Original Article

Practical approaches to early stage life sciences technology valuations

Received (in revised form): 29th September 2009

Stephen Mayhew
is a Manager in the Consulting Practice at Kinapse Ltd. Stephen has over 10 years' experience in life sciences organisations, focusing extensively on valuation, deal-making and asset and portfolio management within the pharmaceutical and biotechnology industries. Stephen holds a BSc with first class honours in biochemistry from the University of Liverpool, a PhD in biochemistry from the University of Leeds and an MBA with distinction from Imperial College Business School.

ABSTRACT With fierce competition in the market for late stage life sciences assets, pharmaceutical companies seeking partnering strategies to bolster pipelines and drive long-term revenues are increasingly looking towards earlier stage compounds and technologies. Valuations are essential components of effective partnering transactions in the life sciences industry, however owing to the perceived uncertainty and risk associated with early stage life sciences technology, early stage valuations are a contentious area of valuation practice. Meaningful early stage valuations require new approaches that integrate complementary evaluation practices to build more widely accepted, balanced and transparent valuation outputs that facilitate productive and mutually beneficial transactions and form the basis for successful long-term partnerships. This article outlines a series of practical steps that encourage the use of encompassing approaches that blend complementary qualitative and quantitative techniques to build realistic and widely accepted early stage valuations. The methodology promotes rigorous interrogation of early stage life sciences technology to identify and characterise key value drivers, and advocates the development and simulation of robust practical scenarios to generate meaningful valuation outputs with practical relevance.
Journal of Commercial Biotechnology (2010) **16,** 120–134. doi:10.1057/jcb.2009.31; published online 3 November 2009

Keywords: life sciences valuation; early stage valuation; practical valuation approaches

VALUATIONS ARE ESSENTIAL COMPONENTS OF EFFECTIVE TRANSACTIONS IN THE LIFE SCIENCES INDUSTRY

As the life sciences industry responds to market pressures, declining productivity, increasing regulatory burdens, looming patent expiries and generic competition, industry leaders are increasingly seeking externally oriented strategies to augment pipelines, secure finance, expand portfolios and drive long-term revenues. As a consequence, accurate valuation of life sciences assets is of fundamental importance for managerial decision making in areas including licensing, mergers and acquisitions,

Correspondence: Stephen Mayhew
Kinapse Limited, Tuition House, 27-37 St. George's Road, Wimbledon, London SW19 4EU, UK
E-mail: stephen.mayhew@kinapse.com

Box 1: Life sciences assets

The portfolio theory of the firm – often known as the sum-of-the-parts approach – proposes that the value of a business or firm is defined by the value of the collection of individual assets owned by the firm. Within the life sciences industry, many different types of assets contribute to the value of businesses, firms and individual projects, and therefore to the value of the industry as a whole. Life sciences assets include tangibles such as land, buildings, equipment, workforce, products/technology platforms and customers, and intangibles such as patents, brands, knowledge, reputation, information and processes.
Intangibles such as thought capital and intellectual property (IP), are invariably linked to defined product opportunities such as R&D projects or marketed drugs and typically represent the key platforms for value generation in the industry. Pharmaceutical and biotechnology products are generally patented at an early stage of the R&D process, which entitles the patent holder to a period of market exclusivity following drug approval. This allows the opportunity for profitability through premium pricing strategies, and provides the incentive for firms to commit to the significant and high-risk investment of developing a new drug. However, the uncertainty involved in R&D makes valuation of life sciences IP inherently difficult, which presents unique challenges for valuation of businesses, firms and individual assets within the industry.
In general, IP must possess three attributes in order to be capable of valuation:

(i) *Separability* – the IP must conceptually be a stand-alone asset capable of being transferred to third parties without disposing of the business.
(ii) *Protectability* – there must be a legal capacity to transfer interest in the asset.
(iii) *Longevity* – the IP must represent a medium- or long-term capital asset in its own right.

Nonetheless, even in instances where these attributes are apparent, valuation of IP is a contentious topic. Common practical difficulties associated with IP valuation arise from different perceptions of necessity, commercial applicability and useful lifetime of IP assets, while there is a relative dearth of publicly available information relating to royalty-rates and licensing terms for transactions involving IP-based assets.

R&D resourcing, financial investment and stock-floatation.

However, life sciences valuation is often considered a somewhat esoteric concept. Traditional valuation methods are generally considered to have limited applicability in the life sciences industry owing to the inherent uncertainty associated with lengthy product development cycles, high failure-rates and undefined product/market profiles of life sciences assets. Furthermore, virtual 'new-economy' firms with minimal infrastructure and which rely largely on external service providers are increasingly common to the industry. Many such firms do not have marketed products, and as a consequence their value is almost exclusively based upon R&D assets (see Box 1 for an overview of life science assets). Nonetheless, numerous valuation techniques have been specifically developed to account for the inherent uncertainty within the life sciences industry and are finding increased utility, particularly for late stage assets where the key parameters governing anticipated cash flows – such as time to market launch, probability of regulatory approval and product sales forecasts – can be estimated with reasonable accuracy.

EARLY STAGE VALUATIONS ARE AN IMPORTANT – YET CONTENTIOUS – AREA OF VALUATION PRACTICE

With fierce competition in the market for late stage life sciences assets, pharmaceutical companies seeking to access new and promising compounds and technologies are increasingly looking towards earlier stage opportunities. Early stage partnering has become an important component of life sciences business strategy, as evidenced by the significant proportion of early stage deals across the industry in recent years (Figure 1).

