Measuring the Full Value-Effect of an Event: The Healthcare Reform Act

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Abstract

We present a method to measure the full stock market value effect of an event using stock and options prices. We apply the method to an event with complex value effects: passage of healthcare reform, the Patient Protection and Affordable Care Act of 2010 (PPACA). We show how the method can be used to provide useful ballpark figures for the net effects of new legislation or other events with positive and negative provisions. The method can be used for ex ante and ex post government policy analysis, and is applicable to most major events because it only requires that some affected stocks have traded stock options.

JEL Classifications: G14, G38, I13.
Keywords: Event study, valuation, healthcare reform.

* We are thankful for comments from Kim Larkins at Amgen, Scott Shortenhaus at Eli Lilly and Company, Joe Cook at Pfizer, Inc., and Ted Buckley at Shire Group.

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1. Introduction

The seminal work of Fama, Fisher, Jensen, and Roll (1969) established the event study method to measure whether the announcement of new information has a statistically significant effect on a firm's stock market value. Thousands of subsequent event studies have used this basic approach with various statistical tools or expected return models. Many of these studies only measure a fraction of an event's value effect because the events are partly anticipated by investors. We propose a method to better measure the full value effect using stock option prices together with stock prices.

Our method comes from the mergers literature, including Subramanian (2004), Barraclough, Robinson, Smith, and Whaley (2012), and Borochin (2013), where they try to disentangle two value effects caused by a merger announcement; the synergy value and the signal about the standalone values of the bidder and target. One crucial estimate from the method is the probability that the merger will be completed. In our application, the analogous estimate is the ex ante probability that the event will occur. Earlier event studies that claim to measure the full value effect of an event must argue that this probability is zero. For our event, we find that the probability is 70 percent two days before the event.

The purpose of our study is to show that generalizations of these earlier approaches are widely applicable and useful outside of mergers. We apply our more general method of using option data to estimate probabilities to a complex event: U.S. House of Representatives passage of the healthcare reform law, the Patient Protection and Affordable Care Act of 2010 (PPACA). We also examine a related event: the subsequent Supreme Court ruling on PPACA constitutionality. The law impacts various segments of the healthcare sector of the economy in different ways. For example, stock analysts expected hospital firms to benefit most, but pharmaceutical firms to be less affected because the PPACA required pharmaceutical firms to pay fees to help finance other provisions in the PPACA.

The notion that good estimates of event probabilities could be very useful is not new. Brennan (1990) explains that stock price changes due to partially anticipated events must be adjusted to properly measure the full value effect of an event. Malatesta and Thompson (1985), Acharya (1993), Chaplinsky

and Hansen (1993), and Prabhala (1997), suggest that firm-specific attributes and other predictors of the probability of an event can be used to estimate the event probability. The potential problem with this approach is that data on firm-specific attributes may be scarce, or if available, may not provide reliable predictions of the event probability. Indeed, when private information makes up the bulk of the explanatory power of the event probability, using public information to predict the event probability will be of little value. Our method produces a market-based event probability that likely captures at least some of the effects of private information.

More recently, Wolfers and Zitzewitz (2009) and Snowberg, Wolfers and Zitzewitz (2012) suggest that one can use the traded event securities from prediction markets to estimate event probabilities and compute the full value effect. In fact, one reason that we selected PPACA passage to illustrate our method is that it had an event security traded on Intrade, a well-known prediction market. We compare the Intrade-generated probabilities to those we generate from options and stock prices. The Supreme Court event also had an event security traded on Intrade.[1]

Interestingly, Intrade's PPACA passage probability matches our probability quite closely, but Intrade's Supreme Court decision probability differs considerably from ours. We estimate PPACA passage probability at 70 percent two days before Congressional passage, compared to 76 percent for the Intrade probability. For the Supreme Court constitutionality ruling, however, our probability was 68 percent, while the Intrade probability was 30 percent.[2] Various investment analysts were predicting a 50 percent probability. Intrade traders were much more pessimistic about the Supreme Court vote and the difference in beliefs between Intrade, analysts, and option markets was substantially greater, perhaps reflecting greater opacity of the Supreme Court to outsiders.

The greater opacity of Supreme Court events compared to Congressional events is likely due to more public news about votes from Congressmen compared to Supreme Court justices, who do not make

[1] Our financial-market-based approach is now even more attractive because Intrade closed down on March 11, 2013.
[2] These are the probabilities on June 26, 2012, two days before the ruling was announced. Before oral arguments were held March 26-28, 2021, there was little difference between the two but that changed after oral arguments. The Intrade probability was 66 percent on March 25, 2012, but fell to 35 percent on March 29, 2012. Analysts reports set the probability at 65 percent before oral arguments and 50 percent afterward.

public statements about their votes. Although there are experts selling their insights on Congress and the Supreme Court to specialized investors (see Jerke, 2010), that insight could be relatively more important for Supreme Court events. Therefore, stock investors and Intrade investors are on more equal footing with respect to Congressional events but perhaps not Supreme Court events, hence, we find similar probabilities for the House vote but not the Supreme Court vote.

We believe that our method could be useful for ex ante and ex post public policy analysis. Legislation often contains offsetting provisions negotiated among different political factions. For example, the PPACA imposes a fee (tax) on brand name pharmaceutical sales to offset the additional profit pharmaceutical firms should earn from sales to people newly insured under the PPACA. In turn, the fee is used to help pay premiums for the newly insured. Was the fee set too low as some criticized at the time, does it just offset the windfall, or do pharmaceutical firms end up losing on net?

We find that PPACA passage had little effect on the equity values of pharmaceutical firms on average, and positive effects on hospital and insurance firms. Before adjusting for the probability of the event happening, we estimate that hospital firms gained $1.13 billion, but the gain is $3.77 billion after adjustment. However, for-profit hospitals account for only one ninth of all patient days and hospital surgical operations. Assuming similar valuation for non-profit hospitals, the gain is $33.9 billion. To put this in perspective, the fees and discounts imposed by the PPACA on pharmaceutical firms was estimated at $84.8 billion over ten years (Johnson, 2010). No fees were imposed on hospitals. The value effect on the insurance industry is $2.92 billion unadjusted, $9.73 billion after probability adjustment, and $19.46 billion to account for the fact that half of those insured use non-profit insurers. The total effect of the PPACA comes to $53.36 billion.[3]

We measure the effects ex post, but the method could be used for ex ante analysis by government or industry officials. For example, Congress could publicly release a bill and a vote date. Based on the

[3] We find that the PPACA had no significant effect on the value of medical device firms. Similar to pharmaceutical firms, they also have to pay fees under the PPACA. We do not report results for medical device firms because they are essentially repeats of the pharmaceutical firm results. That is, there is no net effect of the PPACA on their market values, there is no evidence of abnormal trading in their shares around the PPACA, and they provide no reliable estimate of the PPACA probability.

option market reaction to the vote announcement, both government and industry officials could determine investors' estimates of the net effect of the bill's provisions. The PPACA was negotiated between government and industry officials in a way that supposedly balanced negative and positive provisions, therefore, the net effects on taxpayers and healthcare firms were supposed to be small.

For example, the pharmaceutical industry was first to offer concessions to the government, but the Obama administration was still criticized for giving them a sweetheart deal.[4] The Obama administration claimed that fees imposed on pharmaceutical firms recaptured the benefits that they would earn from extra sales to newly covered patients. Conversely, higher fees imposed on insurance companies would penalize them for fighting against PPACA passage.[5] Our results showing some value increase for the insurance companies implies that their strategy paid off better than that of the pharmaceutical companies.

Our method could also be used to better estimate public or private damages associated with an event. The Securities and Exchange Commission often estimates damages from corporate fraud and the Federal Trade Commission estimates damages from illegal business practices. As long as some of the firms involved have traded stock and options, our method can give a more accurate estimate of total damages.

The next section develops a simple model that illustrates how we measure the full effect of an event, along with how we identify the parameters of the model. Section 3 describes the healthcare reform event in more detail, along with analysts perceptions of the probabilities of House passage and the Supreme Court ruling. Section 4 describes the data and the sample, and reports the model results. Section 5 uses results from section 4 to estimate the net effect of the PPACA on the healthcare industry. Section 6 is a conclusion.

[4] Tumulty (2009) quotes Henry Waxman, chairman of the House Energy and Commerce Committee commenting on the Obama administration's pharmaceutical deal: "It was not particularly a deal I would have made... I'd rather benefit the seniors than let the drug companies have a big windfall." Similarly, Hamburger (2009) reports that House Speaker Pelosi said that if the drug companies agreed to give up $80 billion, the real value could be twice as much.

[5] Kirkpatrick (2009) quotes President Obama as follows: "To their credit, the pharmaceutical companies have already agreed to put up $80 billion" but that the health insurance companies "need to be held accountable."

2. A simple framework for measuring the full stock value effect of an event

In this section, we first set up the problem using a simple model of a stock whose current price reflects the expected value of a future event. We show that one cannot typically use the observed price change on the event announcement date to measure the full effect of an event on a company's per share value. Next, we present a model that uses a firm's stock and options prices to identify some unknown parameters that can be used to determine the full effect. We also discuss some potential complications that could impact our identification strategy. Finally, we discuss the empirical method that we apply to option and stock price data to estimate the model parameters.

2.1 Measuring the full stock value effect of an event

Consider a stock whose current price is S_t, and whose future value will be either S_n if there is no event at time T, or $(S_n + V_e)$ if there is an event at T. The full value effect of the event is V_e. For simplicity, we do not distinguish between the event announcement and the event, that is, the announcement and the event occur at the same time. For now, assume that the stock's expected return is small enough, or that T is short enough, that the effects of discounting can be ignored. If the probability that the event will occur is *p*, then stock price at time t is:

$$S_t = p\,(S_n + V_e) + (1 - p)\,S_n = S_n + p\,V_e. \qquad (1)$$

At the end of each day t, investors reassess the event probability as well as the values of V_e and S_n. We assume that changes in p, V_e, and S_n are independent. Therefore, the change in the stock price on day t is:

$$\Delta S_t = \Delta S_{n,t} + \Delta p_t\,V_e + p\,\Delta V_{e,t}\,. \qquad (2)$$

For now, assume that there are no changes in the values of V_e and S_n (to be considered later), therefore, the stock price change on event day t is:

$$\Delta S_t = \Delta p_t \, V_e \,, \tag{3}$$

and the full value effect can be computed as

$$V_e = \Delta S_t \, / \Delta p_t \,. \tag{4}$$

Equation (4) shows that the full effect of an event on a firm's stock value is the observed stock price change divided by the change in the probability of the event. Some event studies claim to measure the full value effect of an event by the observed price change on the event day or over an event window.[6] In our terms, this requires $\Delta p_t = 1$, which means that the event is a complete surprise to investors, hence, they revise p from 0 to 1 on the event day.

