# Using Real Options Theory to Evaluate Strategic Investment Options for Mobile Content Delivery: A Case Study

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## ABSTRACT

*With a rich fare of localized content, but limited regional media outlet channels, mobile content generates new business opportunities for Media News, a small media company with considerable growth potential. Two business models are considered: partnering with wireless service providers and strategic alliances with mobile content syndicators. First, the models are evaluated based on their resource requirements, market share acquisition, revenue generation, and nature, scope and control of content and bandwidth. Then, real options analysis is used to value Media News' managerial flexibility in responding to uncertainty in investment choices specific to the media industry. The modeling approach, analytical methods, and decision support tools employed in this paper serve as exemplar for engineering managers involved in strategic investment decisions, especially in emerging areas such as mobile commerce.*

*Keywords: Decision-Making, Mobile Content Services, News Media, Real Options, Valuation*

## INTRODUCTION

The growth of the mobile content market has been fueled by factors such as increasing subscriber growth, maturing network technologies, and mushrooming content types. Market research leader, Juniper Research, predicts that the mobile content market will reach $17.5 Billion in 2012 worldwide from $9 billion in 2007 (http://juniperresearch.com/). Media companies worldwide are capitalizing on this market growth by investing in mobile content services. In this article, we present systematic methods to value investments in the media industry through a real-life example of *Media News*, a growing media company. *Media News*

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established an image of a lifestyle, business, and sports magazine. It covers multifarious topics, including home and garden, food and dining, arts, and special surveys, such as an annual feature about the best doctors in town. *Media News'* monthly circulation is about 20,000 and its readership is estimated at about 69,700, primarily drawn from the upper-middle class. About 85 percent of its income is from advertising while the remainder is derived from subscription and newsstand sales. *Media News* has approximately a 10 percent share of the local market as of late 2008, which is estimated to be about 15 percent of households. At the time of this study, the magazine's 17 employees included two editors, and administrative and advertising support personnel. Freelancers hired on contract produced most of the articles and pictures. *Media News* is an emerging company with substantial growth prospects. To enhance its market base and provide more real-time content, *Media News* entered into an alliance with two TV channels, MidWest-TV and BPN 14, and a web service provider, Channel 4000. *Media News'* web site has its own customized search engine and presents a variety of timely news from business to college sports. *Media News* also broadcasts its content on its TV partners' web sites, in addition to exhibiting links to its partners' real-time headlines on its own web site. *Media News'* goals behind these partnerships are to disseminate its content via multiple channels and increase circulation, thus guaranteeing a continuous source of revenues.

The traditional net present value (NPV) approach to valuing investments consists of selecting projects that yield expected returns in excess of the return required in financial markets from assets of comparable risk. The NPV approach implicitly assumes pre-commitment to future plans and considers investment decisions as "now or never" propositions. Further, van Putten and Macmillan (2004) argued that employing traditional DCF analysis to value investment decisions of growing companies produces inaccurate results, especially when the DCF value of the project is barely positive or slightly negative. Investment decisions should therefore be based on an expanded NPV criterion, which incorporates the flexibility value along with the direct NPV of expected cash flows from an immediate investment. Real options analysis (ROA) has been particularly used to value investments of media firms who are increasingly facing pressure to adapt quickly to the dynamics of the industry. Dimpfel et al. (2002) argued that ROA is particularly successful in emphasizing the high degrees of uncertainty and irreversibility peculiar to the media industry and, if used correctly, can contribute to the reactive and proactive management of flexibility in media companies. The authors argued that media companies exhibit a high degree of irreversibility due to their firm-specific, low reselling value and high operating expenses attached to the costs of infrastructure and marketing. *Media News*, being a small media company with considerable growth potential amid uncertainty, is clearly a good candidate for applying real options theory. The analytical methods employed in this paper provide useful insights to engineering managers who are constantly faced with the dilemma of which projects to invest in and which ones to abandon. The illustrations developed demonstrate how managerial decisions may be facilitated with the aid of low cost real options tools.

The remainder of this paper is organized as follows. In the next section, we evaluate two strategic models for *Media News* based on a qualitative cost-benefit analysis. We then undergo a quantitative analysis based on ROA. Using sensitivity analyses, we show that ignoring the valuation of these options can lead to the wrong decision. Finally, we provide a foundation to generalize the results of investment in the technology sector, specifically in the areas of mobile gaming and commerce.

## MOBILE BUSINESS MODELS FOR *MEDIA NEWS*

Growing firms' alliances are most valuable when built with large firms that possess leading-edge technological resources. *Media News*,

being a young and dynamic company, is likely to gain considerable consumer endorsement for its products and services through a strategic alliance with established service providers. Such strategic alliances fall under the category of co-specialization, thus providing the ability to exploit the synergies resulting from combining *Media News'* resources with those of its potential partners. *Media News* is also making connections with other businesses around the region by displaying their ads on its website. We propose two strategic alliances for *Media News*- one with wireless service providers (WSPs) and the other with mobile content syndicators.

## Model 1: Partnering with WSPs

In this model, *Media News* hosts the entire content and actively recruits subscribers. The WSP provides the necessary technical infrastructure for content delivery to the subscriber. A direct relationship is established between the content provider and its subscribers. We apply the schematics from Weill and Vitale (2001) to depict this business model in Figure 1. *Media News* is responsible for content provision, direct interaction with subscribers and advertisers, establishment of customer relationships, and market campaign design while the WSP takes care of the technology infrastructure. A distinct feature of wireless delivery is customized information. This customization is *Media News'* sole responsibility. Reuters (http://mobile.reuters.com) was among the first media companies to experiment with such a strategic alliance to deliver financial markets' news and data to WAP-enabled phones and other handheld devices. Ericsson supplied the technology, terminals, and wireless data communication expertise, while Reuters provided news and data and introduced customers from the financial services sectors.

