

# FROM RECIPE TO DINNER: BUSINESS MODEL PORTFOLIO IN THE EUROPEAN BIOPHARMACEUTICAL INDUSTRY

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## Abstract

This article builds on the analogy between business model and recipe, originally proposed by Baden-Fuller and Morgan (2010), to discuss the concept of business model portfolio. Based on the study of the different business models of four European biotechnology companies, we explore the notion of business model portfolio defined as the range of different ways a firm delivers value to its customers to ensure both its medium term viability and future development. Business model portfolios balance the level of promises and the level of interdependencies of business models. They are a way to articulate and finance the firm's activities in the medium run and to ensure idiosyncrasy to protect its future health. Build on the analogies business model/ recipe and business model portfolio/ dinner, they are described on concise and shorthand ways and propose principles to organise new ways to make money in existing activities.

## Keywords

Biopharmaceutical, business model portfolio, corporate strategy, coherence, value chain, activity

## INTRODUCTION

Original business models emerge in new industries and become rapidly iconic: the name of the instigator company serves as a label to name the business model and articles or case studies recount how the firm disrupted the traditional business logic. Those of firms that have shaped the biotech industry (such as Amgen, Millennium, Celera Genomics or Genentech) revolutionised the environment by inventing unprecedented ways to bridge upstream research, venture capitalists and large firms. Since their creation, the most successful biotech companies have generated revenues by implementing several different business models simultaneously to serve different customers. But the portfolio of business models underlying these success stories have been generally hidden by the most emblematic model. Firms even small ones manage a portfolio of business models to develop the market value of their activities and to generate revenue streams to balance the time lag between investment and revenues, risks, interdependency and expected returns.

The article examines the biopharmaceutical industry (i.e. pharmaceutical and biotechnology companies) to analyse how biotech firms manage portfolio of business models to deliver value simultaneously to different markets. Teece [1] defines a business model as the ‘way in which the business enterprise delivers value to customers, entices customers to pay for value, and convert those payments to profit’, and we define a portfolio of business models as the range of different ways a firm delivers value to its customers to ensure both its medium term viability and future development. Following Baden-Fuller and Morgan[2], we explore the analogy of business models as recipes. We argue that firms develop business model portfolio as hosts combine different recipes to cook dinner for their guests. The business model is only one element of the strategy. The analogy for the strategy of strategy of the firm is the dinner, which is a combination of dishes.

Using four in-depth case studies we explore how small biotech firms use different business model designs to generate added value and profit from their activities, and to create midterm viability by organising and combine these models at the firm’s corporate business architecture level.

The article contributes to current learning in three ways: first, it introduces and discusses the notion of a portfolio of business models as a way to articulate and finance the firm’s activities in the medium run and to ensure idiosyncrasy to protect its future health. Second, it analyses how young firms manage to build simultaneously a short term business and invest

into their future business. Third, it builds on the recipe/dinner analogy to discuss the combination of business models within small firms.

The first part of the article contextualizes iconic business models in the biopharmaceutical industry and explores the analogy between business models and recipe. It introduces the analogy between cooking the dinner and portfolio of business models. The data and methodology section then describes the four case studies of firms and their six business models, while the third section discusses management of a business model portfolio.

### BENEFITING FROM THE THREE MAIN ACTIVITIES IN THE BIOTECH INDUSTRY

The biotech industry has been the setting for much development in the commercialization of science, leading to the increasing role of university patenting [3]. Venture capitalists and governments supported the evolving biotechnology firms by providing critical resources and by developing an institutional environment that enabled partnerships between universities, science based start-ups and large pharmaceutical firms. Even if it is still a small industry, biotechnology received unprecedented interest from scholars who studied it as a model of the new economic organisation in the knowledge economy. Indeed, the emergence of the modern biotechnology during the mid 1970's coincided with the increasing role of science in the economic competition. Small biotech start-ups have been the way to bridge academia and large pharmaceutical firms. Within the highly regulated industry, science based start-ups are developing the scientific breakthrough results [4] via strong partnerships with pharmaceutical companies.

The drug development value chain is based on a drug development route that follows five well known (usually consecutive) steps leading to the market: research and drug discovery, preclinical studies (animal tests), phase I (early human clinical trials), phase II (medium-sized human tests) and phase III trials (large human tests). However, since 2000, the value chain has been de-integrated, and a new form of networked industrial structure involving highly specialised actors is emerging [5]. Large pharmaceutical firms fill gaps in their R&D pipelines and research portfolios by collaborating with smaller firms, buying or co-developing drugs at any stage of development [4]. In the Drug development model, small firms are involved in the riskiest stage of the process (drug development) funded by venture capital while pharmaceutical firms partner or buy out successful start-ups or SMEs, picking up actors developing promising results. Most biotech firms are specialising in one or two

elements of the classic drug development value chain (fig 1).