Despite the high proportion of early stage transactions across the industry, valuation of early stage life sciences technology remains a highly contentious topic among life sciences professionals. A commonly cited reason for this contention is that the high degree of uncertainty and risk relating to the necessity, commercial applicability and useful lifetime of early stage technology (such as preclinical and early clinical phase R&D projects) invariably leads to differing perceptions – and hence lack of agreement – about early stage valuations. As a consequence, the practice of early stage

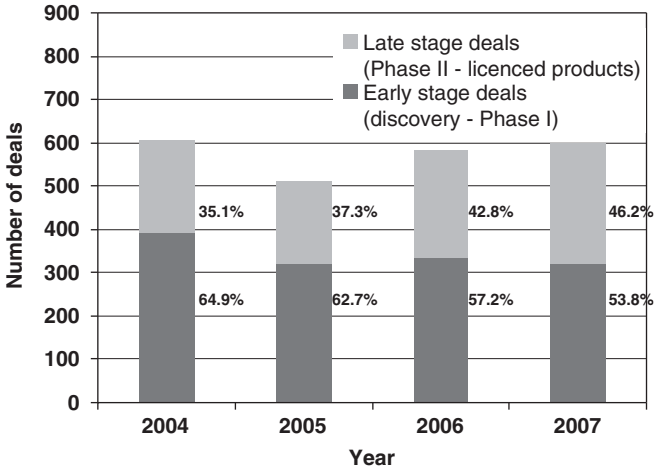

Figure 1: Number of partnership deals by stage.
Source: Windhover, Burrill & Company.[1]

valuation is viewed by many as indeterminably vague, imprecise and often meaningless.

However, many valuation methodologies exist that can account for both uncertainty and risk (see Box 2 for a summary of life sciences valuation techniques). Furthermore, research into the valuation practices employed among life sciences valuation professionals from across the industry suggests that much of the contention surrounding early stage valuations arises from neither uncertainty nor risk *per se*, but from the commonly held view of the practice of valuation as a narrow, highly quantitative set of defined techniques and methodologies which rely on numerous, well-defined assumptions in order to generate precise value outputs. Such a narrow perspective of valuation as a tool invariably places significant emphasis on the precision of the valuation output, which is exquisitely dependent upon the assumptions that are used in the valuation process. In many cases it is the inability to reconcile differing perceptions surrounding the assumptions used in early stage valuations that leads to contention over the resulting disparate valuation outputs. In order to avoid this contention and conduct more meaningful early stage valuations, new approaches towards valuation are required.

MEANINGFUL EARLY STAGE VALUATIONS REQUIRE ENCOMPASSING APPROACHES TOWARDS VALUATION

Much of the contention surrounding early stage valuations can be minimised – and even avoided – by adopting more holistic perspectives in which valuation is considered not just as a narrow, highly quantitative process, but as a broader more encompassing framework. While the selection of the appropriate valuation methodologies is undoubtedly an integral component of a rigorous valuation approach, over-reliance on narrow quantitative techniques that yield discrete and seemingly impossibly precise outputs invariably results in valuations being met with scepticism. Repositioning the view of valuation as a broad and encompassing framework is an effective approach to deriving meaningful valuations of early stage life sciences technology. Such an approach expands the perspective of valuation by utilising a framework that incorporates a range of qualitative and quantitative evaluation practices to generate balanced and more widely accepted early stage valuations.

Box 2: Life sciences valuation techniques

The objectives of most asset valuation techniques are to identify and quantify the value of incremental cash flows attributable to a given asset, and to capitalise these cash flows at an appropriate discount rate. Numerous asset valuation techniques ranging from simple market comparables to more complex economic profit-based approaches have been specifically developed to account for the inherent uncertainty within the life sciences industry, and are finding increased utility.
In broad terms, life sciences asset valuation techniques can be grouped into cost-based, market-based, income-based and option-based methods. Each approach has advantages and drawbacks, and it is therefore important that the method(s) chosen for any given valuation is appropriate for the specific purpose. Central to the applicability of any valuation output are the valuation input parameters used, and the importance of selecting appropriate and relevant parameters values cannot be overstated.

Cost-based methods: These valuation methods focus on the costs associated with developing or acquiring an asset and are based on the premise that an investor would pay no more for an asset than the amount necessary to reproduce it. Cost-based methods are typically backward-looking and do not account for future benefits that may be derived. Such methods are predominantly restricted to use in valuations for accounting purposes and are commonly known as book values.
The relevant valuation parameters for cost-based valuation methods are typically the accumulated costs incurred. Such costs may include research funding/costs, legal, Intellectual Property (IP) and administrative fees and non-recoverable taxes. Depending upon the age of the asset, these costs may be adjusted for depreciation, inflation or exchange-rate fluctuations.

Market-based methods: Market value is the value a willing buyer with complete information will pay to a willing seller in an open and honest transaction, and market-based methods determine the value of an asset based upon comparison with similar assets. Market-based methods such as comparables or benchmarking are straightforward and can be useful in cross-checking other valuation methods or developing industry 'rules-of-thumb'. However, the problem with market-based valuations of life sciences assets is the appropriate choice of comparable asset(s). Even where financial information about similar assets is publicly available, given the complexities of life sciences R&D projects it is rare to find two assets sufficiently alike to be directly comparable. Intangible assets such as brands and IP typically have a present and future value to the owner of the asset, and there are numerous cases of firms owning major intangible assets being acquired at prices significantly in excess of book values reported in the balance sheets. If publicly available, comparable parameters that can be used to value life sciences assets include the value of milestone and royalty payments associated with similar transactions. However, because the terms of most transactions are not disclosed, values may have to be estimated from the sale of firms owning substantial assets, or from share price to earnings (P/E) ratios of such firms. This approach is relatively straightforward in the case of firms with a single asset, but becomes more difficult where firms have a portfolio of assets where the relative contributions of the individual assets to the overall valuation can be difficult to determine.

