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Robots at the Gates?

Robotic Process Automation, Skills and Institutions in Knowledge-Intensive Business Services

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Abstract

Against the backdrop of the fourth industrial revolution, this paper examines the emergence of Robotic Process Automation (RPA) as one of the new technologies that are shaping the future of work and reconfiguring sectoral business and innovation systems and models. It discusses how the institutional context can potentially mediate the digital transformation of services, how RPA affects workers' employment and skills, and how it alters inter-organisational relationships and capabilities. Bringing together different strands of academic literature on employment studies, innovation, and technology studies, it deploys a comparative institutional perspective to explore the potential effects of RPA and illustrates their plausibility through mini case studies from knowledge-intensive business services.

JEL Codes: J5, O3, J2

Keywords: Labour-management relations; innovation; skills; technological change.

Key Points

1. This paper examines the emergence of Robotic Process Automation (RPA) as one of the new technologies that are shaping the future of work and reconfiguring sectoral business and innovation systems and business models.

2. It discusses how RPA affects workers' employment and skills, how it alters inter-organisational relationships and capabilities; and how the institutional context can potentially mediate the technology-induced organisational change and the digital transformation of back-office operations.

3. Bringing together different strands of academic literature on employment studies, innovation, and technology studies, it discusses the expected effects of automation on skills, jobs, and organisational forms.

4. The paper illustrates the plausibility of the arguments through mini case studies from knowledge-intensive business services.

Contents

Abbreviations

AI – Artificial Intelligence
BPO – Business Process Outsourcing
CME – Coordinated Market Economy
CoE – Centre of Excellence
CRM – Customer Relationship Management
EPL – Employment Protection Legislation
ER – Employment Relations
ERP – Enterprise Resource Planning
HTML – Hyper Text Markup Language
IRPA – Institute for Robotic Process Automation
IT – Information Technology
KIBS – Knowledge-Intensive Business Services
KYC – Know Your Client
LME – Liberal Market Economy
ML – Machine Learning
NLP – Natural Language Processing
OCR – Optical Character Recognition
RPA – Robotic Process Automation
SSI – Sectoral Systems of Innovation
TUC – Trades Union Congress

1. Introduction

One of the preconditions for productivity in advanced industrialised countries is not only to diffuse innovations from the IT sector to non-IT sectors, but also to equip workers with the skills to harness the full potential of new technologies (van Ark 2014). New technologies include diverse innovations such as artificial intelligence, cloud computing, mobile apps, crowd-working platforms, and Blockchain ledger technologies, among others. The coalescence of these technologies of the so-called 'second machine age' (Brynjolfsson and McAfee 2016) in various sectoral contexts are promising productivity gains via automation and digitalisation. But they are also reshaping work organisation, skills, and organisational boundaries, whilst disrupting ecosystems, business models and value chains.

Automation was until recently understood as one of the main instruments for improving productivity in the manufacturing sector, epitomised by the gradual introduction of robotic technologies. By contrast, labour-intensive and knowledge-intensive services, entrenched in the so called Baumol cost disease, were perceived as less susceptible to automation. Yet, the ongoing fourth industrial revolution does not only affect manufacturing settings, in what is commonly termed as "Industry 4.0" (see Krzywdzinski 2021; Martinelli *et al.* 2021). In addition, it drastically affects knowledge-intensive business services (KIBS) such as IT, telecommunications, financial and professional services.

Our paper focuses on one of these new technologies: Robotic Process Automation (RPA). RPA is not a futuristic scenario. Instead it has grown significantly in recent years pioneered in industries such as IT and telecommunications (Lacity *et al.* 2015; Lacity and Willcocks 2016); professional services (Cooper *et al.* 2019), retail (Stopford and O'Reilly 2022); but also healthcare and financial services. Just like the digital transformation of the previous decades, RPA is broadly expected to reconfigure the relationships between clients and IT suppliers (Miozzo and Grimshaw 2011); the position between new entrants and incumbent firms; and the balance between outsourcing and in-house capabilities.

