7

Platforms, Data and Analytics

7.1 Platforms

Platforms now play a significant role in the digital economy, with platform firms reaching the scale and dominance last seen with the huge vertical corporations of the early 1900s. Platform business models have broad implications for firms across all industries seeking to leverage information technology (IT). Digital technologies are increasingly being integrated into strategy frameworks, with platforms and platform complements providing the potential for future growth.

A platform generally is a cluster of technologies that serve as a base for the development of products, applications, processes or various technologies within the same structural framework. Platforms are also business frameworks that facilitate multiple business models that can be developed into operations and systematically leverage technologies across various domains. Although platform terminologies exist across product development, technology strategies and economics, all have common attributes, the repeated use of a core component to both achieve economies of scale and the lowering of costs in the generation of a broad range of complementary products.

A platform is defined as a group of components that remain stable, while facilitating diversity and evolution within the system through the constraint of the relationships between the other components. The architecture of platforms can be generalized as the modulization of complex systems, where the platform components remain constant while the complements are free to change either as a cross-section or sequentially.

J. Rogers, *Strategy, Value and Risk*, Global Financial Markets,
https://doi.org/10.1007/978-3-030-21978-9_7

Platforms also facilitate firm activities within ecosystems, which can take the form of product lines within a firm's boundaries, multi-product systems across co-dependent firms, and as multiple-sided markets. Business ecosystems are networks of independent firms whose products have more value when used collectively than individually, and are defined by the complements between products within the system. Individual firms can partake in multiple ecosystems, while firms from different industries can participate in an ecosystem. The coordination within an ecosystem is maintained through a combination of standards, contracts and prices.

Platform and platform complements, where demand for a product increases when the price of an alternative decreases, as a strategy contrasts to that of a conventional product strategy. An ecosystem is required for the creation of complementary products and services, and to generate positive network externalities between the platform and the complements. These interactions are significant for firms in which platforms play a major role, as they can generate growth at a much greater rate than that of an individual firm. These complements within a business ecosystem can also be supermodular, where an investment by one firm enhances the value of investments made by other firms.

Technology platform ecosystems are especially relevant in software, where they provide the leverage and optionality for large-scale specialization, either within a value chain or across a wider ecosystem. Short lifecycles require specialization, and the product architectures a high level of modularity, the level to which the components within a system can be divided and recombined and provide flexibility and diversity.

A digital platform is a computing environment for software execution that can include hardware, an operating system, web browsers and associated application programming interfaces and any other software. Digital technologies have two attributes that are distinct from the physical flow and step process technologies that were dominant at the turn of twentieth century. The first is that a computer is a composite system that consists of software and distinct functional components and a platform that supports an array of discretionary options and complements that generate value. The second is that the integrated circuits (IC) that provide the foundation for computer hardware have scaling properties, which are enhanced by the IC size, cost and chip speed improvements that occur with each new generation. Advances within the various component technologies of a computer system also occur independently and at different rates of development. All these attributes combined provided the flexibility to customize computer systems and their component upgrades.

Value within a digital platform system therefore differs significantly from that within a step process. All steps within a step process are critical, with the risk of production bottlenecks hindering the flow and throughput of the overall system. Each step is also interdependent, with any variation across the step processes affecting value. Steps processes therefore required a hierarchical management structure that bridged the steps to reduce the risk of bottlenecks. The value of a step process is therefore proportional to its output.

In contrast, value within a platform system is a function of the sum of its optional complements. The options provide the platform user the right and not the obligation to undertake an activity that creates value for the user. Platform users can determine whether value is greater than the cost for each component, and can add the complement to the system if this is the case. The value of the platform system is therefore proportional to the sum of the individual option values. The greater the number of options within the platform system, the greater the value to individual users. The users and options together are therefore supermodular, where a user's decision influences the incentives of other users, and also their complements.

