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Original Article

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The effect of technology and regulation on the co-evolution of product and industry architecture

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Abstract

This paper explores the co-evolution of product and industry architecture by drawing on a longitudinal study of the UK personal pensions industry between 2005 and 2020. It provides qualitative evidence for the way in which institutional structures, particularly regulation, entwine with firm strategic choices to shape the contours of an industry value chain (IVC). We draw upon modularity theory and the literature on industry architecture to consider how strategic bottlenecks emerged and how value shifted between layers of the IVC. Furthermore, we examine the interplay between the agendas of the regulator and firm strategic responses to unpack how firms (product providers) responded by pursuing integrative innovation and less specialization to mitigate the effects of value migration to strategic bottlenecks. Our findings extend recent work on product and industry architecture, highlighting how markets evolve toward less modular product configurations and less industry specialization in response to these dynamics.

JEL classification: D21, L22, O32

1. Introduction

Product modularization and specialization emerged in the UK personal pensions sector in the early 1990s (Burton, 2018). This paper focuses on the trajectory of this process between 2005 and 2020, looking particularly at the impact of regulatory philosophy on swings toward and away from modularization and specialization, and the role played by strategic bottlenecks in shaping product and industry architecture.

The evolution of product architectures can be traced back to Simon's (1962) work on hierarchy and systems. Subsequent research on product modularity has occurred across a wide variety of contexts such as motor vehicles (Argyres and Bigelow, 2010; MacDuffie, 2013), computers (Baldwin and Clark, 2000), software (MacCormack *et al.*, 2012), semiconductors (Funk, 2008), and bicycles (Galvin and Morkel, 2001). Across these different studies and contexts, a modular product architecture has often resulted in corresponding changes in industry architecture, with firms becoming specialized and new entrant firms emerging in the industry value chain (IVC). However, evolutionary analysis is increasingly shifting to the way entire sectors and their architectures co-evolve (Jacobides *et al.*, 2018), providing the motivation for our paper.

It is often remarked that product architectures transition to more modular configurations, with corresponding firm specialization (e.g., Campagnolo and Camuffo, 2010; Sorkun and Furlan, 2017) influencing firm-level outcomes (Galvin *et al.*, 2020). Langlois and Robertson (1992) argued that modular product architectures benefit firms in two complementary ways: on the supply side through greater specialization and on the demand side through mixing and matching components to fine-tune a product to consumer needs. Extending analysis to vertical disintegration, Jacobides (2005) examined the US mortgage banking industry and identified gains from specialization and gains from trade as the sparks of a process that drives vertical unbundling. When such gains are available, firms engage in intra-organizational partitioning and vertical co-specialization to reduce coordination complexity and task interdependence.

We were intrigued by the potential for product configurations to become less modular and industries less specialized. For example, Fixson and Park (2008) examined the case of Shimano in the bicycle industry. They explained how *designer's seeking value* drove a reintegration process of bicycle drivetrain components in response to consumer demands in the high-performance segment of the market, while the vast majority of the industry remained specialized and the product configuration remained modular. Shifting the unit of analysis to the industry level, Cacciatori and Jacobides (2005) highlighted how capability gaps led to all-in-one providers emerging in the UK construction industry. Furthermore, Jacobides and Winter (2005) examined the Swiss watch industry and found that the emergence of a new technology engineered by vertically integrated rivals undermined the competitive position of the "old" technology and the existing specialized structure of the industry.

Building on these unusual cases, we present modularity theory as a lens through which to understand the various design choices available to firms (Baldwin and Clark, 2000; Tee, 2019). Using a longitudinal study of the complex UK personal pensions industry, we advance existing research on product and industry co-evolution by unpacking the role of regulation and the related technological choices of firms. Regulators rely heavily on private actors for detailed understandings of technology and market dynamics. Existing scholarship has, therefore, often portrayed regulators as "followers" of the private sector, struggling to keep pace with technological and industry dynamics. Moreover, according to (Jacobides and Lianos 2021a: 1122) private firms strive to "set the rules of the game that they themselves were playing." However, regulators often have their own agendas (Wishnick, 2020) to reshape the design of markets and influence levels of competition and innovation and to reshape business models. Given this complex interplay between endogeneity and strategic choices of firms and the exogenous agendas of regulators and policy, it is surprising that research into the extent to which institutional structures, such as regulation, shape the nature of market dynamics and technological choices is under-elaborated, despite influencing the agency of firms and their incentives and design choices (see Jacobides *et al.*, 2014, 2006; Skold *et al.*, 2020). This fundamentally motivated our exploratory research question: *how do regulation and technology shape product and industry co-evolution in regulated markets?*

Our findings highlight how the pensions product architecture initially shifted toward a modular configuration and then in a subsequent period reversed toward a less modular configuration. In considering these counterpoise transitions, we highlight three key contributions. First, we demonstrate how shifts in regulation and regulatory philosophy influenced technological choices and created forces that pushed the industry toward more modular product configurations and specialization. We then highlight the limits to this process as a result of the emergence of strategic bottlenecks in the specialized IVC. This allows us to theorize how they emerge and are protected and how firms respond. In so doing, we present a deeper understanding of how firms, which retained integrative capabilities in the modular phase, could better utilize integrative innovation and an expanded vertical scope, to mitigate the effects of strategic bottlenecks and reimagine how surplus was divided. This enables us to show how value capture between IVC layers changed over time in response to changes in regulation and technology and how product providers utilized the systemic modularity of the product system and (re)integrated governance to (re)capture value. We also draw attention to the interplay between the regulators' ambition to influence competitive dynamics, innovation, and the business models of firms and the resultant strategic choices of firms in the sector.

Using an inductive approach, our paper offers a selective review of the literature, before describing the requisite research methods needed to explore the complexities of the regulatory changes in the industry leading up to 2005 and beyond and the subsequent consequences of these for the industry. Our findings, supported by insights from experienced industry professionals, are followed by an extended discussion and a critical agenda for future research pathways.

2. Literature

Firms make product design choices with differing appropriation prospects in the context of existing capabilities and the shape of the industry architecture (Jacobides *et al.*, 2006). At one end of a continuum, modular products define the relationships between components and interfaces such that components may be designed and produced independently by separate groups, strategic business units, or firms (Schilling and Steensma, 2001). An important feature of modular products is the way in which they enable firms to design components autonomously and simultaneously, so long as they adhere to stable design rules (Baldwin, 2020). At the other end of the continuum, integrated products incorporate components that are interdependent and connect together via interfaces that are specialized or idiosyncratic (Sanchez, 2008) and are often designed by firms in the initial stages of the product lifecycle (Tee, 2019).

Existing scholarship has typically argued that the evolution of product architecture shifts from one of "complex, non-standard interfaces, through simple company-wide standard interfaces and ultimately to industry-wide standards" (Shibata *et al.*, 2005: 15). Corresponding with this shift toward more modular product architectures featuring industry standards (Sanchez, 2008), an IVC co-evolves to feature greater levels of co-specialization as intermediate markets mature and gains from specialization and trade become available (Jacobides, 2005).

Despite this common, but not universal, trajectory, products can also evolve toward being less modular and industries less specialized, especially in cases where the limits to modularity are reached (Brusoni, 2005), such as complex coordination (Ernst, 2005), innovation complexity (Brusoni *et al.*, 2007; Rivkin, 2000), competency traps (Zirpoli and Becker, 2011), or commoditization (Pil and Cohen, 2006). Some authors have argued that an evolution toward less product modularity may be initiated by firm choices. Henderson and Clark (1990) asserted that reintegration is possible following an architectural shift in product technologies. Others have suggested the primacy of demand-side processes, such as changes in consumer preferences (e.g., Christensen *et al.*, 2002). Fixson and Park (2008) studied Shimano in the bicycle industry and remarked that integrative innovation occurred in response to consumer demands in the high-performance segment of the market. Furthermore, Dietl *et al.* (2009) noted different "architectures of value creation" in the European car industry and emphasized how Mercedes was able to pursue a differentiated strategy through higher levels of integration.

These same design choices often influence industry architecture. There are a number of potential industry architectures that may feasibly exist, (Jacobides, 2008) and the architecture that comes to structure an IVC may be partly designed (via regulation or standards) or may otherwise emerge through a range of "technological, institutional or social artefacts that allow for two or more independent entities to divide labor" (Jacobides *et al.*, 2006: 1203). Changes in industry architecture are largely driven by the capabilities of firms (Jacobides and Hitt, 2005), the extent of transaction costs (Baldwin, 2008; Argyres and Zenger, 2012), or managerial attempts to shape value capture (Jacobides *et al.*, 2016). Jacobides *et al.* (2006) suggest that firms can navigate changes in industry architecture through acquiring an "architectural advantage" related to pursuing high levels of complementarity (e.g., between assets and activities, see Argyres and Zenger, 2012) and high levels of asset mobility with low switching costs. Similarly, a firm in a layer of an IVC can achieve an architectural advantage and position itself as a bottleneck in the development and delivery of a product and thereby disproportionately capture value relative to other players (Jacobides *et al.*, 2006; Jacobides and Tae, 2015; Masucci *et al.*, 2020). As an industry architecture evolves, opportunities for firms to position themselves as bottlenecks emerge (Pisano and Teece, 2007; Baldwin, 2015), and the pursuit of a bottleneck strategy (Baldwin, 2015, 2020; Hannah and Eisenhardt, 2018) can enable such firms to control resources, limit market access, or leverage power over other firms (Jacobides and Tae, 2015).

To date, the work of Baldwin and Clark (2000) is perhaps the most detailed. Their longitudinal study of the computer industry highlighted that the resulting changes in the industry structure impacted the distribution of value across the IVC (such as semiconductors versus computer manufacturers). Existing explanations for shifts toward less industry specialization have centered around the need to address capability gaps (Cacciatori and Jacobides, 2005; Jacobides and Winter, 2005). Beyond these explanations, Kapoor (2013) studied firm-level data from the semiconductor industry to highlight how integrated incumbents were able to initiate systemic innovations. An exploration of the global automotive industry by Jacobides *et al.* (2016) detailed how the industry architecture shifted to a modular and specialized structure in the late 1990s, but it failed to create value and risked handing power and influence to other firms. However, firms in the sector reversed the trajectory of the product architecture to less modularity to reassert their dominance.

The effect of regulation on industrial and competitive dynamics, however, is severely underelaborated, despite regulation playing a crucial role in many industries (Jacobides *et al.*, 2006, 2014; Freij, 2021). Regulatory philosophy often adopts a precautionary perspective by seeking to deter harmful practices or anti-competitive behavior from entrenched incumbents (Jacobides and Lianos, 2021a), reducing the risk profile of systemic actors (Jacobides *et al.*, 2014), and providing robustness and stability to future shocks (León and Berndsen, 2014). Furthermore, where regulators ex ante define the rules of the game, they can also actively encourage structural competition and innovation. Through influencing market dynamics, the effect of regulation can also extend to influencing product design, often reflecting concerns for unbundling (Freij, 2021), but also the way in which entire sectors are architected and evolve across time (Freij, 2018). For instance, Jacobides *et al.* (2006) acknowledged that regulation acts as an institutional interface that influences the industry architecture and moderates the division of labor. Given the interest of regulators in competitive dynamics and innovation, as well as systemic resilience, there are overlaps between modularity theory and regulatory policy (Farrell and Weiser, 2003; Haldane and May, 2011; Yoo, 2016), and a number of scholars have remarked how regulators can leverage modularity theory to reconfigure and open up markets and encourage innovation (Brousseau and Glachant, 2011), while providing systemic resilience and robustness (León and Berndsen, 2014). More recently, the features of modularity theory and architectural regulation have been noted by a number of scholars to explain agendas and tensions in literatures on platforms and ecosystems (e.g., Jacobides and Lianos, 2021a,b; Jenny, 2021).

