Volume in Redundant Assets

by

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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 study volume on the S&P 500 index and four contingent claims on the index, the options, the traditional (legacy) futures contract, the E-mini futures contract and the ETF, over a long time-period of more than 3000 trading days. Legacy futures volume has trended downward while other series have trended upward. Overall futures volume has shown an upward trend, suggesting that the E-mini contract has at least partially supplanted the legacy contract. All series are highly cross-correlated but do not share time-series regularities; for example, higher January volume occurs only in the cash index market. Vector autoregressions indicate that all series are jointly determined. Consistent with the informational role of derivatives markets, volume innovations in contingent claims lead those in the cash market. There also is evidence that trading activity in contingent claims (specifically, options) predicts absolute shifts in stock market volatility and aggregate state variables such as the term structure and the credit spread, as well as absolute returns around major macroeconomic announcements.

Introduction

Securities 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 trading volumes across contingent claims? Does volume in one market lead volume in 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 trading activity in the cash assets within the S&P 500 index along with activity in three contingent claims on the 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 (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 the analyses of Ross (1976), Hakansson (1982), and Detemple and Selden (1991). But, these models do not address the relation, if any, between trading activity and market completion. In contrast to the theoretical silence about options volume, trading in options is actually quite active.

Another line of research suggests that options markets may alter the incentives to trade on private information about the underlying asset. According to Cao (1999), 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

[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.

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, 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 flow forecasts 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 preceding 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 indicates 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. Nevertheless, no studies have analyzed options volume in relation to *other* equity derivatives.

Index futures contracts would also be redundant in a frictionless world, but Gorton and Pennachi (1993) and Subrahmanyam (1991) indicate that 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 of our knowledge, no studies have considered the relation between index futures markets and alternative equity derivatives.

[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.

With regard to exchange-traded funds (ETFs), the third type of contingent claim we analyze, Hasbrouck (2003) shows that ETFs 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. Furthermore, there has been *no* analysis of ETF volume vis-à-vis that in the underlying index, nor in relation to derivatives markets such as those for futures and options.

As for 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. Thus, 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: 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, index futures (the legacy contract as well as the newer E-mini contract) and index options. Beyond analyzing basic time-series properties of the volume data, we aim to address the following issues (we first pose the question and then present the economic motivation):

- Are these redundant securities substitutes or complements to each other and the cash market? Specifically, if one security gains popularity and acts as a substitute

for another, then it should drain volume away from another, so that volumes may exhibit opposing trends. On the other hand if both securities act as hedging vehicles and as venues for efficiency-enhancing arbitrage trades, then volumes should exhibit common trends.

- Do volume innovations in one market lead other volume series? If derivatives attract informed agents due to lower transaction costs and enhanced leverage, then shocks to trading activity in derivatives should forecast those in the cash market, as arbitrageurs trade to close the gap in the cash market with a lag.
- Does derivatives volume reflect responses to changing macroeconomic conditions? If agents trade in derivatives markets to hedge against macroeconomic uncertainty or exploit private information (due to lower trading costs and increased leverage), then trades in derivatives should forecast daily shifts in macro variables and perhaps predict returns around macroeconomic announcements.
- Is the relation between trading activity and the macroeconomy different across different contingent claims? Some contracts have small contract sizes (e.g., the E-mini and the ETF) and may cater to less-sophisticated retail clienteles. These contracts may play a less material role in forecasting macroeconomic conditions. On the other hand, if options are particularly attractive to agents because of their non-linear payoffs, then we would expect to see a greater role for options trading activity in forecasting macroeconomic conditions.

To address the preceding issues, we use data that span a long (twelve-year) period, which allow us to uncover reliable patterns in these time-series. To the best of our knowledge, our paper represents the first attempt to analyze trading activity that spans the cash equity market as well as multiple contingent claims on equities.

We find that all volume series (cash as well as contingent claims) fluctuate significantly from day to day, but fluctuations in derivatives markets are higher than those in the cash market. Further, daily changes in futures, cash, options and ETF volumes are strongly and positively

correlated. We also consider the time-series properties of trading activity across the four contingent claims. Our results reveal that regularities are not common to all series. For example, while all series exhibit higher volumes at the beginning of the week, 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). Further, we find that cash, options, E-mini futures, and ETF volumes have trended upward, but legacy futures volume has trended downward, indicating that the E-mini contract has at least partially supplanted the legacy contract. Aggregate futures volume (i.e., the combined E-mini and legacy volume), however, shows a strong upward trend. On aggregate, all contracts appear to be complementary to each other, demonstrating a strong upward trend.

We conduct a vector autoregression to examine the dynamics of the four volume series. This provides reliable evidence of joint determination. Specifically, contemporaneous correlations in VAR innovations are strongly positive across all of the markets. Further, the accompanying impulse response functions reveal that the series are jointly determined, and confirm that volume innovations in contingent claims 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 state of the macroeconomy. We uncover evidence that put options volume predicts absolute changes in the short rate, the term structure, and the credit spread. In addition, legacy futures volume also predicts shifts in the short rate and the term structure. Moreover, volume in these claims forecasts stock market volatility after accounting for volatility persistence. There also is some evidence that volume in contingent claims predicts absolute returns 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, index options data are from OptionMetrics. This database provides the daily number of contracts traded for each option on the S&P 500 index. We approximate the total daily options volume by multiplying the total contracts traded in each index option by the end-of-day quote midpoints[3] and then aggregating across all options listed on the index.[4]

CRSP has volume data for the S&P 500 and the S&P 500 ETF (SPDR). 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. Anderson and Dyl (2005), however, 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 1997-2002 time period and find that median volume drops by about 37%, which is less than the 50%

[3] Because of the difficulties involved in aggregating options of different maturities and strike prices, options volume is imputed in dollars for each option and then cumulated across options. This creates the possibly that options volume dynamics could be driven by shifts in prices, rather than quantities traded. However, we have verified that the results are qualitatively similar when we calculate options volume by simply summing the traded quantities across options.

