The Dark Side of Financial Innovation

Brian J. Henderson*
George Washington University

Neil D. Pearson†
University of Illinois at Urbana-Champaign and MIT

September 4, 2008

Abstract

The ability to create securities providing state-contingent payoffs tailored to specific investors seems conducive to improving allocative efficiency. But if some investors assign incorrect probability weights to events, financial institutions can exploit these errors by creating financial instruments that investors overvalue. We analyze the pricing of SPARQS, the most popular listed structured equity product, and document that they are sufficiently overpriced that their expected returns are less than the riskless rate. In a standard model of portfolio selection, such securities would not rationally be purchased by an investor whose marginal utility covaries negatively with the SPARQS returns, and it is difficult to rationalize the SPARQS purchases in the context of a plausible normative model of rational investors. SPARQS are however consistent with the hypothesis that investment banks design structured products to exploit investors' valuation errors.

* *E-mail:* bjhndrsn@gwu.edu. George Washington University, Department of Finance, Funger Hall Suite #502, 2201 G Street NW, Washington DC 20052. Phone: (202) 994-3669.

† *E-mail:* pearson2@illinois.edu. University of Illinois at Urbana-Champaign, Department of Finance, 109 Wohlers Hall, 1206 Sixth Street, Champaign, IL 61820. Phone: (217) 244-0490.

The Dark Side of Financial Innovation

Abstract

The ability to create securities providing state-contingent payoffs tailored to specific investors seems conducive to improving allocative efficiency. But if some investors assign incorrect probability weights to events, financial institutions can exploit these errors by creating financial instruments that investors overvalue. We analyze the pricing of SPARQS, the most popular listed structured equity product, and document that they are sufficiently overpriced that their expected returns are less than the riskless rate. In a standard model of portfolio selection, such securities would not rationally be purchased by an investor whose marginal utility covaries negatively with the SPARQS returns, and it is difficult to rationalize the SPARQS purchases in the context of a plausible normative model of rational investors. SPARQS are however consistent with the hypothesis that investment banks design structured products to exploit investors' valuation errors.

1 Introduction

Much of the extant literature portrays financial innovations as helping economic agents achieve a desired function in the presence of one or more market inefficiencies or imperfections.[1] For example, new securities may be created to allow investors to achieve desired payoffs not spanned by the previously available financial instruments, or loosely to complete markets. Ross (1976) takes this "spanning" view of financial innovation in arguing that the introduction of option contracts improves allocative efficiency when the previously existing set of securities fails to span the state space.[2] Other research presents financial innovations as arising to ameliorate imperfections such as agency conflicts (Ross (1989)), to reduce transactions costs (Ross (1989), McConnell and Schwartz (1992), and Grinblatt and Longstaff (2000)), and to minimize the impact of taxes or regulations (Miller (1986) and Santangelo and Tufano (1996)). Dynan, Elmendorf, and Sichel (2006) suggest financial innovation has played a key role in reducing the volatility of economic activity. A common element in these papers is that financial innovations arise in response to market inefficiencies or imperfections and provide the benefit of ameliorating at least one inefficiency or imperfection.[3] This generally benign view of financial innovation is unsurprising, since, as noted by Tufano (2003), "bringing new securities to market requires the voluntary cooperation of both issuers and investors."

Financial institutions' ability to create securities providing state-contingent payoffs tailored to the needs or desires of specific investors or groups of investors seems especially conducive to improving allocative efficiency. But there is a dark side to the ability to create instruments with tailored payoffs. If some group of investors misunderstands financial markets or suffers from cognitive biases that cause them to assign incorrect probability weights to events, financial institutions can exploit these misunderstandings and cognitive biases by creating financial instruments that pay off in the states that investors overweight and do not pay off (or pay off less highly) in the states that investors underweight, leading the investors to value the new instruments more highly than they would if they understood financial markets and correctly evaluated information about probabilities of future events. That is, financial institutions can exploit investors by creating precisely the securities or other financial instruments for which investors are willing to overpay. Some innovative financial instruments may be created solely or primarily for this reason, rather than for the benign reasons

[1] Tufano (2003) provides a thorough summary of the literature on financial innovation.

[2] Qualifying this view, Elul (1995) demonstrates that introduction of non-redundant assets in incomplete markets does not always improve welfare. The introduction of a new asset may make some or all agents worse off. Allen and Gale (1991) argue that relaxing short-sale restrictions by allowing unlimited short-sales may not be desirable.

[3] Frame and White (2004) and Tufano (2003) also discuss the fact that some financial innovations arise in response to regulations and differences in taxation. As Frame and White (2004) point out, whether one sees this innovation as beneficial or deleterious will depend on one's views of the regulatory or differential taxation regime.

that have been the focus of much of the literature.

We provide evidence on the dark side of financial innovation by focusing on Stock Participation Accreting Redemption Quarterly-pay Securities (SPARQS), a subset of the U.S. publicly issued structured equity products (SEPs). SEPs are medium-term notes issued by financial institutions and have payments based on another company's common stock price, multiple common stock prices (e.g., baskets of common stocks), a stock index, or multiple stock indices. They are designed and issued by banks and investment banks and typically marketed to retail investors. SPARQS, created and marketed by Morgan Stanley, are the most popular of the SEPs with payoffs based on the prices of individual common stocks. An example is provided by the SPARQS based on the price of National Semiconductor Corporation common stock that were issued by Morgan Stanley on April 23, 2004. Although this SPARQS issue had cash flows based on the price of National Semiconductor stock, the securities were issued by, and were obligations of, Morgan Stanley. We present relevant evidence and argue that it is difficult to rationalize investors' purchases of SPARQS within the context of any plausible normative model of the behavior of rational investors. The SPARQS appear to offer no benefit to investors that is not already provided by the existing set of available financial instruments, and their negative abnormal returns are large enough that the SPARQS' investors' welfare would likely be improved if they simply invested in bank certificates of deposit.

Between 1992 and 2005 investors purchased over $50 billion of SEPs from investment banks or the investment banking arms of banks, indicating that at least some retail investors include these products in their portfolios in significant quantities. Through the end of 2005, about 43% of the SEPs had payoffs based on individual equities, about 48% had payoffs based on stock indexes, and about 9% had payoffs based on multiple stocks (e.g., baskets of stocks) or multiple stock indices. Structured equity-linked notes primarily are marketed to retail clients, as noted by Pratt (1995) and Bethel and Ferrel (2007). Frequently, the issuing financial institution arranges for the structured product to be listed on the American Stock Exchange (AMEX), NASDAQ, or the New York Stock Exchange (NYSE) following issuance, providing at least some secondary market liquidity to the buyers of the product.

It is worth emphasizing that structured equity products are liabilities of the issuing financial institution and not of the company whose stock is the underlying asset. An immediate implication is that the designs of structured products are neither determined nor even influenced by the financing needs and capital structure policies of the company whose stock is the underlying asset. Rather, the issuing financial institution sells the structured product, and then trades in the underlying common stock and possibly derivative contracts in order dynamically to hedge the resulting equity exposure created by its short position in the structured product. The issuing financial institution can select any payoff pattern that it thinks investors will find appealing, subject to the caveat that the issuing financial institution will avoid issuing structures that are extremely costly or difficult to hedge.[4]

We focus on the SPARQS because they are the most popular of the listed SEPs. From the first SPARQS issue in June of 2001 through the end of 2005, Morgan Stanley issued 69 different SPARQS, with total proceeds of $2,176,745,314. The SPARQS have maturities of approximately one year, are callable (and frequently are called) after approximately six months, and have high coupon rates. The call feature places a "cap" on their payoffs, making their payoffs concave functions of the underlying stock prices that are similar to those of covered call positions. Other financial institutions offer very similar products under different names, e.g., the STRIDES offered by Merrill Lynch and the YEELDS offered by Lehman Brothers. Henderson and Pearson (2007) document that the typical SEP based on an individual equity is similar to a SPARQS issue in that it has a payoff that is a concave function of the underlying stock price, a short original time to maturity, and a high coupon.[5]

We conduct a thorough analysis of the pricing of the SPARQS on their issue dates and find that the primary market investors pay on average an eight percent premium for these securities, where the premium is defined as the difference between the offering price and an estimate of the fair value. This is a large premium for a product that is callable after about six months and has a maximum maturity of slightly more than one year, as it implies that the purchaser locks in a negative abnormal return of at least eight percent per year relative to a dynamically adjusted portfolio of the underlying stock and bonds with the same risk. Examination of the behavior of the secondary market price premia to the model values over time indicates a gradual adjustment toward the model values. While we do not estimate the values of the other types of SEPs, the information we have suggests that they also tend to have markups of about the same size.

Departing from the risk-neutral measure, we demonstrate that these premia are large enough, and the expected lives of the SPARQS short enough, that under the objective measure the expected returns on the SPARQS are less than the risk-free rate of interest. In a standard model of portfolio choice, such a security is rationally purchased by an investor only if its returns covary positively with the investor's marginal utility (Merton (1982)). The returns of the SPARQS covary positively with the broad market indices, and for the vast majority of investors almost certainly covary positively

[4]For example, to our knowledge only one SEP has included a digital payoff.

[5]SEPs with payoffs based on stock indexes typically have payoffs that are convex functions of the underlying stock index, longer times to maturity, and low coupons. See Henderson and Pearson (2007).

with consumption and negatively with marginal utility. Thus, it is difficult to rationalize primary market purchases of SPARQS by investors who hold portfolios that are positively correlated with or uncorrelated with the broad market indexes. Such SPARQS investors would have been better off investing in bank certificates of deposit, and it seems unlikely that investor purchases of SEPs can be explained by any plausible normative model of the behavior of rational investors.[6]

It is also unlikely that SPARQS satisfy any hedging needs of retail investors. The payoffs of SPARQS are qualitatively similar to those of covered calls, but SPARQS are callable by the issuer at a time-varying schedule of call prices, complicating their use as hedging instruments. Even for positions such as naked long put options for which SPARQS at first glance seem like a reasonable hedge, hedges involving ordinary exchange-traded options and the underlying stock seem more natural. Thus, hedging motives are unlikely to explain investors' demand for SPARQS. The SPARQS also do not provide tax advantages, are not particularly liquid, and do not appear to help investors avoid transactions costs.

Investment banks designing and selling SEPs is an example of a conflict of interest between financial institutions and their customers, about which there is a large empirical literature. Part of that literature addresses whether commercial banks acting as underwriters exploited information asymmetries to take advantage of public customers both before the passage of the Glass-Steagall Act and after banks were again permitted to underwrite some debt issues in the 1980s and 1990s.[7] In a recent survey Mehran and Stulz (2007) conclude that the evidence is "unambiguous" that the hypothesized "adverse impacts [on investors] simply do not exist." In marked contrast, though in a different context, we find that in selling its own (equity-linked) notes at least one underwriter clearly does take advantage of its customers.

Other researchers who have found that investors pay more than the fair market values for innovative securities include Rogalski and Seward (1991) and Jarrow and O'Hara (1989), who examined foreign currency warrants and Primes and Scores, respectively. These researchers argue that the securities they consider provide hedging benefits to investors, so their results do not have the negative implications for the products that ours do. Outside the U.S. markets, Szymanowska, Horst, and Veld (2005) estimate the values of reverse exchangeable securities issued in The Netherlands by ABN AMRO with payoffs based on the prices of other common stocks, while Baule, Entrop, and Wilkens (2005) calculate margins in the German retail structured products market using a sample

[6]Such strong statements cannot be made about many other high-cost financial products, for example mutual funds with high loads. Because an investor can hold mutual fund shares for several or even many years the expected return on a high-load mutual fund can exceed than the riskless rate.

[7]See, e.g., Kroszner and Rajan (1994), Puri (1994), Drucker and Puri (2005), and Drucker and Puri (2006).

of German "discount certificates" based on the prices of individual common stocks.[8] Burth, Kraus, and Wohlwend (2001) provide evidence about the pricing of Swiss structured products based on individual equities, which also have sizable markups. None of these researchers estimate the expected returns under the objective measures, so again their results do not have the negative implications about the products that ours do.[9]

The next section of the paper briefly describes the market for SEPs and the SPARQS that are the focus of our analysis. Section 3 analyzes the pricing of the SPARQS at the offer date and their post-issue performance. Section 4 departs from the risk-neutral measure used for valuation and shows that reasonable estimates of expected returns under the objective measure are less than the riskless rate. Section 5 discusses the implications of our findings and briefly concludes.