For most events, this is not true. In most cases, the event probability and its change are unknown, although investors spend time and resources forming estimates of them. If those estimates were available to us, then we could compute the full value effect using (4). In some limited cases, those expectations are available in prediction markets. Wolfers and Zitzewitz (2009) and Snowberg, Wolfers and Zitzewitz (2012) show how the prices of traded contracts on the outcomes of political events can be used as estimates of the event probabilities. They promote the combination of prediction market probability estimates and event studies as a way to more precisely measure the value effects of political events. Indeed, their clever use of prediction markets allows them to confirm some ex ante predictions using ex post market price reactions.

[6] Most studies adjust the price for the expected stock return on the event day or over the event period. We have assumed that this is small enough to ignore in our presentation.

Their approach is limited, however, by the menu of events that prediction market owners are willing to securitize and offer for trade. Often the most widely traded event securities, and therefore, most profitable for prediction markets to offer, are events featured prominently in the popular press, such as presidential elections. Congressional passage of a new piece of technical legislation, or adoption of an arcane regulatory rule by a government agency, could generate large value effects for certain firms, yet never draw enough interest from prediction markets traders to warrant an event security.

Options can be used to make their approach much more widely applicable. Option pricing equations can be combined with (4) to add independent information and degrees of freedom, allowing us to identify or over-identify all of the free parameters in our problem. For example, suppose that there are N traded call options on our event-affected stock, each with the expiration date of $T_c > T$, and differentiated only by their exercise prices X_i, i = 1, 2, 3,…, N. Then our model can be augmented to form a system of asset pricing equations as follows:

$$
\begin{aligned}
S_t &= p\,(S_n + V_e) + (1 - p)\,S_n \\
C_{1t}[S_t, X_1] &= pc_{1t}[(S_n + V_e), \sigma_e, X_1] + (1 - p)c_{1t}[S_n, \sigma_n, X_1] \\
C_{2t}[S_t, X_2] &= pc_{2t}[(S_n + V_e), \sigma_e, X_2] + (1 - p)c_{2t}[S_n, \sigma_n, X_2] \\
&\ldots \\
C_{Nt}[S_t, X_N] &= pc_{Nt}[(S_n + V_e), \sigma_e, X_N] + (1 - p)c_{1t}[S_n, \sigma_n, X_N].
\end{aligned}
\qquad (5)
$$

This system includes the stock price equation and N option price equations. Much like the stock price is defined by two state-contingent payoffs, each option price is expressed as a claim on two options whose values are state-contingent. We suppress the risk free rate, r, and expiration date T_c, from the options equations because they are the same for each equation and are assumed to be known. $C_{it}[S_t, X_i]$ is the observed price of call option i, with exercise price X_i, $c_{it}[(S_n + V_e), \sigma_e, X_i]$ is the theoretical (Black-Scholes or binomial) price of the option contingent on the event occurring, σ_e, is its associated return

volatility, $c_{it}[S_n, \sigma_n, X_i]$ is the theoretical price of the option contingent on no event occurring, and σ_n, is its associated return volatility.

System (5) contains five unknown parameters, *p*, S_n, V_e, σ_e, and σ_n, therefore, we need prices on four traded options, along with the stock price, to just identify the system. We will use more than four options in our model estimation so that the system will be over identified.

We have chosen to only use call options in our estimations, but put options could also be used to increase the number of identifying restrictions. Including a put with exercise price X_i is particularly useful if a call option with exercise price X_i is either not offered or seldom traded. Of course, if put-call parity holds closely, then one should not use both a put and call with the same exercise price and expiration date in system (5) because their prices are interdependent. One can also use options with expiration dates different from T_c if additional restrictions are required, but then additional unknown volatility parameters must be estimated, adding to the number of options required to identify all of the unknown parameters.

2.2 Potential complications for parameter identification

Our simple model assumes that the firm's value depends on a single event, however, at any point in time, a firm's stock and options prices could be affected by more than one event. This could obscure some of the parameter estimates, making them noisy or difficult to identify. Consider a hypothetical example using the passage by the U.S. House of Representatives of the PPACA on March 21, 2010. The event occurred at the end of the first quarter, and the sample firms issued their first quarter financial reports in the following months. Hence, the next major event for our sample of firms was their quarterly earnings reports, which could have common industry effects.

Figure 1 illustrates the possible interplay between the events. For simplicity, we assume that the PPACA event occurs one period in the future, and the earnings event occurs two periods in the future. Our model estimates are grounded in the market prices of a firm's stock and options prices on each day t. The most important model estimate is the PPACA event probability p. When we estimate the model, we

ignore the earnings event and its probability q, and attribute the daily changes in estimates of p to new political information that changes the probability that the PPACA will pass the House.

[Figure 1 here]

A potential estimation problem arises if the two events are related. Suppose that at time t, the earnings event probability q increases, and this somehow increases the PPACA probability p. Then our model could attribute an increase in the stock price at time t to new information about an increase in p, but the increase is due to an increase in q. Another possibility is if the PPACA contains an immediate tax on high-earning companies, then the two events would be linked because an increase in earnings combined with PPACA passage implies greater tax expense for a high earning firm. Furthermore, the effect is asymmetric, affecting only our estimate of the passage state price.

We believe that this identification problem is not an issue in our case because the two events are unrelated. Furthermore, changes in the stock price due to changes in expectations about the firm's future earnings affects the two PPACA state prices at time t+1 by the same amount. Hence, there is a parallel shift in both state prices (passage and rejection), but no change in the implied PPACA state-specific drifts in price over time, or the probability of passage.

Our model identifies parameter changes related to new information about the PPACA. New information about the PPACA could affect the passage state price or the passage probability, but not the rejection state price. The PPACA information has no effect on the rejection state price because that is the price investor expect under the condition of no PPACA.

Figure 2 shows a stylized stock price pattern for a firm experiencing a hypothetical event. We assume that the event has a positive effect on the firm's market value, hence, the state price conditioned on the event exceeds the state price conditioned on no event. We also assume that the Event state price drifts at a two percent rate per period, and the NoEvent state price drifts at a one percent rate (they could drift at the same rates if systematic risk is the same for both states).

[Figure 2 here]

The figure shows how the actual stock price drifts somewhere in between the two state-specific prices, closer to the Event (NoEvent) price if the event probability is above (below) 50 percent. The drift rate of the actual stock price is also a weighted average of the state-specific drift rates. New information about the event is introduced periodically as an increase in the event probability, where the event uncertainty is fully resolved in the last period. We could have decreased the probability periodically and had the stock price end up at the NoEvent price. Many other stock price patterns are possible by moving the probability up and down during the event period.

We are unlikely to find an ideal pattern such as the one in Figure 2 for our event because there could be unknown events that could impact identification. An identification problem can also appear on the first event date even if a second event is know, because on the first event day, there is a transition from the first event to the second. This problem is illustrated in Section 4.

We minimize the effects of unknown events in the following ways. First, we focus on what we believe is the major event common to a group of firms over the same calendar period. If information about smaller common events is released during our event period, the effects should be small. Second, if some firms in the group experience major firm-specific events, we minimize their effects by estimating the model parameters for each firm, and then using group averages as our final parameter estimates. Third, our estimates of the full value effects of the event will rely on model estimates obtained over only a few days at most. A short event period should minimize the chance that information about another significant event is released during our event period.

2.3 Parameter estimation method

Our method estimates the market's expectations about firm values in the two possible states; the event state and the no-event state. In our first empirical application, the event state is "the U.S. House of Representatives passes the PPACA," and the no-event state is "the House does not pass the PPACA." Of

course, we will only observe the firm's stock price in one of the two states. Nevertheless, we can still identify the market's latent beliefs about a firm's value in both states.

Under no-arbitrage conditions, the two state values for our event must be reflected in the values of the securities of the affected firms. For common stock, the relation between the state values and stock price is linear, but for options, the relation is nonlinear. Each option provides unique information to the system because each has a different exercise price (or expiration if one chooses to include options with different expiration dates). With different exercise prices, each observed option price changes at a different rate in response to observed stock price changes. Similarly, the theoretical options values respond differently to changes in the latent state-contingent firm values because their exercise prices differ.

We select short-maturity, near-the-money, highly-traded options for our system because these options are highly concave in stock price changes (high gamma), hence, they provide non-redundant information to our system, and more reliable identification of the unknown parameters. Additionally, a high trade volume could make the contract price is less noisy and more informative.

We treat the state-specific equity values that determine option payoffs as latent variables to be estimated. Those values can change each day, along with the probability that the event will occur. Daily stock price changes capture useful information about changes in market expectations about the two future state payoffs and the event probability. Therefore, we produce separate estimates of the variables of interest for each day of our event period, representing market expectations for each day. This allows us to track the evolution of beliefs as the event day approaches.

The theoretical values of the options in (5) can be computed accurately using the Black-Scholes formula and by selecting at-the-money and near-the-money options from the menu of traded options for the firms affected by the event. Note also that we will focus most of our analysis on the event day or a short event window around the event day. This allows us to present the equations in (5) using the physical or true probabilities, when in fact, those equations hold precisely only for the risk neutral probabilities. But the risk neutral and true probabilities only differ in relation to the difference between the risk-free

return and a security's expected return, which should be small over a short period of time. If one uses our method to estimate the current probability of an event expected to occur far in the future, then one should take care to interpret the estimated probability as a risk neutral probability, which underestimates the true event probability.

State-contingent pricing models similar to the framework in (5) have been solved in Subramanian (2004), Barraclough, Robinson, Smith and Whaley (2012) and Borochin (2013) using a variety of methods. For ease of use and replication, we describe the results obtained using the Global Optimization toolbox in MATLAB. This package was developed to optimize multivariate objective functions in the presence of local minima, which fits the highly nonlinear framework in (5) well.

Our problem is to find the vector of unknown parameters $\theta = \{ p, S_n, V_e, \sigma_e, \text{and } \sigma_n \}$ that solves (5). We use an overidentified system based on (5) to construct an objective vector, and then minimized the objective vector. The objective is a vector of squared differences between a given day's observed stock and options closing prices, and the associated theoretical prices determined by the state prices and no arbitrage conditions. Define P_t as the vector of market prices, i.e., the left hand side of the price equations in (5), and $\hat{P}_t$ as the vector of theoretical values, i.e., the right hand side in (5). Then our objective function $M(\theta)$ is:

$$M(\theta) = [P_t - \hat{P}_t(\theta)]' (W) [P_t - \hat{P}_t(\theta)]. \quad (6)$$

Because there are too few restrictions to compute the covariance matrix W, we use a two step procedure to obtain standard errors. First, we use W = I to obtain unbiased but inefficient nonlinear least squares estimates of θ_t on each day t, and second, we compute the Fama and MacBeth (1973) standard errors from the time series of estimates. Statistics based on these standard errors should be conservative because they combine variation due to belief revisions with estimation noise.

