DIGITAL ASSEMBLERS:
THE ECONOMICS OF NEW BUSINESS MODELS

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Abstract:

Assembling consist in gathering goods and arranging them in packages to provide customers with modular goods that fit to their needs and preferences. The paper proposes, first, an analytical framework aimed at contrasting the possible business models available to produce these composite goods. It is based on four criteria: whether the assembling is performed by an intermediary or by the final user, whether the integration among components of the good is based on generic or specific standards, whether the users are granted with specific or generic rights of uses, whether the demand or the supply can capture the information generated by the consumption of the good. We then develop a theoretical model aimed at understanding the economics and the sustainability of these various models. We focus on assemblers’ strategies and we show that they face a trade-off between capturing rents and sharing it with the providers of components. It enables us to explain under what conditions monopoly can emerge in assembling, or to the opposite providers of function can successfully exploit “niches” where they will directly market their products, or competitive assemblers can survive by differentiating. Conclusions can be then drawn on the way competition among potential intermediaries can impact on the organization of transaction chains, and on the volume and distribution of transaction costs.
1-INTRODUCTION

The massive diffusion of computers and electronic networks has been transforming deeply the economics of activities based on information, either its diffusion or its production. With the raise of the last generation of Information and Communication Technologies (ICTs), symbolized by the Internet, information goods and services are characterized by variable costs (of reproduction) tending toward zero and strong and multiple network externalities. Those features are due both to the particularities of the technologies that have been developed to manage information — those technologies being characterized by fixed costs of R&D and very low variable costs of production, by increasing return of adoption, by standards of interoperability reinforcing network externalities, etc.; cf. Varian & Shapiro [1998] — and to the specificities of information as a good (Arrow [1962]). The production and exchange of information goods and services are now characterized by a set of new characteristics and the notion of Digital Economy is often used to qualify the new economics of information industries. These transformations have a huge impact on our economies for at least two reasons. First, the way information can be managed impact on the way economic agents can coordinate. The new technical capabilities make it possible to implement (or generalize) new forms of organization, impacting on efficiency and distribution of wealth. Second, digital activities constitute an organizational laboratory. Since they are characterized by specific and quasi-pure constraints (such as marginal costs nearly equal to zero), organizational innovations in production, in marketing, or in the regulation of players are facilitated. These innovations can then be adopted in other industries1.

Among the innovations carried out by the digital economy, new business models are central. This buz-word has been popularized in the second part of the 1990’s to designate the new way of organizing the relationship between the supply and the demand of information goods and services. Indeed, with the raise of the Internet, many technology, information and services producers have been increasingly relying on the specific feature of information networks and technologies to serve the customers on an innovative basis. The most visible aspect of these new models was that these services were (partly) free. Indeed, because of fixed cost, of the increasing returns of adoption, of the potential locking-in of customers, (etc.), it was considered possible to rely on future or derived revenues to finance the providing of free information services, at least for the take off period of the market.

With the passing of time, it is easier to identify the commonalities among these new business models. According to us, they combine a new way to organize the relationship between demand and supply, and pricing strategies that take into account network externalities, the specificity of information and the ability to differentiate and

1 Digital activities are unique since many of their characteristics tend to be pure and because they are typified by a specific combination of those features. However, many other economic activities resemble to some extent to digital ones. Moreover, with the raise of the knowledge based economy, most of economic activities get closer to the characteristics of the digital economy, because the share of fixed (R&D) costs is raising, because (cognitive) externalities tend to become more important with the technological hybridization of goods and services, etc., and new organizational models can then be implemented.
discriminate thanks to digital technologies. Because they combine the ability to process quasi-instantaneously huge amounts of information, the capability to store it at low cost in a way that allows fast and smart retrieving, and the power to transmit it through a seamless, universal and global network, ICTs provide economics agents with extended capabilities to coordinate and to manage transactions. Moreover, the ability to code any type of information into digits and to manage them thanks to automated processes allow controlling the use of information — thanks to encryption and tracking; see Brousseau [2003].

Digital technologies in network, and the Internet in particular, led to focus the attention of many scholars on the impact of these technologies on coordination among economic agents. Indeed, because it is a cheap, pervasive and global technology, the Internet seems to be a permissive condition for a significant reduction of transaction costs. Its ability to reduce search costs and to allow on-line negotiation to settle deal could even make of it the technical infrastructure on which a "walrasian like" matching between demand and supply would occur. However, this model of costless and neutral intermediation between demand and supply remains a pure fiction, since transaction costs, while reduced, remain superior to zero. Moreover, while shrinking, the costs of managing information do not tend to zero. Information is still costly to manage, because ICTs have a cost, and (essentially) because agents can benefit from the strategic exploitation of their private information. In that context, intermediaries — i.e. these agents that dedicate their production means to provide services aimed at facilitating coordination among suppliers or between them and the final consumers — are of importance because they impact on the organization and the efficiency of the exchange system.

Facts also lead to focus on intermediaries. Indeed, many of the Internet success-stories involve them. E-Bay, Amazon, Google, Yahoo, Autobytell, are all intermediaries. Their success is based on their ability to facilitate of organize exchanges between providers and customers of informational or tangible goods. As pointed out by Brousseau [2002], they can perform various tasks. By managing information about customers’ demands and suppliers’ proposals, they facilitate the matching of their plans. By performing logistic operations (as holding inventories or moving goods), they adapt these plans when they do not spontaneously match. By dealing with information asymmetries between the two sides of the markets, they help to solve problems drawing from adverse selection, moral hazard, and defaults of enforcement. By ensuring the liquidity of exchanges when necessary, they allow market clearing. There are however, very different ways to perform these tasks, and intermediaries can in addition choose to perform only one of them or to provide them all on a bundled basis; leading to a wide range of possible business models.

These intermediaries relying on digital networks to experiment new ways of coordinating supply and demand might have in the long run strong impacts on the

\[2\] The fact that digital technologies allow to manage in the same time the object of the transaction and the information controlling this exchange facilitates the development of these new business models in the information sector. However, new business models can also be adapted to activities that are not purely informational. Indeed the coordination and pricing principles on which these models are based can be partly implemented (and sometimes already exist) in tangible activities, or in informational activities that do not rely on digital technologies.
organization and the performance of the economy, on the structure of industries and on the properties of markets. However, since alternative models can develop, it is essential to understand how the providers of these services can cover their costs (direct sales, subscription fee, advertisements, etc.), what are their incentives to provide alternative intermediation services (i.e. Are these alternative models characterized by contrasted levels of pay-off?), how these models compete among each other, what is the value added by these intermediaries, etc.?

This paper seeks to provide insights on the economics of the new business models in general and of the business models of digital intermediaries in particular. We propose first an analytical framework aimed at dealing with the economics of New Business Models in general (section 2). Then, we will investigate the economics of a specific category of intermediaries: assemblers (section 3). Indeed, we will point out in our second section that New Business Models are strongly influenced by the modularity of digital technologies and information goods. Digital goods are made of complementary components that are assembled together in order to address complex needs. One of the roles played by intermediaries is precisely to assemble components to bundle them in packages that correspond to consumer needs. In our view they do not match a demand with a supply that \textit{ex ante} fits consumers qualitative preferences, they qualitatively adapt the supply to the demand.

The category of intermediaries we are interested in is both very large and different from the category on which the existing literature focuses.

- Assemblers range from these software companies like Microsoft that buy various components of a software and combine them with its built-in components to provide users with a ready-to-use package that correspond to a category of usage, to these portals that provide information services to their customers by arranging access to various information services provided by third part. Many media companies are also assemblers in the sense that they buy entertainment or news to assemble them in packages adapted to various customers’ categories (corresponding to channels in TV broadcasting). There are moreover assemblers outside from the digital world. Automakers, for instance, are typically assemblers of various components made by independent producers specialized on various technologies and functions.