A platform has no value without the combination of one or more complements. Complementors have value when there is optionality, or the right but not the obligation to choose one complement over an alternative within the platform complementary modules, units within a system that, while are structurally independent, can function in combination. The value of the option is low when consumer preferences are homogeneous and predictable, and high when preferences are heterogeneous or unpredictable, and when there is uncertainty around future technology paths.

Complementors can also provide a source of investment capital for the platform sponsor and facilitate platform growth, especially when there are significant network externalities. Platform sponsors also have to initially build scale on one side to attract participants and third parties on the other. The network externalities within these participants create the chicken or the egg problem, whether to initially build the platform's supply side or the demand side. Solutions for platform sponsors to address this issue include cross-subsidization and providing free products and services.

Platforms are diverse in terms of their economies of scale, network effects, investment approaches, openness, growth subsidies and means of monetization. Industrial platforms initially were closed manufacturing systems, where firms designed and engineered their platform and complements to support the product variety and flexibility required to respond to demand dynamics. The rise of open platforms led to the vertical to horizontal transformation of the computer industry towards the end of the twentieth century. Open platforms not only influenced firms within the computer industry, they also transformed the structure of the industry itself.

Two types of digital technology open platforms and related ecosystems emerged during the last two decades of the twentieth century. Open product platforms distribute the design and production of the various complex modular system components over multiple independent firms. Open exchange platforms, which originated with the rise of the Internet and World Wide Web in the 1990s, emerged as websites structured to facilitate transactions in goods and services, information and opinion. The sponsors of open platforms in both cases can allocate essential tasks to third parties while maintaining control over critical and unique platform components.

Product platforms can be further defined as standards-based product platforms and logistical product platforms. Standards-based product platforms establish standards that facilitate the ability for the system components to operate within the platform, and therefore, the design of complex systems for the production of goods and services. Logistical product platforms coordinate the movement of products and services via a system integrator that manages a complex network of step processes. Standards-based and logistical open product platforms are both contingent on ecosystems of various suppliers of components and tasks to produce a final product.

Exchange platforms differ from product platforms as they enable exchanges between agents, and are defined as having two- to *n*-sided markets. Value within an exchange platform, as with product platforms, is a function of the options it facilitates. Exchange platforms enable the efficient connection and transfer of goods and services and information through the medium of the platform.

Exchange platforms can be further split into two sub categories. Transaction exchange platforms support transactions in markets between buyers and sellers to exchange property rights for payments. Digital transaction platforms are one example, where there are two sides—the buy side and the sell side. Communication exchange platforms support the exchange of information and opinion, and can be structured as point-to-point operations such as email, or broadcast through television, radio, newspapers and social media. The senders and receivers of messages comprise the two principle sides within these platforms, while also facilitating the ability of agents to sell advertising and collect data.

Open and closed platforms have a number of similarities. Both have as a foundation the modularization of its core platform and its optional complements. Modular design, or modularity, subdivides a system into smaller parts or modules that can be created independently for use in various systems.

Platform systems also have the upside of numerous options, which include network effects, risk, modularity, the complementary between modularity and risk, and also facilitate the decentralization of tasks and decisions. The fundamental property that underlies all platforms is that they generate options, or the right but not the obligation to transform the product in response to new consumer demand, prices and technologies.

Platforms and their related ecosystems have the potential to redefine industries, business models and the generation of value. Platform technologies include cloud computing, which encompasses data, software, analytics and artificial intelligence (AI), and new technologies such as DNA foundries, fintech, robotics and the industrial Internet. Platforms will also converge technologies such as energy storage, electric vehicles, AI and robots, and ultimately, drive the transformation of industries and the realignment of industry boundaries.

Platforms also provide a foundation for non-proprietary call options on its functionality, which are linked to platform value and growth. The platform options have no downside risk, with more options and upside risk increasing value and growth for the platform sponsor. The division of the platform components into modules also increases value, as modularity provides more options to the platform. Finally, platform sponsors can use patents as options to control standards, to scale and to achieve network effects.