We use the Cox and Rubinstein (1979) binomial pricing model to estimate the call option value as a function $\hat{C}_t(\theta)$. This model accounts for the early exercise premium from dividend payouts and is therefore a less noisy estimator of the unknowns than an analogous estimation using the Black-Scholes formula. State-contingent volatility addresses the term structure of volatility issues first raised by Barone-Adesi, Brown and Harlow (1994).

We specify the range of θ from which the estimation will draw proposals for each of the five unknowns as follows. The range of the risk-neutral probability is the open interval (.01,.99), and the state-contingent payoffs and volatilities are constrained to be within 15% of the current price and option-implied volatility levels, respectively. This constraint on the parameter space rules out implausibly high and low state-contingent values and volatility levels. To avoid ruling out valid solutions, we specify a support region that is greater than the realized changes in stock values on the event day.

We then use the multi-start global optimization solver in Matlab to estimate a θ_t for each firm-day's prices. The optimization is run with 3000 different starting points[7] to minimize the chance of finding a local, rather than the global, minimum. Putting the time series of firm-specific estimates together allows us to track the evolution of the fundamental market expectations about the likelihood and impact of the event on a single firm.

Many firms are exposed to events as significant as the healthcare legislation, and therefore, provide useful information about its expected effect. Each firm is also subject to its own idiosyncratic shocks that add noise. To maximize usable information and minimize noise, we aggregate estimates from several firms together. We do this by taking each firm's estimate of θ_t and equal-weighting them to produce an overall estimate of θ_t.[8]

[7] The larger the sets of starting points, the higher the likelihood of finding the global maximum. Values above 3000 do not seem to change the estimation, suggesting it is sufficient.

[8] Another option is to jointly estimate unknowns using data from several firms at once. In the merger literature, this approach is taken by Subramanian (2004), Bester Martinez and Rosu (2011), Barraclough Robinson Smith and Whaley (2012) and Borochin (2012) who use both target and acquirer data simultaneously. Since the number of firms significantly affected by a large event is much greater than those affected by a merger, the number of parameters to be estimated is substantially higher. For our event, we find that trying to estimate the parameters for many firms simultaneously resulted in poorer quality estimation.

The starting values for the prices at each iteration are based on observed values at the start of the event window. The starting values of the option volatilities are the averages of the observed implied volatilities for the particular options used in system (5). The event probability is initialized to 0.60.

3. The healthcare reform event: The Patient Protection and Affordable Care Act of 2010 (PPACA)

In this section we describe the PPACA event, and discuss how it was expected to affect the profitability of different industries in the healthcare sector of the economy. We treat the U.S. House of Representatives passage of the PPACA as our focus event because it has more news associated with it compared to the U.S. Supreme Court ruling on the constitutionality of the PPACA.[9] We characterize the Court ruling as a possible reversal of the PPACA passage, hence, it was expected to have similar but opposite effects when compared with House passage.

The House passage of the PPACA was a major but relatively uncertain event. Many on both sides of the healthcare reform debate believed that it would have large impacts on the healthcare sector. Liberto (2011) reports that $1.06 billion was spent on PPACA-related lobbying by various interests during 2009 and 2010. A single company (Amgen) hired 33 lobbyists and spent $10.2 million. Many lobbied to include (exclude) provisions favorable (unfavorable) to them.

The importance of the PPACA was also reflected in substantial political maneuvering. In section 3.1, we describe the political environment leading up to the House passage, and then briefly describe the legal challenges that led to the Supreme Court ruling. In section 3.2, we use analyst reports from investment banks to gauge how investment analysts perceived the effects of the PPACA, and how they handicapped the probability that it would pass the House. Similarly, we discuss how analysts judged the probability that the Supreme Court would rule the PPACA unconstitutional.

[9] The Supreme Court's decision involved several issues but the crucial issue was the PPACA's mandate that all individuals purchase health insurance or pay a penalty (tax). Without this mandate, the insurance pool would not be sufficient to support the PPACA.

3.1 The political steps leading to PPACA passage by the U.S. House of Representatives

President Obama and Congressional Democrats invested considerable political capital to pass the PPACA. The PPACA was composed and passed by the Senate on December 24, 2009 following intricate political gyrations. Table 1 lists the major political steps taken to pass the PPACA.

[Table 1 here]

Passage of an amended PPACA in the House remained highly uncertain until March 9, 2010, when a speech by Speaker Pelosi made it clear that she would push the PPACA through the House, and implied that it would pass the Senate using "reconciliation".[10] Reconciliation circumvents filibusters and only a simple majority of Senators is required to pass a reconciliation bill. The House narrowly passed the PPACA on March 21, 2010 by a vote of 219-212, with 34 Democrats and all Republican representatives voting "no". It was no surprise that President Obama signed the PPACA on March 23, 2010.

In an attempt to stop the PPACA in the courts, 28 states filed lawsuits against it, most notably Florida. After a few unfavorable rulings by state and U.S. circuit courts, the Obama administration appealed to the Supreme Court to resolve the constitutionality of the PPACA, and the Court agreed on November 14, 2011 to hear the case.

The Supreme Court held oral arguments for three days starting on March 26, 2012.[11] During oral arguments, the usual swing voter Justice Kennedy appeared skeptical that the PPACA was constitutional. Except indirectly during oral arguments, the justices do not make their opinions public before a final ruling is announced, therefore, there is little relevant news about the outcome compared to the House vote, where representatives often publicly state or change their views. The ruling was announced three months later on June 28, 2012, with Chief Justice Roberts as the swing voter, forming the 5-4 majority that upheld the PPACA.

[10] See Pelosi Remarks at the 2010 Legislative Conference for National Association of Counties, March 9, 2010, http://pelosi.house.gov/news/press-releases/2010/03/releases-March10-conf.shtml, last accessed December 29, 2010.
[11] See http://en.wikipedia.org/wiki/Constitutional_challenges_to_the_Patient_Protection_and_Affordable_Care_Act, last accessed August 12, 2013.

3.2 Investor perception of the PPACA passage

The investment community had a wide range of beliefs about the likelihood that healthcare reform would pass. We searched the analysts reports of major investment firms on Thomson One Banker for those that mentioned "healthcare reform" and the "probability", "likelihood", or "chance" of PPACA passage.

Table 2 illustrates the uncertainty associated with analysts beliefs about the probability of PPACA passage. This was partly because previous efforts at comprehensive healthcare reform had failed (e.g. the Clinton Administration in the 1990's). Senator Kennedy's death and the election of Republican Scott Brown on January 19, 2010 to replace him created additional uncertainty among analysts. But in the days just before passage, most analysts moved their estimates of the chance of PPACA passage to somewhere around 50 percent. This implies that passage was still uncertain but was not a complete surprise.

[Table 2 here]

In the next section, we show that our model estimate of the probability of PPACA passage started rising around March 17, 2010, although it was already at around 60 percent when it jumped just before PPACA passage on March 21, 2010.

Regardless of their probability assessments, most investment analysts judged the effects on healthcare firms similarly. They weighed increased sales volume from more PPACA-insured patients, against lower reimbursement rates per patient from the government. The PPACA also levied fees on healthcare firms to claw back some of the additional profit that firms would earn from higher patient volumes. Hospitals in particular were expected to do well on net because they would see fewer uninsured patients in their emergency rooms where they were required to give uncompensated care. Another positive for hospitals was that the final bill included fees only for pharmaceutical and insurance firms.

There was much less news and analyst reporting surrounding the Supreme Court ruling on the PPACA. We again searched Thomson One Banker for analyst estimates of the "probability", "likelihood", or "chance" that the "Supreme Court" would rule the PPACA constitutional. On March 23, 2012,

Deutsche Bank reported results from an investor survey that showed 83% believed that there was at least a 50% chance that PPACA would be held constitutional. On June 4, 2012, Cowen and Company reported that their expert consultants estimated that the probability fell from 65% before oral arguments on March 26, 2012, to 50% afterward. The change was due to Justice Kennedy's skeptical questions about the constitutionality of requiring that everyone buy health insurance. On June 21, 2012, Deutsche Bank also estimated a 50% chance that the PPACA would be held constitutional.

4. The data and the sample

4.1 Data sources

Stock related data is taken from the Center for Research in Securities Prices (CRSP) daily master file. The variables used include closing prices, returns, cash dividends, and shares outstanding. Stock prices used in our model are the closing stock prices at the end of normal daily trading. Daily option-related data are taken from OptionMetrics, including expiration dates, exercise prices, closing bid and ask price quotes, trading volume, implied volatilities, and open interest. Option prices used in our model are the midpoint of the closing bid and asked prices. The rates on U.S. Treasury bills with the same maturity of the options are used as risk free rates.

One reason for selecting the PPACA passage is that Intrade offered an event security on PPACA passage, with trading starting in January 2010. It also offered an event security on the Supreme Court's constitutionality decision, with trading starting in January 2011. Intrade was an online prediction market offering event securities whose prices can be interpreted as measuring the probabilities that particular events will happen. We use the Intrade probabilities for comparison with our model-generated probabilities.

Intrade's House passage security offered holders a one dollar payout if the PPACA passed the House of Representatives by June of 2010, and zero otherwise. The Supreme court security offered holders a one dollar payout if the Supreme Court ruled the PPACA unconstitutional by December 31,

2012. Hereafter, we adjust the data for the Supreme Court security so it can be interpreted as the probability that the Supreme Court would rule that the PPACA was constitutional. Intrade provided trade by trade data, so we select the trades closest to the close of trading in the U.S. securities markets (4 PM Eastern Time) and averaged their prices to get daily closing prices that time-match the closing stock and options prices.[12]

4.2 The sample of firms in the healthcare industry

The PPACA event is expected to have significant effects on firms in the healthcare industry. We select the major sectors of the healthcare industry from the North American Industrial Classification System (NAICS) codes as follows: Hospitals (622110, 622210, 622310), Direct Health and Medical Insurance Carriers (524114), Pharmaceutical/Biological Products (325411, 325412, 325413, 325414), and Medical Equipment and Supplies (339112, 339113). Because the PPACA treats the Pharmaceutical/Biological Products industry and the Medical Equipment and Supplies industry similarly, and we find a similar negligible effect of the PPACA events on both industries, we only present results for the Pharmaceutical/Biological Products industry.

Table 3 lists our sample of companies for three industries: hospital, health insurance, and pharmaceutical/biotech. We use six firms from each industry. We found that using at least eight traded options to estimate the model parameters for each firm on each day produced stable model estimates. There are only six firms with at least eight daily-traded options in each of the hospital and health insurance industries. The pharmaceutical industry offered more firms with the required data, however, we selected the six top firms to be consistent. Including more than six firms in the pharmaceutical group has no effect on the results.

