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The evolution of the ability to effectively innovate in a transnational organization – A configurational analysis

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ABSTRACT

The transformation of transnational organizations coincides with the innovation ability and is based on the evolutionary changes in MNEs. The phenomenon of interest is investigated with a qualitative study through interviews with senior directors of a pharmaceutical MNE in both headquarters and subsidiaries supplemented with company data and information. A configurational analysis using fuzzy set Qualitative Comparative Analysis (fsQCA) transfers the antecedent and outcome conditions into equifinal paths. The ability to innovate effectively is a function of the complexity of organization, complexity of science in light of local responsiveness. The findings contribute to enlarging the transnational theory regarding the ability to innovate effectively and the reconfiguration to a neomultidomestic archetype. The transnational organization with its evolutionary developments and re-configurations is the driver for worldwide innovation in an uncertain environment and with the challenges of new drug development a vehicle for innovation in the pharmaceutical industry. The study is important because it provides access to one of the leading pharmaceutical companies investigating its evolution and reconfiguration to adapt to new challenges in an ever-changing international business and scientific environment.

1. Introduction

The pandemic in the early 2020s has highlighted the connectedness of international business, scientific results and global health. The call for a cure, a vaccine or medication, was a call for medical doctors, academics, research labs and pharmaceutical multinational enterprises (MNEs) to develop their capacities in the interest of the common international health. The impact on organizations and R&D departments within these company structures has never been so necessary and asked for international collaboration and innovation. Especially, pharmaceutical companies are at the forefront of innovation, and their ability to effectively innovate in a global environment is a lifesaver. The innovation through drug development positions the infrastructure and innovation within transnational corporations. The transnational organization's complexity has led to network structures, strategic alliances, and collaborative agreements facilitating innovation across borders. This research explores how the complexities that adjust to a globalized innovation and production system's demands impact the procedures within a large MNE by focusing on AstraZeneca and its innovation ability.

The transnational paradigm (Bartlett and Ghoshal, 1989, 1992) is a framework that positions Multinational Enterprises (MNEs) according to their historical background and location of their HQs in the first place and derives typologies in an international context, respectively. It goes back to the integration-responsiveness (IR) framework (Prahalad and Doz, 1987; Bartlett and Ghoshal, 1989;

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Meyer and Su, 2015). They argue that global integration and local responsiveness are combined in MNEs and develop a typology of multi-domestic, international, global and transnational strategies, organizations and innovation. Many scholars have used the transnational management and IR framework (Harzing, 2000; Rugman et al., 2011) to analyze specific sectors with quantitative studies. The transnational management challenges are especially relevant to the biopharmaceutical sector in the management of global organizations as a dominant organizational form. By conducting an in-depth qualitative analysis, the study introduces a neo-configurational approach (Misangyi et al., 2017; Greckhamer et al., 2018; Fainshmidt et al., 2020) that provides a theoretical expansion to identify new archetypes and their evolution. This article deals with the investigation into the complexities of science, organization and innovation in the transnational framework (Bartlett and Ghoshal, 1989, 1992), and how it influences the ability to innovate effectively within a sector dominated by scientific results and business adaptations with far-reaching impact.

The innovative effectiveness of organizations engaged in research and development ("R&D") of new medicines in both HQ and subsidiaries impacts all our lives. The impact stems from the sector's primary objective to develop and deliver new medicines to patients as effectively as possible. The following research questions are at the core of this paper: *How do the complexity of organization and science under the financial constraints lead to the ability to innovate in a transnational corporation? How do transnational corporations effectively innovate in an R&D intensive industry?*

The article provides empirical evidence to support the extension of the theory, via examining the innovation ability in one of the leading biopharmaceutical companies in the world with expert interviews from across the various functions in the transnational corporation (finance, strategy, science and organization) and between Headquarters and subsidiaries. We use the fuzzy set Qualitative Comparative Analysis (FsQCA) to provide insights into the within and cross-case analysis to identify configurations. This approach combines an in-depth understanding of interviews and a longitudinal examination of organizational observations and changes. The paper enlarges the understanding of complexity in organizations and in science, but also the evolution of the ability to innovate effectively under constraints. The more complex organizations are, the more difficult it gets to find the optimal application of available funding and efficient ways to innovate new drugs in a competitive setting. On the one hand, the complexity helps to cooperate swiftly and internationally for scientific results and leverage expert knowledge; on the other hand, it could also deter it.

2. The theoretical underpinning

2.1. The transnational management

The evolution of the Multinational Enterprise (MNE) with its complexity of trading, developing and sharing knowledge (Adenfelt and Lagerström, 2006), highlights the double-edged sword of sharing globally while allowing for local adaptations or sharing locally while developing global knowledge. Examples of the evolution of MNEs have arisen which show the knowledge transfer from headquarters to their local suppliers (Giroux, 2000; Rangan and Sengul, 2009; Meyer and Su, 2015), but also the evolution of the impact of corporate innovativeness on the decision to decentralize (Williams and Van Triest, 2009; Thite et al., 2012; Malen and Vaaler, 2017). Zander (1999) investigates the role of foreign acquisitions introducing new and more distantly related technology to the multinational network. He stresses the findings that provide an evolutionary view of the multinational corporation involving a gradual development into new technology fields through maturing international operations and departures from established technology portfolios via foreign acquisitions. Theoretically, the MNE and HQ-Subsidiary relationship are at the center of innovation capability, knowledge and organizational complexities with international management theoretical approaches ranging from innovation theory (Cerne et al., 2013), social capital and dynamic capability theory (Sheng and Hartmann, 2019; Zhang et al., 2019), the resource-based view (Un and Rodriguez, 2019) to global networks (Cano-Kollmann et al., 2018).

In a recent publication, Mees-Buss et al. (2019) stress the occurrence of a neoglobal corporation in an enlargement of the transnational paradigm. The development and evolution of the MNE as archetypes of multi-domestic, global, international and transnational companies build the core of the administrative heritage of the transnational paradigm. The development of organizations over time is based on the need to adapt to changing circumstances. These developments include different ways to manage global efficiency, local responsiveness, and worldwide learning. This goes in parallel to the motivation of the MNE's evolutionary development from resource-, market and competition seeking to the global intelligence scanner (Bartlett and Beamish, 2008). In recent developments the focus of a transnational management is therefore on innovation sensing, responding and implementing. Innovation as a challenge was added and the early manifestations of R&D created as local-for-center from the decentralized hubs leading to a locally leveraged innovation process in the transnational organization. The relationship between HQs and subsidiaries follows along these lines based on the integration-responsiveness framework (Prahalad and Doz, 1987).

2.1.1. Integration-Responsiveness (I-R) framework

The transnational paradigm (Bartlett and Ghoshal, 1986, 1989) centers around an organization's ability to possess global efficiency and local responsiveness together with worldwide innovation. In later publications, Bartlett and Ghoshal (1989) expanded their work to include challenges that organizations would face when implementing transnational strategies (Bartlett et al., 2008). Bartlett et al. (2008) extended the theory by developing a greater insight into the challenges within global organizations. The key areas of the extension cover the strategic imperatives and organizational challenges, such as managing integration, responsiveness and flexibility, worldwide innovation, and learning to engage in cross-border collaboration. The literature around the I-R framework (Devinney et al., 2000; Venaik et al., 2004; Haugland, 2010; Meyer and Estrin, 2014) positions the local responsiveness and global integration in various contexts and with criticism. It supports the view that it moves from the strategic orientation of the original idea to HQ-subsidiary relationships, enlargements of completeness (IRC) and export markets (IRE). The necessity of using it as an analytical tool and its

embeddedness in the transnational management to lead to local responsiveness, global efficiency and the third dimension of worldwide-learning hints towards the conceptualization of I-R-W or even innovation and the role of science in the respective industries. The pharmaceutical industry has shown that their companies can be categorized in the I-R and TM framework according to their administrative heritage in the following Fig. 1. Both local responsiveness and global integration can be either weak or strong and leading to position the innovation ability in the context of the transnational management from local for local, global for local with the new adaptations to the networks with locally leveraged and globally linked innovation.

With the innovation challenges stronger in 21st century identified as a driving motivation for MNEs to expand and go abroad in new markets. The organizational challenges, managerial capabilities and collaborative as well as competitive challenges adjusted to these demands evolved around the specific complexities of the industries. For our investigation, the complexity of organizations and the complexity of science behind the innovation in the pharmaceutical industry show the causal links to the ability to innovate effectively.

2.2. Complexity of organization

2.2.1. Organizational complexities

The embeddedness of a subsidiary's relationships in the corporate and external network shows positive signs for the received innovation's contribution to business performance. There are positive links between a subsidiary's embeddedness in the external network, whereas the contribution to the business performance of receiving an innovation can be negatively affected when the innovation is unique compared with other innovations on the market (Hallin et al., 2011). Gupta and Govindarajan (1999) consider the MNE as a network of knowledge that flows from subsidiaries to HQs and empirically assess their concept. Based on their research, Harzing and Noorderhaven (2006) conceptualizes this as a study of the four-fold typology of subsidiary roles – global innovators, integrated players, implementors, local innovators. The strategic flow of knowledge between headquarters and subsidiaries strengthens the relative importance of knowledge and product flows between subsidiaries suggesting that MNCs are getting closer to the transnational company's ideal type.

Bartlett and Ghoshal (1986 and 1989) transnational theory explain the emergence of transnational enterprises that are a combination of the historical development and the country of origin of the headquarters – multinational (domestic), international and global concepts. Combining all the conditions is the transnational management for the MNEs in the 2000s and 2010s showing a network structure. The conceptual side to the theoretical underpinning offers a tool for analysis for MNEs in terms of their competitive, collaborative, innovative, managerial and organizational challenges. Pharmaceutical MNEs fall into all categories such as multinational, international and global typologies as they have origins in Europe, US and Japan - the HQ based in the Triad. There has been the emergence of a complementary theory such as network theory (Gulati et al., 2000). The theory examines how networks of organizations operate, and this is congruent to the inter-organizational network (Ghoshal and Bartlett, 1990) and the transnational organizational process models developed in respect of global Innovation (Bartlett et al., 2008).