Building on this theoretical foundation, we recognize that design choices may co-evolve toward and away from modularity and specialization. A missing piece of the jigsaw is how do changes in regulation affect such pathways and more specifically how does the interplay between regulator ambitions and the strategic choices of firms play out in terms of product and industry co-evolution. To explore this, we briefly look next at the regulatory context for personal pensions in the UK.

3. Regulatory context

Regulation typically aims to ensure the efficient performance of a market and to promote competition and innovation, while generating welfare outcomes for stakeholders (Llewellyn, 1999; Brousseau and Glachant, 2011). Financial services is a complex sector prone to periods of instability. The principal regulator of UK pensions is the Financial Conduct Authority (FCA) and, for occupational and workplace pensions, The Pensions Regulator. Firms are also subject to extensive and diverse European Commission directives, in relation to matters such as fund management, financial markets regulations, anti-money laundering measures, and ensuring that the products sold meet consumers' needs. The sheer complexity and range of this regulation is beyond the scope of this paper; however, we briefly outline the key regulatory landscape that has shaped the sector.

Between 1986 and 2013, the then primary UK financial regulator, the Financial Services Authority (FSA) (predecessor to the FCA) based its regulatory activities upon a precautionary principle and the ex post minimization of harmful and anti-competitive practice. When pursuing its policy goals, the regulator sought to correct market imperfections by issuing compliance rules

and bringing enforcement for non-compliance against firms. The FSA had four statutory objectives: the protection of consumers; integrity in the financial system; reducing financial crime; and promoting public understanding of financial services. The emphasis of these regulatory objectives foregrounded a welfare approach to "protecting consumers" and ensuring firms provided consumers with standardized and comparable information about prices, product features, and key risks in order to facilitate rational and informed decision-making (Callaghan, 2013, 2014).

Since the financial crisis of 2008, the landscape of the financial services market has been changing due to an overhaul in regulation philosophy (Anagnostopoulos, 2018), and financial regulation has been transformed by at least three interdependent factors—innovation, modularity, and digital technologies (Brousseau and Glachant, 2011). Drawing upon the principles of the deregulation and liberalization agendas of earlier years, the regulator reflected an interest in industry architecture reform—an approach to architectural regulation that Wishnick (2020) noted in US financial markets. The regulator sought to reshape the design of financial markets and influence levels of competition and innovation, as well as to reshape business models, "spurred on by the concerns over rent-seeking from entrenched incumbents" (Jacobides and Lianos, 2021a: 1132). While ex post correction of errors was governed through sanctions, architectural regulation, on the other hand, was constituted by creating ex ante rules of the game that applied to actors and regulated behavior among the various "layers" and "components" of the market (Farrell and Weiser, 2003; Wishnick, 2020).

By 2013, the UK Government phased out the FSA and shifted its functions to the Bank of England and a number of new regulators, such as the FCA, signaling a continuation of its commitment to mitigate systemic risk while fostering competition and innovation. The corresponding Financial Services Act, 2012, imposed a duty on the FCA to actively *promote* competition in the interests of consumers (FCA, 2017) through championing consumer choice and product portability, encouraging innovative markets, partly through the constitution of regulatory sandboxes that facilitate innovation, experimentation, and reciprocal learning between regulator and firms (Jacobides and Lianos, 2021a,b), tackling anti-competitive conduct, and intervening, if necessary, ex post to ensure competitive forces drive good outcomes for consumers (p.8). The FCA's subsequent 2017 manifesto, "Our Approach to Competition" noted how "changing the rules of the game can have a significant impact on how firms compete, and thus on consumer outcomes" (p.8). Moreover, the "duty to promote competition" had much in common with the features of modularity theory, and the FCA described its regulatory levers as an ability to limit market concentration and market power by removing barriers to entry and barriers to switching; limiting anti-competitive behavior such as self-preferencing; ensuring transparent price discrimination and access to comparable information; and reducing overall product complexity. Overall, these levers, according to the FCA, are aimed at enabling rather than hindering innovation.

The complementarity between modularity theory and regulatory policy has been noted in financial markets and other contexts (Farrell and Weiser, 2003; Haldane and May, 2011). While Yoo (2016) noted that regulators may have "pro-modularity bias," León and Berndsen (2014) suggested that regulation developed from modularity theory supports market resilience by limiting cascades and isolating negative feedback (Haldane and May, 2011) in localized components and firms. Thus, modularity protects systemic resilience and provides robustness and stability to future shocks (León and Berndsen, 2014). Furthermore, Brousseau and Glachant (2011) suggested that modularity could create "openness of reconfiguration" and perpetuate competition.

3.1 The pensions context: leading up to 2005

The UK pensions sector has often been at the center of regulatory concerns (Hannah, 1986), in particular mis-selling scandals in the 1990s (Ward, 2000). The UK Government legislated for a new personal pensions regime in the Financial Services Act, 1986, implemented in 1988 (Burton, 2018). The new personal pension product was launched simultaneously alongside a strong economic outlook and generous tax incentives for consumers that ultimately created a boom in the demand for personal pensions (Burton, 1994). Pensions regulation aimed to "free

up the market and to come down heavily on malpractice" (Hudson *et al.*, 1996: 218) through enforcement.

Following the personal pension regime launched in 1988, product modularization and specialization emerged in the sector in the 1990s (Burton, 2018). The Financial Services Act, 1986, imposed significant compliance costs that significantly increased the costs of owning distribution, resulting in product providers closing down their distribution, and which resulted in the emergence of independent financial advisor (IFA) firms in an intermediate market. Furthermore, financialization had created a demand-side impetus for personal investments and stock ownership, fueled by waves of privatization, and in response product providers moved to co-create technical standards with third-party fund management firms to widen the choice of investments available to consumers. As a consequence, by the late 1990s the IVC followed a simple specialized structure as shown in Figure 1.

Significant waves of regulatory and fiscal policy change occurred between 1997 and 2006, as the FSA began to change its regulatory philosophy. The first significant fiscal change related to how pension funds were taxed. Branded a "tax raid on pensions," the UK Government removed the 10% tax credit on dividends that could be reclaimed by pension fund managers, thereby making pension funds less tax-efficient and, moreover, tax-equivalent to collective investment schemes.[1] The consequence of this policy change was significant. Prior to this, product providers offered a relatively small range of tax-advantaged pension funds offered by in-house fund management teams and/or third-party investment management firms. As pension funds were no longer tax-advantageous for consumers, and the demand environment necessitated increased choice, product providers connected pension products to thousands of collective investment schemes, developed in line with UCITS industry standards, offered by external fund management firms. The UCITS standards enabled product providers to expand to offer thousands of investments funds within just a few years.

The second significant change related to policy changes in the wider savings and investments sector, which later had significant implications for the "platforming" of the sector. In 1999, regulations were introduced that permitted an Individual Savings Account (ISA), a tax-efficient savings account that could also be invested in collective investment schemes, without the constraints of limiting access to the capital until retirement in the way a pension does (Emmerson and Tanner, 2000). With a policy aim of increasing the UK savings ratio, initially contributions were limited to £7000 per year, an amount which was indexed in line with the Consumer Prices Index each year.

In anticipation of the ISA, an incumbent pensions firm, Skandia Life, launched a multi-product platform, known by the regulator as a "fund supermarket." The fund supermarket encompassed a common range of thousands of collective investment funds that could either be "wrapped" in an ISA or held in an investment portfolio and linked to complementary components such as portfolio management modeling software. In this first wave, however, personal pensions were designed "off-platform" due to technical incompatibilities.[2] Many fund management firms in the IVC (e.g., Fidelity Investments) also saw the ISA as an opportunity to forward integrate into product provision. Four early movers initially dominated the fund supermarket landscape (Skandia Life [now Old Mutual], Fidelity Investments, Transact, and CoFunds [now Aegon]; The Lang Cat, 2019). The IVC of the "fund supermarket" model followed this specialized structure as shown in Figure 2.

While the sector had already begun to adopt increasing product modularity and industry specialization, the influence of modularity theory on regulation philosophy came to the fore around 2001, as the FSA sought to pursue aims of unbundling to reduce pensions complexity and to

1 Collective investment schemes are pooled funds, similar to mutual funds in the USA. They are designed by fund management firms often in accordance with transnational standards, such as the UCITS (Undertakings Collective Investments in Transferable Securities). UCITS are investment funds, regulated at a European Union (EU) level. In creating a set of common rules and regulations it allows such funds: to seek a single authorization in one EU member state and to register for sale and market across EU member states.

2 The "technical incompatibilities" relate to the 1997 changes in pension fund taxation. Prior to 1997, pension funds were incompatible with collective investment schemes and could not be mixed and matched. In 2000, firms were working through the complexities of resolving these technical incompatibilities.

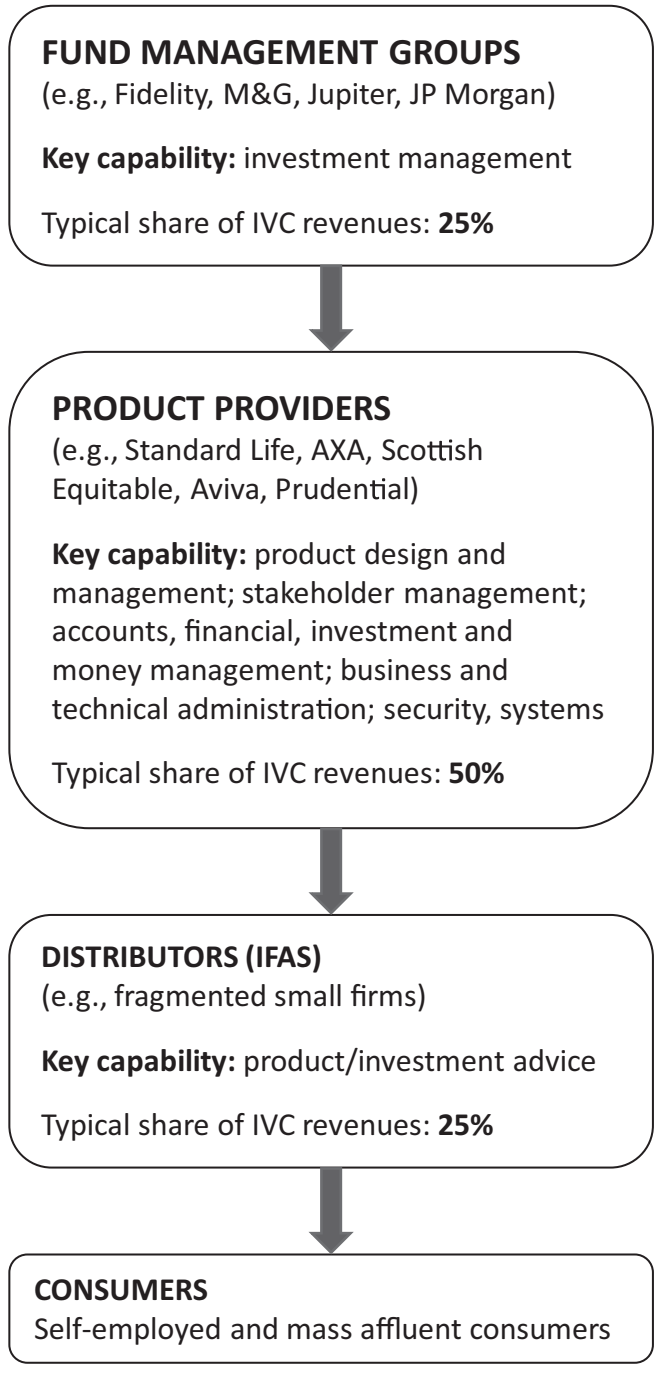

Figure 1. Typical IVC structure (late 1990s)

limit rent-seeking by powerful firms. In 2001, Stakeholder Pensions[3] were introduced with a central objective to change the ratio of state to private pension provision from 60:40 to 40:60

3 A Stakeholder Pension is a "defined contribution personal pension. They have low and flexible minimum contributions [and] capped charges" (Money Advice Service).

