Business Model Representation Incorporating Real Options: an Extension of e3-value

Dennis Kundisch
School of Business Administration & Economics
University of Paderborn, Germany
dennis.kundisch@wiwi.uni-paderborn.de

Thomas John
Cooperative Computing & Communication Laboratory
University of Paderborn, Germany
thomas.john@c-lab.de

Abstract

Business models are not typically doomed to remain as they are; rather, they may contain a variety of options to be changed or extended. Nevertheless, current approaches for business model representation cannot handle such options, because no appropriate modeling constructs are available. This substantially inhibits the qualitative consideration of options in business model design. Also, it inhibits the integration of options into subsequent quantitative analysis. Our contributions in this context are twofold: at a ‘macro-level’, we combine business model representations with real options theory from finance. At a ‘micro-level’, we extend one widely established and applied business model representation, namely e3-value, for handling real options. We develop the graphical notation necessary for option modeling and a corresponding extension of the format e3-value ontology. Finally, we illustrate in a case study how the proposed extensions can support options reasoning and also serve as a basis for the correct financial analysis of a business model.

1. Introduction

A business model can be defined as “the representation of a firm’s underlying core logic and strategic choices for creating and capturing value within a value network” [29]. In recent years, interest in the business model concept has surged [28, 35]. The business model is seen as a key determinant of a firm’s ability to create value [6] and there is widespread agreement regarding the business model’s importance to a firm’s success. At the same time, the business model concept has been criticized for being “fuzzy and vague” [1], and scholars do not have a common understanding of the concept [35]. Nevertheless, the importance of its financial dimension is widely acknowledged [1, 21, 35].

The financial analysis of a business model generally refers to the analysis of revenue streams and cost structures [35], with the ultimate goal being to design a business model which yields a positive net present value [36]. Such a valuation based on expected revenue and cost streams determines the value of an ‘as is’ business model. It is performed under the implicit assumption that a business model is static during its lifetime and does not possess the flexibility to be altered.

However, business models are not typically doomed to remain as they are; rather, they may contain a variety of options to be changed or extended [20]. Options, for example, may exist to increase sales through additional distribution channels or target markets. Likewise, the option to introduce complementary products or services is often present. For example, the initial implementation of an Internet portal could allow the range of offered e-services to be expanded [4]. Further elements of a business model may be seen as optional in that they may be exchanged in favor of others or abandoned completely. In analogy to financial options, all such options are called real options. They are defined as “the right, but not the obligation, to take an action (e.g., deferring, expanding, contracting, or abandoning) at a predetermined cost” [8].

If an investment opportunity includes real options, it is essential to consider their value. Valuing an investment without considering the inherent option value always leads to an undervaluation [5, 8, 31] and thereby potentially to shortsighted decisions and underinvestment [31] – worthwhile business opportunities may be rejected. Consequently, when determining the financial viability of a business model which contains real options, it is necessary to explicitly consider the value of these options.

In reality, business models are too complex to be dealt with without abstractions. Thus, working with a business model actually means working with “a model of the business model”: a representation of it [6]. Such a business model representation (BMR) can be a mixture of textual and graphical elements, or any rather formalized ontology which aims at representing a business model [35]. A BMR is used, for example, to im-
prove the understanding, communication, and analysis of a business model's underlying logic [17]. It may also facilitate business model innovation by enabling experimentation [9] and can be utilized as the basis for defining requirements to the underlying information systems [11]. For these purposes, a large number of approaches are available (e.g., [7, 12, 16, 17, 24]).

Of the available BMRs, none does explicitly cover the options which a business model may contain. Options are not considered at a qualitative level, i.e., no appropriate modeling constructs are available to represent optional elements of a business model (research issue 1). Because they cannot be modeled qualitatively, options cannot be seamlessly incorporated into subsequent quantitative analysis either (research issue 2) – even though the instruments needed to value options are readily available in finance theory. Hence, no currently available BMR supports options reasoning and, in the presence of real options, none provides a basis for the correct financial analysis of a business model.