Figure 1: The traditional drug development value chain



The biotech industry also witnessed value chain de-integration opening up many opportunities for developing new activities. It did not only focus on products, but also on specific and high value added service elements. Experts (see appendix 1 and 2) usually identify two main activities in addition to the drug discovery process described in fig 1. (1) The architecture and recombination of knowledge from the biotech and biopharmaceutical industries, in which firms reorganise their knowledge to detect opportunities aiming to mobilise, combine or benefit from external knowledge. This activity is based on the ability of the firm to orchestrate knowledge from its partners rather than on its own ability to develop new drugs, and may involve value chain reconfiguration; (2) The processes optimization: Firms' managers - and the industry as a whole - promised to shorten drug development process and to reduce the drug development overall costs. As biotechnologies mature, costs become more significant, and the more efficient industrialisation of services, R&D or production processes, or the improvement of linkages between the two, become more important.

#### Business Models, from recipes to dinner

Baden-Fuller and Morgan propose to describe business models in three different ways: first of all, they point out that the most noticeable function of business models is to “operate as descriptors at the generic level”. They give us a way to describe different kinds of activities. Activities and organizations can be classified according their types of behavior. Second, they describe business models as tools. They argue that management scholars and managers are using business models as biologists use model organisms (like Arabidopsis or C. elegans) or like economists are using economic models. Set of business models are used to describe and give labels to ways of “how firms operate in various different generic ways and then classify firms (or activities) according to which kind of business model they follow”. They reason with models as a tool to inquire into how firms work, and to figure out relationships between their different elements so as to imagine how they might work. They also use it to assess the differences between different modes of functioning. Business models as a tool for inquiry is

especially useful when industries change rapidly. New technologies may require new business models to capture value, as in the biotech industry where scientists have been able to create value from the production of scientific results, extending the existing pharmaceutical industry value chain backwards towards basic scientific research. The existing business models are sources of inspiration for the creation of new businesses, based on innovative technologies.

Finally, an original view of business models proposed by Baden-Fuller and Morgan is business model as recipe. The recipe notion provides a set of ideal types to follow and recognize that variations exist between types and within types. They argue that business model defines the “business characteristics and its activities in a remarkably shorthand and concise way, in a way that matches the generic level that defines a kind or type of behavior, neither too general, nor too particular in its details” (Baden-Fuller and Morgan 2010). We deepen their original idea of business models as recipes by emphasizing the five elements which characterize recipes:

- The first element is a very general characterization of the recipe, to fit into general categories like entrée/main course/dessert or very easy/easy/difficult/very difficult to cook; quick/reasonable/long to cook or cheap/average/expensive dish or need oven, microwaves oven or freezer. Usually, in recent cooking recipe books, these categorizations come with pictograms which indicate the category of recipe.
- The second element is the list of ingredients and the required quantity. The list of ingredients is useful not only when you are cooking but also to plan and to establish your shopping list etc. The ingredient list is usually flexible, the recipe may be cooked without certain ingredients or some ingredients may be substituted by others. The good cook knows how to replace missing ingredients by others and adapt the generic recipe.
- The third element is the description of the different stages of the recipe, from the beginning to the final dish. Making the recipe supposes having tacit and implicit knowledge on how to put ingredients together. It also requires elements like casseroles, instruments etc. which are supposed to be available. The description requires enough details to be replicable and enough concision to be applicable. Recipes are based on principles rather than templates, giving broad direction to put ingredients together and to cook them rather than describing a full and detailed process. Adaptation and creative interpretation are usually welcome and depend on the ability of the cook.
- The fourth element is the photograph, picture, drawing of the dish to allow the cook to

make an ex ante representation of what it could be. It creates a benchmark, objectives to reach and gives also a visual representation of the category in which the business model is developed.

- Finally, the last element of recipe is the complementary elements of the dish. Which wine to drink with the dish, what can be the entrée or the dessert to accompany that dish, etc.

Table 1 presents the analogy between business model and recipe. It contributes to better define the components of business model and its limits. First of all, we propose to characterize business models in biotech on two dimensions, the level of the promise (which depends on the time lag between investments and revenues, risk and expected returns) and the degree of interdependencies with other actors. It pictures of business models as pictograms categorize recipes.

The second element - the list of ingredients and the required quantity - is the resources required by the business model to perform its activity: critical resources, resources possessed internally or not. The access to complementary resources conditions alliances and the position of the firm into the value chain [6] and the success of a business model in generating profit depends on the accumulation within the organisation of strategically important resources [7].

The different stages of the recipe refer to implementation sequence: from the informal and first business model idea to a process of trial and error shaping the final business model [8], or how to modify a business model following a continuous process: rethinking customers, technology, business system infrastructure and economics and profitability [9]

The representation of the dish, fourth element, corresponds to ex ante representation, the iconic business model inspiring strategists and managers. Most of contributions are based on case studies: Xerox [10], low cost airlines business model [11] or American Express[12] .

Finally, the analogy with recipe includes complementary elements like suggested garnishes, suggest dishes to cook a dinner and wine. The section 3 focuses on last point.

Table 1 sums up each element of the analogy between business model and recipe. It highlights that a specific recipe, as business model, is only a part of a dinner. It underlines the complementary elements which come with the dish of the recipe.