Rangan and Sengul (2009) showed the role of information and communication technology (ICT) in the transnational exchange, which can open to incentive theory of exchange governance and cross-border coordination theory of value creation. They suggest that in modern MNEs ICT has reduced asset specificity, made equality more contractible, supported decentralized coordination, and shifted effort and cooperative adaptation. Harzing (2000) and Rugman et al. (2011) enlarged the framework into quantitative studies and

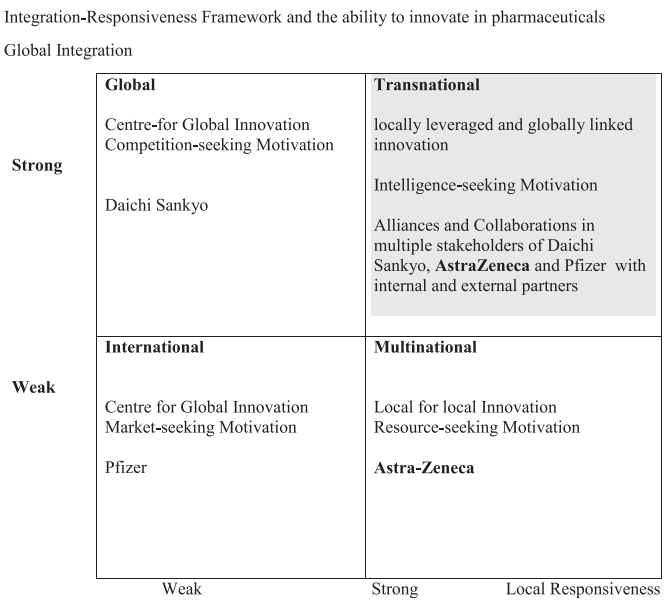


Fig. 1. Evolution of the MNE, complexity of organization, complexity of science and innovation.

investigated the re-conceptualization with a stronger focus on innovation and production in regional hubs. Meyer and Su (2015) highlight that the transnational solution works best in subsidiaries established by acquisitions and more likely to develop distinct organizational structures, cultures and identities that can become an obstacle to smooth integration in a transnational organization.

Bartlett et al. (2008) identify innovation through R&D as one of the core challenges facing transnational organizations. This applies to all organizations within the biopharmaceutical sector as it is recognized that one of the fundamental challenges in attaining effective R&D productivity (Khanna, 2012; Paul et al., 2010), some go as far as stating there is a productivity crisis in the whole sector (Cockburn, 2007; Dimitri, 2011; Pammolli et al., 2011). Whilst recognizing that productivity challenges (Rugman et al., 2011) are a significant area, there is a lack of insightful knowledge of how companies manage this as put forward by Johnson et al. (2003) and reinforced by Keupp and Gassmann (2009). Malen and Vaaler (2017) emphasize that countries differ in national governance institutions protecting shareholders and employees. This would moderate the relationship between organizational slack and innovation effort, which is the targeted allocation of firm resources towards developing new products and services and creating more complex organizational structures.

2.2.2. *Organizational networks*

There has been an increasing need to seek partnerships between firms in the form of collaboration and alliances to maintain a balanced portfolio. Evidence exists in the increase in the number of partnered products within portfolios of large biopharmaceuticals. The networks of these organizations operate internally and externally as a core management focus. Several forces require effective management within the network, and allocation of R&D funding is a key force. Hagedoorn and Schakenraad (1992) examine alliances to understand trends in inter-firm cooperation and the role played by a large group of companies. Their analysis enables the identification of major international networks of inter-firm alliances. There is a clear preference in the sector towards alliances (Rothaermel, 2001) that leverage complementary assets (exploitation alliances) over alliances that focus on building new technological competencies (exploration alliances). Danzon et al. (2005) also bring in the focus of strategic alliances and an understanding of the alliances that exist in all stages of R&D coupled with the impact of alliances on success rates. They put forward evidence that R&D productivity in an alliance, particularly in phase 2 and 3 of clinical trials, has a higher probability of success. However, the study does not consider the nature of the alliance, how it was formed, contractual arrangements and how it was effectively managed. All of which are material to the success of such drug development.

Fig. 1 represents and combines the I-R framework embedded in the transnational management and applied to the innovation in the pharmaceutical industry.

2.3. *The complexity of science - the biopharma transnational organization*

Like Mees-Buss et al. (2019), this paper deals with a specific company, and therefore the specific production and innovation angle is going to be analyzed further. What Unilever was for them is AstraZeneca for this article. We need to focus on the scientific angle as the focus of enlargement in a new organizational setting responding to the changes of our times.

Large biopharmaceutical firms seek novel, innovative products to complement their internal R&D activities. Such alliances are part of the transnational process of globally sensing and implementing innovation (Bartlett et al., 2008). As with many other companies in an integrated network system of the transnational corporation, the heart of the business is the scientific development of the product. The production line or timeline is the scientific development of the drug process. The complexity of science (Fuentes et al., 2018;

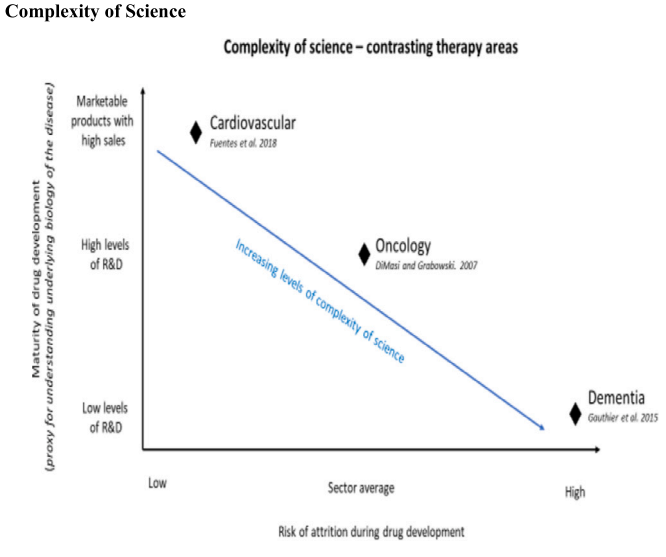


Fig. 2. Complexity of science.

DiMasi and Grabowski, 2007; Gauthier et al., 2016) derives from the certainty and uncertainty of the disease's biology. Whether maturity of the drug development and risk of attrition during drug development is low or high contributes to science's complexity. Therefore, the drug development for cardiovascular medicines is considered as a well-understood area of science (Fuentes et al., 2018), oncology is on a mid-level of complexity (DiMasi and Grabowski, 2007) and less understood disease areas such as neuroscience are considered as complex science (Gauthier et al., 2016). Therefore, we can highlight that the uncertainty surrounding the biology and the drug production process aligns with the complexity of using the HQ and subsidiary relationship in the creation process (Fig. 2 here).

2.3.1. *Scientific developments in networks*

Empirical evidence supports that regional technology clusters are an important source of economic development. Von Zedtwitz and Gassmann (2002) conclude that research is concentrated in only five regions worldwide, while development is more globally dispersed. Investigations into the R&D subsidiaries (Broekel et al., 2015) show an advantage of locating subsidiaries within a local cluster. The findings propose that it is advantageous to locate subsidiaries within such clusters, enabling favorable positioning in terms of national knowledge networks. Their study identifies two principal location rationales, access to markets and science. The principal determinants lead to four archetypes of R&D internationalization: 'national treasure,' 'market-driven,' 'technology-driven,' and 'global'. A global R&D network would comprise multiple hubs geographically dispersed; all R&D units are interconnected via an internal network and interacts with external organizations (Fig. 3) which is like the transnational archetypes.

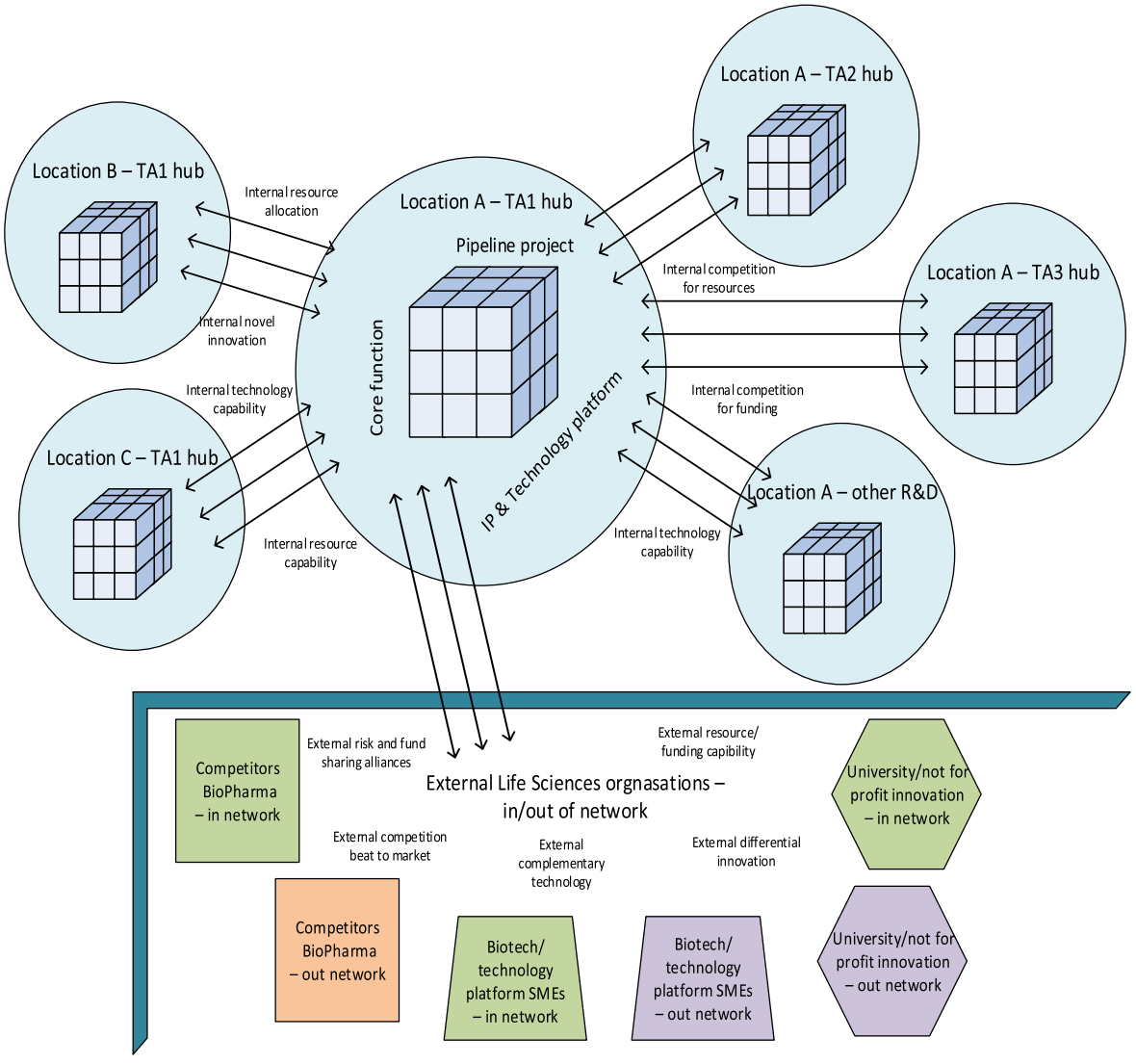


Fig. 3. Global Biopharmaceutical organizations R&D network – Production and innovation process.

2.3.2. Clinical developments and constraints

There is an active market in this space for start-ups, and small firms use such alliances as a source of funding and access to resources. Due to the significant cost of clinical development (Joglekar and Paterson, 1986; DiMasi et al., 1991, 2003), smaller firms lack resources and are facing funding constraints. Bruton et al. (2004) suggest in the study of global R&D that organizations and strategies are dynamic and constantly evolving. This aligns with Teece (1986) who ascertains that there is a need for the innovating firm to establish a prior position in these complementary assets.

