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Modularity, value and exceptions to the mirroring hypothesis

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ABSTRACT

The mirroring hypothesis suggests a correspondence between product, firm and industry architecture, however, empirical support to date has been mixed. Drawing upon an inductive study of the UK pensions industry, we break new ground by investigating the extent to which product, firm and industry architectures correspond in the face of changing institutional dynamics – most notably dynamic regulatory change. In considering periods of both correspondence and non-correspondence at the aggregate sector level, our results show that firms in the sector seek the efficiency benefits of product component-level mirroring, but only to the extent that the component has low value. In contrast, where components provided an opportunity to capture value, managers strategically chose non-correspondence by developing stronger relational ties with suppliers and, in a later period, through vertical (re)integration, despite the systemic modularity of the product.

1. Introduction

A key question in modularity research is the degree to which the design of products, firms and industries correspond or “mirror” each other¹ (Burton and Galvin, 2018a; Burton, et al., 2020b; Colfer and Baldwin, 2016). In an era characterized by global markets and the specialization of value chains (Burton et al., 2020a; Elia, et al., 2019; Meissner, et al., 2021), this question has added importance given the potential for ‘embedded coordination’ that is associated with modular designs (Sanchez and Mahoney, 1996). Traced back to work on systems decomposability (Simon, 1962), task contingency (Lawrence and Lorsch 1967; Galbraith 1973), information-hiding (Parnas, 1972), and communication structures (Conway, 1968), the mirroring hypothesis suggests two bi-directional relationships: (1) mirroring will occur between firms’ choices of product architecture and firm architecture, and, (2) between firms’ architectural choices and industry structures (Burton et al., 2020b; Colfer and Baldwin, 2016). The resulting relationships across different architectural levels have important implications, and existing research has remarked upon how the mirroring hypothesis impacts the type of knowledge and capabilities developed by firms, the transaction costs encountered, the location of firm boundaries, and how industries are structured and surplus divided (Baldwin 2008; Jacobides, et al., 2006; Brusoni, et al., 2011).

Colfer and Baldwin (2016) identified that mirroring can be examined

at varying units of analysis relating to the design of products (and their components), firms (and their SBUs, units, design groups), and the way in which industries are configured. Typically, the product system is a schematic which assigns components to functions and determines the way in which components connect together via interfaces (Ulrich, 1995). Further, the division of labor within a firm, or between and across different firms, recognizes how tasks in the product system (and the knowledge related to tasks) are allocated within or between firms. In the extant mirroring hypothesis literature, how firms connect together in a particular sector is typically investigated through proxies such as the presence or absence of organizational ties, such as levels of communication and information-exchange, co-location, and employment relations (Colfer and Baldwin, 2016). Mirroring or correspondence is said to be present when the schematic of the product system mirrors the division of labor and/or division of knowledge. For instance, a modular product architecture developed by a group of loosely-coupled firms or an integrated product developed by a single firm represents stylized examples of mirroring (Burton and Galvin, 2018a,b).

Across a range of empirical settings and different architectural levels, and utilizing a variety of organizational ties, the mirroring hypothesis has found strong empirical support in both firm- and sector-level studies (Colfer and Baldwin, 2016, annexe). While the mirroring is a key feature within many firms and across many sectors, a related stream of research has emerged to consider the conditions under which the mirroring

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¹ In this paper, we use the term mirroring / correspondence and misting / non-correspondence interchangeably.

hypothesis does not hold and thus the mirror may become ‘misted’ (Furlan, et al., 2014). A meta-analysis of recent work by Sorkun and Furlan (2017) clustered so-called ‘misting’ contingencies into six categories: four of which focussed on product and firm level contingencies and two explanations were offered at the sector level. While the correspondence between product component and task boundaries is particularly strong, the largest body of work on ‘misting’ comes from scholars who have challenged the assumption that the product system is an adequate schematic for the division of knowledge and therefore a common misted relationship occurs when knowledge boundaries are misaligned with the division of labor (Brusoni, et al. 2001; MacDuffie 2013).

This paper speaks to this body of work and breaks new ground by examining how mirroring across a sector is influenced by the role of institutional dynamics and, in particular, how changes in regulation connect to subsequent shifts in the product system and the division of labor. By examining regulatory dynamics at an aggregate sector level, we illuminate the degree to which firms in a sector pursued correspondence or non-correspondence. Specifically, in order to examine incidences of correspondence and non-correspondence at the sector level, we explored how regulation shaped the correspondence of product design and the division of labor across both a number of incumbent firms and new entrants. Only a handful of prior studies have examined the mirroring hypothesis at an aggregate sector-level despite the recognized value in shifting evolutionary analysis to the way entire sectors and their architectures evolve (e.g. Fixson and Park, 2008; Galvin and Morkel, 2001; Jacobides, 2005; Jacobides, et al., 2018). Furthermore, the limited number of sectoral studies have primarily focused upon incidences of technological change, disregarding the possible significant effects of exogenous institutional change such as regulation.

Our study recognizes that research into how regulation shapes the nature of product design and the division of labor is under-elaborated, despite institutional structures shaping the agency of firms and their incentives (Jacobides, et al., 2014; Jacobides, et al., 2006). For example, Jacobides (2006, p1203) acknowledged that regulation influences patterns of industry architecture and moderates the division of labor. Therefore, changes in regulation impose complex dynamics that affect the evolution of industries and the different competitive positions of firms, as well as the way products and services are designed (Freij, 2018). In this context, we present a longitudinal study of the UK personal pensions industry motivated by the research question, *how does regulation shape the correspondence of product design choices and the division of labor?*

To signpost our contributions, we highlight distinctive phases of correspondence and non-correspondence. Our research shows that frequent and dynamic regulatory changes in the sector between the early-1990s and 2012 fundamentally reset competitive dynamics in the sector, and which ushered in an increasingly modular product architecture and specialized industry structure. However, after 2012 further waves of regulatory change and firms’ endogenous responses resulted in a process of de-modularization and despecialization as firms sought to integrate product components within a broader modular architecture in order to capture value in modular markets. In the face of continued regulatory change, managers perceived limits to modular markets and sought the efficiency benefits that come with component-level mirroring, but they only did so to the extent that modular components were perceived as low value, and component standardization and homogeneity were perceived as beneficial. In contrast, where regulatory change was conceived as an opportunity for differentiation and value creation, managers strategically chose non-correspondence by developing stronger relational ties with suppliers, and in a later period, engaged in vertical (re)integration, despite the systemic modularity of the product system. Therefore, we emphasize the centrality of the role of ‘value’ in correspondence choices where value ensues in cases of components being designed to create unique complementarity and functionality within the product (Argyres and Zenger, 2012).

As an inductive study, our paper is structured as follows: first, we briefly introduce the contours of existing scholarship pertaining to the mirroring hypothesis and the phenomena of ‘misting’. Second, we introduce the regulatory context of the UK pensions sector. We then describe our inductive methods and approaches to coding our data. Fourth, we highlight our findings using illustrative quotations. Finally, we provide an extended discussion and theorization and offer concluding remarks.

2. Literature

Product systems encompass three distinct features: (1) an architecture that represents the blueprint for the product design; (2) components which contribute to the products’ function, and (3) interfaces which document how components connect together (Baldwin and Clark, 2000; Bouncken, et al., 2015; Ulrich, 1995). Drawing upon Ulrich’s modular-integrated continuum of stylized product types, integrated product architectures incorporate components that are interdependent and which connect together in idiosyncratic ways (Sanchez, 2008). Modularity theory, however, asserts that product systems can be decomposed into sub-systems and components, and which connect via standardized interfaces (Ulrich, 1995; Schilling, 2000). At the heart of modular theory is the presence of ‘loose-coupling’ (Orton and Weick, 1990) between components that facilitate a (near) one-to-one mapping between product functions and components (Ulrich, 1995). Loose-coupling permits components to be designed and produced independently by separate individuals, teams, or firms (Sanchez, 2008), increasing component-level innovation (Galvin et al., 2020) and potentially reducing development cycle time and increasing speed to market (Lau, et al., 2011; Sanchez and Collins, 2001).

Similarly, modular organizations are decoupled into discrete units such as departments, projects or teams (MacCormack, Baldwin and Rusnak, 2012; Schilling and Steensma, 2001). In such cases, the interfaces between loosely-coupled organizational units determine how the units interact when they function together in an organization design (Sanchez, et al., 2013) and may encompass standardized operating procedures that act as the equivalent of interfaces and minimize the need for ongoing communication and information-sharing (Tee, 2019), product planning forums (Campagnolo and Camuffo, 2010), and flexible work arrangements and arms’ length contracting to allow a firm to reconfigure its organizational components as and when desired (Schilling and Steensma, 2001).

The potential for correspondence between product systems and organizational systems has come to be known as the ‘mirroring hypothesis’ (Colfer and Baldwin, 2016; Elia, et al., 2019; Sanchez and Mahoney, 1996). In essence, it suggests that the modules of technical systems will predict the location of firm boundaries or ‘what does what’ within the system will correspond to ‘who does what’. Thus, product systems comprised of discrete modules can be designed and developed by loosely coupled organizations, such as separate teams or firms, whereas product systems with high levels of internal interdependence require tighter coupling such as present in a single firm.