Table 1: Analogy between business models and recipes

	Recipe	Business model	Position of the paper
General characterization	Entry/main course/dessert Level of difficulty to cook Level of price Time to cook the recipe	Level of promise (lag between investment and revenues, level of risk and expected returns) Interdependencies with other organization	Presentation as a methodology to characterize business models based on literature review
List of ingredients	Main list Potential substitutes	Resources required Critical resources	Main papers: Lecoq et al. (Lecoq, Demil et al. 2006), Gambardella, McGahan (Gambardella and McGahan 2009)
The different stages of the recipe	Sequence of tasks to be done Sequence of putting the ingredients together	Sequence of events to implement the business model	Main papers: Brink and Holmen (Brink and Holmén 2009), Morris et al. (Morris, Schindehutte et al. 2005), Voelpel (Voelpel, Leibold et al. 2004)
Picture of the dish	Visualization of the dish cooked	Iconic business model and examples labeled with the name of iconic companies like Amazon, 3M, Dell or Google	Main papers: Magretta 2002 (Magretta 2002), Hunter (Hunter 2006), Chesbrough and Rosenbloom (Chesbrough H.W. and Rosenbloom R.S. 2002)
Complementary elements	Wine to drink with, garnish	Portfolio of business model	Discussed in section three

## DATA COLLECTION AND ANALYSES

To characterise business models and to explore how firms exploit business model portfolio, we build on case studies of European biotech SME and their business models. Data collection has been designed to gather data at two levels: business models and firms. We combine expert insights and case studies of business models to characterize the different business models related to the three main activities in biotech: drug discovery, architecture and recombination of knowledge and processes optimization. Then we conduct four case studies of European biopharmaceutical SMEs to gain fine grained analysis of business models portfolio, showing how young companies employ different models to optimise the allocation of their resources. First of all, based on existing contributions, the general characteristics used to present the business models are clarified. Then the four cases under study are briefly presented to understand how business models are articulated within firms.

## Categorization of business models

Business models have been categorized by management scholars ACCORDING TWO dimensions: first, the level of promises which depends upon the time lag between investment and returns which, the level of risks and the expected returns [13, 14] and second, the interdependencies with other actors [15].

Based on the analogy with cooking recipes, we can intuitively imagine that the level of promises differs if the recipe comes from “cooking for dummies” or from “The best recipes of haute cuisine chiefs”. In biotechnology, the level of promises sums up three elements: Time lag between investment and revenues, the level of risk and the expected returns. The time lag between investment and revenues characterises how and when a product or service reaches the market. It determines the firm’s ability to finance its day-to-day activities: if the lag time between investments and revenues is long, cash is burnt and firms’ activities must be funded by their other activities, or by venture capital. The lag time also affects appropriation levels – investors financing firms involved in R&D will appropriate part of the potential rents as their returns, and their slice of the action will increase the longer the product or service takes to come to market. The level of promises also covers the dimension of risks, both technological and financial. With biopharmaceuticals the technological risk is generally high and drug failure can happen at any step of the value chain (DiMasi, Hansen et al. 2003). When the time lag is long, the firm burns cash and several round tables are required to fund day to day activities. Intermediary results are usually difficult to assess [16, 17] and increase risk for the firm and for its investors. The third dimension of the promise is the Expected Returns i.e. the anticipated level of value generated by the activity, and the promises made by the firm to its shareholders in terms of the return they can expect on their investments. The level of the firm’s returns will depend upon the size of the targeted market, the amount of investment and the degree of its success in appropriating rents. When the time lag is long, expected returns must be high.

Interdependencies with other organisations are related to the levels of specificity of the firm activity. Afuah and Utterback [18] argued that during the emerging phase, assets and equipment remain generic. As the market matures, firms become more specialised and interrelations between suppliers and producers (and even consumers) will increase. When interdependencies are high and the firm needs additional competencies to perform its activity, alliances may be formed, complicating both its control of the activity and its ability to appropriate rents. When exchanges with other actors remain non-specific,

interdependencies are lower and the firm is better positioned to appropriate the generated rent.

Any business model can be characterised on the two main dimensions. Usually, business models on the drug development activity make high promises. They require long investment before the launch on the market; the activity is highly risky and often requires firms to ally to finance and pursue their activities, and such development activity is only possible because expected returns are very high. Delivering such promises is highly challenging. At the opposite end of the scale, a service business model, based on process optimisation, makes a reasonable promise, which may easily be delivered. It is characterised by shorter time to market, lower investment needs and smaller expected returns, which can enable the firm to carry through development internally.

### Business Models at the Firm Level

To describe business models and how they are enacted within a young firm, we focus on four companies funded after 2000. We employed the technique of searching for polar types, where an important guideline is to select cases that contradict patterns noted in prior cases study [19]. So we sought companies with business models that differed substantially from the fully integrated pharmaceutical company business model [5] that has been studied often. We selected four European biopharmaceutical companies which suited these criteria and agreed to be part of the study.

Data collection began with meeting the founders of the company and questioning them about the company's history, its activities and markets. Each interview lasts at least two hours and generated an overall view of the company's bundle of activities. (A high level of confidentiality was assured to secure access to strategic information.) The second phase was dedicated to analysing documents and cross-referencing internal sources against information from specialized press and website sources. The third phase comprised in-depth individual interviews lasting an hour and half with the CEO, chief scientific officer (CSO) and chief financial officer (CFO) of each firm, focusing on the financing model, the structure of costs, investments, scientific challenges, times to market and the revenue model. We also asked about the firm's partners and their levels of involvement, and about intellectual property issues around the firm's products or services, parameters which help us determine the company's business models and the way its portfolio is managed.