7.2 Cloud Computing

Analytics, data and cloud computing together will have a significant impact on business and the economy in general. Cloud computing systems (the Cloud) are technology platforms that provide the modules, services and the functionality that can be used repeatedly across numerous information technology (IT) applications. The Cloud also provides access to a portfolio of scalable IT services on demand and as required by firms. Third-party developers can embed Cloud modules and services into their own products, which facilitates further adoption of the Cloud platform. Cloud computing platforms, by design, do not connect the third parties and are therefore not two-sided markets, and have no exponential network effects, with growth a function of adoption by third parties.

Cloud computing service offerings can be generalized as three standard models—Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). SaaS is a software distribution model, in contrast to on-site software delivery, where software is centrally hosted and accessed over the Internet through devices that connect to Cloud applications, and is typically a pay-as-you-go service. PaaS provides a development and distribution environment on the Cloud, and the ability to develop scalable product and service applications as a pay-as-you-go service. IaaS provides real-time virtualized computing, storage and networks resources over the Internet that allows clients to build information technology infrastructure that scales with demand with a pay-as-you-go structure.

Cloud computing, storage and software offer technology infrastructure to clients that has cost flexibility and an operating expense as opposed to a capital investment. Cloud computing users include start-ups and SMEs (small and medium-sized enterprises) that are scaling, large corporations migrating legacy systems to the cloud, and private equity firms with investment portfolios that have technology and cost optimization business strategies. All business types can also benefit from an asset-light business model, and a significant decrease in information technology costs generally. It will take time for the migration of corporate information technology to the Cloud to fully materialize as firms write down the sunk cost of their existing legacy systems. Given the size of spending on information technology in general, however, the potential for the Cloud to transform business models and operations is enormous.

7.3 Artificial Intelligence

Artificial intelligence (AI), a subfield of computer science, is the ability of a system to interpret and act on data so as to achieve particular objectives. These objectives can include speech recognition, visual perception, language translation and decision-making. AI has the potential to be as transformative as the impact of computer technologies, with the exponential growth in data and the continuing developments in computing and algorithms driving the world's dominant technology firms to invest substantial sums in their AI capabilities.

The transformative impact of AI is the next phase to follow that of databases, which have continually lowered the cost of storing data since the 1980s. While developments in the first generation of software were driven by developments in databases, so will AI drive the next generation of analytics and prediction software. As with the personal computer and mobile phone technology waves, AI has the potential to redefine the technology industry's business models in both operations and new business ventures.

Cloud computing will be structured into two AI businesses—one that focuses on consumer services and the other on business and corporates.

Machine learning will be offered to firms across industry sectors that do not have the capabilities to build and scale AI through internal technology platforms. AI offers new capabilities to firms across industries that are facing transformative technologies in transportation, energy, manufacturing, biotech and media. Global personal transportation, for example, is worth approximately $10 trillion, and those that succeed in this market will also have spill-over synergies in other AI-related technologies, such as robots and drones. Autonomous vehicle AI investments are also an example of how technology firms are moving beyond software into hardware.

The larger issue, however, is whether AI will further concentrate the market power of the world's dominant digital technology firms. These firms—through their resources and capabilities in data, computing, algorithms, human assets and investments—are likely to capture much of the value in AI market share. As with the rise of databases, software and personal computers in previous technology waves, the likelihood of the transformation of industries, business models, industry boundaries, the decline of incumbents and the concentration of dominant firms is significant.

7.4 Quantum Computing

While full-scale quantum computing is unlikely in the foreseeable future, it will have specific applications as the result of significant advances in the technology, which are likely to be ready much earlier than previously forecast.

The foundation of quantum computing is the behaviour of sub-atomic particles. One property of this behaviour is superposition, where a particle can be in two states simultaneously. Quantum bits, or qubits, can have a value of one and zero at the same time, in contrast to the binary elements, or bits, in current computers, which can only have a value of either zero or one at the same time. Through the threading together of numerous qubits, the number of states represented grows exponentially, and provides the ability to calculate potential outcomes in the millions instantaneously.