To establish a link between real options and BMRs, our contributions focus on research issue 1 and are at two levels: at a ‘macro-level’, we combine BMRs with the theory of real options from finance by introducing qualitatively the notion of optionality, or options reasoning, into the domain of BMRs. At a ‘micro-level’, we extend one specific BMR to enable it for handling real options. Based on a literature review, we identify e3-value [12] as the most suitable among the currently available BMRs to support option valuation. We extend this representation in two ways: First, we develop a graphical notation for modeling options. Second, we provide a formal integration of this notation into the e3-value ontology. The proposed extensions support options reasoning and also serve as a basis for the correct analysis of a business model’s financial viability. Using a case study, we illustrate how the extended notation can be applied and how explicitly considering options can affect the financial analysis of a business model.

2. Business model representations

The literature on business models has become extremely comprehensive [35], but no common understanding of the business model concept has emerged so far [1, 35]. This lack of common understanding, naturally, also extends to the approaches to represent business models. Given this ambiguity – in order not to unnecessarily exclude representational approaches – we adopt a wide understanding of a BMR: Every BMR which (I) allows representing the model of a specific business, and (II) provides a graphical representation qualifies as a BMR in terms of this research.

To identify available representations in the literature, in addition to keyword search, we followed a structured approach as recommended by Webster et al. [32]: We used recent reviews of the business model literature ([1, 14, 35]) and as a first step selected the articles on BMRs mentioned there. Taking the corresponding articles as a starting point, we went backward by reviewing the sources they mention and forward by reviewing the articles which cite the representations identified in the previous steps. We restricted ourselves to BMRs which have been treated in a non-marginal way in a book or peer-reviewed journal article. Altogether, this yielded 12 approaches (see table 1).

<table>
<thead>
<tr>
<th>Business model representation</th>
<th>Domain of origin</th>
<th>Main concepts</th>
<th>Main scope</th>
<th>Design tool / financial tool</th>
<th>Options considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity system map* [23]</td>
<td>Strategy</td>
<td>Strategic theme, activity</td>
<td>General</td>
<td>No / No</td>
<td>No</td>
</tr>
<tr>
<td>Business models for e-government (BMeG) [22]</td>
<td>E-business</td>
<td>Partner, object ex-change, (dis)advantage</td>
<td>E-government</td>
<td>Yes / No</td>
<td>No</td>
</tr>
<tr>
<td>Business model ontology (BMO) [17]</td>
<td>E-business</td>
<td>Interrelated building blocks</td>
<td>General</td>
<td>Yes / No</td>
<td>No</td>
</tr>
<tr>
<td>Causal loop diagram [7]</td>
<td>Causality theory</td>
<td>Choice, consequence</td>
<td>General</td>
<td>No / No</td>
<td>No</td>
</tr>
<tr>
<td>e3-value [12]</td>
<td>E-business</td>
<td>Actor, value exchange</td>
<td>General</td>
<td>Yes / Yes</td>
<td>No</td>
</tr>
<tr>
<td>E-business model schematics [33]</td>
<td>E-business</td>
<td>Actor, flow, relation</td>
<td>E-business</td>
<td>No / No</td>
<td>No</td>
</tr>
<tr>
<td>Eriksson-Penker business extensions of the Unified Modeling Language [11]</td>
<td>Information systems</td>
<td>Actor, interaction, goal, rule</td>
<td>General</td>
<td>Yes / No</td>
<td>No</td>
</tr>
<tr>
<td>Resource-event-agent* (REA) [16]</td>
<td>Accounting</td>
<td>Resource, event, agent</td>
<td>General</td>
<td>Yes / No</td>
<td>No</td>
</tr>
<tr>
<td>Strategic business model ontology (SBMO) [27]</td>
<td>E-business</td>
<td>Actor, goal</td>
<td>General</td>
<td>Yes / No</td>
<td>No</td>
</tr>
<tr>
<td>Value map [2], [30]</td>
<td>Value networks</td>
<td>Actor, value exchange</td>
<td>General</td>
<td>No / No</td>
<td>No</td>
</tr>
<tr>
<td>Value net* [19]</td>
<td>Value networks</td>
<td>Actor, activity, flow</td>
<td>General</td>
<td>No / No</td>
<td>No</td>
</tr>
<tr>
<td>Value stream map [24]</td>
<td>Value networks</td>
<td>Actor, value stream</td>
<td>ICT</td>
<td>No / No</td>
<td>No</td>
</tr>
</tbody>
</table>