[Table 3 here]

[12] Intrade was a 24 hour market, although it marks its own daily close of trading at 7 PM Greenwich Mean Time. Intrade closed down on March 11, 2013.

As deduced from the analyst reports, the investment community did not consider the event (House passage of the PPACA) to be relatively likely until early- to mid-March, therefore, we start our event period on March 1, 2010. Our more important results are focused on only a few days around the day of passage. We use the same length event period (16 trading days) for the Supreme Court event, starting with June 7, 2012.

Our method requires that a company's stock and options prices be sensitive to the event, in order to reliably identify and estimate the model parameters. That is, investors must consider the event to be important enough to have an impact on their trading and pricing. Furthermore, this must hold on average because our final parameter estimates are averages of the firm-specific parameters for the firms in industries that exhibit significant event impacts (to reduce firm-specific parameter noise).

To decide if an industry group is affected by the event, we examine the cumulative average abnormal returns (CAARs) and cumulative average abnormal volume (CAAV) for the groups during the event period. [13] We apply standard event study methods and use Eventus software for the computations. We use the market model with the equal-weighted CRSP index as the market index.

Table 4 presents the CAARs and CAAVs covering various overlapping event windows. Each window ends with day 0, which is the "event day." Because the House event occurs on a Sunday, the event day is the next trading day, March 22, 2010. The shortest event window [-1; 0] includes the event day plus the first trading day before the event, March 19, 2010. Each of the other windows cover the event day plus one week of pre-event trading [-5; 0], or two weeks of pre-event trading [-10; 0], or three weeks of pre-event trading [-15; 0]. The Supreme Court event day is June 28, 2012, and we use similar event windows relative to that date.

[Table 4 here]

Table 4 provides support for the notion that PPACA passage and the Supreme Court ruling had significant net effects on the hospital and health insurance industries, but not the pharmaceutical industry,

[13] See Campbell and Wasley (1996) for details on volume event studies, where log-transformed relative trading volume replaces returns in the traditional return event study

at least from an investors perspective. The CAARs and CAAVs for the pharmaceutical group are all relatively small and statistically insignificant, except for ten days before the Supreme Court event which show marginally significant CAARs.

The hospital firms were most highly affected, consistent with investment analyst expectations. Most of the CAARs and CAAVs for the hospital group are relatively large and statistically significant. The large positive CAAVs imply that investors were trading well above normal amounts of the firms' shares in the days leading up to the PPACA.

The insurance group has smaller CAARs than the hospital group, but they are still substantial enough to expect that our model could pick up pricing effects from the PPACA event. The significant CAAVs for the group also support the notion that investors were trading insurance firms' stocks leading up to House passage and the Supreme Court decision. The negative CAARs in reaction to the Supreme Court decision can be explained as follow. The court ruled that the individual mandate was constitutional (the crucial issue), but also ruled that the PPACA could not be used to force states to expand Medicaid. Insurance companies manage the care of Medicaid patients, and Cowen and Company (June 4, 2012) projected that Medicaid expansion would increase Medicaid coverage by sixteen million people. Therefore, no Medicaid expansion would mean fewer Medicaid patients managed by insurance companies.

Although pharmaceutical firms experienced positive CAARs, none are statistically significant within five trading days of the event, and all are relatively small. Furthermore, there is very little evidence that investors were trading these stocks at above normal levels during the event period. Based upon this evidence, most of the model parameters estimates that we present below are averages for a sample of twelve firms; the six hospital firms plus the six insurance firms.

We also examined options trading around the two events for the twelve firms. Trading volume was very similar for both events. Trading increased on average by 167% during the [-2; 0] event period, and fell by 121% on the day following the event. Because daily options volume is highly volatile, neither of these results is statistically significant. Open interest increased during the [-15; -1] event period by

about 21% for the House event, and then fell by 26% on the event day. The decline on the event day is statistically significant at the one percent level. Open interest rose only 7% for the Supreme Court decision during the [-15; -1] event period, with no significant decline on the event day.

4.3 Model estimates of PPACA passage probability and Supreme Court constitutionality probability

For each trading day from March 1, 2010 to March 23, 2010, and from June 7, 2012 to June, 29, 2012, we estimate our model parameters using the set of equations in (5) for each firm, and then average across firms. Figures 3 and 5 illustrate the probability estimates for the House passage event and the Supreme Court ruling event, respectively. The probability of the event implied by stock and option prices is the most important parameter for our purposes. We report the associated series of daily Intrade-generated probabilities for comparison.[14]

[Figure 3 here]

Figure 3 shows that our daily model probabilities and Intrade probabilities move along together throughout the event period, but deviate from one another in several ways. We do not expect the two series to track each other exactly because stock and option investors and Intrade traders do not necessarily have the same expectations about the PPACA.

The two series diverge substantially at the end of the period because there should be little Intrade security price change after the event day. But stock prices reflect the passing of one event and the emergence of the next event. For our sample of firms, the emerging event is likely to be their coming earnings reports, which could have some common industry influences. Figure 3 shows that on the day following the event (March 23, 2010), the PPACA uncertainty has been resolved, hence the Intrade probability remains at 99 percent. But the model probability resets to 50 percent for the next event,

[14] Note that we plot parameter estimates for an extra day beyond the event in order to illustrate some differences between the Intrade-generated and asset-price generated series. Also note that the two-day periods with no observation markers are weekends during which there are no model-generated estimates because there are no stock and option price changes.

perhaps reflecting an equal chance of two new states; e.g., unexpectedly high or unexpectedly low first-quarter earnings.

On the event date, the model-generated probability will never approach 99 percent like the Intrade probability because stock prices must account for the transition from one event to the next. If the PPACA was the only event, the model also would have generated a probability close to 100 percent. Therefore, because the true PPACA passage probability is 100 percent at the end of trading on March 22, 2010, we use the model probability at the end of trading on March 18, 2010 (70 percent) to compute the change in event probability during the two day event window [-1; 0]. That change is 30 percent (100 percent minus 70 percent). We assume that the next-event probability did not change during the [-1; 0] window.

Note that the model probability and the Intrade probability are quite close on March 19th, 18th, and 17th, although the model probability is somewhat lower. The lower model probability is consistent with lower estimates we found in analyst reports (see above). Even when analysts started raising their probability estimates starting around March 16, 2010, none of them set their probabilities as high as the Intrade probabilities. The rising probabilities could have reflected the fact that on March 15, 2010, President Obama announced that he would delay a visit to Thailand in order to help push the PPACA through the House (see Cowen and Company, March 16, 2010).

Before March 16, 2010, the model and the Intrade probabilities appear to be somewhat noisy. Nevertheless, some of that volatility could reflect news about the prospects of PPACA passage. For example, the large (small) jump in the model (Intrade) probability on March 9, 2010 coincides with Speaker Pelosi's speech about pushing the PPACA through the House.

We have more confidence in the estimates over the last several days of the event period because the CAARs and CAAVs showed significant investor activity close to the event day. The model should fit better when investors make greater stock prices adjustments or more trades that incorporate important PPACA news, such as Obama delaying his Thailand trip from March 19, 2010 to March 21, 2010. This could imply that he expected it to pass before March 21, 2010.

The importance of significant price adjustments and trading volume is considered in Figure 4. We replace the model probabilities generated from the twelve hospital and insurance firms, with model probabilities generated from the six pharmaceutical firms. The pharmaceutical group probability is more volatile and is far from the Intrade probability on March 19, 2010. We place little confidence in the pharmaceutical group probability estimates because we know that the pharmaceutical group's CAARs and CAAVs show little evidence of investor activity around the event.

[Figure 4 here]

Figure 5 illustrates the time series of model-based and Intrade-based probabilities associated with the Supreme Court event. Unlike for the House event, there is little variation in the probabilities until the last few days before the event. There is some common movement between the two probability series over time, and some convergence between them on the day before the event (June 27, 2012), but otherwise, there is a large gap between the probabilities derived from stock and options prices compared to those obtained from Intrade.

[Figure 5 here]

What could explain such a large difference between the two series of probability estimates? Our model estimates reflect much larger trades than the Intrade estimates. One might expect stock and options investors to be better informed, indeed, the model-based probabilities were closer to predicting the eventual outcome. The larger model-based probability is also consistent with the probability estimates sent by stock analysts to their investors during the period (see above). Analysts often hired legal experts to provide insight for their private reports (Cowen and Company, June 4, 2012). The model-based and Intrade probabilities were much closer for the House passage event, perhaps because that event involved more publicly disclosed information, or because of a more successful "political intelligence" for the House vote (Jerke, 2010).

4.4 Model estimates of the two state prices

A. Passage or rejection of the PPACA by the House of Representatives

For each of the twelve sample firms, we obtain a PPACA passage state price and a PPACA rejection state price for each trading day between March 1, 2010 and March 23, 2010, using the set of equations in (5). We also collect the actual stock price each day. All of these prices are scaled by the passage state price estimated on March 1, 2010. Therefore, each price series can be viewed as a cumulative return, with a starting price measured relative to the PPACA passage price. Finally, we average the state prices and the actual prices each day across the twelve firms.

We plot the three price series in Figure 6. The passage price starts at 1, and the rejection price starts at about 0.95. As in the stylized example in Figure 2, the actual price is simply the weighted average of the two state prices, with the weight being the model-generated probability shown in Figure 3. That probability starts at about 0.50, hence, the actual market price starts at about 0.975, squarely in between the two state prices.

[Figure 6 here]

Note that there is very little appreciation in the actual price until March 15th or 16th. The slight appreciation up to that point is almost entirely due to the appreciation in the passage price. Indeed, the rejection state price is essentially flat until the event date, when it jumps from 0.95 to 1. Then it jumps again on the day after the event by another five percent. In contrast, the passage state price appreciates at a constant rate during the last eight days of the period.

What accounts for the sharp difference in behavior between the two state prices? Actually, the two prices move together until March 9, 2010 (House Speaker Pelosi speech date) and then start to diverge. We believe that after March 9, stock and option investors start to focus more on PPACA news, and our model picks this up. The potential positive or negative effects of the House PPACA vote becomes more evident in the state prices as we approach the event day.

The unusual behavior of the rejection state price on the event day and the following day likely reflects the issue of mixed events. Had there been only the PPACA event to consider, then on the event day, the rejection price would be irrelevant, the PPACA probability would be 1, and the actual and

passage prices would be the same. But with another event to come, the event day estimates are a mixture of two events, and the parameter estimates are mixtures. Indeed, if the second event probability is 0.50, an equal weighting of the two event probabilities would be 0.75 [=(1 + 0.5)/2]. This is, indeed, the model-generated probability plotted in Figure 3 for March 22, 2010.

The actual price on March 22, 2010 is 1.088 and the model-generated passage state price is shown as 1.108. But we know that the passage probability is 100 percent, so the actual price and the passage price should be the same, i.e., 1.088. The 1.108 is the up-state price for the next event, for example, if the sample firms end up reporting unexpectedly high first quarter earnings.