A second property of quantum computing is entanglement, in which qubits are able to be in two states simultaneously in a manner that can lead the qubits to act in unison. This second property makes it possible to code algorithms that bypass the current computing sequential logic process, and arrive at results by excluding those that are incorrect at a much faster rate than current computers.

As large-scale qubits appear to be unattainable for at least a decade, the question is whether there are practical applications for the current state of the technology. Researchers are focusing on three areas in which quantum computing is expected to be relevant in the short term.

The first concerns the analysis of the natural environment and the modelling of the behaviour of molecules, as nature itself is quantum mechanical, and therefore aligns with quantum computing principles. Quantum computing can model sub-atomic particle behaviour exactly, while current computing can only arrive at approximations of this behaviour. One sector that can benefit from this technology is the chemicals industry, with computational chemistry facilitating the discovery of new materials.

The second is machine learning, where quantum computing is uniquely applicable to specific problems that can be an issue in current computing. Quantum computing is particularly relevant to specific types of probability-based algorithms, computations that do not follow a logical deterministic step sequence as derived in classical computing.

The third area is complex optimization problems that have variables that are too numerous for current computer processing. While these quantum computing applications appear to be narrow in scope, in combination, they have the potential to address a wide range of problems, making the technology generally applicable to specific areas in the short term.

Other applications of quantum computing include developing cryptography systems to replace the current encryption technology, improved financial risk management systems for the calculation of financial exposures, potential losses and adjusting portfolio risk, and in renewable energy by improving system efficiency and developments in solar cell materials. Quantum computing will also become a component of the dominant tech firms' cloud computing offerings, where scale and capabilities are especially relevant within specific applications.

7.5 Data

Big data is defined as a broad range of new and massive data sets from which new forms of value and insights can be extracted. The data is classified as unstructured, structured and semi-structured data. Unstructured data is information that does not have a defined data model, and includes text, social media, natural language, digital images, communications, science data, health-related data and search data. Structured data is information that is separated into standardized components within a defined data model, which can range from individual data points, dates and text to data that includes multiple data components. Semi structured data is a type of structured data that—while it does not conform to formal data models—does contain separate semantics, and record and field hierarchies, within the data.

Cloud computing is a technology that provides universal access to shared pools of resources and services, typically over the Internet. This common sharing of resources and services can achieve economies of scale and a variable cost for a firm's technology infrastructure. Data as a service is one of these services, where Cloud computing vendors can import large volumes of data, analyse the data and publish the results back to clients.

The economics of big data and machine learning algorithms has largely been a function of the centralizing of data-intensive processing on the Cloud, which has significantly driven down computing costs. AI is also moving towards another computing paradigm, where data processing is performed on a network 'Edge'. Edge computing is defined as devices that interconnect with the physical world, where applications, data and services are located away from central nodes to the edge of the Internet. Examples can include smartwatches, autonomous cars and devices connected through the Internet of Things. This architecture can reduce communication bandwidth to a central data centre by locating data and analytics in proximity to the data source, providing speed and the optimization of computer resources. This technology architecture has added another dimension to the economics of data and analytics, with local processing versus processing data on the Cloud further influencing data and analytics performance and the associated costs.

7.6 Analytical Management

Information has become one of the most powerful commodities in the world today. From the 1980s, the value derived in information technology moved from hardware to software as computers became commoditized. Today, value is being transformed again—in this instance, from software to data. Technology innovations will continue to drive the growth in the volume and types of data firms can access for analysis. Information systems management is increasingly being integrated into business strategy, with data availability improving as a result. This process is providing a rich source of business and financial data, much of which is proprietary to an organization, and which managers and investors can utilize for analysis.