Colfer and Baldwin (2016) have argued that an ideal proxy for mirroring is one that assesses organizational ties such as the type of coordination and information-exchange between firms. Thus, the design and development of modular products often occurs across multiple, specialized firms accompanied by low levels of coordination, and an absence of co-location and employment relations, as the modular structure and interface standards provide a degree of embedded coordination (Sanchez and Mahoney, 1996). This embedded coordination may provide benefits in the form of increased efficiency such as reduced communication and control costs (Querbes and Frenken, 2018), organizational efficiency (Sorkun and Furlan, 2017) reduced sourcing costs (Hoetker, et al., 2007) and enhanced gains from specialization and trade (Jacobides, 2005; Sanchez, et al., 2013). In comparison, for integrated products the usual logic is that mirroring is present when product design

and development occurs within the boundary of a single firm; often reflected in high levels of coordination, co-location, and shared employment relations.

Despite the suggested efficiency benefits associated with mirroring, there are a growing number of cases where the mirroring relationship is absent or becomes ‘misted’. For example, it has been noted that in some industries such as aircraft (Argyres, 1999) and motor vehicles (MacDuffie, 2013) rich organizational ties persist, despite high levels of systemic product modularity. Similarly, in respect of air-conditioning systems, knowledge-sharing across firm boundaries occurred even when products were highly modular (Furlan et al., 2014). Further, in the camera industry, firms became vertically integrated even though the product remained modular (Windum, Haynes and Thompson, 2019). Sorkun and Furlan’s (2017) meta-analysis of misting contingencies suggests six possible explanations for the mirroring hypothesis failing to hold. Of these, four explanations occur at the product and firm level (component technological change, innovativeness of product architecture, product complexity and capability dispersion amongst suppliers) with the remaining two explanations operating at the industry level (inter-firm rivalry and logistics costs associated with the supply chain). More recently, Leo (2020) built a series of mirroring-related propositions around the relative completeness of a firm’s architectural knowledge, however, the focus of their work remains at the product and firm level.

What is surprisingly missing from existing research is how different institutional structures - such as regulation – impact upon design choices and the division of labor in a sector and hence how it impacts the absence or presence of mirroring. From a policy perspective, regulation is often aimed at deterring harmful practices or anti-competitive behaviors (Jacobides and Lianos, 2021). However, at an industry level, these regulatory structures provide a framework that determines competition dynamics and the way that the industry is architected to deliver value to the end customer. As such, regulatory change at the product level (e.g. restrictions on what can be sold and to whom) and at the industry value chain level (e.g. the extent to which firms may occupy subsequent stages in a value chain such as product design and consumer advice) impacts the architecture of entire industries and how these industries evolve over time (Freij, 2021). Viewed through a modularity lens, these institutional structures may shape firm boundaries, their incentives and potentially their design choices (Jacobides et al., 2014). For example, Brousseau and Glachant (2011) present how regulation may open up markets and encourage innovation, while Jacobides, et al. (2006) suggest that regulatory forces influence the industry architecture and moderates the division of labor.

In respect of the mirroring hypothesis, regulatory change has been ignored and much of the extant literature has focused upon endogenous factors such as technology and knowledge-based explanations (e.g. Cabigiosu and Camuffo, 2012; Cabigiosu, Zirpoli and Camuffo, 2013; Furlan, et al. 2014; Sorkun and Furlan, 2017). Regulation, a largely exogenous variable,² represents a different type of challenge for firms’ design choices. Major changes in the regulatory environment can create a level of environmental dynamism that impacts the pathways of product and industry architecture as firms adjust their approach to creating and capturing value (Jacobides et al., 2006; Jacobides, 2015). While firm-level design choices may coevolve with changes in technology and knowledge at the component level, significant regulatory change has the potential to require firms to react quickly and significantly adapt their entire product artefact or organization design.

² Jacobides and Lianos (2021) suggest that private firms strive to establish the ‘rules of the game’ across industries, however, regulators often have their own agendas (Wishnick, 2020) that will shape the design of industries/markets. The exogenous agendas of regulators are often tempered by allowing industry participants to provide feedback and engage in the regulatory process such that regulator changes are not entirely exogenous to the industry.

Regulatory change may also result in significant changes across the entire industry system, thereby providing something of a reset button for firms to rethink how to deliver value to customers.

Overall, our paper seeks to deepen existing understandings of product and firm design choices within the context of regulatory change. Adaptation by firms to other types of changes – notably technological change - has often resulted in non-correspondence (Furlan, et al., 2014) and empirical evidence points to the potential of adopting a systems integrator role (Brusoni et al., 2001) or vertically integrating (Windum et al., 2019) to cope with unforeseen complexity.

3. Regulation context

The financial services industry is prone to periods of instability, and regulations frequently play a significant role in protecting consumers. Financial services firms are subject to a wide range of regulation and a detailed discussion is beyond the scope of this paper. However, the principal regulator of UK pensions product providers is currently the Financial Conduct Authority (FCA) and, for occupational and workplace pensions, The Pensions Regulator (TPR), but firms are also subject to extensive European Commission directives.

Between 1986 and 2013, the then primary UK financial regulator, the Financial Services Authority (FSA), had four statutory objectives: the protection of consumers; integrity in the financial system; reducing financial crime; and, promoting public understanding of financial services. Regulatory supervision entailed a mix of risk-based and principles-based aims, and was considered ‘light-touch’ and business-friendly (Gieve and Provost, 2012). Regulatory principles encouraged consumers to take responsibility for their own decisions and firms were required to provide standardized and comparable information about prices, features, and risks to facilitate rational and informed decision-making (Callaghan, 2013; 2014). Prior to 2013, the FSA had recognized the complementarity between regulation and competition. However, by 2013 the newly-established FCA sought to actively promote competition and innovation in the interests of consumers (FCA, 2017).

Personal pensions are a retirement vehicle that rewards savers with a tax-free lump sum and a pension income on a selected retirement date. Personal pensions are often purchased by (1) those who do not have access to an employer-funded occupational scheme (e.g., self-employed), (2) affluent individuals with private pension arrangements; (3) those who contribute to a pension on behalf of non-earning family members, or (4) by any individual who wishes to consolidate their varied legacy pensions into a single product. The dominant product types have differed across time as successive Governments have changed pensions rules and regulations. The division of labor in the sector has also reconfigured substantively during the time period that our study corresponds to, providing a further motivation for our choice of context.

4. Method

In this study, we utilized a case analysis of the UK pensions industry between 1985 and 2020. We selected the UK pensions industry precisely because it had undergone numerous periods of regulatory change since the mid-1980 s (Burton, 2018). Furthermore, existing literature relating to the mirroring hypothesis has largely ignored ‘intangible’ products, emphasising (almost exclusively) manufacturing firms and industries (see review papers by Colfer and Baldwin, 2016; Sorkun and Furlan, 2017). Moreover, the sector is widely-recognized as a highly-regulated industry and an example of service productization (Burton and Galvin, 2022; Wirtz, et al., 2021).

The data for this research come from a longitudinal study conducted in 2014 and 2020. We collected data using semi-structured interviews at different units of analysis - about product architectures, firms, and industry structure, and we invited participants to discuss important changes in the industry since the mid-1980 s. The mid-1980 s was chosen as the starting point for the study as it is widely recognized as the

Table 1

Illustrative Quotes	Themes	Aggregate dimensions of mirroring hypothesis
Period 1: mid-1980 s to late-1980 s		
<ul style="list-style-type: none"> “It was all intertwined, interlinked” “it had to be all our own components, and if you changed one thing, the whole thing changed” “They were incredibly tough to change because everything’s integrated”. “Everything centred around the with-profit fund. You couldn’t develop any new features without impacting on the fund. So innovation was stifled” 	Integrated product architecture	Mirroring hypothesis supported; integrated product corresponds to vertical integration and ties of common firm membership, high levels of information-exchange and co-location
<ul style="list-style-type: none"> “The industry was dominated by a relatively small number of large insurance companies who did everything themselves, from product design to fund management to sales. The trouble was there were few people to outsource to and we were making very healthy profits, so no need to worry or get excited about innovation” 	Vertical integration	
<ul style="list-style-type: none"> “Development was done by multi-disciplinary teams within the firm, an actuary; marketing; an IT team; finance. We were all co-located, all sitting in the same building”. “We were all co-located, working together in teams to get any small improvement done” 	Organizational ties: High information-exchange Co-location Common firm membership	
Period 2: Early-1990 s to mid-1990 s		
<ul style="list-style-type: none"> “An opportunity to provide choice to customers, which was severely lacking, especially in the gold rush of financial de-regulation” 	Modularization as a process to respond to demand-side factors	Exception to mirroring hypothesis
<ul style="list-style-type: none"> “We had a nightmare trying to unit-link. We had some investment funds that priced at different times of the day. Some funds were denominated in GBP and of course others were invested in dollar assets. We had to work all this out. Valuing a customers’ pension was not straightforward. This all required thinking through so that we could standardize everything and we also had to make sure we can add and remove funds without everything getting very complicated” “We had to settle upon standards to link unit-linked funds to the product. Initially we tried a few different approaches but eventually we managed to agree on a template that could cover most eventualities and the different kinds of components, the template consisted of the characteristics of the fund, such as when it was priced, investment and redemption protocols, data feeds and that sort of thing” “In a big monolithic, proprietary ‘with-profits’ system, it’s not very easy to do because you have to commit major surgery to cut the fund component out of the system” 	Standards-setting Challenges to standardization	Modularisation occurs within firm boundaries
<ul style="list-style-type: none"> “Company specific standards, information transfer protocols, and linking criteria. But they were all our own funds, at least initially. At this point we weren’t outsourcing because we thought we had the capabilities to make a success of just linking our own funds” “There were standards we developed in the system, one bit talking to another, so we were building interfaces to try and componentise the system to cope with unit-linking, but at this stage we couldn’t link to other external funds because it was just too complicated, one step at a time” “[...]a tied sales-forces automatically carries risk and fixed costs. From that point of view, if you are selling as well as administering as well as running funds, vertically integrated, you carry risk and cost in all areas. Whereas, if you are segmenting the value chain and just focussing on a key component, such as product design, there’s still money to be made by specialising in a certain part of that value chain. That’s why we switched to using independents” 	Product modularisation -	
<ul style="list-style-type: none"> “As unit-linking took hold, we realized we could begin to look at how the organization was structured. We realized that we could separate customer service teams. We developed a separate investments team” “Once we had split out the teams, we implemented the typical SBU structure around products, each with their own P&L and recharges from centralized services such as customer services, legal, compliance, and so on” 	Corresponding modularisation of firm structure	
<ul style="list-style-type: none"> “The product was so simple, an admin system, a few unit-linked funds, no real flexibility yet, it meant we could all just work separately and make quick incremental changes” “Once we had decided to unit-link and set standards, we recognized we needed to access expertise and capability and we could only do that by locating functions where that capability was at its strongest. For example, the admin teams were in Norwich, presumably because it was cheaper, and the investment teams were in London because that’s where the expertise was” 	Organizational ties: Low information-exchange Geographic dispersion Common firm membership	
Period 3: mid-90 s – 2005		
<ul style="list-style-type: none"> “We started off with around six unit-linked funds, all our own. But, we recognized quickly that we just didn’t have the capabilities to manage investment funds in all markets of the world, and our investment performance was quite shocking. With the big fund management groups always knocking on our door, we decided to just hand investment management over to them. By the end of the 90’s we had linked to about 30 fund management groups and offered over 200 investment funds. With an emerging tech-boom this was crucial” “We realized that customers just wanted more choice and to diversify their investment across multiple fund management groups. They didn’t want all their money managed by us and so it was demand-side forces that led us to outsource investment management” 	Modularization across firm boundaries	At the <u>component</u> level of the product architecture: Mirroring hypothesis supported as integrated product components corresponds to vertical integration and ties of common firm membership, high levels of information-exchange and co-location, whereas modular components are outsourced and correspond to ties of an absence of common firm membership, low levels of information-exchange and geographic dispersion