2 Structured Equity Products

Structured equity products evolved from related equity-linked instruments that were issued in the 1980's.[10] These predecessor instruments typically were issued by non-financial corporations to raise funds, and were underwritten by investment banks in the same way that other corporate securities often are. These predecessor instruments typically converted into, or had payoffs based on, the issuing firm's common stock. An example is provided by Preferred Equity Redemption Cumulative Stock (PERCS), which is a form of convertible preferred stock created by Morgan Stanley in 1988 and issued by a number of non-financial corporations during the late 1980's and early 1990's, using Morgan Stanley as the underwriter (see Harty (1992), Pratt (1994), and Chen, Kensinger, and Pu (1994)).[11] As the market evolved in the early 1990s, several investment banks sold SEPs in private transactions in which the investment bank functioned as both the issuer and underwriter and the payoffs were based on the common stock of another company. In July 1992, Merrill Lynch issued the first public index-linked structured note in which the issuing firm and

[8] Both the Netherlands reverse exchangeable securities and the German discount certificates have concave payoff functions and are similar to U.S. SEPs based on individual equities.

[9] Some insurance companies sell equity-indexed annuities that are similar to some publicly offered SEPs with payoffs based on equity indexes. Bernard and Boyle (2008) argue that these products are designed to exploit investors' cognitive biases in evaluating probabilistic information.

[10] Yet earlier antecedents are described in Chapter 2 of Mason, Merton, Perold, and Tufano (1995).

[11] PERCS were convertible preferred stock with a mandatory conversion date typically about three years after the issue date. The conversion ratio varied with the price of the underlying stock in such a way as to create a capped payoff equivalent to the payoff of a covered call strategy using an out-of-the-money three-year call option. The PERCS also paid dividends that exceeded the dividends paid by the underlying common stock. According to the SDC database, PERCS were issued by 16 companies between 1991 and 1996, including Sears Roebuck, Texas Instruments, General Motors, K-Mart, RJR, and Citicorp. Related competing products were developed and underwritten by Morgan Stanley's competitors. See Schroth (2006) for a discussion of underwriters' innovations in the equity-linked products market.

underwriter were the same.[12] These Market Index Target-Term Securities (MITTS) were linked to the performance of the S&P 500 Index and guaranteed investors the return of invested principal and capped participation in the index returns. In July of 1993, Salomon Brothers sold the first publicly offered SEP based on an individual equity price in which the issuer and underwriter were the same entity. Salomon's Equity-Linked Securities (ELKS) offered investors a high coupon (6.75%) and capped participation in the stock performance of Digital Equipment Corporation, a non-dividend paying stock, similar to an income generating covered call position in the underlying stock.

Publicly issued structured equity products typically are marketed to retail investors (Bethel and Ferrel (2007)). As the SEPs market evolved in the mid-1990s, considerable uncertainty surrounded the direction of future Internal Revenue Service treatment of structured products. According to Pratt (1994), the IRS originally required separate treatment of the debt and equity option portions. In fact, due to the uncertainty about the tax treatment of structured products, Merrill Lynch placed all of the original MITTS with tax-deferred accounts. Some uncertainty remains even for recent issues,[13] and it appears that the structured equity products are typically marketed to investors with tax deferred (e.g., self-directed IRA) accounts.[14] It does not appear that the publicly issued SEPs provide any significant tax benefit to investors.

Secondary market liquidity in SEPs is limited (Bethel and Ferrel (2007)). Some SEPs are listed on exchanges, for example the AMEX, with the issuing firms acting as market makers. Some of these exchange-listed SEPs trade nearly every day, but trading volumes are small and on some days there are no trades.[15] The other SEPs that trade only over-the-counter of course have very limited secondary market liquidity.

[12] As Baubonis, Gastineau, and Purcell (1993) note, banks issued equity-linked certificates of deposit prior to the first Merrill Lynch MITTS in 1992. These prior equity-linked CDs were FDIC insured CDs, which differ from SEPs since they are not registered debt and offer investors protection against the issuer's default.

[13] The pricing supplement for the Morgan Stanley/National Semiconductor SPARQS issued on April 30, 2004 reads in part: "There is no direct legal authority as to the proper tax treatment of the SPARQS, and consequently our special tax counsel is unable to render an opinion as to their proper characterization for U.S. federal income tax purposes. Therefore, significant aspects of the tax treatment of the SPARQS are uncertain. Pursuant to the terms of the SPARQS, you have agreed with us to treat a SPARQS as an investment unit consisting of (i) a terminable forward contract and (ii) a deposit with us of a fixed amount of cash to secure your obligation under the terminable forward contract, ... The terminable forward contract (i) requires you (subject to our call right) to purchase National Semiconductor Stock from us at maturity, and (ii) allows us, upon exercise of our call right, to terminate the terminable forward contract by returning your deposit and paying to you an amount of cash equal to the difference between the call price and the deposit. If the Internal Revenue Service (the "IRS") were successful in asserting an alternative characterization for the SPARQS, the timing and character of income on the SPARQS and your tax basis for National Semiconductor Stock received in exchange for the SPARQS might differ." See http://www.sec.gov/Archives/edgar/data/895421/000095010304000641/0000950103-04-000641.txt.

[14] We thank Gang Hu for verifying that the SPARQS almost never appear in an extensive dataset of institutional trades.

[15] Anecdotal evidence suggests that limited liquidity has been an issue from the outset of the market. For example, after Salomon Brothers issued an exchange-listed Equity-Linked Security (ELKS) in 1994, one trader noted "the guys who created [ELKS] and the secondary market traders went in separate directions" (Pratt (1995)).

Table 1 presents some summary information about the market for structured equity derivatives from 1992 through 2005. There were 1,588 issues, with aggregate proceeds of $50,082,039,526. The early years of the sample period saw few issues, and more than one half of the issues and 40% of the proceeds are from 2004 and 2005. In addition to showing the numbers of issues and the aggregate proceeds, the table also disaggregates the sample according to whether the payoffs are based on an individual equity price, an equity index, multiple equities, or multiple indices. The summary statistics in Table 1 reveal that of the $50 billion investors have paid for structured equity products in the U.S., roughly 43% of the proceeds have been from products linked to individual equities, 48% from index-linked products, and the remaining 9% from products linked to multiple stocks or indices. This sample used in Table 1 comprises to our knowledge the entire universe of publicly registered structured equity-linked notes issued by financial institutions in the U.S. during the period 1992–2005, excluding private, over-the-counter transactions.[16] To be included in the sample, a product must be issued and underwritten by the same financial institution and have a payoff dependent upon the price or return of another firm's equity, an equity index, or multiple equities or indices (for example, baskets of equities or the difference in the percentage changes of two indices).[17]

Table 2 lists the indices that are most frequently referenced by the index-linked products. The best-known U.S. equity indices, the S&P 500, NASDAQ-100, and Dow Jones Industrial Average, together account for 63% (343 of 543) of the issues linked to equity indices, and a larger fraction of the proceeds. The Nikkei index and Russell 2000 round out the top five most frequently referenced indices. The remaining indices are varied, and include non-U.S. indices such as the FTSE 100 and the Dow Jones Euro STOXX 50, broad sector indices such as the S&P Midcap 400, specialized indices such as the Lehman Brothers 10 Uncommon Values Index, and industry indices. For example, indices focusing on the housing sector, biotechnology, oil services, and semiconductor

[16] We constructed the sample by first identifying every financial institution that issued an equity-linked note that was listed on the AMEX or included in the Mergent database. The issuers are ABN AMRO, Bear Stearns, Bank of America, Canadian Imperial Bank of Commerce, Citibank (Salomon), CSFB, Goldman Sachs, JP Morgan, Lehman Brothers, Merrill Lynch, Morgan Stanley, UBS, Wachovia, and Wells Fargo. We then searched the EDGAR database of the U.S. Securities and Exchange Commission (SEC) for all issues by these financial institutions and identified all structured equity-linked notes, regardless of whether they were ever listed on the AMEX or included in the Mergent database. Because the SEC's EDGAR database includes all registered issues, the only SEPs that might be missed are those issued by a financial institution that was not included on our list of issuers because it never issued a structured equity-linked note that was listed on the AMEX or included in the Mergent database. As a check, we compared our sample to the instruments identified as structured equity-linked products in Mergent's Corporate Bond Source and at www.Quantumonline.com. All products identified as structured equity-linked products in Mergent's Corporate Bond Source and at www.Quantumonline.com appear in our sample, suggesting that our search of the E.D.G.A.R. database collected the entire universe or nearly the entire universe of registered structured equity-linked notes.

[17] The sample includes some U.S. SEPs based on non-U.S. equities or indices, including some that are described as "currency protected." These currency protected products often have a dollar-denominated payoff based on the local currency return of a non-U.S. equity or index.

firms all appear in the sample.

Merrill Lynch's MITTS are one of the most frequently issued index-linked products. MITTS are sold at their face values and provide exposure to increases in a reference index along with the guaranteed return of principal. The issue linked to the Dow Jones Industrial Average and sold on January 14, 2002 is an example. These MITTS are non-callable, do not pay interest, and mature on January 16, 2009. At maturity, each MITTS returns the $10 principal, plus a supplemental redemption amount equal to the product of the $10 principal and the amount by which the percentage increase in the reference index, adjusted downward by two percent per year, exceeds the index value on the issue date. Thus, investors in these MITTS are guaranteed to receive their principal and also participate in the growth of the index less two percent per year.

Table 3 lists the underlying common stocks that were used as the reference stocks for at least five different structured equity product issues linked to individual equities. There is a heavy concentration in technology stocks and large, high-profile stocks. Intel, Cisco Systems, Texas Instruments, Motorola, and Cendant are the five most common reference stocks and together accounted for 103 issues, or roughly 12% of the total sample of notes linked to individual equities.

3 Pricing and Expected Returns of SPARQS

From June 2001 through December 2005 Morgan Stanley issued 69 SPARQS, the most frequently issued of the listed SEPs. Of these 69 issues, 64 were listed and traded on the AMEX and the remaining 5 issues were not listed on any exchange. This section of the paper presents estimates of the premia or markups for the 64 SPARQS issued by Morgan Stanley and listed on the AMEX, where the premium is defined as the percentage difference between the offering price and an estimate of the fair market value. It also examines the SPARQS' post-issue performance relative to portfolios of the underlying stock and bonds that have the same risk. The analysis includes only the SPARQS that were listed on the AMEX because the market prices needed to examine the securities' post-issue performance are not available for the five unlisted issues.

We focus on the SPARQS for several reasons. First, the 69 issues and total proceeds of $2,176,745,314 were both the largest number of issues and greatest total proceeds of any of the products based on individual equity prices. Second, different SPARQS were structured consistently, making them well suited for a broad analysis. Third, the bulk of the other products based on individual equity prices issued by both Morgan Stanley and other investment banks are qualitatively similar to the SPARQS, and some are very nearly identical (e.g., the callable STRIDES issued by Merrill Lynch). This suggests that our results for the SPARQS are likely to generalize to many of the other products. Fourth, the SPARQS are relatively short-term: they have maturities of slightly over one year (average = 1.15 years) and are callable after six months (average = 0.6 years). This means that good volatility information is available from the implied volatilities of traded options and the possible pricing errors due to our neglect of stochastic volatility and interest rates are less important than they would be for the longer-term products, reducing the risk that valuation errors in our pricing model affect the conclusions. Finally, the fact that 64 of the 69 issues were listed on the AMEX allows us to estimate the post-issue performance (i.e., abnormal returns) of the SPARQS.

3.1 Value on the Issue Date

We estimate the values of the SPARQS using a standard approach that builds on the Black and Scholes (1973) and Merton (1973) framework in which under the risk-neutral probability the underlying stock follows the geometric Brownian motion

$$\mathrm{d}S_t = rS_t\mathrm{d}t + \sigma S_t \mathrm{d}\widehat{W}_t, \tag{1}$$

where $\widehat{W}$ is a Brownian motion under the risk-neutral probability, S is the underlying stock price, σ is the volatility of the underlying stock, and r is the riskless rate of interest. The Black-Scholes-Merton partial differential equation for the SPARQS value $V(S,t)$ is

$$\frac{\partial V(S,t)}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V(S,t)}{\partial S^2} + rS\frac{\partial V(S,t)}{\partial S} - rV = 0. \tag{2}$$

The terms of the SPARQS provide the boundary conditions for equation (2).[18]

In particular, each SPARQS issue has an exchange ratio that determines the payoff in the event that the SPARQS is held to maturity. If the SPARQS are not called or terminated early, at maturity each SPARQS pays the final coupon and also pays an amount equal to the product of the exchange ratio and the final price of the underlying equity.[19] This provides the terminal boundary condition

$$V(S,T) = RS_T + c_T, \tag{3}$$

where R is the exchange ratio and c_T is the final coupon paid at maturity T. The exchange ratio is commonly either one or one-half, so a SPARQS typically roughly corresponds to either one or one-half share of the underlying stock, respectively.