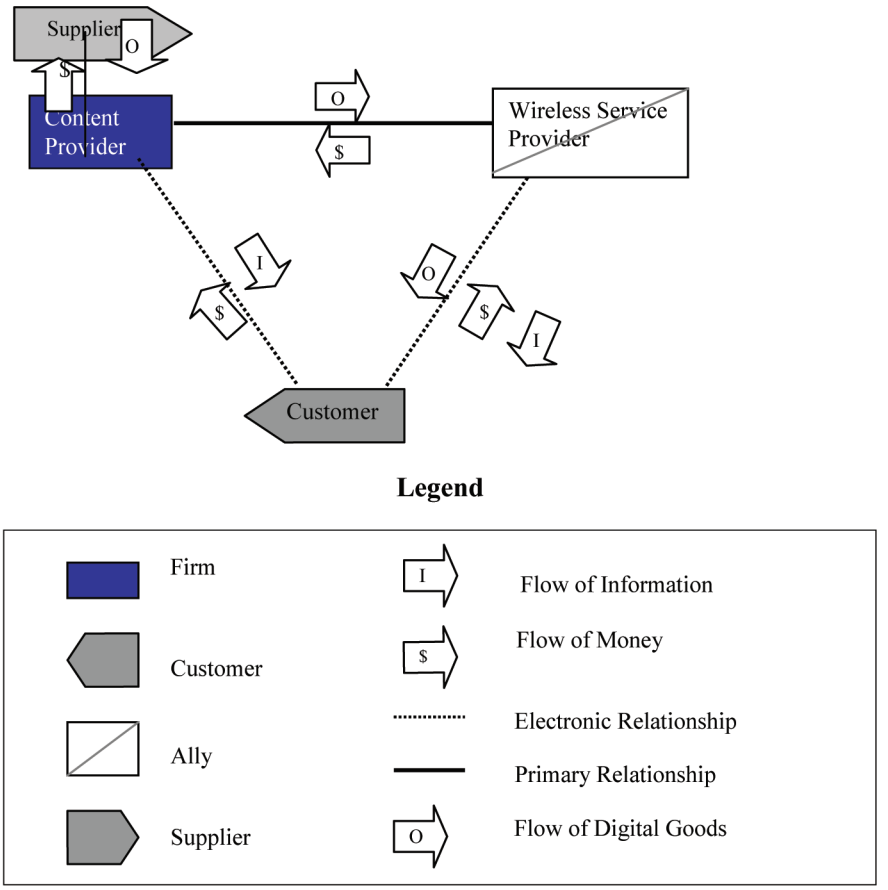
From a technological perspective, the wireless application protocol (WAP) provides the basis for a micro browser built into mobile devices. The mobile profile markup language (XHTMLMP) provides the source for new content, while the wireless markup language (WML) supports legacy WAP content. Markup languages facilitate the presentation layer services for wireless devices while capitalizing on their unique advantages. The accompanying client-side scripting language, WMLScript, provides for additional intelligence and presentation control. WAP gateways transform data from web sites into suitable formats for display in mobile devices. Subscribers pay for wireless service and content. The subscription fee and advertising income that *Media News* receives may also be shared with the service provider.

## Model 2: Partnering with Content Syndicators

Model 2, which we present in Figure 2, allows mobile users to receive information from a variety of content sources through web-to-wireless service providers. Most news organizations adopting this model are presumed to have already set up their own web sites. *Media News* has no direct business links with wireless subscribers. The web-to-wireless providers recruit and interact with subscribers as well as advertisers. They also have to solicit subscribers using the content from the media with which they have a partnership. The content might be reorganized and integrated into a similar format by the service providers before they get customized and transmitted to the subscribers' handheld devices. AvantGo (http://avantgo.com) serves as the classic example of this model. AvantGo's content providers include MSNBC, CNET, Golf Channel, Wired Online, and The New York Times. It is estimated that more than 1,000 channels are partnering with AvantGo. The varying content types are delivered and automatically updated every time mobile users synchronize their handheld devices.

Web clipping is an example of a delivery technology for this model. The more modern version is the use of RSS (Really Simple Syndication), an XML (Extensible Markup Language) technology for distributing links or syndicating content on your website that you like others to use. In a sample web clipping scenario, a web

*Figure 1. Partnering with WSPs*



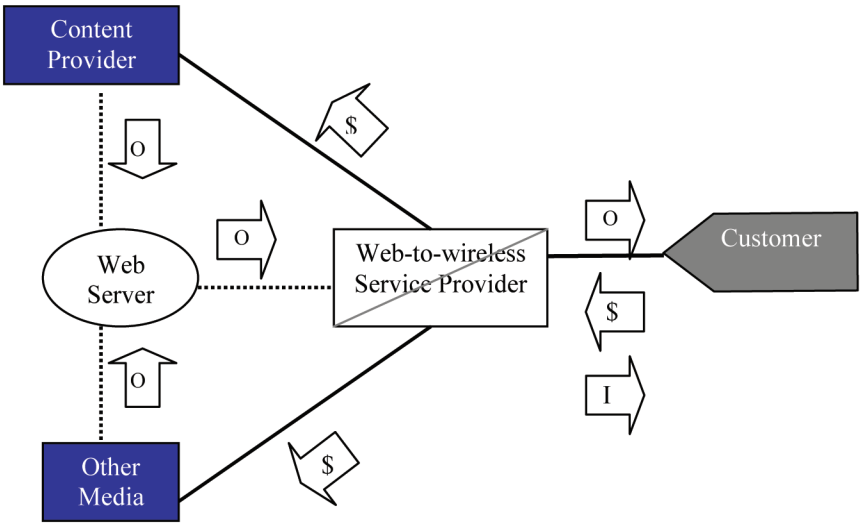

server, in response to a query from a Palm query application (PQA), serves an appropriately formatted page. First, the query is passed via a web clipping proxy, which translates it into an HTTP query to the web server. The web server, in turn, sends back a web clipping. The page might be either static or dynamic, and the proxy compresses the HTTP response and sends it to the client. This model allows large web text or complicated graphics to be transmitted from web-to-mobile devices. *Media News* sells content to the web-to-wireless service provider. Subscribers pay the web-to-wireless service provider for access to that content.

## Comparison of the Two Models

The dynamic nature of the business models associated with mobile content services poses considerable challenges to content providers such as *Media News*.

1. **Market share:** Readers, subject to service availability, may receive content even in remote areas. Under Model 1, there is a potential increase in customers for both *Media News* and the wireless provider. The wireless communication media environment is highly competitive. Users may