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Table 1 (continued)

Illustrative Quotes	Themes	Aggregate dimensions of mirroring hypothesis
<ul style="list-style-type: none"> “Providers wanted to offer more choice, but they had to do it within a fixed price, and so this limited the kinds of investments we could link to. It also limited the amount of commission we could pay to distributors, a kind of perfect storm I guess”. 	Regulation - stakeholder pensions	
<ul style="list-style-type: none"> “We just bolted stakeholder pension rules onto our existing proprietary systems and standards, it was all a bit messy behind the scenes but it sort of worked” 		
<ul style="list-style-type: none"> “To stay within the cap, we had to get our own house in-order cost-wise, be more efficient, but we also had to hammer down on the fund management industry to get cheaper charges from them” 	Regulation and efficiency concerns driving outsourcing	
<ul style="list-style-type: none"> “The trouble was that we were huge fixed cost companies. The 1 % cap pushed out our break-even point to about 15–20 years, and made selling pensions capital-intensive and basically unprofitable. We needed to quickly shift to being a variable-cost company to survive in the market and this drove further outsourcing” 		
<ul style="list-style-type: none"> It was called ‘end-to-end’ proposition management. There was a proposition team responsible for the product and consisted of product designers, actuaries, and systems people who closely managed a profit and loss for each product line. They were also responsible for managing internal and external suppliers and driving the end to end costs down to maximise profit” 	Organizational ties (outsourced components)	
<ul style="list-style-type: none"> This was a period of scooping up and co-locating teams into one location in different parts of the UK to be more cost-efficient, but also to share knowledge and expertise” 	Low information-exchange Geographic dispersion Absence of common firm membership	
<ul style="list-style-type: none"> “By the mid-2000 s, we had pretty much outsourced most of the investment components, but the bits we had in-house, like product development, customer service, were all regrouped back together into cohesive team for efficiency reasons but also to manage the end-to-end proposition and product system” 	High information-exchange Geographic co-location Common firm membership	
Period 4: 2005 – 2012		
<ul style="list-style-type: none"> “It was a massive opportunity for all, but especially new entrants who had no legacy book to protect” 	Regulation – opportunities and risks from SIPP and ISA	At the <u>component</u> level of the product architecture:
<ul style="list-style-type: none"> “It put our entire legacy book of pensions at risk of being switched. Basically, every penny of our embedded value was at risk” 		Exception to mirroring hypothesis: value of component acts as a contingency to the mirroring hypothesis; modular high value components associated with ties of high information-exchange and geographic co-location, despite outsourcing
<ul style="list-style-type: none"> “Protect against the churn of their legacy pension assets to competitors and new entrants and take advantage of the huge opportunities of pensions consolidation and the booming ISA market” 		
<ul style="list-style-type: none"> “Platform operators entering the UK market offering ready-made open architecture systems to product providers” 	Platform operators enter the sector	
<ul style="list-style-type: none"> “We immediately contracted to outsource to allow full open architecture and plug and play. We looked at the propositions we wanted to launch and within a year we were there” 	Outsourcing to the platform operators	
<ul style="list-style-type: none"> “The new platform systems had full open architecture. It was designed knowing it needed to plug into everything else” 		
<ul style="list-style-type: none"> “They had been quick to set standards with suppliers so every-one could link in. As a customer of the system we could also decide which bits we wanted and buy, and which we didn’t. Why didn’t we build it ourselves?. Time was short, capital was short, and we knew absolutely nothing about platforms” 		
<ul style="list-style-type: none"> “A case of jumping from the frying pan into the fire” 	Realization of the risks	
<ul style="list-style-type: none"> “It was 99 % standard. Everybody added every component possible, you could do it ten times faster and very limited cost. That’s why I think ‘plug and play’ is too pure and takes away differentiation” 		
<ul style="list-style-type: none"> “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. The platform came in and was chipping away at your underlying margins as we all competed for volume until you can’t make any money at all. We thought the stakeholder regime 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 and stop the rot” 		
<ul style="list-style-type: none"> “Colocation partnering model, where quality is important, particularly in an ambiguous and fast-changing environment” 	Organizational ties	
<ul style="list-style-type: none"> “You don’t need to collocate for standardized stuff. If it’s a clearly-defined task, you can outsource with minimum oversight. An example would be simple regulatory change or minor tweaks to product features. But, when you’re uncertain, and you see an opportunity to create a differentiated solution then the more you co-develop, the more you need to be in the same place” 	Low-value components: Low information-exchange Geographic dispersion Absence of common firm membership	
<ul style="list-style-type: none"> “Where the development is a differentiating factor, we worked very closely with the supplier we’ve outsourced to, given that it’s probably a) important to us and b) the component knowledge is a separate skill to the core product knowledge, and we need to know how it works”. Conversely, where the component was low-value and offered limited opportunities for differentiation: “like our quotation module was just outsourced. We don’t particularly want it to be a differentiator. And so it doesn’t get a whole lot of focus, we let them get on with it and we trust them to meet our specification” 	High-value components High information-exchange Geographic co-location Absence of common firm membership	

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Table 1 (continued)

Illustrative Quotes	Themes	Aggregate dimensions of mirroring hypothesis
Period 5: 2012 – 2020		
<ul style="list-style-type: none"> “Advisors, because of all the regulatory challenges, have big 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. Bundling, efficiency, and risk management went hand-in-hand after RDR” <p>“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 of power has shifted. Product providers couldn’t compete on levels of commission, and instead had to cater to the demands of intermediaries”.</p>	Regulation – RDR driver for product reintegration driven by requirements of distribution	At the <u>component</u> level of the product architecture, exception to mirroring hypothesis
<ul style="list-style-type: none"> “They had a vested interest in having their own in-house funds, with bigger manufacturing margin, at the heart of the bundle. They under severe pressure to make money in a commoditized world as products by this time were almost free of charge, the only margin was in investment management or advice and so many product providers embraced bundling very quickly” <p>“You’ve still got all of that underlying ‘plug and play’, but actually the way it’s presented to customers, we’re chunking it up in pre-packaged bundles. We’re kind of closing down variety in the interests of efficiency, risk and hopefully value”</p> <p>“We had an open architecture platform but which we open and close doors for different bundled propositions, for different consumers, for different advisors”.</p> <p>“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”</p>	Product reintegration	Value of component acts as a contingency to the mirroring hypothesis. High value components largely insourced, but some remain with suppliers. Exception to mirroring hypothesis based upon formal and relational contracting for some high value modular components
<ul style="list-style-type: none"> “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” <p>“in the power blocks, we were so close to the other firms. We co-located, shared information and ideas, knowing that we all had the same interests, and were protected by contracts and the inability to share the bits we developed with anyone else”</p> <p>“We needed to bring back in house many of the high-value components that offered us differentiation”.</p> <p>“a few big deals were sealed as medium-sized platforms merged to get scale or capability and try to compete with the leaders”</p> <p>“we bought an advisor firm. So we now have our own advice capability in house, which we’ve now fully integrated and rebranded”.</p> <p>“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”.</p> <p>“Once we had acquired component providers, we needed to co-locate every-one so we can make our proposition more distinctive”.</p> <p>“Having defined the basics, you can then disperse the development with minimal oversight”</p>	Organizational ties	
	Low-value components:	
	Low information-exchange Geographic dispersion Absence of common firm membership	
	High-value components	
	Route 1 – Formal and Relational Contracting	
	High information-exchange Geographic co-location Absence of common firm membership	
	Route 2 - Insourcing	
	High information-exchange Geographic co-location Common firm membership	

beginning of the personal pension era, and which was implemented in the UK in 1988, following the Social Security Act, 1986 (Burton, 2018).