Data analysis starts by looking at how the firm designed its business model based on one of the three generic activities in the biopharmaceutical industry. Then the analysis considers the

firm as a whole, to discover how it combined its different business models to implement its overall strategy. Three of the four firms were managing a portfolio of different business models, while the other replicated the same business model in order to maximise its value proposition on different markets: we study how each enacts its business models to generate and appropriate rents.

### Presentation of the Four Cases

OphSmart is a small company of thirty people founded in 2005 which develops a pipeline of products all focusing the ophthalmology therapeutic domain. OphSmart is involved in two main activities: drug discovery and knowledge architecture. In the drug discovery realm, OphSmart specialises in upstream collaborations with universities to renew its own pipeline. In terms of knowledge architecture, OphSmart seeks to shorten drug development times by repositioning drug candidates in ophthalmology. These drugs are bought from other companies. Then OphSmart manages a network of firms to develop the molecules: it does not invest in manufacturing or laboratories, OphSmart externalises every step of the drug development. It therefore runs three interrelated business models concurrently: collaboration with universities to discover molecules; repurposing of existing molecules to its therapeutic domains and organising networks to form a virtual company. Each time, the business logic is based on a dense network of contacts, built up over the projects and over the previous deep involvement in the industry of the management team.

Emics is a small company run by a team of three people which, since its founding in 2003, has specialised in one therapeutic domain (a worldwide infectious disease) and is mainly focused on developing two vaccines that originated in the firm's in-house scientific collaboration with an academic laboratory. Emics engages in two activities successively: drug discovery to identify new potential vaccines, and knowledge architecture to orchestrate the vaccine development. Thus Emics has two related business models: the collaboration for discovery and the virtual organisation with its network of partners and suppliers to develop its vaccines, arranging its partners' different competencies to form a virtual vaccine company.

OpteX is a company of fifty employees, founded in 2000 which specializes in engineering and providing high value added services. OpteX has developed two activities: process optimisation and knowledge architecture. At the beginning the company proposed one business model based on process optimisation: the technology platform, and developed

know-how about optimisation of research and drug production processes. In 2004 it offered a complementary service - based on the same generic activity but with a different value proposition – by becoming a contract manufacturer, producing specific molecules for pharmaceutical companies. While the therapeutic domains addressed may be different, the technology underlying its two main business models - technology platform and contract manufacturing - remains the same. In 2008 OpteX started marketing technology brokering services, based on its new knowledge architecture activity that was building on its network of partners, clients and suppliers.

Betwin was founded in 2007 and employs a staff of five. Its main activity is knowledge architecture: the company buys a drug candidate at early development stages (first proof of efficiency or preclinical trials), then develops it through an array of partners and suppliers and resells the drug candidate after later trials (for example after phase II). Betwin has bought three molecules in different therapeutic areas in the past two years, replicating the same business model each time and creating a subsidiary for each project

## ADAPTING BUSINESS MODELS TO THE MAIN ACTIVITIES IN THE BIOTECH INDUSTRY

The empirical study shows that firms transform and adapt the generic activities in the biotech industry to design different business models. For each activity, one to three different business models are identified in the biotech firms<sup>ii</sup>.

### First activity: Drug Discovery

For the drug discovery activity, firms share risks with partners and aim to shorten the time lag between investment and revenues through collaboration. The Collaboration for Discovery Model helps to deal with the high risk/ long time lag inherent to drug discovery activities. OphSmart and Emics develop alternative sourcing of innovation by collaboration to share the risk and speed up the process of carrying out extreme upstream research to develop new drugs. They limit their investment and risk by specialising in upstream research and early discovery phases, and sign exclusive licences with their discovery partners to appropriate value. The time lag is shortened and investments are recouped by selling on drug candidates to partners lower in the value chain. Although the risk of drug failure remains, partnering allows firms to lower its own risk for the company. The collaboration for

discovery business model formulates high level of promises. Interdependency is also high - as the partner is a key to accessing knowledge - but expected returns, based on drug selling, are also high.

#### Knowledge Architecture activity

In that activity, firms create value by changing the architecture of knowledge of the industry. They develop virtual, repurposing or brokering activities to rearrange knowledge and benefit from it. Virtual business model focuses on drug development activities, but firms have no laboratory or no research or manufacturing capabilities and outsource almost everything, coordinating research that is actually performed by its partners. The business logic and source of value of this model are in orchestrating a network to develop a drug product, with product price and time and cost savings as the means of capturing value. Such virtual activities speed up the process of drug development and promise a medium time to market. As research execution is shared amongst the different partners, risks are reduced compare to drug development activities as less investment is required than in an integrated company, although - of course - this model is still sensitive on drug failure. The level of promises is medium as partners share the results. Interdependency with other firms is high because the core activity of virtual firms depends entirely on its partner alliances for access to knowledge, equipments and markets. The returns expected to successful drug development are high. OphSmart, Emics and Betwin all use this business model.