Income-based methods: These methods take a view of the future cash flows attributable to an asset, which are typically derived from the ability of a product to reach the market and generate sales. A widely accepted set of income-based method for life sciences asset valuation are based on discounted cash flow (DCF) approaches.
DCF techniques identify the likely future investment and revenue cash flows associated with an asset, which are then discounted according to financial theory to give a net present value (NPV) of the asset. Various DCF techniques have been developed specifically for life sciences assets. For example, risk-adjusted NPV techniques are designed to explicitly account for the technical risks of drug development by adjusting cash flow forecasts based upon the success rates of development phases, whereas scenario analysis and decision-tree techniques attempt to model the effects of variations in key technical and market parameters on the value of an asset, and allow the possibility of project failure/abandonment to be included in the valuation approach. Because of the high complexity and uncertainty of life sciences R&D, numerous technical parameters including development time, cost (or negative cash flow) and probability of success govern the ability of a product to reach the market, whereas market parameters such as market size and growth, market share and peak sales dictate the revenues that can be generated by sales once approved.
In order to determine all of the cash flows attributable to a life sciences asset, an appropriate forecast period must be selected during which the future cash flows and earnings are expected to occur. In the case of life sciences assets, the forecast period is based upon the product and cash flow life cycles and typically lasts from market approval until patent-term expiry. In order to capitalise the forecasted cash flows during this period, an appropriate discount rate is applied. The discount rate represents the opportunity cost of capital to the firm or investors in the project, and can be determined using numerous different methods such as weighted average cost of capital methods or expected return on investment 'hurdle rates'.

Option-based methods: These methods similarly take a view of future earnings to estimate the value of an asset, but they also place value on the right – but not the obligation – to make a decision under fixed terms at a fixed point in the future. Options methods such as the Black-Scholes model and more sophisticated compound options models such as binomial lattices are widely used in valuations of financial assets, and are increasingly finding applicability in valuations of life sciences assets where options to abandon and options to expand (that is invest in the next phase of development) can be used to represent the stage-gate nature of life sciences R&D projects.
Although real options have strong theoretical applicability for valuation of life sciences assets they are conceptually challenging and tend to rely on numerous assumptions, and are thus difficult to model in practice. For example, the options parameter of volatility – which represents the variability in the value of outcomes under different options and is generally derived from changes in pricing of similar products over time – is very difficult to determine in the case of life sciences assets because of the idiosyncrasies of individual R&D projects.

ENCOMPASSING VALUATION APPROACHES INTEGRATE COMPLEMENTARY EVALUATION PRACTICES TO BUILD ROBUST VALUATION OUTPUTS

A central tenet of an encompassing approach to valuation is the principle that an integrated suite of complementary qualitative and quantitative evaluation practices provides more widely accepted, balanced and transparent valuation outputs that facilitate productive and mutually beneficial transactions.

Value can be defined as a measure of *the utility derived from consumption of a* '*good*' and is by definition subjective and multi-faceted. As value reflects the utility derived from consumption, it follows that a good will be valued highest by those able to derive the greatest utility from its consumption and *vice versa*. It is important here to recognise the context within which utility can be realised. For instance, in the case of early stage life sciences technology, utility may be derived directly from the technology (termed *independent value*) as in the case of a novel therapeutic compound, or may exist in the capacity of a technology to lever the value of other assets (termed *dependent value*), as in the case of a novel discovery platform that speeds the identification of potential therapeutic candidates. Consequently, any valuation approach needs to consider not simply an early stage technology in isolation, but also the context of its use in the prevailing environment.

It is also important to recognise that the utility derived from a good is ultimately realised upon its consumption, therefore a good also represents a store of utility until such point that consumption takes place. The capacity to store utility provides a basis upon which goods can be traded, thereby allowing value to be quantified in monetary terms. Consequently, value is commonly defined based upon the net cash flows attributable to a good (which can be thought of as *economic value*). However, goods may also represent as yet unrealised opportunities to provide utility (which can be thought of as *potential value*). While economic value reflects the value of a good as it currently stands, potential value reflects the value that could be realised in the event of further investment, and therefore it is important to recognise that the overall value of a good is comprised of both economic and potential components.

Measuring value, or valuation, is the process of determining worth, and any comprehensive approach to valuation should consider both economic and potential components of value as well the context within which value is to be realised. This is illustrated by the valuation matrix shown in Figure 2, which defines the overall value of a good in terms of its constituent independent and dependent economic and potential values.

In the case of life sciences technology, economic value reflects the net cash flows attributable to the technology (for example licensing income, product revenues, divestment proceeds and so on) in its current state with no further investment other that that which has already been committed. Of the many valuation techniques with applicability to life sciences technology (Box 2) discounted cash flow (DCF) techniques that measure the net present value (NPV) of a technology – based upon forecasted future cash flows and projected risk in view of the current status of the technology – are widely used to determine economic value.