We recruited 31 senior managers from 6 product provider firms via Linked-In who self-reported relevant professional experience that continuously spanned the entire period and who all held a strategic role in either product development, systems design, investment management, or actuarial. We approached participants who had a wide range of experience in the industry, with particular expertise in personal pensions, and who had strategic experience designated by job titles such as “Head” and “Director”. The sample is shown in Table 1:

The first set of interviews were conducted in 2014, and we held follow-up interviews by video call during 2020 with 19 of the original participants who remained in the industry. Each interview took between 45 and 75 min. Our participants were closely involved with the events about which they reported. We described to participants that we were

interested in how pension products and the sector had evolved, and the important drivers and mechanisms that may help illuminate our research question. We informed participants about the broad scope of our interests but allowed any connection to specific events, drivers or mechanisms to emerge spontaneously during the interviews. As a consequence, follow-up questions varied in each interview to allow us to more deeply explore specific topics of importance to each participant.

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 based upon changes in stylized product type. The process we used is an example of “temporal bracketing” (Langley, 1999) that aims to identify meaningful time units within a stream of longitudinal or historical data, and we invited participants to assign a product architecture type to each time period identified. Then, we asked them to describe the product system

	Mid-1980s to late 1980s	Early-1990s to mid- 1990s	Mid-1990s to 2005	2005–2012	2012–2020
Product level themes	Inductive coding	Inductive coding	Inductive coding	Inductive coding	Inductive coding
Firm level themes	Inductive coding	Inductive coding	Inductive coding	Inductive coding	Inductive coding
Sector level themes	Inductive coding	Inductive coding	Inductive coding	Inductive coding	Inductive coding

Fig. 1. Matrix structure used to structure inductive coding.

pertaining to each sub-period. To assist participants, we provided them with a stylized product architecture typology (see, Burton and Galvin, 2018a,b; 2020a). The stylized product architecture described the characteristics of an integrated product architecture, a modular product architecture designed by a single firm (closed and modular), a modular product architecture designed by a group of specialized firms (open and modular), and a hybrid product architecture that exhibits a combination of characteristics, both part open and part closed, part integrated and part-modular. In our study, there was a significant degree of commonality in the periodization across the participants and hence the following five sub-periods and corresponding product types were identified:

- Mid to late-1980 s: Integrated product
- Early to mid-1990 s: Closed and modular product
- Mid-1990 s to 2005: Hybrid product
- 2005–2012: Modular product
- 2012–2020: Hybrid product

The sub-periods served as a basis for the second part of the interview that followed on. We asked a series of open-ended questions related to each sub-period such as ‘what was going on in this time period? ‘what led to this change?’, and ‘what was the result of this change?’. Thus, the periodization provided a structure whereby an inductive logic was used to derive key themes in each particular time period.

Following transcription of the interviews, we used template analysis to code the interview data. Template analysis is a flexible type of thematic analysis developed by King (1998; 2012). We followed an approach elaborated by Burton and Galvin (2018) in combining a matrix and template analysis method. We chose to code the data ourselves because we recognize that coding can sometimes be reductive, and we wished to stay immersed in the experiences of participants in order to enhance the richness of the descriptions we produced. Our initial coding of the first few interviews (six) highlighted that themes were clearly emerging at three different units of analysis – (1) industry level themes, (2) firm level themes, and (3) themes about the product design, and this observation enabled us to create a matrix within which to thematically code and structure the interview data, with the five time periods on the x axis and product, firm and industry themes on the y axis. The matrix we developed to structure our coding is shown in Fig. 1.

We were particularly interested in understanding the relationship between different time periods and links between themes across time, e. g. how changes in one time period affected subsequent time periods. 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, 2013). Where new themes emerged or other changes to the templates were made, previously coded interview transcripts were re-examined, and this iterative process continued *ad-finitum*. Finally, given the inductive nature of our approach, the flexibility of our template analysis allowed us to balance a search for ‘integrative’ themes that permeated the data but at the same time not lose

sight of interesting and unusual detail (King and Brookes, 2016).

To supplement our interviews, we also collected secondary data by searching a range of publications including publications by the Financial Conduct Authority, the trade media, and other financial media such as the Financial Times and Citywire. We used keywords that related to the mechanisms and drivers identified by our participants as important events, for example ‘pensions simplification’, ‘retail distribution review’ and ‘platform’ and we created a database of publications and arranged them by year of publication to align with our matrix structure. Following, we reviewed each deposit in the database for applicability to our research question and drew upon relevant material where it provided additional clarity. Finally, we were able to access privileged market and technical reports produced by two leading consultancy firms to the sector, and who also acted as independent ‘experts’ reviewing samples of our coding and providing sense-checking to our overall narrative (King and Horrocks, 2010).

5. Findings

5.1. Period 1: mid-1980 s to late-1980 s

Until the 1980 s the pension industry initially offered a range of simple products sold through large vertically-integrated insurance companies. The product system featured few choices and limited variety. For instance, pensions typically only offered one investment option, a ‘default’ choice called a ‘with-profits’ fund. Respondents remarked that, “it was all intertwined, interlinked”, “it had to be all our own components, and if you changed one thing, the whole thing changed” (R29), “they were incredibly tough to change because everything’s integrated” (R14), and “Everything centred around the with-profits fund, all other features such as the price, the performance, the benefits, the amount of life insurance, all were totally interdependent with the way in which the with-profits fund worked. So, basically, you couldn’t change anything without starting from scratch” (R7).

The integrated product architecture corresponded with firm architecture, and the sector comprised of vertically integrated firms indicating support for the mirroring hypothesis. The situation was summarized as follows: “The industry was dominated by a relatively small number of large insurance companies who did everything themselves, from product design to fund management to sales” (R19).

Changes in regulation via the Financial Services Act, 1986 (which came into force in 1988) distinguished between ‘tied’ agents, who could only recommend the products of one company, and independent financial advisers (IFAs), who could advise on products from across the industry. The regulations detailed compliance standards between product providers and distributors, and increased the regulatory cost of maintaining a tied distribution structure. For example, “The issue was that the costs of running a tied sales team became too high, due to the risk. The regulations added in significant compliance risk, and the risks of non-compliance and regulatory fines were very high. Initially, we thought we

could do it, by providing extensive training to our sales people but in the end the cultures of sales and compliance were too dissimilar, and so we decided to close it down and outsource to IFA firms who were responsible for their own advice to the regulator” (R3). Further respondents remarked upon the motives to transfer distribution and advice to IFA firms in the following ways, “While the regulations pushed up the costs of tied distribution, it also set out in various regulatory handbooks, the expectations of financial advisors, and the standards by which product providers and financial advisers should trade with each other. These regulatory guidelines enabled us to offer contracts for distribution to regulated IFA firms knowing the standards we could expect to receive, and as IFA firms were paid commissions we could trade knowing that it was cost-effective, so long as we could offer them something distinctive to sell to the customer” (R22). The regulatory changes that came into effect in the early-1990 s left few tied advisers in the sector. Regulation had significantly increased the risks and costs associated with internal ownership and management of the activity. As one respondent recalled: “[...] a tied sales-forces automatically carries risk and fixed costs. From that point of view, if you are selling as well as administering as well as running funds, vertically integrated, you carry risk and cost in all areas. That’s why we switched to using independents” (R9).

5.2. Period 2: Early-1990 s to mid-1990 s

By the early-1990 s, in order to respond to demand-side changes from IFA firms and consumers for greater investment variety, a modular technological innovation started to permeate the industry as product providers began to mix and match a range of third-party investment funds to the pension product in order to provide “an opportunity to provide choice to customers, which was severely lacking, especially in the gold rush of financial de-regulation” (R25).

Linking the investment products of different third-party firms required a form of technological modularization and a process of standards-setting that involved trial and error, “We had to settle upon standards to link unit-linked funds to the product” (R11). The trial and error process was challenging and required extensive ex-ante problem-solving, “We had a nightmare trying to unit-link. We had some investment funds that priced at different times of the day. Some funds were denominated in GBP and of course others were invested in dollar assets. We had to work all this out to link to multiple different funds and then standardize everything for the customer. This all required thinking through so that we could standardize everything” (R3). However, through a process of trial and error, the modularization process progressed between 1990 and 1995 through developing “company specific standards, information transfer protocols, and linking criteria with the investment firms that had entered the industry in this period” (R8). For example “the standards needed to standardize certain things like dealing time, redemption terms, and so on, and standardize the flows of information such as unit prices” (R29).

As the modularization process ensued, the corresponding firm architecture was also partitioned. For example, “As unit-linking took hold, we realized we could begin to look at how the organization was structured. We realized that we could have a separate investments team that managed the relationships with investment firms and managed the interface between the respective firms” (R4). Further, as teams began to operate independently the need for co-location disappeared: “Once we had decided to unit-link and set standards, we recognized we needed to access expertise and capability and we could only do that by locating functions where that capability was at its strongest. For example, the admin teams were in Norwich, presumably because it was cheaper, and the investment teams were in London because that’s where the expertise was and that’s where our investment suppliers were” (R12).