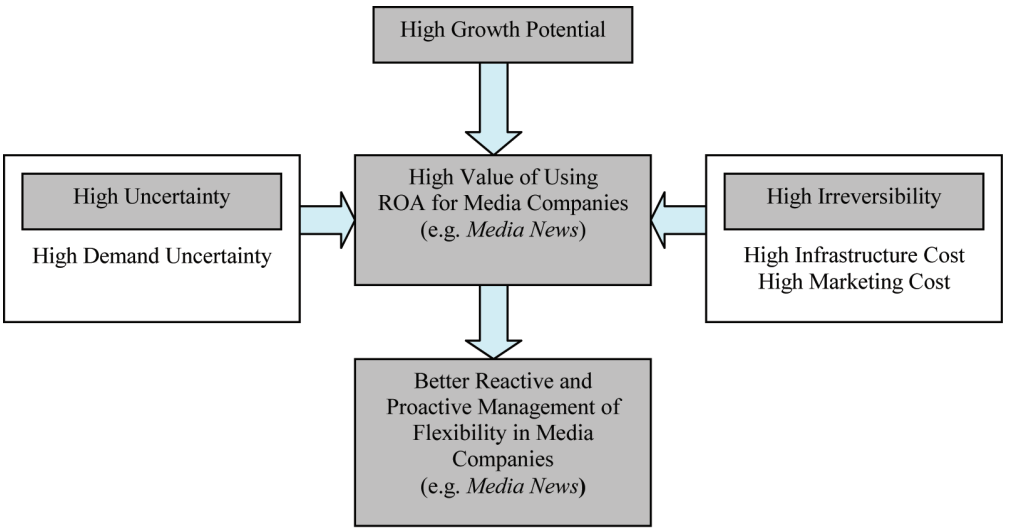
*Figure 2. Partnering with content syndicators*




switch providers if they find that offered content is not timely or that other companies offer richer content at lower rates. To lower this risk, *Media News* needs to offer attractive content to satisfy subscribers' interests, while keeping its fares competitive compared to those of other wireless content providers. *Media News* can reach wireless subscribers such as executives and sales and delivery personnel in addition to its regular subscribers. Under Model 2, the web-to-wireless service provider transmits content, compiled from all the media channels it partners with, to the subscribers it recruits. The greater the number of subscribers, the more readers *Media News* can potentially reach.

2. **Revenues:** Model 1 is likely to provide *Media News* with higher revenues through advertising fees and wireless subscriptions. However, specific revenue and profit-sharing agreements need to be worked out between *Media News* and the service provider. Under Model 2, *Media News* does not deal with wireless subscribers, since that is the job of the service provider. *Media News'* revenues from selling content are only dependent on the terms of its contract with the web-to-wireless provider. It doesn't vary proportionally to the number of subscribers or advertisers.
3. **Bandwidth:** Under Model 1, the amount of content delivered is limited by bandwidth. The bandwidth usually provided by WSPs is not that high, so the data transmitted are limited to small chunks. It takes a long time to transmit long paragraphs and high-resolution images, necessitating the use of tiny displays. *Media News* needs to tailor its content accordingly. Under Model 2, the service provider optimizes its technology for all partnering media companies but hardly customizes its infrastructure for any specific partner. On the other hand, the web clipping infrastructure, underlying the second alliance model, supports rich displays with larger real estate space and multiple modes of data interaction.
4. **Control:** Model 1 gives *Media News* complete control over delivered content. Span of control extends over (a) presentation: editing and designing the layout of wireless

*Figure 3. Relevance of ROA in valuing Media News' investment decisions*




content, including content either covered by *Media News* or purchased from other media; (b) source of content: the content is either entirely from *Media News* or from both *Media News* and its partnering media provider, in which case *Media News* gets to decide which content gets delivered by wireless; and (c) advertising: the content and layout of wireless ads are controlled by *Media News* and matched with news content to enhance ads' effects.

5. **Nature and scope of content:** *Media News* has an alliance with Channel 4000 and two TV stations allowing it to deliver online content. The content provided by these partners, such as real-time news and weather forecasts, compensates for the magazine's limited real-time coverage. However, *Media News'* partners' news coverage is itself regional and limited to the U.S. Midwest. Model 2 looks meaningful therefore in this regard. Besides web-to-wireless service providers, some wireless application service providers (ASPs) also favor localized information. Webraska (http://webraska.com) is one example. It provides location-specific information to mobile carriers and portals for services such as yellow pages and directions; local events, movies, and attractions; and travel and commuting. The in-depth local investigation stories reported by *Media News,* for example, the best doctors in town and the region's best sightseeing spots, always convey valuable information.

## FROM BUSINESS MODELS TO REAL OPTIONS

The survivability of the telecommunications and entertainment industry has been shown to be especially risky and uncertain (Grover & Saeed, 2003; Kim, 2007; Rhéaume & Bhabra, 2008). The case of *Media News*' partnerships is no different. Figure 3 illustrates why ROA contributes to the reactive and proactive management of flexibility for a media company like *Media News*, whose expected subscriber base is a major source of uncertainty.

Media users span a wide range of socio-demographic segments and have heterogeneous tastes and exhibit a short-spanned loyalty, if any,

towards the media they subscribe to. That lack of sustained loyalty is due to many reasons:

1. Media users' preferences change rapidly, especially when it comes to media formats. Media providers better keep up with technology to retain their technology-oriented customer base.
2. No objective quality criterion exists for selecting media content; media users may be tempted to be indifferent in their consideration of one media over the other.
3. In some media segments, such as advertising-based broadcasting, there is no direct interaction between the media company and the consumer. Specifically, when it comes to its interaction with users acquired through its partnerships with Wisc-TV, UPN 14, and Channel 3000, *MM* maintains an indirect and anonymously mediated relationship.

Further, once implemented, *Media News'* decisions cannot be completely reversed without incurring heavy cost burdens. Strategic flexibility in *Media News'* context is the company's ability to reformulate its strategies and reconfigure its resource allocation upon receiving up-to-date numbers. *Media News'* flexibility to abandon any one of its partnerships, for instance, is an example of defensive flexibility because it protects the company against downside losses caused by a lower than expected subscriber base, or unaccounted recurring costs.

Strategic investment decisions involve both quantitative and qualitative analyses. The numerical data used for our calculations were obtained through face-to-face interviews with *Media News*' executives, telephone interviews with marketing managers of WSPs and content syndicators, and subscription information available on media companies' websites. The structured interview sessions with the magazine executives were conducted with the aid of questionnaires, which were prepared early in advance and emailed to them. The questionnaire was designed to gather information about the magazine's strategic position on exploring wireless content services as a viable business development option. Secondly, it was designed to assess the magazine's capabilities in terms of infrastructure, human resources, customer profile, circulation, status of its existing partnerships, content-generation capabilities and data that would facilitate the determination of initial investment costs and recurring expenses. On completion of every interview session, interview transcripts were analyzed. Secondary questions and items for further clarification were then marked out for subsequent sessions. The three interview sessions conducted provided adequate information to facilitate the analysis. Secondary sources of information employed include the magazine's web site, survey data available from the media watchdog Media Audit (http://mediaaudit.com), web sites of popular WSPs such as Cingular (now AT&T), Verizon, Sprint, and NEXTEL and web-to-wireless service providers such as AvantGo, NTT DoCoMo, and EarthLink.