[18]If the underlying stock pays dividends equation (2) will hold before and after each ex-dividend date, with a boundary condition at the ex-dividend date connecting the solutions.

[19]Adjustments to the exchange ratio are made for corporate events such as stock splits.

The terminal boundary condition (3) is not relevant for stock prices in the entire domain $(0, \infty)$ because the SPARQS will be called prior to maturity if the stock price is sufficiently high, and will be terminated early if the underlying stock price is very low. Following an initial period of call protection of about six months, the SPARQS are callable by the issuer at a schedule of call prices that increases over time. The call price schedule is chosen so that, if the SPARQS are called, the combination of the call price and the coupons received to date provides a yield (internal rate of return) specified in the pricing supplement. For example, the SPARQS issued on April 30, 2004 based on National Semiconductor Corporation common stock were callable beginning on October 30, 2004, with a yield-to-call of 20.50%. The call price on each day is the cash payment such that the payment due the investors at the time of call plus the past coupons the investors have already received provides an internal rate of return of 20.50%. In particular, the call price on each date t for which the securities are callable satisfies the equation

$$P_0 = \sum_{\{i|t_i \leq t\}} \frac{c_{t_i}}{(1+y/2)^{2\tau_i}} + \frac{C(t)}{(1+y/2)^{2\tau}}, \tag{4}$$

where P_0 is the original issue price, $C(t)$ is the call price at time t, y is the specified required yield-to-call, c_{t_i} is the i-th interim cash flow (interest payment) paid by the SPARQS at time t_i, τ_i is the time from the issue date to the i-th interest payment measured using the 30/360 day-count convention, and τ is the time from the issue date to t, again measured using the 30/360 day-count convention.

This call provision provides the upper spatial boundary for (2). It has the effect of capping the return to the SPARQS so that the maximum return is equal to the specified yield y, and causes the SPARQS to have a payoff similar to that of a covered call position in the underlying stock where the call price of the SPARQS plays a role analogous to the strike price of the call option in the covered call position. (A difference is that the call price of the SPARQS varies over time.) That is, the SPARQS can be interpreted as analogous to a covered call, in which the buyer sells the call back to Morgan Stanley in exchange for the coupons. The boundary at which Morgan Stanley calls the SPARQS is a free boundary determined as part of the solution, assuming that Morgan Stanley determines the call policy in order to minimize the value of the SPARQS.

Finally, the SPARQS have a "clean-up" provision under which they will be terminated early in exchange for an estimate of the present value of the remaining cash flows if the underlying stock price becomes very low. Specifically, in the event that the underlying stock price closes below a specified price, usually \$2 per share, on two consecutive days, a "Price Acceleration Event" occurs.

This accelerates maturity of the SPARQS issue to that date, and the investor receives the product of the exchange ratio and the closing stock price plus the net present value of all future coupons, computed using an estimate of the term structure of zero-coupon rates on Morgan Stanley's senior unsecured debt.[20] This early termination or "acceleration" provision provides the lower spatial boundary for the partial differential equation (2).

The terms of the SPARQS are selected so that the offering price is equal to the product of the exchange ratio and the stock price on the offering date. Because Morgan Stanley's marketing costs, hedging costs, any other costs, and profit are embedded in the offering price, the offer price must exceed a reasonable estimate of the fair value. As mentioned above, the exchange ratio is commonly either one or one-half, so the SPARQS can be interpreted as similar to a covered-call position on either one or one-half share.

Using the pricing model described above, we first compute estimates of the fair values of the SPARQS as of the dates they were offered for sale. This requires several parameter values for each issue, of which the volatility σ is the most important. Because the SPARQS, if called, are likely to be called early, we use the implied volatility on the SPARQS offering date of the call option contract in the OptionMetrics database that: (i) has a time to expiration that most closely matches the time to first call of the SPARQS; and (ii) has a strike price equal to the SPARQS call price as of the first call date, adjusted (divided) by the exchange ratio. The daily stock prices and returns of the underlying stocks used in the analysis come from the CRSP daily files, and the historical values of LIBOR for the offering dates were collected from Bloomberg. Given these parameter values, and the partial differential equation (2), we take the log transform to obtain a partial differential equation with constant coefficients and then approximate the solution using a standard finite difference scheme described in Appendix 1.

For each SPARQS, Table 4 presents the estimate of value on the offering date, the issue price, and the premium of the offer price over the value estimate. The table also includes some information about the SPARQS and the inputs used in the valuation model. The average offering price at the offering date is 8.77% above the calculated model price, indicating that primary investors are paying a large premium for these securities. The value-weighted average premium, 7.71%, is only slightly smaller. The finding that the value-weighted premium is slightly smaller than the equal-weighted premium indicates that the premia on larger issues tend to be lower than those on

[20]We use LIBOR as a proxy for these zero-coupon rates. Through the end of 2005, only one SPARQS issue, referenced to Corning, experienced a Price Acceleration Event. On July 31, 2001 and August 1, 2001, the stock of Corning closed at $1.6 and $1.56 per share, respectively, which triggered the price acceleration event on the SPARQS linked to Corning's stock. See Baker and Quinn (2005) for a description of Corning's convertible preferred stock issue and the stock price collapse allegedly due to short-selling pressure.

smaller issues. Given that the SPARQS are callable after six months and have an average initial term-to-maturity of slightly more than one year, the magnitudes of the equally and value-weighted premia are impressive. These results imply that investors who purchase the SPARQS at the offering prices can expect to suffer average abnormal returns of –8.77% (equal-weighted) or –7.71% (value-weighted) over six to twelve months relative to dynamically adjusted benchmarks formed from the underlying stocks and bonds. As we see below, these premia are large enough that reasonable estimates of the expected returns on the SPARQS are less than the risk free rate of interest.

3.2 Post-Issue Return Performance

The results in Section 3.1 indicate that investors who purchase the SPARQS at the offering prices on average pay a premium of about 8% over estimates of their values. Initial over-pricing of this magnitude implies that the SPARQS will subsequently under-perform the proper risk-adjusted return benchmarks formed from the underlying stocks and bonds. This section examines the secondary market performance of the SPARQS subsequent to the issue date, and confirms that investors in the SPARQS do in fact suffer negative abnormal returns following the issue date.

As of December 31, 2005, Morgan Stanley had issued a total of 69 SPARQS. Of these 69 issues, only 5 were not listed on the AMEX. The remaining 64 securities have secondary market prices available in the NYSE Trade and Quote (TAQ) database. The empirical tests in this section, which rely on secondary market returns, restrict analysis to the 52 SPARQS issued and listed on the AMEX prior to July 1, 2005 to ensure each SPARQS has at least six months of return data subsequent to the issue date. Daily prices, dividend distributions, market capitalization, and SIC classifications for the underlying equities come from The Center for Research in Securities Prices (CRSP) database. The daily returns on the SPARQS come from the last traded price in the NYSE Trade and Quote (TAQ) database. Implied volatilities for listed options on the underlying equities come from the OptionMetrics database. Additionally, the London interbank offer rates come from Bloomberg. Daily accrued interest values on each of the SPARQS are computed based on the coupon schedules in the EDGAR filings.

Examining the secondary market returns requires a return metric for the SPARQS. We construct a total return measure, defined as the change in the invoice or "full" price, divided by the invoice price. Using the fact that the invoice price is the sum of the traded or "clean" price and accrued interest, the daily return from date $t-1$ to date t is:

$$R_{i,t} = \begin{cases} \frac{AC_{i,t}-AC_{i,t-1}+P_{i,t}-P_{i,t-1}}{AC_{i,t-1}+P_{i,t-1}} & \text{if } AC_{i,t} \geq AC_{i,t-1}, \\ \\ \frac{CPN+AC_{i,t}-AC_{i,t-1}+P_{i,t}-P_{i,t-1}}{AC_{i,t-1}+P_{i,t-1}} & \text{if } AC_{i,t} < AC_{i,t-1}, \end{cases} \tag{5}$$

where $P_{i,t}$ and $P_{i,t-1}$ are the closing market prices on trading dates t and $t-1$ respectively, CPN is the periodic interest payment, and $AC_{i,t}$ and $AC_{i,t-1}$ are the accrued interest on trading dates t and $t-1$ respectively. The accrued interest portion tracks the part of the periodic coupon the seller of a bond owes to the buyer upon settlement. Since the coupon is paid to the bondholder as of the close of business on the record date, which is a specified number of calendar days before the payment date, the accrued interest component resets to zero on the day after the ex-coupon date and the condition $AC_{i,t} < AC_{i,t-1}$ is satisfied only on this date. Thus, an investor who owned the security on the record date will receive the coupon on the distribution date.

The SPARQS derive their value from the underlying stock price and their returns can be described by the model

$$R_{i,t} - r_t \approx \Omega_{i,t}\left(r_{i,t} - r_t\right) + \eta_{i,t}, \tag{6}$$

where $i = 1, \ldots, N$ indexes the SPARQS and their underlying stocks, $R_{i,t}$ is the return on the ith SPARQS on date t, $r_{i,t}$ is the return on the common stock underlying the ith SPARQS, r_t is the riskless rate on date t, and $\Omega_{i,t} \equiv \frac{\partial V_i(S_{i,t},t)}{\partial S_{i,t}} \frac{S_{i,t}}{V_i(S_{i,t},t)}$, where $V_i(S_{i,t}, t)$ is the value of the ith SPARQS given by the pricing model in Section 3.1. With this definition $\Omega_{i,t}$ is the elasticity of the SPARQS price with respect to the stock price. While equation (6) holds only approximately because it treats the elasticity $\Omega_{i,t}$ as constant within each day, we expect the approximation to be excellent.

If the SPARQS are priced correctly relative to the stock without any markup or premium then the residual $\eta_{i,t}$ in (6) would be close to zero, where the difference from zero is due to possible miss-specification of the pricing model, inherent approximation errors in its numerical solution, the assumption that the elasticity $\Omega_{i,t}$ is constant within each day, and features of the market microstructure such as the discreteness of price quotations. If the SPARQS are over-priced relative to the stock then cumulative residuals of the form $\sum_t \eta_{i,t}$ should be negative. This model thus provides another perspective on the magnitude of the markups or premia embedded in the offering prices of the SPARQS.

We also consider the risk-adjusted performance of the SPARQS relative to the market index.

Applying the market model to the underlying stock, the return for the underlying stock is

$$r_{i,t} - r_t = \beta_i \left(r_{M,t} - r_t \right) + \varepsilon_{i,t}, \tag{7}$$

where $r_{i,t} - r_t$ is the excess return of the underlying stock i on date t over the risk-free rate of return r_t and $r_{M,t} - r_t$ is the excess return on the value-weighted CRSP market portfolio on date t. Combining equations (6) and (7), the market model for the SPARQS based on the index returns is

$$\begin{aligned} R_{i,t} - r_t &= \Omega_{i,t} \left[\beta_i \left(r_{M,t} - r_t \right) + \varepsilon_{i,t} \right] + \eta_{i,t} \\ &= \Omega_{i,t} \beta_i \left(r_{M,t} - r_t \right) + \Omega_{i,t} \varepsilon_{i,t} + \eta_{i,t}. \end{aligned} \tag{8}$$

If the SPARQS underperform on a risk-adjusted basis, the accumulated (over event-time) averages across all SPARQS issues of the residuals in equations (6) and (8) should be negative. Similarly, if the underlying stocks underperform their risk-adjusted benchmark, equation (7) will have negative cumulative residuals. Testing these hypotheses requires averaging the residuals across issues in addition to accumulating them over time. A complication arises because the numbers of issues in the averages differ on different dates because some SPARQS drop out of the sample due to calls and the price acceleration event that occurred on one issue. This complication is handled by first computing the average returns of the available SPARQS (the inside sums over i in equations (9), (10), and (11) below), and then cumulating the average residual returns over event time (the outside sums over t).