5.3. Period 3: mid-90 s – 2005

As the 1990 s progressed, the modularization of the investment components continued and the range offered increased substantially through outsourcing: “we started off with around six unit-linked funds.

With the big fund management groups always knocking on our door, we decided to just hand investment management over to them” (R24). However, by 1997 the UK Government made pension funds less tax-efficient for consumers, and pension funds became tax-equivalent to collective investment schemes.³ Pensions funds, at a stroke, were no longer tax-advantageous, and product providers were able to connect pension products to the thousands of collective investment schemes, designed to a common standard (UCITS), offered by third party fund management firms. Exemplifying the effect of this change, one respondent remarked: “By this time, most third-party funds in the market was UCITS-compliant and pension funds were not. As such, while the tax changes did damage to consumers, they were a boon for us as we could now connect to UCITS funds. Within about two years we had gone from thirty funds to over 2000 investment funds because you could almost bulk-connect to an investment managers entire fund range through one simple one-page contract” (R26).

Given the substantive increase in the range of investments available within pension products as a result of these policy changes, a number of component firms emerged in the intermediate market to connect pension products to services such as portfolio and retirement modelling software, investment data feeds and other investment related componentry. As one respondent exemplified, “In the late-1990 s, we started to see firms from the investment industry develop new components to connect to pensions. This all started with the tax changes and UCITS standards, and investment firms that had expertise in data or modelling saw opportunities to sell their components to product providers. It became a standard part of products very quickly” (R11).

A wave of regulatory change occurred from 2001. Following a regulator investigation into the mis-selling of pensions that began a decade before, the then Labour government introduced a new ‘benchmark’ pension-type known as Stakeholder Pensions. This effectively created an industry standard cap on pensions charges (initially 1 percent per year). The 1 % charge cap put limits on what firms could do and the range and types of products and investments they could offer: “Providers wanted to offer more choice, but they had to do it within a fixed price, and so this limited the amount of commission we could pay to distributors, a kind of perfect storm I guess” (R5). The economic impact upon firms was significant: “The trouble was that we were huge fixed cost companies. The 1 % cap pushed out our break-even point to about 15–20 years, and made selling pensions capital-intensive and basically unprofitable” (R21).

The correspondence of firm architecture also altered. Many firms began to seek efficiencies and to work out how to remain profitable under such circumstances. Specialized components such as customer service began to be co-located into a “centre of excellence” in order to minimize costs. The situation was summed up as follows: “By the mid-2000 s, we had pretty much outsourced most of the investment components, but the bits we had in-house, like customer service, were all grouped into a cohesive team for efficiency reasons” (R6).

5.4. Period 4: 2005 – 2012

Until 2003–4, product providers had largely ignored a set of pension rules known as the self-invested personal pension (SIPP) rules until further regulatory change known as ‘pensions simplification’ was announced. The then Labour government had recognized that while it had been successful in re-setting expectations around the ‘price’ of pensions, the stakeholder pension had otherwise been a failure, limiting innovation and failing to excite distributors and consumers. It

³ Collective investment schemes are pooled funds, similar to mutual funds in the US. They are designed by fund management firms often in accordance to 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 authorisation in one EU member state, and to register for sale and market across EU member states.

announced a plan to simplify the hundreds of legacy pension regimes dating back to the 1950s into a single set of flexible rules. The Government saw this as a process of ‘pensions simplification’; the industry, on the other hand, saw a single set of rules as an opportunity for ‘pension consolidation’ – an opportunity to re-advise all existing customers to switch into a new product type that had more flexible rules and significant investment choice. Importantly, the product had no price cap, “*It was a massive opportunity for all, but especially new entrants who had no legacy book to protect*” (R6). While opportunities abounded, one participant remarked: “*It put our entire legacy book of pensions at risk of being switched. Basically, every penny of our embedded value was at risk*” (R14).

A few years earlier (1999) the Labour government had also announced a new savings product in the savings sector – Individual Savings Account (ISA) – which was a tax-efficient way to hold investments and which took off during the tech-boom of 1999/2000. By 2004, many product providers had launched an ISA. However, pensions simplification and ISA offered an opportunity to create a product family architecture connected to a common range of components. It was conceived as a way to generate huge numbers of new consumers but also protect the legacy pension book from competitive attack. This vision, however, required a momentous shift away from proprietary legacy systems to a ‘multi-product platform’ architecture model featuring pensions, ISAs and other product types – and speed to market was critical.

The opportunity was spotted first by “*platform operators entering the UK market offering ready-made open architecture technology systems to license to product providers*” (R8). The platform operators originated in Australia and New Zealand and entered the UK in about 2004 in anticipation of the pensions simplification regime, and attracted product providers who needed to “*protect against the churn of their legacy pension assets to competitors and new entrants and take advantage of the huge opportunities of pensions consolidation and the booming ISA market*” (R16). As one participant remarked “*we immediately contracted to outsource to allow full open architecture and plug and play. We looked at the propositions we wanted to launch and within a year we were there*” (R30). Another remarked “*The new platform systems had full open architecture. It was designed knowing it needed to plug into everything else. They had been quick to set standards with suppliers so every-one could link in. As a customer of the system we could also decide which bits we wanted and buy, and which we didn’t. Why didn’t we build it ourselves? Time was short, capital was short, and we knew absolutely nothing about platform technologies*” (R24).

However, while the platform architecture had a high degree of modularization, there was already a realisation that if every product provider plugged into the same architecture, the damaging economic effects of the era of stakeholder pensions may be worsened: “*A case of jumping from the frying pan into the fire*” (R13), as one participant stated. However, utilizing the platform operators provided “*further impetus to the shift to a variable cost operating model*” (R1) and yet “*It was 99 % standard. Everybody added every component possible, you could do it ten times faster and very limited cost. That’s why I think ‘plug and play’ is too pure and takes away differentiation*” (R5). Another remarked, “*The platform came in and was chipping away at your underlying margins as we all competed for volume until you can’t make any money at all*” (R16).

5.5. Period 5: 2012 – 2020

5.5.1. Power blocks

A re-bundling of modular components emerged on the basis of regulations set out in the Retail Distribution Review (RDR) in 2012. RDR was a set of regulatory instruments which included banning commissions between product providers and IFA firms. 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 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. Those IFA firms who wished to stay in the market had a primary aim: lobby product providers for differentiated products that consumers would be willing to pay for. As a consequence, 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. ... suddenly the IFAs were no longer reliant on being ‘fed’ commission by product providers and instead the balance of power had shifted. Product providers couldn’t compete on levels of commission, and instead had to cater to the demands of intermediaries*” (R14).

Following RDR, product reconfiguration ensued. The emergence of industry configurations – which respondents called ‘power blocks’ – represented an approach to reversing an arms’ length division of labor based on relational contracts between firms. Power blocks comprised of a product provider acting as a lead firm, bringing together various industry actors such as the platform operator, one or more IFA firms, a few fund management groups, and other participants, to create a unique product architecture exclusive to the 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, the property configuration and so on. We collaborated and agreed what the proposition would encompass, we also discussed bespoke customer servicing, data-sharing between us, and ultimately how costs and revenue would be shared*” (R2). 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, multi-lateral relational contracts, “*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*” (R4).

At the product level, while the architecture remained modular, components were made less modular through re-architecting the component design and component interface. Different components still interfaced with other modules on the platform in the same way, however, in a power block, different modules may come with additional features through the collaboration with other component providers in the block. For example, “*Within the power block, we created a range of funds with a different share class that had a lower price. In other cases, we created portfolio funds that invested, in part, into assets that were otherwise unavailable to retail investors, such as funds which were otherwise closed to new business, or private equity, all sorts of things. But they were unique components and exclusive to the power block*” (R2). Sometimes components were bundled together within a modular architecture to create additional value exclusively for power block actors, for example “*We linked the exclusive funds to other bespoke components in order to create components sets that were unique, such as linking portfolio modelling software to the exclusive fund ranges, or bespoking customer service and so on*” (R11).

In seeking differentiation, product providers utilized co-development and co-location to progress component development with power block suppliers who had coalesced around the architecture such as a “*co-location partnering model, where quality is important, particularly in an ambiguous and fast-changing environment*” (R23). The decision as to whether to co-develop and co-locate with external firms was primarily based on the ‘value’ potential of the development. For example, “*where the component was low-value and offered limited opportunities for differentiation it was just outsourced. We don’t particularly want it to be a differentiator. And so it doesn’t get a whole lot of focus, we let them get on with it and we trust them to meet our specification*” (R3). Another remarked “*you don’t need to co-locate for standardized stuff. If it’s a*

clearly-defined task, you can outsource with minimum oversight and at arms' length. An example would be simple regulatory change or minor tweaks to product features. But, when you're uncertain, and you see an opportunity to create a differentiated solution then the more you co-develop, the more you need to be in the same place" (R12). Another respondent affirmed this idea, "Where the development is a differentiating factor, we worked very closely with the supplier we've outsourced to, given that it's probably a) important to us and b) the component knowledge is a separate skill to the core product knowledge, and we need to know how it works. In the power blocks, we were so close to the other firms. We co-located, shared information and ideas, knowing that we all had the same interests, and were protected by contracts and the inability to share the bits we developed with anyone else" (R30). Another remarked, "There's actually a lot of intellectual property in co-development with key suppliers that we need to tap into. The relationship has to be closer and it's an almost permanent co-location of the development teams" (R7).