- This wide category has however to be contrasted with what is generally qualified as infomediaries in the literature. Infomediaries often refer to Referrals, Shopbots, Gatekeepers\footnote{For the referrals, the model of Autobytel.com is well described in Scott Morton F., Zettelmeyer F., Risso J. (2001). Smith and Brynjolfson (2001) and Smith (2002) analyze a gatekeeper specialized in the books price comparisons. Baye, Morgan and Scholten (2001, 2002) describe the gatekeeper Shopper.com that enables firms to advertise the price of their products, mainly electronic and digital products (camera, laptops, printers, scanners…).} These players are specific in the sense that they are essentially information brokers aimed at reducing search costs. They do not directly participate in the transaction and are in that sense very different of what characterize commercial intermediaries for Spulber [1996] since they don’t hold any property rights on the exchanged products. This later characteristic is essential according to Spulber because it allows intermediaries to rearrange the supply, to make it compatible with the customers’ preferences.
The existing literature focuses mainly on electronic brokerage; i.e. on these infomediaries that facilitate the matching between suppliers and consumers or that improve market transparency, but without being directly involved in the transactions. For example, Baye and Morgan (2001, 2002) have been interested in the business models of Internet gatekeepers. These digital intermediaries provide information on the prices and delivery conditions for thousands of products offered by firms subscribing to their service. Baye and Morgan analyze the optimal pricing strategies for a gatekeeper. That later has to request advertising fees to firms (that want to advertise their prices) and subscription fees to customers (that want to collect information on marketing conditions). Baye and Morgan found that the gatekeeper should set low subscription fees to attract most consumers and set high advertising fees to limit firms’ participation to its site to maintain, thus, price dispersion on the market. The latter condition is important since the added value of a gatekeeper arises from the persistence of price dispersion. Whereas full participation by firms would lead to a unique price, a partial participation maintains price dispersion, thus enabling the gatekeeper to make profit. According to the authors, the firms that advertise on the gatekeeper’s site set lower prices than the firms that do not advertise on the site, but get larger market shares⁴.

The business model of matchmakers (Jullien, Caillaud, 2003) is quite similar to the gatekeeper’s. However, the economics of matching relies strongly on network externality (direct and indirect), and the role of a matchmaker consists in attracting as many providers and consumers as possible on its site to stimulate network effects. It is optimal for a matchmaker to target full participation of customers and firms, whereas it is in the interest of the gatekeeper to target partial participation of firms. This later approach has to be linked to the growing literature on two-sided markets, on which a service provider face two interdependent demands (because there are network externalities; e.g. between credit card holders and affiliated retailers), while inefficient bargaining conditions prevent the two sides of the market to share the surplus resulting from an efficient matching. Intermediaries can then implement discriminating pricing strategies to ensure the maximization of their surplus by playing on cross-subsidization (e.g. Rochet & Tirole [2001], Parker, Van Alstyne [2000]).

In this paper, we want to investigate another business model of digital intermediation: the assembler's one. The added value of an assembler comes from the modularity of digital goods. Contrary to a gatekeeper, the rationale for an assembler is not price and propensity to pay dispersion, but modules dispersion and the heterogeneity of preferences. In this paper, we aim at analyzing the pricing and packaging policy of an assembler. We also consider the impact of competition between assemblers.

2- A TYPOLOGY OF DIGITAL BUSINESS MODELS

The goal of this section is to propose an analytical framework aiming at grasping the essential dimensions of digital business models in order, first, to differentiate them according to the smallest possible number of dimensions, second, to analyze the economics of alternative models. The resulting framework should enable us to analyze

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⁴ See also Saliba (2003) for an extension of this model to heterogeneous markets.
the economics of existing and future business models implemented by the providers of digital or information goods.

Our goal is to be exhaustive in being able to deal with most of the possible business models, while remaining parsimonious in describing them thanks to the fewest possible number of dimensions. We will then first identify the relevant dimensions to contrast various business models. These dimensions will be drawn from what we consider as being the essential features of digital markets either because they contrast modes of value creation, or because they describe the constraints that impact the organization of the relationships among players. Then we will point out the alternatives that contrast business models along these different dimensions. The combinations of these (discrete) alternatives should enable us to describe most business models.

Before detailing the various features that characterize BMs, we will first detail our vision of digital activities.

21- DIGITAL ACTIVITIES AS MODULAR ACTIVITIES

We seek to grasp the way demand and supply coordinate in the case of digital intensive goods and services. It can be information goods, or services that have a tangible component but that are distributed thanks to digital networks (which are used to provide information intensive additional services). Our analysis is based on three assumptions.

Assumption 1: Digital goods and services are of a modular nature. Basic components — corresponding to “functionalities” — are assembled to produce services that meet consumers’ needs. Consumable services that have a value of use are therefore made of “packages” of basic functions.

This fits with the Lancaster [1979] vision of consumption and goods. Consumers are seeking for a collection of attributes. In the case of digital goods, basic attributes are the contents or the processes associated to a digital sequence or to a tangible device. A specific combination of processes and contents results in “composite goods”. In the line of Economides and Salop [1992] and Economides [1996], one can analyze how different industry configuration result in various patterns of competition among the suppliers involved in the production of these functions. Indeed, the way the assembling of this package is made is a major factor of singularization of the different models. Moreover, the competition between two “provision schemes” plays at two levels. First, a single need can be met by “packages” of different functions (just as a transportation need can be met by different technological systems: road, rail, air, corresponding to various packages of services). This leads to a competition among packages that are close substitutes or not. Second, a given package can be assembled through different (organizational) processes. That leads to a competition among organizational models.

Assumption 2: Digital activities are characterized by three basic operations:

- The production of functionalities. Functionalities result from the providing either of tangible goods or information services, or a mix of them. It corresponds either to an informational content or to an informational process.

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5 We present here the assumptions that are specific to our analysis. Of course we accept standards assumptions about the economics of information and knowledge that are fixed prices goods, of public nature, etc. See Shapiro & Varian [1998].
• **The assembling** of functionalities. Each functionality does not produce any value of uses by itself. They are multipurpose, and have to be combined with each other to result in a service that fit to particular needs of a specific category of users.
• **The consumption** of services by which a user transform a service in value of use (either because he is satisfied — in the case of final users — or because he can use the service to generate new service or new knowledge — in the case of producers).

This second assumption mostly draws from the first one. Digital goods are composite goods made of components that are multipurpose in the sense that they can be implemented in different goods, but that do not produce any value of use *per se*, because the information set or the informational process does not fit directly to any concrete need. This is therefore through the combination of these functions that needed services are produced. Software is a good example. A spread-sheet or a word processor, or even a more specialized software aimed at managing financial operations small business, are made of basic components that manage the screen, the hard-disk, the printing resources, and that operate basic — e.g. sorting, calculating — or more sophisticated operations on information — e.g. checking grammar or turning tables into graphical representations —. Any software is made of basic components that are useless when considered alone, and that are recombined differently in various softwares. The same apply for many information services or databases. They are produced by combining data or information flows (usually coming from heterogeneous sources in contrasted formats), with processes to organize, stock, retrieve and distribute them.

**Assumption 3: Users (or consumers) are not neutral in the process of value creation**, since they can themselves assemble the functionalities, and since their use of the digital goods generate information that is itself generating value of use.

This second assumption relies on two ideas.

• First, digital technologies are an ensemble of integrated techniques that rely on a common basic principle: the transformation of any signal — whatever its form (voice, image, text), or its nature (content or process command) — in a set of digit that can be processed and transmitted by the same technical system according to similar procedures. This generates a de facto meta-standard that strongly facilitates the integration and the interoperability of digital sequences and digital information processing devices. Those agents who want to integrate heterogeneous digital components have “simply” to manage interfaces; i.e. to implement gateways and translators among them. By contrasts, in the case of many other technologies, interoperability among components is more complex and costly to manage because it does not depend on the management of interfaces only. Often components have to be designed in function of the other components. There are mutual specializations among components (corresponding to the idea of asset specificity in the sense given by Williamson [1985]), while in the digital technologies most components are compatible among each others (as soon as interfaces are appropriately managed). This gives the consumers the opportunity to credibly become their own assembler. There are many examples of that in the digital industries. Most PC owners, for instance, assemble themselves a set of hardware and software resources to

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6 This characteristic is obviously reinforced by the public nature of information goods and the tending to zero reproduction costs of digitized information.
customize their information system. The users of open-source software are also most of the time their own assemblers. This capability organizes therefore a virtual competition between consumers and specialized assemblers. McKelvey [2001] describes such a competition about various modes of assembling, and we seek to investigate the economics of the interaction among these alternative ways of producing digital goods.