The transformation of data into information and into value by firms that dominate the digital economy is having effects across all industries. Firms will require investments in data and analytics infrastructure, and in many cases, the transformation of the business model to remain competitive. Data and analytics in the digital economy are the new technologies of systematic management, and increasingly, a core capability and a source of competitive advantage and value. Analytics is about finding value in data, and deriving insights that can solve specific business objectives that align with strategy. As innovations in technology continue to add to the volume of data available as a resource, a range of advanced statistical methods are available for the analysis of a range of complex business problems.

Economics, finance, statistics and machine learning combined can provide an analytical framework for management to provide structure to complex business problems and to gain insights into a firm's internal and external environment. The analytical framework can be applied to a broad set of business domains that include product innovation, supply chain optimization, identifying financial drivers, sources of risk, consumer behaviour and advertising, customer profitability, optimal pricing and resource allocation.

The application of explanatory statistics can offer insights into a firm's enterprise and consumer behaviour, revenue, cost, profit and production functions, factor demand and other business relationships. These statistical techniques include structural model equations, discrete event simulation, dynamic simulation models and time series applied to continuous, discrete and categorical data. Supply chain optimization methods can be applied to inventory management, optimizing third-party supply chains and scalable Cloud solutions.

Predictive statistical learning techniques are classified as supervised and unsupervised. Supervised learning involves the building of a statistical model for the prediction or estimation of an output on one or more inputs. These problems can be found in business, medicine and public policy. Unsupervised learning has inputs that, while there is no supervising output, can however learn from the relationships within the data sets. Supervised methods include linear and logistic regression, additive models, LASSO, support vector machines and K-Nearest Neighbors, while unsupervised methods include Principal Component Analysis and Clustering Methods.

7.7 IT Investments

Investment in information technology (IT) has become a major component of the capital budget in many service and manufacturing organizations. Although IT investments can be highly risky, the corporate rewards can be enormous. Managing this capital expenditure in today's business environment raises a number of important issues for decision makers, including how IT investments should be integrated with strategy, and the risk management implications of these investments.

IT projects can be viewed as an activity where resources are allocated with the goal of maximizing shareholder value. Any IT investment such as software, platforms or data analytics is therefore managed with the goal of maximizing value, where value is defined in terms of the market value added to the firm. IT investments are not only costly, they are also often risky due to the uncertainty of the value of future payoffs.

The return on investment (ROI) concept applies principles from finance to maximize the value of IT investments and expenditures. In a conventional discounted cash flow (DCF) valuation analysis, a forecast of the future cash flows is discounted at the risk-adjusted opportunity cost of capital to obtain the present value. Present values are derived for both costs and benefits to obtain the net present value (NPV), and if the NPV is positive, the project is considered viable.

The NPV of a feasible project corresponds to the change in value of a firm if it proceeds with the investment. If the NPV is positive, the decision would be to proceed with the investment, as this would increase firm value. Likewise, if the NPV is negative, the investment should not be made. Valuing IT investments using cost benefit or ROI analysis, however, has always been a problem in computation. It is typically easier to calculate the costs of the investment than it is to calculate the benefits or returns. There are concepts such as partitioning benefit or returns analysis into tangible and intangible benefits that can be used. One approach is to ignore all intangible benefits and focus on tangible benefits, as most tangible benefits can be converted into measurable returns.

The uncertainties associated with a firm's IT investments can also be defined as project- and market-related risks. Project-related risks are associated with the planning, implementation and management of a firm's IT project, such as the technology not delivering, cost overruns and project setbacks. Market-related risks are the factors that can influence the demand for a firm's products and services, such as customer approval and the behaviour of competitors. Even if a project meets management expectations, any capabilities created by the IT investment may not be suitable for the existing market environment at the time of completion.

Other uncertainties that can be associated with software investments include development costs, coding issues and subsequent operational failures, developments in future technologies and standards, user acceptance, and the potential costs associated with changes in processes. Managers cannot always predict how systems will need to be adapted to changing user requirements, market developments and developments in technology.