In contrast, the potential value of a life sciences technology reflects the range of investment opportunities that exist to generate utility from the technology, such as the potential to develop new product lines or expand into new markets. Options-based valuation methods (Box 2) are purportedly finding increased use on the basis of their ability to quantify the potential value of unrealised opportunities (a 'real' option is the right to invest in a potentially valuable technology by paying the investment cost before the opportunity to invest disappears). However, research undertaken into the

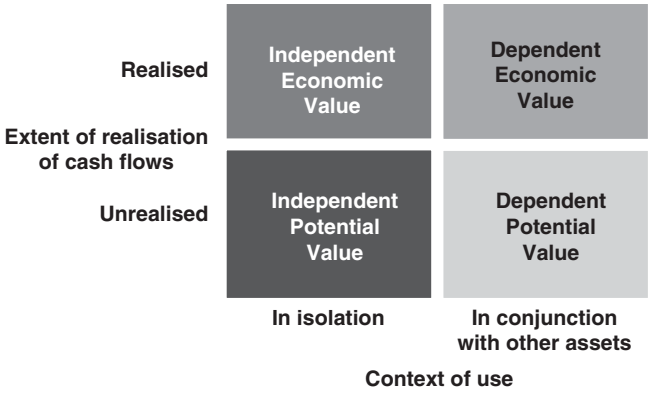

Figure 2: The valuation matrix.
Notes: The matrix provides a classification of the nature of value based upon the ability of a technology to generate cash flows and the context of its use; independent economic value reflects the ability of a technology to generate cash flows in isolation without further investment, such as in the case of a marketed therapeutic product; independent potential value reflects the ability of a technology to generate cash flows in isolation following subsequent investment, as in the case of a therapeutic compound in clinical development for an as yet unapproved indication; dependent economic value represents a technology's ability to generate immediate cash flows in concert with other assets, such as a therapeutic compound approved for use in combination with another compound(s); dependent potential value represents a technology's ability to generate cash flows in association with other assets following further investment, as in the case of a compound which is part of an unapproved combination therapy for a new indication. It should be emphasised that a given technology may simultaneously possess none, one, two, three or all four of the different characteristic components of value.
Source: Stephen Mayhew.

valuation practices employed among valuation professionals from across the life sciences industry suggests that options-based methods are used only to a limited extent within the industry (Figure 3), and that the majority of valuations tend to disregard the potential components of value. Although arguably a valid approach for late stage assets where future cash flows can be forecast with reasonable certainty and accuracy, this can be problematic for early stage life sciences technology where the ultimate commercial necessity, applicability and useful lifetime is frequently difficult to determine, and where value is often largely comprised of the unrealised potential to generate cash flows (Figure 4). To realise the full value of early stage technology invariably requires further investment, therefore in order to derive meaningful early stage valuations it is essential that the valuation approach encompasses both economic and potential components of value.

PRACTICALITIES OF ENCOMPASSING APPROACHES FOR VALUATION OF EARLY STAGE LIFE SCIENCES TECHNOLOGY

Although conventional DCF valuation approaches can be readily used to quantify economic value, it is generally more challenging to apply these conventional approaches to determine potential value. This is largely because the increased uncertainty associated with realisation of potential value requires numerous assumptions to be made about key valuation parameters for which actual information is as yet unknown, which can result in unwieldy and controversial

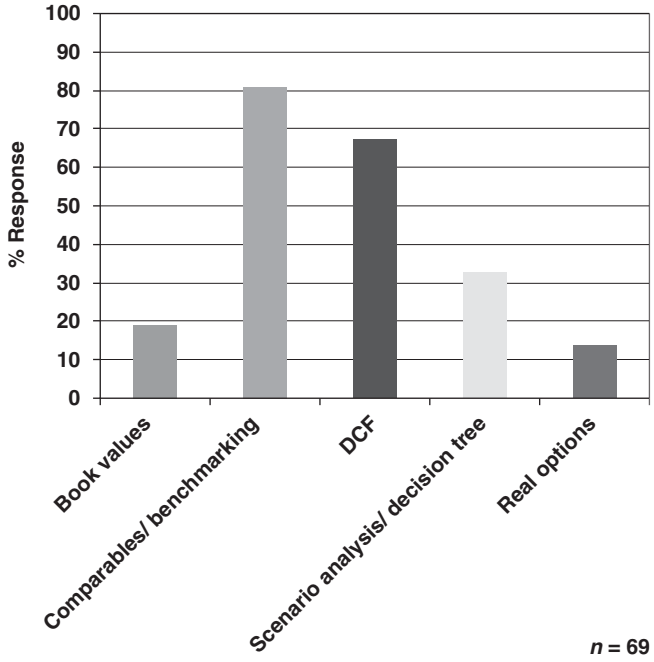

Figure 3: Techniques employed in practice for life sciences valuations.
Notes: Data obtained from a survey of valuation practices undertaken among 69 life sciences valuation professionals from across the industry including pharmaceutical executives ($n=8$), biotechnology executives ($n=21$), venture capitalists ($n=9$), consultants ($n=7$), health-care analysts ($n=9$) and university technology transfer executives ($n=15$).
Source: Stephen Mayhew.

valuations. And although options-based approaches have strong theoretical applicability for quantification of potential value, they tend to be conceptually demanding and are often difficult to model in practice.

To address the challenges associated with valuation of early stage life sciences technology, a series of six practical steps have been developed to encourage the use of encompassing approaches that blend complementary qualitative and quantitative evaluation practices to build realistic and widely accepted early stage valuations. The methodology promotes rigorous interrogation of a technology to identify and characterise key value drivers, and advocates the use of conventional valuation approaches alongside the application of more expansive valuation perspectives to integrate the dependent and independent economic and potential components of value into meaningful valuation outputs with practical relevance.

Step 1. Identify the economic and potential value drivers

The term value driver refers to any characteristic of a life sciences technology that confers utility and as such represents a source of value. The economic value of an early stage life sciences technology reflects the net cash flows attributable to the technology as it currently stands. Cash flows are typically relatively straightforward to identify – cash inflows generally arise from subscription/ licence income or sale revenues, whereas cash outflows are the costs associated with developing and maintaining the technology.