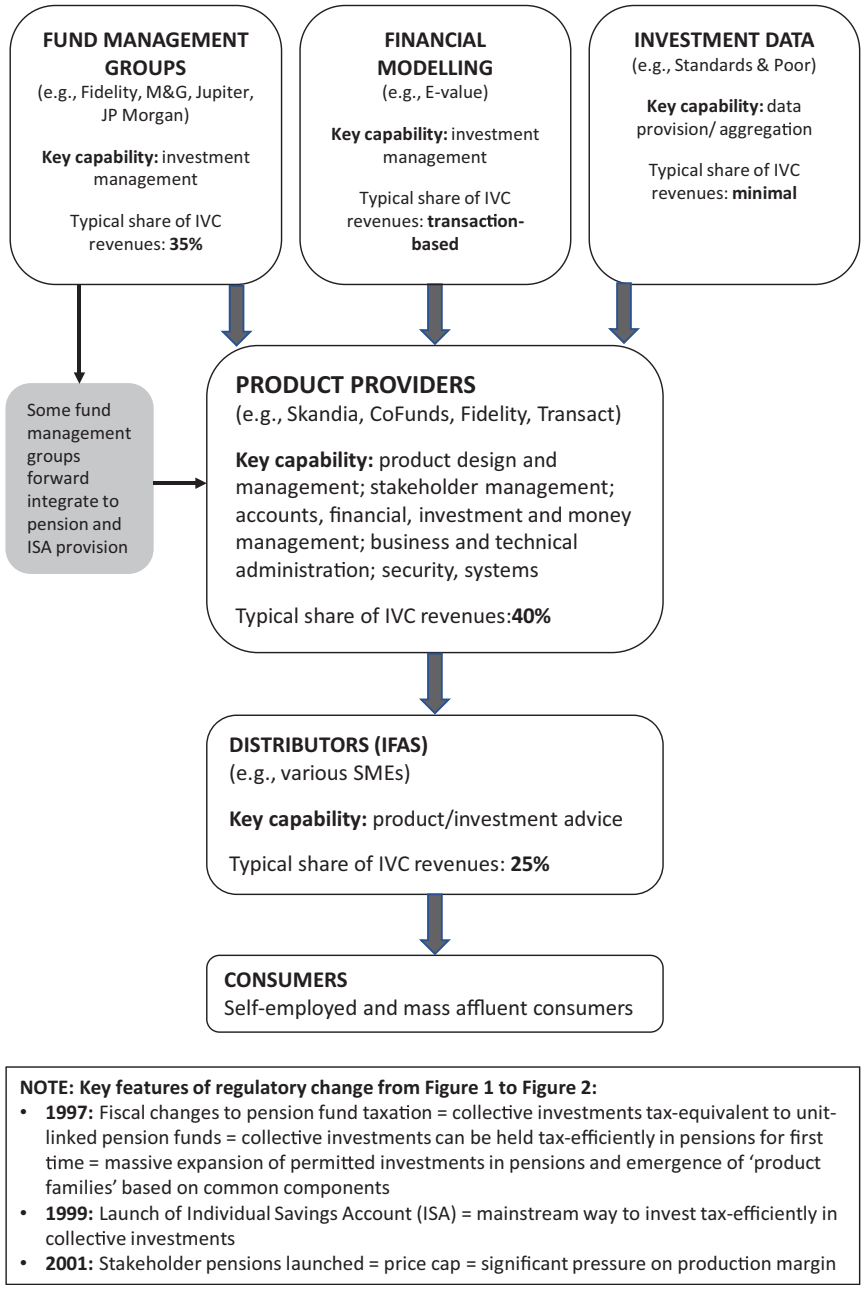

Figure 2. Typical IVC structure (fund supermarket architecture c2000–2005)

by 2050 to address the so-called pensions time bomb (House of Commons, 2001). Stakeholder Pensions were a "benchmarked personal pension" (Banks and Emmerson, 2000: 46): a simple 1% per year charge, low minimum premiums to widen access, and easy portability. While the Stakeholder Pension was successful in some respects, there is little evidence that it reduced complexity (Waine, 2006), although it significantly reduced the profitability of product providers.

The 2002 Sandler report on "Medium and Long-Term Retail Savings in the UK,"[4] recognized that "Pensions taxation is extremely complex and this has a number of effects…[it] leads to confusion both for the public and professionals; [and] this is a disincentive for saving" (House of Commons Library, 2008: 3).

To further address complexity and unbundling, regulations known as "pensions simplification" were announced in 2003, implemented in 2006, and developed a single set of pension rules replacing a myriad of hundreds of existing and highly complex rules. Pensions simplification created a single architecture of regulatory standards for (nearly) all new and existing pension products. In anticipation of pensions simplification, many incumbent product providers had recognized, however, that the changes to the taxation of pension funds in 1997 meant that the "fund supermarket" business model could be reengineered by extending collective investment schemes to pensions. Until pensions simplification was announced in 2003 and implemented in 2006, however, there had been little impetus to do so as incumbent product providers already held the majority of pension assets and benefited from the corresponding rents. However, the risks and opportunities presented by the pensions simplification architecture fundamentally changed this dynamic.

Pensions simplification was recognized as an opportunity not just for simplification but for *pensions consolidation*. The industry recognized that a flexible modular product architecture could tempt existing consumers to consolidate their myriad of legacy pensions into a single product, making it easier for consumers to keep track of their pension, ISAs, and other investments together in a single investment platform. Until pensions simplification, product providers had largely ignored a niche pension product, known as the self-invested personal pension (SIPP)[5] which was originally legislated in 1989, but which now received renewed attention. In anticipation of simplification, product providers recognized that the SIPP could provide the modular architecture to profit from the anticipated consolidation wave. However, to leverage the opportunities a technological shift away from legacy systems designed around pension funds to a multi-product platform architecture was required. With pensions simplification set for 2006, consolidation meant both a vast business opportunity (for the winners) and a significant risk to firms' embedded value (for the losers), and speed to market was critical, and this regulatory event provides a relevant starting point for our study.

The UK pensions sector is subject to extensive and dynamic regulation that provides a unique context in which to explore its effect on product and industry co-evolution. This complexity, particularly over the past three decades, means that secondary data alone are not enough to adequately tell the story. While secondary data provide breadth, they do not allow for the depth required to deeply understand the forces shaping the industry. Our rationale for methodological choices is predicated by the valuable opportunities that unusual cases offer for theory-building (Fixson and Park, 2008). We use a case analysis of the industry between 2005 and 2020 to explore the mechanisms that lead to more or less modularity and more or less industry specialization and to illuminate the interplay between the agenda of the regulator and the strategic choices made by firms in the sector.

4. Method

This study is a snapshot that forms part of a much larger study carried out to examine changes in the sector between the mid-1980s and 2020. We selected this industry precisely because it had undergone numerous periods of regulatory change. More importantly our choices were framed by the fact that modularity scholars have largely ignored "intangible" products emphasizing (almost exclusively) manufacturing industries (see Campagnolo and Camuffo, 2010 for a review).

Answering "how" and "why" questions demanded examining phenomena from the perspective of the lived experience of those working in the industry. Data come from a longitudinal study conducted in two phases in 2014 and 2020, using semi-structured interviews at different

4 For an overview of the issues relating to simplification, see https://www.insurancetimes.co.uk/sandler-report-urges-simplification/1348049.article.

5 For further information, see https://commonslibrary.parliament.uk/research-briefings/sn03697/.

units of analysis about product architectures, firms, and industry structure. We initially recruited 31 senior managers, from six product provider firms via LinkedIn, who self-reported professional experience that continuously spanned the entire period. All held a strategic role in product development, systems, investment management, or actuarial.

We held follow-up interviews by video call during 2020 with 19 of the original participants who remained in the industry. We began the interviews by describing that we were interested in the evolution of products and the sector. Thus, we informed participants about the broad scope of our interests and located the interview within the field of product and industry evolution, but allowed any connection to technology, regulation, or other factors to emerge spontaneously. Follow-up questions also varied in each interview in order to allow us to more deeply explore specific topics of importance.

In both sets of interviews, the structure was divided into two consecutive parts. First, we invited participants to "chunk" the time period into meaningful sub-periods. Then we asked them to describe the product artifact pertaining to each time sub-period. To assist participants, we provided a stylized product architecture typology (see, Burton and Galvin, 2020). This process of "chunking" is an example of "temporal bracketing" (Langley, 1999) that aims to identify meaningful time units within a stream of longitudinal or historical data. We found that there was a significant degree of commonality in the periodization across participants and the identification of product types. The following five sub-periods and product architecture types emerged:

- Mid- to late 1980s: Integrated product.
- Early to mid-1990s: Closed and modular product.
- Mid-1990s to 2005: Hybrid product.
- 2005–2012: Modular product.
- 2012–2014: Hybrid product.

When we re-interviewed in 2020, we repeated the process and explored the period 2014–2020. We were able to discern the following:

- 2014–2015: Hybrid product.[6]
- 2015–2020: Hybrid product.

The sub-periods served as a useful structure for the second part of the interview in which we asked a series of open-ended questions such as: "What was going on in this time period?"; "What led to this change?"; and "What was the result of this change?". Periodization provided a structure for inductive logic to be used to derive key themes in each time period.

Following transcription of the interviews, we used template analysis, a flexible type of thematic analysis, developed by King (1998; 2012) to code the interview data. We followed the approach suggested by King and Horrocks (2010) and further elaborated by Burton and Galvin (2018a), in combining a matrix and template analysis method. Our initial coding of early interviews highlighted that themes were clearly emerging at three different units of analysis: industry level; firm level; and product design. This enabled us to create a matrix to thematically code further interview data, with periodization and units of analysis providing the x and y axes of our matrix, respectively. This enabled us to code responses to each cell of the matrix to understand the relationship between different time periods and links between themes across time. Each interview transcript was coded separately, one at a time, by both authors, and differences in coding were resolved through inter-coder dialogue and discussion (Miles *et al.*, 2013). Where new themes emerged or other changes to the templates were made, previously analyzed interview transcripts were re-examined, and this iterative process continued. Finally, we reviewed our template for integrative themes that related to our research question.

This process was supplemented by secondary data obtained by searching a range of publications from the FCA, trade media, and other financial media such as the Financial Times and

6 An extension of the 2012–2014 period described by participants in the first set of interviews in 2014.

Citywire. Using keywords that related to our study, we created a database of articles and publications and arranged them by year of publication date. Following, we reviewed each deposit in the database for applicability to our research question. Finally, we were able to access privileged market and technical reports produced by two leading consultancy firms to the sector.