A one-step binomial tree is used to illustrate the uncertainty associated with the IT investment decision. The payoff is represented as three cash flows, with the costs at t_0 of \$100,000, and two possible payoffs at t_1 (one step into the future) of \$198,000 at one branch if the outcome is favourable, and \$66,000 at the other branch if the outcome is unfavourable.

Arbitrary probabilities of 0.5 are assigned to each branch, and a discount rate of 10% is used. These are simplified parameters for the purpose of illustration. If the decision is made to invest immediately, the benefits are the expected value of the profit stream at time t_0. Over the time period Δt from t_0 to t_1, the benefits can either go up to uS (favourable) or down to dS (unfavourable), with values at t_1 defined as:

$$uS = 198,000$$
$$dS = 66,000$$

Table 7.1 illustrates the cash flows for the decision to invest immediately.

The return on the outlay of \$100,000 to invest immediately is \$20,000, and therefore, the IT investment would be accepted immediately based on this analysis.

The IT investment is now analysed using the concept that there is value in the form of a real option. This option offers the flexibility to defer any IT investments until one-time step into the future, at which point, new information will become available.

A binomial model is again used to illustrate the option to defer, or a call option on the IT investment at t_1, with a strike of K = 110,000 (the costs at t_1 equivalent to \$100,000 × 1.1^1).

At t_0, the payoff for the call option on the IT investment is:

$$c = Max\left(S_T - K, 0\right) \quad (7.1)$$

where c is the value of the call option, and T is equal to t_1.

The payoffs for the option at the up and down nodes at t_1 are:

$$c_u = Max\left(uS - K, 0\right) \quad (7.2)$$

$$c_d = Max\left(dS - K, 0\right) \quad (7.3)$$

Table 7.1 IT investment cash flows: invest immediately

Costs at t_0	= (100,000)
Favourable savings at t_1	= 198,000
Unfavourable savings at t_1	= 66,000
NPV at t_0	$-100,000 + 0.5 * \left(\frac{198,000}{1.10}\right) + 0.5 * \left(\frac{66,000}{1.10}\right)$
	= 20,000

The expected value of the call option at t_0 is:

$$c = P(t,T)\left[0.5 * Max(uS - K,0) + (1-0.5) * Max(dS - K,0)\right] \quad (7.4)$$

where $P(t, T)$ is the discount factor. The expected cash flow payoff at t_0 is therefore:

$$c = P(t,T)\left[0.5 * Max(198{,}000 - 110{,}000{,}0) + (1-0.5) * Max(66{,}000 - 110{,}000{,}0)\right] = 40{,}000.$$

In this IT investment example, the alternative strategies are to either exercise at t_0 or wait until t_1. The manager has the right to invest immediately in the IT investment at t_0, and a call option on delaying the IT investment with exercise at t_1. The DCF analysis implies that the project should proceed immediately as the discounted cash flows are positive. The decision to proceed with the IT investment at time t_0, however, gives up the right to exercise the call option at t_1. Therefore, the value of the decision to invest immediately at t_0 is $20,000 (the value of investing immediately) minus $40,000 (the value of the call option, or the option to defer), which equals ($20,000).

Although the initial insight is that the best alternative based on the NPV analysis is to invest at t_0, it is clearly not the optimal decision for adding value to the firm when the option to defer is also considered. If the DCF analysis had given a negative NPV for the project at t_0, the right to defer the project may still have value due to the call option. Even though the project had a positive NPV at t_0, the firm may gain by delaying the project and proceeding with it in the future. In the DCF analysis, this right is worthless and adds no value to the firm. When the right to delay the IT investment is considered as a call option, however, this right does have value and should therefore be considered in the analysis.

7.8 Patent Options

Intellectual property (IP) is a form of property right that covers intangible creations of the human intellect—such as literary and artistic works, designs, symbols, names, images and inventions—that are used in commerce and can be protected under law. There are two types of IP property rights—copyright, the granting of exclusive rights to a creator of an original work, and industrial property rights, which encompass trademarks, designations of origin, industrial designs and models, and patents.