## Background on ROA and Literature Review

A real option is the right, not the obligation to undergo an endeavor (defer, expand, contract, abandon, etc…) at an agreed upon price (exercise price) for a predetermined period (life of the option). As is the case for financial options, the value of a real option is derived from the value of the underlying risky asset (value of investment, project, or acquisition), the exercise price (amount of money invested to exercise the option), the time to maturity of the option, the volatility of the value of the underlying asset (riskiness of the underlying asset's cash flows), and the risk-free rate prevalent during the life of the option. The right to buy the underlying asset at the exercise price is a *call* option whose payoff is calculated as the difference between the underlying value and the exercise price. Alternatively, a put option is the right to sell the underlying at the exercise price with payoff at maturity equaling the difference by which the exercise price exceeds the underlying value.

Options that can only be exercised upon their maturity are referred to as *European* options while those that can be exercised anytime during the lifetime of the project are entitled *American*. Real options are differentiated by the type of flexibility they represent. For example the right to defer, expand, or extend a project is an American call option, while the right to abandon a project is an American put. Various option combinations are possible by constructing portfolios of options and compounding options on options, both simultaneously and sequentially.

ROA has been amply used for the valuation of finance-related projects, retailing, auctioning, contracts, mergers & acquisitions, outsourcing, and leasing which are characterized by substantial risks (Mittendorf, 2004; Marcus & Anderson, 2006; Jiang et al., 2008; Kumar & Turnbull, 2008; Su et al., 2009). ROA has also been applied to value the flexibility embedded in operations management, facility management, manufacturing and production management, capacity planning, supply chain management, and inventory management projects (Boute et al., 2004, Kamrad & Siddique, 2004; Kamrad & Ord, 2006; West & Bengtsson, 2007; Jao et al., 2007; Zhao & Tseng, 2007; Berling, 2008; Dulluri & Raghavan, 2008; Li & Rajagopalan, 2008; Driouchi et al., 2009; Huang, 2009; Lin, 2009). In addition, ROA has been applied to value environmental projects (Guthrie & Kumareswaran, 2009; Leroux et al., 2009), power and oil & gas-related projects (Takizawa & Suzuki, 2004; Wang & Min, 2006; Tseng & Lin, 2007; Bøckman et al., 2008; Hahn & Dyer, 2008; Porchet et al., 2009), research and development projects (Pennings & Lint, 2000; Koussis et al., 2007; Kim et al., 2008a; Miller & Clarke, 2008; Wu et al., 2008c), and pharmaceutical and health-related projects (Levaggi & Moretto, 2008; Pertile, 2009), among others.

The IT literature has been particularly successful in using ROA to value IT-related investments. Many authors used ROA to derive optimal timings for IT-related investments in real world business situations (e.g. Benaroch & Kauffman, 1999, 2000; Campbell, 2002; Gordon et al., 2003; Kauffman & Li, 2005; Benaroch et al., 2006a; Benaroch et al., 2007; Ziedonis, 2007; Khansa & Liginlal, 2009). Also in IT, authors such as Kim and Sanders (2002) and Benaroch (2001, 2002) developed frameworks to assist managers in evaluating and justifying IT investment decisions. Prior research also proposed variants of ROA that are specific to peculiar types of IT investments (Benaroch et al., 2006b; Wu et al., 2008).

ROA was shown to be particularly valuable in evaluating networking and communications project due to the high level of demand uncertainty and the immensity of sunk costs. Angelou and Economides (2008) combined ROA and the more qualitative analytic hierarchy process to better value investments in information and communications technologies infrastructures. Camacho and Menezes (2009) evaluated the real options embedded in networking projects under regulated and unregulated environments. Similarly, d'Halluin et al. (2007) used ROA to determine optimal timing for network capacity investment. Kim (2006) applied real options theory to study the economic value of modularity in networks' quality of service. Kim (2007) applied ROA to evaluate IP telephony network and its savings over the total link capacity of a circuit-switched network. Kim et al. (2008b) used ROA to assess technology migration options in the wireless industry. To capture the inherent uncertainties in the Internet's Quality of Service assurances, Gupta et al. (2006) developed a utility-based options pricing approach that provides new ways for "fair risk sharing" among Internet providers and customers. In their paper, Harmantzis and Tanguturi (2007) used ROA to facilitate investment decisions related to the deferral of the expansion from 2.5G to 3G networks the expansion of a 2.5G network using Wi-Fi as an alternative technology.

## Applying Real Options Analysis

In Model 1, as a sole content provider, *Media News* owns the content and the subscriber base and consequently has the power to defer partnership with the WSP until uncertainty is

at least partially resolved. Alternatively, with Model 2, when purchasing content from other media providers, *Media News* possesses the option to abandon the partnership if the results do not conform to expectations.

### *Model 1. Analyzing the Partnership with a WSP*

To establish a five-year partnership with a WSP, as determined from the direct interviews held with *Media News'* managers, an initial seed investment of $35,000 is required for hardware, software and installation costs. However, starting in year #1, an annual recurring cost of $140,000, covering maintenance costs and two additional employees' salaries, is needed for the five-year projection period. Revenues are assumed, based on *Media News'* projections, to grow at 50 percent, 40 percent, 20 percent and 20 percent in years 2, 3, 4, and 5, respectively. Using the traditional DCF model and a market risk-adjusted discount rate of 20%, year #1's break-even number of subscribers was estimated at 5,497. Monthly subscription fees, as used in the calculations, were taken off *Media News'* web site and confirmed from our interviews.

*Option to defer*: Traditional DCF analysis of a project quantifies its static value and makes the implicit assumption that the project decision must be made immediately, ruling out the possibility of deferring the investment until uncertainty is resolved. When it is possible to delay the investment decision without losing potential benefits, an option to defer exists (Dixit & Pyndick, 1994). Many authors have studied the dynamics of deferring investment in technology until uncertainty is partially or totally resolved. For example, Kauffman and Li (2005) analyzed the investment timing strategy for a firm that is considering adopting one of two incompatible and competing technologies. The option to defer an investment can be modeled as a call option (Dixit & Pindyck, 1994). Using the Black-Scholes pricing formulae for a call option, the defer option is computed as in Equation 1.

$$C_0 = S \times \mathrm{N}(d_1) - Ke^{-r_f T} \times \mathrm{N}(d_2) \quad (1)$$

$C_0$ is the value of a European option at time $t=0$, $r_f$ is the risk-free interest rate, S is the price of the underlying asset, $\sigma$ is the volatility or risk of the underlying asset, $K$ is the strike price of the call, i.e. the price at which the underlying asset can be purchased if the option is exercised, $T$ is the time to maturity, and N (.) is the cumulative distribution function for the standard normal distribution. $d_1$ is given by