Repurposing business model consists on choosing a molecule in development or on the market for one therapeutic domain and repositioning it towards a new therapeutic domain as in the case of OphSmart. Choosing already developed molecules allows these firms to re-start the product development chain without having to go through the discovery phase. The value is created by the detection of the opportunity and the development of the product, and captured from time and costs savings as well as from product sales. The time lag is short to medium because the safety and efficacy of the repurposed molecules have already been proved in their original therapeutic domain, so pre-clinical and clinical trial stages are shorter. Risks are medium because the probability of failure is low, but drug development still requires investments for later trials and marketing. Interdependency with other firms is important as it is key to detecting opportunities, and successful alliances are necessary for taking the drug to its new market development: thus dividing the intellectual property rights can become a central (sometimes difficult) issue. These companies have a product that can

go to the market quickly: investments can be recouped and cash starts flowing. Expected returns are high, but limited compared to full drug development. The level of promise is medium in that business model.

Brokering business models establishes linkages between technologies and firms which are not yet connected like OpteX does. In this context it refers to the detection of a molecule in one company's pipeline that could interest another company, making the connections and managing the transaction between the two firms [20]. The market is not the drug market but biopharmaceutical firms. Detecting the opportunity is the source of the value creation, and value is captured when the technology broker receives a commission. So the time lag is very short and the risks are low (drug failure has no impact and few investments are needed). The level of promises remains low as the brokers articulate different competencies. Interdependency is high, as it is the basis of the company's business, but, clearly, expected returns are low compared to those of a product company.

All these activities are part of the knowledge architecture activities. They are undertaken by small firms with highly skilled and well informed scientists who are able both to combine different technologies, therapeutics and also to negotiate agreements with CEOs: Emics manages the development of two vaccines with only three people; OphSmart manages four repurposed drugs and four drug candidates with thirty people, Betwin manages three product with a team of five; OpteX management team connect previous clients and partners. Activities are performed at the value chain margins and accessing it through partners, sourcing innovation from other firms or connecting companies together to make deals. In these business models, firms articulate knowledge in original ways to produce new drugs or to offer new services that are unique on the market. Comparing to the traditional business model of drug discovery these business models reduce time to market and risks: managing an array of partners brings expertise at the much needed moment and reduces investments confronting to the fully integrated pharmaceutical company.

#### Process Optimization activities

The process optimisation activities deal with optimising drug development processes. R&D or production processes can be made more efficient, or linkages between the two improved. Optimisation concerns services, research tools or production. In our firm we found two business models built on it.

Technology platform business model includes engineering and technological developments,

molecule optimisation, screening, etc., and generally focus on the early drug development phases. They are many forms of platforms (such as open technology platforms, proprietary platforms, etc.) but broadly speaking they provide technological developments through service contracts or act as co-developers at some product development steps. This technological development activity creates value, which is then captured through the price of the service or the success of the drug or technology co-developed. The level of promises is low. Time lag is short to medium, and risks are low (in the simpler service case) or medium for co-development activities. Interdependency and expected returns are also low or medium, again depending on the form (contract or co-development partnership) of the activity. It was the initial business model of OpteX.

The Contract manufacturing business model, often called CMO (for Contract Manufacturing Organisations) is based on optimisation processes for the production of preclinical, clinical and final batches for other actors of the value chain. This business model is also in the portfolio of OpteX.

Activities in business models based on process optimisation are not core to the main value chain, but provide services for value chain actors. Firms provide the same kind of actions for any product, corresponding to the 'layer player' archetype [21]. With short time to market these business models generate cash in the short term.

Table 2 presents the adapted business models based on the three activities in the biopharmaceutical industry. Each of the business models improves at least one of the criteria: reducing risk for collaboration in discovery, maintaining high returns with limited risks for business models based on knowledge architecture and shortening time to market for optimisation business models. All the firms have developed specific business models within the same industry, organising them to address specific customers needs and to extract added value from their activities.

Table 2: Adapted business models

Business Model	Firms	Generic activity	Inter-dependency	Level of promises	Time Lag	Risks	Expected returns
Collaboration for discovery	OphSmart, Emics	Discovery	High	High	Long	High	High
Repurposing	OphSmart	Knowledge architecture	High	Medium	Medium	Medium	High
Virtual	OphSmart, Emics, Betwin	Knowledge architecture	High	Medium	Medium	Medium	High
Technology Brokering	OpteX	Knowledge architecture	High	Low	Short	Low	Low
Technology Platform	OpteX	Process Optimisation	Medium/high	Low	Short/Medium	Low/Medium	Medium
Contract manufacturing organisation	OpteX	Process Optimisation	Low	Low	Short	Low/Medium	Medium

### BALANCING A BUSINESS MODEL PORTFOLIO

The four studied companies have been searching for an attractive proposal to consumers and investors: companies based on drug discovery and development activities had to reduce time lag between investment and returns, downsize risks and deal with interdependency while keeping up high returns. So they searched for alternative business models, different from the Amgen business model, i.e. the fully integrated biopharmaceutical company and combine different business models. The business architectures of OphSmart, Emics and OpteX involve managing several business models simultaneously, with two generic activities in each case. But the cases also suggest that when the expected returns seem limited, actors adapt their activity to address a larger number of consumers or to reduce the investment: building a portfolio of business model, even for a small firm like OpteX, appears as a way to enhance expected returns. A key issue for these companies is to keep promises high and to moderate time lag and risks in order to attract investors, redeploying or extending the same business logic towards additional consumers. Betwin is the only one which invests in the same activity into different markets.