The overarching need of the biopharmaceutical organization is effectively maintaining a balance of pipeline progression on the backdrop of budgetary constraints. The influence of the financial constraints on R&D organizations' structure and decision- making processes is provided in the management matrix structure for R&D projects, which is a single internal R&D hub. Zhang et al. (2019) explore how a firm's internal knowledge and organization structure influences its strategic alliance formation. They propose a propensity to engage in strategic alliances within the biopharmaceutical sector where the firm's knowledge breadth and its R&D organization structure's centrality positively influence its absorptive capability. Motives for engaging in R&D projects need to be understood because there is a fundamental difference between a large biopharmaceutical firm and a not-for-profit organization. A not-for-profit organization seeks funding and grants with the primary aim to advance scientific knowledge, whereas a large biopharmaceutical firm faces financial constraints imposed by its investors. It is pivotal in understanding the funding model when examining large biopharmaceutical's overall R&D costs.

It has been established that early-stage R&D inherently has more uncertainties as they still have several phases of development to complete (Banerjee and Siebert, 2017; DiMasi et al., 2003; Danzon et al., 2005). These are the key drivers of forming early-stage cooperation. Late-stage R&D alliances are less motivated with uncertainty but driven by scarcity of R&D funding. The studies into the cost of R&D (Joglekar and Paterson, 1986; DiMasi et al., 1991, 2003) base their findings on the individual firm level.

2.4. Innovation and R&D development in MNEs

Regarding innovation in the transnational organization, Bartlett and Ghoshal (1986, 1989) and Ghoshal and Bartlett (1990) explore the internal challenges of managing innovation in the context of an organization's network of subsidiaries. Harzing (2000) evaluates the transnational management theory empirically and comes up with support for the typology. She emphasizes the change of multinational strategy and organization into multi-domestic strategies and organization. Rugman et al. (2011) enlarge the framework and re-conceptualize it to fit the challenges of the millennium. Most of the research has been in the context of examining the internal structure and management of innovation. With the increasing importance of leveraging an internal and external global network and the complexity of effectively managing more research needs to focus on combining innovation with organizational complexity (Chesbrough, 2003; Garnier, 2008). This was then explored in-depth in terms of exploring the firm's internal R&D network and managing global R&D organizations. The innovation challenge accounts for the different types of MNEs as, local for local, centre-for-global, locally leveraged and globally linked innovations.

Innovation productivity has been a core driver for strategic organizational design and the structure of large biopharmaceutical organizations as evidence by the large wave of M&A in the past two decades resulting within the sector (Cockburn and Henderson, 2001). Hagedoorn and Wang (2012) conclude that internal and external R&D, through either R&D alliances or R&D acquisitions, are complementary innovation activities at higher investment levels of in-house R&D. Conversely, where lower levels of in-house R&D efforts exist, internal and external R&D lends to a substitutive strategic approach. The R&D process of a multinational/domestic typology moves into the transnational organization and provides insights into the challenges that lead to alliances and strategic decisions.

There is an S-shaped relationship between R&D internationalization and innovation performance. Chen et al. (2012) build on prior studies that examine R&D internationalization within firms (Håkanson, 1990) and a specific focus on the concept of the “decentralization- recentralization” evolution (Håkanson, 1990; Gassmann and von Zedtwitz, 1999). The study builds on Gassmann and von Zedtwitz (1999) findings that decentralized R&D sites set up to preserve autonomy and national identity lead to inefficiency and redundant R&D activities for the firms.

To portray the typology of technological innovation processes in a transnational context, Binz and Truffer (2017) expand the existing innovation system concepts to consider the globalization of innovation. They conclude that a global innovation system perspective is key for further research into the growing area in terms of spatial complexity. Furthermore, their contribution assists in understanding the innovation systems within transnational organizations. Driven by the speed of change in technologies, R&D organizations continuously adjust their operations (Gassmann and von Zedtwitz, 1999). The capacity to innovate effectively is at the core of the transnational corporation. Mikalef et al. (2020) pointed out that innovation capabilities can be radical or incremental and added environmental uncertainties to their big data studies. Incremental innovations concern minor changes and small alterations to products and radical innovations, however, need considerable changes in the company and significant changes in products and services.

Gassmann and von Zedtwitz (1999) provide a study that establishes five distinct types of R&D organization in multinational companies and identifies following typologies: ethnocentric centralized, geocentric centralized, polycentric decentralized, R&D hub, and the integrated R&D network organization (Gassmann and von Zedtwitz, 1999). We can link these typologies with the transnational management approach (Bartlett and Ghoshal, 1986 and 1989 with its adaptations). The advantage of using the transnational management concept is that it offers a coherent approach of analyzing the challenges in a global business context with a specific focus on worldwide learning and innovation in a complex organizational, administrative heritage.

In the literature, the HQ and subsidiary relationships (Rugman et al., 2011) align with the value chain activity and the changes in

national subsidiaries' location advantage after regional integration. They highlight innovation, production, sale and administration to come up with archetypes of innovation. Fig. 3 shows the application of global innovation in structure, production and sale of drugs.

Using the transnational management perspective, the ability to innovate is therefore a function of the complex organizational structures, the underlying complexity of science in the pharmaceutical industry and its local responsiveness.

The choice was based on the transnational model of the administrative heritage (complexity of organization), complexity of science (innovation challenge of sensing-responding-implementing), local responsiveness (archetypical structure of multi-domestic to have a stronger focus on subsidiaries and local markets). Since our focus is on innovation and biopharmaceuticals, we consider the conditions which are typical for the companies and industry: complexity of organization as an important company criterion, complexity of science

Table 1
Cases for calibration – interviewees, positions and size of companies.

Case	Current position	HQ v subsidiary perspective	Organizations within sector they have worked for*	Functional areas worked in
BusDevHQ	Investment Manager, Biopharma VC	HQ	AstraZeneca **L** Biocity **S** Genzyme **M** Sanofi **L** UCB **M**	Venture capital Director - Strategy, Business development and Investment Project Management Research Translational medicine
DevHQ1	Director	HQ	AstraZeneca **L** BMS **L**	Business Development Consulting/Scientific advisory Legal
DevHQ2	Director	HQ	AstraZeneca **L**	Business Development
DevHQ3	Executive Director	HQ	AstraZeneca **L** Ipsen **S** Chiron **M** Post Doc Academic Research **S**	Business Development Portfolio Management Research
DevSciHQ	Transaction Director	HQ	AstraZeneca **L**	Business Development Senior Research Scientist
FinSub1	Director	Subsidiary	AstraZeneca L Medimmune L	Finance
FinSub2	Director	Subsidiary	AstraZeneca L Medimmune L	Finance
FinSub3	Director	Subsidiary	AstraZeneca L Medimmune L Post Doc Academic Research S	Finance Project management Research
LegDevSciHQ	Associate Director, Academic Alliances; Scientific Partnering & Alliances	HQ	AstraZeneca **L** Medical research council **M** Academic research **S**	Business Development Legal Research Scientific technology
LegSub	Director	Subsidiary	AstraZeneca L Medimmune L	Legal
OrgSub	Vice President	Subsidiary	AstraZeneca L Medimmune L	Business Development Partnering and strategy Project management Commercial and marketing
ResHQ1	Director of Emerging Innovations, Scientific Partnering & Alliances	HQ	AstraZeneca **L**	Research Scientific technology Translational medicine
ResHQ2	Director	HQ	AstraZeneca **L**	Research
SciHQ	Senior director	HQ	AstraZeneca **L** Lilly **L**	Clinical development and operations
StratDevHQ	Due Diligence Director	HQ	AstraZeneca **L** Eisai **M** GSK **L** Roche **L**	Business Development Commercial Director Strategy New Product Development
StratHQ	Director	HQ	AstraZeneca **L** GSK **L** J&J **L** Academic research **S**	Business Development Research Strategy/planning
StratSub	Associate Director Partnering and strategy	Subsidiary	Centocor GSK L Medimmune L Promedior, Inc. Academic research S	Business Development Research Strategy/planning

L = large & complex (full in).
M = mid-size fairly complex.
S = small internally not complex (fully out) but small levels external network complexity.
* Used for calibration coding of complexity of organization.

as a dominant feature in the industry, local responsiveness as a typical feature in the I-R framework showing the typical administrative heritage feature for HQ-subsidiary relationship and as an outcome condition the ability to innovate effectively under constraints. Now we have added the constraints as clear feature for the industry.

3. Data collection, analysis and results

Qualitative research is linked to the research questions that require in-depth and detailed investigation designed to analyze a description, comparison or prescription (Johnson and Harris, 2002). The execution of qualitative research 'involves the studied use and collection of a variety of empirical materials - case study, personal experience, introspective, life story, interview, observational, historical, interactional, and visual texts - that describe routine and problematic moments and meanings in individuals' lives. Accordingly, qualitative researchers deploy a wide range of interconnected methods, hoping always to get a better fix on the subject matter at hand' (Denzin and Lincoln, 1994. p2). There are several advantages and limitations to qualitative research which should be considered when formulating a research strategy. Qualitative data provides a rich, holistic and real perspective. Offers a more precise way to assess causality within an organizational setting (Miles, 1979). Creswell and Plano Clark (2011) emphasize that the findings require personal interpretation, and due to the limited number of participants, it can be difficult to draw generalizations. Qualitative research is aimed at a detailed level of analysis, and large sample sizes are not viable as such prescription is not viewed as directly compatible in qualitative research as it is in quantitative research (Johnson and Harris, 2002). Ghauri et al. (1995) believe that the difference between quantitative and qualitative research is more than quantification. Qualitative research differs from quantitative research in five key areas. These are the use of positivism, acceptance of postmodern sensibilities, capturing individual's point of view, examining constraints of everyday life and securing rich descriptions (Denzin and Lincoln, 2017). The advantages of interviews are a more accurate and clearer picture of the respondent's position and meaning of the situation (Ghauri et al., 1995). A shortcoming of the use of interviews is that it demands a skilled and cautious interviewer. The interviewer is required to have a comprehensive understanding of the research problem and the information they are seeking (Ghauri et al., 1995).

There are many ways to interpret findings such as statistical analysis or, as in our case, the cross-case examination via a fuzzy set Qualitative Comparative Analysis (fsQCA) (Ragin, 2008; Fiss, 2011; Greckhamer et al., 2018). For this paper, the qualitative in-depth analysis (Corley and Gioia, 2004; Gioia et al., 2012; Creswell and Creswell, 2018) is driving the investigation to identify configurations and to understand the evolution of the ability to innovate in MNE. In terms of Bartlett and Ghoshal (1986, 1989) typology, the company has started as a multinational organization and developed into a transnational organization due to alliances. It sees itself as a network organization. We use the theoretical underpinning to develop the questions for semi-structured interviews with senior directors at AstraZeneca, a transnational firm. The in-depth interviews provide a good basis of small N cases for a fsQCA to combine theoretical and empirical knowledge from the data gained to derive configurations. This is supported by company information and historical data for the strengthening and understanding of the evolutionary part.

3.1. Sample and data collection

Due to the nature of R&D in biopharmaceutical organizations, a wealth of data exists in respect of R&D activities for assets in clinical stages. For this study, annual reports show R&D pipeline at the time of the reporting year-end, along with financial data such as R&D expenditures and R&D assets acquired through acquisition. These publications also incorporate organizational information such as current strategy, industry challenges they seek to tackle, major M&A transactions and significant organizational changes. Findings from this data illustrate what the changes were and key drivers on why the changes occurred.