* = the contributing author makes no explicit reference to the term “business model”: These approaches had been developed before the business model concept gained prominence. Nonetheless, they are listed because of their conceptual similarity to later approaches which are explicitly intended to represent business models.
The identified BMRs originate from a wide range of domains. They make use of various conceptual approaches, and to some extent convey a different understanding of the business model concept. Also, the employed terminology is rather inconsistent. These representations have (with differences in scope), for example, been referred to as “business model representations” [6, 35], “business model ontology” [17], methods for “business modeling” [11, 22], and “conceptual models” [21]. In some instances, there is also confusion about whether a BMR only refers to the representation of a specific business [6], or whether BMRs also comprise representations of conceptual business model aspects. Following this second notion, for example, Zott et al. [35] categorize their visualization of value driver interactions in [3] as a BMR – even though that visualization is not capable of representing the model of a specific business. Another source of confusion is the fuzziness of the business model concept itself, for example, towards the concepts of strategy and value networks. This conceptual fuzziness inhibits the identification of representations which are rooted in other literature streams, but which may still qualify as a BMR. For example, the “activity system map” [23] is an approach to visualize strategies, which is rooted in the strategy literature and does not make explicit reference to business models. However, it has been noted that activity system maps and business models are very similar and that “it is not clear how Porter’s conceptualization of strategy differs from what others call business models” [28].

Of the identified representations, none explicitly considers real options as they are defined above. The term “option” is only used in [22], but with a different meaning. Thus, to be able to represent a business model including the embedded options, each of the representations would need to be extended – which leads to the question of which representation is most suitable for handling options.

As the ultimate goal is to have a representation which combines the design of a business model with a correct financial analysis, a representation which already provides tool support (I) for design, and (II) for financial assessment of a business model without options seems best suited. Half of the identified representations come merely as conceptual tools. They define a number of main concepts and provide a corresponding graphical notation. For BMcG, BMO, e3-value, REA, SBMO, and Eriksson-Penker business extensions, there are also software tools available which support the design and change of a business model. e3-value, however, is the only representation that provides a software tool which integrates the design and the financial evaluation (using capital budgeting techniques) of a business model. Thus, this representation seems best suited for an option-based extension.

3. Case study

The following case study is based on a case by Copeland et al. [8] which analyzes the business idea of a French Internet portal. While keeping all the figures, the case study was conceptually simplified and slightly adapted.

The business idea of the Internet portal is to sell the recovery software Recover to business clients and provide the corresponding support services so that customers have instant expert help if needed. The software is developed by a US-based software manufacturer and in France is to be sold exclusively by the Internet portal. After-sales support for Recover is provided by a local software service provider.

The Internet portal expects to sell 200 licenses of Recover in the first year and to double sales by year 6. The unit price is expected to initially be $30,000, but to decline to $20,000 due to competition. The continuing value of the business after the first six years is $44.748 million (based on an expected growth rate of the cash flows of 3% and capital costs of 12% after year 6). The initial investment for starting the business amounts to $35 million. Capital costs and risk-free rate for the six-year period are estimated to be 13.88% and 5.13%, respectively. The volatility of the rate of return is 30%. Further details concerning the expected cash flows for Recover are summarized in table 2.