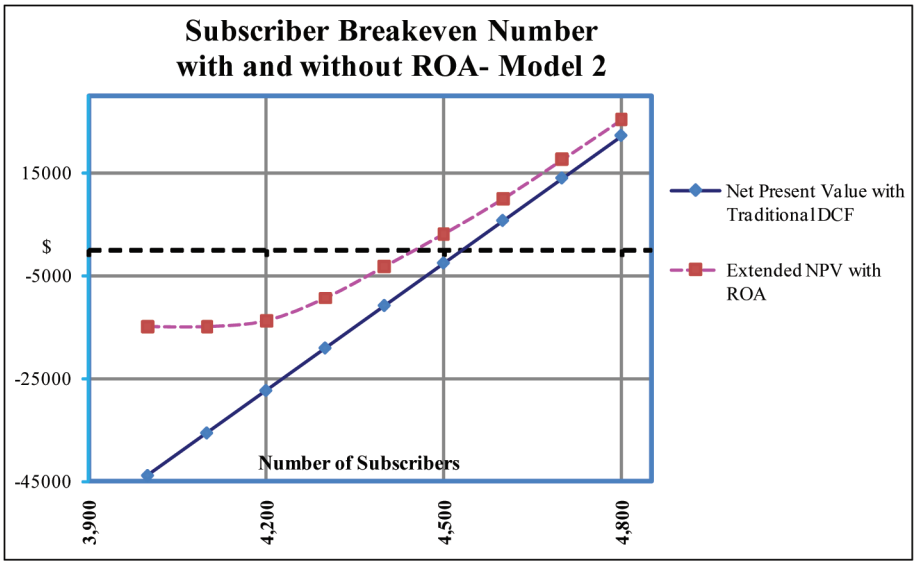
$$d_1 = \frac{\ln(S / K) + (r_f + \frac{\tilde{A}^2}{2})T}{\sigma\sqrt{T}} \quad (2)$$

and

$$d_2 = d_1 - \sigma\sqrt{T} \quad (3)$$

The details of what is imputed for each of Equation 1's parameters are shown in Appendix A (Figure 7). We used Excel 2007, one of the most ubiquitous decision analysis applications, to automate the valuation of real options and assists managers in quantifying the embedded strategic value for a range of proposed or existing investment scenarios. We used a myriad of volatility estimates pertinent to specific industries. A volatility of 20 percent was obtained using the Crystal Ball tool (Mun, 2002) on *Media News'* expected future cash flow (Appendix A, Table A.2). Excel was then used to evaluate whether *Media News* should proceed with the partnership immediately or delay until uncertainty is resolved. It is assumed that *Media News* is not likely to face any serious competition in the next five years and first-mover advantage is also precluded. Starting with 5,500 subscribers in year #1, the recommendation is not to proceed with the partnership, considering that embarking on the partnership immediately is less valuable than the option to delay it. Appendix A depicts the resulting output assuming a 10 percent cost outlay due to delaying the project.

*Figure 4. NPV analysis with and without ROA- Model*



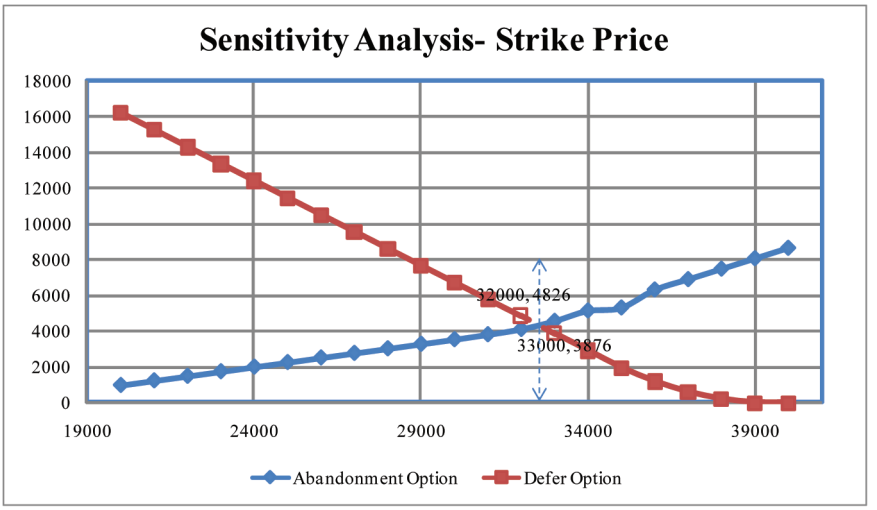

## *Model 2. Analyzing the Partnership with Content Syndicators*

Instead of partnering with a WSP, *Media News* can partner with other media providers. In that case, we assume, based on our interviews with *Media News'* managers, that an additional $10,000 of seed money is required initially to establish the partnership. However, the partnership will allow *Media News* to save the equivalent of one employee's salary. As before, revenues are assumed to grow at 50 percent, 40 percent, 20 percent and 20 percent in years 2, 3, 4, and 5, respectively. Using the traditional DCF model and a market risk-adjusted discount rate of 20 percent, year #1's break-even number of subscribers is 4,531.

*Option to abandon:* Traditional DCF analysis does not capture management's flexibility to abandon its partnership with content syndicators, if it proves unsuccessful. An abandonment option gives the right to get out of a risky situation at any time by selling it for a fixed price (the striking price). Since at any time during the five years of partnership, *Media News*' management can, after reviewing the progress of the alliance, decide to terminate the partnership with the media provider by paying some penalty. *Media News'* right to abandon its partnership is formally equivalent to an American put option on a stock. Since an American put option can be exercised at any time up to the maturity date of the option, a binomial option pricing model needs to be used (Geske & Johnson, 1984). The major assumption of option pricing models is that the underlying asset's process w(t) defined on $[0, \infty)$ is a continuous-time Brownian motion stochastic process with drift parameter $\mu$ and variance parameter $\sigma^2$. The binomial lattice approximates the process $\ln S(t)$ with a discrete process by fixing a time step $\Delta t$ and $n$ intervals on $[0, T]$, such that $\Delta t = T/n$. A binomial lattice uses two multiplicative values $u$ (up) $= \exp[\sigma(\Delta t)^{1/2}]$ and $d$ (down) $= 1/u = \exp[-\sigma(\Delta t)^{1/2}]$, with $u > 1 > d$ and their respective probabilities $q$ and $1 - q$ respectively.