5.5.2. Vertical (re)integration

Power blocks had delivered some success in driving up margin, however, with pensions consolidation still dominating the sector, the risks of potential shake-out were non-trivial, and the power blocks were perceived as not fulfilling their promise. For instance, "the power blocks drove up margin, a bit, but the trouble was that we all wanted a share bigger than we should have, and this either meant someone was getting squeezed, or the consumer price went up and damaged sales volumes. Getting that balance right was near-impossible" (R14). With the need to recapture value also clear, product providers began re-assessing which components to (re)insource and which to continue to outsource, "We needed to bring back in house many of the high-value components that offered us differentiation" (R21).

Less industry specialization was eventually driven by vertical (re) integration though the technical architecture remained modular. In the product provider layer, product providers started to purchase IFA firms who were profitable, and so "RDR meant we had to buy advisor firms to avoid lock-out. So we now have our own advice capability in house, which we've now fully integrated and rebranded" (R27). Product providers also backward integrated into upstream component suppliers to buy-in specialist capabilities and develop potential focal areas of differentiation, "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" (R9). A number of respondents remarked that often whole component sets were re-insourced, "In the power blocks, we had developed more integrated component sets and so wanted to 'lift' the whole lot back in, and so, where we could we acquired suppliers that matched the component sets we wanted to build our advantage around" (R19).

The shift to (re)insourcing for high-value components further embedded the notion of perceived 'value' into how development was organized. For example, for low-value components outsourcing and low coordination remained the preferred development model, "having defined the basics, you can then disperse the development with minimal oversight" (R30). Another remarked, "where the innovation is pre-defined, say by regulation, or is an incremental change within an existing set of standards, we gave them a manual and a delivery deadline and said 'just do it'" (R29). However, for high-value components, these were reintegrated into the firm, "we re-insourced the components and the people and we had a distinctive, co-located platform team that worked on our product set" (R6).

6. Discussion

We looked for evidence of the effect of regulatory change upon the product design choices of firms in the sector, and the presence or absence of a corresponding division of labor. Through our case analysis, we deepen existing conceptions of the mirroring hypothesis by

highlighting how regulatory change influences these choices, and we emphasise the centrality of the role of 'value' in correspondence decisions.

Overall, our findings show how systemic shifts in regulation pushed the sector towards more modular product configurations and greater specialization between the early 1990 s and 2012. However, our findings highlight that further waves of regulation between 2012 and 2020 encouraged firms to pursue less specialization and higher levels of complementarity between selected components within a modular architecture in a subsequent phase - a trajectory that is unusual and which enables us to provide a fine-grained analysis of periods of correspondence and non-correspondence in different architectural trajectories towards and away from modularity and specialization (see also [Jacobides, et al., 2016](#)).

Much of the existing literature has considered non-correspondence from the perspective of the firm and its product architecture, often asking what kinds of product architecture feature non-correspondence? The complexity of a product architecture has featured strongly in the literature (e.g., [Cabigiosu, et al., 2013](#); [MacDuffie, 2013](#); [Sosa, et al. 2004](#); [Zirpoli and Camuffo, 2009](#)) as complex products often entail unpredictable levels of unforeseen interdependence ([Argyres and Bigelow, 2010](#); [Zirpoli and Becker, 2011](#)) and increased coordination costs, such as in the aircraft ([Argyres, 1999](#)) and motor vehicles ([MacDuffie, 2013](#)) sectors. At the component level of the product artefact, [Furlan, et al. \(2014\)](#) examined the air-conditioning industry and noted that non-correspondence occurred at the component level of the product artefact in the presence of high levels of component technological change thereby increasing transaction costs. Our case analysis, however, offers an alternative perspective and contends that institutional structures – such as regulation – create a dynamic and turbulent environment that affects correspondence decisions. Our study suggests that regulation has been central to the design choices of firms, shaping and reshaping architectures in successive waves. This enables us to make a number of important contributions.

6.1. Correspondence and the shift towards modularity and specialization (early-1990 s to 2012)

In the shift towards more modularity and specialization, our findings enable us to closely-link the process of regulatory change to increasing product modularity and specialization in the sector, reflecting broad support for the mirroring hypothesis.

The first wave of regulatory change that encouraged product modularization was contained in the Financial Services Act, 1986. These changes differentiated between an 'independent' financial adviser (IFA) – a firm able to offer independent advice relating to a wide range of financial products – and a 'tied' adviser - a firm only able to offer advice relating to one product provider. The regulations also detailed the compliance and operating standards between product providers and independent financial advisers. As product providers had calculated that the regulatory costs of maintaining a tied advice service were prohibitive, and that the demand-side impetus for independent financial advice was likely to accelerate due to an expansion of customer demand for investment choice linked to financialization, these regulatory forces pushed product providers to re-architect the product design and division of labor by shifting the tasks of distribution and consumer advice across firm boundaries to IFA firms in the early 1990 s. Drawing upon [Jacobides \(2005\)](#), the increase in the cost of production ushered in by the regulation was entwined with standardized ways to exchange information and govern market contracts facilitating gains from trade and specialization and so the intermediate market for independent financial advice grew quickly and product providers transferred these tasks to specialized firms in a search for productive efficiency.

In the subsequent period between the early-1990 s to mid-1990 s, supply-side and demand-side forces entwined once more to further encourage product providers to re-architect the product system in a

modular direction by moving investment management across firm boundaries to specialized investment firms. The financialization agenda of the 1980 s and early-1990 s had resulted in a large number of UK and global fund management groups entering the UK financial services sector who were attracted to the high-growth potential of the UK pensions sector given the deregulation agenda of the then Conservative government (Burton, 2018). In the decade preceding, policy changes had already deregulated and reconfigured investment markets and the Government had a policy agenda to increase pension saving rates, and so product providers needed to respond to the step-change in demand heterogeneity. As a consequence, product providers began a process of creating interface standards through trial and error to connect third-party investment funds offered by the fund management groups to the pension product, and by the mid-1990 s the heterogeneity in potential supply partners resulted in many product providers expanding their range of investment funds that were offered to consumers from about half-a-dozen to between 30 and 50. The arguments here follow a similar pattern, regulation and policy entwined to create a functioning intermediate market, however, in the absence of interface standards defined by regulation, market actors collaborated to define idiosyncratic standards to connect third party investment funds to pension products in order to facilitate gains from trade and take advantage of demand-side change.

Colfer and Baldwin (2016) noted that a less common form of mirror-breaking relates to a single firm creating a modular architecture within its own boundaries (see also Hoetker, 2006). Sanderson and Uzumeri (1995), for example, noted how Sony designed the Walkman as an internal modular platform that supported high variety. Our findings point towards modularization occurring over a considerable period of time, in our case a period of up to ten years elapsed for distribution, consumer advice and investment components to migrate across firm boundaries and so for an extended period during this process the product architecture exhibited closed and modular characteristics, an example of non-correspondence. This suggests that during a modularization process, static and cross-sectional studies of correspondence may reveal a misalignment of task and firm boundaries (a la classic mirroring), however, when seen temporally non-correspondences may be a temporary phenomenon that only plays out over long time periods.

The pace of change towards greater product modularity and specialization accelerated, however, between 1997 and 2005. First, branded a “tax raid on pensions”, the UK Government made pension investments less tax-efficient for consumers, and pension investments became tax-equivalent to collective investment schemes. The consequence of this change in fiscal policy was far-reaching. Prior to the change, product providers had created a relatively small range of tax-advantaged pension investments with third-party investment firms in the early to mid-1990 s that were available for consumers to select from when buying a personal pension (eg, about 30–50). Pension investments, at a stroke, were no longer tax-advantageous, and product providers were advantaged if they connected pension investments to the thousands of collective investment schemes, designed to a common operating standard (UCITS), offered by investment management firms in the intermediate market. This resulted in a significant re-architecting the division of labor in the sector as significant outsourcing to investment management firms re-architected the closed and modular product architecture to a more open and modular configuration.

Second, in 1999 regulations were introduced by the then Labour Government that permitted an Individual Savings Account (ISA) – a tax-efficient savings account that could be invested either in cash or collective investment schemes, without the constraints of limiting access to the capital in the way a pension does (Emmerson and Tanner, 2000). ISAs were also designed to connect to the thousands of collective investment funds in the intermediate market utilizing common UCITS standards, and which opened up the possibility for product providers to create modular product families (e.g., ISA, pension) linked to a common investment platform and other common components, such as portfolio

planning modules.

Third, in 2001 Stakeholder Pensions⁴ were introduced as a ‘benchmarked personal pension’ (Banks and Emmerson, 2000, p46) and which defined a number of minimum “stakeholder” product standards, a simple 1 % per year charge, low minimum premiums, and easy portability between product providers. These standards put significant downward pressure on the margins of pension product providers who, in turn, sought further efficiencies through intermediate markets.

Finally, by 2003, regulations known as ‘pensions simplification’ were announced (and implemented in 2006) to develop a single set of pension rules replacing a myriad of existing and highly-complex rules and standards. Given the earlier separability of the sector and growing interest in modular product families, pensions simplification marked the entry of platform operators into the sector and initiated a significant architectural ‘reset’ of the product architecture, with subsequent changes to the division of labor. Product providers licensed technical modular platforms to offer modular product families including a pension and an ISA, connected to common components and which quickly developed into an open and modular dominant design.