In contrast, the potential value of an early stage life sciences technology is that which could conceivably be realised from a range of

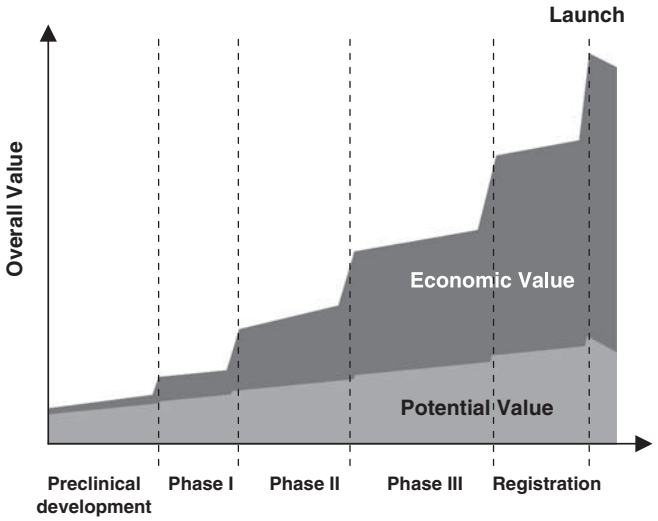

Figure 4: Illustrative value of a typical therapeutic asset.
Notes: Overall value increases as the asset progresses through successive phases of development towards becoming a marketed product with the ability to generate cash flows. Value inflections occur at phase transitions associated with completion of key milestones and reflect the mitigation of risk at each stage. The overall value of the asset is comprised of economic components based upon the net cash flows attributable to the asset (for example licensing income, product revenues and so on) and potential components that represent the value that could be realised in the event of further investment (for example development of new product lines, expansion into new indications and so on). In early phases of development much of the asset's overall value is potential in nature, which reflects both the high requirement for further R&D investment and the high degree of uncertainty that the asset will ultimately reach the market. This uncertainty is reduced as the asset passes through successive phases of development, which is reflected in the asset's increasing economic value as it progresses towards the market.
Source: Stephen Mayhew.

different investment opportunities (for example investment aimed at reducing development risk, expanding existing markets, creating new applications and so on), therefore in order to determine potential value, each of the potential value drivers – that is the available investment opportunities – must be identified.

The valuation matrix (Figure 2) can serve as a practical tool to aid identification of both the economic and potential components of value, and the practice of mapping the value drivers of an early stage technology according to their position on the matrix is a useful way to ensure that each component of value is considered during the valuation process.

However, because of the subjective and multi-faceted nature of value it can be difficult to identify all of the independent and dependent economic and potential value drivers for an early stage technology, and therefore it is also helpful to adopt an approach that systematically considers different perspectives of value.

Based upon analogous principles to the balanced scorecard[2] the expansive perspective approach to valuation (Figure 5) retains the conventional financial perspective that recognises economic value, but also systematically incorporates other perspectives of value to build more widely accepted, balanced and ultimately more meaningful

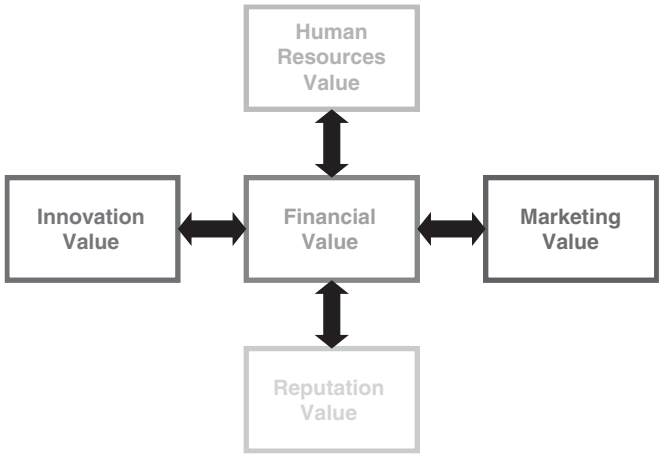

Figure 5: The expansive perspective approach to valuation.
Notes: The approach incorporates different perspectives of key groups of stakeholders to build more widely accepted, balanced and meaningful early stage life sciences valuations. Each perspective typically recognises different value drivers associated with a technology; the innovation perspective recognises value based upon a contribution to the application of new ideas; the human resource (HR) perspective recognises value based upon the impact on employees; the reputation perspective considers value based upon the perceptions of external stakeholders such as customers, suppliers and society; the marketing perspective views value in terms of commercial activity in markets. The financial perspective recognises value based upon the ability to generate shareholder wealth. In this respect, the financial perspective represents any direct economic benefit to the overall value of the business, and importantly, also integrates the components of value from each of the other different perspectives into an overall valuation output.
Source: Stephen Mayhew.

valuation outputs. The expansive perspective provides a means of interrogating a technology to gain insights into where the greatest value is located, as well as highlighting areas where value can be created or strengthened. Because of the subjective nature of value, there is no universal prescription for the perspectives to be incorporated for any given valuation, save that each of the perspectives adopted should be clearly relevant to the valuation being undertaken. Notwithstanding this, there are certain key organisational perspectives reflecting the interests of key stakeholders that are generally relevant in the case of early stage life sciences valuations, and which recognise the independent and dependent economic and potential components of value on the basis of their contributions to finance, innovation, human resources, reputation and marketing.

Figure 6 illustrates how the valuation matrix and the expansive perspective can be integrated into an encompassing framework to identify the value drivers of early stage life sciences technology.

Step 2. Evaluate the economic and potential value drivers

Once a technology's value drivers have been identified the next step is to quantify the value attributable to each driver, and in practice value is generally expressed in financial terms.