- Second, on a market for information or on a market for knowledge, the supply and the demand side are difficult to disentangle since any agent is both information (or knowledge) user and producer. There are of course very different situations ranging from the spontaneously generated evaluation by the consumer on his satisfaction resulting from the consumption of a service, to the innovation he can derive from what he learnt, and including his insights about the way the services could be better adapted to his needs or enhanced. Actively or unintendendly, the user of a service generates information, and sometimes knowledge, which can be of value, either for the other users (who could benefit of information on the quality of the service or on its optimal condition of use) or for the agents involved in its production (who could better target or design their output). To the limit the “user” can be an intermediate producer whose information output results from the information he consumed. This is typically the case for the developers in open source software communities who “invent around” existing inventions, for many digital artists that rearrange digital contents to produce new works of authorships, or for many consultant that reorganize and synthesize existing information.

To sump up, digital markets are characterized by the fact that there is no complete separation between the demand and the supply side. The users are both final users, in the sense that they consume the services provided by the suppliers per se, and suppliers of intermediate goods and services. Given this they are both potential providers of complementary service and potential competitors for the suppliers of functionalities, and the providers of assembling services. They can provide the suppliers of functionalities with useful knowledge and information to enhance them, or they can themselves become producers of functionalities. They can provide the assemblers with information enabling the later to target more efficiently the users, and can also decide to substitute to them by assembling the final services for themselves.

Figure 1 synthesizes these assumptions setting our analytical framework. Digital markets can be described through the organization of the relationship among three categories of agents: the producers (of functionalities), the assemblers and the consumers. The later consume services, which are packages of functionalities assembled either by themselves or by intermediaries: the assemblers. The consumption of the service generates information that can become an input, either for producing functions or for assembling them.

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7 Figure 1 describe the case in which the consumer provides its feedback information either to the producers of to the assembler, the three operations seem therefore to be split among three different types of actors. However, our framework takes into account the case where users internalize the assembling. Moreover the case in which the user becomes a functionality provider is just a limit case of our model, which could be considered, as such, just by taking into account this specific situation into the parameters when it is modelized.
Our analysis of digital business models will consist in identifying the way transactions are organized among these three categories of agents. We will consider two aspects: the topology of the network of relationship and the conditions of exchange, the later being characterized by the transmission of rights of use between agents and by the settlement of an appropriation regime for the value created by the uses of the digital service. Our principal goal will be to analyze how agents can manage their activity — i.e. their pricing and differentiation strategies — given the “structural” choices they and their competitors made to organize the assembling and to control the uses, and to capture the value created by these uses. These later choices characterize the business model they (and their competitors) implement, and constrain their strategy to make profit or to be satisfied. The competition among and within the three categories of players determines the sustainable models and the distribution of wealth among the different categories of players.

**Figure 1: The Analytical Frame**

![Diagram of the Analytical Frame]

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**22- Four Dimensions to Contrast Business Models**

According to us four dimensions allow to contrast most digital business models, while in the same time they are sufficient to grasp their main features:

- The two first ones characterize the organization of the industry and the competitive frame in which transactions occur. They set the strategic frame in which the various parties negotiate (and in which they select a positioning ex-ante) by setting whether assemblers compete (both among each other and with the final users), and by setting whether the competition is organized among functionalities or packages.
- The two later describe how players manage the transaction by setting rules on how the transmitted functionalities or services can be used and how the value resulting from their use is shared among the transacting parties. Put another way, these dimensions describe how property rights over digital resources — i.e. the rights of...
use and the rights to capture the residual benefits of their usage — are distributed among the parties involved in the production, the assembling or the consumption of digital packages.

221- THE ORGANIZATION OF ASSEMBLING

Whether an intermediary is involved or not in the assembling of functions is the first line of discrimination among business models. Let us insist on the idea that this assembler is not a simple broker that matches existing supply of goods, which characteristics already qualitatively fitting to the users needs (and that is therefore reduced to a reservation price), with a demand characterized by a propensity to pay. The assembler re-organizes a supply of functions that do not directly fit to user’s needs. It operates a matching on quality in addition to a matching on the terms of exchange. Moreover, he has to technically “assemble” the components.

In practice an assembler can rely on contrasted economics tools to buy and integrate the various components of its service. He can, as Microsoft does, acquire the (start-up) firms that develop and market the functionality. He can, as many portals do, simply buy a license of exploitation to an information provider. The notion of assembler is therefore quite wide, it range from the info-mediaries that market information packages as TV channels or Internet Portals do, to industrial assemblers like computer manufacturers, and include on-line retailers (since they assemble portfolios of consumer goods)\(^8\).

Assembling generates costs that correspond to an addition of transaction costs and technical costs. Transaction costs are generated because the assembler has to set deals with the producers of functions he buys, and with the final customers. Technical costs result from the technical operations necessary to actually make compatible and interoperable the various components bought on the market for functionalities. Indeed, these components do not spontaneously interact together. Interfaces and gateways have to be designed to turn the “package” to turnkey information goods.

Assembling tasks and associated costs are performed and born by the final user when an assembler does not intervene in the process. When there are several users, the presence of an assembler enables to avoid the performance of many redundant operations since the assembler transact ones with each of the functionalities providers — whatever the number of times he resell it to users — and design once and for all the interfaces among them. Assembling costs being to a large extent fixed and reproduction costs being nearly equal to zero, assemblers generate efficiency gains. However, they have to be remunerated for the service they provide, and might eventually capture rents. This generate a tradeoff both for the users and the producer of functionalities, who will balance efficiency gains with the cost of the intermediation service, and with the redistribution due to the presence of a third part that can adopt a strategic behavior. In addition, if users have different preferences, they face another trade-off. On the one hand, an assembler seeking to maximize efficiency gains, might provide the users with a standardized package — that correspond to the functionalities required by the average,

\(^8\) In the future one could refine our typology by taking into account the fact that these various categories of assemblers do not provide exactly the same “assembling” service. Our dichotomic variable could become more precise by considering intermediation as a set of services that are generally bundled — e.g. informational matching, logistic matching, transaction securization, liquidity guaranty; see Brousseau [2002] — and by considering whether these services are provided or not by the assembler.
or the mode, or the most (or the less) demanding users (depending on the distribution of preferences, of assembling costs and of the users’ propensities to pay) — that will not therefore meet their specific needs. They will benefit from low cost of assembling, but will have to bear maladaptation costs (of the package to their needs). In addition, the assembler of standardized package could benefit from a market power that could enable it to capture rents. On the other hand, the assembler can seek to customize assembling. In that case, it and the user loose part of the efficiency gains in assembling. Moreover the user can be discriminated on a customized basis. Variable as the heterogeneity of the preference, the concentration of the provision of assembling service, the ability to vertically or horizontally differentiate packages, etc impact on these complex trade-offs. In depth investigation are necessary to better understand the properties of business models based on the presence of not of an assembler.

222- Universal vs. Proprietary Standards

While we noted above that digital technologies favor the integration among functionalities because they constitute a kind of meta-standard allowing the interoperability of these functionalities, the level of interoperability can vary, resulting in defaults of inter-operability and associated assembling costs (either the interoperability is imperfect, or huge means have to be dedicated to the development of gateways and interfaces). In fact, in the digital world, universal standards exist — as those that are the heart of the Internet — and they have a tendency to expand. However, there is generally a reverse of the coin with the generality of a standard. To become universal he has to fit to the lowest common denominator (of the functions). Universal interface standards generally ensure a poor interoperability, only, resulting in high assembling costs. This is why many sub-standards exist. They are generally designed to solve a set of specific interoperability problems. Since they are more specialized, they are more efficient in the management of the operation they target, but they obviously are less efficient in dealing with alternating set of problems. A community that face a specific set of problems, which are badly addressed by universal standards, often designs specialized standards. In our framework, if a set of functionality producers decides to enforce a common specific standard, this will result in reduced assembling cost among their output, and higher assembling costs between their functionalities and the functionalities relying on other standards.

The scope and the specialization of interface standards are therefore of interest when one consider business models because they impact on efficiency and on the organization of competition.