Some notation is required to formulate the test statistics. Let t, and later u, index event time, i.e. $t = 0$ is the issue date, $t = 1$ is the first date after issue, etc. Let τ_i be the calendar-time issue date of the ith SPARQS. For example, 1 January 1995 might be calendar day 0, and the ith SPARQS might have been issued on calendar day $\tau_i = 1,321$ (which is event day 0 for this issue). Thus $\tau_i + t$ is the calendar date t days following the issue date of the ith SPARQS. Let A_t denote the set of the indices of the SPARQS that are available for trading on event day t. Thus, A_t is the set of SPARQS indices that have not been called or had a price acceleration event on the tth date after issue. Initially (at event-time 0) the set A_0 has N elements $A_0 = \{1, 2, 3, \ldots, N\}$, where $N = 52$ is the total number of SPARQS for which we have sufficient secondary market price data. As some SPARQS are called, or disappear due to a price acceleration event, some indices disappear from A_t. Let $\text{card}(A_t)$ denote the cardinality of A_t, that is $\text{card}(A_t)$ is the number of SPARQS that are still available for trading on event-date t. We are interested in testing the hypotheses:

$$\sum_{t=0}^{L}\left(\frac{1}{\text{card}(A_t)}\sum_{i\in A_t}\eta_{i,\tau_i+t}\right) = 0, \tag{9}$$

$$\sum_{t=0}^{L}\left(\frac{1}{\text{card}(A_t)}\sum_{i\in A_t}\epsilon_{i,\tau_i+t}\right) = 0, \tag{10}$$

$$\sum_{t=0}^{L}\left(\frac{1}{\text{card}(A_t)}\sum_{i\in A_t}(\Omega_{it}\epsilon_{i,\tau_i+t}+\eta_{i,\tau_i+t})\right) = 0, \tag{11}$$

where the residuals being summed are defined in equations (6)–(8). Appendix 2 describes the computation of standard errors for the test statistics above.

Table 5 presents the cumulative average residual returns (CARRs) for the three models for various periods following the issue dates, along with their standard errors, t-statistics, and sample sizes. Panel A presents the CARRs in equation (9) from the SPARQS pricing model (6). In this model, testing the hypothesis that the average residuals in equation (9) equal zero provides another perspective on the overpricing of the SPARQS. The results in the columns headed "+1" and "+2" indicate that the SPARQS exhibit positive excess returns in the first two trading days following issue. However, the results in the other columns reveal that the cumulative average residuals quickly turn negative, and for the 20-day period the SPARQS exhibit an average residual return of –1.95%, with a t-statistic of –2.57. The magnitude increases to –4.87% (t-statistic –2.01) for the 140-day period. The point estimate remains almost as large (–4.40%) at 200 days, though this last estimate is not significantly different from zero, partly due to the decline in the sample size from 52 to 31 as issues are called. Given the magnitudes of the estimated standard errors, these findings are consistent with the results in Section 3.1 indicating the SPARQS are initially sold at a premium of about 8% to reasonable estimates of their fair values.

These results in Panel A suggest a slow decay of the markup or premium that is observed at the offer date. Figure 1 confirms this by showing the average daily percentage premium of the market price over the model price, where the SPARQS price is the daily closing price (including accrued interest) and the model price is computed using the interest rate and underlying stock implied volatility from that day.[21] Consistent with the results in Panel A of Table 5, the percentage price premium of the SPARQS exhibits a gradual decay over the first 140 post-issue trading days. After 140 trading days, or somewhat over six months, the premium shows a modest increase. This increase occurs because the period of call protection has ended, and some of the SPARQS are being

[21] We conjecture that the slow decay of the premium and negative abnormal performance are not arbitraged away because the SPARQS are hard to borrow.

called. (Note that the sample size decreases from 52 to 39 between post-issue days 120 and 140, and further declines to 31 by day 200.) These calls change the composition of the sample because SPARQS that are highly likely to be called have small premiums—the payment in the event of call is deterministic, so there is little room for error or disagreement about the value of an issue that is highly likely to be called.

The actual returns of the SPARQS are determined by both their performance relative to the underlying stocks and the performance of the underlying stocks. Panel B presents evidence about the performance of the underlying stocks relative to the market index—specifically, it presents the CARRs in equation (10) based on the market model (7) for the underlying stock. After the first two days, these CARRs do not exhibit any significant under- or over-performance of the underlying stocks relative to the market index. However, the post-event returns for the first and second days are negative and significant, indicating brief underperformance of the underlying stocks. This is an interesting pattern since the SPARQS issues have no impact on the fundamentals of the underlying stocks, and presumably convey no information about the stocks.[22]

Panel C of Table 5 examines the performance of the SPARQS relative to the market index by presenting the CARRs in equation (11) based on the SPARQS market model (8). Although the point estimates suggest the SPARQS underperform the market-adjusted benchmark, they are not statistically significantly different from zero. The CARRs for the SPARQS market model (Panel C) incorporate the residuals in both the model of the SPARQS return relative to the underlying stock (Panel A) and the model of the underlying stock return relative to the market index (Panel B). The standard errors in the market model for the underlying stocks are much larger than those for the SPARQS relative to the underlying stock and prevent the return of the SPARQS relative to the market from being significant. Thus, there is evidence only for underperformance of the SPARQS relative to the underlying stocks.

Table 6 finishes the examination of the post-issue performance by presenting buy-and-hold returns to the SPARQS and the underlying stocks, as well as the returns on several benchmarks. The first row of Panel A shows that the average return to the SPARQS over the first 200 post-issue trade dates is -6.02%, where the average return is computed by cumulating the daily averages for each event day. The second row shows the average performance of benchmarks formed by cumulating average daily returns of the form $r_t + \Omega_{i,t}\,(r_{i,t} - r_t)$. These returns are those of a portfolio with an exposure to the underlying stock return chosen to match the sensitivity or elasticity $\Omega_{i,t}$ of the

[22]We wonder whether this pattern might be related to the issuer's hedging activity, though we have no evidence or other reason to believe that this is the case.

SPARQS return. This benchmark has stock price exposure identical to that of the SPARQS, and experienced an average return of −1.41 over the 200 post-issue days. The difference between the return on the SPARQS and the return on the benchmark, −4.36%, is consistent with the CARRs in Panel A of Table 5.

Panel B of Table 6 compares the cumulative average daily returns of the SPARQS to the benchmarks formed by cumulating the average daily returns of the form $r_t + \Omega_{i,t}\beta_i\,(r_{M,t} - r_t)$. These returns are those of a portfolio with an exposure to the market index identical to that of the SPARQS. The first row repeats the returns on the SPARQS from Panel A, and again shows that the average return to the SPARQS over the first 200 post-issue trade dates is −6.02%. The second row shows cumulative average daily return on the benchmark of 4.27%. The difference between the return on the SPARQS and the return on the benchmark, –10.81%, is consistent with the CARRs in Panel B of Table 5.

4 Expected Returns of the SPARQS

The analysis in Section 3 provides evidence of large markups on the SPARQS and post-issuance underperformance consistent with the large markups. Given that the SPARQS have original maturities of only slightly more than one year and many issues are called after six months, the markups are large enough to suggest that the expected returns of the SPARQS might be less than the risk-free rate of interest. This section presents evidence that this is in fact the case for reasonable estimates of the expected returns of the underlying assets.

To estimate the expected return on each of the SPARQS, we assume that the expected return on the underlying stock is a constant μ, and in particular that the stock price follows the geometric Brownian motion

$$\mathrm{d}S_t = \mu S_t \mathrm{d}t + \sigma S_t \mathrm{d}W_t, \tag{12}$$

where W is a Brownian motion under the objective probability. We estimate the expected return μ using both the Capital Asset Pricing Model (CAPM) and the Fama-French three-factor asset pricing model, with several different estimates of the market and factor risk premia.

Second, because the stock price process (12) is a diffusion process and the SPARQS payoff is a function of the stock price (and time), the conditional expected payoff $Y(S,t) = E[\text{payoff}\,|\,S,t]$ satisfies the Kolmogorov backward equation

$$\frac{\partial Y\left(S,t\right)}{\partial t}+\frac{1}{2}\sigma^{2}S^{2}\frac{\partial^{2}Y\left(S,t\right)}{\partial S^{2}}+\mu S\frac{\partial Y\left(S,t\right)}{\partial S}=0, \tag{13}$$

with boundary conditions determined by the terms of the SPARQS. This equation is similar to the partial differential equation (2) satisfied by the value of the SPARQS, except that (13) contains the expected return on the stock, μ, instead of the risk-free rate r, and does not include the discounting term $-rY$.

The terminal boundary condition for Y is the payout to the SPARQS at maturity date T, $Y\left(S,T\right)=V\left(S,T\right)$, which is the same terminal boundary for the SPARQS value V given in equation (3) above. As was the case in the valuation of the SPARQS, the terminal boundary condition is not relevant for stock prices in the entire domain $(0,\infty)$ because the SPARQS are callable by the issuer following an initial period of call protection. The upper spatial boundary for the expected payoff Y is given by the call price schedule (4) that provided the upper spatial boundary for V. An important difference is that for the value V the upper spatial boundary is a free boundary, i.e. the schedule of prices $\overline{S}(t)$ at which a SPARQS issue is called is determined as part of the solution in order to minimize the value of the SPARQS. For Y, the upper boundary is a fixed boundary determined by the previous solution for $\overline{S}(t)$, i.e. $Y(\overline{S}(t),t)=V(\overline{S}(t),t)=C(t)$.

The lower spatial boundary condition comes from the price acceleration event discussed in subsection 3.1, and is identical to the lower boundary for V, i.e. $Y(\underline{S},t)=V(\underline{S},t)$, where $\underline{S}$ is the stock price at which the price acceleration event occurs.

As in subsection 3.1 we compute the solution of the p.d.e. by using a logarithmic transformation to obtain a partial differential equation with constant coefficients, and then approximate the solution using a standard finite difference scheme. The solution provides an estimate of the expected payoff $Y(S,t)$ for each point in the domain. The expected returns to investing in a SPARQS at the initial offering are then computed as

$$E[\text{return}]=\left(Y\left(S_{0},0\right)+\sum_{\{i|t_{i}<\min(t_{\text{call}},T)\}}c(t_{i})\right)\Bigg/\left(P_{0}+AC_{0}\right)-1, \tag{14}$$

where S_0 is the price of the underlying stock on the issue date (time 0), $Y(S_0,0)$ is the expected payoff conditional on S_0, P_0 is the offering price, AC_0 is the accrued interest on the issue date, t_{call} is the call date, and T is the maturity. This equation slightly understates the expected returns, as some of the coupons are received before the call date or maturity and the simple sum $\sum_{\{i|t_{i}<\min(t_{\text{call}},T)\}}c(t_{i})$ does not reflect any reinvestment of these coupons.

These calculations require estimates of the expected returns μ of each underlying stock. We compute these using both the Capital Asset Pricing Model (CAPM) and the Fama-French three-factor asset pricing model, with several different estimates of the market and factor risk premia. To use the CAPM we need market model "beta" coefficient estimates, which we obtain by estimating the regression

$$r_{i,t} - r_t = \alpha_i + \beta_i \left(r_{M,t} - r_t \right) + \varepsilon_{i,t} \tag{15}$$

for each underlying stock using five years of monthly data leading up to the SPARQS issue date, where $i = 1, \ldots, N$ indexes the stocks underlying the N SPARQS, $r_{i,t} - r_t$ is the excess return of the underlying stock i on date t over the risk-free return r_t, and $r_{M,t} - r_t$ is the excess return on the value-weighted CRSP market portfolio on date t over the risk-free rate of return. Using the estimated β for each stock, the expected return estimates obtained in equation (15) are combined with estimates of the expected excess return on the market portfolio, $E\left(r_{M,t} - r_t\right)$, to yield the expected returns on the underlying stocks $E\left(r_{i,t}\right)$:

$$E\left(r_{i,t}\right) = r_t + \beta_i \left(E(r_{M,t} - r_t) \right). \tag{16}$$

The extant literature does not completely agree about the magnitude of the equity premium. Fama and French (2002) suggest that widely used risk-premium estimates of about 8%, which are based on historical returns of stocks over bonds, overstate the market risk premium during our sample period. Welch (2000) reports on a comprehensive survey of researchers' estimates of the equity risk premium and presents survey evidence that the average estimated equity premium for a horizon of one year is approximately 6.5% and the estimated 10-year equity premium is roughly 8%. Due to the lack of consensus on the equity risk-premium, we use several different estimates. The historical average excess return on the market portfolio over the 1926–2001 time period of 7.89% is the first proxy. In addition, we use the average excess return of 8.35% from the more recent period of 1993–2001, which ends at about the beginning of the SPARQS sample period. Finally, in light of the ongoing debate in the literature about the size of the historical equity risk premium, we somewhat arbitrarily use 6% and 8%.[23]

Panel A of Table 7 presents the estimate of the expected returns of the SPARQS using the market model betas and CAPM to estimate the expected returns on the underlying stocks and the four different estimates of the market risk premium. The underlying stocks have an average

[23] Mehra and Prescott (1985) and some subsequent literature suggest that much smaller equity premiums are consistent with plausible equilibrium models. Since the expected returns on the SPARQSs are monotonically increasing in the size of the equity premium, using lower estimates such as the 1% to 3% range suggested by Mehra and Prescott (1985) will only decrease the expected return estimates.

loading on the market risk factor, or β, of 1.86. The results show that the average expected returns on the SPARQS range from 0.76% to 2.56% for the various estimates of the market risk premium, with standard errors of between 0.46% and 0.55% respectively. The medians range from 1.06% to 2.69%. It is important to note that the table reports estimates of the average expected returns, not the average risk premia in excess of the risk-free rate of interest. The average value of one-month LIBOR during 2001–2005 was 2.28%, indicating that the average expected returns of the SPARQS computed from the CAPM are not much different from the average risk-free rate during the period.