The abandonment option binomial tree is shown in Appendix B (Figure 8). We have derived a volatility of 45 percent using the Crystal Ball tool on *Media News'* expected future cash flow. The output of the Crystal Ball tool, along with the abandonment option binomial tree obtained using John Hull's DerivaGem

*Figure 5. Sensitivity analysis upon varying the strike price*



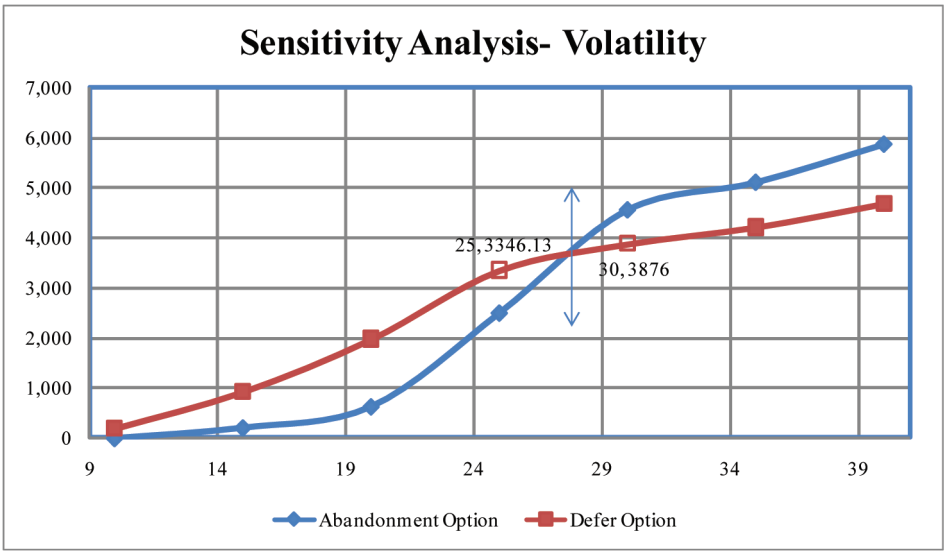

tool (http://www.rotman.utoronto.ca/~hull/software/) are shown in Appendix B (Table B.2). $u = \exp[\sigma(\Delta t)^{1/2}]$ and $d = 1/u = \exp[-\sigma(\Delta t)^{1/2}]$ so with 1 period and a volatility of 45%, $\Delta t = 1$ and $\sigma = .45$, so $u = 1.5683$and $d = 0.6376$. The risk-free interest factor is $R = \exp[r_f \Delta t] = \exp[.05] = 1.0513$ (continuous compounding). The risk-neutral probabilities are computed as $q = 0.4445$ and $1\text{-}q = 1 - 0.4445 = 0.5555$. Discrete compounding is suitable for certain flows (e.g., yearly payments at stated rate), but for lattice work, especially with time periods less than a year, continuous compounding works better. Starting in the last time period, the value with the put option is the maximum of the striking price and the value without abandonment. If *Media News* does not abandon the partnership, it gets the risk-neutral expectation of the possible successor nodes, discounted back at the risk-free rate, using continuous compounding for discounting. If *Media News* abandons the partnership, it gets the striking price $K$. Based on the conducted interviews, the salvage value if the partnership is abandoned is $30,000. Therefore, the value of the put is maximum$\{30,000, V\}$. This reasoning applies at every node that is not in the last time period (See Appendix B for full lattice).

Assuming 4,520 subscribers in year #1, traditional DCF analysis gives a negative NPV, indicating that the partnership is not feasible because the present value of expected future inflows amounts to $44,097.46 and is below the initial investment of $45,000. Using the binomial approach to perform ROA, the extended NPV amounts to $49,395.10; this exceeds the initial investment of $45,000 indicating that the partnership is feasible. The difference of $5,297.64 between the extended NPV and the base NPV is the value of the abandonment option. This example illustrates how the traditional NPV approach, in the presence of managerial options, undervalues the value of the partnership and could lead to a non-optimal decision.

## NUMERICAL ANALYSIS AND DISCUSSION

The analytical studies that we conducted thus far are not sufficient to make a final decision. With regard to *Media News*' partnership with a WSP, immediate partnership could potentially generate revenues and create barriers to entry for other competitors. However, given the relatively high break-even number of subscribers and *Media News*' lack of national coverage,

*Figure 6. Sensitivity analysis upon varying cash flow volatility*




high uncertainty surrounds year #1's projected demand for *Media News'* services, as discussed earlier. At first glance, partnering with content syndicators seems to be a strategically sound proposition in that it allows *Media News* to expand its services to include national coverage, which could in turn further develop its subscriber base.

Initial DCF analyses results, shown in Tables A.1 and B.1 in Appendices A and B respectively, reveal that the NPV of partnering with a WSP is positive at $264.82, while that of partnering with content syndicators is negative at -$902.54, using the same discount rate of 20 percent. Therefore, using simple DCF analysis, *Media News'* decision would be to choose Model 1. Using ROA, however, the value of the defer option embedded in Model 1 is $1,972.9, while the value of the option to abandon, embedded in Model 2 is $5,297.6. By adding the values of the options to the NPV obtained using DCF, we get an extended NPV of $2,237.72 for Model 1 and $4,451.06 for Model 2, as shown in Figure 4. Therefore using DCF analysis, without accounting for embedded options, could have led *Media News* to select a sub-optimal model.

## Sensitivity Analyses

While various sensitivity analyses are possible with the scalable decision model we have designed, we have chosen to limit the scope of our analysis to the following two scenarios.

1. **Strike price:** To compute the defer option embedded in the partnership with the WSPs we have used a strike price of $35,000. On the other hand, we have used a strike price of $30,000 to value the abandonment option embedded in the partnership with content syndicators. We relaxed these assumptions by varying the strike price from $20,000 to $40,000. The results in Figure 5 reveal that the break-even strike price, for which *Media News* would be indifferent between both options, is between $32,000 and $33,000. Up until this strike price, *Media News* is better off partnering with WSPs. For a strike price greater than $33,000, *Media News* is better off choosing the partnership with content syndicators. Recall that the strike price, in the case of the defer option, is the initial seed investment, which is required for hardware, software and installation

costs. If *Media News* decides to delay the partnership, it would lose this seed investment. On the other hand, in the case of the partnership with content syndicators, the strike price corresponds to the penalty that *Media News* might have to pay to abandon the partnership.

2. **Volatility of the underlying cash flows:** Using the data that we collected from our interviews with *Media News*' management, we derived a volatility of 20% from the cash flow of the partnership with WSPs, and a volatility of 45% from that of the partnership with content syndicators. These initial assumptions indicate that the partnership with content syndicators is more risky, but can lead higher returns on the upside. We relaxed these initial assumptions and ran another sensitivity analyses by varying the volatility, or risk, of the underlying cash flows for a fixed strike price of $35,000. The results in Figure 6 show that for a strike price of $35,000, *Media News* is better off partnering with content syndicators for a volatility value higher than 28%.