Universal interoperability standards result in high assembling costs, but maximize the ability to combine functionalities, and strengthen competition among the producers of

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9 In practical terms universal standards do not guarantee per se the ability to make compatible two components. There are two cases. The universal standard can be incomplete, in the sense that it sets-up common technical solutions for only part of the problems that have to be dealt with. The universal standard can be complete — in the sense that he designs solutions for all the potential problems to be fixed — but optional —, since it would be useless for the users to implement solutions to problems they do not face in their specific case. In both cases, the users of the universal interface standard have to face assembling costs, since they have either to complete or to select the solutions they will implement. Moreover, as interfaces standards refer to situation in which several parties interact; the resulting negotiation costs can be high.
functionalities. Proprietary standards result in contrasted assembling costs. Assembling costs are low among the functionalities referring to the proprietary standards, but very high with functionalities referring to another standard (either the universal standard or another proprietary standard), resulting in a *de-facto* reduced ability to combine functionalities. Moreover one can expect that the producers using a proprietary standard will avoid competing strongly among each other (by controlling the access to the standard, setting alliances, etc.). Competition on the market for functionalities should be reduced, and will be more likely to be organized among packages of functionalities enforcing different standards. Put another way, a competition will be organized among standards rather than among functionality producers within each standard.

In our analytical frame, we do not try to analyze the economics of competition among standards and how universal standards succeed or not in emerging. We take for granted that a set of universal (but imperfect) standards are available and that the agents can decide to develop and use more specific standards — qualified as proprietary standards — either to control the intensity of competition (if they are functionality producers or assemblers), or to benefit from lower assembling costs and more efficient packages (if they are users or assemblers). Choosing a solution leads *ex-post* to settle the degree of competition among functionality providers and among assemblers, and to determine the frame within which they can decide their pricing strategy.

223- Fragmentation of Rights of Use

Performing a transaction consists in transferring rights of use from one “supplier” to one “client”. In the digital world these rights can be cut up in elementary units and made enforced by technological means. Any digital sequence — whether it is a book, a movie, a software, etc — can be segmented in a set of sub-sequence, and digital code — i.e. encryption and decryption keys — can be implemented to manage the access to these sub-sequences in order to control how it is used (Elkin-Koren & Salzberger [2000], Brousseau [2003]). For instance codes of access can enable the supplier to transmit the right to read, but to store, the right to execute, but to transmit to a third part, the right to use the digital sequence for a limited period only, or for a limited number of time. Put another way, the broad rights of use that are associated to traditional property rights — e.g. *usus*, *fructus* and *abusus* in the Civil Code — can be split into a long list of specific rights of use. This evolution in the management of information set, which is made possible by the technology, is consistent with the trend observed in the design of property rights institutions. Indeed, with the raise of the information and knowledge-based society, IPRs have been evolving toward increasingly extended rights to control the use of intangibles by title deeds owners. For the past two decades; the later have been granted with tougher rights to control finely how their licensee can use their copyrighted works or patented technologies.

Business models will be contrasted by the level of fragmentation of these rights of uses granted by the providers of digital goods to the users. Producers of functionalities (or

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10 Indeed, there is a potential competition between functionality producers, since they can compete in marketing functions that are close substitutes, and since there is also an indirect competition between functionalities through the competition among packages addressing the same needs through different technological options.
assemblers) might seek to control how the customers will actually use the transmitted
digital sequence, or not.

- In the former case, the owner will make effort to disentangle the various rights of
  use that are bundled in the traditional property rights system. It will then bear
  unbundling costs of in making each of them enforced (inducing measurement and
  enforcement costs; see Barzel [1989]). The benefit of such strategy is twofold. First,
  it is permissive condition for a discrimination strategy. Indeed, every use of
  functionality or of a service can be priced at the highest possible price given the
  dispersion of the propensity to pay of each customer. This result in quasi-perfect
  price discrimination. In a sense, unbundling the rights of use correspond to the
  versioning strategies described by Shapiro and Varian [1998]. Second, it helps to
  control information leakage by strengthening and extending the information
  monopoly of an intellectual title deeds owner.

- The later case corresponds to the fact that the seller transmits bundled right of use
  without trying to control how those who buy the right to access to information and
  knowledge will use it.

In addition to the costs mentioned above, unbundling property rights on information and
knowledge, has two strong impacts on the users wealth. First, it makes more complex
transaction over information and multiplies them\(^{11}\). Transaction costs increase then.
Second, thanks to the sales of unbundled rights, suppliers acquire a very precise
information over the users, allowing the former to discriminate the later more and more
efficiently. This result in complex effects on welfare and its distribution since, on the
one hand, the users get customized services adapted to their needs, and in the other
hand, their surplus is captured by suppliers from which it is costly to switch to another
provider (since competitors do not have access to the knowledge necessary to provide
the customized services) (see Acquisti & Varian [2001]).

224- Residual Rights on the Value Created by the Use

The fourth dimension contrast those digital providers that try to capture the rights of
controlling the information that is generated by the use of a digital sequence, versus
those who let the residual rights to the users. As pointed out by our framework, the user
of functionality (or of an assembled service) generates passively of actively information
that can be of value for the suppliers in general. This information range from data on
how a digital set is used, to creations and inventions drawing from the contents
transmitted to the user. As compared to what happens in the real world, this information
is more easily accessible and manageable in the digital world since it is created, stored,
transmitted, processed at a very low cost on the same infrastructure than the one on
which the initial goods and services are produced and used. For instance, log files and
cookies track Internet users and result in low costs profiling. Possible digital tags buried
in digital sequences allow identifying the creators of the various components of a digital
work of authorship, which would be based on borrowed contents. Consequently the
control over the information derived from the use of information goods will be of
critical importance in digital business models. One can point out, in addition, that this

---

\(^{11}\) Either it make transactions more complex since each of them lead to negotiate and make enforced the
details of the rights of uses that are transferred, or it multiplies them since a transaction tend to be
organized for each use (while when transferred rights are bundled, a contract is signed to transfer several
rights of use)
control is also of importance because of the very nature of information. Intellectual property rights systems traditionally address the issue of the spillovers among inventions and creations, which could harm the initial creator’s recognized exclusive rights. Quotations and other principles systems — whether they concern the works of art or technological inventions — allow to recognize the contribution of prior creations and inventions, and to organize transfers among property rights holders. In the same spirit, patents holders can implement in their technology licensing agreements “grant back” provisions to benefit of rights of use over the inventions drawn from the licensed technology by their licensees (see Bessy and Brousseau [1998]). In the digital world, these attempts to control the information created by the user (or its value) tend to be systematic, because information and knowledge are factors of creation of new information or knowledge, because information leakage can ruin the market value or the initial information and knowledge, and because the technology allows to control at a lower costs this created information.

For a digital provider, capturing the value created by the users has three costs. First, it should negotiate with the later access to its information (probably in exchange of part of the potential surplus), and/or it should dedicate means to capture this information or to control the way the user create and invent around the transmitted functionality or service. Second, it decreases the user’s incentive to generate relevant and accurate information or to innovate. In addition, one can mention that the value of the information provided by one user is often very dependent of the information provided by the other users. These strong externalities among the information sets generated by the various users add an additional constraint in the tradeoff that digital suppliers have to face.

23- SIXTEEN CLASSES OF BUSINESS MODELS

To sum up, one can build a first typology of digital business models on the basis of the choice between two options for each of the four dimensions we identified.

- Whether an assembler takes place between the supply of functionalities and the demand is an essential axis of discrimination among models. Assemblers will reduce transaction and technical assembling costs. However they can capture rents and provides the users with packages that do not perfectly meet their needs. This is why we will investigate in the second part of this paper how the competition among assemblers and the ability of users to bypass assemblers — which is strong in the digital world as compared to other domains —, impact on the way assemblers behave and on the quality of service provided to users.

- When interface standards are closed, users benefit from specialized services that efficiently meet a category of needs. However, the reduced competition among functionality providers allows these later to capture rents. Moreover, users cannot address needs that are hybrid to those that are targeted by the closed standards at a low cost. In the later case they face high assembling costs. To the opposite, the universal interface standards, which are a characteristic of the digital world, provide the users with wider possibilities of customized assembling. Moreover, they implement a de facto strong competition among the providers of functionalities — which cannot be organized in consortia. However assembling costs are higher than those get when one proprietary standard targets a specific usage. A coming paper should address this tradeoff between the nature of competitions among functionality
providers, and the assembling costs born by the users given the dispersions of their preferences for “packages” of specific functions.