This is supplemented by interviews that provide insight into the sector regarding how impacted organizations and how present-day challenges manifest themselves. Sheng and Hartmann (2019) explore in their investigation through interviews with senior managers or executives of MNEs in HQ and subsidiary validity and managerial relevance, and we take this into account similarly.

Data collection of experts: The analytical unit of analysis comprises 17 sub-business units (SBUs) or functional areas. The 17 directors of business development, finance, legal, scientific and innovation background are interviewed to provide expert insight into the evolution of the innovation ability in one of the major players of drug development in the world between 2016 and 2019. The overall understanding of the functional areas, HQ-subsidiary position and their experiential business background are captured in Table 1. Due to the HQ-subsidiary classification, their current functional and previous experience, the directors provide a detailed insight into the unit of analysis. Table 1 identifies the interviewees with their respective organizational background and expertise. The triangulation stems from having HQ and subsidiary directors of finance, legal, science, and organization to cross-check the arguments delivered. This gives an in-depth perspective of the complexity of organization and science of one of the leading biopharmaceutical MNEs.

3.2. Qualitative analysis

The structured interviews show the embeddedness of the complexity of organization in HQ and subsidiary perspectives, production and the innovation ability. The research question aligned with senior executives' interviews in an international biopharmaceutical company provides insights into international collaborations' organizational challenges. The Table 2 provides the structure of the qualitative investigation from first order themes with direct quotes of the interviewees, then second order themes leading to aggregate dimensions (Gioia et al., 2012) and the basis for the QCA analysis in Section 3.3.

The first theme of the investigation highlights how the organization has fostered innovation within R&D. The respondents' respective answers show the relevance of the organization's complexity with R&D and innovation as components. Several aspects of

Table 2
First, second order and aggregate dimensions.

First order theme	Second order theme	Aggregate dimension = conditions
"Organization has matrixed internal and external networks which are managed 'through dedicated teams'" "Through collaborations, expert recruitment" Context of internal recruitment of key scientific and clinical experts (DevSciHQ). "..By building its R&D hub next to a major teaching hospital and working extensively with the local academic population via mentoring and knowledge sharing" (also relevant to the ability to innovate effectively) (StratDevHQ) "Greater autonomy for teams - governance and the ever-increasing tendency to command and control structures with single points of accountability stifles collaboration and novel thinking because the definition of novel becomes "what one can convince the single decision-maker to accept" "External are freer thinking, and so it becomes more challenging to find the gold nuggets as distinct from pet theories and ramblings" "Corporate level forging of links and from individual to individual - not really joined up between the two though" (SciHQ) Challenge from working with external partners is "careful with certain confidential info but overall attempt to be as open as possible" (DevHQ3) "Dedicated external outreach and innovation sub-teams" "Dedicated alliance management for key external partners; project management internally" (LegDevSciHQ) The organization sources Innovation from "both in house and external collaborations" "firewalls and minting confidentiality when some of the top innovators are working with multiple companies, need to keep check of precious IP" (StratHQ)	*Context of internal recruitment of key scientific and clinical experts* Using teams, experts and academia outside the HQ, in R&D hubs	**Organizational complexity**
"Allow innovation to lead in any direction regardless of company mission" and "Harder to keep control of external networks, especially academics" on the current organization, and overall perception of the sector concluded that it "lacks innovation" (LegSub) "Very large and complex organization with X leader now have focus and strategy which never used to happen, which foes from the beginning to the end of the R&D process. Used to be siloed he has made that seem less" (StratSub) "..Many of the innovators have been bought by much larger companies as those larger companies struggle to remain profitable and produce for shareholders" (FinSub1)	*Complex side to the HQ administrative heritage*	
"Structure of organization too hierarchical, too many levels of approval, lack of time, decision making slow" (FinSub3)	*Complexity, hierarchy and the difficulties* regarding levels of approvals and decision making.	
"Partnerships with Government agencies" innovation is sourced "Multitude of ways, Open innovation portal, innovative challenges, networking" (ResHQ1)	*Open innovation portal* *Government partnerships*	**Innovation challenge** **Complexity of Science**
'Challenges of Innovation? "1) Mindset of individual corporate 2) the creative environment (or how process-driven) that environment is 3) changing strategy and continual re-organization' "Suggested improve innovation changes to organizational structure 'more matrix vs hierarchy and cross-sector/group projects'?"Increasing focus on academic staff working alongside and allow staff academic roles; strong open innovation activity"(BusDevHQ) "Not much in big global companies as complex throughout" (ResHQ2)	*Challenges of Innovation*	
"Explore innovation with higher risk" "Invest more in R&D, collaborate more" "need for higher speed" (DevSciHQ) Need for acquiring new technologies for example "More innovations comes from biologic drugs" (DevHQ2) "Balancing the career and funding drivers for academic blue skies research, with the translational agenda and the different rigour and robustness required for industrial research. Better cross-sector understanding of the pressures on scientists across academic and industry. Appreciation of the attrition rate, and iterative nature of drug discovery" (LegDevSciHQ) The ability at "looking at new solutions to old problems, e.g. using big data processes for disease understanding" 'competitions, encouraged out of box thinking, post-doc and PhD studentships so training innovators for the future'(StratHQ)	*R&D investment* *Academic blue sky research* *Nature of Drug discovery*	

(*continued on next page*)

Table 2 (*continued*)

First order theme	Second order theme	Aggregate dimension = conditions
"There are multiple challenges in managing global internal and external networks, to date, I have not seen an optimum structural model that is truly effective" (FinSub2) "Companies are investing too heavily in the later stage pipeline at the risk of killing groundbreaking innovation in the early stages of the pipeline". (FinSub1) "I believe you could add more Research scientists to have a broader reach towards new areas of focus." (FinSub1) "Larger early research and TS organizations and possibly more clinical trials in new indications." "I think people feel that speeding up processes at times will make drug discovery go faster." (FinSub1) "Areas that can be improved to enhance innovation include the ability "allow people to explore ideas without constraints of projects" and "Reward for innovative areas outside of mainstream thinking" (LegSub) "Not much in big global companies as complex throughout" (ResHQ2) "..Many of the innovators have been bought by much larger companies as those larger companies struggle to remain profitable and produce for shareholders" (FinSub1)	*Subsidiaries are the R&D hubs* *Global Complexities* *Local Responses*	**Local responsiveness and global integration**
Partly driven by the lack of "reward for innovators" and should "Reward to quality of drugs produced, not quantity" (DevHQ2) "Lack of funding/incentive at a government level" (LegSub) Reward for innovative areas outside of mainstream thinking" (LegSub) "The ratchet of ever-increasing regulatory and commercial requirements imposed by regulators and HTAs adds financial burdens onto those risks" (OrgSub)	*Reward for innovators* *Financial Burden*	**Ability of innovate effectively under financial constraints**
"More partnerships and get the R&D organization to be more porous" "Too much choice and too many fads" (ResHQ1) Suggested improvements to current innovation effectiveness "allow the risk of failure to be more acceptable and allow scientists time and liberty to explore, and have team goals (vs individual)" (BusDevHQ) "Ability to concentrate on delivering the best medicines" area needs improvement (ResHQ2) "The ability to discover new targets" (DevHQ1)	*R&D organization* *Effectiveness* *Best medicines* *New Targets*	

Adapted to Gioia et al. (2012).

the subsidiaries and HQs depict the coordination of innovation from the HQ and the legal, financial and scientific expertise located in the subsidiaries.

The *complexity of the organization* with internal and external networks is highlighted in the responses of the directors from the HQs and then from the subsidiaries. The insights derived from the HQ directors show that teams, collaborations, experts and internal and external networks of the drug development are controlled and coordinated via the Headquarters. The responses of directors emphasize the rationale for using teams, experts and academia outside the HQ, in R&D hubs. The subsidiary perspective suggests a much more complex side to the HQ administrative heritage, such as coordination issues, difficulty to control on one side, and better coordination of the functions through the HQ on the other side. The responses show that the complexity of the organization has both benefits and disadvantages. Additionally, one respondent stresses the role of innovators and their attractiveness for large companies. One response highlights the *complexity, hierarchy and the difficulties* regarding levels of approval and decision making. A good reflection of the complexity of the global biopharmaceutical organization and its network structure aligns with these responses in Fig. 2 above.

The innovation challenge in the transnational structures was addressed and can be highlighted by the responses. The innovation challenge is part of global companies' complexity with their partnerships with governments, academia and multiple ways of open innovation. Additionally, the issue of rewarding innovators in this context is emphasized. An important issue comes as innovation is linked to the speed of innovation and the higher risk of scientific discoveries. New technologies, drug development in R&D collaborations, and academic blue-sky research embedded in the structures of the *complex scientific* developments are highlighted by the responses of the HQ directors. On the other hand, the subsidiary perspective rounds up the perspectives derived from the HQ directors' responses. Since the subsidiaries are the R&D hubs, their views consolidate the picture of the HQ directors. The *local responsiveness* was assessed by both the HQs and subsidiaries.

Understanding the *ability to innovate efficiently* from the various perspectives occurring in the biopharmaceutical company, the HQ directors emphasize the improvements to the approach towards exploring new technologies, allowing time to explore and fail, but also to discover new targets and medicines: Simultaneously, the financial constraints in rewarding innovation and quality and quantity of drugs produced are among the issues that have arisen in the discussion. The subsidiary perspectives support the view that exploring ideas without constraints is necessary for the quality and speed of science and innovating effectively. Groundbreaking research can easily be impaired by focusing on the later stage of the research pipeline.

3.3. Configurational analysis - fsQCA

Using a set-theoretical or configurational analysis provides both a research philosophical and a technical angle. Set relations are a natural way of structuring and categorizing relationships. The field of management has gone through many iterations and ways to provide configurations and archetypes of organizations, strategies, performance, human resource and financial information. Recently, a neoconfigurational approach has been highlighted into which also this research can be classified (Misangyi et al., 2017; Greckhamer et al., 2018: Fainshmidt et al., 2020).

Ragin (1987, 2006, 2008) identifies that knowledge of the theory, and a deep case understanding is necessary to use fuzzy-set Qualitative Comparative Analysis (fsQCA) to bridge qualitative and quantitative results in a comparative analysis of the cases. Fuzziness added to a crisp set understanding provides a more differentiated understanding of an underlying topic. Set theoretically, the conditions are calibrated from the interviews and classified into empty and full membership in the set, which is crisp set analysis to start with, whereas fuzzy sets are using variation between 0 and 1. In preparation of the calibration, the qualitative part has identified the aggregate dimensions in table which are transferred into conditions. Qualitative Comparative Analysis belongs to Configurational Analyses which is an equifinal approach and identifies asymmetric relationships.