A patent gives its owner the right to exclude others from making, using, selling or importing an invention for a limited time period without the authorization of the patent owner. A patent is therefore a limited monopoly granted by the government for the term of the patent, after which other parties can make, use or sell the invention once the patent expires. Patent rights are granted by government in exchange for the public disclosure of the invention, typically fall within the jurisdiction of civil law, and form an essential component of competitive advantage in some industries.

Patents can be used by firms as options—either internally or through licensing—that are exercised at some future stage to create and sell commercial products. The research and development (R&D) costs for a patent are typically significantly less than the actual product development for the majority of new technologies. A firm can, therefore, have an incentive to patent new technologies and not bring those patents to market. New technologies can be patented and either not used (or are sleeping), or licensed to others, and therefore used to maintain a dominant position. Sleeping patents can be used by a firm to either deter entry by investing in the R&D required to obtain a patent and letting the patent sleep as an option, or to license the patent to third parties, especially when there are network effects.

The sleeping patent can be viewed as a call option. Expenditure on R&D today that leads to a patent is effectively buying a call option on the subsequent technology that can be called in the future. A patent grants the right but not the obligation to either further invest and commercialize the technology or license the patent. The asset value is the NPV of the cash flows from either commercializing the technology or from its licensing. The R&D expenditures and commercialization investments—or annual patent fees in the case of licensing—are equivalent to the net exercise price on the patent option.

A significant percentage of the market valuation of high-tech firms is the optionality associated with their technologies and patents, and is a function of the firm's stock price volatility and option value. The stock price volatility can reflect the volatility of a patent value, and used as a proxy for the volatility of the patent returns and as a parameter in the valuation of patent call options.

Firms in R&D intensive industries can, therefore, hold patent portfolios and allow the majority to sleep, and either exercise and commercialize a small number of patents, or license the patent to other firms that do not have the capabilities for such R&D investments. The patent holder has two options embedded in a patent—the option to use it exclusively or to license it to third parties. The structure of patent licenses from the licensee's standpoint can also be framed as an option. A licensee can pay an initial fee, or premium, to buy an option when entering into a licensing contract, for the rights to develop and commercialize the technology covered by the patent.

The patent holder can also use it as an asset to establish standards in markets that have strong network effects, and grant the use of the patent by third parties. A firm can use a patent to support the adoption of a platform, encourage third-party developers to use the intellectual property to invest in the sunk costs required for the adoption of the platform, and therefore, use the asset to gain an edge for other parties.

A simple example follows to illustrate the value from licensing a sleeping patent. The sleeping patent is valued as a three-year European call option on the patent to attract third-party developers to a platform, with potential license fees from three to ten years. The intrinsic value for the patent call option is:

$$\text{Patent Call} = \text{Max}\left(S_t - X, 0\right) \tag{7.5}$$

and has the following parameters:

S_t = NPV of the potential licensing fees from three to ten years,
X = the patent capitalized R&D costs (assumed to be constant),
σ = volatility of the underlying asset,
r = the risk-free interest rate,
T = the call on the patent in three years.

The value of the patent call option with S_t = \$75 million, X = \$50 million, σ = 20%, r = 5% and T = 3 is therefore \$25.98 million. As the strategy is to use the patent to attract third-party developers to the platform, the patent call option value of \$25.98 million is capitalized, as the value is in the network effects of allowing the third parties to commit to the platform's functionality. In practice, an American binomial model would be used over the simple European Black-Scholes illustration used here to capture early exercise.

Bibliography

Baldwin, C. Y. and Clark, K. B. Design Rules: The Power of Modularity. MIT Press, Cambridge, MA, 2000.