To interpret these results, note that on the issue date the SPARQS have beta coefficients that are typically somewhat greater than one-half of the betas of the underlying stocks. While the SPARQS betas are not constant over time (they go to zero as the call boundary is approached, and increase toward the stock price beta as the stock price drops), a beta of somewhat over one-half is a reasonable "back of the envelope" estimate. Combined with the average underlying stock beta of 1.86, this suggests that the average SPARQS beta is about one. This beta, taken alone, suggests that the average expected return is about equal to the market risk premium. But these risk premia are almost complete offset by the negative abnormal returns stemming from the markups on the issue dates.

Since the SPARQSs' underlying stocks tend to be large growth stocks, the market model likely over-estimates the expected returns on the underlying stocks. Over-estimating the expected returns on the underlying stocks results in overstated expected returns on the SPARQS themselves. For this reason, we also use the three-factor model of Fama and French (1992) to estimate the expected return μ of each of the underlying stocks. The procedure is the same for the market model where the first step is to estimate factor loadings for each of the underlying stocks,

$$r_{i,t} - r_t = \alpha_i + \beta_i \left(r_{M,t} - r_t \right) + s_i \left(SMB_t \right) + h_i \left(HML_t \right) + \varepsilon_{i,t}, \tag{17}$$

where $r_{M,t} - r_{f,t}$, SMB, and HML are the excess returns on the market portfolio, small stocks over large stocks, and high book-to-market stocks over low book-to-market stocks. The average factor loadings on the market, SMB, and HML are 1.528, 0.244, and -0.464, respectively. The -0.464 loading on the book-to-market factor is consistent with the underlying stocks being growth stocks. Combining the factor loadings with estimates of the expected returns to the factors using the equation

$$E\left(r_{i,t} \right) = r_t + \beta_i \left(E(r_{M,t} - r_t) \right) + s_i \left(E\left(SMB_t \right) \right) + h_i \left(E\left(HML_t \right) \right) \tag{18}$$

results in estimates of the expected returns μ used in the calculation of the expected payoffs.

Panel B of Table 7 presents the average expected returns to the SPARQS based on the Fama-French three-factor model to compute the expected returns of the underlying stocks. The column headed "1926–2001" estimates the Fama-French factor risk premia using the realized returns from 1926 to 2001, while the column headed "1993–2001" estimates the factor risk premia using the realized returns from 1993 to 2001. The next two columns use the realized returns from 1926 to 1993 to estimate the risk premia on SMB and HML, but use 6% and 8%, respectively, for the market risk premium. The average expected returns range from -0.27% to -1.71%, depending on the estimates of the factor risk premia. For three of the four cases zero is within two standard errors of the estimate, and we are unable to reject the hypothesis that the SPARQS' expected returns are greater than zero. However, we can reject the hypothesis that the expected returns are greater than 2%, which is less than the average risk-free rate that prevailed during the period. Thus, these estimates provide strong evidence that the expected returns on the SPARQSs are less than the risk-free rate.

The finding that SPARQSs have expected returns below the risk-free rate is striking because the values and returns of the SPARQS covary positively with the broad market indices, suggesting quite strongly that their returns covary positively with both investors' aggregate wealth and aggregate consumption, and covary negatively with investors' marginal utilities. In a standard model of portfolio choice, a security with expected return less than the risk free rate is rationally purchased by an investor only if its returns covary positively with the investor's marginal utility (Merton (1982)). Thus, it is difficult to rationalize primary market purchases of SPARQS by investors whose portfolios have positive or zero correlation with the broad market indexes.

5 Conclusions and Implications for Future Research

We present evidence that SPARQS, the most popular of the listed U.S. structured equity products, are sufficiently overpriced at their initial offerings that they have expected returns less than the riskless rate. While our analysis is limited to SPARQS designed and sold by Morgan Stanley, other investment banks offer very similar products.[24] In a standard model of the portfolio choice, such a security is rationally purchased by an investor only if its returns covary positively with the investor's marginal utility (Merton (1982)). The returns of the SPARQS covary positively with

[24] One of the authors has used several types of SEPs as valuation exercises in his financial engineering class for the last 10 years, and has found that other products have markups similar to those for the SPARQS. In addition, the markups we estimate for the SPARQS are similar to those estimated for SEPs in non-U.S. markets by Szymanowska, Horst, and Veld (2005), Burth, Kraus, and Wohlwend (2001), and Baule, Entrop, and Wilkens (2005).

the broad market indices, and for the vast majority of investors almost certainly covary positively with consumption and negatively with marginal utility. Thus, the finding that SPARQSs expected returns are less than the riskless rate make it difficult to rationalize primary market purchases of SPARQS by investors who hold portfolios that are positively correlated or uncorrelated with the broad market indexes. Such SPARQS investors would have been better off investing in bank certificates of deposit. SPARQS also appear not to be motivated by any desire to benefit from a preferential tax treatment, circumvent regulations, reduce agency conflicts, or reduce transactions costs.

Relatedly, it seems unlikely that SPARQS satisfy any hedging needs of retail investors. The payoffs of SPARQS are qualitatively similar to those of covered calls and, with the exception of naked puts, it is difficult to think of a position for which a purchased SPARQS is a reasonable hedge. SPARQS are callable by the issuer at a time-varying schedule of call prices, decreasing their usefulness in hedging even those positions such as naked puts for which at first glance they might seem like useful hedges. Setting aside specific arguments about what positions are or are not naturally hedged by SPARQS, in order to believe that SPARQS are designed to satisfy investors' hedging needs one would need simultaneously to believe that the investors who purchase SPARQS (i) are sophisticated enough to understand that SPARQS hedge the position that they have; but (ii) too unsophisticated to be aware that the underlying common stock and exchange-traded options on it provide alternative fairly priced hedging vehicles.

Another possible hypothesis is that investors purchase SPARQS as a vehicle for compensating their stockbrokers for investment advisory services that they might provide. The finding that SPARQS have expected returns less than the riskless rate but covary positively with the broad market indices immediately raises doubts about the plausibility of this hypothesis—most investors would be better off investing in bank certificates of deposit. It is difficult to argue that the overpricing of SPARQS is a mechanism for compensating brokers for investment advice when the investor would have been better off not receiving advice to purchase SPARQS. However, we cannot rule out the hypothesis that the overpricing of SPARQS is a vehicle for compensating brokers for investment advice to purchase other products, though this seems unlikely.

The overpricing of SPARQS is, however, consistent with the hypothesis that banks and investment banks design SEPs to exploit investors' misunderstandings of financial markets, cognitive biases in evaluating probabilistic information, and framing effects. For example, Shefrin and Statman (1993) argue that narrow framing and loss aversion[25] can cause investors to demand positions

[25]See Kahneman (2003), Barberis, Huang, and Thaler (2006), and Barberis and Huang (2005).

that are similar to covered calls, and also make investors value a single security that provides these payoffs more highly than a portfolio of other securities that produces an equivalent payoff. This dark side of financial innovation is in stark contrast to the generally benign view of financial innovations in most of the literature.

The demand for SPARQS is also consistent with overconfidence. In the behavioral literature, confidence is frequently modeled as the perceived precision of an information signal,[26] and an overconfident investor is one who believes that future returns are distributed narrowly around their expected outcome. Such an investor will value highly securities such as SPARQS because he or she will undervalue the embedded written call. This however does not provide an explanation of why investors might prefer SPARQS to covered call positions created using exchange-traded call options.

The finding that SPARQS have negative expected return does not allow one to distinguish among various hypotheses for why investors demand SPARQS. It is worth emphasizing, however, that the issuing banks and investment banks choose the payoff profiles. Henderson and Pearson (2007) present evidence that investors make different choices, depending on the nature of the underlying asset—when the underlying asset is an individual equity the SEPs are typically short-term with concave payoff profiles and high coupons, and when the the underlying asset is an index the SEPs are longer-term and provide principal protection. Exploring the reasons for these differences appears to be an interesting area for future research.

[26]See, for example, Kyle and Wang (1997), Daniel, Hirshleifer, and Subrahmanyam (1998), and Odean (1999).

References

Allen, Franklin, and Douglas Gale, 1991, Arbitrage, short sales, and financial innovation, *Econometrica* 59, 1041–1068.

Baker, Malcolm, and James Quinn, 2005, *Harvard Business School Case Number (206018), Corning: Convertible Preferred Stock* (Harvard Business School Publishing: Boston).

Barberis, Nicholas, and Ming Huang, 2005, Stocks as lotteries: The implications of probability weighting for securities prices, Working Paper.

——— , and Richard Thaler, 2006, Individual preferences, monetary gambles, and stock market participation: A case for narrow framing, *American Economic Review* 96, 1069–1090.

Baubonis, Charles, Gary Gastineau, and David Purcell, 1993, The banker's guide to equity-linked certificates of deposit, *Journal of Derivatives* 1, 87–95.

Baule, Rainer, Oliver Entrop, and Marco Wilkens, 2005, What do banks earn with their own credit risk? Theoretical and empirical evidence from the German retail market for structured financial products, Working Paper.

Bernard, Carole, and Phelim Boyle, 2008, Structured investment products and the retail investor, Working Paper.

Bethel, Jennifer E., and Allen Ferrel, 2007, Policy issues raised by structured products, in Robert E. Litan Yasuki Fuchita, ed.: *New Financial Institutions and Instruments: Opportunities and Policy Questions* . pp. 167–193 (Brookings Institution Press).

Black, F., and M. Scholes, 1973, The pricing of options and corporate liabilities, *Journal of Political Economy* 81, 637–54.

Burth, Stefan, Thomas Kraus, and Hanspeter Wohlwend, 2001, The pricing of structured products in the Swiss market, *Journal of Derivatives* 9, 30–40.

Chen, Andrew H., John Kensinger, and Hansong Pu, 1994, An analysis of PERCS, *Journal of Financial Engineering* 3, 85–108.

Daniel, Kent, David Hirshleifer, and Avanidhar Subrahmanyam, 1998, A theory of over-confidence, self-attribution, and security market under- and over-reactions, *Journal of Finance* 53, 1839–1885.

Drucker, S., and M. Puri, 2005, On the benefits of concurrent lending and underwritting, *Journal of Finance* 60, 2763–2799.

——— , 2006, Banks in capital markets: A survey, in B. Espen Eckbo, ed.: *Handbook of Corporate Finance: Empirical Corporate Finance, Volume 1* . pp. 189–227 (North-Holland).

Dynan, Karen E., Douglas W. Elmendorf, and Daniel E. Sichel, 2006, Can financial innovation help to explain the reduced volatility of economic activity?, *Journal of Monetary Economics* 53, 123–150.

Elul, Ronel, 1995, Welfare effects of financial innovation in incomplete market economies with several consumption goods, *Journal of Economic Theory* pp. 43–78.

Fama, E., and K. French, 1992, The cross-section of expected stock returns, *Journal of Finance* 47, 427–465.

——— , 2002, The equity premium, *Journal of Finance* 57, 637–659.

Frame, W. Scott, and Lawrence J. White, 2004, Empirical studies of financial innovation: Lots of talk, little action?, *Journal of Economic Literature* XLII, 116–144.

Grinblatt, Mark, and Francis A. Longstaff, 2000, Financial innovation and the role of derivative securities: An empirical analysis of the Treasury STRIPS program, *Journal of Finance* 55, 1415–1436.

Harty, Emmet, 1992, Pains and gains of PERQS and LEAPS, *Risk* 5, 36–39.

Henderson, Brian J., and Neil D. Pearson, 2007, Patterns in the payoffs of structured equity products, Working Paper.

Jarrow, R., and M. O'Hara, 1989, Primes, Scores: an essay on market imperfection, *Journal of Finance* 44, 1263–1287.

Kahneman, Daniel, 2003, Maps of bounded rationality: Psychology for behavioral economics, *American Economic Review* 93, 1449–1475.

Kroszner, R., and R. Rajan, 1994, Is the Glass-Steagall act justified? a study of the U.S. experience with universal banking before 1933, *American Economic Review* 84, 810–832.

Kyle, A., and F. Wang, 1997, Speculation duopoly with agreement to disagree: Can overconfidence survive the market test?, *Journal of Finance* 52, 2073–2090.

Mason, Scott P., Robert C. Merton, André F. Perold, and Peter Tufano, 1995, *Cases in Financial Engineering and Tax Risk: Applied Studies of Financial Innovation* (Prentice Hall: Englewood Cliffs, New Jersey).