5. Findings

5.1 The shift toward more modularity (2005–2012)

While four early movers dominated the fund supermarket landscape in the early 2000s, by 2005 the number of fund supermarkets in the sector had increased to 13 (The Lang Cat, 2020), as new entrants and incumbents entered the sector. By this time, around 40% of advised new business and existing assets were now held on fund supermarkets (The Platforum, 2015). The IVC was predominantly specialized, with each layer focusing on areas of distinctive capability. A few product providers occupied two segments of the IVC, often by way of in-house fund management, but most firms sourced investment funds from specialized third-party fund management firms. Distribution was almost exclusively through third-party IFA firms.

The "first wave" fund supermarket model was underpinned by legacy systems and product providers innovated by developing idiosyncratic standards with suppliers to connect components. Competitive advantage derived from capabilities in product design and systems integration by linking to a wide range of collective investment funds. The key driver for competitive advantage was *the ability to connect as many funds, and as many financial planning tools as possible, and as quickly as possible* but *scale was crucial, you could use your scale to negotiate better contracts with suppliers at better terms*.

5.1.1 Changes in regulation

Announced in 2003 and implemented in 2006, the UK Government streamlined the existing complex range of pension regulations into a single set of rules. Pensions simplification did not aim to directly regulate product design but rather created a single set of rules and standards within which firms could innovate. The evolution to a single set of rules was seized upon by the product providers[7] and platform operators[8] as an opportunity to aggressively market "pension consolidation." In the race to persuade consumers to consolidate numerous legacy pension schemes into a single product, the platform operators developed a modular pension (SIPP) that adhered to the new simplification rules at speed and offered licensing arrangements to product providers in the sector. In contrast, the legacy systems of product providers were unable to be re-architected, and outsourcing to the platform operators now seemed the only viable solution, especially given that speed to market was a strategic imperative. This fast-changing context increased the level of competition in all layers of the IVC: *Competition got stronger, we went from about six to 30 platforms. We saw a proliferation of new entrants who eventually dragged the incumbents to change their models*.

5.1.2 Changes in technological choices

During the early 2000s, technology firms in Australasia had previously executed the "platforming" of retail investment and pension products in their home market and recognized the opportunities in the evolving UK landscape. Based upon their prior experience, and the emerging separability of the UK sector, the platform operators had developed a modular technical architecture that encompassed multiple products (SIPP, ISA, and collective investment account) and permitted an almost unlimited range of collective investment funds and complementary components that connected to the platform technology via standards. The modular platform

7 In this paper, we refer to firms that offer pension products as "product providers." These firms are authorized by the FCA to conduct business in personal pensions. However, these firms are also authorized as platforms, and the regulator also uses the term "platform service providers." The industry, in contrast, rarely uses either of these terms and often uses the shorthand of "platform" or "investment platform" to denote the product provider.

8 We use the term "platform operator" to denote the technology firms which license the platform technology to the product providers.

architecture attracted product providers who needed a platform architecture to *protect against the churn of their legacy pension assets to competitors and new entrants*. One respondent highlighted that *it costs us a lot of money to keep up with legislation, regulation, and product enhancements, and it's just not efficient anymore to make all of those changes in-house. We are not a specialist technology provider. It makes much more sense for us to use the new platform because they're servicing multiple providers and so it is faster and cheaper.* Another respondent summarized: *We wanted to be ready to take advantage of pensions simplification; to take advantage of the maturing ISA market; and protect our legacy book with ultra-high margins. As a customer of the platform, we could decide which bits we wanted to buy, and which we didn't. Time was short, capital was short, and we knew absolutely nothing about technology.*

The technological disruption threw everything up in the air, and the IVC was separating into distinctive and separable activities, *specialization is definitely going on and there's re-carving up of the old value chain* because *as soon as you outsource your systems, you outsource control, and you outsource the standards and components to link to those systems. But, it meant that we could instantly access thousands of components. Our old proprietary system couldn't do any of that*.

By the end of this period, with sales of SIPPs increasing exponentially—from just 427 in 2005 to 230,000 in 2012 and over 700,000 by 2014 (FCA, 2019)—the scale opportunity put downward pressure on margins resulting in a focus on building sales volume. The impact on production margin is summed up by one respondent: *Pensions were very profitable, but in came the platforms, not profitable anymore. You basically tried to hang on. We had more volume than other people so we could squeeze the suppliers who had linked in harder; we could still make enough money provided we could keep volumes up but it wasn't like the game before. We thought … stakeholder pensions was bad at 1% … it had now been chipped to 0.25% or less. You had to win volume through pensions consolidation or try to work out a way to differentiate.*

Legacy personal pension sales also started to collapse.[9] At the same time the effects of the financial crisis were also starting to bite. The market value of pension assets was eroded due to stock market volatility, resulting in a reduction of product provider revenue flows from annual charges. However, despite this volatility, the "platform" model was reaping rewards in terms of scale for those early-mover product providers who had outsourced to platform operators around 2005. In addition, early movers who had switched their business model from a largely fixed cost model to a variable cost model enjoyed a cost advantage and were growing market share, despite a large number of new entrants.

5.1.3 Emergence of strategic bottlenecks—platform operator layer

While the platform architecture had a high degree of modularity, there was already a realization that if every product provider plugged into the same platform operator, the damaging economic effects of the era of stakeholder pensions and the financial crises may be further worsened: *It was 99% standard. Everybody added every component possible, but "plug and play" takes away differentiation.*

While outsourcing to the platform operators provided scale benefits, differentiation came at a very high cost. The dilemma facing incumbent firms was that *for simple regulatory change, the cost of change was low. These platform operators had 15+ clients each, and so the cost of change could be divided by 15. But, for innovations that provided differentiation that was far more difficult*. Another respondent elaborated: *You bore the full development cost, and you were in a queue. The platform operators were, at the time, basically technology firms with limited capacity. You often had to wait ages to be prioritized, and the day rate costs for development was simply eye-watering. And, given the contracting model was scale-based, if you couldn't convince them the innovation would lead to exponential scale they wouldn't play ball*. The platform operators were *more interested in signing up new product providers than innovating with us. It's understandable, but it stifled our ability to innovate*. The power balance had fundamentally shifted to the platform operators: *We were naturally interested in acquiring IP, whereas they*

9 Unit-linked personal pension sales fell from 230,000 in 2005 to 135,000 in 2012. Stakeholder pensions doing likewise, falling from 237,000 in 2005 to 180,000 in 2012 (FCA, 2019).

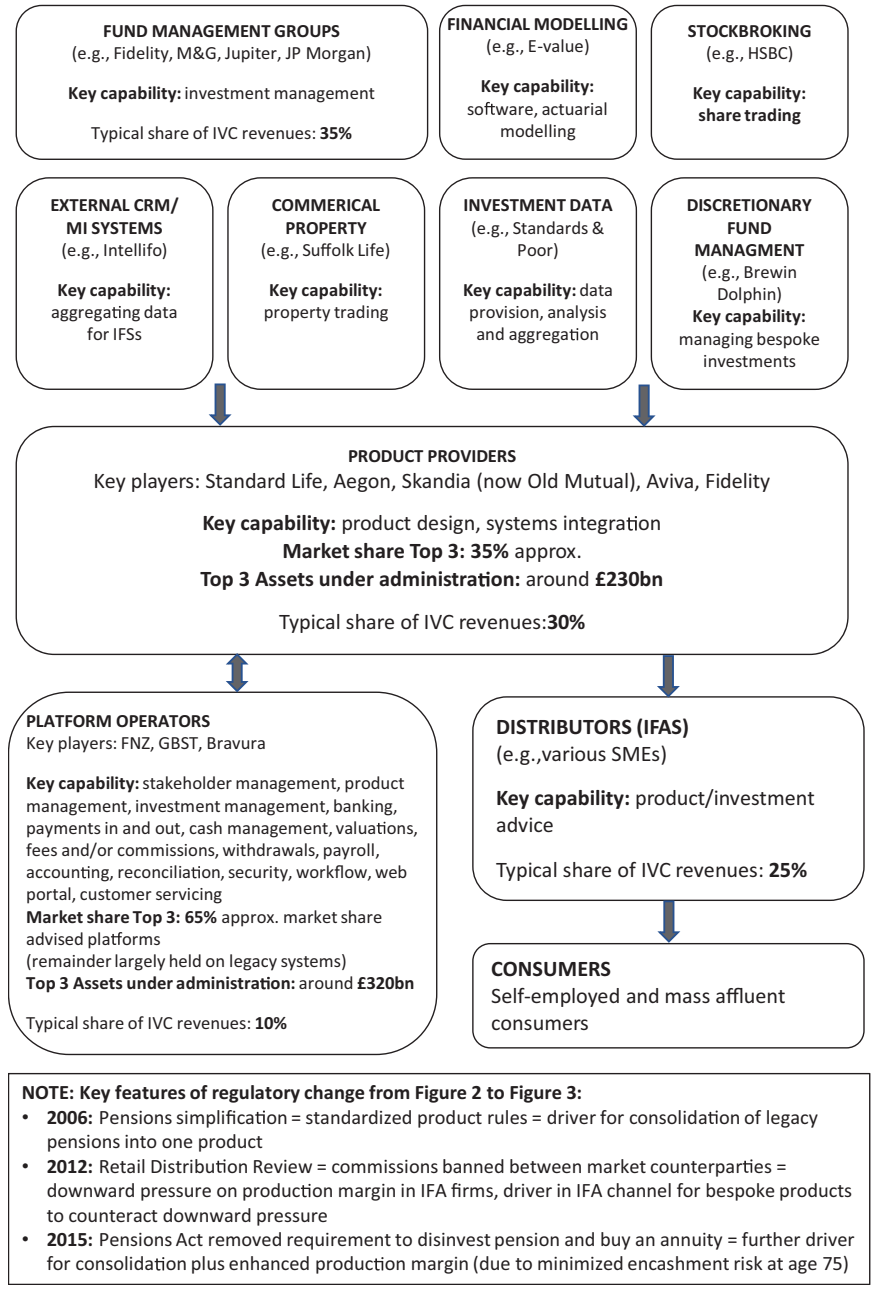

Figure 3. Typical IVC structure (platform architecture c2005–2015)

were not interested in sharing it. On new innovations, we were limited to one year IP before it reverted to them and it led to a general feeling of standardization, with the platform technology firms reaping all the rewards.

By the end of this phase, the IVC of the platform architecture was structured as shown in Figure 3:

5.2 The transition phase (2012–2015)

By 2012, assets held on platforms had grown to c£150bn and sales of SIPPs had increased to 230,000 (FCA, 2019). New entrants had swelled the number of product providers licensing the platform technology to 23 (FCA, 2018; The Lang Cat, 2020). Advised new business flows were now approximately 70% onto platforms (The Platforum, 2015; The Lang Cat, 2020). The first-wave "fund supermarket" product providers who had since outsourced to the platform operators remained dominant.[10] However, other early-mover incumbents such as Standard Life had grown market share (The Lang Cat, 2020).