This widespread diffusion of automation speaks to broader academic debates on the 'future of work' (Holtgrewe 2014; O'Reilly *et al.* 2018; Rani and Grimshaw 2019; Simms 2019; Wajcman 2017; Willcocks 2020). However, much of the recent scholarship on the future of work in a digital age has been fixed disproportionately on the rise of platforms and platform work (Gandini 2019; Healy *et al.* 2017; Howcroft and Bergvall-Kåreborn 2019; Kenney and Zysman 2016; Rahman and Thelen 2019; Wood *et al.* 2019). By contrast, in-depth qualitative studies of the impacts of innovations on employment outside of the digital (online) economy are lacking (Grimshaw and Miozzo 2021).

This warrants an investigation of the effects of automation technologies, such as RPA, and their impact at the individual, organisational and sectoral level. Overall, the key questions that guide this exploration are the following: What are the characteristics of RPA and what can be automated? What is the underlying business model and who are the key players in the RPA ecosystem? What is the expected impact of RPA on employees' skills and their jobs? How do we expect that organisational boundaries, interorganisational forms and firm capabilities will be reconfigured? How can networks of actors and local institutions potentially influence the adjustment process?

To answer these questions, we will focus on the sectoral contexts of Knowledge-Intensive Business Services (KIBS), including financial services, IT and telecommunications, and professional services, because recent evidence suggests that they are at the forefront of digitalisation (McKinsey 2016: 11). Furthermore, we will mostly focus on the national contexts of Germany and the United Kingdom because multinationals from these home country contexts are front-runners in digital transformation (Ahlers *et al.* 2018). Large incumbent firms in these countries are likely to be 'early adopters' as they have both the resources and capabilities to implement cutting-edge innovations such as RPA. The two countries also exhibit sufficient institutional variation (Witt *et al.* 2018) to gauge potential institutional effects. For instance, the finance sectors in the UK and Germany are still relatively unionized, but with different underpinning structures and power resources (Eurofound 2019); there is therefore scope to derive lessons about the power resources of employers and trade unions, and the role of the institutional context.

The rest of the paper is structured as follows. The second section briefly reviews the national and sectoral institutional contexts of innovation, employment and skill-formation that may potentially affect the implementation and roll-out of innovative technologies of the fourth industrial revolution. The third section delves deeper into the nature of Robotic Process Automation, how it differs from other AI technologies and what is the underlying business model and the key players (incumbents and newcomers) in the RPA market. The fourth section discusses the potential impact of RPA at the individual and organisational level with a focus on skills, jobs, and outsourcing/organisational boundaries. The paper illustrates some of the expected effects using mini (vignette) case studies from KIBS firms, which enhance the plausibility of the arguments. The final section concludes, by proposing an analytical frame, sketching the possible institutional effects, and raising some questions for future research.

2. The Context: Sectoral Systems of Innovation, Employment and Skills

The consensus on the academic debate so far is that AI and intelligent automation will have wide-ranging effects on organisations and their practices (see Benbya *et al.* 2021; Coombs *et al.* 2020; Kellogg *et al.* 2020). New technologies offer immense possibilities for the reshaping of production and employment systems and threaten to bring the 'end of work' (Herrigel 2020: 612–3). Recent influential studies revived a new technological determinism by adopting a dystopian view about the future of work (Frey and Osborne 2017). From a different perspective, the bleak future was also reinforced by sociological works on the platform economy, which emphasised the exploitation, exhaustion, and algorithmic control of platform-workers (Gandini 2019; Wood *et al.* 2019).

Our approach differs from the perspectives that are driven implicitly or explicitly by some degree of technological determinism that attributes agency to technology and ignores or downplays the social shaping of technology (MacKenzie and Wajcman 1999). Technological determinism holds an essentialist view of technology arguing that its design, broken down into affordances or material properties, renders its impact inevitable and universal. In deterministic accounts, the technology defines - and to a large extent prescribes work practices, employment relationships, markets, and professional boundaries (Barrett *et al.* 2012).

By contrast, our approach is grounded in earlier works in the fields of industrial sociology and comparative employment relations, which criticised accounts of technological determinism as neglecting human agency or the broader socio-economic, political and institutional context in which technology and its effects take place (Gospel 1991; Hyman and Streeck 1987; MacKenzie and Wajcman 1999; Sorge 1991). These works suggest that the effects of technological innovations on work and employment are ambiguous.