There is also a second product, the back-up software PreventLoss, whose functionality is complementary with that of Recover. Because of this complementarity, it is assumed that many customers of Recover will also buy PreventLoss. The cash flows of PreventLoss are expected to amount to 30% of Recover’s cash flows; its introduction requires an additional investment of $10.5m. The introduction of PreventLoss can take place immediately or at any time after the introduction of Recover. Thus, the Internet portal can

### Table 2. Summary of financial parameters of Recover

<table>
<thead>
<tr>
<th>Item</th>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (# licenses)</td>
<td>200</td>
<td>230</td>
<td>264</td>
<td>303</td>
<td>348</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Price/license ($)</td>
<td>30,000</td>
<td>27,660</td>
<td>25,510</td>
<td>23,520</td>
<td>21,690</td>
<td>20,000</td>
<td></td>
</tr>
<tr>
<td>Cost/license ($)</td>
<td>9,000</td>
<td>8,600</td>
<td>8,100</td>
<td>7,700</td>
<td>7,400</td>
<td>7,000</td>
<td></td>
</tr>
<tr>
<td>Cost for support services/license ($)</td>
<td>4,000</td>
<td>3,726</td>
<td>3,625</td>
<td>3,502</td>
<td>3,359</td>
<td>3,200</td>
<td></td>
</tr>
<tr>
<td>Initial investment ($)</td>
<td>35,000,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuing value ($)</td>
<td>44,748,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
defer the introduction until some experience with Recover has been gained and thereby some uncertainty regarding the market success of PreventLoss has been resolved. In the following section, the main concepts of e3-value are introduced using this case study.

4. e3-value methodology

The e3-value methodology was initially developed to help in the design and evaluation of e-commerce businesses, but it has also been applied in a variety of other domains such as telecommunications, banking, energy, or entertainment [13]. Designing an e3-value model starts with identifying the involved actors and the value exchanges which occur among these actors. These value exchanges are subsequently valued financially to understand which economic performance each actor in the network is likely to have. The main concepts of e3-value are the following [12] (see also figure 1):

- **Actors** are the partners who work together within the business model (e.g., the Internet portal and the software service provider). Actors are represented by rectangles. If they have common characteristics regarding their value exchanges and the value they assign to value objects, they are grouped in market segments (represented by a stack of actors).

- **Value objects** are the objects which are exchanged by the actors (e.g., Recover and support services). They are shown as text next to the value exchanges.

- **Value ports** are the means by which actors show the environment that they offer or request certain value objects. In and outgoing value ports which belong together are grouped in value interfaces. The respective value objects (in and outgoing) have to be exchanged simultaneously, because an actor always wants to have something in return for the value objects offered.

- **Value exchanges** connect value ports of different actors, thereby showing that these actors would like to exchange value objects.

These main concepts and their relations are part of an ontology, which has been formalized in the Unified Modeling Language (UML) [12]. This ontology also contains the activities which are performed by actors. For simplicity, these activities are left out of the model here (as, e.g., in [13]).

The semantics of an e3-value model are further refined by concepts which are not part of the formal ontology. Whereas value exchanges are dependencies among actors (or inter-actor dependencies), dependency elements represent dependencies within actors (or intra-actor dependencies). They can be split (joined) by OR (AND) connection elements [13]. They illustrate which ingoing value objects are needed to produce certain outgoing value objects. The specific need of a customer or a market segment is represented by a start stimulus. Scenario paths, starting from a start stimulus, comprise all value exchanges which are necessary to fulfill a customer need. A stop stimulus (or several stop stimuli) marks the end of such a scenario path.

Profitability analysis in e3-value is first of all based on profitability sheets which the e3-value software tool can automatically generate. Profitability sheets show the number of incoming and outgoing value objects and their value. The sum of in and outflows for a given actor determines its cash flow in a given period and provides a first impression of the economic attractiveness of a business model (see figure 2). This initial assessment can be complemented by a multi-period view in which a series of cash flows is evaluated to determine their present value [34]. This multi-period view is also supported by the e3-value software tool.

The calculations of the net present values of Recover and PreventLoss are summarized in table 3. The net present value of Recover is 8-312,411. Hence, with Recover alone, the business model is not viable from a financial perspective. However, there is also the second product which could be introduced, but considering PreventLoss, the situation becomes even worse. The net present value of PreventLoss is 8-93,723, leading to a net present value of 8-406,134 for the two products combined.