On the following day (March 23, 2010), however, the PPACA event is no longer in play, hence, the relative locations of the prices return to something like what they were on March 1st. The new event (e.g. earnings reports) has up- and down-state prices that both incorporate the positive PPACA event value that was resolved the day before. The new spread between those prices reflects the value difference between the new up and down states.

Another way to understand the unusual behavior of the rejection state price is to consider what it would have looked like if the PPACA had been rejected. In that case, the rejection price path would have been smoother and the passage state price would have fall sharply, ending up close to the rejection state price, although not equal to it because of the effect of the next event.

B. Constitutional or unconstitutional ruling by the Supreme Court

We repeat the same analysis for the Supreme Court event. For each trading day between June 7, 2012 and June 29, 2012, and for each of the twelve sample firms, we estimate a constitutional state price and an unconstitutional state price and collect the actual stock price for each day. All of these prices are scaled by the constitutional state price estimated for June 7, 2012.

Figure 7 plots the three series of prices during the event period. The prices move together but exhibit little appreciation until the end of the period, starting June 26 and ending June 28. The smaller appreciation for the Supreme Court event can be explained by the negative CAARs for the insurance

firms, which brings down the average when combined with the positive hospital CAARs. For the House event, both the hospital and insurance firms had positive CAARs.

[Figure 7 here]

The large rise in the unconstitutional state price on the day before the event and the event day again likely reflects the issue of mixed events. And again, the new event could be the common effects expected for the firms' second quarter earnings reports, because the Supreme court event comes at the end of June. Also similar to the PPACA event, once the Supreme Court event is resolved, the small difference between the new up and down state prices reflect a smaller expected value effect of the new event (e.g. second quarter earnings reports).

4.5 Model estimates of the two state price volatilities for the House passage-rejection event and the Supreme Court constitutional-unconstitutional event

In addition to the two state prices, our model provides estimates of the volatilities of the two state prices implied by the options pricing model. For each of the twelve sample firms, we obtain a PPACA passage state price volatility and a PPACA rejection state price volatility for each trading day between March 1, 2010 and March 23, 2010, using the set of equations in (5). We average the state price volatilities each day across the twelve firms. We do the same to obtain the Supreme Court constitutional state price volatility and the Supreme Court unconstitutional state price volatility for each trading day between June 7, 2012 and June 29, 2012.

We plot the volatility series for each event in Figure 8, Panels A and B. The important feature of both panels is that the volatilities are lower when the state includes the PPACA. Investors expected that the average volatility of the twelve firms with the PPACA in force would be lower than if it was rejected. This expectation could reflect the fact that with the PPACA in force, the government could more closely regulate the healthcare industry. Typically, regulated industries have less volatile cash flows. Indeed,

Epstein (2009) suggests that the PPACA more or less turns the healthcare industry into a regulated public utility.

5. Assessing the full value effect of the PPACA

We can now compute the full effect of the PPACA passage on the market value of the equity of the firms in the hospital and health insurance industries. Because Table 4 shows no significant CAARs for the pharmaceutical industry, we do not compute an effect for that industry. The full value effect is estimated by the value of the equity for an industry, times the CAAR for the industry, divided by the change in our model-based estimate of the event probability over the [-1; 0] window.

At the close of trading March 18, 2010, the hospital firms covered in CRSP had an equity market value of $15.3 billion. The CAAR for the hospital industry over the [-1; 0] event window is 7.74%. If one assumed that the House passage was a complete surprise, the value effect of passage on the hospital industry amounts to $1.13 billion. But based on our model estimate that the probability of the event changed during the [-1; 0] event window by 30% (100% - 70%), the full value effect is $3.77 billion.

According to the American Hospital Association (2011), in 2010, for-profit hospitals accounted for only about one ninth of all patient days and hospital surgical operations. Assuming similar valuation for non-profit hospitals, the industry's net worth is $138 billion. Therefore, the net effect of the PPACA on the hospital industry was about $33.9 billion. To put this in perspective, the fees and discounts imposed by the PPACA on pharmaceutical firms was estimated at $84.8 billion over ten years (Johnson, 2010).

The value effect on the insurance industry is estimated as follows. At the close of trading on March 18, 2010, the health insurance firms covered in CRSP had an equity market value of $137.8 billion. The CAAR for the health insurance industry over the [-1; 0] event window is 2.12%. Assuming a complete surprise, the value effect of passage on the insurance industry amounts to $2.92 billion. Using the change in event probability during the [-1; 0] event window of 30%, the full value effect is $9.73 billion. But again, this estimate ignores the fact that about half of those covered by health insurance are

covered by non-profit health insurers.[15] Assuming similar valuation for non-profit insurers, the net effect of the PPACA on the health insurance industry was about $19.46 billion.

The total effect of the PPACA comes to $53.36 billion. This is a ballpark figure based on assumptions about the value of the nonprofit portions of the hospital and health insurance industries. The effect on the equity market value of the for-profit portion of these industries is more precise, about $13.46 billion. This assumes that CRSP includes most of the for-profit hospital and health insurance companies. It also excludes any effects on firms' bond values, and we do not consider the effects on firms that supply the hospital and health insurance industries or the effects on firms that might be required to offer better insurance to their workers because of the PPACA.[16]

The value effect for the Supreme Court constitutionality decision is not exactly comparable to the House passage because it was not a pure acceptance of the PPACA. It affected the insurance industry differently than the House passage event. The Supreme Court decision has no statistically significant effect on the insurance industry. The effect on the hospital industry, however, was quite similar (CAAR of 6.85% compared to 7.74%).

The full value effect on the hospital industry is computed as follows. At the close of trading June 26, 2012, the hospital firms covered in CRSP had an equity market value of $25.5 billion. The CAAR for the hospital industry over the [-1; 0] event window is 6.85%. Based on our model estimate that the probability of the event changed during the [-1; 0] event window by 32% (100% - 68%), the full value effect is about $5.46 billion. Again adjusting for the fact that for-profit hospitals account for only one ninth of all hospital patient days, the effect was about $50 billion. The difference in value effect compared to the House event is mostly because the value of firms in the hospital industry rose considerably between March 2010 and June 2012.

[15] See "Basic Facts & Figures: Nonprofit Health Plans," Alliance for Advancing Nonprofit Healthcare, http://www.nonprofithealthcare.org/resources/BasicFacts-NonprofitHealthPlans.pdf, last accessed on 8/15/2013.

[16] We considered some firms that supply the hospital industry but found little or no reliable effects.

6. Conclusion

This paper employs a method developed in the mergers literature using stock and options prices to estimate ex ante event probabilities. We use the probabilities to compute the full value effects of an event; the U.S. House of Representatives passage of the healthcare reform law (PPACA). Many event studies do not adjust for the fact that their events are partly anticipated. In our case, the adjustment triples the measured effect of the event on the market value of the affected firms.

We believe that this method is applicable to many events that are partly anticipated, and likely to be more precise than alternative methods such as using public data on firm-specific attributes to estimate event probabilities, or using event securities from prediction markets. Our method produces a market-based event probability that likely captures at least some of the effects of private information and is based on high-volume asset markets. For an event with substantial public information available (House passage), we find our probability estimate and that of a prediction market are quite close. But for an event with little public information (Supreme Court constitutionality), the estimates differ considerably.

We believe that our method could be useful for ex ante and ex post public policy analysis. For example, when legislation has offsetting provisions, the method could be used to measure the net dollar effect of those provisions on the affected company or industry. For the PPACA, we find that the positive and negative provisions affecting the pharmaceutical industry just about offset one another. But the hospital industry benefited considerably from PPACA passage; about $33.9 billion.

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Table 1

Chronological political steps to passage of the Patient Protection and Affordable Care Act of 2010 (PPACA)

Date	Political Events
January 2008-November 2008	Presidential candidate Obama pledges to pass comprehensive healthcare reform in an effort to distinguish himself from Democratic candidates and Republican John McCain.
February 24, 2009	President Obama describes his healthcare vision to a joint session of Congress.
March 2009	President Obama holds meetings with industry leaders about healthcare reform.
April 2009-August 2009	House and Senate craft bills - many Congressmen return home to hold contentious town hall meetings after which more security was assigned to some Congressmen.
November 7, 2009	House passes a healthcare reform bill which was ignored by the Senate.
December 24, 2009	Senate passes the PPACA after attaching it to another House-passed revenue bill to maneuver around the requirement that all revenue-related bills must start in the House. Special provisions were added to a create filibuster-proof majority.
January 2010-February 2010	House Speaker Pelosi adds several amendments to satisfy colleagues but the bill would then require re-passage by the Senate. But re-passage was uncertain because Senator Kennedy had died, and replacement Republican Scott Brown pledged to filibuster in the Senate.
February 25, 2010	President Obama holds healthcare summit with Democrats and Republicans.
March 9, 2010	House Speaker Pelosi implies that unusual "reconciliation" could be used to pass the amended PPACA in the House and then the Senate vote would require a simple majority.
March 21, 2010	The House narrowly passes the PPACA.
March 23, 2010	Obama signs the PPACA into law.

Table 2

Investment analysts perceptions of the probability of Patient Protection and Affordable Care Act of 2010 (PPACA) passage

This table lists analysts' estimates of the probability that the PPACA would pass during the months leading to its eventual passage in the U.S. House of Representatives on March 21, 2010. The dates listed are the dates of the analysts' reports. Analyst reports to their clients are compiled in the Thomson One Banker database, which we searched for the terms "healthcare reform" and "probability", "likelihood", or "chance" of PPACA passage.

Date of Analyst Report	Analyst Estimate of the Probability that the PPACA would Pass
January 7, 2010	Wells Fargo puts the chance of PPACA passage by the House at 10%, and the chance for passage of any comprehensive healthcare law at 20-30 %.
January 20, 2010	Morgan Stanley reduces the chance of PPACA passage to 40% citing Republican Scott Brown's election to the Senate replacing Democrat Senator Kennedy on January 19, 2010.
January 20, 2010	Deutsche Bank changes its opinion of PPACA from "imminently passable" to "unlikely to pass" citing Republican Scott Brown's election.
January 20, 2010	Jeffries International and Wells Fargo downgraded the chance for PPACA passage because they viewed using reconciliation to be too politically risky for Democrats.
January 21, 2010	Credit Suisse described the PPACA as no longer viable.
February 23, 2010	Sanford C. Bernstein & Co. judged PPACA passage to be 20% because mid-term 2010 elections would divide Democrats and make using reconciliation unlikely.
February 23, 2010	Raymond James & Associates estimated PPACA passage at 20-30%.
March 3, 2010	Well Fargo estimated PPACA passage at 30% if it came up for vote before March 26, 2010, when Congress was due for its spring break.
March 4, 2010	Avondale Partners estimated passage at 51% after President Obama, Speaker Pelosi, and Senator Majority Leader Reid started to meet frequently.
March 5, 2010	Cowen and Company upgraded its estimate of PPACA passage from 30% to 50%.
March 16, 2010	Madison Williams and Company expected PPACA passage soon because Speaker Pelosi and President Obama made personal calls to wavering Democrats, and President Obama had delayed a scheduled trip to Thailand until March 21, 2010.
March 17, 2010	Sanford C. Bernstein & Co. reported that the House Budget Committee had passed a reconciliation bill and upgraded their estimate of PPACA passage from 20% to above 50%.