The economic components of life sciences technology value can readily be quantified using conventional financial valuation techniques (Box 2), and research indicates that market-based comparables/benchmarking methods and income-based DCF methods are widely used for these purposes (Figure 3).

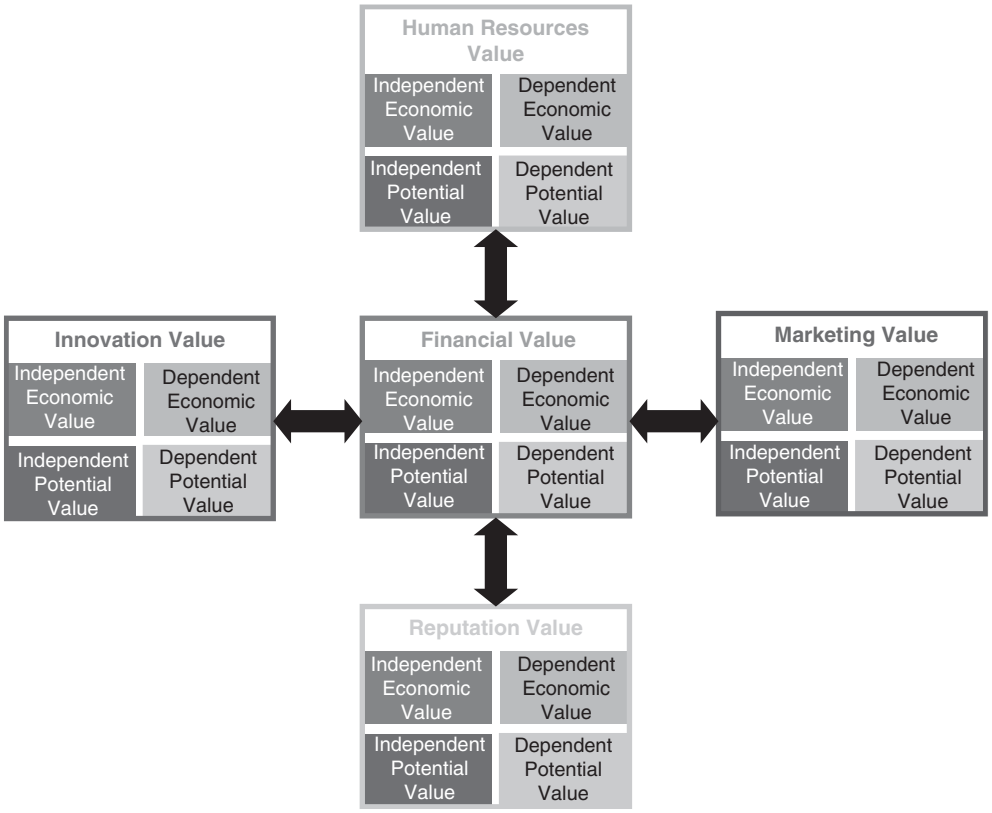

Figure 6: The encompassing framework approach to early stage life sciences valuations.
Notes: To illustrate how the encompassing framework adopts different perspectives to provide more comprehensive early stage valuations, consider an early stage life sciences technology such as a software platform that predicts more accurate human pharmacokinetic profiles.
The innovation perspective recognises value based upon a contribution to the application of new ideas, which in the case of early stage life sciences technology includes R&D, process and products. From the innovation perspective, use of the software may reduce the costs of conducting large numbers of bench experiments, and thus be of significant independent or dependent economic value depending on whether the platform achieved this directly or in conjunction with existing *in silico* discovery capabilities. The potential value of the software may be represented by an as yet unrealised ability to independently or dependently predict further characteristics of drug metabolism such as toxicity, which could be measured in terms of anticipated improvements in preclinical or clinical Phase I attrition rates.
The HR perspective recognises value based upon how the technology impacts employees. In the case of the software platform, economic value may derive from the ability of the software to independently or dependently enhance labour productivity, whereas the potential value of the technology may result from its prospective ability to independently or dependently increase employee satisfaction, which might be measured by levels of employee morale.
The reputation perspective considers value based upon how the technology might affect the perceptions of external stakeholders such as customers, suppliers and society. Here the economic value of the software may lie in its capacity, either directly or in conjunction with other technology, to positively impact levels of repeat business. From the reputation perspective, the platform may have potential value from an anticipated ability to independently or dependently reduce adverse safety events in patients, which might be measured by the willingness of key opinion leaders to endorse a given brand.

Income-based approaches that take a view of the future cash flows attributable to a technology are generally considered to be the most 'conceptually correct' valuation methods, however such approaches often depend on numerous assumptions which can sometimes be difficult to model in practice. Therefore, where possible (that is where financial information is available for sufficiently comparable technology) it is invariably good practice to augment income-based valuations using market-based comparables/ benchmarking approaches.

In contrast, potential value is often measured in non-financial terms and therefore in most cases must be monetised. Put simply, monetisation is the process whereby perceived value measured in non-financial terms is translated into a corresponding financial value, and typically involves determining the payment cash flows necessary to obtain equivalent utility to that which could be derived from the technology (as determined using market-based comparables/benchmarking approaches), and subtracting from these payment cash flows the investment cash flows required to realise the potential value.

As value is subjective, the degree of monetisation of potential value will depend upon individual perceptions of willingness to pay to obtain equivalent utility to that derived from the technology. This has clear consequences for the magnitude of the valuation output, which will be highest from the perspective of those that recognise the greatest degree of utility in the technology and *vice versa*. This is known as *value discrimination* and can have practical commercial implications for early stage valuations.