Many sectors have seen a strategic shift towards pushing their product architecture towards modularity, with implications for industry dynamics and supply chain management (Baldwin and Clark 2000). While IT innovations may also be characterised by modularity this is likely to play out differently in terms of industry dynamics and the 'unbundling of corporate functions' (Gospel and Sako 2010) observed in previous decades. Given the 'inseparability of production and information technology' (Miozzo and Grimshaw 2005: 1426), any introduction of IT innovation is likely to have feedback loop effects; and, we are more likely to see a reconfiguration of roles and relationships within and across organisations.

In a similar vein, automation will not only degrade and eliminate jobs; it will likely amend the nature and design of existing jobs. Knowledge workers will not necessarily lose their jobs (Rani and Grimshaw 2019) and technology might in fact assist in the improvement of job quality. Technology may also have unintended consequences. For instance, Barley (2006; 2020) emphasised the enhanced opportunities that technology confers for 'esoteric knowledge' triggering workers to develop new intelligences, skills and competencies.

This section explores the ambiguous effect of technology on work and employment through the lens of comparative institutionalist literature. The central argument is that national, sectoral and workplace institutions affect the extent and mode of adoption of technology, including automation, and of global best practices, thus filtering their convergence pressures on organisational structures, job design, work practices and workers' outcomes more broadly (Crouch and Streeck 1997; Dobbin 2005; Doellgast *et al.* 2009a; Edwards and Kuruvilla 2005; Guillén 2001).

More particularly, comparative institutionalist scholars argue that 'strong' institutions can serve as 'beneficial constraints', because they encourage management to invest in technology and broader workplace innovations, which improve productivity whilst benefitting workers as well (Sorge and Streeck 1988). The most relevant institutions in this regard include national/sectoral systems of innovation, employment, and skill formation, which we review briefly in the remainder of the section.

2.1 Innovation Systems

The early literature on innovation systems used the nation state as the main unit of analysis as many of the institutions that facilitate learning and capability-building operate at the national level (Miozzo and Walsh 2006). The concept of a national innovation system therefore includes the interaction of diverse regulatory and institutional aspects such as: the tradition of scientific education; patterns of basic research funding; university-industry collaborations; labour mobility; venture capital system and national technology policy. For instance, in the German innovation system the creation and diffusion of innovative technologies are likely to be supported by nation-wide actors and organisations such as the Max Planck Society and the Fraunhofer Society (Allen 2010). In the UK innovation system markets are more prominent via university-industry collaborations, and commercialisation of research via spin-offs and science parks (Walker, 1993). The latter complement market-based innovation and diffusion by imitation of first movers and disruptors, while agencies such as Innovate UK and NESTA seem to have a less important role than their counterparts in Germany.

Later conceptualisations of innovation systems increasingly shifted the focus from national to 'sectoral systems of innovation' (Li *et al.* 2021; Malerba 2005). Each sectoral innovation ecosystem is characterised by constellations of firms, e.g. incumbents, new entrants, producers, users, suppliers; and non-firm actors e.g. governments, regulators, industry alliances, standard setting organisations (Li *et al.* 2021). The key takeaway is that the diffusion of innovation is stimulated, on the one hand, through the interactions of these actors, and on the other hand, the knowledge and technology, and demand and market conditions. The actors' behaviours are likely to be guided by organisational routines, which are often adjusted through 'learning-by-doing' and in a 'trial-and-error' fashion and generally responding to uncertainty and new technologies through 'experimentation' (Cantwell *et al.* 2010: 571–3; Grimshaw and Miozzo 2021: 25–6).

More generally, the SSI approach emphasises the sectoral specificities of innovation and how innovation takes place in quite different sectoral environments. Similarly, the business ecosystems literature emphasised the industry level as a significant unit of analysis (Ansari *et al.* 2016: 1830–2). However, an ecosystem might focus on value-creating activity (e.g. an innovation) and cover a variety of industries (Sako 2018). Indeed, recent developments in automation might transcend sectoral contexts, blurring the boundaries between sectors, and provoke the development of new ecosystems and organisational forms. Finally, in the fourth industrial revolution, new ecosystems are likely to rely on 'platform-based' relationships, in which 'platform leaders' set the tone and direction of travel (Gawer and Cusumano 2014).