Table 3

Sample of firms in three healthcare-related industries

The stock and options prices of these firms are used to estimate the probability that the PPACA would pass, and that probability is later used to measure the full effect of PPACA passage.

Industry	Company
Hospital	Tenet Healthcare Corp.
	Community Health Systems
	Universal Health Services Inc.
	Lifepoint Hospitals Inc.
	Healthsouth Corp.
	Health Management Associates Inc.
Health Insurance	Aetna Inc.
	Cigna Corporation
	Wellpoint Inc.
	Health Net Inc.
	United Health Group Inc.
	Wellcare Health Plans Inc.
Pharmaceuticals/Biotech	Bristol Myers Squibb Co.
	Merck & Cc. Inc.
	Pfizer Inc.
	Amgen Inc.
	Johnson & Johnson
	Abbott Labs

Table 4

Cumulative Average Abnormal Returns and Cumulative Average Abnormal Volume for Firms Grouped By Industry around Two Events: Passage of the Patient Protection and Affordable Care Act of 2010 (PPACA) and the Supreme Court Ruling on the Constitutionality of the PPACA

This table reports Cumulative Average Abnormal Returns (CAARs) and Cumulative Average Abnormal Volume (CAAV) around the passage by the U.S. House of Representatives of the PPACA on March 21, 2010, and the Supreme Court ruling on PPACA constitutionality on June 28, 2012. Because March 21, 2010 is a Sunday, the next trading day, March 22, 2010 is our "event date," for the House passage. Because healthcare reform was expected to affect different industries differently, we group firms into three industries defined by their North American Industrial Classification System (NAICS) codes: Hospitals (622110, 622210, 622310), Direct Health and Medical Insurance Carriers (524114), and Pharmaceutical/Biological Products (325411, 325412, 325413, 325414). Each daily abnormal return or abnormal volume is the average for the six firms in the particular industry group, and these are compounded over various event windows, i.e., several trading days preceding the event plus the event day. Abnormal returns and volume are estimated using standard event-study methods and the CRSP Equal-Weighted Index as the market index. *t*-statistics (cross-section adjusted) are reported in parentheses.

Panel A. House Passage of PPACA - Cumulative Average Abnormal Returns (CAARs)

[Event Windows; Event Day = 0]	Hospital Group	Insurance Group	Pharmaceutical Group
[-1; 0]	7.74% (2.66)***	2.12% (0.63)	0.80% (0.50)
[-2; 0]	8.04% (2.25)**	5.42% (2.31)**	1.32% (0.67)
[-5; 0]	11.36% (2.24)**	4.76% (0.81)	1.77% (0.63)
[-10; 0]	7.87% (1.13)	2.86% (0.36)	1.41% (0.37)
[-15; 0]	8.61% (1.02)	1.83% (0.19)	0.88% (0.19)
Panel B: House Passage of PPACA - Cumulative Average Abnormal Volume (CAAV)			
[-1; 0]	93.89% (1.93)**	83.86% (3.58)***	23.38% (1.19)
[-2; 0]	136.10% (2.35)***	139.33% (4.30)***	25.72% (0.96)
[-5; 0]	204.15% (2.06)**	96.95% (1.64)*	-20.38% (-0.09)
[-10; 0]	233.59% (2.17)**	2.05% (0.14)	-90.83% (-0.56)
[-15; 0]	204.52% (1.47)*	-44.25% (-0.14)	-213.02% (-1.09)

Panel C: Supreme Court Ruling PPACA Constitutional - Cumulative Average Abnormal Returns (CAARs)			
[-1; 0]	6.85% (6.62)***	-1.30% (-1.19)	0.28% (1.31)
[-2; 0]	8.79% (8.35)***	-0.79% (-0.81)	0.39% (1.01)
[-5; 0]	7.81% (10.81)***	-0.70% (-0.79)	0.68% (1.00)
[-10; 0]	10.49% (7.34)***	-3.20% (-2.46)**	1.37% (2.09)*
[-15; 0]	12.65% (7.94)***	-5.02% (-3.00)**	2.56% (2.19)*
Panel D: Supreme Court Ruling PPACA Constitutional - Cumulative Average Abnormal Volume (CAAV)			
[-1; 0]	306.40% (8.23)***	307.02% (10.74)***	-23.66% (-1.00)
[-2; 0]	389.83% (8.54)***	385.29% (11.00)***	-43.28% (-1.49)
[-5; 0]	602.02% (9.33)***	570.09% (11.51)***	-33.33% (-0.80)
[-10; 0]	999.00% (11.60)***	962.47% (14.35)***	-44.70% (-0.81)
[-15; 0]	999.00% (11.97)***	999.00% (17.06)***	-8.52% (-0.12)

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (one-tail) test levels, respectively.

Figure 1

Complications in model parameter estimation arising from more than one major event impacting the event period.

This figure is used to illustrate how a succession of events could impact the estimate that we obtain from our model of the probability of the first event happening. In our case, our focus is on the event probability that the U.S. House of Representatives will pass the Patient Protection and Affordable Care Act of 2010 (PPACA). A potentially confounding event for our sample is the common industry-wide effect of firms' subsequent quarterly earnings announcements.

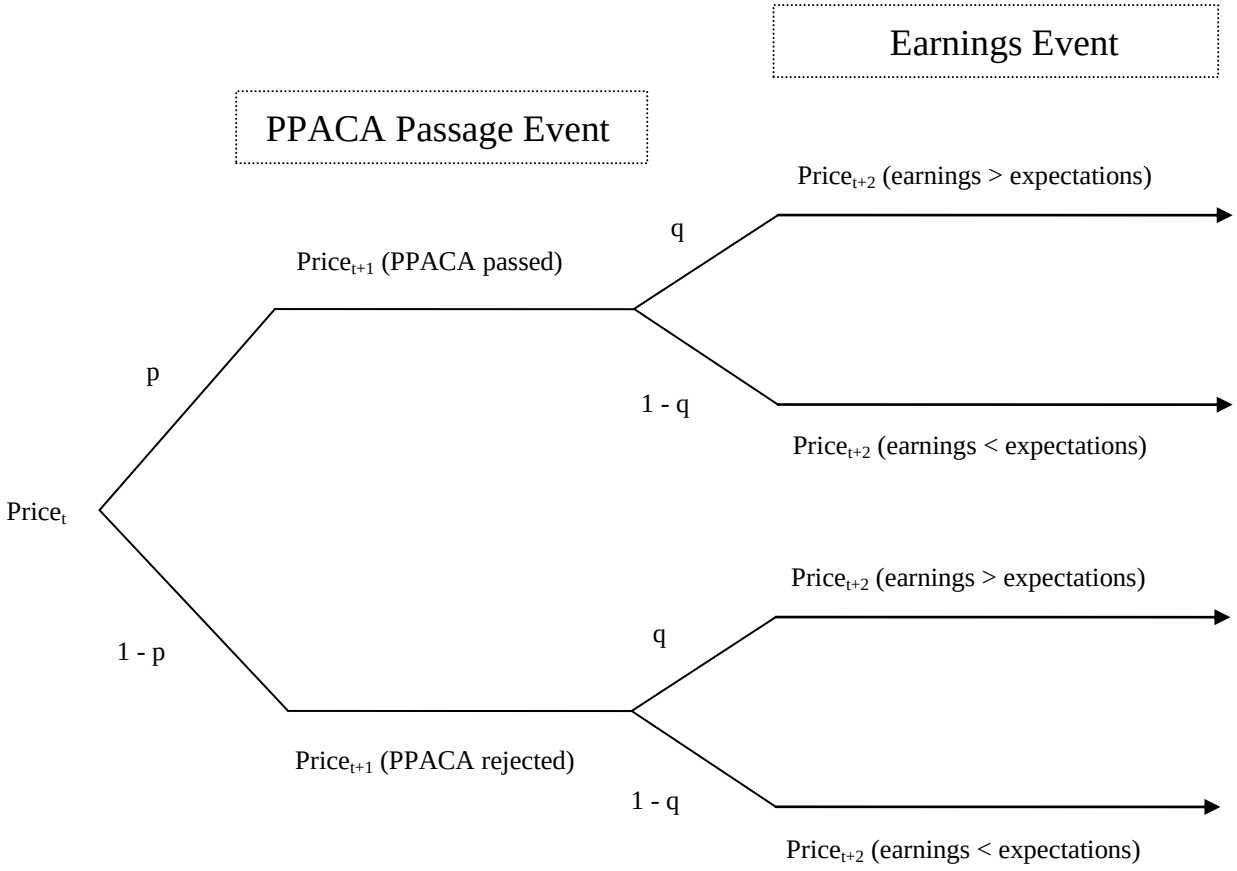


Figure 2

Stylized stock price pattern for a firm experiencing an event

This figure portrays an idealized stock price path ("Actual") for a firm whose value will be impacted by whether or not an event occurs. The "Event" ("NoEvent") stock price is the price that the stock would take if uncertainty had been resolved and it was known for sure that the event would (would not) occur. The Actual stock price is a weighted average of the Event and NoEvent prices, where the weight is the probability that the event will occur. In this case, the probability of the event occurring increases consistently in steps over time until the event occurs, and the Actual stock price equals the Event stock price. Many other Actual price paths are possible depending upon the change in the probability at each point in time.