FsQCA finds applications in various disciplines and backgrounds from political sciences, sociology to management (Berg-Schlosser et al., 2009; Fiss et al., 2013; Fotiadis et al., 2016; Greckhamer et al., 2018; Homayouni et al., 2009; Kvist, 2007; Misangyi et al., 2017; Ott and Kimura, 2016; Schneider and Wagemann, 2013; Wagemann and Schneider, 2010; Woodside et al., 2011; Woodside and Zhang, 2013). These authors use fsQCA to classify societal, cultural and organizational behavior and add a neoconfigurational approach to management research discussions. Organizational and governance configurations are an important way to classify relationships and enlarge theoretical concepts (Legewie, 2013, 2017; Lewellyn and Fainshmidt, 2017; Schiehll et al., 2018). This article approaches the ability to innovate efficiently in MNEs as joint sets of conditions which combine to a complex entity and highlight the set-theoretic relationships (Ragin, 1987, 2006, 2008). From small, medium to large N cases, fsQCA offers to identify configurations of identified conditions in qualitative and also quantitative investigations (Mikalef and Pateli, 2017; Mikalef and Krogstie, 2020; Mikalef et al., 2020).

For this investigation, it offers the advantage that the small number N of expert interviews (Fan et al., 2016; Furnari et al., 2021) can be calibrated into the conditions of a set-theoretic analysis to show the necessary and sufficient conditions of the solution. Table 3 presents the calibration of the themes of the interviews of the directors situated in the HQ and subsidiaries of AstraZeneca with financial, legal, strategic, scientific, business development and venture capital expertise among knowledge of the industry sector and experience in the collaborative and competitive environment of the pharmaceutical industry.

The calibration uses the theoretical embeddedness of the administrative heritage for the complexity of science, the classification of the complexity of science (Fuentes et al., 2018) from easy to complex drug development, the empirical insights of the financial information and the ability to innovate effectively from the data. The classification into full and empty membership and the mid anchor of 0.5 was used to classify the membership in the calibration process in line with good practices – theoretical knowledge and empirical knowledge. We benefit from the observational insights and knowledge of the company of one of our authors (Rihoux and Ragin, 2009; Schneider and Wagemann, 2013):

3.3.1. Descriptive stats

Table 3 also shows the mean and standard deviation of the values for the conditions. of Org, Sci, LocResp and Inn. The highest mean value can be seen for the complexity of organization condition. The minimum and maximum, the number of cases and those missing cases are identified.

The next step in our configurational analysis is the provision of the necessity analysis (Schneider, 2019), Venn Diagrams, truth table and truth table analysis, and the empirical tests of sufficiency and XY plot.

3.3.2. Necessity analysis

We follow Schneider (2019) and the updated two-steps with necessity analysis first and then the sufficiency analysis afterwards. Greckhamer et al. (2018) and Schneider and Wagemann (2010 and 2013) pointed out that the necessity test is essential for the configurational analysis. Table 4 below emphasizes the strength for the necessary condition analysis and how the conditions on their own and in joint sets are strongly supported by the threshold of necessity 0.97 consistency and 0.6 coverage. Both the ability to innovate efficiently and its negation are a function of the complexity of organization, the complexity of science and local responsiveness.

The high consistency levels are also reflected in the truth table analysis that complexity of organization is a necessary condition for the outcome. Checking the condition with over 0.90 (Greckhamer et al., 2018) in the necessity analysis, Org (Complexity of Organization) is consistent with the descriptive stats of having the min and max values 0.67 and 0.93, but also in truth table analysis we can see that Org is a necessary condition for the outcome. The high value of Org goes back to the calibration and is aligned to the complexity of the organization which was emphasized by the responses. This is also consistent with our results and the respective empirical and company knowledge.

For the Supersubset analysis, Table 5 identifies all subsets with the consistency, coverage and combined levels. Rihoux and Ragin (2009) highlight subset relations for fuzzy sets whenever membership scores in one set are less than or equal to membership scores in another set. The values of the sub-set analysis support our XY-plot findings and show the various options of joint sets identified in the Venn Diagrams as well. We can identify this in our Table 5 below.

Table 3
Calibration table and descriptive stats.

Variable (and label)	Definition for coding	Role in theoretical model	Coding gradations	Descriptive Stats			
				Mean	SD	Min	Max
Complexity organizations (ORG)	Complexity of organizational structure, specifically the challenges in managing R&D in a complex network.	Degree if complexity of R&D network (internal and external) defines fit into the transnational paradigm (Bartlett and Ghoshal, 1989; Lewellyn and Fainshmidt, 2017; Schiehll et al., 2018)	0 = Not at all complex 0.33 = Some complexity but manageable 0.5 = Moderate complexity 0.67 = Fairly complex 1 = High degree of complexity	0.82	0.11	0.67	0.9
Complexity science (SCI)	Ability to translate lab based research into viable clinical medicines. Having effective translational science capabilities and deploying within internal and external innovation network. See Fig. 2	Dimension influences the composition of an organizations R&D capabilities and product pipeline. (DiMasi and Grabowski, 2007; Fuentes et al., 2018; Gauthier et al., 2016). Studies into the cost of drug development, the body of work led by DiMasi and Grabowski (2007) and DiMasi et al. (1991, 2003) primarily focus on the increasing cost associated with drug development.	0 = No challenge 0.33 = low levels of R&D but high risk (see Dementia drugs) 0.5 moderately challenging (Oncology) 0.67 = significantly challenging (Cardiovascular) 0.8 = fairly challenging (Vaccine) 1 = extremely (EBV vaccine)	0.45	0.20	0	0.67
Local Responsibility (LocResp)	Degree to which individual manages organizations at a local subsidiary level (HQ v Subsid)	Local responsiveness pressures include differences in customer needs, differences in distribution channels, availability of substitutes and the need to adapt, market structure, and host government demands (Prahalad and Doz, 1987, pp. 20–21).	0 = Fully out – purely operating at HQ 0.25 = some local responsibilities 0.5 = blend of local and HQ responsibilities 0.75 = mainly local element of HQ responsibilities 1 = Fully in local only role	0.69	0.29	0.25	1.00
Ability to effectively innovate (INN)	Importance of the need to seek globally for innovation and create an effective internal R&D organization and links into the external alliance network.	Measure of how an organization is able to translate innovation to commercial success. (Bartlett et al., 2008; Rugman et al., 2011; Schiehll et al., 2018)	0 = Fully out - inability to innovate 0.2 = basic ability 0.4 = constrained ability to innovate 0.6 = ability to innovate with challenges 0.8 = high ability to innovate with challenges 1 = Fully in	0.63	0.08	0.6	0.8

Table 4
Necessity test.

INN			~INN		
	Consist	Coverage		Consist.	Coverage
Org	1.00	0.78	Org	1.00	0.45
Sci	0.66	0.94	Sci	0.89	0.72
LocResp	0.85	0.78	LocResp	0.90	0.48
~Org	0.29	1.00	~Org	0.49	1.00
~Sci	0.80	0.93	~Sci	0.92	0.61
~LocResp	0.43	0.89	~LocResp	0.58	0.68
Org + Sci	1.00	0.78	Org + Sci	1.00	0.45
Org + LocResp	1.00	0.72	Org + LocResp	1.00	0.41
Sci + LocResp	0.96	0.78	Sci + LocResp	0.99	0.46
Org + Sci + LocResp	1.00	0.72	Org + Sci + LocResp	1.00	0.41

Table 5
SuperSub set analysis.

INN				~INN			
	raw				raw		
	consistency	coverage	combined		consistency	coverage	combined
Org*Sci*LocResp	0.965854	0.550000	0.737902	Org*Sci*LocResp	0.809756	0.803226	0.811570
Org*LocResp	0.862394	0.847222	0.882861	Org*LocResp	0.527804	0.903226	0.232795
Sci*LocResp	0.965854	0.550000	0.737902	Sci*LocResp	0.809756	0.803226	0.811570
Org*Sci	0.936031	0.663889	0.806605	Org*Sci	0.719321	0.888710	0.705463
LocResp	0.778723	0.847222	0.791798	LocResp	0.476596	0.903226	0.190076
Org	0.775862	1.000000	0.854400	Org	0.445402	1.000000	0.173205
Sci	0.936031	0.663889	0.806605	Sci	0.719321	0.888710	0.705463

3.3.3. Truth tables and Venn diagram

To understand the joint sets of the paths leading to innovation ability, Table 6 below shows the truth table of the investigation into the complexity of the organization, science, and local responsiveness experienced by the transnational managers. The presentation highlights that the paths to the ability to innovate effectively as an outcome offer many configurations which show the underlying story.

The truth table identifies the paths to the ability to innovate as a function of complexities of organization and science and local responsiveness. The raw consistency, the PRI and SYM consistencies are provided for the ability to innovate effectively under constraints and its negation.

To visualize the results, we offer the Venn Diagrams which identify these configurations. The cases are identified and clustered in the cells with the same configurations aligned to the truth table above. The Venn Diagram (Rihoux and Ragin, 2008) is not only the first thought when we talk about set-theoretical relations but also a good reflection of the Boolean algebraic treatment of empty and full membership of the conditions. The joint sets derived from the qualitative analysis highlight that all cases are dealing with the complexity of organization which is the x-axis in the diagram and a necessary condition for the outcome.

All cases are accounted for on the right side, which is full membership (1). On the y-axis is the complexity of science and the result is on both sides up and down of the middle line. This shows that both empty (0) and full (1) membership is considered. Similarly, local responsiveness as condition is positioned in the inner and global integration in the outer part of the Venn Diagram. The story of the qualitative investigation and the cross-case analysis is represented in the Venn Diagram (see Fig. 4).

The Venn Diagram is consistent with the truth table analysis below. It is clearly identified that the cases with Org*Sci are (110) from subsidiaries and then Org*LocResp (101) are – three HQs and one subsidiary. The negation of the ability to innovate is captured in Org*Sci*LocResp (111) and the one case of Org* ~ Sci* ~ LocResp (100).

Table 6
Truth table.