• The digital provider can decide to transfer bundled of unbundled right of use of its functionality or service. The tradeoff is mainly depending upon the costs of controlling the client’s use of the digital good (and the ex-ante cost associated to the settlement of ad-hoc agreements), on the one hand, and the risks of information leakages and the ability to capture consumers’ surplus, on the other hand. Further investigations, in the line of the models developed by Varian, should allow to better investigate this tradeoff in the long run and to assess the main conditions of sustainability of business models based on perfect price discrimination.

• Whether the provider tries to control and capture the information generated by the users induces a fourth tradeoff. The incentives either to capture the value created by users or to control the hazards of information leakage are balanced by the costs of controlling the user’s behavior, by the risks of users strategic manipulation of information and by the possible necessity to deal with several users in the same time.

Table 1 provides an example of the various resulting business models. It point out that every of our 16 configurations corresponding to one possible business models and provides examples of their existence. Analyzing the conditions of existence and the sustainability and of these various models requires a two-step process. In the first step, one should analyze the four tradeoffs that agent face when they have to make decision to organize their digital transactions. In the second step, one should analyze how the solution of these four tradeoffs combine in framing the characteristic of a specific model, which economics can then be analyzed in its most relevant dimensions. Following this line, our paper will now focus on the first tradeoff (Assembler/no assembler). In the next section, we attempt to build a theoretical framework for analyzing the economics of digital assemblers. This framework is rather basic but enables us to grasp the essence of assembling. First we consider a single monopoly and we examine the incentives for the providers to contract with this assembler or to bypass it. Then we consider competition between assemblers and its impact on the market structure.
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3- A THEORETICAL MODEL OF DIGITAL ASSEMBLING

31- THE BASIC FRAMEWORK

Let consider a digital market characterized by a modular production and a need for assembling these modules together. On such a market, we can find two kinds of strategic players: the producers of digital modules in one hand and the assemblers on the other hands. Both can strategically interact to offer packages (or digital services) to consumers. By convenience, we consider \( N \) providers of digital modules (or functionality) at the downstream level. We assume that each supplier produces only a single module at a fixed cost \( F \). Since the modules are immaterial, the cost for reproducing them is null. The upstream level is characterized by the presence of one or two assemblers. Their activity consists in assembling or packaging the digital modules and selling them.

However, each provider can choose either to sell his module to the assembler or to sell it directly to the end user. If he chooses the latter option, he can obtain a price \( q \) for each sold unit. We assume that \( q \) is exogenous and depends on several factors like the degree of compatibility between the modules, the degree of vertical integration between the providers and the assemblers,... If the provider prefers contracting with an intermediary, then he transfer his property rights on his modules for a fixed price \( P \) (fixed fee). \( P \) is set by the providers (after a collective negotiation with the assembler).

The sequence of decision is as follows:

- **Stage 1:** each provider chooses either to contract with an assembler (and to cede his module at a fixed price \( P \)) or to market directly his module at the unit price \( q \).
- **Stage 2:** the assembler(s) assembles his modules in package and then sets a retail price for each package.
- **Stage 3:** given their preference, the consumers buy modules packages sold by the assembler and/or buy individual modules sold by the independent providers. For the latter modules, the customers have to assemble and integrate them to the assembler’s package before using them.

In the first stage, the provider has to balance the profit of ceding his rights to an assembler for a fixed amount of money (independent of the quantities sold by the assembler) and the profit of selling directly his products to the users. In the latter case, there is some uncertainty on the expected revenues. The lower \( q \), the larger the number of modules sold through an assembler. Typically \( q \) should be low, and bypassing should be infrequent when most of the providers are vertically integrated with the assembler or when the latter has developed some proprietary standards for assembling the modules.

The other parameters in the model are the costs for assembling and packaging the modules. These assembling costs are different when this task is done by the assembler or by the end user.

Let define \( c_A \) as the assembler's cost for assembling the modules owned by the assembler. \( m c_A \) is the cost for packaging \( m \) modules. Let \( c_U \) the user cost for assembling a module with the other modules (cost for integrating this module to the other modules).

**Assumption 1:** \( c_U > c_A \)
The assembler has a cost advantage compared with the end user. The assembling costs of the assembler are lower than those of the user, because the former benefits from some economies of scale (specialization). The ratio $c_I/c_A$ measures the cost advantage of an assembler or equivalently the difficulty for a user to bypass the assembler. This ratio increases if the assembler owns a proprietary standard (as Microsoft does).

If $Z(m)$ is the retail price for a $m$-modules package provided by the assembler, then the full price paid by the customer for acquiring the $N$ modules is $Y(m)$

$$Y(m) = Z(m) + (N - m)(q + c_U)$$

We assume that the users have only a demand for the full system and derive no utility from a single module or from incomplete packages (containing less than $N$ modules).

For convenience, we consider a linear demand defined by $D(Y) = 1 - Y$.

**Assumption 2:** $N(q + c_U) < 1$

According to this assumption, there still exists a positive demand if all the providers decide to sell their modules directly.

**32- Competition between Assemblers and Market Configuration**

First, we consider the case of a single assembler facing $N$ providers and try to determine the market configurations that could emerge. Then we will compare these market configurations with those arising in the presence of two assemblers.

**321- The Case of a Single Assembler**

Let define $D(Y)$ the end user demand for a full price $Y$.

Then the profit for the assembler is given by

$$\Pi^A(m) = (Z(m) - mc_R)D(Y(m)) - mP(m)$$

The providers that are contracting with the assembler (providers designated by $I$ for insider) have a profit

$$\Pi^I(m) = P(m) - F$$

and the providers that are bypassing the assembler (providers designated by $O$ for outsider) have a profit

$$\Pi^O(m) = qD(Y(m)) - F$$

Now we start solving this model by considering the second stage of the game.

**Stage 2:** Let consider that the assembler has acquired $m$ modules. Then her best strategy consists in setting the price $Z(m)$ that maximizes her profit:

$$\max_{Z(m)} \Pi^A(m) = (Z(m) - mc_A)D(Y(m)) - mP(m)$$

By deriving the profit with respect to $Z$, we obtain:

$$Z^*(m) = \frac{1 + mc_A - (N - m)(q + c_U)}{2}$$
How does the unit price for a module vary with the number of modules included in the package?

The unit price $\frac{Z^*(m)}{m}$ decreases with the number of modules controlled by the assembler since $\frac{\partial Z^*(m)}{\partial m} = -2\left(\frac{1-N(q+c_U)}{4m}\right) < 0$. The price of a module packaged by the assembler tends to decline as long as he reinforces his position on the market.

The demand for the complete set of modules $s$ is given by:

$$D(Z^*(m)) = \frac{1-(N-m)(q+c_U)-mc_A}{2}$$

The demand tends to increase with $m$ since $q+c_U$ is always higher than $c_A$ (assumption 1). The assembler has a stimulating effect on the demand of digital modules.

The equilibrium profit of the assembler can be rewritten:

$$\Pi^A(m) = \frac{(1-(N-m)(q+c_U)-mc_A)^2}{4} - mP(m)$$

Stage 1: Let assume that the price $P$ results of a bargaining between the assembler and the providers. This bargaining concerns the sharing of the profits obtained by the assembler. We do not detail the process of bargaining, but we just assume that the result of this process is characterized by a share $\alpha$ of the profit for the providers and a share $(1-\alpha)$ let to the assembler. As the profit of the assembler is given by

$$\frac{(1-(N-m)(q+c_U)-mc_A)^2}{4},$$

then the fixed price obtained by a provider that is contracting with an assembler is

$$P(m) = \alpha \frac{(1-(N-m)(q+c_U)-mc_A)^2}{4m}$$

Then the profit of an insider (a provider who contracts with the assembler) is given by:

$$\pi^I(m) = \alpha \frac{(1-(N-m)(q+c_U)-mc_A)^2}{4m} - F$$

whereas the profit of an outsider (a provider who markets his module) is defined by:

$$\pi^O(m) = q \frac{(1-(N-m)(q+c_U)-mc_A)}{2} - F$$

Finally the net profit of the assembler is given by:

$$\Pi^A(m) = (1-\alpha) \frac{(1-(N-m)(q+c_U)-mc_A)^2}{4}.$$
When $\alpha$ is equal to one (the assembler has no power of bargaining), his net profit is null.