OphSmart's business model portfolio combines three business models to balance time lag, risks and interdependency to keep returns on investment high. To benefit from spillovers, all activities are intertwined: whether a molecule is repurposed or discovered in-house, it will be developed via the virtual development business model. OphSmart redeploys its activities to capture value at different stages of the value chain. Emics runs two business models based

on one generic activity each, allowing it to balance time lag and risks because, although these two criteria should be high (as in its discovery-based business model), they are lowered by its knowledge architecture activity. OpteX's business models do not promise high returns, but time lags are short and risks low, allowing it to generate short-term rents successfully. OpteX originally build on the process optimisation generic activity to manage two business models that were internally coherent -the technology platform and CMO-activities followed the same sequential drug development steps – and based on the same production optimisation business logic. But the firm also detected the opportunity of technology brokering on the value chain using the strong network of clients developed via its original business models - they naturally became both sources and customers for its new technology brokering model, with OpteX acting as a link between them. OpteX was able to align this new activity coherently both with its business sector and with its current activities. Once its three business models are stabilized the company will be able to take more co-development risks in its technology platform business model.

Finally, Betwin has one business model which it has replicated continuously, because it focuses on new opportunities created by intermediary markets, assures it of a medium time to market with medium risks and promises high returns to investment. Betwin's founders recognised this new opportunity on the value chain, and adapted their business logic specifically to match this profit zone. Betwin has developed capabilities to detect molecules and to organise networks to deliver them. So the firm is organized on a virtual business model to buy early developed molecules to create value for its customers and interprets specifically the business model of the virtual company to match exactly the profit zone identified.

These four companies show that business models can be balanced to insure short or medium time-to-market, which is important as it is difficult for small companies to survive the long period – of maybe twelve years - without turnover and profit involved in longer-term models. Long time lags between investment and the first generation of turnover can often lead to rejection by investors, whereas being able to promise mid-term rents can reassure shareholders that they will see a return on their investment within five years.

Table 3 sums up each firm's business model portfolio, and emphasises the relationships between the generic activity mobilised and the relationship between business models.

Table 3: Business model portfolios

	OphSmart	Emics	OpteX	Betwin
Core Activities	1 Drug discovery 2 Knowledge Architecture	1 Drug discovery 2 Knowledge Architecture	1 Process Optimization 2 Knowledge Architecture	1 Knowledge Architecture
Business models	1 Collaboration for Discovery 2 Virtual, 3 Repurposing	1 Collaboration for Discovery, 2 Virtual	1 Technology Platform, 2 Technology Brokering 3 CMO	1 Virtual
Relationships between business models	Complementary at different stage of the value chain	Complementary at different stage of the value chain	Complementary resources	Replication of same business model
Therapeutic domains	Identical	Identical	Identical (or close)	Different

The drug development route is long and highly risky. However, a drug which becomes a blockbuster appears as a jackpot. To cope with this polar situation, firms invest in different business models to limit the level of risk and to reduce the time lag between returns and investments for part of their activities. Within the generic drug discovery activity, firms form alliances to reduce risks and to benefit from additional competencies to develop new drugs. Involved in dense networks to perform their activities, they need to be able to manage interdependencies effectively. For firms investing in knowledge architecture activity, their activity is to manage linkages with other actors, and they are thus also highly interdependent. Finally, firms that invest in optimisation, and whose business is to optimise other actors' production processes, so they, too, depend on others. These business model portfolios portray an interesting link between with promises and interdependencies. So (compared to fully integrated pharmaceutical companies), small firms have found ways to promise high value, medium risk and acceptable time lags provided that they accept high interdependencies. In those new business models, firms are involved in dense networks, sharing returns and decisions.

## DISCUSSION

With Baden-Fuller and Morgan, we emphasized the role of business model as model of activity to describe how firms operate in various generic ways and then classify these activities according the model they follow. We form the notion of business model portfolio to define a range of different activities allowing a firm to meet different consumers' needs

and build the idiosyncrasy of the firm's bundle of activities. Business model portfolios highlight the uniqueness of the combination of resources to deliver value propositions. The analogy with recipe and dinner proposes shorthand ways to characterise business models and business model portfolio and ways to articulate original combination of activities within small firms.

#### Business model portfolio in small firms

In maturing industry, specialisation and division of work within the value chain create opportunities for firms to design new business models and new value propositions. Small firms engage in biotechnology activities by transforming the ways of creating values in those activities. The creation of original business models leads to various ways to translate firms' core competencies. The existence of a portfolio of business models reveals the firm's maturity as it develops from the start-up phase (based on a single business model) to managing a more complex architecture designed to reduce risks and maintain equilibrium across a variety of activities. Case studies reveal that firms tend to add activities that relate to some aspect of their existing ventures, either based on the same core competence or developed to take exploit certain common technological and market characteristics. Different business models can be driven by similar business logics, when they extend the market niche addressed or the services or products offered to similar audiences. Companies may run parallel, vertical integrated business models to cover more sectors of their value chain, and their consecutive articulation can allow the firm to benefit from synergistic effects, adding more value for customers and (hopefully) more profit for the firm.