2.2 Employment Relations Systems

In a very similar pattern to the early innovation systems literature, employment systems also tend to be studied and articulated at the nation state level (Bamber *et al.* 2021; Bosch *et al.* 2009). Admittedly, national employment relations (ER) institutions have been eroded in recent years across advanced industrialised countries (Baccaro and Howell 2011). These include diverse trends such as deregulation and relaxation of employment protection legislation, union power decline, and collective bargaining decentralisation.

Differences in ER institutions among liberal market economies (LMEs) and coordinated market economies (CMEs) are associated with divergent capacities for social actors to coordinate and negotiate responses to the employment effects of RPA. In LMEs, where trade unions have been most weakened, as in the United Kingdom (Gospel and Edwards 2012), unions' capacity to influence organisational changes stemming from automation is weak. This does not mean that there are no trade union activities at all; for instance, the national-level TUC is pushing for a taskforce to influence the impact of automation (O'Grady 2021).

By contrast, in CME countries where trade unions have been most resilient, like Germany for example (Hassel 2014; Jackson and Sorge 2012), trade unions and employer associations are expected to have greater resources to influence the process of adopting automation, ensuring job security, redeployment, and retraining initiatives. Employment protection legislation, as well as active labour market policies, may help to limit dismissals and promote reskilling and redeployment; the adjustment might be negotiated with local unions or works councils – even though employers might still engage in 'institutional toying' and circumvent any institutional constraints (Benassi and Kornelakis 2021).

In recent years 'methodological nationalism' has been criticised for failing to capture important within-country variation, and comparative employment relations scholars proposed the sector level as the most fruitful level of analysis (Bechter *et al.* 2012). Indeed, there are many ways in which employment relations institutions at the sectoral level may shape the direction of organisational change, despite weak power resources at the national level. They may slow down the pace of technological change in the workplace and the adoption of innovations or influence the process and effects of their adoption (Kornelakis 2014; Kornelakis 2016). Trade unions in the UK, such as Unite, developed toolkits to manage the effects from the shift to online banking (Kornelakis *et al.* 2021), while others, such as Unison, developed guides on how to bargain automation at the workplace (UNISON 2018).

Similarly, there is some scattered evidence that suggests that German unions use more actively collective bargaining structures to manage the uncertainty stemming from automation. For example, in Deutsche Telekom Service the workers' union was involved from the beginning of the introduction of RPA to eliminate 'the fear of RPA as a job killer' (Einacker and Anzer 2020: 7). Another example is a recent collective agreement that the Ver.di union signed with the company Eurogate, in which a substantial part for 'future-proofing' the port workforce in anticipation of automation are sizeable investments in training.

2.3 Skill Formation Systems

Broadly speaking, the institutional structures responsible for initial and continuous skill formation operate at the national level and comprise of the country's education and training system. The German skill formation system is known for its 'dual system', which combines on-the-job and off-the-job training; and for its collective orientation, which is characterised by a multi-stakeholder governance structure including the Federal Institute for Vocational Education and Training (BIBB), schools, local governments as well as peak employers' associations and trade unions. The dual system of vocational education and training (VET) in Germany has seen the recent introduction of shorter apprenticeship programmes that develop narrower skills to respond to employers' immediate needs as well as a general decrease in engagement with the system. While large employers still offer a high number of apprenticeships, SMEs are withdrawing from the system. Even more importantly, the number of entrants in the VET system every year has declined vis-à-vis higher education (Durazzi and Benassi 2020). Despite those challenges, the dual VET system still contributes to develop broad, medium-high-skills, that are crucial to the German economy.

The UK Apprenticeship system provides in stark contrast to this picture. Despite recent reforms introducing the apprenticeship levy and trying to improve the quality of the training, the UK System remains rather dysfunctional. The number of apprenticeships is lower than in Germany and concentrated in large employers even though a larger share of UK, compared to Germany, are SMEs. Furthermore, the quality of the curricula and the level of competence achieved by the apprentices are very mixed due to the great variation across private training providers, which dominate the British quasi-market for training (Grimshaw and Miozzo, 2021: 8–9; Benassi et al 2021; Fuller and Urwin 2021).