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

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.

Price-data.com provides data on index futures. The legacy and E-Mini 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.[5] This method of construction implies possibly discrete changes around the expiration dates of the futures contracts. In the empirical analysis, the raw series are adjusted for various time-series regularities including indicator variables around expiration dates.

Given that E-mini futures contracts started trading on September 9, 1997, we use daily data starting from this date to December 31, 2009, i.e., more than 3000 trading days. Table 1 provides summary statistics for the basic volume series. The volumes are those reported by the data source, and each contract has a different associated multiplier. Thus, ETFs (SPDRs) trade in units of one-tenth of the index and futures trade in units of $250 times the index.[6] Further, E-Mini futures trade in units of $50 times the index. These scale factors need to be borne in mind while comparing the levels of volume across the different contracts. For the cash and legacy futures volumes, the means are fairly close to the medians, thus indicating little skewness. There is some evidence, however, of skewness for the E-Mini, options, and ETF volumes.

Panel B of Table 1 provides summary statistics for absolute proportional changes in volume (in percentages). 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 larger fluctuations in derivatives relative to cash volume are consistent with informational flows being reflected in derivatives markets. Specifically, if volume arises at least partly due to the arrival of new information (as Andersen, 1986, suggests) and trading on this information is reflected in

[5]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.

[6] The multiplier for S&P 500 the legacy futures changed from 500 to 250 on November 3, 1997. Prior to this date, the legacy volume is multiplied by a factor of 2.

derivatives markets, one would expect these markets to be more sensitive to changes in informational 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 that some days have very large positive changes in trading volume; this is confirmed by the consistently positive skewness statistic for each of the four series.

Figure 1 presents the time-series plots of the series. In this figure, the E-mini and legacy futures series are combined for convenience, taking into account the differences in the multipliers.[7] The upward trend in all series is consistent strong increase in stock trading activity documented elsewhere (e.g., Chordia, Roll, and Subrahmanyam, 2010). The Spider (ETF) volume has grown 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 legacy index futures is 250). 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. All series are highly volatile, thus confirming the patterns in Panel B of Table 1.

Table 2 provides the correlation matrices for levels (Panel A) and percentage changes (Panel B.) 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 correlation pattern for futures disappears in Panel B, which reports correlations in percentage daily changes. Indeed, percentage changes in volume are strongly positively correlated amongst all of the series.

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). In VAR estimation, it is desirable to first

[7] Thus, the futures series plotted is legacy futures volume + 0.2 * E-mini futures volume.

remove common regularities and trends from the time-series in order to mitigate the possibility of spurious conclusions. Series with secular trends, seasonal, or other common time-series regularities may seem to exhibit joint dynamics simply because of such commonalities. Prior research (Chordia, Roll, and Subrahmanyam, 2001) finds that market-wide bid-ask spreads do indeed exhibit time-trends and calendar seasonals. It seems quite possible that the volume series could also exhibit such phenomena.

Thus, after log-transforming the raw volume 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 equity volume). Since little is known about seasonalities or regularities in contingent claims volume, this adjustment is of independent interest. In Section III, innovations (residuals) from the adjusted 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. In addition, rebalancing trades by agents in response to major informational announcements (Kim and Verrecchia, 1991), and informed trading prior to such events, suggests dates surrounding macroeconomic releases might be unusual. We thus include indicator variables for macroeconomic announcements about GDP,[8] the unemployment rate, and the Consumer Price Index. We use a dummy variable for the five days preceding the macro announcement date and another for the announcement date and four days thereafter. Since announcements are generally made in the morning (Fleming and Remolona, 1999), the release date itself mostly belongs to the post-announcement period. The choices for dummies are based on prior evidence that trading activity and liquidity are altered before as well as after these announcements (Chordia, Sarkar, and Subrahmanyam, 2005).

[8] GDP numbers are released in three stages: advance, preliminary, and final. Our exploratory analysis revealed that trading activity only responds to the announcement of the preliminary number. Hence this is the announcement used to construct the dummy variable for GDP announcements.

Table 3 reports regressions of the natural logarithms of the five raw volume series on the preceding adjustment variables. The log transformation is used to account for the skewness reported in Table 1 and the Cochrane and Orcutt (1949) transformation is used to correct for residual autocorrelation. Such correction brings the Durbin and Watson (1950, 1951) statistics into the acceptable range (as seen in the last row of each regression). For parsimony, the following discussion is restricted to coefficients that are significant at the 5% level or better.

First, confirming the results observed in Figure 1, the trend in volume is strongly positive for the cash index, the options, the E-mini futures, and the ETF, but negative for the legacy futures. The overall positive trend in futures volume evident within Figure 1 thus is due to the fact that the positive trend in E-mini volume dominates the negative trend in the legacy futures volume. Figure 2 depicts this phenomenon by plotting separately the legacy and E-mini contract volumes and clearly demonstrates that the E-mini contract has at least partially supplanted legacy futures volume.

