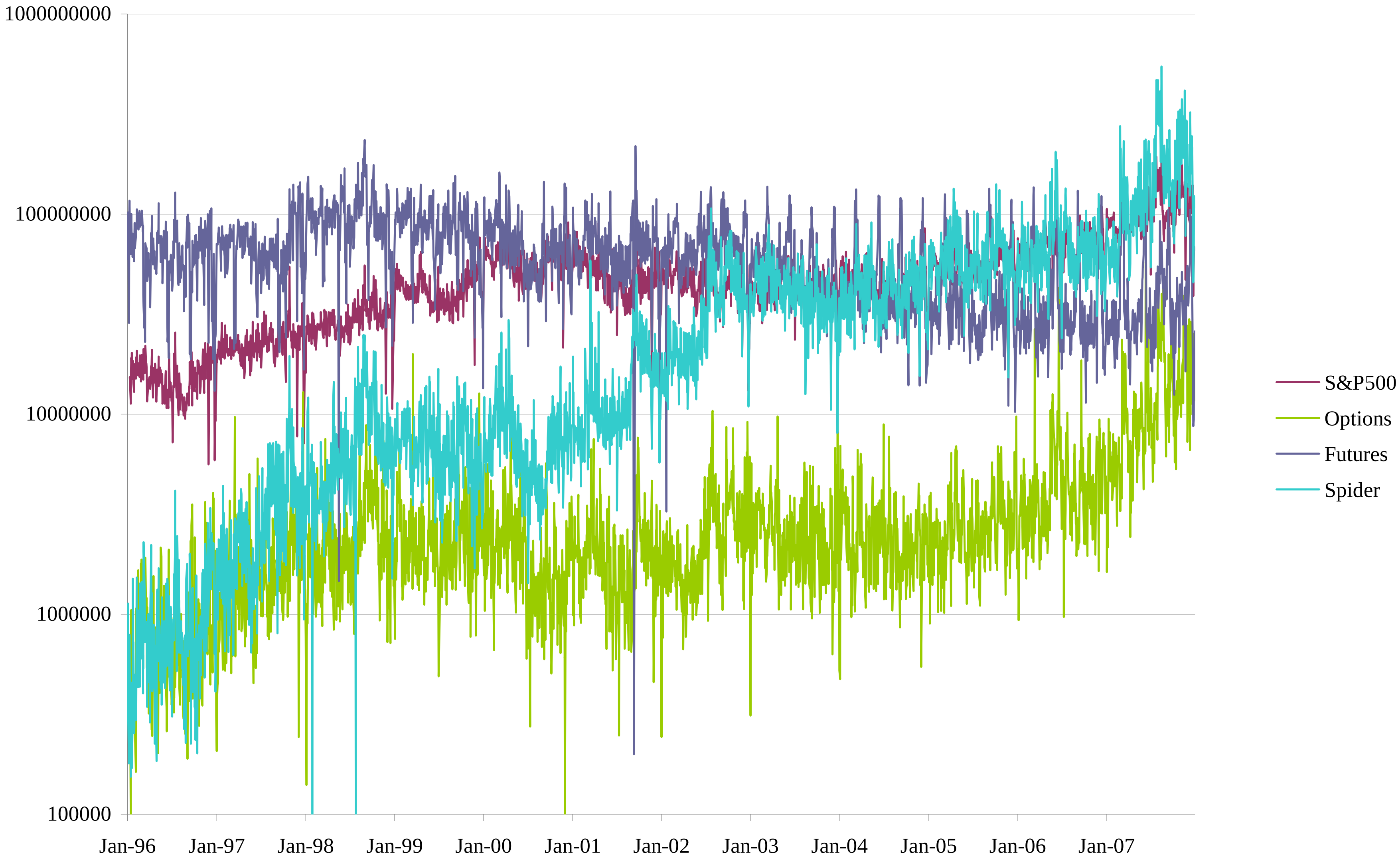

Figure 2: Impulse Response Functions

Here are impulse response functions from a VAR with daily volume for the S&P 500 Index, and for S&P 500 options, futures, and ETF. The time-period is 1996 to 2007. The data are the orthogonalized residual series from the regressions reported in Table 3.