From 2012, the modularity of the pension product started to reconfigure. Announced in 2006, the 2012 Retail Distribution Review (RDR; see FCA, 2014a) implemented further regulatory change. One key dimension included making commissions, between market counterparties, illegal. In practical terms, the market was perceived by the FCA as dysfunctional, firstly because product providers could compete with each other on the basis of the level of commission paid to IFA firms (and in turn this often resulted in higher customer charges) and secondly as product providers could "mask" the level of product charges by negotiating "cash rebates" (commissions) with fund management firms based upon scale; the higher the scale, the higher the rebate.[11] As one respondent summed up: *Typically, we were getting on average about 0.75% cash rebate from the fund managers – obviously it depended upon the fund – and with that income we could then keep the product price as low as c0.25%. So, we received about 1% in total as a typical revenue model. RDR came along and banned cash rebates. But, nobody dared put the product charge up above 0.5%. So, our revenue model halved more or less. It became impossible to survive unless you could get scale, differentiate or start taking manufacturing margin from elsewhere.*

The implications were felt along the entire IVC with product providers under increasing pressure to differentiate in the face of diminishing margins. Most product providers became concerned: *How do you add value back? Margins get squeezed so tight, that somebody in the value-chain's got to do something different because there's a footrace to the floor.* The critical strategic question became which components to insource and which to outsource: *If you think that a particular component is where you get the majority of your margin, this will influence whether you insource or outsource. Companies that have investment capability are naturally going to insource that. Obviously, if you have software capability, you might insource that.*

5.2.1 Emergence of strategic bottlenecks—distribution layer

Prior to RDR the cost of advice had been embedded implicitly in product charges. In other words, IFA commissions were paid by the product provider from its product charges. RDR mandated that the cost of advice had to be negotiated directly between the IFA firm and the client. It was anticipated that many customers would be unwilling to pay for explicit up-front financial advice, at the levels previously embedded, and many IFA firms would either exit the market or implement more efficient business models. IFA firms had to adopt a new business model to survive.

Those IFA firms which wished to stay in the market had two aims: to lobby product providers for differentiated products that consumers would be willing to pay for, while at the same time, lower compliance risk associated with giving investment advice. For example, *advisors have compliance challenges and also need to be more efficient, a lot of advisors wanted a packaged proposition, where the compliance risks of asset allocation and fund selection was effectively outsourced to the product provider. Bundling, efficiency, and risk management went hand-in-hand after RDR.* Consequently, IFA firms began horizontally consolidating with other IFA firms to acquire scale and exert influence over product providers. As one respondent recalled: *The bundled propositions IFA firms demanded could be white-labelled by the IFA firm so they appeared to be designed by the IFA. With IFA firms investing hugely in CRM systems, suddenly the IFAs were no longer reliant on being "fed" commission by product providers and instead the balance*

10 Skandia (now Old Mutual), CoFunds, Fidelity, and Transact held about 45% market share.

11 An example: Firm A could offer its pension product at a product charge 0.5% pa and promise to "pass-on" all rebates from fund management firms (typically 0.75%) to the customer. Firm B offers its pension at say 0% pa product charge, and the product provider keep the rebates. In the example, Firm A has the cheaper product and yet it appears to the customer as if Firm B does. RDR banned this type of commission between firms so firms had to compete more transparently.

of power has shifted. Product providers couldn't compete on levels of commission, and instead had to cater to the demands of intermediaries.

Following RDR, two transitional approaches to product reconfiguration emerged, namely *modularity with guidance*, which focused on bundling and *formal and relational contracts*, which were known by industry insiders as "power blocks."

5.2.2 Modularity with guidance

In response to demand in the IFA market, bundling was also attractive to product providers who moved to embed bundled products because, *they had a vested interest in having their own in-house funds with manufacturing margin at the heart of the bundle. They were under severe pressure to make money in a commoditized world. The only significant margin was in investment management and so many product providers embraced bundling very quickly.*

Bundling was perceived by many respondents as a potential source of differentiation based upon internalized capabilities in fund management. Product providers collaborated more closely with their own fund management divisions to create unique bundles of investment options. For instance, a respondent recalled: *Where can we make extra margin? We made bundles with our own extra special funds, called our elite range.* A further respondent commented: *We did guided architecture, the "guiding" remains within the framework of the modular architecture, but you're seeing a big narrowing down now, and providing an extra guided step.*

However, it was acknowledged that this may not be an effective long-term solution to differentiation. One respondent highlighted: *I think it quickly became quite clear that bundling modular components was not going to gear-shift margin. It certainly helped, but the shift needed was in the way you could integrate a whole range of components as unique for the client and the IFA. This meant making the funds interdependent with other components. So, you created a bundle of investment funds that the IFA chooses, you linked it all to financial modelling tools, bespoke customer service, client reports, and allowed the IFA to co-brand.*

5.2.3 Formal and relational contracts

Whereas *modularity with guidance* was an attempt to differentiate using existing capabilities in fund management and use bundling and marketing to "guide" customers toward investments with higher production margin, the emergence of new IVC configurations, which respondents called *power blocks*, represented a different transitional approach to less modularity. Power blocks comprised a product provider acting as a "systems integrator," bringing together various industry actors, such as the platform operator, one or more significant IFA firms, a few fund management groups, one or more financial modeling software providers, and possibly other IVC participants, to create a unique product for that particular value chain configuration. For example, *We created at least six power block configurations. Based upon customer segmentation models, we had what we called the discretionary advice configuration. We invited three of the big IFA firms who advised those kinds of clients [high net-worth individuals], and we invited in their panel of discretionary fund managers. We collaborated and agreed what the proposition would encompass, we also discussed bespoke customer servicing, data-sharing between us, and ultimately how revenue would be shared.* As part of these power blocks, the actors would be restricted from providing the same component or technology to other power block configurations or other firms. The actors of the power block created unique components that were non-transferable to other settings, despite the systemic modularity of the platform architecture.

The power blocks were governed through closer, multilateral relational contracts. These arrangements *couldn't involve arms-length contracts because we needed to work together closely in the design of the proposition, but also once it had been offered to the market we needed real-time information-sharing and cooperation to manage it over time. Often, we co-located people together during design to ensure the proposition worked effectively. The contracts also needed to specify how investment costs and resources would be shared, we all contributed capital, as well as how revenues would be divided. We had to agree on how the pie was shared between us.* The result is a degree of integration in respect of product design. Firms are not

vertically integrated, but utilize formal and relational contracts that have closer multilateral ties to coordinate innovation.

5.3 The shift toward less modularity (2015–2020)

By 2015, despite the RDR still creating significant disruption in the IVC, the value of assets held on platforms had nonetheless increased to £239.3bn, with new entrants escalating to 30. Sales of SIPPs continued to increase, reaching 700,000 by 2015 and nearly 1 million by 2018. Market shares held by the top players remained largely unchanged, although market concentration of the top four slightly reduced (FCA, 2018).

New regulations, which continued to favor consolidation of legacy pensions into SIPP products and hence onto platforms, came into force via the Pensions Act, 2015. With around 60% of legacy pensions assets held in the "de-accumulation" phase, the Pensions Act withdrew the requirement to buy an annuity at age 75, meaning that pensions could remain invested until death and drawn down to provide a retirement income.[12] This change also opened up the significant opportunities for defined benefit pensions (occupational pensions) to be switched to a personal SIPP at retirement and drawn down while continuing to be invested. This announcement by the Government came with no forewarning or prior consultation.

While pensions simplification in 2006 had relaxed the capital adequacy requirement for SIPP product providers and encouraged several new entrants, the financial crises had caused regulators in the EU to revisit the capital adequacy requirements of many financial institutions. Although the initial focus was on the banking sector, by 2015 the FCA had grown concerned about the capital adequacy of SIPP product providers, and capital adequacy was significantly strengthened (FCA, 2014b). The requirement to hold additional capital weakened the profitability of product providers, further emphasizing the need to secure production margin from other IVC layers. As one respondent summed up: *Taking back manufacturing margin was key. Some purchased share trade platforms. Others, discretionary management firms.*

Many IFAs had also recognized that, in a post-RDR world, they would only survive if they could be more efficient by consolidating all their clients onto one or two preferred platforms in order to reduce costs and leverage power for a larger slice of IVC surplus. IFAs began creating panels of platforms, often consisting of a "low-cost" platform for mass market customers and a further platform with a key marker of differentiation that would appeal to their wealthier clients. Product providers also recognized that massive scale was crucial to survival, and being selected by IFA firms as one of the platforms on their panel was a strategic imperative.

The need for product providers to differentiate to appeal to the (re)platforming wave in the IFA market was compelling and urgent. Modularity with guidance and power blocks had delivered some success in driving up sales and production margin, however with the Pensions Act signaling a second wave of "pensions consolidation" and IFA firms actively consolidating all existing clients onto one or two platforms, the risks of potential shake-out were non-trivial. With the need to recapture value also clear, product providers began re-assessing which components to (re)insource and which to continue to outsource. According to one respondent: *We recognized that IFA firms were platforming based upon key areas of differentiation that suited their client base. We knew IFAs wanted one or two platforms that had distinctive features and capabilities. The trouble was in the last decade we had outsourced most things with arms' length contracts.* Another remarked: *We needed to bring back in house many of the high-value components that offered us differentiation.*

Less product modularity and less industry specialization were driven by horizontal and vertical (re)integration. To secure scale, horizontal consolidation was occurring at all levels of the IVC.

12 It is worth noting that prior to pensions simplification in 2006 it was a requirement to buy an annuity upon retirement. In 2006, this was changed to "at age 75," and the SIPP product developed by the platform operators in 2006 had a feature known as "income drawdown." With many consumers between 2006 and 2015 still choosing to purchase an annuity, this feature was rarely utilized. The Pensions Act then removed this requirement to buy an annuity completely. Furthermore, as annuity rates have consistently fell over time due to increased life expectancy, lower interest rate expectations, improving health, etc., income drawdown has grown in popularity. As the profitability of pensions is very sensitive to the duration that the product is held (as fees are charged on a per year basis), this regulatory change substantially increased the notional profitability of SIPPs with an income drawdown feature.

For example, in fund management *bigger groups were gobbling up newer fund groups to bring their expertise in to widen their own product set*. In the IFA layer, consolidation was also evident because *at the advisor level, IFA consolidators came in, and, so, the advice-side became much less fragmented. The big consolidators knew they needed to leverage power over the product providers to stand a chance*.

In the product provider layer, horizontal integration was also occurring, but to less an extent because *Many of the platforms are not that profitable, but withdraw from the market or sell out and you not only lose the new business, but more importantly, you probably lose the huge existing pension book you have because IFAs will not leave their existing customers invested in a product provider who is closed*. Nonetheless, horizontal integration occurred and *a few big deals were sealed as medium-sized platforms merged to get scale or capability and try to compete with the leaders*.