Given these calculations, the business model appears not to be financially viable. However, the implicit assumption behind the calculations is that either only Recover or both products are introduced immediate-

![Figure 1. e3-value model of the Internet portal](image)
ly. In contrast, for the introduction of PreventLoss there is not only the choice between an immediate introduction and no introduction at all. PreventLoss’ introduction can also be deferred so that it is only introduced if there are enough customers of Recover to make the PreventLoss introduction profitable. If demand for Recover remains low, there is no need to (unprofitably) introduce PreventLoss and incur the initial investment of $10.5m.

The fact, however, that the introduction of PreventLoss can be deferred, cannot be accounted for in the profitability analysis currently incorporated into e3-value. This is because that analysis to date is solely based on net present values and does not support the valuation of real options. Also, the optional character of PreventLoss to date cannot be modeled graphically. So far some ad hoc notation denoting optionality or separate diagrams (called evolutionary scenarios [12]) would have to be used – bringing along potential problems with regards to consistency and clarity of a model. Therefore, in the following, we develop the extensions needed to appropriately model optionality in e3-value models.

### 5. Real options

Real option theory, based upon financial option pricing theory, seeks to determine the value of options on real assets. The following types of simple options can be distinguished [8]:

- **Abandonment option:** the right to stop a project in exchange for its salvage value
- **Contraction option:** the right to sell out a certain share of a project for a salvage value
- **Deferral option:** the right to postpone an investment to a later point in time
- **Expansion option:** the right to increase the project value for a fixed price
- **Extension option:** the right to extend the lifetime of a project for a fixed price

The abandonment and contraction options are analogous to financial put options, because they confer the right to sell certain goods. The other three types of options are analogous to call options. All these types of options can either belong to the class of European options (which can only be exercised at maturity) or American options (which can be exercised at or before maturity).

For the valuation of real options, the most common approaches are binomial trees and closed-form solutions based on partial differential equations. The binomial valuation is more intuitive than closed-form valuations and does not necessitate their complex mathematics [8]. Therefore, it is employed in the following as originally developed in [10] and refined for handling irregular cash flow patterns in [8]. Rather than to elaborate on the theoretical details of the valuation, our aim in the following is to illustrate how optionality can be integrated into a BMR and how the consideration of options can affect the estimated financial viability of a business model. Comprehensive overviews of real option valuation have, for example, been provided by Copeland et al. [8] (with a rather practical focus) and Trigeorgis [31] (with a rather technical focus).
6. Options in e3-value

6.1. Development of option-based extensions

To introduce options into e3-value, the following questions have to be answered: Which option types can in principle be modeled in e3-value? Which requirements does the graphical notation have to fulfill? Which modeling constructs are affected by the introduction of options? How can options be represented graphically? And finally, how is the formal relationship between the new constructs and existing ones? These questions will each be addressed in turn.

An e3-value model represents structural aspects of a business model. It does not make statements concerning the timing of the underlying processes or of the overall business model. Though timely aspects are incorporated into the financial analysis, the respective information is not represented in the graphical model or the formal ontology. Thus, only those option types can be modeled whose exercise can affect the structure of a business model. These option types are the option to abandon, to defer, to contract, and to expand. Each of them is either capable of adding or removing elements of the e3-value model or of changing the underlying quantities. The option to extend cannot be modeled in the e3-value context because its exercise affects only the time frame of a business model and not its structure.

Requirements for a suitable graphical notation can be derived (I) from the desirable compatibility with the e3-value software tool, and (II) from general best-practices for graphical modeling. One advantage of e3-value is that the design of a business model is facilitated by a corresponding tool. Thus, the extended notation should be representable with that tool. This may be achieved through the functionality to adapt original notation elements (as implemented in the latest version 3.48). Furthermore, the extended notation should comply with “good notation principles” [26]. These, among others, demand a graphical notation to have a clear mapping of concepts to symbols, be consistent with past practice, and without overloading of symbols.

The affected modeling constructs, above all, are value exchanges and actors. Options affect value exchanges, because option exercise can add or remove value exchanges in an e3-value model. Options can also affect actors, because option exercise can include new actors into the e3-value model or exclude current ones.