How does the profits of the providers evolve with $m$?

For the outsiders, we have:

$$\frac{\partial \pi^O(m)}{\partial m} = q \left( \frac{q + c_v - c_A}{2} \right) > 0$$

The profits of the independent providers increase with the number of modules controlled by the assembler.

Concerning the profits of the insiders, we have:

$$\frac{\partial \pi^I(m)}{\partial m} = \alpha - 4 \left( 1 - (N - m)(q + c_v) - mc_A \right) \left( 1 - N(q + c_v) - m(q + c_v - c_A) \right)$$

The sign of this expression depends on the sign of $\left( 1 - N(q + c_v) - m(q + c_v - c_A) \right)$

It exists a $\overline{m}^s = \frac{1 - N(q + c_v)}{(q + c_v) - c_A}$ such that:

for $m > \overline{m}^s$, then $\frac{\partial \pi^I(m)}{\partial m} > 0$

And for $m < \overline{m}^s$, then $\frac{\partial \pi^I(m)}{\partial m} < 0$

The profit curve with respect to $m$ has a U-shape. When the number of insiders ($m$) is low, their profit tends to decrease with $m$ and it goes up when the number of insiders gets closer to $N$.

What is the equilibrium configuration for the providers? Will we observe a full integration of the modules by the assembler (a configuration without bypassing of the assembler)? Will we observe a hybrid configuration with the coexistence of direct selling and assembling?

To determine the equilibrium configuration, we introduce a concept of stability that has been largely used in the literature dealing with coalitions and cartel formations (Donsimoni (1985)).

Since the alternative for a provider consists either in contracting with the assembler (to be an insider) or in selling directly on the market (to be an outsider), a market configuration is defined by the number of insiders $m^*$ and the number of outsiders $N - m^*$. Let call it a $m^*$ market configuration.

**Definition:** A $m^*$ market configuration corresponds to an equilibrium if it satisfies both a condition of internal stability

$$\pi^I(m^*) \geq \pi^O(m^* - 1)$$

and a condition of external stability

$$\pi^O(m^*) \geq \pi^I(m^* + 1)$$
The condition of internal stability establishes that an insider has no incentives to breach his contract with the assembler and to sell directly his module (in this case, the number of insiders will diminish from $m^*$ to $m^*-1$).

The condition of external stability establishes that an outsider has no incentives to turn towards the assembler and cede his property rights to her.

When a single assembler is present on the market, then two different equilibrium configurations can emerge.

**PROPOSITION 1: EQUILIBRIUM MARKET CONFIGURATION WITH A SINGLE ASSEMBLER**

If 
\[
q < \frac{\alpha + N(1-\alpha)c_U - Nc_A}{N(1+\alpha)}
\]

then the market configuration consists in 
\[m^* = N\] (pure configuration in which the assembler controls all the modules).

If 
\[
q \geq \frac{\alpha + N(1-\alpha)c_U - Nc_A}{N(1+\alpha)}
\]

then two equilibrium configurations can appear:

- if 
\[\pi^I(N) > \pi^O(N-1)\], then the market configuration consists in 
\[m^* = N\] (pure configuration)

- if 
\[\pi^I(N) \leq \pi^O(N-1)\] the equilibrium configuration consists in 
\[m^* < N\] (hybrid configuration in which the assembler coexists with $N-m^*$ independent providers

**Proof:** see annex.

When the expected revenues from direct sales are too low ($q$ low), then the market configuration likely to emerge is characterized by an assembler selling the full package of modules.

Conversely, when the providers have the opportunity to sell directly their modules at a high price, then a hybrid market configuration can appear. Whatever the retail price $q$, the assembler is always active. He always succeeds in acquiring some of the $N$ modules.

**PROPOSITION 2: There always exists a lower limit for the number of modules controlled by the assembler.**

**Proof:** see annex

This lower limit is given by 
\[\hat{m}^S = \alpha \left( \frac{1-N(q+c_U)}{q+c_A-c_U} \right)\] where $\hat{m}^S$ is defined by 
\[\pi^I(\hat{m}^S) = \pi^O(\hat{m}^S)\]. Then we can conclude that the role of the assembler will be strengthened when the bargaining power of the providers is high (direct selling becomes less profitable), the user costs of assembling is large and the number of modules is low.

We can notice on figure 2 that in an hybrid configuration the outsiders earn a higher profit than the insiders. In fact outsiders have a free-riding behavior. By selling directly
their modules they benefit from the positive effect of the assembler pricing policy, that stimulates demand. They also benefit from the reduction of assembling costs. The larger the number of modules controlled by the assembler, the lower the assembling costs borne by the users.\(^{12}\)

**FIGURE 2: THE CURVES OF PROFITS IN THE HYBRID MARKET CONFIGURATION**

Let consider two assemblers (1 and 2) on the digital market, that compete for acquiring modules of the N suppliers and for selling them. The customers have always a demand for a system and derive no direct utility from incomplete packages (containing less than N modules). The providers will have the alternative to sell directly their modules, or to transfer their property rights to the assembler 1 or the assembler 2. In the latter case, they will compare the price offered by each assembler. Let define \(P_1\) (respectively \(P_2\)) the fixed price obtained when contracting with the assembler 1 (resp. the assembler 2).

The providers that are contracting with the assembler \(i\) (\(i=1,2\)) have a profit:

\[
\pi^i(m_1, m_2) = P_i(m_1, m_2) - F
\]

and the providers that are bypassing the assemblers have a profit

\[
\pi^o(m_1, m_2) = qD(Y(m_1, m_2)) - F
\]

\(^{12}\) See annex 2 for a variant of this model with an inelastic demand.
Let consider the last stage of the game

**Stage 2:** If the assembler \(i (i=1,2)\) has acquired \(m_i\) modules and her rival owns \(m_j\) modules, then his best strategy consists in setting the prix \(Z_i(m)\) that maximizes his profit:

\[
\max_{Z_i} \Pi_i^A(m_i, m_j) = (Z_i(m_i, m_j) - m_i c_A) D(Y(m_i, m_j)) - m_i P_i(m_i, m_j)
\]

By deriving the profit with respect to \(Z_i\), we obtain:

\[
Z_i = \frac{1 - Z_j + m_i c_A - (N - m_i - m_j)(q + c_U)}{2}
\]

We can notice that the best reaction function is decreasing with the rival price. It is in the interest of an assembler to decrease the price of his package if the other assembler has decided to raise the price of her own package. This strategic substitutability is due to the complementarity of the two packages (they have to be integrated or assembled together before being used by the consumers).

The price equilibrium are given by:

\[
Z_1 = \frac{1 - (N - m_1 - m_2)(q + c_U) + (2m_2 - m_1)c_A}{3}
\]
\[
Z_2 = \frac{1 - (N - m_1 - m_2)(q + c_U) + (2m_1 - m_2)c_A}{3}
\]

We observe that \(Z_1 > Z_2\) if and only if \(m_1 > m_2\). The larger the number of modules contained in a package, the higher its price.

The demand for the full system is then given by:

\[
D(Z_1, Z_2) = \frac{1 - (N - m_1 - m_2)(q + c_U) - (m_1 + m_2)c_A}{3}
\]

Like in the monopoly case, the demand increases with the number of modules owned \((m_1 + m_2)\) since \(q + c_U > c_B\)

We can write the equilibrium profit for the two assemblers:

\[
\Pi_1^A(m_1, m_2) = \left[\frac{1 - (N - m_1 - m_2)(q + c_U) - (m_1 + m_2)c_A}{3}\right]^2 - m_1 P_1
\]
\[
\Pi_2^A(m_1, m_2) = \left[\frac{1 - (N - m_1 - m_2)(q + c_U) - (m_1 + m_2)c_A}{3}\right]^2 - m_2 P_2
\]

We can notice that the revenues of the two assemblers are identical whatever the number of modules they own. This result comes from the complementarity of the modules. Each assembler sells the same number of packages and the unit revenue for a package is constant whatever the sharing of the modules between the two assemblers.