Forward and backward vertical integration became more prevalent across the IVC from 2012, but accelerated after 2015. For example, product providers started to purchase IFA firms which were profitable, and so *we bought an advisor firm. So we now have our own advice capability in house, which we've now fully integrated and rebranded*. The logic was summarized as *a must-do. IFA firms were the keys to the door. That is the customer. Most IFA firms have re-platformed by switching all their clients onto one or two platforms, and you just can't be locked out. The potential damage is just too painful.*

Product providers were also backward integrating into upstream component firms to develop potential focal areas of differentiation, for example, *we bought a stockbroking business* or *we bought a portfolio software company to give us aggregated reporting and portfolio construction, which is much richer than the standard platforms can do*. One respondent summarized: *Look, you need to decide how you are going to compete. One of our competitors decided it was financial modelling, they bought software suppliers. For us, its discretionary fund management, so we bought probably the world's largest and most prestigious discretionary manager.* Some product provider firms, however, vertically integrated both upstream and downstream, *We recognized that we needed to buy distribution to avoid lock-out, but we also wanted a few distinctive areas of differentiation, and while we already had our own fund management arm, we also took equity stakes in a whole host of firms such as software, commercial property, discretionary fund management, and so on. We had to get back control and use our power to start leading the market the way we wanted to.*

By the end of this period, the IVC had reconfigured to less specialization, as shown in Figure 4. By now, 43 platforms held nearly £500bn of assets and accounted for over 80% of advised new business and around 70% of pension assets (The Lang Cat, 2020). Despite the growth in the number of platforms, the market shares of the first- and second-wave early movers had held firm: Skandia (now Old Mutual), Fidelity, and Transact still accounted for about 25% of pension assets. However, three of the large incumbents of the 1990s, including Standard Life and Aegon had leading market share positions, accounting for about 35%. Many of the new entrants had gained little traction with market shares of between 1 and 4%. SIPP sales remained the dominant way to purchase a personal pension with nearly a million new SIPPs, while legacy personal pension sales continued to fall (FCA, 2019).

Our extended discussion next is structured as follows: (1) we discuss the shift toward more modularity and specialization between 2005 and 2012, in which we highlight the role of regulation; (2) we show how strategic bottlenecks subsequently developed in the platform technology and distribution layers of the IVC; (3) we then illuminate how product providers firms responded to these bottlenecks through integrative innovation by developing "power blocks"—a quasi-ecosystem of firms to develop product configurations with less product modularity; and, (4) from 2015, given the mixed success of integrative innovation, we show how product provider firms pursued vertical (re)integration of both downstream and upstream components firms to further mitigate the power and control of the platform technology bottleneck. We complete our discussion with some concluding remarks and opportunities for further research.

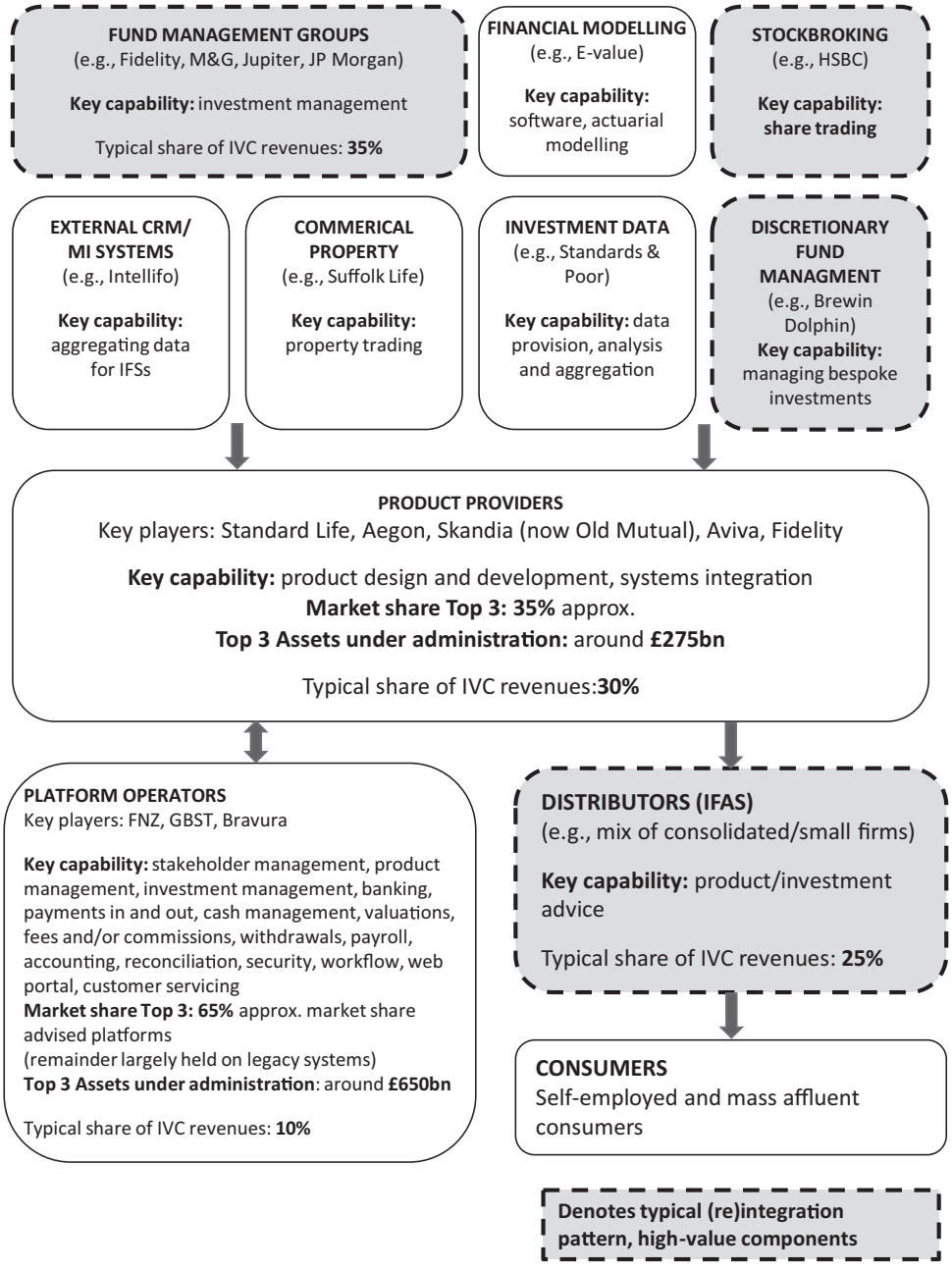

Figure 4. Typical IVC reintegration 2020

6. Discussion

We looked for evidence of the mechanisms associated with shifts to more or less product modularity and whether there was a corresponding shift toward more or less specialization. By doing so, we offer four contributions to the existing literature on product and industry co-evolution in the context of a regulated sector. We foreground the importance of the interplay between the strategic choices of firms and the exogenous agendas of regulators and policy.

6.1 The shift toward more modularity and specialization

Extant literature has primarily explained shifts toward increasing modularity through technological change and product development processes (e.g., Ulrich, 1995; Schilling, 2000) and through the changing architecture of inter-organizational relationships (Brusoni *et al.*, 2001; Cabigiosu and Camuffo, 2012; Tee, 2019) and the emergence and adoption of formal and informal standards (Garud and Kumaraswamy, 1995; Garud *et al.*, 2002). Our *first contribution* is to take an institutional, sector-wide lens and to show how shifts in regulation policy re-set the rules of the game and pushed the industry toward more modular product configurations and greater firm specialization between 2005 and 2012. The step change occurred in anticipation of, and following, pensions simplification regulations, as the legacy systems of product provider firms were unable to be re-architected to take advantage of market opportunities that favored modularity. Spurred on by pensions simplification, the SIPP product became embedded as the modular dominant design as regulations encouraged unbundling, which attracted platform technologies and a vast array of component firms into the sector.

In anticipation of pensions consolidation set for April 2006, a number of platform operators with modular technical architectures and with marked similarities to a supply chain platform described by Gawer (2014) had entered the sector with a platform technology that could accommodate modular product families and attend to the anticipated heterogeneity in demand as consumers consolidated the legacy pensions they held. Product providers were able to license the platform technology in a way that it could be tailored to their strategic aims based upon tens of thousands of different module combinations (The Lang Cat, 2019). Following an earlier role in the "platforming" of investment markets in Australia, the platform operators had recognized that the existing UK fund supermarket model already had an emerging separability (see also Jacobide and Kudina, 2013; Burton *et al.*, 2020) and that the regulator had corresponding objectives around competition and innovation, and together these factors enabled them to quickly leverage an architectural advantage.

Despite the regulators' aims to promote competition and innovation, however, many incumbent firms were slow to react as they believed product modularity and narrowing of vertical scope would ultimately hurt them. As such, early moves to the modular platform technology were initially perceived as only creating option value (Baldwin and Clark, 2003), and firms talked about a "last man standing" strategy relating to their existing products. New entrants, conversely, were greatly attracted to the modular platform technology and saw its adoption as an opportunity to acquire a significant position in market and leverage rents from the pensions consolidation wave. Once the lead incumbent firm, however, announced a licensing agreement with a platform operator in 2005 (Standard Life licensing the FNZ platform technology), other incumbent product provider firms were quickly forced to exercise their option and judged that the SIPP would fulfill the varied needs of different market segment and millions of consumers, while offering them opportunities to capture value from pensions consolidation and mitigate the risk of existing pension assets and corresponding rents being "churned" to competitor firms. These dynamics initiated a subsequent wave of modularization and specialization that spanned the period 2005–2008. This wave attracted over 30 new entrants and quickly displaced legacy business models.

This disruption has much in common with Jacobides (2005) case study of the US mortgage banking sector. However, whereas in the US mortgage banking sector, the shift toward more specialization was driven endogenously, our case analysis points toward a more active role of regulation that subsequently shaped firm responses. With mis-selling scandals still fresh in the consciousness of the regulator and with policy aims to widen consumer choice, curb excessive price discrimination, and reduce complexity through unbundling, the regulators interest in "architectural regulation" (Wishnick, 2020) had reshaped the sector toward greater modularity and specialization, and, given the urgency of the 2006 simplification deadline, incumbent firms were forced to quickly follow, or potentially be selected out.

Following the shift toward greater modularity and specialization, our *second contribution* relates to how modularity and specialization in regulated sectors can lead to the emergence of strategic bottlenecks. While incumbent product providers recognized an opportunity to

create value through modular product families, increased component variety, speed to market (Sanchez and Collins, 2001), and competition based on superior marketing and branding (e.g., West, 2003; Hobday *et al.*, 2005), they ultimately failed to capture value in the reconfigured specialized ecosystem. Instead, the shift toward greater product modularity and specialization failed to deliver the anticipated economic benefits. Existing research has indicated several contexts in which there are challenges and limits to capturing value in modular markets (Chesbrough and Kusunoki, 2001) related to complexity in innovation (Brusoni *et al.*, 2007; Rivkin, 2000), competency traps (Zirpoli and Becker, 2011), and commoditization (Pil and Cohen, 2006).

Our case analysis, however, enables us to shift the analysis to the industry level and reassert that different industry architectures embody different appropriation characteristics (Pisano and Teece, 2007). The shift to a modular platform architecture and corresponding specialization had resulted in value migrating away from product providers to two bottleneck positions that emerged in the IVC: (1) from 2008 to the platform operators who held architectural control and intellectual property (IP) of the technology and (2) from 2012 to IFA firms who acted as a gatekeeper and controlled access to distribution and the customer experience (e.g., Baldwin, 2015, 2020; Jacobides and Tae, 2015; Hannah and Eisenhardt, 2018).

The first strategic bottleneck occurred in the platform operator layer, and by 2008 most product providers had outsourced technology to the platform operators. The reconfiguration of firm boundaries to a narrower scope, however, left many product providers with an integrator role but few technological capabilities in either the architecture or component layer, a limited span of control, and little or no formal IP. Most had outsourced architectural IP to the platform operators and component IP to component firms, opening a Pandora's Box that allowed others to claim a significant proportion of the value (Henkel *et al.*, 2013).