## Limitations of Real Options Analysis

Despite its usefulness, the ROA methodology has some limitations. First, misestimated volatilities can lead to significantly erroneous results in option valuation. To address this limitation, we substantiated our numerical analysis with data collected during our interviews with *Media News*' management and used this data to derive the volatilities. Second, although quite realistic to model the prices of stocks or other financial instruments, the assumption of geometric Brownian motion may be unrealistic to model the price of real assets. This assumption of the price of the underlying asset being random is violated if the market is a monopoly or an oligopoly as the small number of market players may influence the price of the underlying asset. In the case of *Media News*, the presence of many players dampens this limitation.

## CONCLUSION

Due to limited budget provisions, local news publishers have a hard time catching up with advances in technology, and they often get relegated to outlier status. We addressed the feasibility of two business models for *Media News* to expand into the wireless market. For *Media News*, which already has an alliance with TV and wired web, wireless delivery completes the picture of print, broadcast, online, and wireless presentation. The face-to-face interviews with executives of the magazine brought out the practitioners' vision of technology and the difficulties encountered by publishers in the new era. Based on the nature of the partnership, local news publishers and WSPs may share the income in both models. The study also identified specific roles and responsibilities for each party. Wireless service companies contribute the technical component, and the news publishers contribute a plethora of rich content, such as stories and news coverage.

No matter which model the magazine prefers to adopt, it is likely that both types of partnership require content generation in a format suitable for publishing over the web. To generate and manage its own web content, *Media News* needs to recruit editors and journalists who possess the appropriate technical background. Steve Outing, president of Planetary News (http://www.planetarynews.com/), a media research firm, refers to such people as "editorial scientists" or "content engineers." An editorial scientist is someone who has been trained in computer-assisted reporting, and a content engineer is the person who is able to develop and maintain content database structures and create content presentation. Web and wireless presence alter not only a journalist's job and required skills but also the format in which the content is displayed. Media content for wireless could ordinarily be divided into two parts. One is news content, and the other is advertising. For wireless, the news content requires the following: (a) ruthless editing, (b) filtering and selecting the best content, (c) adding explicit headlines, and (d) categorization. On

the other hand, wireless advertising presentation is less conclusive. Although customization and personalization are highly recommended for wireless ads, one also needs to adhere to the standards and recommendations of such bodies as the Wireless Advertising Association (http://mmaglobal.com/main). It is interesting to note that mobile content has revolutionized real-time news broadcasting. For example, Web-enabled cell phones will allow ordinary citizens to shoot and send news photos and video to the local newspaper or TV station—or publish them to their own personal Web sites—also called moblogging. This has now become a rage in countries such as Japan where the wireless infrastructure is more advanced than in the United States. Thus, real-time news, not just print, but also videos are possible to be captured by reporters/bloggers and delivered to mobile customers' cell phones.

Traditionally, managerial decision making tends to focus on short term profits instead of aiming for more flexibility, which if exploited in a timely manner, can bring in more profits. We showed that using traditional cost-benefit analyses, such as DCF, can lead to suboptimal decisions, especially in the media industry where uncertainty and irreversibility are high. We have, instead, proposed that ROA can be used to value technology investments under uncertainty, in the particular the case of growing media firms and demonstrated how *Media News* can choose between its two expansion options using real options theory. We urge managers to exercise the options embedded within their projects. Barnett (2005) argued that real options are only valuable if management exert the necessary attention to exploit flexibility inherent in projects and extract their full theoretical value. Tiwana et al. (2007) also showed how important it is for managers not to neglect embedded real options when valuing projects. On the other hand, managerial over-commitment to projects embedding real options could also be detrimental. Tiwana et al. (2006) illustrated how real options can sometimes lead to escalation of commitment on the part of software project managers and recommended recognizing the value of timely project termination when needed.

The results of this article are easily extensible to other areas of mobile commerce both from both, the investment and technological perspectives (content engineering, for instance). Our ongoing work consists of modeling the options embedded in the partnerships in the presence of competing standards in the media industry where "winners take all" and first-mover advantage is of considerable importance. It is important for media companies to invest in and set the dominant market standard before consumers are locked in, as the costs of switching to another technology are prohibitively high for media firms. The state of competition between various technologies would determine a threshold, beyond which it would be profitable to defer investment until competition uncertainty is resolved and one of the technologies becomes the standard.

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## APPENDIX A: ANALYSIS OF MODEL TO PARTNER WITH THE WSP

*Table A.1. Cash flow for the partnership with the WSP*

| Parameters | Years | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 |
| WACC | 20% | | | | | |
| Growth Rate | | | 50% | 40% | 20% | 20% |
| Initial Investment | -$35,000 | | | | | |
| Recurring Cost | | -$140,000.00 | -$140,000.00 | -$140,000.00 | -$140,000.00 | -$140,000.00 |
| Revenues | | $82,225.00 | $123,337.50 | $172,672.50 | $207,207.00 | $248,648.40 |
| | ($35,000.00) | ($57,775.00) | ($16,662.50) | $32,672.50 | $67,207.00 | $108,648.40 |
| | | | | | | |
| NPV | $264.82 | | | | | |
| Present Value (Income) | $35,264.82 | | | | | |
| Number of Subscribers | 5,500.00 | | | | | |