This study’s contribution to the debate on the mirroring hypothesis lies in the fact that regulation that aims to promote competition in a sector may also de facto encourage increasing product modularization and specialization, affirming that regulation shapes the agency of firms, their incentives, technological choices, and the contours of the prevailing industry architecture (Jacobides, et al., 2014; Jacobides, et al., 2006). In our case analysis, regulation and policy acted on the supply and demand side almost simultaneously. On the supply side, regulation acted to provide both standards for product design (stakeholder pensions and pensions simplification) and distribution, within which product providers were forced to innovate and influencing the relative efficacy of make or buy decisions. Furthermore, regulations which targeted specific pension products further encouraged unbundling as product providers sought to create value through intermediate markets in a rapidly changing context.

On the demand side, various policy changes associated with financialization and fiscal policy encouraged demand heterogeneity and which encouraged the creation of intermediate markets through which gains from trade and specialization became realizable in the 1990 s. By 2003, while pensions simplification sought to minimize complexity (House of Commons Library, 2008, p3), the simplification event was recast as a demand-side opportunity by embattled product providers as they recognized that pensions simplification was also an opportunity for pensions consolidation, and a way to capture value from ‘churning’ pensions from competitor firms. Product providers quickly responded to the consolidation opportunity as consumers, encouraged by sector actors, looked to consolidate all of their legacy pensions into a single modular product with more features, flexibility, portability, and often at a lower price. The industry architecture also shifted to a highly specialized structure, and hundreds of supplier firms coalesced around the emerging modular technical architecture, including stockbroking firms, discretionary fund managers, systems providers and other specialized firms. This mirroring between the modular product architecture and the highly specialized industry value chain accelerated over period 4 to reach a level of mirroring as suggested in Fig. 2.

6.2. 2012 and 2020: Non-correspondence and the shift away from specialization

While the regulations relating to pensions simplification in 2006 created an opportunity for product providers to create value through modular product families and common components, the shift towards

⁴ A stakeholder pension is a “defined contribution personal pension. They have low and flexible minimum contributions [and] capped charges” (Money Advice Service).

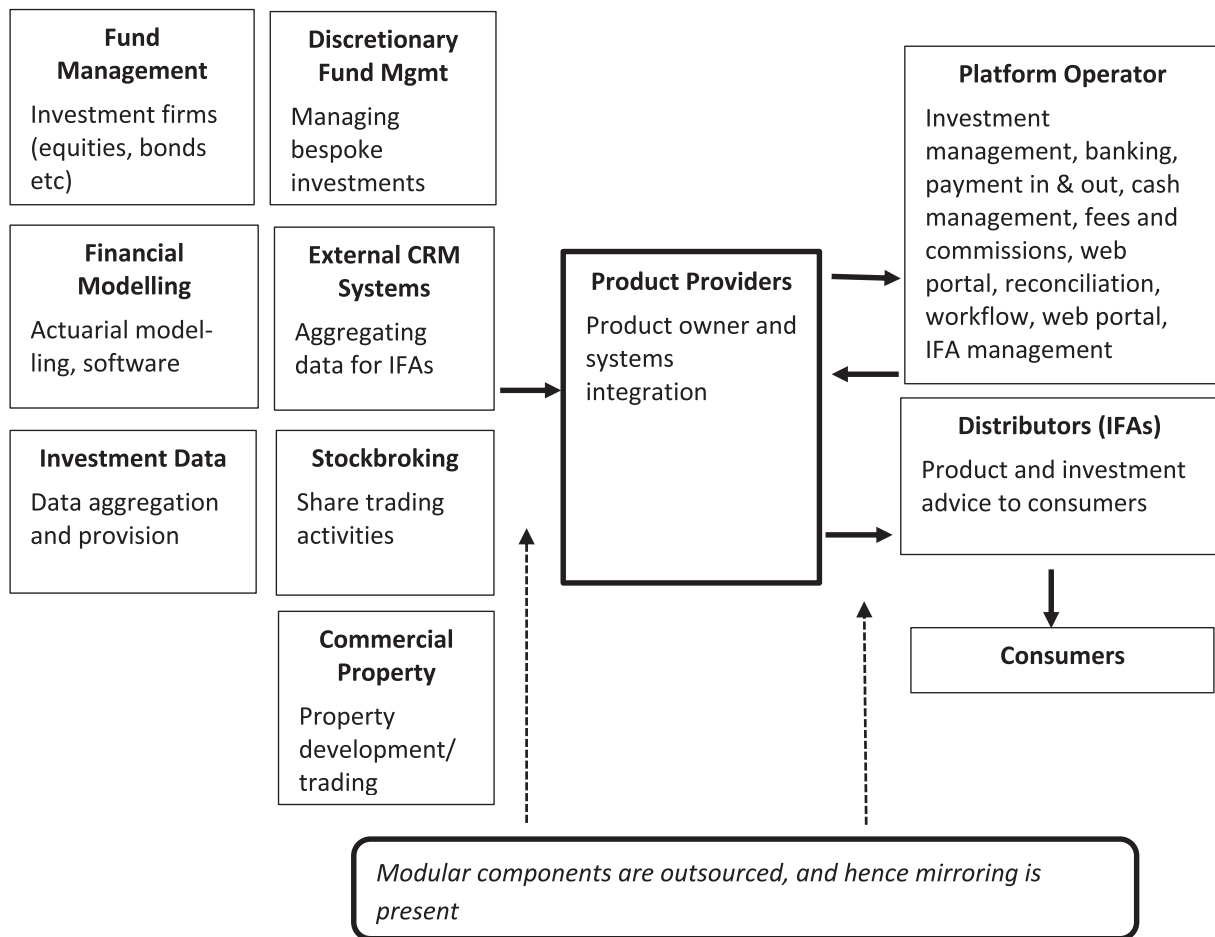


Fig. 2. Modular industry architecture circa 2012.

greater product modularity and specialization ultimately failed to deliver the anticipated value. The reconfiguration of firm boundaries to a narrower scope in the mid-2000s had left many product providers with “dangerously homogenous strategies” (Jacobides, et al., 2014, p19), few capabilities in either the technical architecture or component layer of the product system and a limited span of control making it increasingly difficult for product providers to capture value. 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 (Brunsoni, et al., 2007), competency traps (Zirpoli and Becker, 2011), and commoditisation (Pil and Cohen, 2006). Our case analysis, however, enables us to shift the analysis to the sector level by asserting that different industry architectures embody different appropriation characteristics (Pisano and Teece, 2007). In our case, pensions simplification and the standardization it entailed had been widely adopted by the entire sector. The platform technology also enabled product providers to mix and match component technologies, however, the product providers faced a ‘mirroring trap’ (Colfer and Baldwin, 2016) owing to inimitability, and fierce, winner-takes-all, competitive dynamics, as well as a loss of architectural and component IP to other actors in the sector (Burton and Galvin, 2022).

Langlois (2003, p24) asserted that “in a world of change, modularity is generally worth the cost” because the cost of high-levels of inter-firm communication and information-exchange would be prohibitive. Similarly, modular product structures can yield competitive performance effects through radical innovations, short development cycles and speed to market (Powell, 1992; Galvin et al., 2021). Our findings provide a counterpoint to these assertions. and we extend the work by Colfer and

Baldwin (2016) by showing how product providers responded to the mirroring trap by ‘misting’ and selectively utilizing a process of increasing the complementarity between high-value components within the modular product architecture, and utilizing relational contracts with suppliers with corresponding high-levels of information-exchange and co-location.

In our case analysis, product providers pursued a strategy of strict correspondence for low-value modular components (such as those components subject to small-scale regulatory change) with corresponding low-levels of buyer-supplier information exchange. Low-value modular components encompassed those components that had aspects of component design and interface standards defined by regulation, or those components that were generic (see Argyres and Zenger, 2012; Burton and Galvin 2020). Examples of these components include pre- and post-sale quotation modules and market and investment data feeds. In other words, where the component was low-value and generic, the component was governed through standardized arms’ length contracts. However, where the modular component was perceived as high-value and an opportunity for differentiation and value creation, product providers utilized relational contracts to co-design the component, with corresponding high-levels of buyer-supplier information exchange and co-location, despite the systemic modularity of the product system. While each component remained modular and interfaced in standardized ways with the technical platform, some components were co-designed to create unique complementarity and functionality (Argyres and Zenger, 2012).