The exercise of call-like options (deferral and expansion option) can add additional value exchanges to the e3-value model. Because these optional value exchanges may be added at some time in the future – when a given option is exercised – we term them optional (future) value exchanges (represented by a dotted line). The exercise of call-like options can also add additional actors to the e3-value model if these have previously had no connection to other actors except for optional (future) value exchanges. In such a case, an actor constitutes an optional (future) actor (represented by a dotted line rectangle), because it is only part of the e3-value model if an option is exercised at some time in the future.

Conversely, put-like options (abandonment and contraction option) can remove value exchanges and actors from an e3-value model. Because the value exchanges affected by such an option already exist, they constitute optional (existing) value exchanges (represented by a dashed line). They are part of an e3-value model until the corresponding put-like option is exercised. If an existing actor is only connected to the remaining model via optional (existing) value exchanges, the exercise of the corresponding put-like options can remove this actor from the e3-value model – the actor will have no connection to the e3-value model any more. Such an actor is termed an optional (existing) actor (represented by a dashed line actor).

Finally, it is important to indicate the owner and reach of an option as well as its maturity. An owner has to be indicated, because otherwise it would be implicitly stated that any actor who has access to a certain optional value exchange...
has the right to exercise the corresponding option. However, by definition, an option confers an exercise right just to the owner. Thus, option ownership has to be exclusive. An option value interface (represented by a shaded value interface) for each option highlights the actor who can take action and exercise the option.

The reach of an option refers to the question of which value exchanges belong to a specific option/option value interface. The reach is determined by the corresponding scenario path: an option comprises all optional value exchanges which are within the same scenario path as the corresponding option value interface. The argument is as follows. In e3-value, different scenario paths are assumed to be independent in the sense that value exchanges in two separate scenario paths do not affect each other. A value object can only be transferred via value exchanges which belong to the same scenario path. Thus, the exercise of an option cannot affect value exchanges which belong to a different scenario path. In contrast, the exercise of an option can potentially affect all value exchanges on the same scenario path. For example, if an abandonment option for an optional (existing) value exchange is exercised, previous and subsequent value exchanges may become infeasible. Therefore, an option has to comprise all optional value exchanges which are within the same scenario path as the corresponding option value interface.

Concerning option maturity, it is important to recall that e3-value does not incorporate timely aspects into the graphical model. However, option maturity is crucial information which has to be represented in an e3-value model to fully allow an option’s significance to be judged. To remain in line with the current approach of e3-value, but at the same time not losing information on maturity, for the time being we suggest annotating the option interface with a comment. There, information on maturity and further information deemed necessary by the modeler can be documented.

The graphical notation of the optionality constructs is summarized in figure 3. It is representable in the e3-value software tool and complies with the good notation principles. Thus, the two requirements outlined above are fulfilled. Examples for modeling the various option types are given in figure 4. There, an American abandonment option with a 2-year maturity is owned by a supplier who can discontinue manufacturing a product. This is modeled by optional (existing) value exchanges. Because the customer has no other value exchanges but these optional ones, upon option exercise the customer would not have any value exchanges at all, and thus is modeled as an optional (existing) actor here (the supplier is assumed to also have other value exchanges which are not shown). The comment note indicates that the option is American (Am.) and has a 2-year maturity (2 yr.). Regarding the deferral option, the supplier could introduce a product at a later point in time. This is modeled by optional (future) value exchanges. Because the customer has no value exchanges except for the optional ones, i.e., currently is not part of the e3-value model, the customer is modeled as an optional (future) actor here (again, the supplier is assumed to have other value exchanges). The comment note indicates that the option is European (Eu.) and has a 2-year maturity. For the contraction and expansion options, an analogous logic applies. One difference is, however, that these option types are always related to a non-optional value exchange because they contract or expand quantities relative to the quantity of another, non-optional value exchange.

The formal integration of the additional constructs into the e3-value ontology is realized through additional subclasses of the original classes value interface, elementary actor, and value exchange (see figure 5). Also, a new class option was introduced, which ensures consistency of the additional constructs. For instance, it ensures that each option has either optional (existing) or optional (future) value exchanges, but not both types at the same time. This is necessary, because it would be meaningless to have, for example, a sce-
nario path which consists of successive optional (future) and optional (existing) value exchanges.