There is no doubt that lifelong learning is crucial when it comes to technology-induced employment restructuring. Trade unions and business associations can negotiate a process of reskilling as part of collective bargaining arrangements; and we have seen similar retraining initiatives in sectors facing intense technological change such as the telecommunications industry (Doellgast *et al.* 2009b). Hence, retraining is more likely to appear in settings with strong labour market actors, who use their associational power to produce public goods sometimes with the active support of the state, as in the case of Luxembourg (Kornelakis *et al.* 2021).

Yet, skill acquisition is not only restricted to national or sectoral structures of vocational training. It may also take place via externalisation to training providers (Benassi *et al.* 2020), or by recruiting ready-made skills, as evidenced by large-scale outsourcing contracts that are accompanied by programmes of staff transfer (for the IT sector, see Miozzo and Grimshaw 2011). The content and duration of skill formation is also quite important. It may range from short courses to develop *narrow skills*; or longer on-the-job training to develop *broad skills* and 'redundant capacities'.

Finally, it should be noted that the national/sectoral VET systems complement the supply of skills from Higher Education (HE) institutions. Indeed, in the UK and Germany there is a high share of university graduates entering KIBS firms, and because of the relative reliance on higher education, the locus of skill formation may be in the context of universities' curricula rather than in apprenticeship programmes. However, this remains a question, given the broader dissatisfaction of graduate employers with the (digital) skills of graduates, which -at least in the UK- can be attributed to the vast marketisation of the sector (Kornelakis and Petrakaki 2020).

Keeping these remarks in mind the next section examines in greater detail the nature of robotic automation of processes.

3. Technological Change: The Case of Robotic Process Automation

3.1 What is Robotic Process Automation?

Robotic Process Automation (RPA) refers to configuring software bots to do the work previously done by people (CIPD 2017). For example, this might be transferring data from multiple input sources, like email and spread sheets, to systems of record like Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) systems. Before deciding which tasks can be automated, the process owners usually go through the 'proof-of-concept' stage (Lacity and Willcocks 2016: 6–7) to make sure the roll-out will be worthwhile.

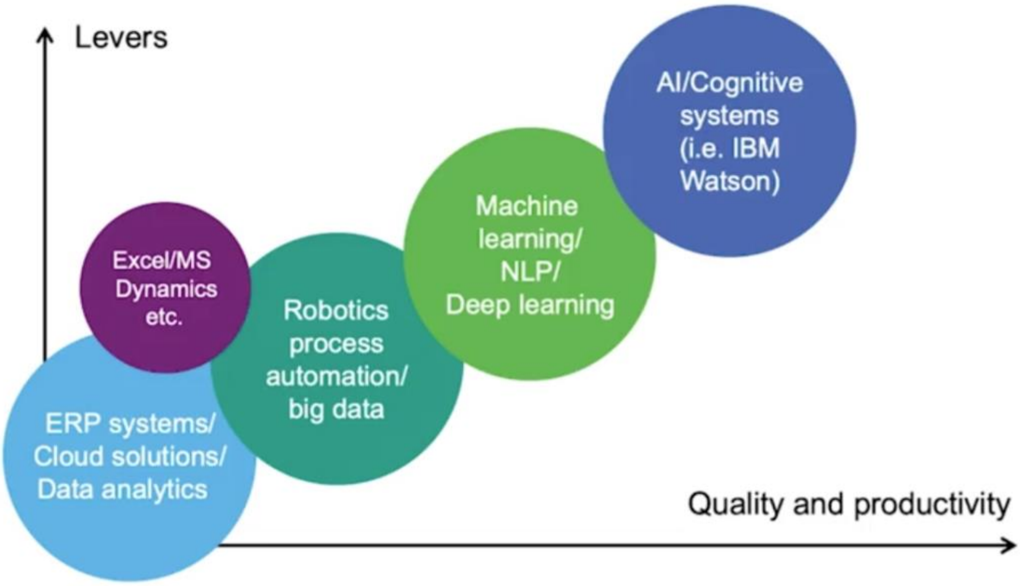
In general, the precondition for tasks to be automated is that they should be definable, repeatable, and rules-based (Wasser *et al.* 2015). In other words, processes should be well-documented and standardised; relying on structured data; with well-defined rules; and are worth automating because they represent labour-intensive and time-consuming activities. The introduction of RPA can be centralised, for example with a web-based application by IT Service, or decentralized, in which the end-user can create the software robots (Automation Anywhere 2019). The IT vendors provide the bot creator and the bot runner software in a client-server environment. The bots are built through a bot creator platform.