McConnell, John J., and Edwardo S. Schwartz, 1992, The origin of LYONS: A case study in financial innovation, *Journal of Applied Corporate Finance* 4, 40–47.

Mehra, R., and E. Prescott, 1985, The equity premium: A puzzle, *Journal of Monetary Economics* 15, 145–161.

Mehran, Hamid, and René M. Stulz, 2007, The economics of conflicts of interest in financial institutions, *Journal of Financial Economics* 85, 267–296.

Merton, Robert C., 1973, Theory of rational option pricing, *Bell Journal of Economics and Management Science* 4, 141–183.

——— , 1982, On the microeconomic theory of investment under uncertainty, in K. J. Arrow, and M. Intriligator, ed.: *Handbook of Mathematical Economics, Vol II* . pp. 601–669 (Amsterdam: North-Holland).

Miller, Merton H., 1986, Financial innovation: The last twenty years and the next, *Journal of Financial and Quantitative Analysis* 21, 459–471.

Odean, Terry, 1999, Do investors trade too much?, *American Economic Review* 89, 1279–1298.

Pratt, Tom, 1994, You can't keep a lid on public equity derivatives; low-risk structured notes overcome regulatory roadblocks and bad press., *Investment Dealers' Digest* pp. 12–12.

——— , 1995, Equity derivatives vanish and explanations multiply; but boosters insist underwritten deals will be back., *Investment Dealers' Digest* pp. 15–15.

Puri, M., 1994, The long-run default performance of bank underwritten securities issues, *Journal of Banking and Finance* 18, 397–418.

Rogalski, Richard J., and James K. Seward, 1991, Corporate issues of foreign currency exchange warrants, *Journal of Financial Economics* 30, 347–366.

Ross, Stephen A., 1976, Options and efficiency, *Quarterly Journal of Economics* 1, 75–89.

——— , 1989, Institutional markets, financial marketing, and financial innovation, *Journal of Finance* 44, 541–556.

Santangelo, Robert, and Peter Tufano, 1996, *Harvard Business School Case Number (297056), Financial Engineering and Tax Risk: The Case of Times Mirror PEPS* (Harvard Business School Publishing: Boston).

Schroth, Enrique, 2006, Innovation, differentiation, and the choice of an underwritter: Evidence from equity-linked securities., *Review of Financial Studies* 19, 1041–1080.

Shefrin, Hersh, and Meir Statman, 1993, Behavioural aspects of the design and marketing of financial products., *Financial Management* 22, 123–134.

Szymanowska, Marta, Jenke Ter Horst, and Chris Veld, 2005, Behavioral factors in the pricing of financial products, Working Paper.

Tufano, Peter, 2003, Financial innovation, in George Constantinides, Milton Harris, and René Stulz, ed.: *Handbook of the Economics of Finance, Volume 1a Corporate Finance* . pp. 307–336 (Elsevier).

Welch, Ivo, 2000, Views of financial economists on the equity premium and on professional controversies, *Journal of Business* 73, 501–536.

Appendix 1 Solution of the Partial Differential Equation

Section 3.1 presents the partial differential equation (2) satisfied by the values of the SPARQS. We compute the values by first taking the log transform $X = \ln(S)$ and $U(X,t) = V(S,t)$, after which the function U satisfies

$$\frac{\partial U(X,t)}{\partial t} + \frac{1}{2}\sigma^2 \frac{\partial^2 U(X,t)}{\partial X^2} + \left(r - \frac{\sigma^2}{2}\right)\frac{\partial U(X,t)}{\partial X} - rU = 0. \tag{A.1}$$

The partial differential equation (A.1) is easier to work with than equation (2) because it has constant coefficients.

We approximate the solution of (A.1) using an explicit finite difference scheme. Employing centered differences, the above equation becomes:

$$\frac{U_i^k - U_i^{k+1}}{\Delta t} + \alpha_1 \frac{U_{i+1}^k - 2U_i^k + U_{i-1}^k}{\Delta X^2} + \alpha_2 \frac{U_{i+1}^k - U_{i-1}^k}{2\Delta X} - rU_i^k = 0, \tag{A.2}$$

where $\alpha_1 = \sigma^2/2$, $\alpha_2 = r - \sigma^2/2$, and the time step $\Delta t = 1/250$ or one trading day. The stock price grid consists of evenly spaced observations of $X = \ln(S)$, so that $\ln(S_i) = i \times \Delta \ln(S)$, where $\Delta \ln(S) = \sigma \times \sqrt{3\Delta t}$. Some rearranging yields the difference equation:

$$U_i^{k+1} = c_1 U_{i+1}^k + c_2 U_i^k + c_3 U_{i-1}^k, \tag{A.3}$$

where the coefficients c_1, c_2, and c_3 are

$$c_1 = \frac{1}{2}\sigma^2 \frac{\Delta t}{\Delta X^2} + \frac{1}{2}\left(r - \frac{\sigma^2}{2}\right)\frac{\Delta t}{\Delta X}, \tag{A.4}$$

$$c_2 = 1 - \sigma^2 \frac{\Delta t}{\Delta X^2} - r\Delta t, \tag{A.5}$$

$$c_3 = \frac{1}{2}\sigma^2 \frac{\Delta t}{\Delta X^2} - \frac{1}{2}\left(r - \frac{\sigma^2}{2}\right)\frac{\Delta t}{\Delta X}. \tag{A.6}$$

When the underlying stock pays dividends we impose the boundary condition

$$U(\ln(S), t_d^-) = U(\ln(S-d), t_d^+). \tag{A.7}$$

across the dividend dates, where d is the amount of the dividend and t_d^- and t_d^+ are the times immediately before and after the ex-dividend date. The dividend amounts and ex-dividend dates as come from the previous twelve months' history in CRSP. We include only regularly occurring dividends in the analysis.

Appendix 2 Computation of Standard Errors

This appendix describes the standard error computations for the cumulative average residual returns (CARRs) in Section 3.2. Testing the significance of the CARRs described in Equation (10), which are computed from the market model for the underlying stocks in Equation (7), involves computing the variance of the following statistic:

$$\sum_{t=0}^{L}\left(\frac{1}{\text{card}(A_t)}\sum_{i\in A_t}\varepsilon_{i,\tau_i+t}\right), \tag{A.1}$$

where $\tau_i + t$ is a calendar date. We make the following assumptions about the residuals:

$$\begin{aligned}
\text{var}(\varepsilon_{i,\tau_i+t}) &= \sigma_i^2, && \text{(A.2)}\\
\text{cov}(\varepsilon_{i,\tau_i+t}, \varepsilon_{j,\tau_i+t}) &= \rho_{ij}\sigma_i\sigma_j, && \text{(A.3)}\\
\text{cov}(\varepsilon_{i,\tau_i+t}, \varepsilon_{i,\tau_i+u}) &= 0 \quad \text{for } \tau_i + t \neq \tau_i + u, && \text{(A.4)}\\
\text{cov}(\varepsilon_{i,\tau_i+t}, \varepsilon_{j,\tau_i+u}) &= 0 \quad \text{for } \tau_j + u \neq \tau_i + t. && \text{(A.5)}
\end{aligned}$$

Comparing (A.2) to (A.4) and (A.3) to (A.5), one can see that the covariance differs depending upon whether the time indices of the ε's are the same. Let $I(v, w)$ be the indicator function taking the value 1 if $w = v$, and 0 otherwise. The variance of the sum (A.1) is

$$\begin{aligned}
&\text{var}\left[\sum_{t=0}^{L} \frac{1}{\text{card}(A_t)} \sum_{i \in A_t} \varepsilon_{i,\tau_i+t}\right]\\
&= \sum_{t=0}^{L}\sum_{u=0}^{L} \frac{1}{\text{card}(A_t) \times \text{card}(A_u)} \sum_{i \in A_t}\sum_{j \in A_u} \text{cov}(\varepsilon_{i,\tau_i+t}, \varepsilon_{j,\tau_j+u}) && \text{(A.6)}\\
&= \sum_{t=0}^{L}\sum_{u=0}^{L} \frac{1}{\text{card}(A_t) \times \text{card}(A_u)} \sum_{i \in A_t}\sum_{j \in A_u} \rho_{ij}\sigma_i\sigma_j I(\tau_i + t, \tau_j + u), && \text{(A.7)}
\end{aligned}$$

where if $i = j$ (the same issue) then $\rho_{ij} = 1$. To compute the right-hand side of (A.7) we estimated σ_i, σ_j, and ρ_{ij} from the returns over the first 150 post-event days following the ith and jth issues. This involves computing σ_j from the 150 post-event days following the jth issue, and computing ρ_{ij} from the overlapping days. If there is no overlap in the ith and jth post-event windows, then there is no need to calculate ρ_{ij}. Once we have computed the right-hand side of equation (A.7), the standard error is simply the square root of the variance and the t-statistic is straightforward.

The next case involves testing the significance of the CARRs in equation (9), which are based on the SPARQS pricing model benchmark described by equation (6). Thus, it is necessary to compute the variance of the sum on the left-hand side of (9), which is the variance of the sum

$$\sum_{t=0}^{L}\left(\frac{1}{\text{card}(A_t)} \sum_{i \in A_t} \eta_{i,\tau_i+t}\right). \tag{A.8}$$

Computation of this sum's variance is similar to the procedure for the sum in equation (A.1), where we make assumptions about the η's similar to the assumptions in (A.2) through (A.5) about the ε's. One difference is that we allow for the (negative) serial correlation in the errors at different dates. The source of η_{i,τ_i+t} is the pricing error of a derivative relative to its underlying stock, which seems likely to be (and in fact is) negatively serially correlated. We assume that the pricing errors for SPARQS i follow an AR(1) process with autocorrelation coefficient ζ_i, or specifically that

$$cov(\eta_{i,\tau_i+t}, \eta_{j,\tau_j+u}) = \begin{array}{ll} \gamma_{ij}\theta_i\theta_j & \text{for } \tau_j + u = \tau_i + t,\\ \gamma_{ij}\theta_i\theta_j\zeta_j^{(\tau_j+u)-(\tau_i+t)} & \text{for } \tau_j + u > \tau_i + t,\\ \gamma_{ij}\theta_i\theta_j\zeta_j^{(\tau_i+t)-(\tau_j+u)} & \text{for } \tau_j + u < \tau_i + t, \end{array} \tag{A.9}$$

where $\gamma_{ij} = 1$ for $i = j$. Thus, the variance of the sum (A.8) is

$$\begin{aligned} & \text{var}\left[\sum_{t=0}^{L} \frac{1}{\text{card}(A_t)} \sum_{i \in A_t} \eta_{i,\tau_i+t}\right] \\ = & \sum_{t=0}^{L}\sum_{u=0}^{L} \frac{1}{\text{card}(A_t)\times\text{card}(A_u)} \sum_{i\in A_t}\sum_{j\in A_u} \text{cov}(\eta_{i,\tau_i+t}, \eta_{j,\tau_j+u}) \quad (A.10) \\ = & \sum_{t=0}^{L}\sum_{u=0}^{L} \frac{1}{\text{card}(A_t)\times\text{card}(A_u)} \sum_{i\in A_t}\sum_{j\in A_u} \gamma_{ij}\theta_i\theta_j J(i,j,\tau_i+t,\tau_j+u), \quad (A.11) \end{aligned}$$

where the function J is the autocorrelation function defined by

$$J(i,j,v,w) = \begin{array}{ll} 1 & \text{for } \tau_j + u = \tau_i + t, \\ \zeta_j^{(\tau_j+u)-(\tau_i+t)} & \text{for } \tau_j + u > \tau_i + t, \\ \zeta_i^{(\tau_i+t)-(\tau_j+u)} & \text{for } \tau_j + u < \tau_i + t. \end{array} \quad (A.12)$$

The final CARRs test statistic for which we derive standard errors are the CARRs for the SPARQSs' market model benchmark as described by equation (11). This case is more complicated because the residual is $\Omega_{it}\epsilon_{i,\tau_i+t} + \eta_{i,\tau_i+t}$ and thus has two components. If the residual ε_{i,τ_i+t} is homoskedastic then $\Omega_{i,\tau_i+t}\varepsilon_{i,\tau_i+t}$ and $\Omega_{it}\varepsilon_{i,\tau_i+t} + \eta_{i,\tau_i+t}$ are not, implying that simply to mimic the method for the left-hand side of (9) is not correct. For this purpose, it is necessary to consider a procedure that recognizes $\Omega_{it}\varepsilon_{i,\tau_i+t}$ and η_{i,τ_i+t} are distinct errors with different properties, but correlated. To do this we need to specify the correlation between the ε's and the η's. Assume:

$$\begin{aligned} \text{cov}(\varepsilon_{i,\tau_i+t}, \eta_{i,\tau_i+t}) &= c_{ii}, \quad (A.13) \\ \text{cov}(\varepsilon_{i,\tau_i+t}, \eta_{j,\tau_i+t}) &= c_{ij}, \quad (A.14) \\ \text{cov}(\varepsilon_{i,\tau_i+t}, \eta_{i,\tau_i+u}) &= 0, \quad (A.15) \\ \text{cov}(\varepsilon_{i,\tau_i+t}, \eta_{j,\tau_j+u}) &= 0, \quad (A.16) \end{aligned}$$