We also note that the cash S&P 500 has a strong January seasonal in volume, which is not as evident 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.[9]

We also observe that volume in all series is statistically lower on Mondays relative to other days of the week. This is a result with no obvious explanation, and deserves analysis in future research. It may be worthwhile to investigate whether this regularity is also found in

[9] 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.

contingent claims on other assets such as bonds and foreign currencies, and if so, to uncover the underlying cause.

Cash index and contingent claims volumes tend to be higher on days following unemployment announcements. Due to the use of logarithms, the regression coefficients have the usual proportional change interpretation; thus, for example, the coefficients imply that cash index and options volumes are higher by 2% and 14%, respectively, in the period subsequent to the unemployment release. These findings indicate that traders adjust their holdings in response to the new macroeconomic information conveyed by the announcement (Kim and Verrecchia, 1991). Also note that derivatives volume does not consistently increase prior to macroeconomic announcements (the pre-announcement dummies are not consistently positive and significant for all contingent claims). This does not preclude the possibility that volume may rise prior to more material announcements; we revisit this issue in Section IV. We also find that E-mini futures volume is significantly lower just prior to contract expiration.

III. Vector Autoregression

The regressions of the previous section yield four OLS residual series that we now analyze with a vector autoregression (VAR).[10] A VAR seems desirable because the five 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.[11] 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 five volume series being jointly determined or to innovations in some series leading others.

To address such possibilities, a VAR is the natural tool. In this VAR, the five volume time-series OLS residuals described above are the endogenous variables. In addition, since

[10] The OLS residuals are used for the VAR while Table 3 reports regressions after a Cochrane/Orcutt transformation to correct for autocorrelation.
[11] See Chakravarty, Gulen, and Mayhew (2004) and Hirshleifer, Subrahmanyam, and Titman (1994).

volatility is a strong driver of volume (e.g., Gallant, Rossi, and Tauchen, 1991), a measure of anticipated volatility is included as an exogenous variable. The volatility measure is the VIX, an indicator of the implied volatility of the S&P 500 index published by the Chicago Board Options Exchange.[12] In applying the VAR, the number of lags is determined 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 five for the VAR.

Correlations in VAR innovations are reported in Panel A of Table 4. The correlation patterns generally confirm those in Table 2; specifically, all series are strongly and positively cross-correlated. 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. The lowest correlation is between options and the E-mini contract, indicating heterogeneous clienteles across these markets. Overall, these findings indicate that the volume series are jointly determined.

Panel B of Table 4 presents the coefficients of the exogenous proxy for volatility, i.e., VIX. All volumes are significantly and positively related to VIX. This supports the notion that higher expected future volatility is associated with increased volume, consistent with the results of Gallant, Rossi, and Tauchen (1991). The results also accord with the intuition that high expected volatility would increase returns from speculative trading (Kyle, 1985) and thus attract more informed volume.

Impulse response functions (IRFs) portray the full dynamics of a VAR system. An IRF tracks the effect of a one standard deviation shock to one variable (henceforth termed a ”shock” or “innovation” for convenience) on the current and future values of the other variables. Since

[12] Implied option volatility is used because speculative activity that sparks turnover would likely respond to expected volatility, rather than realized volatility. We are grateful to Bob Whaley for providing the VIX data.

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 3 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 the 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 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 in legacy futures volume are useful for predicting volume in the other markets. Volume innovations in contingent claims significantly forecast volume in the cash index (labeled "spot" in figure 3.) Interestingly, innovations in options and legacy futures forecast cash volume for up to ten days, whereas the forecasting ability of E-mini futures and ETF volume innovations is less persistent and the statistical significance lasts for only three to four days. This is consistent with the notion that options and legacy futures, with their larger contract sizes, attract a more sophisticated clientele, whose trading activity more strongly leads in the cash market than the E-mini and ETF markets. In sum, the IRFs reliably indicate that the time-series of trading activity are jointly determined.

Figure 3 also indicates that innovations in cash index volume are not useful in forecasting other volume series (though derivatives innovations forecast cash index volume), suggesting that volume in contingent claims leads that in the cash index at daily horizons. These results are consistent with the notion that contingent claims, by offering lower transactions and higher

leverage, are preferred by informed agents, so that trading activity in the cash market follows innovations in contingent claims volume.

IV. Volume and Price Formation

The volume series are worth examining in their own right, but the examination sheds little light on the role, if any, volume plays 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). Note, however, that 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. Finally, it is possible that since options cover more contingencies than other (linear) derivatives, volume in options markets may play a more material role in forecasting movements in macroeconomic variables.

To examine the preceding ideas, we first take a look at the empirical relation between cash and contingent claims volume, and daily shifts in common macroeconomic indicators.[13] We then explore the behavior of volume around major announcements to ascertain the predictive

[13] We use the unadjusted volume series, rather than the residual series used for the VAR, because the residual series suffers from a look-ahead bias (the full time-series is used to construct the residuals), thus hampering the interpretation of predictability results.

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. Here, the short-term interest rate is proxied by 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.[14] The S&P 500 is the 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 the volume series. The use of daily data, of course, promises better power in testing the predictive ability of volume for shifts in macroeconomic indicators.