The platform operators managed to develop and occupy a bottleneck position by controlling the modularity of the platform architecture and licensing the technology to multiple product provider firms, thereby encouraging competition and severely weakening their appropriability (Adner and Kapoor, 2016). While the product providers continued to act as integrators and shaped the corresponding contracts with component firms, the platform operators controlled the technology and acted as a gatekeeper for the pace and speed of component innovation. In prior work, Baldwin (2015: 10) noted that strategic bottlenecks are "part of a technical system that has no – or very poor – alternatives," and firms wishing to capture value need to carefully manage strategic bottlenecks in an IVC. In our case, product providers had no viable technological alternatives, limited architectural or component-level capabilities or IP. However, while Baldwin (2015) noted that strategic bottlenecks are not cast in stone and industry architectures can change dramatically over time (Pisano and Teece, 2007), our case analysis reveals that the platform operators managed to occupy this position through developing a modular platform architecture that paralleled the regulators' aims and by controlling innovation and the modularity of the architecture. While competition is inevitably fierce in the platform operator layer of the IVC and firms in this layer are subject to close regulatory scrutiny, this serves to limit the bottleneck power they could otherwise yield. Only three firms dominate this layer.[13] As a result, the platform operators have grown powerful over time, despite having limited (or nil) visibility to end customers (Jacobides *et al.*, 2018).

Our findings also enable us to highlight the role of regulation in the emergence of the technology bottleneck. Prior to the regulators' interest in promoting competition and innovation, product providers had occupied a sole position as systemically important institutions, the failure of which could lead to systemic risk. Since the platform operators had entered the sector and acquired positional and architectural power, the regulator recognized these firms as also being systemically important and sought to maintain a balance in the degree to which the platform operators could wield power arising from their relative position. On the one hand, the emergence of the platform operators as a bottleneck begs the question: Why not acquire the platform

13 For example, FNZ are reported to have c£300bn assets and was recently acquired by investment management firms CPDQ and Generation for £1.65bn (Insider, 2018) who then completed an acquisition of rival GBST in 2019. However, the UK Competition and Markets Authority (CMA) has recently demanded FNZ sell GBST due to concerns over market concentration risks (CMA, 2020).

operator? While the platform operators were initially technology start-up firms, multiple firms in the product provider layer were licensing the platform technologies from just three operators, and vertical integration of the platform operator was perceived as unattractive and likely to attract regulatory and CMA[14] scrutiny. Furthermore, product providers recognized that if they wished to acquire the platform operator it was highly probable, if not certain, that competitor product provider firms would re-platform their assets—and associated rents—to a rival platform operator thereby reducing the attractiveness of the acquisitive target. On the other hand, the power wielded by the platform operators was also constrained by the regulators. The regulator and CMA had concerns that limiting competition in the platform technology layer may lead to a less resilient and less robust market structure. Moreover, while the FCA (2017) noted that vertical integration can sometimes create market efficiencies, it also needed to eliminate conflicts of interest and systemic risk. Thus, this limited opportunities for platform operators to forward integrate into product provision, as well as their ability to consolidate horizontally.[15]

The second strategic bottleneck emerged around 2012 in the distribution layer of the IVC, providing a second example of how regulation can encourage strategic bottlenecks. However, prior to 2012 (the implementation of the RDR), IFA commission were bundled as an integral part of the product price. As such, product providers could compete based upon the level of initial commission paid to IFA firms (a feature of the industry which benefited incumbent firms with access to significant capital). RDR regulations mandated unbundling and IFA firms were faced with negotiating fees directly with consumers. The RDR, therefore, can be interpreted as further regulation that continued to unbundle the product architecture, and as a consequence the regulator expected price discrimination to lower prices for the benefit of consumers. Furthermore, the dense inter-firm ties between product providers and IFA firms (based upon non-disclosed commission) were also dismantled as IFA firms were expected to ensure "best" whole of market advice.

While the number of IFA firms and the fees they could negotiate were expected to reduce once they became transparent to the customer (The Guardian, 2012), RDR also had the effect of shifting ownership of the customer experience away from the product provider to IFA firms who now acted as a gatekeeper. The IFA firms who survived this shake-out (often those with access to capital and/or deep customer relationships) demanded differentiated or bespoke products from product providers which consumers would be willing to pay substantial fees for. At the same time, given the fragmented nature of the UK financial advice sector,[16] the IFA market attracted substantial private equity and IFA consolidator firms that drove horizontal consolidation (FT Adviser, 2019), which enables these powerful distribution firms to exert significant power and influence over product providers for bespoke products. As a consequence of these dynamics, rather than IFA fees falling, a rising share of the IVC surplus ensued. Given that customers could primarily be accessed only through IFA firms, product providers were at high risk of lock-out if IFA firm demands were unmet, and the increasing power and size of the IFA firms presented a significant bottleneck.

6.2 Transition period: integrative innovation and relational governance

In response to the emergence of both upstream (technology) and downstream (distribution) strategic bottlenecks, our *third contribution* relates to how product providers responded. Our findings highlight that most product providers initially responded by pursuing two types of "integrative innovation" (Fixson and Park, 2008) during a transition phase between 2012 and 2015, albeit with mixed success.

The first type of integrative innovation—m*odularity with guidance*—saw product providers use the modularity of the platform technology to develop self-preferencing component bundles with a proprietary investment component (such as an investment fund) at its heart. These had

14 Competition and Markets Authority (https://www.gov.uk/government/organisations/competition-and-markets-authority).

15 For instance, the CMA blocked a merger between two of the three platform operators (https://www.gov.uk/cma-cases/fnz-gbst-merger-inquiry).

16 FCA report (2019): https://www.fca.org.uk/data/retail-intermediary-market-2019.

higher production margin so as to make the entire component bundle more profitable, but also less portable (Burton and Galvin, 2020). In addition, product providers used the component bundles to exert pressure on upstream component firms who wished to be part of the bundle in order to secure preferential contracting terms. Consequently, the product provider bundled the components together by virtue of the way they were priced and/or marketed to smaller IFA firms which lacked the power to fully leverage their emergent bottleneck position. This corresponds with West's (2003) suggestion that marketing and branding may offer the only opportunity to capture value in open markets. Beyond 2015, however, the regulators' concerns about open competition fueled it to view guided modularity as potentially anti-competitive that resulted in further regulatory guidance that resulted in this type of "re-bundling" difficult without attracting regulatory scrutiny.

The second type of "integrative innovation" that we theorize from our data is the emergence of *formal and relational contracts*, which participants referred to as *power blocks*. This is similar to the idea of ecosystems (Jacobides *et al.*, 2018) that coalesce around a particular innovation. In our case, power blocks refer to a formalized IVC configuration, whereby the product provider acted as a lead firm and sought to coalesce a group of trustworthy firms in each layer of the IVC and who each held strong market positions to develop differentiated modular component configurations that were perceived as opportunities for value creation. At the product component level, each component governed through the power block configuration was differentiated on some performance criteria and made less portable or re-usable through re-architecting the component design. As components in the bundle became more specific to each other, functioning together in idiosyncratic ways, they also became less portable and re-usable outside the power block, fundamentally changing their coupling characteristics. Thus, our conception of power blocks highlights that when product components and the interfaces between them become more tacit, the governance arrangements become richer and more relational.

The power blocks entailed formalized governance, including co-location, suggesting that firms substitute weak organizational ties such as arms' length market contracts with stronger ties and fewer players to pursue profitability (Chesbrough and Prencipe, 2008). Furthermore, the quasi-vertical integration in the power block served to establish parameters for how value capture was divided, but also for how development costs and IP would be shared. The power blocks also acted as a mechanism for product providers to mitigate the effects of the bottlenecks through widening their span of control. Whereas existing research has suggested splitting a bottleneck into modules or reintegrating bottlenecks as possible strategies to mitigate or null their effects (Adner and Kapoor, 2010; Baldwin, 2015), our case points toward a further possibility—establishing quasi-vertical scope configurations that enmesh the bottlenecks in relational governance modes that encourage the bottleneck to cede (some) control over its operation and/or its ability to be exercised. Moreover, the power blocks show that, while regulators' determine the rules of the game, there remains ample scope for firms to execute strategic choices that reimagine the product and industry architecture in a way that serves their own ends.

6.3 The shift toward less modularity and specialization

The power blocks had mixed success and eventually gave way to vertical (re)integration. As Colfer and Baldwin (2016) enquired, instead of relational contracting, "why not unite the actors within the boundaries of a single firm?". Our *fourth* contribution relates to a reintegration phase between 2015 and 2020 and shows how further broadening vertical scope through vertical (re)integration of component firms can be a way to minimize or null the effects of firms occupying a bottleneck. While integrative innovation had delivered some success in driving up margin, there remained risks of exappropriation and the economic risks of the bottlenecks remained significant. Moreover, further pensions regulation triggered by the Pensions Act, 2015, which removed the legal requirement to cash-in a pension at age 75 to purchase an annuity, signaled a second wave of pensions consolidation that would further shake-out the sector.

While Hannah and Eisenhardt (2018) have remarked that innovating upstream from a bottleneck is likely unviable (Adner and Kapoor, 2016), our case analysis suggests that doing so can be

a viable strategy, especially in regulated markets where the technology bottleneck (platform operators) is a well-capitalized, systemically important firm and attempts to acquire the bottleneck would attract regulator and CMA scrutiny. Product providers primarily pursued a strategy of forward and backward vertical integration of both upstream component firms and downstream IFA firms. Participants recounted numerous examples of product providers acquiring component firms, such as investment management firms, share trading platforms, and discretionary fund management firms to secure component IP and differentiate their products in response to the continued consolidation wave. In addition, product providers acquired IFA firms to mitigate the effects of the strategic bottleneck in distribution and avoid potential lock-out. As IFA firms were often less capitalized than product provider firms, there are many examples of acquisitive activity in this layer of the IVC.[17]

While the regulator sought to encourage competition and innovation in the sector through regulatory action that encouraged greater modularity, the endogenous responses of the platform operators eventually resulted in innovation being stifled through their determination of who could license the platform and the type of component innovations developed, by who and when. In other words, they acted as a gatekeeper to the innovation process and scheduled the flow of component innovations to their own advantage. Furthermore, product providers were expected to share component innovation IP with the platform operator who, in turn, licensed the component technology to competitor firms after an agreed time period had elapsed exacerbating concerns over imitation and exappropriation (Ethiraj and Levinthal, 2004; Baldwin and Henkel, 2015). While the power blocks had acted to quicken the speed and pace of component innovation by encouraging the platform operator to prioritize component development of the power blocks, product providers continued to suffer from concerns of distributed component IP.

Product providers perceived that component innovation could only be accelerated and exappropriation threats nulled by pursuing component (re)integration and pushing at the boundaries of the rules in which they were playing. As a consequence, through vertical (re)integration of component firms, product provider firms were able to innovate more successfully within component boundaries, so long as the standards connectivity to the platform architecture was stable. Product provider firms in effect overcame the significant effects of the bottlenecks by widening their span of ownership and control (Baldwin, 2015). Overall, these findings suggest that while greater modularity, influenced by regulatory change, can initially encourage architectural and fast-paced component innovation (Galvin and Rice, 2008; Habib *et al.*, 2020), strategic bottlenecks can emerge in modular markets. Moreover, when the bottleneck is occupied by a firm with architectural advantage, this can create a deficit in the speed and pace of component innovation as bottleneck firms leverage their architectural power to their own advantage. The strategic responses by product provider firms suggest that the fast-paced innovation cycles that are a feature of modularity may be a temporary phenomenon that is eventually eroded through competitive dynamics. Our context, shaped by complexity and the dynamism of a changing regulatory landscape, suggests that product providers recognized that only through broadening their innovation search beyond the existing modular "rules of the game" could they innovate to secure a differentiated position in the market. Whereas other scholars such as Brusoni *et al.* (2007) and Ethira *et al.* (2008) have questioned the relationship between modularity and innovation, we also highlight that speed, pace, and newness of component innovation can be stifled in modular product systems when the bottleneck is occupied by a firm with architectural advantage.