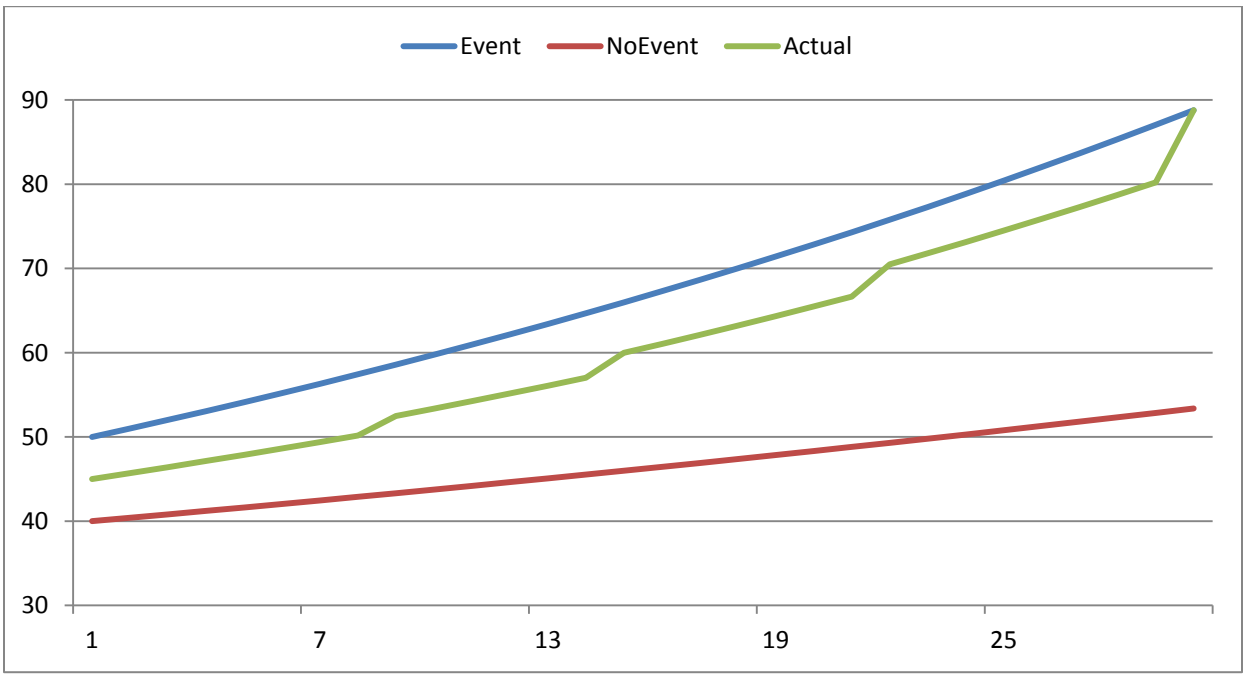


Figure 3

The model-generated probability of PPACA passage compared to the Intrade-generated probability

This figure plots the model-generated probability of PPACA passage by the U.S. House of Representatives, which is the probability implied by the stock and options prices of six hospital firms and six insurance firms. The Intrade-generated probability of PPACA passage is the price of an event security traded on the Intrade prediction market. Probabilities are shown for three weeks of trading before the event, the event day (March 22, 2010), and the day following the event.

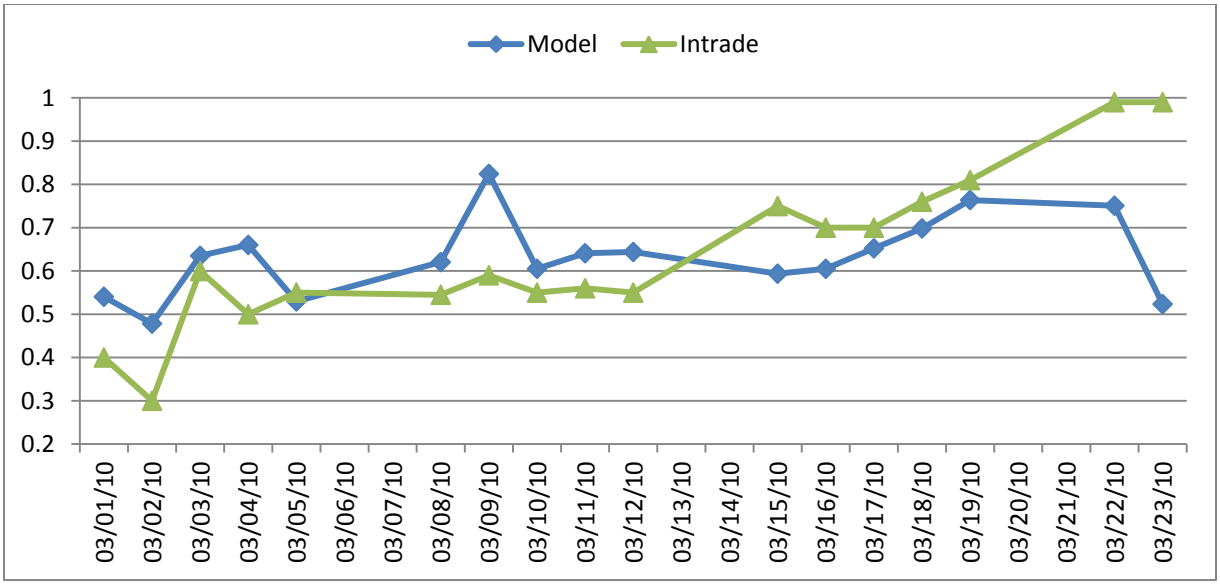


Figure 4

The model-generated probability of PPACA passage estimated from the pharmaceutical group of firms compared to the Intrade-generated probability

This figure plots the probability of PPACA passage by the U.S. House of Representatives that is implied by the stock and options prices of six pharmaceutical firms. Because the PPACA has no significant net effect on pharmaceutical firms, the probabilities implied by their stock and options prices are relatively uninformative. Hence, they differ substantially from the Intrade-generated probabilities, which are the prices of an event security traded on the Intrade prediction market. Probabilities are shown for three weeks of trading before the event, the event day (March 22, 2010), and the day following the event.

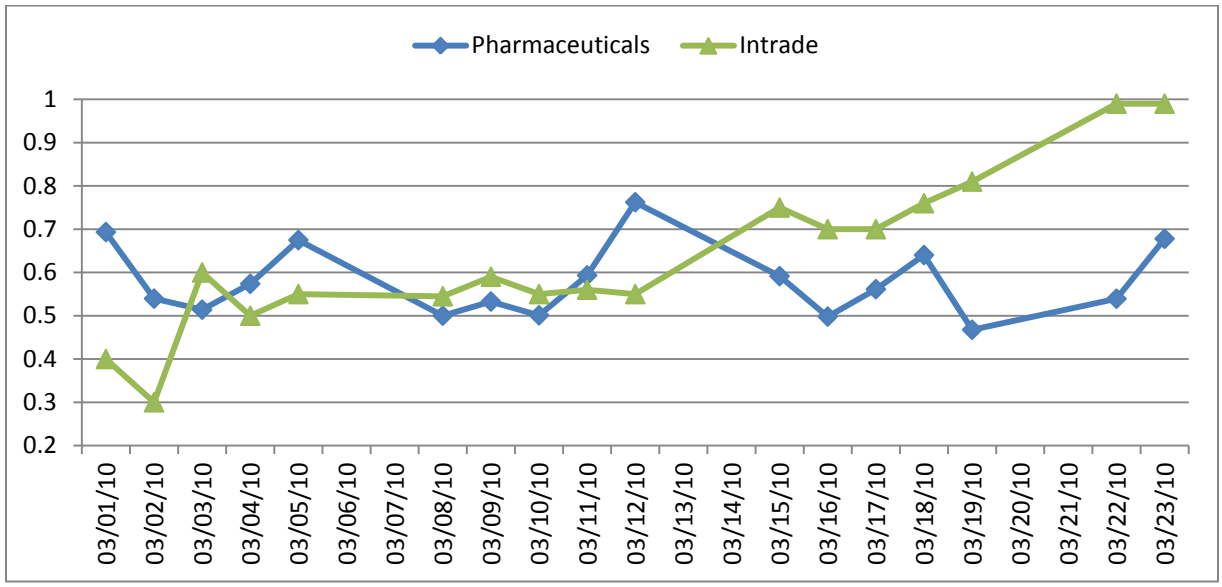


Figure 5

The model-generated probability that the Supreme Court rules that the PPACA is constitutional compared to the Intrade-generated probability

This figure plots the model-generated probability that the Supreme Court rules that the PPACA is constitutional, which is the probability implied by the stock and options prices of six hospital firms and six insurance firms. The Intrade-generated probability of the Supreme Court's constitutionality ruling is the price of an event security traded on the Intrade prediction market. Probabilities are shown for three weeks of trading before the event, the event day (June 28, 2012), and the day following the event.

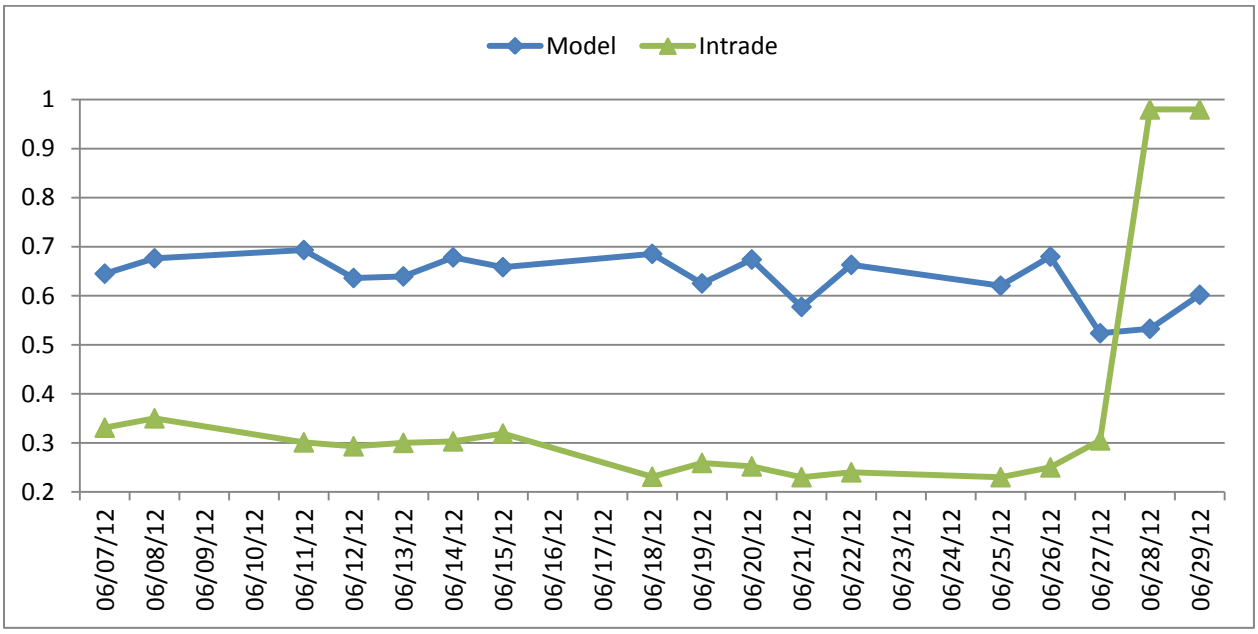


Figure 6

The model-generated state prices for the PPACA passage and rejection states and the actual average stock prices

The model generates a PPACA passage state price and a PPACA rejection state price for the stocks of each of the six hospital firms and six insurance firms, for each trading day during the event period. The state prices, and the actual stock prices, are scaled by the passage state price at the start of the event period (March 1, 2010), so that the scaled prices can be viewed as cumulative returns over the U.S. House of Representatives PPACA passage event period. The average of the prices for the six hospital firms and six insurance firms is plotted for three weeks of trading before the event, the event day (March 22, 2010), and the day following the event.