Panel A of Table 5 presents summary statistics (means and standard deviations) plus 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, as well as the absolute value of the S&P 500 return. We find that with the exception of legacy futures and the credit spread, the correlations of all of the volume series with unsigned shifts in macro variables are positive. The highest correlations are observed between the options volume and the macroeconomic variables. ETF volume also shows high correlations with the term spread as well as the credit spread. Though the positive correlations suggest that volume and macroeconomic indicators are related, they do 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

[14]The (constant maturity) data on the interest rate variables are obtained from the Federal Reserve website at the URL http://www.federalreserve.gov/releases/h15/data.htm#fn11.

the S&P 500 return.[15] 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").

We find that put option volume positively predicts non-signed shifts in all 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, a put volume shift in the amount of the mean daily options volume shift change documented in Table 1 (i.e., 0.38) is associated with an extra 0.15% shift in the term spread. We find that call volume negatively predicts absolute returns in the stock market, which is a puzzle. This consistently strong and positive forecasting capability of put volume but *not* of call volume for shifts in all the three interest rate variables is puzzling.[16] The result, however, is consistent with agents insuring themselves through put options in advance of high absolute changes in macroeconomic variables (which may be accompanied by higher uncertainty in the underlying index market). We also find that cash volume positive predicts absolute shifts in the short rate. Finally, legacy futures volume is positively related to future movements in the short-rate, the term spread and the stock market. E-mini futures have no such predictive ability for the macro variables, indicating perhaps that the clientele in the legacy futures, with its bigger contract size, is more sophisticated.

Note also that absolute equity returns (a measure of volatility) are predictable not only from their own lagged values but additionally from volume in contingent claims. Indeed, increases in put and legacy futures volumes strongly portend upward shifts in stock market volatility after controlling for past volatility. This underscores the role of contingent claims in price formation.

[15] 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.

[16] The negative coefficient of call volume in the regression for the stock market arises as a result of multicollinearity between call and put volume; call volume is not significant in that regression when put volume is excluded.

Overall, there is reliable evidence that volume series contain information about absolute shifts in the macroeconomic variables, 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 (Panel A), and the absolute value of the return in the second regression (Panel B). 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. Where appropriate the regressions are corrected for first order autocorrelation in the residuals as in Table 3.

With regard to the signed return regressions, it is worth reiterating 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, we observe that call volume significantly and positively predicts the return on the day of the unemployment announcement, consistent with buying pressure on calls prior to a positive announcement. We also find that larger returns on the day of the CPI announcement are associated with significantly lower cash

index volume over the previous three days, which is a puzzle. We conjecture that positive news about CPI leaks out more readily than negative news, as there is more incentive to leak good rather than bad news (Bergman and Roychowdhury, 2008).[17] This implies that there would be more private information about negative CPI announcements, implying a volume surge prior to such announcements, leading to the negative coefficient in the cash market. It still remains a puzzle, however, why such a negative coefficient does not extend to contingent claims volume.

In the absolute return regressions (Panel B of Table 6), we find that put volume significantly predicts absolute returns on the day of the announcements, and this result is consistent with the significance of this variable in Table 5.[18] The role of the put option volume is again consistent with agents insuring themselves in advance of material macroeconomic news releases. Overall, the results indicate that trading activity in options markets (but not in other contingent claims) predicts signed and absolute returns informational announcements, supporting the notion that the nonlinear payoffs afforded by options make them particularly appealing to speculators and hedgers relative to other claims. However, the negative sign on cash volume in the signed return CPI regression remains somewhat of a conundrum that deserves attention in future research.

IV. Conclusion

Trading is costly, so it becomes interesting to examine trading activity in assets that would be superfluous in a frictionless world. Finance textbooks are replete with knowledge about how such securities should be priced relative to each other,[19] but comparatively little is known about the relative extent of volume in these claims.

[17] While Bergman and Roychowdhury (2008) discuss this phenomenon in the context of corporate disclosure, the same logic applies to governments, who presumably want to keep sentiment positive for political reasons.
[18] Again, the coefficients can be interpreted in terms of proportional changes in the volume variable; thus, the coefficient of 2.82 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 0.38 in Table 1 implies an extra absolute return of 0.08%. We leave it for the reader to perform other such illustrative calculations on economic significance.
[19] See, for example, Bodie, Kane, and Marcus (2009), Chapters 21 to 23.

To the best of our knowledge, this paper contains the first analysis of the joint time-series of multiple "redundant" derivatives and the cash market. We study trading volume in three contingent claims, index options, index futures (both the legacy and the E-mini contracts), and the ETF, as well as volume in the underlying 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.

We find that the volumes on S&P index options, the ETF, the E-mini futures and on the cash index itself have trended upward over recent years but legacy futures volume has trended downward. The overall index futures volume (legacy plus E-mini) has trended upward, indicating that the E-mini has at least partially supplanted the legacy contract. Trading activity innovations in all series are strongly and positively cross-correlated. Calendar regularities also differ across contracts; for example, there is a January volume seasonal in the cash index but this is not as strongly evident in its contingent claims, which reveals trading in individual stocks at the turn of the year.

Vector autoregressions indicate that the time-series are jointly determined; notably, impulse responses indicate that while contingent claims 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 is consistent with the notion that informed investors trade in contingent claims first, and this trading activity subsequently spills over to the cash market. Furthermore, the forecasting ability of volume innovations in legacy futures and options on cash volume is stronger (more persistent) than those in the E-mini contract and the ETF, suggesting a more sophisticated clientele in the former markets, which have larger contract sizes.