Life sciences technology valuations are rarely undertaken in isolation, and are usually performed for reporting purposes or to inform some form of decision making in relation to potential transactions. For instance, a common purpose of life sciences technology valuation is to help sellers (licensors) and prospective buyers (licensees) to establish financial terms for transactions such as technology acquisitions or licences. As a consequence of value discrimination, prospective buyers might be expected to have different perceptions of the value of a given technology based upon the degree of utility they are able to derive from it. And by recognising and exploiting value discrimination, sellers have an opportunity to realise the greatest value by focusing their marketing activities towards identifying those prospective buyers who are able to derive greatest utility from the technology.

Figure 6: Continued.

The marketing perspective views value in terms of how the technology is likely to affect commercial activity in markets. From this perspective, the economic value of the software may lay in its suitability for sale or licensing, either as a standalone platform or as part of a larger package, whereas the potential value of the technology may derive from expectations of its ability to independently or dependently predict new indications for existing drugs.
The financial perspective recognises value based upon the ability of the technology to generate shareholder wealth. In this respect, the financial perspective represents any direct dependent or independent economic impact the software has on the bottom line of the business (which is typically small in the case of early stage technology), as well as potential cash flows that could be realised from additional investment to further develop the software. The financial perspective also serves to integrate the dependent and independent economic and monetised potential components of value from each of the other different perspectives.
Taken together, the different perspectives provide a more complete view of a technology's value drivers and provide a basis for generation of an ultimate valuation output, which incorporates the dependent and independent economic and potential components of value from each perspective.
Source: Stephen Mayhew.

Step 3. Assess relationships between value drivers

The practice of systematic and inclusive identification and evaluation of a technology's value drivers allows the contribution of each driver to the overall value of the technology to be established. In most cases, the overall value of a life sciences technology is not simply the sum of all the independent and dependent economic and potential components of value, because certain value drivers are likely to be interdependent (and perhaps even mutually exclusive). Furthermore, when evaluating potential value it is important to recognise that in practice many available investment opportunities will never be pursued (and hence the potential value of such opportunities will never be realised).

To illustrate this, consider the case of an early stage technology that has the ability to modify a particular therapeutic compound to enhance half-life. One value driver for the technology may be its capacity as an exclusive product improvement that expands the commercial scope of the therapeutic compound in question, whereas another value driver could be its potential as a platform with applicability to a range of different products. Choosing to develop the technology as a unique product improvement would necessitate restricting its widespread availability (for obvious commercial and competitive reasons), while pursing a platform approach with wide applicability would preclude the opportunity to benefit from the competitive advantages of exclusivity.

Therefore, in addition to individual quantification of each value driver, it is important to assess the nature of any relationships between value drivers. Doing so will not only highlight the key value drivers for the technology, but will also allow the contribution of each key driver to the overall value of the technology to be determined under different scenarios.

Step 4. Develop robust practical scenarios under which value is realised

Valuations of early stage life sciences technology based upon forecasts of future income are frequently viewed with scepticism. Although this is a commonly perceived consequence of the inherent uncertainty and risk associated with early stage technology, in many cases this scepticism arises specifically because of an inability to reconcile differing perceptions surrounding the parameters used in early stage valuation approaches. An effective means of mitigating this scepticism is to focus on selecting a number of specific practical scenarios under which the value of the technology could be realised and developing these scenarios in a 'bottom up' fashion using the most relevant and accepted valuation parameters.

Income-based valuation approaches typically utilise numerous different valuation parameters to generate forecasts of the future income attributable to a technology. For example, consider the case of an early stage compound where a key value driver is the compound's therapeutic potential. In order to forecast the timing of future cash flows, relevant parameters to consider include clinical development timeframes, regulatory submission and review timeframes, commercial timeframes, patent lifetime and so on; and in order to forecast the magnitude of future cash flows, relevant parameters include market size/share, pricing strategies, manufacturing and sales costs and so on. Moreover, the likelihood of realising the future cash flows under any given practical scenario will depend upon the technical risks associated with development of the compound, therefore the valuation approach also needs to account for the technical risks of R&D by adjusting the future income forecasts based upon the probability that they will be realised. In the case of a therapeutic compound, technical risk is mitigated by progression through the stages of clinical development, therefore in order to forecast the likelihood of future cash flows the relevant valuation parameters are the probabilities of success for each development phase.

For many cases involving early stage technology, much of the information relating

to the relevant valuation parameters is unlikely to exist, and therefore assumptions have to be made as to the most appropriate parameter values to use. A common practical pitfall of early stage valuations is the use of unsubstantiated approximations for key valuation parameters. The main drawback with this practice is not that it creates uncertainty around the valuation output – uncertainty is practically unavoidable with early stage valuations – but that it compromises the perceived robustness of the valuation approach, which in many cases is the major source of contention regarding early stage valuations.

In order to generate robust and meaningful valuations it is critical that the valuation parameters used are both realistic and justifiable, which means that any assumptions should be based upon the most appropriate and highest quality available data. Such assumptions may be based on data that relates directly to the technology in question – if such data is available – or may be derived by benchmarking available data against relevant comparable technology, markets, companies or industries. Where assumptions are based on external data, the use of recognised data sources such as renowned experts in the field or reputable market intelligence providers is strongly encouraged to provide credibility and encourage acceptance of the valuation parameters used.

Selecting the most relevant and accepted valuation parameters not only facilitates development of robust practical scenarios to help generate more meaningful and widely accepted valuation outputs, but also allows more informative sensitivity analyses to be performed in order to assess the extent to which changes to individual valuation parameters impact the ultimate valuation output.

Step 5. Use simulation tools to model chosen scenarios

Because of the uncertainty associated with early stage life sciences technology, an important feature of any valuation approach is the ability to assess the extent to which changes to any one or more of the valuation parameters and assumptions used to develop the practical scenarios impact the ultimate valuation output.