#### Business model portfolio and Strategy

The concept of business model highlights that within the same industry, within the same activity, there are different ways to make money. It is thus a tool to position the value proposition in the value chain. Business model portfolio focuses on the internal balance of the firm activities. Different business models can be driven by similar business logics, when they extend the market niche addressed or the services or products offered to similar audiences. Companies may run parallel, vertical integrated business models to cover more steps of the value chain, and their consecutive articulation can allow the firm to benefit from synergistic effects, adding more value for customers and (hopefully) more profit for the firm. Table 3 presents the different strategic positions in portfolio of business model. It

emphasises the two main dimensions to deal with the level of promises and interrelatedness between business models, which deeply affect the organisation of the activities. On the one side, it aggregates technological and financial risks, expected returns as well as modes of financing of the activities between investment and returns; on the other side it assesses the degree of relatedness between existing activities within the firm.

Table 3: Balancing business models portfolio

		Level of promises		
		Low	Medium	High
Interrelatedness between business models	Highly interrelated	Low expected returns for firms mainly involved in service activities. They may serve different interrelated customers.	The firm addresses the same market balancing long time lag business models based on the product development and short time lag business models like those based on knowledge architecture	High expected returns. The firm is highly dependent on external funding. Long time lag. Highly risky for the firm which may generate rents on the long run but the question of rent appropriate remains open
	Disconnected	Pure diversification, based on different activities	Running short and long time lag disconnected activities to balance the portfolio	The firm is investing simultaneously in highly risky business. Based on diversification, such a strategy is too risky for independent firms. Only subsidiary companies may invest in such a strategy

Table 3 presents six business model portfolios for the firm. When the business models are disconnected, running portfolio of business models represents a diversification of activities. If time lag is long, it is a highly risky strategy for small independent firms to run simultaneously disconnected activities. The firm has to fund day-to-day activities through venture capital and it has to convince venture capitalists to invest in disconnected activities, which is virtually impossible. Running simultaneous disconnected business models when the time lag is short is a diversification of activities. Risks remain low as the time lag between investment and returns is short. Medium time lag reveals that the firm is running disconnected business models, with different time horizons. Short time lag may fund the long time lag activities and balance risks, expected returns and cash generation.

When the business models are related, the firm articulates different activities based on the same competence. Firms involved only in drug development are facing highly risky activities while the articulation of different activities around the same technology or competence may balance returns and time horizons. Business models portfolios built by OpteX, OphSmart and Emics balance time lag and interdependencies of business models.

They offer a range of strategic options for entrepreneurial firms. For young firms which have limited resources, the development of a business model portfolio should be based on interconnected business models to limit risks and to benefit from its competencies in different ways. Building and managing a business model portfolio has been a way for small European biotech firms to develop value propositions that balance time lag between investments and revenues, risks, expected returns and interdependencies with other actors.

## CONCLUSION

The need to understand business models and business model portfolios – as concepts and a tool – will intensify as start-ups and small firms increasingly become the cornerstones of economic development. The concept of business model bridges internal organisation and market orientation. A business model portfolio encapsulates the firm's strategy to balance multiple activities, balancing the level of promises and the level of interdependencies. It conceptualises firm diversification within the same industry to generate and capture rents. Finally it illustrates two generic strategies: core competence extension to enlarge the market and to address additional customers and core competence redeployment to serve similar market with the same core competence.

The analogy between business model portfolio and dinner is fruitful as it underlines that concise and shorthand ways to describe and characterise firm activities provides managers with principles rather than template. They have general ideas and guidance to be adapted to the singular situation. Dinner also calls for contextualisation: a dinner is cooked for guests and the cook tries to adapt the dinner with what he perceives from the guest's expectations. The choices of the complementary elements of the dish (wine, desserts, etc.), besides the specificity of the dish due to choices and adaptation of the cook, make the overall dinner unique. In the same way the portfolio of business models insure the idiosyncrasy of the firm because of the choices of managers in building the portfolio, creating business models on complementary resources or addressing new markets with the existing core competence of the firm.

For managers, the concepts of business models and business model portfolios are particularly useful to understand that firms can pursue multiple business models within one strategy. This meso-level analysis generates descriptions that allow strategists to better

position the firm activities. In addition, industry matures, and its activities, actors and their relationship are continually evolving. Business model exploration is necessary and a company with a balanced business model portfolio can develop its experimental business model when other business models ensure medium run objectives. The analogy with recipe and dinner underlines the importance of principles to be guided in new and emerging activity. The categorization of business model according their level of promises and their level of interdependencies provides managers with key landmarks to run existing and new businesses.

For a firm that is deeply embedded in networks, when its frontiers are becoming blurred and its value chain shifting, the notion of the business model portfolio can help improve the coherence of its resource and capability allocations between activities. It drives an analysis of the firm that can allow it to adjust its position on the value chain and its mechanisms for value creation and capture. Managers who initially developed the concept of the business model were searching for a strategic tool that could take into account the problems of how to address several markets with a pertinent value propositions, and how to develop a flexible architecture to do business in complex environment. When value chains are continually reconfigured, heralding the appearance of new zones of profit, a company managing a business model portfolio can easily construct and reorganise its activities in coherence with both the firm and with the evolving environment. Managing a business model portfolio helps piloting the promises made by the firm to its shareholders and clients, and interdependencies. It can give clear indications of synergies that exist - or that should or might exist - between its different activities.