Put options and legacy futures volume predict shifts in the term structure and in the short rate. Furthermore, volumes in put options and legacy futures forecast stock market volatility

even after accounting for volatility persistence. Put volume series also predict absolute returns on the day of major macroeconomic announcements, suggesting that agents trade on private information in derivative markets, possibly to circumvent short-selling constraints in cash markets. The predictive ability of cash volume for shifts in macroeconomic variables is quite limited, indicating that options markets, with enhanced leverage and nonlinear payoffs that cover more contingencies relative to other contingent claims, play a material role in price formation.

This study, being the first on the topic, is exploratory in nature and underscores the importance of developing explicit theoretical models that incorporate trading in multiple contingent claims. Much more needs to be done on the empirical side as well. For example, relating how these series contribute to price formation around other announcements, such as shifts in the stance of the Federal Reserve, would be intriguing. 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) 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, legacy futures, E-Mini futures, and the "Spider" ETF (SPDR). In Panel A, the means, medians, standard deviations, and mean absolute deviations are in millions of contracts (futures, legacy and E-Mini), dollar volume (options) or shares (ETF and Cash). SPDRs trade in units of one-tenth of the index and futures trade in units of $500 times the index. Panel B presents summary statistics for daily absolute changes in percentages. The time-period is September 1997 (debut of the E-Mini contract) through December 2009.

Panel A: Levels

Statistic	Cash	Options	Futures	E-Mini	ETF
Observations	3526	3524	3525	3525	3098
Mean	58.36	5.48	59.70	739.46	71.08
Median	49.74	2.59	55.91	547.75	32.49
Standard deviation	34.64	7.89	51.84	842.08	106.61
Mean absolute deviation	26.23	4.89	25.87	631.77	72.56
Skewness	1.32	3.93	31.41	2.53	1.61
Kurtosis	2.17	23.15	1496.9	7.69	2.79

Panel B: Daily absolute changes (in percentages)

Statistic	Cash	Options	Futures	E-Mini	ETF
Observations	3525	3523	3523	3523	3096
Mean	13.3	38.0	23.0	31.0	29.6
Median	9.7	29.8	17.0	24.1	17.3
Standard deviation	14.3	33.7	28.6	29.5	55.9
Mean absolute deviation	9.2	24.8	15.8	20.3	24.7
Skewness	3.34	1.89	9.82	4.15	10.45
Kurtosis	17.14	5.60	180.6	45.88	188.0

Table 2: Correlation matrix

Here are correlation matrices for daily volume in the S&P 500 (cash) Index, and S&P 500 options, futures (legacy and E-Mini), and ETF. The time-period is September 1997 through December 2009.

Panel A: Levels

Variable	Cash	Options	Futures	E-Mini
Options	0.772			
Futures	-0.166	-0.098		
E-Mini	0.830	0.781	-0.223	
ETF	0.847	0.886	-0.172	0.908

Panel B: Daily Percentage Changes

Variable	Cash	Options	Futures	E-Mini
Options	0.442			
Futures	0.541	0.310		
E-Mini	0.262	0.160	0.295	
ETF	0.549	0.317	0.430	0.286

Table 3: Time-Series Regressions of Volume

Log Volume in the S&P 500 (cash) Index and in S&P 500 Options, Futures (legacy and E-Mini contracts), and "Spider" ETF are regressed on variables intended to remove calendar regularities and trends. Macroeconomic announcements are for Unemployment, the CPI, and the main GDP announcement (not the advance announcement.) The macroeconomic dummies are turned on for two five-day periods: (1) on the five days preceding the announcement and (2) on the announcement date plus the four following days. 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 September 1997 through December 2009. The Cochrane/Orcutt method corrects first order autocorrelation in the residuals.

Body of Table is on following page.