Simple scenario analysis can be used to determine the effects of variations in key valuation parameters on the final valuation output. For example, the impact of a 10 per cent underestimation of market share on the valuation of a given R&D project can be explored by simply increasing the relevant market share parameter variable by 10 per cent and recalculating the value. However, although such approaches recognise that different outcomes are possible, they employ single point estimates and are unable to predict the likelihood of any given occurrence. Calculation of more realistic outcomes requires numerous versions of a single model, each incorporating different parameter variables.

Nowadays highly sophisticated sensitivity analyses can be performed using simulation techniques such as Monte Carlo, which allow the effects of simultaneous variations in multiple valuation parameters to be explored. Monte Carlo applications can be easily incorporated into common spreadsheet software packages allowing thousands of iterations of a valuation model to be performed. This allows a potentially unlimited number of scenarios to be developed from many different parameter variables, each of which is accounted for according to the probability of its perceived value. The final valuation output is then delivered as a probability distribution curve encompassing the range of outcome valuations.

Step 6. Use value ranges to represent valuation outputs

Conventional valuation outputs are typically represented as discrete numerical entities. Outputs of this nature tend to infer a high degree of accuracy and precision, and as a result are often interpreted as definitive

valuations. This can have practical consequences. For example, valuation outputs are often used to set target valuations for transactions, which parties use as a key basis upon which to build deal structuring, pricing and negotiation strategies. At the outset of a transaction, it is not uncommon for parties to have disparate perceptions of the technology's value (with target valuations of sellers and licensors invariably being somewhat higher that those of prospective buyers and licensees). Parties tend to place a very high priority on achieving their target valuations and therefore disparate perceptions of value based upon narrow, misguidedly definitive valuations can prove very difficult to reconcile. This frequently leads to deadlocked negotiations and can potentially compromise what may otherwise be successful and mutually beneficial transactions.

In certain cases – usually involving later stage technology assets where utility is well characterised and widely accepted – it is possible to generate discrete valuation outputs that are considered by both the seller and the buyer to be reasonably accurate and reasonably precise, and in such cases there usually exists broad agreement between the parties as to the technology's ultimate value. However for earlier stage technology where there is typically much greater uncertainty surrounding ultimate commercial utility, it is rare that all parties will be aligned in this regard. Therefore for early stage valuations, it is usually more helpful to represent valuation outputs as probability-adjusted value ranges – or *value profiles* – that encompass and reflect a range of valuations under different practical scenarios. Expansive value profiles tend to be easier for parties to reconcile than narrow discrete outputs, and encourage more realistic expectations of what can be achieved when using early stage valuations to plan transaction and negotiation strategies. As such, value profiles are often more useful in practical terms than conventional discrete numerical valuation outputs.

ENCOMPASSING APPROACHES TOWARDS VALUATION HAVE IMPLICATIONS FOR LIFE SCIENCES TRANSACTIONS

Encompassing approaches towards valuation are necessarily more complex than the conventional valuation methods that focus purely on financial components of value. In addition to the quantitative data and assumptions used in conventional valuation models, encompassing approaches also involve broad and often qualitative practices that require consideration of different components of value from a range of different perspectives. This requires factoring information from all available sources into the valuation approach. Due diligence activities should therefore seek to identify all available information relating to the technology and to its potential uses, which can then be used to generate a comprehensive and inclusive valuation output.

Parties seeking to realise value from transactions involving early stage technology are encouraged to focus their attention on identifying and engaging potential transaction partners with the capacity to exploit the technology to its greatest commercial potential. Encompassing approaches therefore extend the perspective of valuation to more than simply a process for establishing financial terms for transactions, and seek to include and reflect the full scope of shared commitments pertaining to ensuing relationships. This encourages risk-sharing approaches to agreed valuations and long-term success, as opposed to the sole pursuit of near-term target valuations that may compromise longer-term outcomes. Diligence activities should therefore include both the typical 'internal' diligence activities relating to the technology and to potential transaction partners, as well as 'external' diligence activities involving a thorough market assessment. The latter are surprisingly uncommon, yet rigorous external diligence activities to identify potential partners who are best positioned to exploit the technology and for whom the technology represents strategic, technological and cultural

compatibility is key to ultimately realising the full value from transactions involving early stage life sciences technology.

The emphasis on valuation as a means of facilitating productive and mutually beneficial transactions is particularly important in scenarios where repeat business is sought, or where transactions between buyers (licensees) and sellers (licensors) typically represent the start of longer-term relationships in which parties are expected to work together for mutual gain – as in the case of early stage life sciences technology partnerships.

CONCLUSION

Developments in health-care technology and economics are continuing to change the business environment in which the life sciences industry operates. Early stage partnering represents an important component of life sciences business strategy and therefore there is a high need for new approaches to valuation that account for the uncertainty and risk associated with early stage life sciences technology. By incorporating an integrated suite of qualitative and quantitative evaluation practices, encompassing valuation approaches reposition and expand valuation perspectives to provide more widely accepted, balanced and transparent valuation outputs. The use of encompassing valuation approaches can minimise much of the contention that often surrounds early stage valuations, thereby facilitating productive and mutually beneficial transactions that form the basis for successful long-term partnerships.

ACKNOWLEDGEMENT

The author would like to thank Stuart Pavelin for his contribution to this article.

REFERENCES

1. Lawrence, S. (2008) Partnerships remain buoyant. *Nature Biotechnology* 26(6): 602.
2. Kaplan, R. S. and Norton, D. P. (1992) The balanced scorecard: Measures that drive performance. *Harvard Business Review* 70(1): 71–79.