*Figure 7. Defer option embedded in the partnership with the WSP decision*

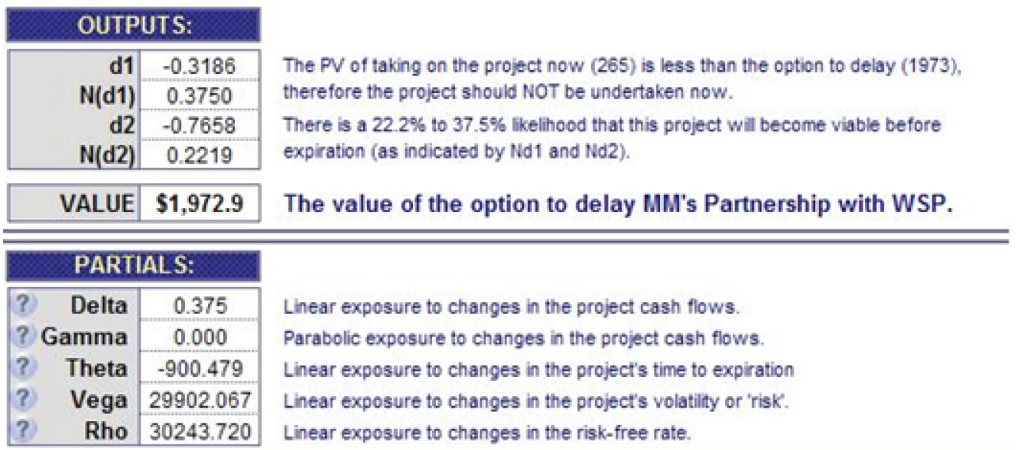

*Table A.2. Volatility of the cash flow for the partnership with the WSP*

| **Crystal Ball Report** | | |
|---|---|---|
| **The following simulation is based onMun's (2002)Logarithmic Present Value Approach. *Media News*' expected cash flow is discounted to time [$PV_0$] and again to time 1[$PV_1$]. The natural logarithm of the ratio $PV_1/PV_0$ is then used as a forecast variable to perform a Monte Carlo simulation on *Media News*' future expected cash flow. The standard deviation of the forecast variable's distribution is the volatility estimate we used in our real options analysis. To get the standard deviation in percentage terms we divided the obtained output's standard deviation by the output's mean.** | | |
| | | |
| **Forecast of LN[$PV_1/PV_0$]** | | |
| | | |
| | Summary: | |
| | Display Range is from 2.64 to7.51<br>Entire Range is from -0.96 to 7.51<br>After 1,260 Trials, the Std. Error of the Mean is 0.03 | |
| | Statistics: | Value |
| | Trials | 1260 |
| | Mean | 5.46 |
| | Median | 5.68 |
| | Mode | --- |
| | Standard Deviation | 1.08 |
| | Variance | 1.16 |
| | Skewness | -1.29 |
| | Kurtosis | 5.59 |
| | Coefficient of Variability | 0.20 |
| | Range Minimum | -0.96 |
| | Range Maximum | 7.51 |
| | Range Width | 8.46 |
| | Mean Standard Error | 0.03 |

## APPENDIX B: ANALYSIS OF MODEL TO PARTNER WITH CONTENT SYNDICATORS

*Table B.1. Cash flow for the partnership with content syndicators*

| **Parameters** | **Years** | | | | | |
|---|---|---|---|---|---|---|
| | **0** | **1** | **2** | **3** | **4** | **5** |
| WACC | 20% | | | | | |
| Growth Rate | | | 50% | 40% | 20% | 20% |
| Initial Investment | -$45,000 | | | | | |
| Recurring Cost | | -$110,000.00 | -$110,000.00 | -$110,000.00 | -$110,000.00 | -$110,000.00 |

*Table B.1. continued*

| Parameters | Years | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 |
| Revenues | | $67,574.00 | $101,361.00 | $141,905.40 | $170,286.48 | $204,343.78 |
| | ($45,000.00) | ($42,426.00) | ($8,639.00) | $31,905.40 | $60,286.48 | $94,343.78 |
| | | | | | | |
| NPV | ($902.54) | | | | | |
| Present Value (Income) | $44,097.46 | | | | | |
| Number of subscribers | 4,520.00 | | | | | |

*Figure 8. Binomial model for the partnership with content syndicators*

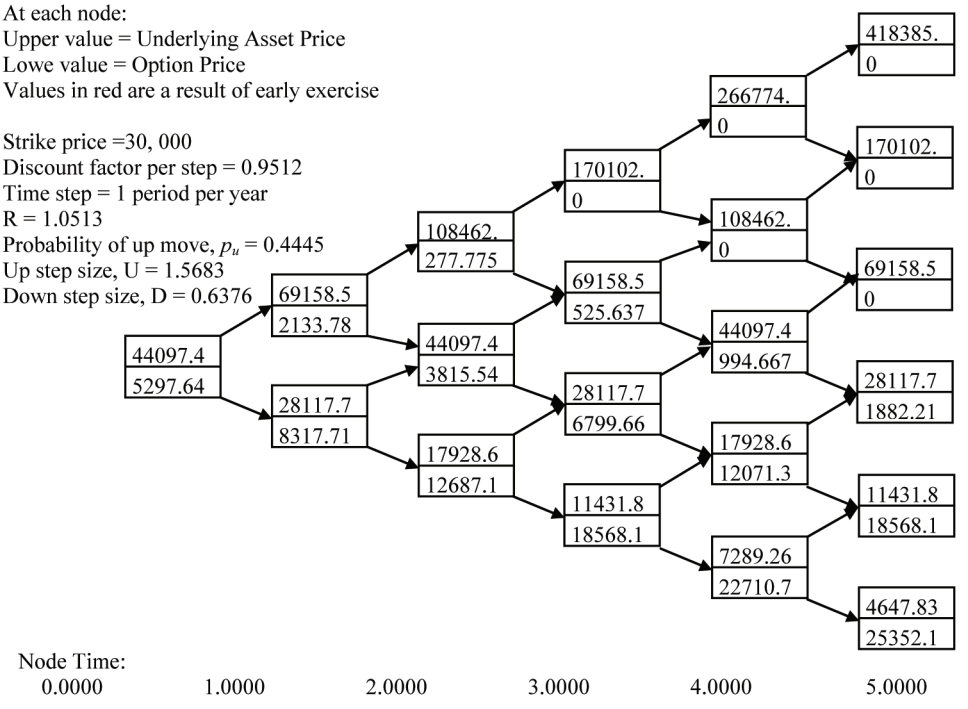

*Table B.2. Volatility of the cash flow for the partnership with partnership with content syndicators*

| **Crystal Ball Report** | | |
|---|---|---|
| **The following simulation is based onMun's (2002)Logarithmic Present Value Approach. *Media News*' expected cash flow is discounted to time [$PV_0$] and again to time 1[$PV_1$]. The natural logarithm of the ratio $PV_1/PV_0$ is then used as a forecast variable to perform a Monte Carlo simulation on *Media News*' future expected cash flow. The standard deviation of the forecast variable's distribution is the volatility estimate we used in our real options analysis. To get the standard deviation in percentage terms we divided the obtained output's standard deviation by the output's mean.** | | |
| | | |
| **Forecast of LN[$PV_1/PV_0$]** | | |
| | | |
| | Summary: | |
| | Display Range is from -0.18 to 2.43<br>Entire Range is from -5.59 to 2.65<br>After 36,911 Trials, the Std. Error of the Mean is 0.00 | |
| | Statistics: | Value |
| | Trials | 36911 |
| | Mean | 1.13 |
| | Median | 1.19 |
| | Mode | --- |
| | Standard Deviation | 0.51 |
| | Variance | 0.26 |
| | Skewness | -1.51 |
| | Kurtosis | 10.73 |
| | Coefficient of Variability | 0.45 |
| | Range Minimum | -5.59 |
| | Range Maximum | 2.65 |
| | Range Width | 8.24 |
| | Mean Standard Error | 0.00 |