Baldwin, C.Y. Design Rules Volume 2 - Chapter 14 - how technology shapes organizations - introducing open platforms and business ecosystems - HBS Working Paper 19-035 2018a

Baldwin, C.Y. (2018) "Introducing Open Platforms and Business Ecosystems", HBS Working Paper (October 2018b)
Baldwin, C.Y. Design Rules Volume 2, How Technology Shapes Organizations. Chapter 13, Platform Systems vs. Step Processes, The Value of Options and the Power of Modularity, HBS Working Paper 19-073 2018c.
Baldwin, C.Y. From step processes to platforms: A real options view of organizational design. Real Options Conference Keynote speech. Boston June 29 2017.
Baldwin, C.Y. Platform systems v Step processes - options and modularity. Chapter 13 Platforms vs Steps 6-15-18
Bridgwater, A. What's the difference between a software product and a platform? Forbes. March 17, 2015.
Clewlow, L. and Strickland, C. Implementing Derivative Models, Wiley, 1998.
Cotropia, C.A. Describing patents as real options, 34 J. Corp. L. 1127 (2009)
European Parliament. Intellectual, industrial and commercial property | Fact Sheets on the European Union. 2019.
Financial Times, Waters, R. Microsoft and Amazon face challengers from on edge of cloud, February 1, 2018a
Financial Times, Waters, R. Tech trends for 2018: the big will get bigger, Richard Waters, December 28, 2017.
Financial Times, Waters, R. The future of computing is at the edge, June 5, 2018b
Financial Times, Waters, R. Time to invest in skills for quantum computing revolution, May 17, 2018c.
Financial Times. Waters, R. Thornhill, J. Quantum computing the power to think outside the box, September 3, 2018.
From step processes to platforms: A real Options View of Org Design, C Baldwin RO Conference Keynote Speech, 6/29/17
Gilbert, R. J, Newbery, D. M. Preemptive patenting and the persistence of monopoly. American Economic Review, June 1982.
Greene, W.H. Econometric Analysis 8th Edition, Pearson, 2017.
James, G. Witten, D. Hastie, T. Tibshirani, R. An Introduction to Statistical Learning: with Applications in R (Springer Texts in Statistics), 7th Edition, 2017.
Kester, W. C. "Today's Options for Tomorrow's Growth." Harvard Business Review 62, no. 2 (March–April 1984): 153–160.
Kulatilaka, N., Balasubramanian, P. and Storck, J. Using real options to frame the IT investment problem, in Trigeorgis, L. (ed.) Real Options and Business Strategy, Risk Books, 1999.
Martin, K, Zysman, J. The Rise of the Platform Economy. Issues in Science and Technology 32, no. 3 (Spring 2016).
Pearson, N. An efficient approach for pricing spread options, The Journal of Derivatives, Fall, 1997.
Pitkethly, R. The valuation of patents - A review of patent valuation methods with consideration of option based methods and the potential for further research. Judge Institute Working Paper WP 21/97, The Judge Institute of Management Studies. March 1997.

Reiss, P, C. Wolak, F, A. Structural Econometric Modeling: Rationales and Examples from Industrial Organization, Handbook of Econometrics, chapter 64, Volume 6, Part A, 2007.

Sullivan, K., Chalasani, P., Jha, S. and Sazawal, V. Software design as an investment activity: a real options perspective, in Trigeorgis, L. (ed.) Real Options and Business Strategy, Risk Books, 1999.

The Economist, Can Sonos beat back the tech giants? Oct 20 2018a

The Economist. Google leads in the race to dominate artificial intelligence - Battle of the brains, December 7, 2017.

The Economist. The race is on to dominate quantum computing, August 18, 2018b.

The Rise of the Platform Economy, Kenney, Martin, and John Zysman, Issues in Science and Technology 32, no. 3 (Spring 2016).

Thomsett, R. Third Wave Project Management, Prentice Hall – Yourdon Press, 1993.

Vakulenko, M. Singh, S. The 9 Types of Software Platforms. Medium.com. June 12 2016.

World Intellectual Property Organization. Understanding Industrial Property. 2016