The class option also ensures that every option has exactly one optional value interface and, thus, is only owned by one actor. It also ensures that every optional value exchange is unambiguously linked to one option value interface and, therefore, can only be invoked by one actor. This last aspect could also have been achieved differently, for instance, through the addition of optional subclasses of the original classes value offering and value port. The latter design choice, however, would have come at the cost of a substantially more comprehensive UML class diagram.

6.2. Application of option-based extensions

With the extended notation it is now possible to correctly model the deferral option character of PreventLoss (see figure 6). Beginning with the start stimulus in the customer market segment, optional (future) value exchanges between the customers and the Internet portal as well as between the Internet portal and the software manufacturer represent the deferral option. They correctly model that the value exchanges related to PreventLoss may come into existence at some time in the future – and do not necessarily have to exist already. The option value interface of the Internet portal shows that it is the portal that has the discretion over the introduction of PreventLoss.

To analyze the impact of considering the PreventLoss deferral option on the financial evaluation, we use the binomial method. The initial value, $34.688m, is the present value of Recover; the time step $\Delta t$ is one year. The up factor $u$ is $\exp(\sigma \sqrt{\Delta t}) \approx 1.35$; the down factor $d$ is given by $1/u \approx 0.74$. The risk-neutral probability $p$ is calculated from $1/(u+d)$, which amounts to $0.51$. The relevant parameters are summarized in table 4. The resulting binomial tree is shown in figure 5, further computational details are provided in [8].

The payout ratio of the cash flows in each period is calculated as the ratio of the expected cash flow in a given period (see table 3) and the corresponding expected present value before payout. For example, the payout ratio in year 1 is given by $3.400/39.502 \approx 8.6\%$. The pre-payout present values in a given node are calculated from the pre-payout present value of the previous period, which is adjusted for payout and then multiplied by the corresponding up/down factor. For example, the upper node of year 2 is calculated from $39.502 \times (1-0.086) \times 1.35 \approx 48.733m$. The other node values are determined accordingly. In the best case, the resulting project value before the last cash flow is paid out in year 6 amounts to $113.880m$. In the worst case, the project value may go down as far as $5.670m$.

The deferral option in each period provides the right to introduce PreventLoss, which yields cash flows amounting to 30% of the Recover cash flows in exchange for a fixed cost of $10.5m. Therefore, the exercise of the option is only worthwhile in those nodes where 30% of the present value of Recover exceed the fixed cost. Checking this condition in every node, the value of Recover including the option on PreventLoss is determined backwards, whereby subsequent nodes are weighted using the risk-neutral probability.

When considering the optional character of the PreventLoss introduction, the resulting present value is $36.245m$. This present value exceeds the initial investment of $35m by $1.245m, thereby making the overall investment worthwhile. Recall that, by contrast, both the business model of Recover alone as well as the business model of the simultaneous introduction of Recover/PreventLoss had been found not to be financially viable and, thus, would have been rejected.

7. Discussion & conclusion

Current approaches for BMR do not consider the options which a business model may contain. This substantially inhibits the qualitative consideration of options in business model design and also their integration into subsequent financial analysis. In this research, we are the first to establish a link between options and BMRs by extending the e3-value BMR. We discussed why abandonment, contraction, deferral and expan-
The formal extension of the ontology ensures the unambiguousness of the notational extensions. Whereas the graphical extensions can already be modeled with the current version of the e3-value software tool, the valuation of options, naturally, is not possible yet. As formalization is a prerequisite for tool support, our formal extension can serve as a first step for an option-based extension of the e3-value software tool. Such an extension would provide a tool that integrates the design of the qualitative logic of a business model with the analysis of its financial logic, while covering static as well as optional aspects of a business model. To develop such an integrated tool denotes a long-term goal in this area of research.