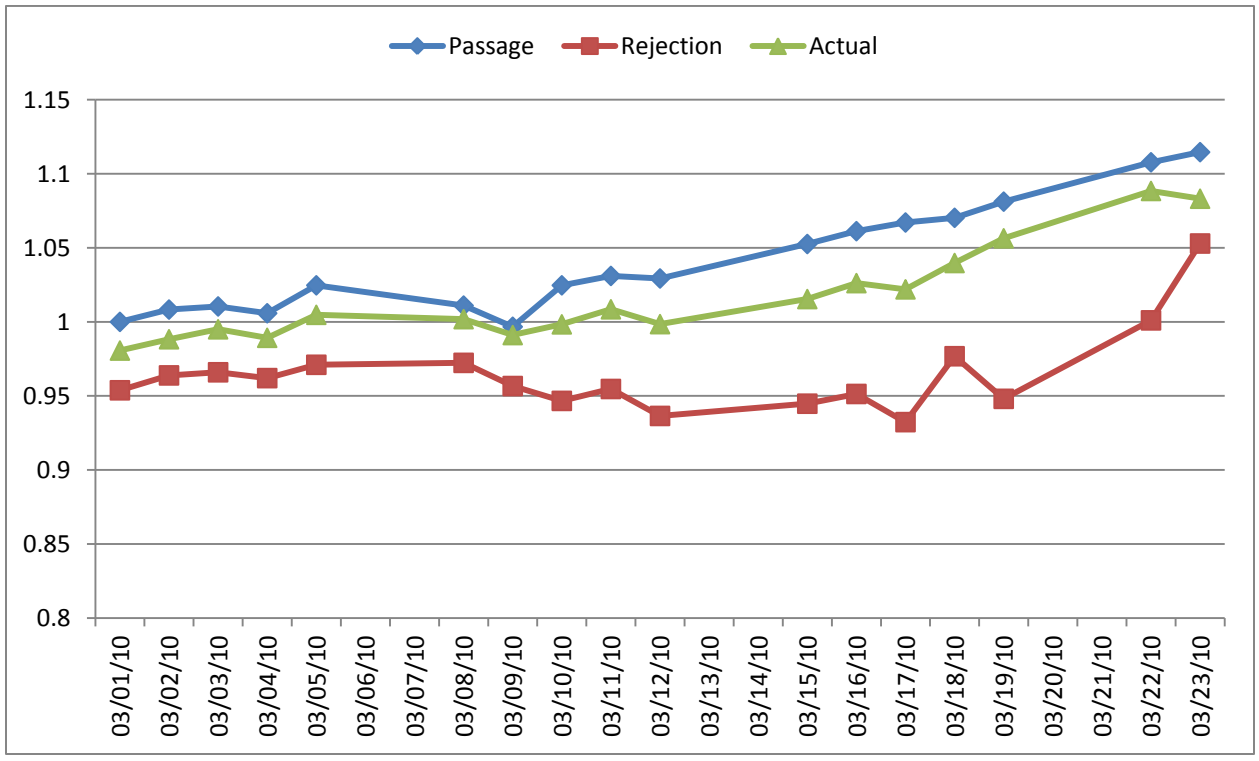


Figure 7

The model-generated state prices for the Supreme Court ruling that the PPACA is constitutional or unconstitutional and the actual average stock prices

The model generates a PPACA constitutional state price and a PPACA unconstitutional state price for the stocks of each of the six hospital firms and six insurance firms, for each trading day during the event period. The state prices, and the actual stock prices, are scaled by the constitutional state price at the start of the event period (June 7, 2012), so that the scaled prices can be viewed as cumulative returns over the Supreme Court PPACA constitutionality event period. The average of the prices for the six hospital firms and six insurance firms is plotted for three weeks of trading before the event, the event day (June 28, 2012), and the day following the event.

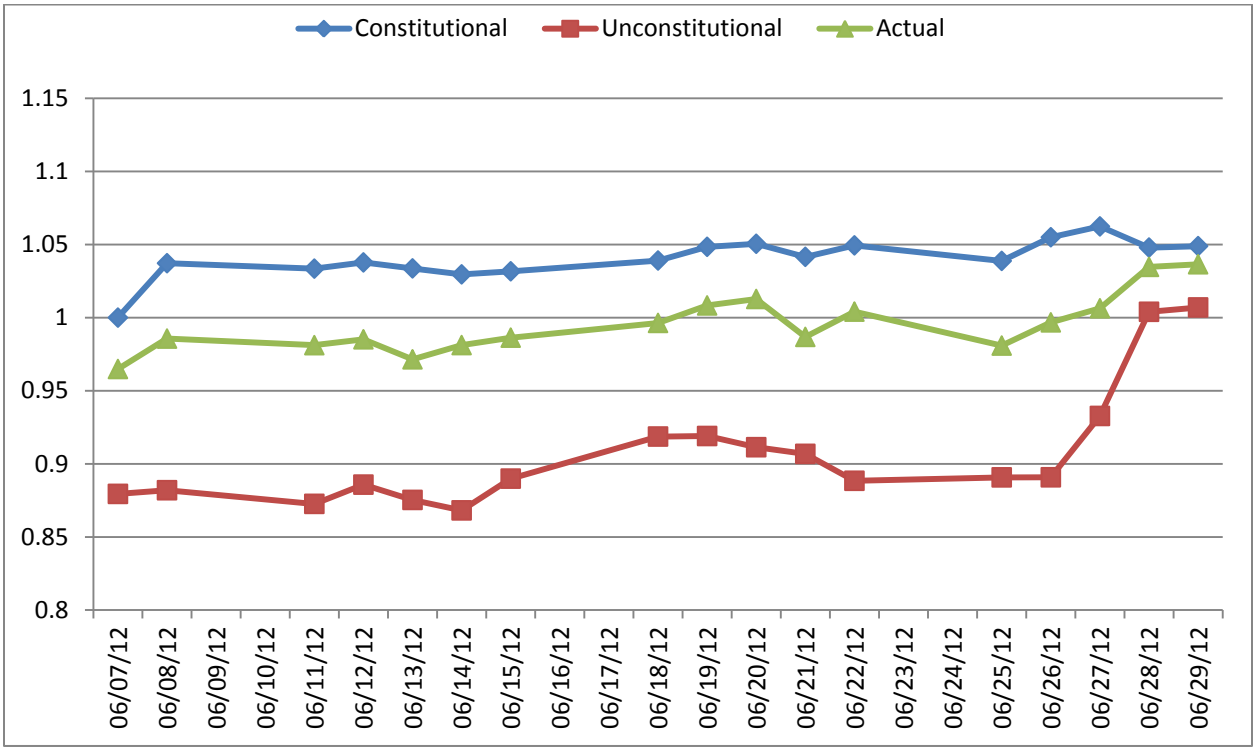
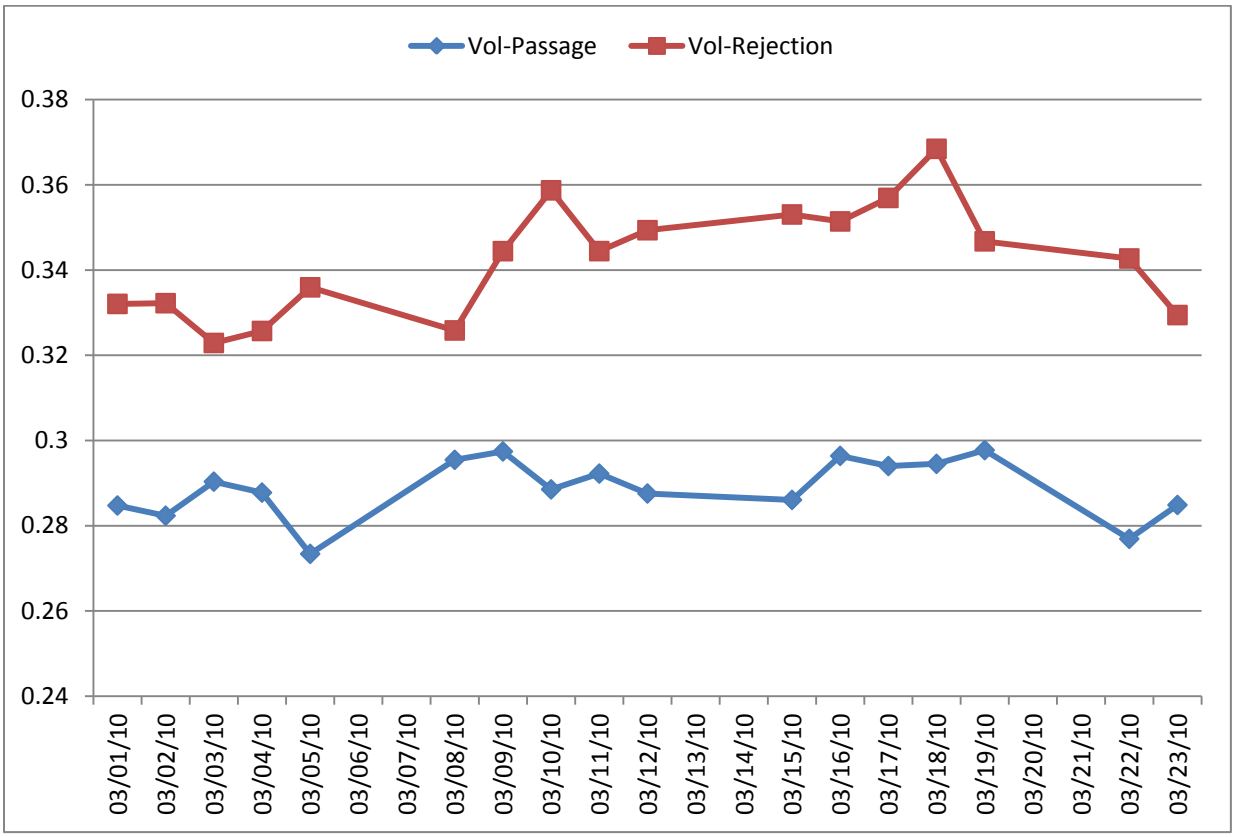


Figure 8

Average model-generated state price volatilities

The model generates volatilities for the two state prices for the PPACA-related events, for each of the six hospital firms and six insurance firms, for each trading day during the respective event periods. The average volatilities for the twelve firms are plotted for the U.S. House of Representatives PPACA passage event in Panel A and for the Supreme Court PPACA constitutionality event in Pane B, for three weeks of trading before the event, the event day, and the day following the event.

Panel A. U.S. House of Representatives PPACA passage event



Panel B. Supreme Court PPACA constitutionality ruling event