Moving beyond Colfer and Baldwin’s general observation of relational contracting as a feature of classic ‘misting’, our data explicates the idea of ‘power blocks’ to deepen existing understandings of how

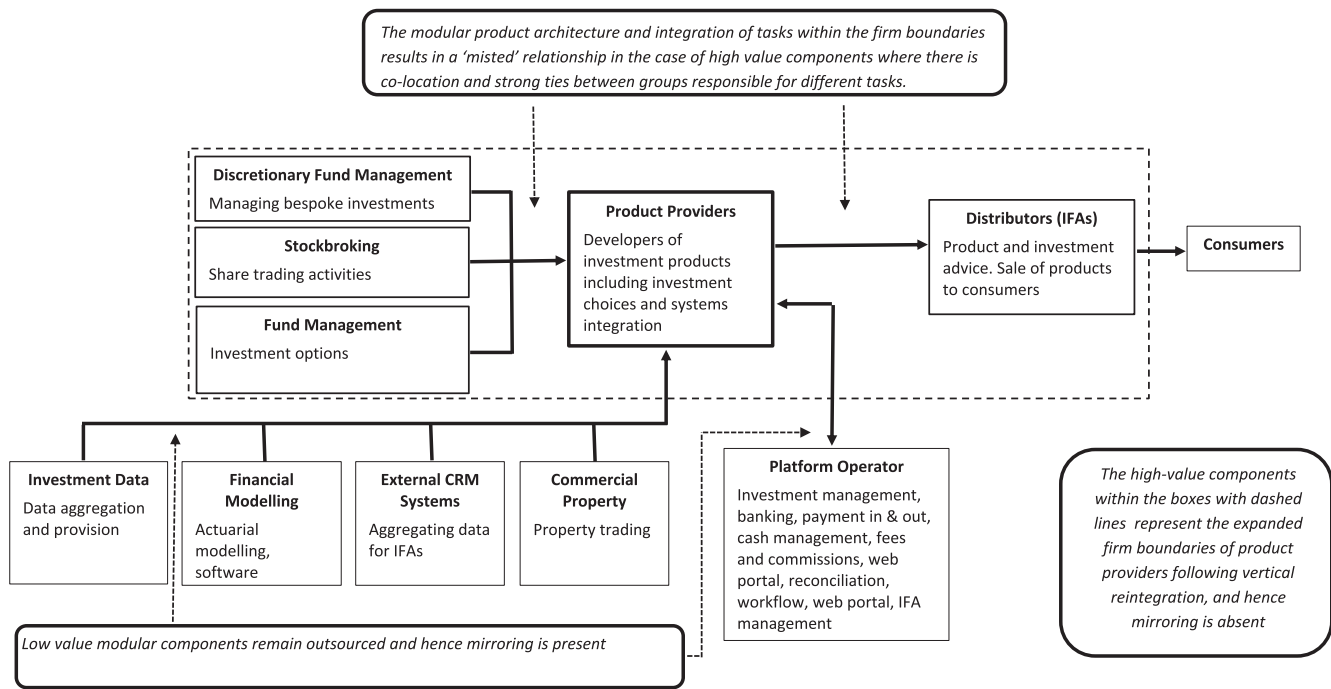


Fig. 3. Industry architecture circa 2020.

relational contracts may help firms overcome the mirroring trap and pursue 'value'. The existing literature has elaborated the benefits of inter-firm coordination for co-exploration (Parmigiani and Rivera-Santos, 2011), particularly in the design of complex or novel components (Cabigiosu and Camuffo, 2012; Furlan et al., 2014) and the formation of alliances and consortia to participate in the design of new product or component systems (Argyres, 1999; Staudenmayer, et al., 2005). Jacobs, Vickery, and Droge (2007), for instance, remarked that modular product structures simplify communication among alliance firms by reducing ambiguity and opportunism risks.

In our case analysis, the Retail Distribution Review (2012) encouraged product providers to coalesce a group of firms – described by participants as a 'power block' - who each held strong competitive positions to develop highly-differentiated modular component configurations that were perceived as opportunities for value creation. Each component governed through the power block configuration was differentiated on some performance criteria and made less portable through re-architecting the component design and interface standard. For example, our findings enable us to show how power blocks developed a range of pension investments, exclusive to the power block, with asset allocation and stock selection that were unavailable outside the power block configuration. Often these exclusive pensions investments were priced differently or had access to asset allocations or stock selection otherwise unavailable in retail markets.

The power blocks typically consisted of a lead firm – the product provider - and corresponding platform operator, an IFA firm(s), investment management firms, and a range of component firms. Within each configuration, the product provider would act as the lead firm to coordinate the design and re-bundling of complementary components in order to develop configurations with higher levels of differentiation and value for its members. Further, the relational contracts that governed the power block served to establish parameters for how value was divided among participant firms (Santos and Eisenhardt, 2005), but also for how development costs and IP would be shared (e.g., Frow, et al., 2015). The relational contracts in the power block often entailed co-location and acted as a quasi-vertical structure to manage the limits of specialization.

However, within a few years the use of power blocks began to

unwind. While the existing literature has commented upon the durability of inter-firm relational contracts based upon compatible motivations related to performance outcomes or strategic differentiation (e.g., Mikkola, 2003), our findings suggest that many of these relational contracts were not long-lasting, and affirm that such types of relational contracting failed due to opportunism risks and potential motivation incongruence among allying firms (Bouncken, et al., 2015). As Bouncken, et al., (2015) noted, modular product architectures can cause coordination problems among alliance firms when the complexity of a wide number of components requires customization to fit with different product architectures of these firms.

As Colfer and Baldwin (2016) enquired, instead of relational contracting, 'why not unite the actors within the boundaries of a single firm? While Garud and Munir (2008) document how Polaroid elected to design and produce components in-house in the face of unresponsive suppliers, our case analysis suggests that while power blocks had delivered some success in driving up value, product providers began re-assessing which components to (re)insource in order to widen their span and control and seek further value. Product providers switched from relational contracting to pursue vertical (re)integration of both upstream and downstream component firms. As component firms were often less capitalized, our participants highlighted numerous examples of acquisition by product providers in these layers of the sector. Our case analysis suggests that the power block configurations eventually gave way by 2015/6 to the desire to re-expand firm boundaries and vertical scope, and the components and assets of acquired firms were reintegrated into complementary component sets to leverage value (Burton and Galvin, 2020). Thus, by the end of our study in 2020 the notion of value at the component level of the product system remained central to the strategizing of product provider firms as they continued to outsource low value modular components with corresponding low-levels of information exchange, whereas for high value modular components these were re-enveloped within firm boundaries. An overview of the sector by 2020 is shown in Fig. 3.

We draw upon and extend theorizing by Argyres and Zenger (2012) to illuminate the central role of 'value' in correspondence dynamics. On the one hand, where the modular component was perceived as low value or generic, and component commoditization yielded efficiencies, strict

correspondence was pursued. In synthesizing both transaction cost economics and capabilities perspectives, *Argyres and Zenger (2012: 1653)* remarked that “if assets are complementary to a firm’s bundle of resources, but are widely held and thus not uniquely complementary, then accessing the asset from external sources is likely”.

On the other hand, where the modular component was perceived as high value, firms attempt to create value through the development of heterogeneous and superior capabilities (*Jacobides and Hitt 2005*) arising from unique, complementary and optimal configurations of assets, resources, and activities (*Argyres and Zenger, 2012*) in order to generate above-average rents (*Barney, 1986*). While the power block configurations were able to generate additional rents for its members, the product provider faced challenges relating to incompatible motivations with other members during the design process and thus the full value of the complementarity of the component sets went unrealized. Further, turning to transaction cost economics, once firms had identified that their assets were uniquely complementary to other assets in the power block, ex-post contracting problems and hold-up occurred, and supplier firms were in a position to extract additional value. In other words, the power blocks were ultimately unable to eliminate rent-seeking by firms and thus product providers enveloped assets and activities within firm boundaries, despite the continued modularity of the product system.

7. Concluding remarks

This study has examined the mirroring hypothesis in the context of the UK pensions sector highlighting the extent to which correspondence is sustained longitudinally. The sector appears to have evolved through periods of correspondence and non-correspondence as it follows different trajectories towards and away from modularity and specialization. It is clearly evident that further retrospective or longitudinal analysis would be beneficial in order to illuminate the evolution of architectures and theorizing on the possible implications of cycles of integration and disintegration (*Siggelkow and Levinthal, 2003, 2005*). Our study highlights the dangers of relying upon static, cross-sectional studies that may run the risk of ignoring temporal delays. Regulatory changes required new architectural choices by firms, but the changes tended to take many months and often years as the industry value chain re-architected to effectively address the new competitive landscape.

For managers and practitioners, our paper highlights that managers should consider when mirroring and misting may be a suitable strategy at the component level of the product system. Our paper provides evidence that partial mirroring, in line with prior studies (e.g., *Pil and Cohen, 2006*), may confer value advantages, especially if managers can partition the product architecture based upon its value characteristics. While our paper features the UK pensions sector, we believe our contributions have wider implications in other industries that feature high-levels of regulation. Existing research has highlighted that regulation shapes institutional structures, including who owns who, and who does what (see also *Jacobides, 2015; Jacobides, et al., 2006; Jacobides, et al., 2014*), and our study indicates that the effect of regulation extends to the way it shapes technological choices, the kinds of product designs that come to exist, the contours of the industry architecture, and the way surplus is divided between firms. In this context, whether firms pursue mirroring or misting is seemingly a central concern. Thus, examining the effect of regulation on industries and the design choices of firms in other sectors would greatly enhance the literature pertaining to the mirroring hypothesis.

Our paper suffers from a number of limitations which may form the basis for future research. While the research benefits from a longitudinal (retrospective) design, different past recollections are invariably tempered by time and their personal involvement in different activities within firms. However, the data was able to show that there were key trends at different time periods. In terms of future research, further opportunities to progress research in this area are likely to be required as

part of any general theory of modularity including examining the precise value characteristics of components in order to better understand how firms organize and manage different product development tasks. Second, examining the performance implications of correspondence and non-correspondence is still a missing part of our understanding. There were variations within the UK pension sector in terms of the extent to which different firms sought to mirror (or mist) their design choices. Some firms altered their design choices far more quickly following technological and regulatory change, and the performance implications of such choices are not clear. Third, the research hints at the relevance of the emergent perspective on the reverse mirroring hypothesis (ie, *Brunsoni and Prencipe, 2011; Sanchez et al., 2013*) which suggests that products may not design organizations, and a reverse direction of causation may be possible. Our study also points in this direction.

CRedit authorship contribution statement

Nicholas Burton: Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Peter Galvin:** Writing – review & editing, Writing – original draft, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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