To achieve this goal, a few limitations have to be addressed. The binomial valuation, which was chosen to illustrate the effect of considering options, comes with some limitations. These include, for example, the underlying assumptions and the difficulty of generating the necessary input data [5]. To make the extensions more useful for practitioners, more appropriate valuation methods have to be identified. There are a number of approaches available to simplify real option valuation. These include, for example, heuristics such as that proposed by Luehrman [15]. Also, approaches based on decision trees can be employed in a manner which is easier to apply than options valuation, but still correct in the treatment of discount rates [25]. Having introduced real options into the domain of BMRs for the first time, it remains to be investigated which options are the ones that will typically be modeled within e3-value and which valuation method best lends itself to their valuation. These two aspects will be the focus of our future research efforts in this area.

There are also some limitations concerning the extended notation. These stem from the focus on actors (and the exclusion of their activities) and the focus on simple options (as defined by Copeland et al. [8], this excludes switching and compound options). Also, timely aspects (e.g., maturities), so far, are only considered informally because the formal e3-value ontology focuses on structural aspects of a business model. A time-based extension of the formal ontology, by explicating assumptions concerning time structures, could improve handling time characteristics of options and also prove worthwhile for exploring the evolution, or dynamics, of a business model. A highly relevant question in this context is how the analysis of options and their exercise can contribute to the understanding of how companies’ business models evolve over time. Hence, how option-extended BMRs can be linked to the broader research on business model evolution should be explored.

### Table 5. Binomial valuation of the case study

<table>
<thead>
<tr>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>8.6%</td>
<td>8.6%</td>
<td>8.5%</td>
<td>8.3%</td>
<td>8.2%</td>
<td>8.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Present value tree of Recover ($ in millions, before payout)</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.688</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Present value tree of Recover including the option on PreventLoss ($ in millions, before payout, * = option is exercised)</th>
</tr>
</thead>
<tbody>
<tr>
<td>36.245</td>
</tr>
</tbody>
</table>

The notational extensions of e3-value are of immediate usefulness for practitioners who are occupied with designing and analyzing business models. The extensions allow optional and non-optional business model aspects to be represented within one e3-value model, and thereby improve the practicability of e3-value. With these extensions, it is no longer necessary to rely on separate diagrams or ad-hoc notation for optional business model aspects. Also, having a notation for optionality readily available can spur creativity with regards to contemplating which previously considered aspects of a business model are optional (i.e., their realization does not need to be decided on immediately), and which additional options are opened up by a specific business model. Furthermore, explicating the available options is a prerequisite for evaluating them. Therefore, the extended notation can serve as a basis for the correct financial analysis of a business model.

As formalization is a prerequisite for tool support, our formal extension can serve as a first step for an option-based extension of the e3-value software tool. Such an extension would provide a tool that integrates the design of the qualitative logic of a business model with the analysis of its financial logic, while covering static as well as optional aspects of a business model. To develop such an integrated tool denotes a long-term goal in this area of research.

The binomial valuation, which was chosen to illustrate the effect of considering options, comes with some limitations. These include, for example, the underlying assumptions and the difficulty of generating the necessary input data [5]. To make the extensions more useful for practitioners, more appropriate valuation methods have to be identified. There are a number of approaches available to simplify real option valuation. These include, for example, heuristics such as that proposed by Luehrman [15]. Also, approaches based on decision trees can be employed in a manner which is easier to apply than options valuation, but still correct in the treatment of discount rates [25]. Having introduced real options into the domain of BMRs for the first time, it remains to be investigated which options are the ones that will typically be modeled within e3-value and which valuation method best lends itself to their valuation. These two aspects will be the focus of our future research efforts in this area.

There are also some limitations concerning the extended notation. These stem from the focus on actors (and the exclusion of their activities) and the focus on simple options (as defined by Copeland et al. [8], this excludes switching and compound options). Also, timely aspects (e.g., maturities), so far, are only considered informally because the formal e3-value ontology focuses on structural aspects of a business model. A time-based extension of the formal ontology, by explicating assumptions concerning time structures, could improve handling time characteristics of options and also prove worthwhile for exploring the evolution, or dynamics, of a business model. A highly relevant question in this context is how the analysis of options and their exercise can contribute to the understanding of how companies’ business models evolve over time. Hence, how option-extended BMRs can be linked to the broader research on business model evolution should be explored.
8. References