**Stage 1:** We assume that the competition between the two assemblers reduces dramatically their bargaining power and pushes \(\alpha\) to the extreme value of one (the
providers capture all the profits on the market. Then the price set by the providers is defined by:

\[
P_1 = \frac{1 - (N - m_1 - m_2)(q + c_U) - (m_1 + m_2)c_A}{9m_1}
\]

\[
P_2 = \frac{1 - (N - m_1 - m_2)(q + c_U) - (m_1 + m_2)c_A}{9m_2}
\]

For obtaining an equilibrium configuration, we need to have \( P_1 = P_2 \). The two assemblers must offer the same price for acquiring the property rights of a module. Otherwise, one of the two assemblers will be inactive and will have incentives to cut his price to attract some providers.

As prices are identical, the assemblers acquire the same number of modules \((m_1 = m_2 = m_D)\) - symmetric solution.

Then the profits of the type I providers are given by:

\[
\pi^I(m^D) = \frac{1 - (N - 2m^D)(q + c_U) - 2m^Dc_A}{9m^D} - F
\]

whereas the profits of the type O providers are defined by:

\[
\pi^O(m^D) = q \left( \frac{1 - (N - 2m^D)(q + c_U) - 2m^Dc_A}{3} \right) - F
\]

How does the profits of the providers evolve with \( m^D \)? As previously in the monopoly case, it exists a \( \bar{m}^D \) such that:

for \( m^D > \bar{m}^D \), then \( \frac{\partial \pi^I(m)}{\partial m} > 0 \)

And for \( m^D < \bar{m}^D \), then \( \frac{\partial \pi^I(m)}{\partial m} < 0 \)

For the outsider providers, we have:

\[
\frac{\partial \pi^O(m^D)}{\partial m^D} = q \frac{2(q + c_U - c_A)}{3} > 0
\]

As the assembler benefits of a cost-advantage, then the profits of the direct sellers increase with the number of modules controlled by the assembler.

**PROPOSITION 3:** For a similar number of modules packaged by the assembler(s), the providers will receive higher revenue from a single assembler than from competing assemblers as long as the bargaining power of providers is sufficiently huge.

**Proof:** Let define \( M \) the number of modules controlled by the assembler(s). In the monopolist case, the providers receive at most
\[ P^S(M) = \frac{(1-(N-M)(q+c_U)-Mc_A)^2}{4M} \]

(for a bargaining power of \( \alpha = 1 \))

whereas in the duopoly case, they receive.

We see easily that \( P^D(M) < P^S(M) \).

This result could seem counterintuitive, but assembler competition reduces the rent that providers can extract from the users and therefore can decrease the expected revenue obtained in exchange of the property rights on their modules. More precisely, a provider will obtain more from a single assembler if his bargaining power \( \alpha \) is higher than \( 4/4.5=0.88 \)

Consequently, providers may appreciate to face just a single assembler and may encourage the emergence of such a monopolist.

**PROPOSITION 4: EQUILIBRIUM MARKET CONFIGURATION WITH COMPETING ASSEMBLERS**

If \( q < \frac{1+NC_U-2NC_A}{2N} \), then the equilibrium configuration consists in \( m^{DS}=N/2 \) (the two assemblers controls all the modules since \( 2m^{DS}=N \)).

If \( q \geq \frac{1+NC_U-2NC_A}{2N} \), then two equilibrium configurations can appear:

- if \( \pi^I(N) > \pi^O(N-1) \), then the market configuration consists in \( m^{DS}=N/2 \) (no independent sellers)

- if \( \pi^I(N) \leq \pi^O(N-1) \), then the equilibrium configuration consists in \( m^* < \frac{N}{2} \) (hybrid configuration in which the assemblers coexists with \( N-2m^{DS} \) independent providers)

**Proof:** see annex

**PROPOSITION 5:** The likelihood of an hybrid configuration is higher in presence of a single assembler than in presence of competing assemblers whatever the bargaining power of the providers.

**Proof:** The threshold value for \( q \) under which the providers have no incentive to sell directly their modules is lower with a single assembler than with two assemblers:

\[
\frac{\alpha + N(1-\alpha)c_U - NC_A}{N(1+\alpha)} < \frac{1+NC_U-2NC_A}{2N}.
\]

The coexistence of independent sellers and assemblers is more likely when an assembler benefits from a monopolist situation.
4. CONCLUSION

The theoretical framework developed in the previous section gives some fruitful insights on digital business models. First, the presence of one or several assembler(s) does not prevent the existence of independent providers that sell directly their modules. Thus, two alternative channels of distribution may coexist on a digital market. Second, the providers may be better with a single assembler than with several competing assemblers, since a single assembler is more efficient to extract the surplus of the users. Finally, a full control of the modules by the assembler(s) is more likely in presence of several competing assemblers. Thus the role of intermediation would be strengthened when several assemblers are competing on the market.

One of the limits in this model is the absence of demand for packages containing less than the N modules. If such a demand exists, then the assembler(s) could offer different packages containing fewer modules than N. This is known as a strategy of versioning (Varian and Shapiro, 1998). For example, if an assembler is controlling m modules, she can design a high quality package with the m modules at a high price and a low quality package with few modules but at a low price. What impact could this strategy of versioning have on the market configuration? Should it benefit to the assemblers and reinforce their role of intermediation on digital markets?

For the assembler, there is a trade-off between an intense strategy of versioning that implies higher packaging cost and a strategy of bundling (a single package including all the modules) that can exclude the customers with a low willingness-to-pay. Versioning enables to discriminate between the end users and to increase sales.

For the providers, as versioning increases the expected rent, the price of their modules should be higher. This can reinforce the role of intermediaries on the digital markets. By selling directly their modules, the providers cannot exert any versioning and do not enhance the value of their modules as efficiently as the assembler(s). Therefore, the role of intermediaries should be strengthened on the markets where versioning is easy to implement like in digital markets. Our future researches will attempt to integrate versioning in our theoretical framework of digital assembling.

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ANNEX 1 : PROOF OF PROPOSITIONS

PROOF OF PROPOSITION 1

Let define \( \hat{m}^s \) as the number of insiders characterized by \( \pi^i(\hat{m}^s) = \pi^o(\hat{m}^s) \).

After some arrangement, \( \hat{m}^s \) is given by:

\[
\alpha \left(1 - (N - \hat{m}^s)q + c_U - \hat{m}^s c_A\right)^2 = q \left(1 - (N - \hat{m}^s)(q + c_U - \hat{m}^s c_A)\right)
\]

If \( q > c_U - c_A \), then there exists a \( \hat{m}^s = \alpha \left(\frac{1 - N(q + c_U)}{q + c_A - c_U}\right) > 0 \) such that for \( m < \hat{m}^s \), then \( \pi^i(m) > \pi^o(m) \) and for \( m > \hat{m}^s \), then \( \pi^i(m) < \pi^o(m) \).

Conversely, if \( q < c_U - c_A \), then such a \( \hat{m}^s \) never exists and \( \pi^i(m) > \pi^o(m) \) for all \( m \).