## Appendix 1: Interviewees

Respondent 1	Vice-President (in charge of European activities) for one of the largest biopharmaceutical companies famous for its biotechnology products He has worked in the biopharmaceutical industry for many years, having started as a scientist thirty years ago in a big pharmaceutical company
Respondent 2	Scientific Director in charge of scientific strategy of a world competitive cluster providing a healthcare shield against infectious diseases, and centre of excellence in diagnostics and vaccines.
Respondent 3	Research Director in a National Institute of Health. Having focused for years on antibodies research, he runs a team looking for therapeutic targets and drug candidates.
Respondent 4	Head of the pharmaceutical department, French Ministry of Finance and Economics, this respondent negotiates with biopharmaceutical companies about reimbursement levels and French market access conditions.
Respondent 5	Research Director in a Centre for the Study of Drug Development, a specialist observer of the biotechnology industry over years and published widely in academic as well as managerial reviews.
Respondent 6	CEO of European Start-up who has worked in the biopharmaceutical industry for more than twenty years and previously founded two other start-ups. His current start-up, founded in 2006, is a nanomedicine company that intends to revolutionize drug delivery and drug addressing.
Respondent 7	CEO of European Start-up (founded in 2006) in parallel with his position of Research Director in a National Health Institute. Start-up business based on a promising technology for radio labelling, preclinical studies and radiopharmaceuticals synthesis; intending to assist other companies in strategic decisions for selecting and developing drug candidate molecules/biomolecules.
Respondent 8	European Start-up Chief Scientific Officer, founder of an information technology firm that provides customized IT solutions for drug development or patients' observations.
Respondent 9	European biotechnology medium company CEO who founded his first company in 2000 to provide propose high value added services for drug development.
Respondent 10	European biotechnology medium company CEO manages a biopharmaceutical company dedicated to the discovery and development of products innovation for a specific disease.
Respondent 11	European biotechnology medium company CEO who manages a biopharmaceutical company founded in 1990 dedicated to the development of vaccines against infectious diseases.
Respondent 12	European biotechnology medium company CSO is the co-founder of a biopharmaceutical company, and manages its scientific programs, collaborations and participations in European consortia.
Respondent 13	European biotechnology medium company Chief Scientific Officer in a company developing vaccines having started his career in a prestigious academic laboratory.
Respondent 14	European biotechnology medium company COO of a biopharmaceutical company dedicated to product discovery and development. He started as a scientific researcher, and has since been involved in the management of many companies.
Respondent 15	European biotechnology medium company CFO for a product-based firm. He has worked in the biotechnology industry for many years and conducted two Initial Public Offerings in different companies
Respondent 16	CFO of European biotechnology medium company European biopharmaceutical company quoted on the NASDAQ.

Appendix 2: Extracts of interviews that helped us to determine the three generic activities present on the drug development value chain.

Generic activity at basis of activity	Discovery	Knowledge architecture	Process optimization
<p>Verbatim extracts from experts' interviews</p>	<p>'This business is about finding the most promising drug' Resp. 6</p> <p>'We discover and patent our drugs and we develop it until phase II' Resp. 11</p> <p>'the company focuses on the development of its pipeline' Resp. 1</p> <p>'We take out a patent for every drug candidate' Resp. 1</p> <p>'These companies are doing in-house research and develop their drugs until phase I or II' Resp. 4</p> <p>'We negotiate with companies that bring to market innovative drugs.' Resp. 4</p> <p>'The collaboration with the academics is very important. I collaborate with experts of the field in order to find the most promising approach for our vaccines' Resp. 13.</p> <p>'Discovery is the heart of our business' Resp. 1</p> <p>'We are developing drug candidates and this is what the shareholders are looking at.' Resp. 16</p>	<p>'Those companies work in network and buy product they did not discover' Resp. 2</p> <p>'Cost is one reason to revisit existing drugs and it can be the centre of a business' Resp. 15</p> <p>'The technology broker are selling intellectual property' Resp. 2</p> <p>'Our company also proposes a catalogue of drug candidates' Resp. 12</p> <p>'Our challenge is to create a comprehensive clinical drug library to screen every neglected disease by 2015' Resp. 7</p> <p>'the virtual companies are developing drug with a network of partners and suppliers' Resp.1</p> <p>'The drug development is so long and so complicated that often the company who discover the molecule is not the one which brings it to market' Resp. 4</p>	<p>'some technology platforms are quiet big in Europe and have found a profitable market segment because they provide very specific services' Resp. 3</p> <p>'we provide high value added services for drug development' Resp. 9</p> <p>'these firms propose advanced tools for research and drug discovery' Resp. 5</p> <p>'We are specialized in the process development' Resp. 9</p> <p>'We are a company specialized in clinical trials and sell it as a service' Res. 5</p> <p>'The companies specialized in safety and evaluation are essential' Resp. 2.</p> <p>'the manufacturing is an important activity and we are working with Contract Manufacturing Organisations which are only doing that' Resp. 14</p> <p>'We outsource the formulation because it has to be done by specialists' Resp. 10</p> <p>'This business is about providing customized IT solutions for companies who are developing drugs' Resp. 8.</p> <p>'We also propose specialized tools to follow clinical trials' Resp. 8</p>

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<sup>ii</sup> The list of business models is not exhaustive and intend to present only the business models revealed by the empirical study.