Explanatory Variable	Cash		Options		Legacy Futures		E-Mini Futures		ETF	
	Coeff.	T-Stat.	Coeff.	T-Stat.	Coeff.	T-Stat.	Coeff.	T-Stat.	Coeff.	T-Stat.
Trend	1.4957	26.28	2.5858	23.17	-1.5247	-24.99	6.4339	59.31	5.0932	65.00
Tuesday	0.0925	13.29	0.1751	9.24	0.1457	9.97	0.1124	4.41	0.1466	9.56
Wednesday	0.1270	15.05	0.1980	8.66	0.1772	10.14	0.1165	3.82	0.1854	10.05
Thursday	0.1027	10.87	0.2169	8.51	0.1377	7.12	-0.0340	-1.01	0.1765	8.61
Friday	0.0523	6.48	0.0628	2.84	0.0845	5.02	-0.2458	-8.36	0.1224	6.96
February	-0.1204	-2.96	-0.1604	-1.64	-0.0620	-0.98	-0.0721	-0.65	-0.0381	-0.51
March	-0.1136	-2.42	-0.0001	0.00	0.0984	1.49	-0.4031	-3.45	0.0312	0.39
April	-0.1033	-2.11	-0.0939	-0.85	-0.0973	-1.45	-0.1091	-0.92	0.0053	0.07
May	-0.1857	-3.75	-0.2506	-2.27	-0.1534	-2.29	-0.1392	-1.17	-0.1131	-1.39
June	-0.1294	-2.60	-0.2004	-1.82	0.0891	1.33	-0.4510	-3.82	-0.0046	-0.06
July	-0.2761	-5.55	-0.2381	-2.16	-0.1396	-2.09	-0.1519	-1.29	-0.1354	-1.67
August	-0.3023	-6.10	-0.2209	-2.01	-0.1400	-2.11	-0.1718	-1.46	-0.0995	-1.23
September	-0.2049	-4.16	-0.0337	-0.31	0.0891	1.34	-0.4888	-4.14	-0.0027	-0.03
October	-0.2051	-4.30	-0.0188	-0.18	-0.0596	-0.92	-0.0843	-0.73	0.0780	0.99
November	-0.3556	-7.71	-0.1877	-1.77	-0.1702	-2.60	-0.3067	-2.65	-0.1838	-2.34
December	-0.2803	-7.02	-0.1804	-1.90	-0.0987	-1.62	-0.8142	-7.57	-0.2142	-2.99
Unemp -5 -1	0.0048	0.32	0.0088	0.23	0.0668	2.39	0.0625	1.28	-0.0305	-1.00
Unemp 0 +4	0.0675	5.21	0.0913	2.70	0.1519	6.29	0.1144	2.70	0.1079	4.06
CPI -5 -1	0.0353	2.79	0.1122	3.34	0.0267	1.08	-0.1633	-3.78	-0.0073	-0.28
CPI 0 +4	0.0234	1.80	0.1385	3.95	0.0992	3.88	-0.1991	-4.44	0.0333	1.23
GDP -5 -1	-0.0524	-2.40	-0.0161	-0.28	0.0378	0.91	-0.1745	-2.39	-0.0231	-0.51
GDP 0 +4	0.0531	2.42	0.0084	0.15	0.1659	4.05	-0.0506	-0.70	0.0635	1.41
Remtrm			0.0176	0.34	0.0119	0.31	-0.8949	-13.39		
Intercept	3.6536	353.44	3.8921	131.76	4.4455	188.03	3.4983	84.88	4.6698	191.91
Adjusted R^2	0.2585		0.1803		0.2147		0.5667		0.5872	
Durbin-Watson	2.373		2.435		2.225		1.989		2.376	

Table 4: Selected VAR Results

Correlations in the innovations from a vector autoregression (Panel A) and coefficients on the exogenous variable, VIX, (Panel B) are reported for daily OLS residuals obtained by regressing the natural logarithms of trading volume of the S&P 500 Index, and of S&P 500 options, futures, and the ETF against calendar regularities and macroeconomic announcements, as shown in Table 3. The time-period is 1996 to 2007. Volume is in number of contracts. The coefficients in Panel B are multiplied by 100.

Panel A: Correlation Matrix

Variable	Cash	Options	Futures	E-Mini
Options	0.456			
Futures	0.466	0.290		
E-Mini	0.206	0.096	0.281	
ETF	0.586	0.349	0.421	0.296

Panel B: Coefficients of VIX

Variable	Coefficient	t-statistic
Cash	0.192	4.67
Options	0.816	7.82
Futures	0.446	5.39
E-Mini	0.484	3.26
ETF	0.699	8.33

Table 5: Volume and the Macroeconomy

Panel A presents summary statistics and contemporaneous correlations between daily log volumes and absolute values of the daily changes in macroeconomic variables and the absolute percentage return on the S&P 500 index. Mean and Sigma are the daily sample average and standard deviation respectively. 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 the following: (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, legacy index futures, E-Mini futures and the "Spider" ETF. The variable LagDepVar is the average three-day lag of the dependent variable. The time-period is September 1997 through December 2009. Volume is in number of contracts, and all volume coefficients in Panel B are multiplied by 1000.

Panel A: Summary Statistics and Contemporaneous Correlations

	Mean	Sigma	Cash	Calls	Puts	Futures	E-Mini	ETF	Short Rate	Term Spread	Credit Spread
	Summary Statistics		Correlations								
Cash	17.86	0.478									
Calls	14.28	0.937	0.7303								
Puts	14.44	1.011	0.7675								
Futures	10.81	0.594	-0.3575								
E-Mini	12.45	1.922	0.6765								
ETF	17.36	1.387	0.7950								
Short Rate	0.0336	0.0561	0.1940	0.2065	0.2447	0.0642	0.0400	0.1144			
Term Spread	0.0538	0.0583	0.2248	0.2474	0.2822	0.0197	0.1354	0.2014	0.6577		
Credit Spread	0.0118	0.0192	0.1866	0.2034	0.2409	-0.0509	0.1376	0.2085	0.0927	0.1671	
S&P 500	0.9373	0.9850	0.1933	0.2186	0.3153	0.1686	0.0727	0.1821	0.1752	0.2485	0.2197

Table 5 contd. on next page

Table 5, contd.