Then we can easily show that for \( q < c_U - c_A \) the only feasible equilibrium configuration is \( m^* = N \) (i.e. the providers have incentives to contract with the assembler). The external stability is directly satisfied since all the providers are controlled by the assembler. And this configuration also meets the condition of internal stability:

\( \pi^i(N) > \pi^o(N) > \pi^o(N - 1) \) since \( \pi^o(m) \) increases with \( m \)

No other stable configuration can emerge (any \( m \) configuration with \( m < N \) will violate the condition of external stability since \( \pi^o(m) < \pi^o(m + 1) < \pi^i(m + 1) \))

Now let consider \( q > c_U - c_A \). In this case, we can notice that \( \hat{m} > \bar{m} \)

Two cases must be considered i) \( \hat{m}^s > N \) and ii) \( \hat{m}^s < N \)

i) We have \( \hat{m}^s > N \) if \( q < \frac{\alpha + N(1 - \alpha)c_U - Nc_A}{N(1 + \alpha)} \). Then the only equilibrium configuration is \( m^* = N \), since we still observe \( \pi^i(N) > \pi^o(N) > \pi^o(N - 1) \) (internal stability)

ii) Conversely for \( q > \frac{\alpha + N(1 - \alpha)c_U - Nc_A}{N(1 + \alpha)} \) (given that \( \frac{\alpha + N(1 - \alpha)c_U - Nc_A}{N(1 + \alpha)} > c_U - c_A \) when \( q > c_U - c_A \), we have \( \hat{m}^s < N \). Then, \( m^* = N \) is still an equilibrium configuration if and only if \( \pi^i(N) > \pi^o(N - 1) \) (external stability still satisfied for a monopolization of the modules supply by the assembler)

Otherwise if \( \pi^i(N) < \pi^o(N - 1) \), there exists a \( m^* < N \) that satisfies both the conditions of external and internal stability.
PROOF OF PROPOSITION 2

We can show that $m^*$ is always higher than $\hat{m}$ in the hybrid configuration. Let assume that $m^* = \hat{m} - 1$. Since $\pi^I(\hat{m}) = \pi^O(\hat{m})$, then $\pi^O(m^*) < \pi^O(m^*+1) = \pi^I(m^*+1)$ and the condition of external stability is violated. Therefore any $m$ configuration with $m < \hat{m}$ cannot be an equilibrium configuration.

PROOF OF PROPOSITION 4

Let $\hat{m}^D$ defined by $\pi^I(\hat{m}^D) = \pi^O(\hat{m}^D)$. After solving this equation, we find $\hat{m}^D = \frac{1-N(q+c_u)}{q+2(c_A-c_u)}$ under the condition $q > 2(c_u-c_A)$. Then for any $m < \hat{m}^D$, $\pi^I(m) > \pi^O(m)$ and for any $m > \hat{m}^D$, then $\pi^I(m) > \pi^O(m)$.

Conversely, if $q < 2(c_u-c_A)$, then $\pi^I(m) > \pi^O(m)$ for all $m$ and the only feasible equilibrium configuration is $2m^D*=N$. The external stability is directly satisfied since all the providers are controlled by the assembler. And this configuration also meets the condition of internal stability:

$$\pi^I(N) > \pi^O(N) > \pi^O(N-1) \text{ since } \pi^O(m) \text{ increases with } m$$

Now let us assume $q > 2(c_u-c_A)$, and let consider the two cases: i) $\hat{m}^D > N$ and $\hat{m}^D < N$

i) We have $\hat{m}^D > N$ if $q < \frac{1+Nc_u-2Nc_A}{2N}$. Then the only equilibrium configuration is $2m^D*=N$, since we still observe $\pi^I(N) > \pi^O(N) > \pi^O(N-1)$ (internal stability)

ii) Conversely for $q > \frac{1+Nc_u-2Nc_A}{2N}$, we have $\hat{m}^D < N$. Then, $2m^D*=N$ is still an equilibrium configuration if and only if $\pi^I(N) > \pi^O(N-1)$ (internal stability)

Otherwise if $\pi^I(N) < \pi^O(N-1)$, there exists a $m^D*$ that satisfies both the conditions of external and internal stability.
ANNEX 2 : ASSEMBLING AND MARKET CONFIGURATION:
THE CASE OF AN INELASTIC DEMAND

Let assume that the customers have a willingness-to-pay for the full package equal to $R$. As long as the full price for the system is below $R$, then each customer buys one package. If the price is higher than $R$, they buy nothing. Moreover there is a continuum of consumers that is normalized to one. Thus, for a full price less than $R$, the demand for each module is equal to one.

Consider the optimal pricing strategy for an assembler that controls $m$ modules. The optimal price for his $m$-modules package is equal to $R - (N - m)(q + c_U)$ (with such a price, the full cost for the users is just equal to their willingness to pay $R$).

The profit of the assembler is then equal to:

$$\Pi^A(m) = R - (N - m)(q + c_U) - mc_A - mP(m)$$

The fixed price obtained by a provider contracting with an assembler is defined by

$$P(m) = \alpha \left( \frac{R - (N - m)(q + c_U) - mc_A}{m} \right)$$

Then the profits of the type I providers are given by:

$$\pi^I(m) = \alpha \left( \frac{R - (N - m)(q + c_U) - mc_A}{m} \right) - F$$

whereas the profits of the type O providers are defined by:

$$\pi^O(m) = q - F$$

We can notice than the profit of the insiders is always decreasing with $m$, whereas that of the outsiders is constant ($\frac{\partial \pi^I(m)}{\partial m} = \alpha \frac{-(R - N(q + c_U))}{m^2} < 0$)

Let define $\hat{m}^S$ as the number of insiders characterized by $\pi^I(\hat{m}^S) = \pi^O(\hat{m}^S)$. Under the condition $q > \frac{\alpha}{1 - \alpha}(c_U - c_A)$, such a $\hat{m}^S$ exists and is equal to

$$\hat{m}^S = \alpha \cdot \frac{(R - N(q + c_U))}{(1 - \alpha)q - \alpha(c_U - c_A)}.$$

For $m < \hat{m}^S$, then $\pi^I(m) > \pi^O(m)$ and for $m > \hat{m}^S$, then $\pi^I(m) < \pi^O(m)$.

Conversely, if $q < \frac{\alpha}{1 - \alpha}(c_U - c_A)$, then such a $\hat{m}^S$ never exists and $\pi^I(m) > \pi^O(m)$ for all $m$. 

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PROPOSITION 6: EQUILIBRIUM MARKET CONFIGURATION WITH A SINGLE ASSEMBLER AND AN INELASTIC DEMAND

For all \( q \geq \text{Max}\left\{ \frac{\alpha (R - N c_A)}{N}, \frac{\alpha (c_u - c_A)}{1 - \alpha} \right\} \), then the market configuration is hybrid, characterized by \( N \cdot \hat{m}^S \) independent providers and an assembler that controls \( \hat{m}^S \) modules where \( \hat{m}^S \) is the integer value of \( \hat{m}^S = \alpha \frac{(R - N (q + c_u))}{(1 - \alpha) q - \alpha (c_u - c_A)} \).

Conversely, for all \( q < \text{Max}\left\{ \frac{\alpha (R - N c_A)}{N}, \frac{\alpha (c_u - c_A)}{1 - \alpha} \right\} \), then the assembler monopolizes the supply of modules.

Proof: The assembler controls all the modules when \( q < \frac{\alpha}{1 - \alpha} (c_u - c_A) \) or \( \hat{m}^S > N \).

The latter condition is equivalent to \( q < \frac{\alpha (R - N c_A)}{N} \).

Conversely when \( q \geq \text{Max}\left\{ \frac{\alpha (R - N c_A)}{N}, \frac{\alpha (c_u - c_A)}{1 - \alpha} \right\} \), then for \( m > \hat{m}^S \)

\( \pi^I (m) < \pi^O (m) \) and for \( m < \hat{m}^S \), \( \pi^I (m) > \pi^O (m) \). Let \( \hat{m}^S \) be the integer value of \( \hat{m}^S \). Since \( \lfloor \hat{m}^S \rfloor \leq \hat{m}^S \), \( \lfloor \hat{m}^S \rfloor + 1 \geq \hat{m}^S \) and \( \pi^O (m) \) is constant.

then \( \pi^I (\lfloor \hat{m}^S \rfloor) > \pi^O (\lfloor \hat{m}^S \rfloor) = \pi^O (\lfloor \hat{m}^S \rfloor - 1) \) (internal stability)

and \( \pi^O (\lfloor \hat{m}^S \rfloor) = \pi^O (\lfloor \hat{m}^S \rfloor + 1) > \pi^I (\lfloor \hat{m}^S \rfloor + 1) \) (external stability)

Thus a \( \lfloor \hat{m}^S \rfloor \)-configuration corresponds to an equilibrium.

Given the proposition 6, the likelihood of an hybrid configuration is higher when the bargaining power of the providers declines. Conversely, when the providers hold all the powers \( (\alpha = 1) \), then the assembler controls all the modules (pure configuration). The providers have no incentives to bypass the assembler since they can extract the whole rent created by the intermediary. The assembler enables them to save on the assembling costs and to capture more surplus from the customers.

Moreover, the likelihood of an hybrid configuration increases with the number of providers and the cost advantage of the assembler.