Org	Sci	Locresp	number	Inn	raw consist.	PRI consist.
1	0	1	8 (53 %)	1	0.957627	0.880952
1	1	0	3 (73 %)	1	0.94964	0.769231
1	1	1	3 (93 %)	1	0.965854	0.820512
1	0	0	1 (100 %)	1	0.981283	0.833333
0	0	0	0 (100 %)	0		
0	1	0	0 (100 %)	0		
0	0	1	0 (100 %)	0		
0	1	1	0 (100 %)	0		

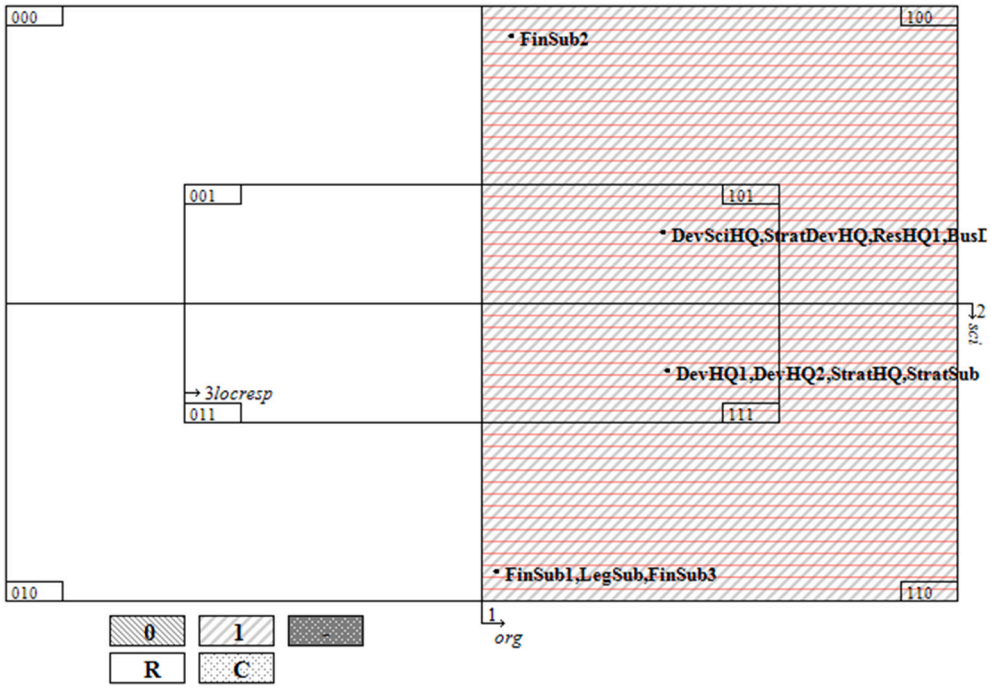


Fig. 4. Venn Diagram for the ability to innovate as a function of complexity of organization, complexity of science and financial constraints.

3.3.4. *Truth table analysis*

Table 7 provides insights deeper insights into the joint sets of the analysis by providing the consistency levels of above 0.89 or 0.91 for the logical remainder of the intermediate, the parsimonious and complete analysis. Ragin and Fiss (2008) provided the notation of core (and contributing) condition as present (●) or absent (□) in the result. The truth table analysis shows the solutions for the ability to innovate effectively (INN) as a function of complexity of organization, science and local responsiveness with its negation (~INN). The frequency thresholds and cut-offs are shown and the cases with membership above 0.5 are identified in the respective cells. This presentation enables us to pinpoint which parts of the company are considered in the paths to the ability to innovate or its negation.

Full membership and absence of membership of the logical remainder in the truth table analysis represent strong results and highlight that the complexity of organization and science are core conditions. The consistency levels are high above 0.80 and specifically, Configuration 1–0.94; Configuration 2–0.86; and raw coverage from 0.66 to 0.84, which is relevant in the fuzzy set analysis. The configurations show high consistency levels and the meaning that the joint set is a subset of the outcome and almost a full set. The coverage values are also high and used for the sufficiency of the result and representing the space of overlap of the joint set (Ragin, 2006, 2008).

The *ability to innovate effectively* as an outcome has two solutions (see Fig. 6) and two solutions for its negation. The ability to innovate is a function of complexity of organization, complexity of science and local responsiveness which shows the equifinal solutions as paths. This means that complex organizational structures lead to a shift in innovation, but also that the more complex the production process for drugs and high uncertainty are leading to a need of more efficient innovation ability. The innovation ability and its constraints are integrated in the outcome but also highlight that when it is too complex in organizations, science and adaptability to local responses, it can lead to a counter-effect and reconfiguration.

Additionally, we have therefore provided the negation ~INN with the respective outcome of two configurations. The negation (inability to innovate effectively) was 0.78 almost close to the 0.8 consistency level which is above the minimum recommended threshold of 0.75 (Ragin, 2006, 2008; Fiss, 2011). We consider therefore the substance of the argument that the inability to innovate has the two configurations with the cases showing membership above 0.5 below:

Cases with greater than 0.5 membership in term org* ~ sci* ~ Locresp: FinSub2 (0.67,0.4).

Cases with greater than 0.5 membership in term org*sci*Locresp: DevHQ1 (0.67,0.4),

DevHQ2 (0.67,0.4), StratHQ (0.67,0.4).

Taking this on board means that the *inability to innovate* effectively is

a) a function of presence of complexity of organization when complexity of science and local responsibility is absent derived from the view of the financial subsidiary.
b) a function of the presence of complexity of organization, complexity of science and local responsibility from the perspective of three HQs with a strategic and development focus.

Table 7
Truth table analysis and logical remainders.

	SOLUTION			
	Inn = f(Org*Sci* LocR)		~ Inn = f(Org*Sci* LocR)	
	Configuration 1	**Configuration 2**	**Configuration 1**	**Configuration 2**
Org	●	●	●	●
Sci	●	□	⊗	●
LocResp	□	●	⊗	●
Consistency	**0.94**	**0.86**	**0.89**	**0.81**
Raw Coverage	**0.66**	**0.85**	**0.54**	**0.80**
Unique Coverage	**0.11**	**0.30**	**0.10**	**0.34**
Overall Consistency	**0.86**		**0.78**	
Overall Coverage	**0.96**		**0.90**	
Frequency Cut-off	**1**		**1**	
Consisency Cut-off	**0.95**		**0.81**	
Cases	Cases with greater than 0.5 membership in term org*sci: FinSub1 (0.67,0.6), LegSub (0.67,0.6), DevHQ1 (0.67,0.6), DevHQ2 (0.67,0.6), StratHQ (0.67,0.6), FinSub3 (0.67,0.6), StratSub (0.67,0.6) Cases with greater than 0.5 membership in term org*Locresp: DevSciHQ (0.9,0.8), StratDevHQ (0.9,0.8), DevHQ2 (0.9,0.6), DevHQ3 (0.9,0.6), ResHQ1 (0.75,0.8), ResHQ2 (0.75,0.6), DevHQ1 (0.75,0.6), SciHQ (0.75,0.6), BusDevHQ (0.67,0.6), LegDevSciHQ (0.67,0.6), StratHQ (0.67,0.6)		Cases with greater than 0.5 membership in term org*~sci*~Locresp: FinSub2 (0.67,0.4) Cases with greater than 0.5 membership in term org*sci*Locresp: DevHQ1 (0.67,0.4), DevHQ2 (0.67,0.4), StratHQ (0.67,0.4)	

⊗ = Absence of an antecedent; ● = Presence of an antecedent; □ = The presence or absence of the

This was the case for those who see innovation happening in HQ dominated directions. This fits with the view that HQ consolidates innovation and innovation happens in subsidiaries with their legal and financial experts located in subsidiaries. This model goes back to the multi-domestic archetype in which the local-for-local innovation challenge happens. After the evolution of the network structure, the locally leveraged innovation dominated the challenges in AstraZeneca. The coordination of the ability to innovate effectively is a new dimension for the administrative heritage. We can, therefore, introduce the neomulti-domestic configuration in the transnational management.

3.3.5. Sufficient conditions

To show the asymmetric relationships, the XY plot in Fig. 5 provides a clear indicator that the model of innovation ability is a function of the complexity of science, the complexity of the organization and local responsiveness. The cases bundled in the diagram show that both sufficiency and necessity can be identified above the diagonal which are strong results for the causal path of joint sets leading to the outcome. Based on Schneider (2019) and Oana and Schneider (2018), we can show that the position of the cases fall into the possible typical and deviant consistency and robust typical and deviant consistency sections on the XY-plot which is also represented in the truth table analysis for the cases.

This means that necessity and sufficiency for the models are in place. According to the asymmetry, the strongest result is derived in the XY-plot for the joint set of the complexities of the organization and science, and the local responsibility leading to the effective ability of to innovate.

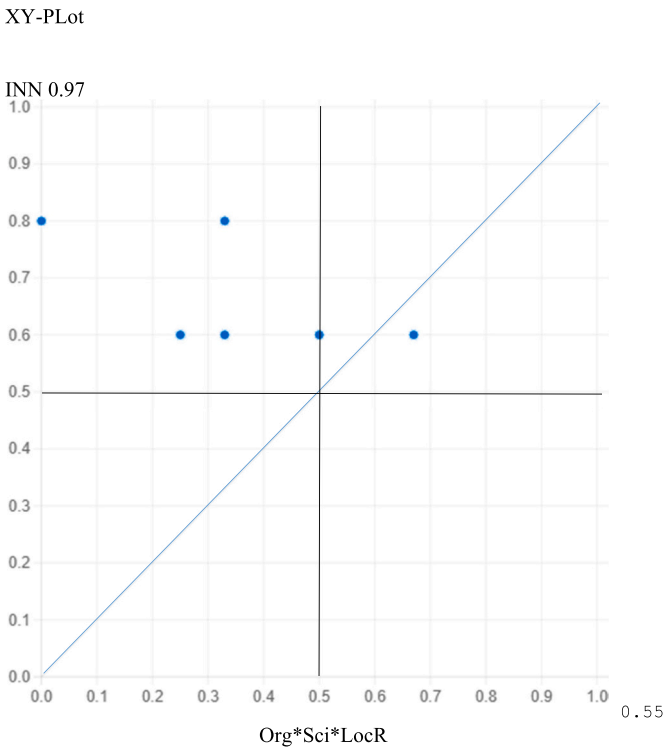


Fig. 5. Necessity and sufficiency for the path to the ability to innovate effectively.

3.3.6. Configurational results

The configurational paths leading to the outcomes of the effective ability to innovate are captured in Fig. 6 below. It emphasizes the equifinal and asymmetric results discussed above. In Boolean expression of the ability to innovate effectively is therefore:

Org*Sci + Org*LocResp → INN and

Org* ~ Sci* ~ LocResp + Org*Sci*LocResp → ~ INN. We use Verbeke et al. (2018) to show the configurations.

Configuration 1 represents the ability to innovate under constraints in the presence of complexity of organization and the complexity of science when local responsiveness is not relevant. The cases which are covered in this configuration are the subsidiaries with a finance (Finsub1 and Finsub3), legal (Legsub)and strategic focus (Stratsub), but also HQs with strategic (StratHQ)and developmental (DevHQ1 and DevHQ2). When complexity of organization and science are relevant for the ability to innovate under constraints the legal and financial subsidiary focus, but also strategic and developmental HQ perspective identify a more transnational perspective integrating both subsidiaries and HQs in the global network.

This presents a strong result for innovation, and we can add the proposition 1 for it.

Proposition 1. If the complexity of organization and the complexity of science are present and the local responsiveness is not relevant, then there is the ability to innovate under constraints an outcome for transnational enterprises.

Configuration 2 represents the ability to innovate under constraints in the presence of complexity of organization and local responsiveness when complexity of science is not relevant. This configuration covers cases for HQs with a focus on developmental (DevHQ1, DevHQ2, DevHQ3), strategic (StratHQ, StratDevHQ), and scientific (SciHQ; DevSciHQ; ResHQ1, ResHQ2)) activities but also those with business development and legal (BusDevHQ, LegDevSciHQ). This configuration was more important from an HQ perspective to allow the subsidiary autonomy and local responsiveness. Outsourcing the ability to innovate under constraints emphasizes the multinational perspective of the archetypical structure of the transnational management.

This presents a weaker result, and we can add the proposition 2 for it.

Proposition 2. If the complexity of organization and the local responsiveness are present and the complexity of science is not relevant, then there is the ability to innovate under constraints an outcome for transnational enterprises.