A bot can be created using various methods such smart recorder; screen recorder; and web recorder (Automation Anywhere 2019). The smart recorder captures objects from applications that use, for example, HTML, Java or Silverlight technologies; and can be used to record an action or series of actions in a computer and build appropriate tasks. The second method is the screen-recorder. This automates processes that involve mouse clicks and keyboard operations. The third method for building a bot is the web-recording method. This can be used for repetitive actions such as extracting data from multiple web pages; extracting data from tables on web pages; or filling web forms. Finally, there is specialist automation software (e.g. Automation Anywhere's Workbench) that does not require any programming effort; it uses several commands and wizards to create automated processes (e.g. IF, THEN, ELSE; email automation; Excel; clipboard; image recognition; error handling).

3.2 What can be Automated? Types of Automation and Domains of Application

From the discussion so far, it is clear that Robotic Process Automation is different from earlier IT-systems integration like ERP systems (e.g. SAP) and CRM systems. These are generally called the ‘legacy’ systems. RPA also moves beyond simple data analytics (Figure 1), as it seeks to harness the availability of structured data and automate or even eliminate processes.

Figure 1: The Evolution of Automation.



Source: AICPA (2019) © Association of International Certified Professional Accountants.

But RPA is also different from other higher-level Artificial Intelligence (AI) technologies such as machine learning (ML); cognitive automation; Optical Character Recognition (OCR); and Natural Language Processing (NLP).

While many of the above technologies are grouped under the generic umbrella term of ‘Intelligent automation’ (see Coombs *et al.* 2020), in fact there are important differences in the level of intelligence and hence the potential domains of application, and substitutability of human skill sets (Table 1).

Table 1: AI Technologies and Domain of Application.

Technology	Brief description	Example application
Machine learning Reinforcement learning Supervised learning Unsupervised learning	Learns from experience Learns from a set of training data Detects patterns in data that are not labeled and for which the result is not known	Highly granular marketing analyses on big data
Deep learning	A class of machine learning that learns without human supervision, drawing from data that is both unstructured and unlabeled.	Image and voice recognition, self-driving cars
Neural networks	Algorithms that endeavor to recognize the underlying relationships in a set of data through a process that mimics the way the human brain operates.	credit and loan application evaluation, weather prediction
Natural language processing	The ability of a computer program to understand human language as it is written or spoken	speech recognition, text analysis, translation, generation
Rule-based expert systems	A set of logical rules derives from human experts	Insurance underwriting, credit approval
Robotic process automation	Automates structured digital tasks and interfaces with systems	Credit card replacement, validating online credentials
Robots	Automates a physical activity, manipulates and picks up objects	Factory and warehouse tasks

Source: Benbya, Pachidi and Jarvenpaa (2021: 24).

The RPA solutions are therefore expected to automate structured digital tasks and interface with existing IT systems. RPA is not applicable to all kinds of tasks and organisational functions. Some of the management functions from KIBS organizations that are amenable to automation include Accounting/Finance operations, but also Human Resources, IT, Operations, and Marketing functions.

Some processes may be customer facing; others may affect revenue or may affect cash flow. Box 1 provides an example from a case of automation in procurement (operations) in Vodafone.

Box 1: Procurement Automation at Vodafone.

The British telecommunications giant's procurement unit issues about 800,000 purchase orders and receives around 5 million invoices a year as its 23 operating companies, including in Egypt and New Zealand, requisition everything from magazine advertising to antennas. But tracking and analysing the effectiveness of these buying practices hasn't always been easy.