Panel B: Predictive Regressions

Variable	Short-term interest rate		Term Spread		Credit Spread		Stock Market	
	Coeff.	*t*-stat.	Coeff.	*t*-stat.	Coeff.	*t*-stat.	Coeff.	*t*-stat.
Cash	3.111	2.62	1.292	0.95	-0.628	-1.37	-0.376	-1.63
Call	-0.872	-1.23	-0.397	-0.49	0.326	1.18	-0.497	-3.56
Put	3.225	4.20	4.179	4.75	0.882	2.99	1.380	8.89
Futures	1.685	2.63	1.609	2.18	0.216	0.87	0.341	2.61
E-Mini	-0.310	-0.90	0.321	0.81	0.002	0.02	-0.018	-0.27
ETF	-0.973	-1.41	-1.110	-1.41	0.113	0.43	-0.199	-1.49
LagDepVar	0.213	31.41	0.150	18.18	0.139	16.51	0.126	13.51
Intercept	-0.249	-4.52	-0.210	-3.34	-0.025	-1.17	-0.013	-1.16
Adjusted R^2	0.328		0.178		0.142		0.169	

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, legacy index futures, E-Mini futures and the "Spider" ETF. "Cashret" represents the compounded three lags of returns on the index. The time-period is September 1997 through December 2009. Volume is in number of contracts. Coefficients on volume variables are multiplied by 1000.

Panel A: Signed Announcement-Day Return

	Unemployment		CPI*		GDP*	
Variable	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.
Cash	-0.7741	-0.43	-3.5910	-2.56	0.1673	0.09
Call	2.5300	2.22	0.9650	1.10	-1.9850	-1.75
Put	-1.6670	-1.40	-0.0987	-0.10	1.0570	0.92
Futures	-0.0450	-0.04	-0.2743	-0.34	-1.1470	-1.02
E-Mini	-1.1220	-1.07	-0.2226	-0.58	-0.7555	-1.34
ETF	0.9366	0.60	1.3300	1.72	1.1610	1.09
Cashret	-0.0633	-0.96	0.0362	0.60	0.0122	0.23
Intercept	0.0021	0.02	0.1252	1.56	0.0268	0.36
Adjusted R^2	0.0235		0.0521		-0.0064	

Panel B: Absolute Announcement-Day Return

	Unemployment*		CPI		GDP*	
Variable	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.
Cash	-0.8858	-0.75	0.1296	0.12	0.2236	0.20
Call	-0.0053	-0.01	-0.9903	-1.66	-0.8020	-1.14
Put	1.6970	2.43	2.8210	3.90	1.5280	2.12
Futures	-0.0144	-0.02	0.3529	0.66	1.2470	1.66
E-Mini	0.0848	0.12	-0.0557	-0.23	-0.1240	-0.34
ETF	-1.0650	-1.04	-0.8945	-1.61	-0.0886	-0.13
|Cashret|	0.0244	0.41	0.1599	2.51	0.0052	0.09
Intercept	0.0336	0.62	-0.0427	-0.86	-0.0580	-1.07
Adjusted R^2	0.0443		0.1960		0.0567	

*Corrected for first-order autocorrelation in the residuals.