The negation of the ability to innovate effectively also identifies important results for the neoconfigurational approach:

Configuration 1 represents the inability to innovate under constraints when the complexity of organization is present, and the complexity of science and local responsiveness are absent. The configuration is only covered by the financial subsidiary that in the absence of complex science and local responsibility the complexity of organization will lead to an inability to innovate. Strikingly, none of the scientific and R&D focussed cases points to this option which highlights that considering difficulties to innovate it is not down to complexity of science and local responsiveness.

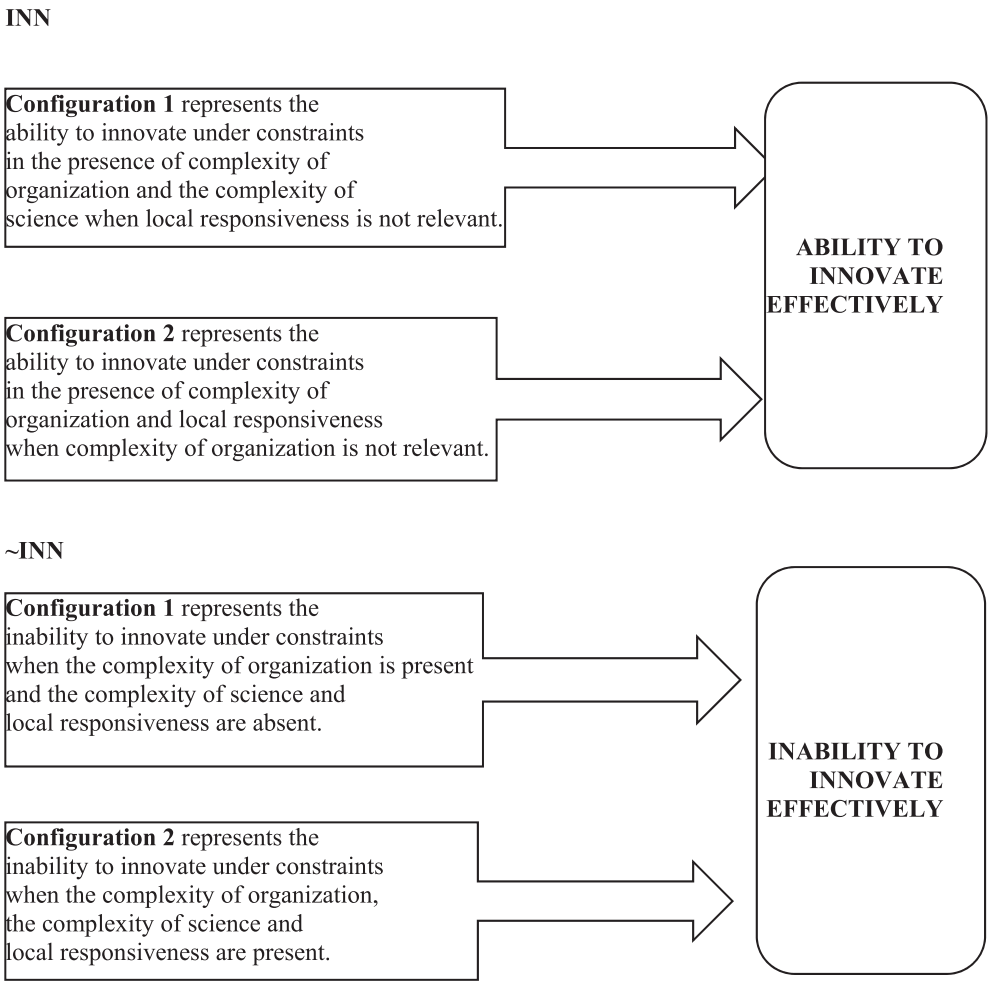


Fig. 6. The configurational paths to the ability to innovate effect.

This presents a strong result, and we can add the proposition 3 for it.

Proposition 3. If the complexity of organization is present and the local responsiveness and the complexity of science are absent, then there is the inability to innovate under constraints an outcome for transnational enterprises.

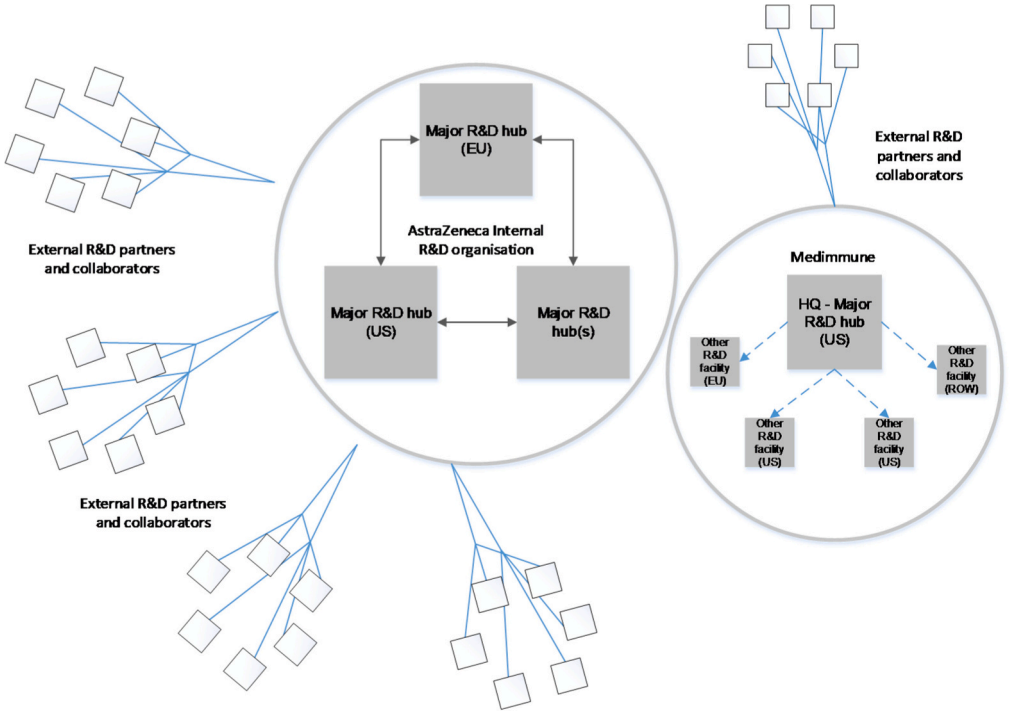
Configuration 2 represents the inability to innovate under constraints when the complexity of organization, the complexity of science and local responsiveness are present. This configuration shows that considering all conditions building a joint set for the inability to innovate, then the strategic and developmental HQs consider this as an option. None of the subsidiaries pointed towards this configuration which highlights the strength of the condition local responsiveness as a part of ability to innovate effectively. From an HQ perspective, innovation ability is a combination of complexity of science, organization, and local responsiveness but also from a subsidiary perspective.

This presents a weak result, and we can add the proposition 4 for it.

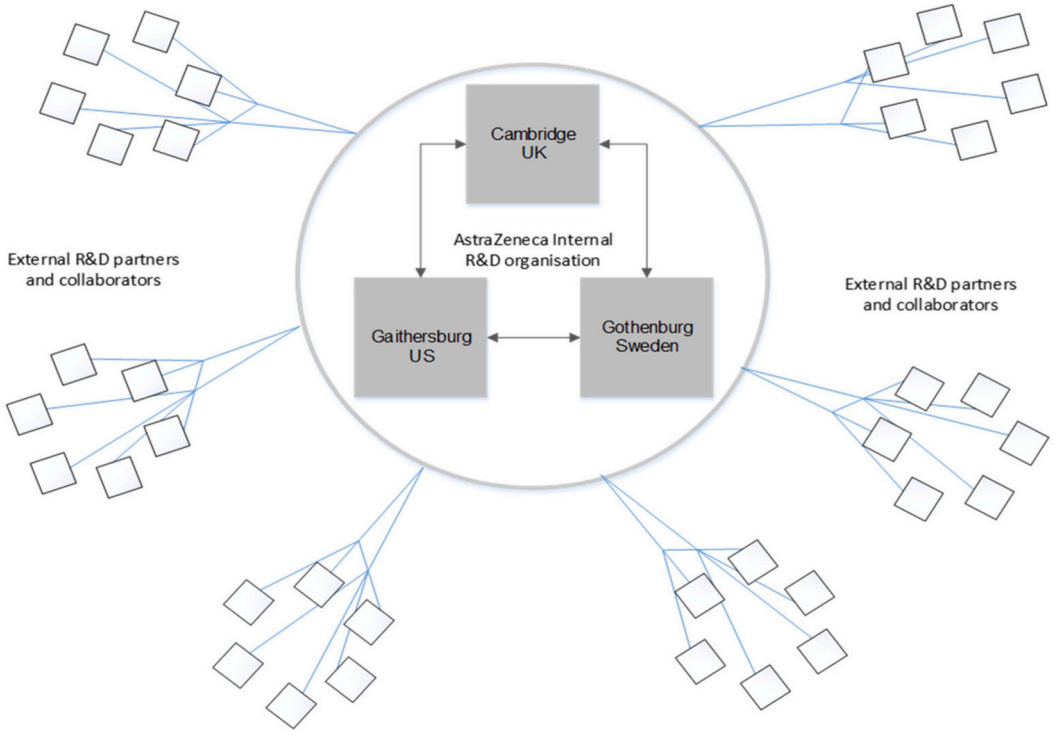
Proposition 4. If the complexity of organization, the complexity of science and the local responsiveness are present, then there is the inability to innovate under constraints an outcome for transnational enterprises.

The results of the fsQCA are congruent to the actual organizational structure that evolved after the 2013 restructuring in that local and organizational complexity influences are apparent due to the separate operating models (see Fig. 7). AstraZeneca endeavoured to operate as a neomulti-domestic MNE however it permitted their main subsidiary Medimmune to operate with prominent levels of autonomy and a centre-for-global innovation model. Consequently, the additional organizational complexity that manifests is a pivotal driver for a subsequent restructure in 2019 where Medimmune brand is retired, and its operations fully integrated into AstraZeneca such that the neodomestic MNE could be achieved.

AstraZeneca and Medimmune subsidiary pre-2019



AstraZeneca post 2019



(caption on next page)

Fig. 7. The evolution of the MNE from Transnational to neomulti-domestic MNE.

3.4. Evolution of innovation ability in pharmaceutical MNE

The responses highlight the necessity of looking at novel solutions, allowing blue-sky academic thinking, reward innovators, and risk-taking while dealing with financial and regulatory constraints. Moving outside and encouraging failure and risk and encouraging innovation ability in the various stages of product development is a factor in the benefits of a neomultinational network.

With company documents and interviews, we can stress that the company has gone through changes and an evolutionary process. The figures classify the complexity of the organization, the financial constraints and the complexity of the science in the drug development process and the production process of the pharmaceutical industry.

AstraZeneca's scientific premise up to 2007 is primarily concerned with the field of small molecules. Due to the need to enhance and evolve their scientific capabilities the firm commenced acquiring biologics companies to move into large molecule area, notably the acquisition of Medimmune in 2007.