Then, the variance of the sum on the left-hand side of (11) is:

$$\begin{aligned} & \text{var}\left[\sum_{t=0}^{L} \frac{1}{\text{card}(A_t)} \sum_{i\in A_t} (\Omega_{it}\varepsilon_{i,\tau_i+t} + \eta_{i,\tau_i+t})\right] \\ = & \sum_{t=0}^{L}\sum_{u=0}^{L} \left[\frac{1}{\text{card}(A_t)\times\text{card}(A_u)}\right. \quad (A.17) \\ & \left.\times \sum_{i\in A_t}\sum_{j\in A_u} \Omega_{it}\Omega_{ju}\text{cov}(\varepsilon_{i,\tau_i+t}, \varepsilon_{j,\tau_j+u}) + \Omega_{it}\text{cov}(\varepsilon_{i,\tau_i+t}, \eta_{j,\tau_j+u}) + \text{cov}(\eta_{i,\tau_i+t}, \eta_{j,\tau_j+u})\right] \\ = & \sum_{t=0}^{L}\sum_{u=0}^{L} \left(\frac{1}{\text{card}(A_t)\times\text{card}(A_u)}\right. \quad (A.18) \\ & \left.\times \sum_{i\in A_t}\sum_{j\in A_u} \left[\left[\Omega_{it}\Omega_{ju}\rho_{ij}\sigma_i\sigma_j + \Omega_{it}c_{ij}\right] I(\tau_i+t, \tau_j+u) + \gamma_{ij}\theta_i\theta_j J(i,j,\tau_i+t,\tau_j+u)\right]\right). \end{aligned}$$

Table 1: Structured Equity Product Issues

Number of issues and aggregate proceeds of U.S. structured equity products in each year during 1992–2005. The sample consists of all U.S. publicly registered SEPs issued from 1992 through 2005 found in the SEC's EDGAR database for the investment banks identified as issuers of equity-linked notes. The statistics presented below group the SEP issues according to whether the reference asset is an individual common stock, a stock index, or multiple stocks or indexes. For each category, the table presents the total number of issues per year and the total proceeds, in U.S. dollars, paid by investors.

Year	Issues Linked to Individual Equities		Issues Linked to Equity Indices		Issues Linked to Multiple Equities or Indices		Total Issues of SEPs	
	Number	Proceeds ($)	Number	Proceeds ($)	Number	Proceeds ($)	Number	Proceeds ($)
1992	–	–	2	105,500,000	–	–	2	105,500,000
1993	6	483,000,000	2	66,000,000	2	141,000,000	10	690,000,000
1994	7	405,862,500	1	25,000,000	1	25,000,000	9	455,862,500
1995	–	–	–	–	1	3,996,000	1	3,996,000
1996	6	483,331,234	5	210,000,000	–	–	11	693,331,234
1997	4	295,769,202	11	869,800,000	–	–	15	1,165,569,202
1998	14	574,134,520	10	8,031,045,162	1	9,000,000	25	8,614,179,682
1999	24	1,275,294,729	24	996,811,000	8	203,964,046	56	2,476,069,775
2000	26	1,126,365,742	13	369,150,000	6	235,145,300	45	1,730,661,042
2001	66	2,630,543,536	27	1,255,097,446	14	370,250,000	107	4,255,890,982
2002	85	2,279,141,605	62	1,865,599,677	11	308,709,910	158	4,453,451,192
2003	131	2,837,954,117	118	3,566,779,870	27	585,070,208	276	6,989,804,195
2004	230	4,145,818,943	133	3,712,414,040	44	893,431,000	407	8,751,663,983
2005	253	5,217,717,319	135	2,934,098,620	78	1,544,243,800	466	9,696,059,739
Total	852	21,754,933,447	543	24,007,295,815	193	4,319,810,264	1,588	50,082,039,526

Table 2: Most Frequent Structured Equity Product Reference Indices

Numbers of index-linked issues and their total proceeds for each underlying index that was referenced by at least two index-linked structured products. The sample consists of all U.S. publicly registered index-linked structured products issued from 1992 through 2005 found in the SEC's EDGAR database for the investment banks identified as issuers of equity-linked notes.

Index	**Number of Issues**	**Proceeds**
S&P 500 Index	227	13,852,977,492
NASDAQ-100 Index	62	1,756,113,316
Dow Jones Industrial Average	54	1,940,734,500
Nikkei Index	52	1,716,027,700
Russell 2000 Index	20	649,450,000
Dow Jones Euro STOXX 50	13	211,615,000
AMEX Select Ten Index	11	662,000,000
The Industrial 15 Index	9	274,600,000
PHLX Housing Sector Index	9	263,503,000
TOPIX Index	8	939,340,000
Lehman Brothers 10 Uncommon Values Index	8	67,877,000
Dow Jones Global Titans	8	179,362,000
S&P Midcap 400 Index	5	116,150,000
AMEX Biotechnology Index	5	70,000,000
PHLX Oil Service Sector Index	3	66,050,000
MSCI EAFE Index	2	36,750,000
Biotech HOLDRs	2	47,025,807
Energy Select Sector SPDR	2	95,000,000
GSTI Internet Index	2	40,920,000
Morgan Stanley High-Technology Index	2	110,000,000
RUSSELL Midcap Growth Index	2	82,000,000
RUSSELL 3000 Index	2	53,750,000
The Biotech-Pharmaceutical Index	2	100,000,000
Semiconductor HOLDRs	2	48,000,000
AMEX Select Utility Index	2	104,000,000
FTSE 100 Index	2	58,981,000

Table 3: Most Frequent Structured Equity Product Reference Equities

Numbers of issues and their total proceeds for each underlying common stock that was referenced by at least five structured equity products. The sample consists of all U.S. publicly registered structured equity products issued from 1992 through 2005 found in the SEC's EDGAR database for the investment banks identified as issuers of equity-linked notes.

Company	Ticker	Number of Issues	Proceeds
Intel	INTC	31	699,290,168
Cisco Systems	CSCO	23	1,099,506,624
Texas Instruments	TXN	19	443,962,495
Motorola	MOT	16	382,871,933
Cendant	CD	14	156,729,838
General Electric	GE	14	458,716,610
Apple Computer	AAPL	13	102,611,651
EMC Corp	EMC	13	486,541,087
Yahoo	YHOO	12	341,074,420
Pfizer	PFE	12	230,491,144
Sun Microsystems	SUNW	11	319,950,508
General Motors	GM	11	34,825,000
Amgen	AMGN	11	334,645,727
Home Depot	HD	10	260,827,000
WalMart	WMT	10	224,329,773
Citigroup Financial	C	10	279,616,970
Echostar Communications	DISH	10	108,128,278
Corning	GLW	10	195,852,568
Qualcomm	QCOM	9	220,101,301
Applied Materials	AMAT	9	430,240,871
Juniper Networks	JNPR	9	137,177,996
EBay	EBAY	9	114,316,331
Walt Disney	DIS	8	180,050,000
Chesapeake Energy Corp	CHK	8	109,127,282
Tyco International	TYC	8	235,872,105
Merck	MRK	8	128,881,733
Nokia ADRs	NOK	8	223,351,922
The Gap Inc	GPS	7	125,718,332
Newmont Mining	NEM	6	120,005,900
JetBlue Airlines	JBLU	6	64,702,500
IBM	IBM	6	270,325,347
Altera Corp	ALTR	6	212,629,000
Lyondell Chemical	LYO	6	160,557,350
Wyeth	WYE	6	270,121,890
Alcoa	AA	5	189,500,000
Worldcom	WCOM	5	266,512,155
Global SanteFe Corp	GSF	5	91,669,777
Oracle	ORCL	5	382,506,512
Micron Technology	MU	5	61,856,250
Waste Management Inc	WMI	5	84,848,000
Dell Computer	DELL	5	105,174,568
JP Morgan	JPM	5	103,605,375
United States Steel Corp	X	5	19,850,000
Valero Energy Corp	VLO	5	73,980,192
Bristol Myers Squibb	BMY	5	49,600,000
Agilent Technology	A	5	38,104,480

Table 4: Details of SPARQS Pricing At Issue Dates

For each SPARQS issued through the end of 2005 and listed on the AMEX, the table presents the issue-level details including the issue date, reference equity, coupon rate, option market volatility, one-month LIBOR, and fair value estimated using the pricing model described in Section 3.1. Issue details are from the pricing supplements in the SEC's EDGAR database.

Issue Date	Underlying Ticker	SPARQS Coupon	Underlying Volatility	One-Month LIBOR	Model Price	Issue Price	Premium to Model Price
6/18/2001	CSCO	8.00%	67.03%	4.07%	17.97	20.38	13.42%
6/26/2001	SUNW	8.00%	81.36%	3.90%	11.87	14.66	23.49%
7/24/2001	ORCL	8.00%	54.91%	3.98%	18.35	19.50	6.28%
8/24/2001	EMC	8.00%	63.50%	3.65%	14.63	16.35	11.72%
10/24/2001	NOK	8.00%	73.56%	2.49%	16.44	19.50	18.59%
12/18/2001	GLW	10.00%	75.90%	2.23%	8.76	10.30	17.54%
1/10/2002	JNPR	12.00%	81.90%	2.35%	19.50	21.99	12.77%
1/31/2002	GPS	6.30%	49.68%	2.41%	13.83	15.05	8.79%
2/22/2002	SEBL	10.00%	64.21%	2.41%	32.18	35.00	8.78%
4/16/2002	TXN	8.00%	43.58%	2.71%	30.56	32.32	5.77%
5/29/2002	QCOM	10.00%	58.59%	2.51%	29.75	32.62	9.66%
8/15/2002	INTC	7.13%	53.69%	1.82%	16.96	18.38	8.40%
9/30/2002	BRCM	8.00%	83.30%	1.80%	5.62	6.61	17.61%
2/28/2003	NEM	7.00%	58.62%	1.38%	12.15	13.76	13.18%
4/28/2003	KSS	6.00%	30.25%	1.39%	28.79	29.57	2.74%
5/21/2003	SGP	8.00%	38.11%	1.25%	17.37	18.50	6.50%
7/30/2003	BBY	7.00%	53.56%	1.18%	19.05	21.45	12.59%
8/22/2003	NXTL	8.00%	42.50%	1.34%	17.93	18.81	4.89%
9/25/2003	NVDA	8.00%	58.18%	1.28%	18.75	20.00	6.68%
10/31/2003	YHOO	8.00%	53.90%	1.42%	18.39	20.26	10.18%
11/26/2003	TXN	8.00%	43.87%	1.41%	26.42	28.23	6.85%
12/30/2003	XLNX	8.00%	43.22%	1.41%	17.67	18.90	6.98%
1/30/2004	ADI	7.00%	38.67%	1.33%	9.12	9.73	6.65%
2/26/2004	GLW	7.00%	45.91%	1.33%	12.00	13.01	8.42%
3/11/2004	TLAB	10.00%	52.31%	1.37%	9.57	10.32	7.79%
3/31/2004	WYE	6.00%	26.63%	1.26%	17.53	18.39	4.93%
4/30/2004	NEM	6.25%	35.46%	1.70%	9.46	10.10	6.73%
4/30/2004	NSM	10.00%	43.41%	1.70%	21.64	23.11	6.76%
5/28/2004	JBLU	10.00%	54.38%	2.04%	13.12	14.19	8.17%
5/28/2004	JNPR	10.00%	51.96%	2.04%	9.54	10.22	7.18%
6/29/2004	AV	10.00%	35.76%	2.32%	15.71	15.81	0.62%
6/30/2004	YHOO	8.00%	47.23%	2.32%	15.50	16.98	9.61%
7/30/2004	EMC	6.00%	33.61%	2.35%	10.13	10.49	3.51%
8/31/2004	AAPL	10.00%	38.11%	2.25%	15.14	15.97	5.51%
9/30/2004	NOK	7.00%	37.47%	2.36%	13.10	13.84	5.66%
9/30/2004	BIIB	7.00%	30.45%	2.36%	5.73	5.93	3.51%
10/28/2004	GT	10.00%	43.07%	2.43%	9.13	9.73	6.61%
10/29/2004	QCOM	6.00%	32.92%	2.39%	9.96	10.50	5.45%
11/30/2004	NVDA	10.00%	48.52%	2.88%	18.21	19.50	7.08%
11/30/2004	IGT	6.00%	32.90%	2.88%	8.33	8.85	6.19%
12/30/2004	MOT	8.00%	37.40%	3.04%	16.37	17.44	6.52%
12/30/2004	TXN	8.00%	33.65%	3.04%	22.77	23.89	4.93%
1/28/2005	LYO	9.00%	34.95%	3.16%	26.90	28.86	7.27%
1/31/2005	ANF	10.00%	36.15%	3.17%	11.65	12.41	6.58%
2/28/2005	CNX	8.00%	46.71%	3.41%	19.45	21.60	11.04%
2/28/2005	XLNX	8.00%	29.88%	3.41%	6.99	7.27	4.01%
3/30/2005	VLO	8.00%	36.33%	3.75%	16.49	17.26	4.64%
3/30/2005	AAPL	10.00%	50.47%	3.75%	9.76	10.71	9.65%
5/31/2005	FRX	7.00%	29.59%	3.73%	18.45	19.34	4.84%
5/31/2005	GSF	7.00%	30.59%	3.73%	16.61	17.53	5.51%
6/30/2005	CHK	9.00%	38.28%	3.81%	21.74	23.36	7.46%
6/30/2005	NVDA	10.00%	46.62%	3.81%	25.52	27.98	9.64%
7/29/2005	DNA	7.00%	32.29%	4.08%	8.26	8.76	6.06%
7/29/2005	WMB	7.00%	31.15%	4.08%	19.71	20.80	5.56%
8/31/2005	APA	7.00%	32.65%	4.25%	33.43	35.38	5.82%
8/31/2005	JNPR	7.00%	31.35%	4.25%	11.20	11.78	5.14%
9/30/2005	XMSR	8.50%	36.00%	4.33%	16.23	17.21	6.07%
9/30/2005	NOV	8.00%	35.05%	4.33%	14.92	15.85	6.23%
10/31/2005	VLO	9.00%	48.24%	4.57%	17.71	19.55	10.37%
10/31/2005	EBAY	7.00%	33.88%	4.57%	9.27	9.86	6.34%
11/30/2005	AAPL	10.00%	39.90%	4.71%	15.69	16.63	5.97%
11/30/2005	RIG	8.50%	33.29%	4.71%	12.31	12.90	4.80%
12/30/2005	COH	7.50%	31.49%	4.83%	16.02	16.88	5.35%
12/30/2005	GILD	7.50%	35.82%	4.83%	13.03	13.85	6.27%
EW Average		8.25%	48.91%	2.94%			8.77%
VW Average		8.15%	44.91%	2.83%			7.81%