The dynamics of regulation and the shifts toward and away from greater modularity and specialization are summarized in Figure 5. While recognizably complex, the UK pensions sector is marked by the imprint of the regulators' agenda to promote competition and innovation in order to improve consumer outcomes in a way that corresponds to the concerns of modularity advocates. The implementation of these aims through a series of major regulatory shifts encouraged greater modularity and resulted in the vertical disintegration of the sector. Further simplification regulations and the evolving separability of the sector attracted platform technology firms

17 Example: Standard Life buying IFA Firm Pearson Jones for £9 m in 2015 and rebranding it as Standard Life 1825. 1825 has since acquired a number of other IFA businesses (e.g., FT Adviser, 2015).

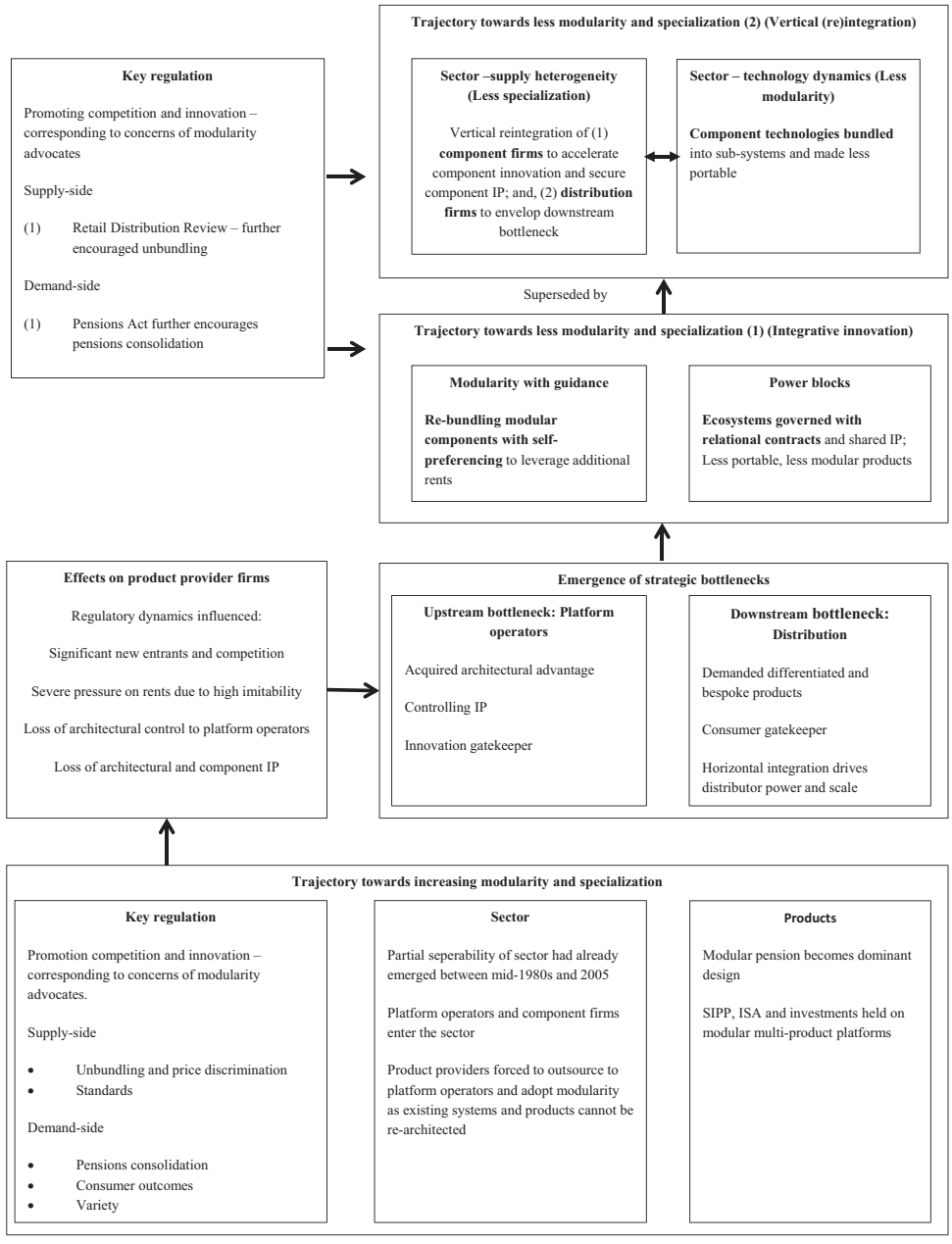

Figure 5. Regulation and industry change: process model

who managed to quickly gain architectural control and occupy a bottleneck position. Further regulation that encouraged unbundling and created a second bottleneck in distribution further exacerbated competitive dynamics for product provider firms. With vertical (re)integration of the technology bottleneck commercially risky and likely to attract regulator scrutiny, product provider firms reacted by widening their span of control through integrative innovation with mixed results and later through acquiring component firms and using the modularity of the platform architecture to accelerate component innovation and occupy a differentiated position in the market.

We turn to our final remarks. Given regulatory change and the subsequent strategic responses by firms have fundamentally changed competitive dynamics, it continues to be dominated by those product provider firms that were vertically integrated incumbents in the 1990s or those innovator firms that held first-mover advantage in the "fund supermarket" wave in the early 2000s. In both cases, the dominant firms remained vertically integrated across two or more component sets during the modular phase, often including fund management and selected specialized components. Thus, we argue that the product provider firms that retained integrative capabilities (see Helfat and Campo-Rembado, 2016) during the modular phase were later able to thrive in the reintegration period by utilizing these retained capabilities to develop a less modular product configuration and offset the higher costs of integration. This suggests that maintaining a broad scope of component capabilities in a modular phase, despite the potential additional costs of doing so, is essential to initiate and derive success from integrative innovation. For example, Standard Life, a life insurance company trading since 1825, has been the market leader in the pensions sector over many years. It was the first mover to adopt platform technologies, but importantly remained integrated in fund management (Standard Life Asset Management) and a number of upstream software components, such as risk modeling and portfolio analysis throughout the modular phase. Standard Life initially mitigated the technology bottleneck occupied by the platform operator through its first-mover scale efficiencies; however, it was one of the first product providers to recognize the appropriation advantages of reintegration and in recent years has acquired a number of firms in the sector, in particular IFA firms which have been rebranded as Standard Life 1825. They also acquired the fund management firm Aberdeen Asset Management to form Standard Life Aberdeen. In contrast, there have been many new entrants (and then exits) to the sector with varying success, and many have continued to follow a modular product architecture with corresponding arms' length governance. While many of these are venture-capital funded, few have had the financial resources or integrative capabilities to match the acquisitive activity of incumbent firms. Nonetheless, successive waves of pension consolidation have enabled a few of these firms, such as Nucleus, to build sustainable positions in the high net-worth end of the market.

Finally, our findings have some important implications for understanding the mirroring hypothesis (Colfer and Baldwin, 2016). Considering the evolution of the product architecture, we find that modular products are associated with high levels of outsourcing (2005–2012) and, as reintegration ensued (2015–2020), we find tailwinds that encouraged both product and industry reintegration. We find examples of non-correspondence that relate to firm perceptions of value capture at the component level of the product artifact (Furlan *et al.*, 2014; Burton and Galvin, 2020). When components were perceived as high value in the modular phase (such as in-house fund manufacturing), these components were maintained within firm boundaries, despite the systemic modularity of the product system. Similarly, in the transition phase, when components were perceived as high value, firms chose to non-correspond through co-development, co-location, and relational contracting through power blocks with component firms, a type of non-correspondence suggested by Colfer and Baldwin (2016). In other words, the notion of "value" at the component level of the product system is central to correspondence decisions.

7. Conclusion

Our study has focused on the dynamic interplay between regulatory philosophy and the strategic responses by firms in the UK personal pensions industry and how this impacted the co-evolution of product and industry architecture. Our findings show that regulation has had a distinctive influence on two phases: more modularity (2005–2012) and less modularity (2015–2020), with a transition phase in-between (2012–2015).

Spurred on by pro-modularity regulation bias, we found that product modularization and the specialization of the sector lead to the emergence of strategic bottlenecks in an IVC. Our case analysis illustrates that faced with a loss of architectural control and constrained component innovation, product providers initially pursued integrative innovation by rebundling modular components and supporting these with marketing and branding, as well as through reconfiguring the level of product modularity by switching to formal and relational contracts in power block

configurations. However, while these efforts had some impact upon value creation, its success was mixed. As a consequence, product provider firms switched to acquire component firms in other layers of the IVC, significantly widening their span of control to mitigate the technology bottleneck leveraged by the platform operators.

We recognize that future research could further elaborate some of our key themes. For example, our study suggests that the effects of bottlenecks can be minimized, even in the absence of architectural control, by widening a firms' span of control to downstream distribution firms to control access to consumer markets and by acquiring upstream component firms to kickstart innovation and secure appropriable IP. Further research on how bottlenecks emerge in modular industries and how they are responded to would add depth to existing understandings of the limits to modularity. Our context is that acquiring the platform owner with architectural advantage was improbable, and further research could examine how regulation in other industries affects decisions to respond to bottlenecks.

While our study has examined personal pensions, the regulatory changes in related markets, such as occupational and workplace pensions, are distinctively different, despite similar products and similar firms. Comparing these two product markets longitudinally may tease out how different regulatory shifts have led to alternate co-evolutionary trajectories for similar products.

Comparing actual and intended outcomes of changes in regulation would also benefit policy debates in the financial services sector. Our case analysis points toward mixed results. On the one hand, in the modular phase levels of competition and the choice available to consumers expanded significantly. One reading of events is that the actual outcomes were almost too successful as product charges fell from between 1.5 and 1.75% per year to around 0.5% per year, barriers to entry were removed, and products were unbundled. The result was that the profitability of product provider firms collapsed. The way in which product providers utilized less modularity and less specialization to counteract these effects points toward actual outcomes that were unintended by the regulator, e.g., less competition. Given that the regulators' aim is to balance competition and innovation with resilience and robustness (León and Berndsen, 2014), these dynamics deserve further scholarly attention.

The literature on the mirroring hypothesis (e.g., Colfer and Baldwin, 2016; Sorkun and Furlan, 2017; Burton and Galvin, 2018b) would also benefit from further empirical and longitudinal research that explores shifts to less modularity and less specialization and how mirroring plays out in alliances and consortia. Furthermore, our study was not able to provide any substantive comment upon the performance outcomes of mirroring versus misting. This also remains an important gap in our understanding.

Lastly, the emergence of platform technologies in the industry speaks to the growing literature on platform architectures and ecosystems (e.g., Gawer, 2014; Adner, 2017; McIntyre and Srinivasan, 2017; Jacobides *et al.*, 2018; Meyer *et al.*, 2018). Our case analysis points toward substantive changes in the configuration of the sector ecosystems. The directionality of the reconfiguration we have presented is unusual. Unusual cases are often useful for theory-building, and studies that examine unexpected structures and trajectories in platform ecosystems are fertile ground for future research.

Supplementary data

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