A reorganization during 2013 in which the firm moved their HQ to Cambridge resulted in the structure as depicted in the Fig. 7 (MNE in 2018). The intent was to create a neodomestic MNE that operated around their three core R&D HQ hubs in the U.K., U.S., and Sweden (Fig. B). The Group maintained two separate units for small molecules and large molecules (biologics) with the latter maintaining the Medimmune brand and HQ. The R&D pipeline consists of 68 % small molecule and 32 % biologics.

The effectiveness of the restructure can be evidenced in part by the ability of the organization to react to the challenge and develop its COVID vaccine in an expedited manner. The vaccine leverages from the Medimmune legacy development and manufacturing capabilities for biologics coupled with research collaboration capabilities at HQ. Post COVID biologics component of R&D has taken on further prominence as now comprises of 68 % of the pipeline.

The advantage of having in-depth interviews representing the different levels of decision-making and functions in AZ also identifies the evolution of innovation in AZ's portfolio of pharmaceutical production. The configurations of the innovation ability and the organizational evolution of a pharmaceutical company were relevant in the vaccine innovation process.

The combination of the complexity of science, complexity of organization, and the local responsiveness are highlighted and emphasized throughout the various levels of responsibility (HQ and subsidiary level) and functions (business development, legal, financial, strategy, science) within the company. Critical voices and strong support have been recorded equally. To even identify configurations and set relations, we used a set-theoretical lens – fuzzy set Qualitative Comparative Analysis.

4. Discussion

4.1. Theoretical implications

The set-theoretical findings of this research emphasize that the complexity of science and organization, and local responsiveness conceptualized in the transnational management are necessary and sufficient for the innovation ability. This is a novel approach, and the results clearly point to the organizational and innovative challenges as intertwined in biopharmaceutical transnationals. The ability to effectively innovate is a function of the complexity of science and organization and the local responsiveness.

The neoconfigurational analysis enlarges the theoretical concept of the transnational organization and overrides the Bartlett and Ghoshal approach that it is a sensing-responding and implementing approach only, but more an equifinal and configurational approach towards a response to changes. It can be clearly stated that the transnational management framework has moved on to a new level in which the complexities of phenomena are drivers. This means that the adaptations mentioned in the interviews lead to complex organizations and reconfigurations which improve the ability to innovate effectively. The transnational management offers a framework which allows the adaptation of innovation challenges to be integrated into a dynamic international organization. Causal asymmetry benefits from the fact that same causal condition can be associated with even opposite outcomes. This is an important

Table 8
Configurations and outcomes.

	Ability to Innovate Effectively	Inability to innovate effectively
Configuration 1 (Strong)	***Proposition 1***: If the complexity of organization and the complexity of science are present and the local responsiveness is not relevant, then there is the ability to innovate under constraints an outcome for transnational enterprises **Organizational and scientific complexity for transnational configuration**	***Proposition 3***: If the complexity of organization is present and the local responsiveness and the complexity of science are absent, then there is the inability to innovate under constraints an outcome for transnational enterprises. **Organizational Complexity without scientific complexity and local responsiveness**
Configuration 2 (Weak)	***Proposition 2***: If the complexity of organization and the local responsiveness are present and the complexity of science is not relevant, then there is the ability to innovate under constraints an outcome for transnational enterprises **Organizational complexity and local responsiveness for multinational configuration**	***Proposition 4***: If the complexity of organization, the complexity of science and the local responsiveness are present, then there is the inability to innovate under constraints an outcome for transnational enterprises. **Transnational Complexity as constraint to efficiency for inherent multinational structures**

aspect of why configurational logic can emphasize issues that are difficult to analyze via correlational logic.

Theoretically, the propositions developed from the study identify both ability and inability to innovate. Combined with the transnational management categories and archetypes, the results of this study identify the configurations leading to ability and inability to innovate effectively. For all the configurations and outcomes, complexity of organization is a necessary condition. To innovate effectively, it is important to combine the conditions complexity of organization with the complexity of science as a transnational typology dependent on the scientific ability. For the multinational typology, the configuration of complexity of organization and local responsiveness highlights the focus on subsidiaries when scientific complexity is not relevant. The Table 8 below shows the configurations and outcomes with the respective propositions to show the theoretical enlargement of the study.

The theoretical contribution highlights that the equifinality of the configurations leading to ability and inability to innovate effectively is dependent on the complexities and typologies of the transnational management. The configurations show their influence on decision-making and understanding of the ability to innovate. Whether a configuration is too complex or not complex enough is a reason why we find an inability to innovate.

Its appreciation impacts the relationship of local and HQ responsiveness and is inherent in the ability to innovate effectively. Supported by the empirical investigation, the theoretical contribution shows clearly that HQ and subsidiaries respond to an interplay of these conditions.

4.2. Empirical implications

The empirical investigation of expert interviews with financial information and the configurational approach of fsQCA combine a concept with an equifinal approach. The fsQCA shows its strength by providing an in-depth qualitative analysis with a fuzzy membership scaling in the data collection, which benefits the calibration and cross case analysis with equifinal paths to the outcome. Both the interviews and company knowledge contribute to the configurational analysis of the data. The truth table analysis shows the consistency levels for the models of innovation ability as a function of complexity of organization, complexity of science and local responsiveness.

This helped to identify the paths to the outcome and the asymmetric relationship of the cases as necessary and sufficient conditions shown in a XY-plot. Adding the Venn Diagrams to visualize the outcome of the investigation strengthens the importance of the conditions and their joint sets. The results are a surprise and show a configurational approach for the typology of a neomultidomestic management structure rather than a transnational company driven by the complexity of organization and science.

4.3. Managerial relevance

With the re-configurations and evolution of the MNE during environmental uncertainties, the complexity of science in the drug development process influences the organizational challenges of transnational network organizations.

The configurations of the innovation ability and the evolution in terms of organizational complexity help the MNE to restructure and understand solutions towards a ‘neomulti’ archetype. Our findings in terms of changes to the organizational archetypes, emphasize the importance of managerial flexibility and local responsiveness by global coordination in an environment of complex scientific developments and constraints.

It pays off to combine resources and set up alliances to tackle the complexities of innovation in the various stages of drug development. The complexity of organization and science and local responsiveness identify the paths to innovate effectively. Similarities and differences in the observation of successful paths support a neotransnational management structure.

It provides managerial capabilities to adapt better to the changes in rapid environmental uncertainties. The results of the analysis are a surprise. This encourages new drug developments and alliances which support the evolution of this organizational form and its adaptation to new realities.

In Astra Zeneca's case, the alliance with University of Oxford produced a rapid vaccine in a local responsive manner and showed the ability to innovate effectively on a global scale.

4.4. Limitations of the study and future research agenda

As with all research, the limitations of our investigation are based on one MNE as the underlying unit of analysis. Even so, we were able to interview 17 directors with triangulations, the number of interviewees could have been enlarged to other companies and a quantitative investigation within the industry. The use of a quantitative investigation for symmetrical relationships could be an avenue for future research investigating the innovation ability, financial and regulatory constraints in a cross-sectional study or multi-level analysis. Future research can now investigate the new form of a neomulti-domestic archetype, but also following Mees-Buss et al. (2019) and their work into Unilever as a neoglobal transnational structure, a neotransnational approach as an evolutionary concept.

5. Conclusion

The coherent approach from conceptualizing to the empirical investigation with in-depth interviews on HQ and subsidiary level, company information and fsQCA strengthens the results of innovation ability under constraints. The outcome of the analysis is that the use of fuzzy set QCA aligns with the complexity of science and organization in a transnational company in the biopharmaceutical industry and provides equifinal solutions in support of the framework.

Transnational management and the evolution of the network structures facilitate the complexity of science and innovation ability. The financial constraints can be circumvented by the efficiency of innovation, such as outsourcing to universities, and the complexity of the organization using local responsiveness in the innovation process, plays a vital role in the next generation of drug development in the biopharmaceutical industry.

How will MNEs innovate, produce, organize and sell in the future due to the uncertainty of environmental factors (health, climate, policies, transport, societal changes)? This could lead to a new wave of investigations into a new world order the current global developments. The neoconfigurational transnational management is benefitting from worldwide innovation of technology, efficient scientific results and flexible local responsiveness to complex organizations and science. The evolution of new ways of organizing and innovating is at the forefront.

AstraZeneca combining resources with the University of Oxford to develop a vaccine shows the exploration of local capacities to benefit worldwide production and sales. As IB researchers, we need to highlight the benefits of a worldwide connection within the new tendencies. Multi-domestic – transnational – neoglobal or neomultinational, the evolution of the MNE has been a history of adaptation to trade barriers, competition as global chess game (global and international) and networks of technological innovation.

The next chapter of the MNE is dependent on different parameters but can grow beyond the constraints due to its history of adaptation. The evolution of the ability to innovate effectively develops in line with the organizational necessities and scientific challenges. Collaborations across geographical distances have so far proven limitless. Our research has uncovered the evolution of the MNE into the neomultidomestic organization, which also highlights the response to geopolitical developments and the adaptation to more efficient organizational structures.

CRediT authorship contribution statement

Samantha Macro: Writing – original draft, Visualization, Methodology, Investigation, Data curation, Conceptualization. **Ursula F. Ott:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Conceptualization.

Data availability

Data will be made available on request.

Appendix A. Appendix

A.1. Interview questions

A.1.1. Background of interviewee

1) What functional roles are held in the sector?
2) What best describes your current job title?
3) Which organizations (both academic and industry) have they worked for in Biopharmaceutical Sector?

A.1.2. Industry and challenges facing innovation

4) What do you consider to be the main challenges to innovation within the Biopharmaceutical firm?
5) How important is innovation to your organization?
6) Examining the last decade how have these changed over time? Have any new challenges emerged?
7) Who do you consider as a successful innovator within the Biopharmaceutical sector? Why?
8) What do you believe are the emergent forms of innovation within the sector?

A.1.3. R&D organization

9) Where is the R&D HQ of your organization? Which countries and places?
10) What function does the HQ take on?
11) Where are the subsidiaries located? And what functions do they take on?
12) Are internal and external R&D networks located near subsidiaries?
13) In terms of innovation where does is the following conducted:

a) Sensing
b) Responding
c) Implementing

14) What are the constraints your organization faces due to finite financial resources?
15) How do you live with these constraints?
16) If you had further financial resources, what key changes would you make to the organization?

17) How do regulatory challenges impact the organization?
18) How are these managed?
19) How are new technologies and innovation sourced? Is there a bias for organic versus acquired?
20) How has your organization(s) fostered Innovation within R&D?

A.1.4. Internal and external R&D networks

21) How does your organization effectively manage internal and external R&D networks?
22) What are the key differences between internal and external networks? How are the differences managed?
23) How are strategic alliances initially sourced? Typically, how do the initial contact/relationships start?
24) Who do you consider to be the main decision makers for determining which international strategic alliances/collaborations to engage in?
25) How effective is the sharing of innovation and technology sourced from external alliances within the internal R&D network?
26) How close are the relationships with alliances, any key differences between internal and external relationships?
27) Other thoughts or insights that you feel may be relevant in understanding the current environment and challenges facing organizations when engaging in drug discovery and development.

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