Table 5: SPARQS Post-Issue Cumulative Average Residual Returns

Post-issue return performance of Morgan Stanley's SPARQS evaluated using cumulative average residual returns (CARRs). For the ith SPARQS issue, the returns to the SPARQS, $R_{i,t}$, and the underlying stock, $r_{i,t}$, are modeled as:

$$R_{i,t} - r_t = \Omega_{i,t}(r_{i,t} - r_t) + \eta_{i,t},$$
$$r_{i,t} - r_t = \beta_i(r_{M,t} - r_t) + \varepsilon_{i,t},$$

where $i = 1, \ldots, N$ indexes the SPARQS and their underlying stocks, $\Omega_{i,t} = \frac{\partial V(S_{i,t},t)}{\partial S_{i,t}} \frac{S_{i,t}}{V(S_{i,t},t)}$ is the elasticity of the price of the ith SPARQS with respect to the stock price. Combining the above equations results in a market model for the SPARQS based on the index return:

$$R_{i,t} - r_t = \Omega_{it}\beta_i(r_{M,t} - r_t) + \Omega_{it}\varepsilon_{i,t} + \eta_{i,t},$$

Panel A presents the CARRs of the SPARQS using the underlying stock return $r_{i,t}$ as a benchmark (i.e., it presents the cumulative $\eta_{i,t}$'s from the first equation above) for various periods following the issue dates, as well as the standard errors and t-statistics. Panel B presents the cumulative average residual returns (CARRs) of the market model for the underlying stocks, along with standard errors and t-statistics. Panel C presents the CARRs of the SPARQS, using the market index as a benchmark. The computation of the standard errors for the various CARRs is described in Appendix 2.

Panel A: Post-Issue SPARQS Performance: Reference Equity Benchmark

	Trading Days After Issue, Cumulative Averge Returns											
SPARQS Model Residuals	+1	+2	+20	+40	+60	+80	+100	+120	+140	+160	+180	+200
Equation (9), $CARRs_\eta$	0.69%	0.76%	-1.95%	-2.30%	-2.69%	-4.05%	-4.19%	-4.39%	-4.87%	-3.94%	-4.25%	-4.40%
standard errors	0.22%	0.26%	0.76%	1.11%	1.40%	1.67%	1.92%	2.15%	2.43%	2.74%	3.08%	3.40%
t-statistics	(3.21)	(2.96)	(-2.57)	(-2.08)	(-1.92)	(-2.43)	(-2.18)	(-2.04)	(-2.01)	(-1.44)	(-1.38)	(-1.29)

Panel B: Underlying Stocks Performance: Market Model Benchmark

	Trading Days After Issue, Cumulative Average Returns											
Market Model Residuals	+1	+2	+20	+40	+60	+80	+100	+120	+140	+160	+180	+200
Equation (10), $CARRs_\varepsilon$	-0.96%	-1.43%	-3.04%	-1.30%	0.69%	1.16%	1.90%	0.62%	2.39%	-2.80%	-5.97%	-7.47%
standard errors	0.36%	0.51%	1.68%	2.53%	3.26%	3.91%	4.54%	5.13%	5.77%	6.52%	7.30%	8.04%
t-statistics	(-2.69)	(-2.80)	(-1.81)	(-0.51)	(0.21)	(0.30)	(0.42)	(0.12)	(0.42)	(-0.43)	(-0.82)	(-0.93)
Sample Size	52	52	52	52	52	52	52	52	39	35	33	31

Panel C: Post-Issue SPARQS Performance: Market Model Benchmark

	Trading Days After Issue, Cumulative Average Returns											
SPARQS Market Model Residuals	+1	+2	+20	+40	+60	+80	+100	+120	+140	+160	+180	+200
Equation (11), $CARRs_{\Omega\varepsilon+\eta}$	0.22%	0.04%	-3.60%	-3.20%	-2.53%	-3.86%	-3.36%	-4.26%	-3.81%	-6.52%	-9.74%	-11.33%
standard errors	0.24%	0.30%	0.93%	1.38%	1.77%	2.14%	2.50%	2.85%	3.29%	3.83%	4.44%	5.03%
t-statistics	(0.91)	(0.12)	(-3.89)	(-2.31)	(-1.43)	(-1.80)	(-1.34)	(-1.50)	(-1.16)	(-1.70)	(-2.19)	(-2.25)

Table 6: SPARQS Post-Issue Buy-and-Hold Returns

Post-issue return performance of Morgan Stanley's SPARQS evaluated using buy-and-hold returns. Panel A presents the equal-weighted cumulative event-time buy-and-hold returns to the SPARQS as well as equal-weighted benchmark returns formed by cumulating in event time returns of the form:

$$R_{i,t} = r_t + \Omega_{i,t} \left(r_{i,t} - r_t \right),$$

where $R_{i,t}$ is the return on the ith SPARQS on date t, $r_{i,t}$ is the return on the underlying stock, r_t is the riskless rate of return on date t, and $\Omega_{i,t} = \frac{\partial V(S_{i,t},t)}{\partial S_{i,t}} \frac{S_{i,t}}{V(S_{i,t},t)}$ is the elasticity of the value of the ith SPARQS with respect to the stock price. Panel A also presents the equal-weighted average event-time premia of the market prices over the model prices. Panel B presents the equal-weighted cumulative event-time buy-and-hold returns to the SPARQS as well as benchmark returns formed by cumulating in event time returns of the form:

$$R_{i,t} = r_t + \Omega_{i,t} \beta_i \left(r_{M,t} - r_t \right),$$

where $r_{M,t}$ is the market return on date t. The sample consists of the SPARQS issued before the end of June 2005 and listed on the AMEX.

Panel A: Post-Issue SPARQS Returns Compared to Reference Equity Benchmark

	Trading Days After Issue Date										
Category	+1	+20	+40	+60	+80	+100	+120	+140	+160	+180	+200
SPARQS Returns	0.20%	-3.21%	-2.63%	-1.22%	-2.33%	-1.67%	-2.85%	-2.13%	-3.80%	-5.17%	-6.02%
Benchmark Returns	-0.49%	-1.33%	-0.46%	1.19%	1.34%	1.82%	0.72%	1.73%	-0.27%	-0.96%	-1.41%
Excess Returns	0.69%	-1.93%	-2.29%	-2.67%	-3.99%	-4.13%	-4.33%	-4.79%	-3.90%	-4.21%	-4.36%
Market Premiums	8.24%	5.90%	4.91%	6.04%	3.23%	2.84%	2.03%	0.84%	1.30%	0.90%	0.51%

Panel B: Post-Issue SPARQS Returns Compared to Market Model Benchmark

	Trading Days After Issue Date										
Category	+1	+20	+40	+60	+80	+100	+120	+140	+160	+180	+200
SPARQS Returns	0.20%	-3.21%	-2.63%	-1.22%	-2.33%	-1.67%	-2.85%	-2.13%	-3.80%	-5.17%	-6.02%
Benchmark Returns	-0.02%	0.44%	0.59%	1.33%	1.53%	1.51%	1.12%	1.37%	2.29%	3.62%	4.27%
Excess Returns	0.22%	-3.54%	-3.16%	-2.52%	-3.81%	-3.33%	-4.22%	-3.79%	-6.38%	-9.36%	-10.81%

Table 7: SPARQS Expected Returns

Equal-weighted average expected returns to investing in the SPARQS on the date of their primary offering and holding them to maturity or call. The expected return estimates are computed by first using either the CAPM or the Fama-French 3-factor model to estimate the expected returns on the underlying stocks, and then solving the Kolmogorov backward equation in Section 4 to calculate the expected payoffs of the SPARQS. Panel A reports the means and medians of the estimates of the expected returns of the 65 sample SPARQSs using the CAPM to compute the expected returns of the underlying stocks, with four different estimates of the market risk premium: (i) the historical risk premium over the period 1926–2001; (ii) the historical risk premium over the period 1993–2001; (iii) 6%; and (iv) 8%. The standard errors of the means are reported in parentheses immediately below the means. Panel B reports the means and medians of the estimates of the expected returns of the SPARQSs using the Fama-French 3-factor models to compute the expected returns of the underlying stocks, with four different estimates of the factor risk premia: (i) the historical risk premia over the period 1926–2001; (ii) the historical risk premia over the period 1993–2001; (iii) the historical risk premia over the period 1926–2001 for SMB and HML and an 6% market risk premium; and (iv) the historical risk premia over the period 1926–2001 for SMB and HML and an 8% market risk premium. The standard errors of the means are reported in parentheses immediately below the means. The average market model beta used in Panel A is 1.86. The average factor loadings on the market, SMB, and HML used in Panel B are 1.528, 0.244, and −0.464, respectively. These factor loadings were estimated using ordinary least squares with five years of monthly returns data from the five-year period immediately prior to the SPARQS' issue dates.

Panel A: SPARQS Expected Returns Based on CAPM For Various Estimates of the Market Risk Premium

	Estimate of Market Risk Premium			
SPARQS Expected Returns	1926–2001 Average	1993–2001 Average	6%MRP	8%MRP
Average	2.22%	2.56%	0.76%	2.30%
Standard Error	(0.53%)	(0.55%)	(0.46%)	(0.53%)
Median	2.37%	2.69%	1.06%	2.44%

Panel B: SPARQS Expected Returns Based on Fama-French 3-Factor Model for Various Estimates of the Factor Risk Premia

	Estimates of Factor Risk Premia			
SPARQS Expected Returns	1926–2001 Average	1993–2001 Average	6%MRP	8%MRP
Average	-0.27%	-0.30%	-1.71%	-0.50%
Standard Error	(0.67%)	(0.70%)	(0.71%)	(0.70%)
Median	0.76%	0.68%	-0.80%	0.46%

Figure 1: Event-Time Average SPARQS Market-to-Model Premium

Average premium of the SPARQS market price to the model price, in event time. For each SPARQS issue and each day, the market-to-model price premium is the difference between the daily SPARQS last price, including accrued interest, minus the SPARQS model price, divided by the the model price. The calculation of the model price, described in Section 3.1, is carried out using stock prices, interest rates, and option volatilities that are updated daily. The figure shows the equal-weighted premium in event time.