Figure 1. Volume for the S$P 500 and its Options, Spider, and Futures

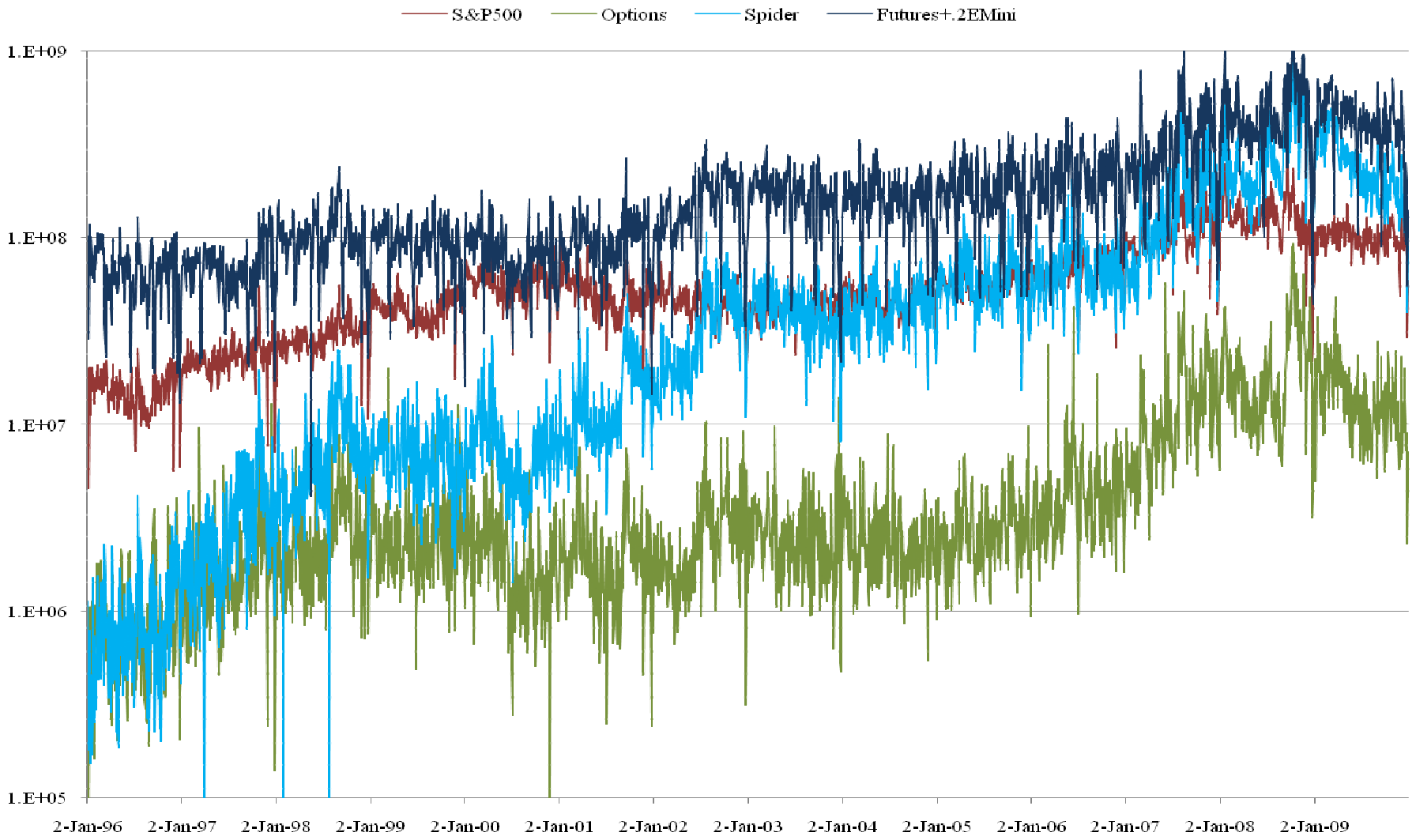

Figure 2. Contract Volumes of S&P 500 Legacy and E-Mini Futures

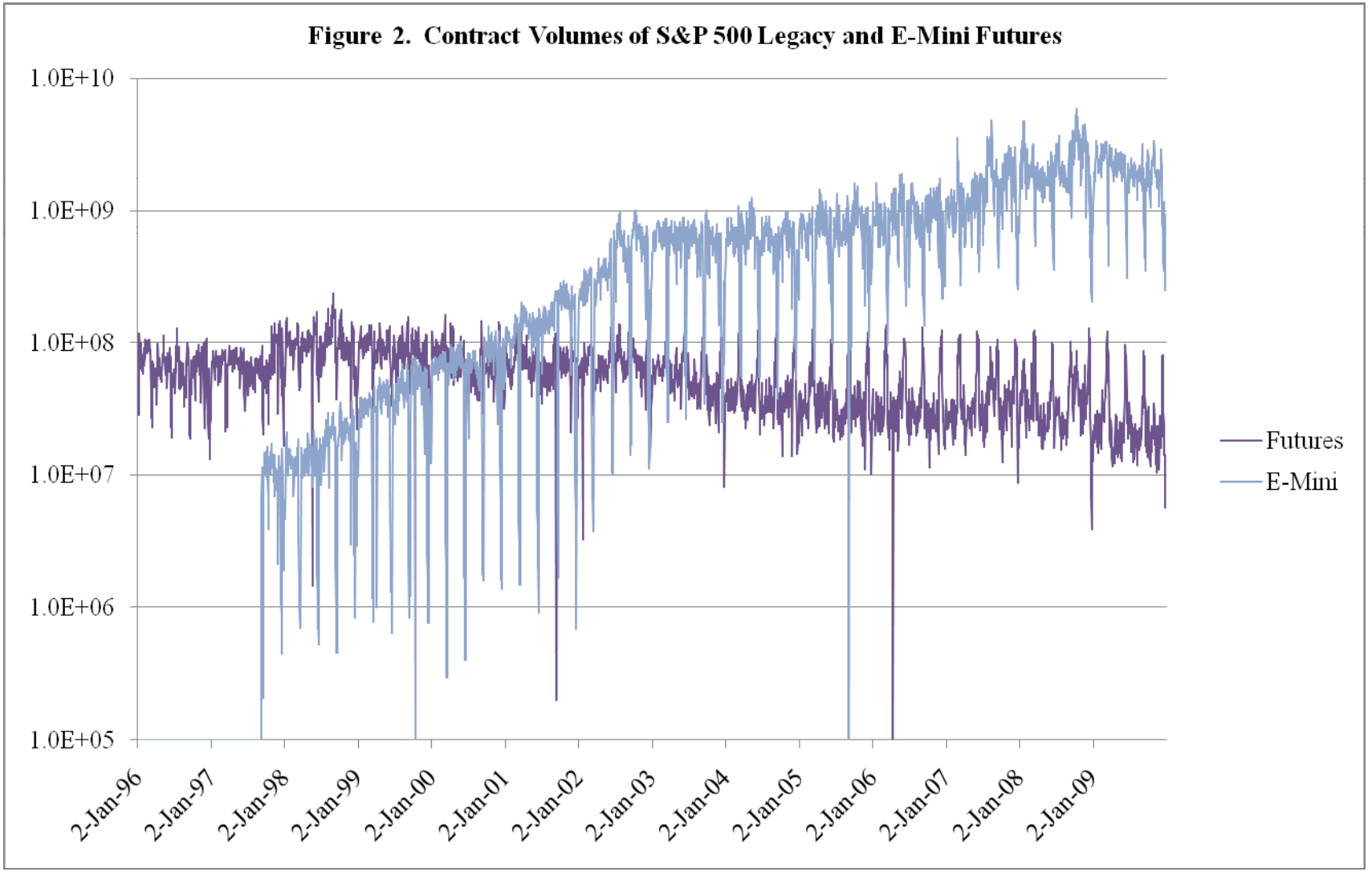

Figure 3: Impulse Response Functions

Here are impulse response functions from a VAR with daily volume for the "spot" (i.e., cash) S&P 500 Index, and for S&P 500 options, futures, E-mini futures, and ETF. The time-period is September 1997 to December 2009. The data are the OLS residual series from the regressions reported in Table 3 (before the Cochrane/Orcutt transformation.)