The difficulty in collating the necessary figures, and the high rate of errors introduced by the extremely manual collection process, meant that the team had little time to analyse the data and make recommendations for improvement. To fix the problem, Vodafone decided to build a supply-chain-analytics control centre to measure efficiency and compliance metrics across its procurement function. The company also hired data scientists to help select key performance indicators and present that information visually to a broad range of users.

The project took nine months. The newly built control centre includes a platform that analyses 20 terabytes of data, or roughly two years of transactions, and a visualization tool that allows the roughly 750 users across the company to spot trends and track performance on a desktop made up of speedometers. The system also relies on robotic process automation to simplify a variety of tasks as well as artificial intelligence and machine learning to identify patterns and boost predictive modelling.

Vodafone is one of many companies that are on the second iteration of digital transformation, where companies use a mix of new technologies to tackle increasingly complex problems, said Vin Kumar, associate principal at consulting firm Hackett Group. "One tool by itself is not doing it," Mr. Kumar said. "You have to use a combination of technology to provide this insight," he said, adding that some of the bigger technology vendors are already trying to integrate these tools.

Vodafone Procurement now has a team of six data scientists managing the platform, while the procurement staff members who previously collected this information have been reassigned to higher-value-added tasks such as strategic sourcing and negotiations

Source: Extract from *The Wall Street Journal* (Shumsky 2019).

Moving from functions to tasks, these are likely to include tasks that are repetitive, rule-based, and rely on structured digital data. Therefore, RPA is more conducive to automating day-to-day processes that do not require high levels of human problem-solving. For instance, processes that have these characteristics typically include payment processing, invoice management, reporting, and accounts reconciliation (Wasser *et al.* 2015). Once these processes are automated, employees may then focus on problem solving, exception handling and troubleshooting activities.

As mentioned above, software bots are likely to follow Boolean logic operators (e.g. IF, THEN, ELSE). For example, for a release of funds to a bank's customer, if the conditions are met, then the bot can automatically release the funds. If the conditions are not met, then the query will go to an employee to handle. The following table outlines some of the functions and tasks from KIBS organizations that are likely candidates for automation.

Table 2: Processes and Tasks that are likely candidates for automation

Function	Finance	HR	IT	Marketing	Operations
Tasks or Process	-Fraud chargeback processing -Direct debit cancellations -Personal account closures -Payment processing -Intercompany reconciliation	-Offer letter -Onboarding	-IT -Equipment ordering -Change request	-Personal loan application opening -Business account onboarding -Customer letters -Automated marketing campaigns -Customer complaints automation	-Purchase Orders -Supplies Orders -Procurement

Source: Authors' elaboration based on Institute for RPA; Wasser et al. (2015: 15–6).

From the above discussion, it follows that RPA is likely to bring a shift in the content of job roles and descriptions. But operations employees will need to undertake training to use RPA tools and digitize their workflows. While RPA bots can undertake a vast majority of routine tasks, operational employees can focus on exceptions handling or other tasks that are not worth automating. Similarly, IT employees can also focus on big transformative projects rather than day-to-day handling of mundane tasks. The next section looks at the 'business model' of RPA.

3.3 The ‘Business Model’ of Robotic Process Automation and the RPA Suppliers Market

Although the concept of a ‘business model’ has many interpretations in the literature (see Lange *et al.* 2015: 389–91), for our purposes, a broad definition would suffice. Following Chesbrough (2010: 355) and also Desyllas and Sako (2018: 102) we hold that a business model may serve many different functions, for instance, it frames the value proposition of the firm; identifies a market segment and stipulates the revenue generation mechanism; outlines the structure of the value chain required to create and distribute the product/service and the complementary assets required; specifies the revenue mechanism by which the firm will be paid for the product/service; estimates the cost structure and profit potential; and describes the position of the firm within the value network linking suppliers, customers and complementors.

The discussion in the earlier sections suggest that the business model of RPA is centred on cost savings, productivity gains and efficiencies. This business model innovation represents a departure from (and disruption to) previous business models in the IT outsourcing market. It offers cost advantages compared to both the IT suppliers who relied on an ‘outsourcing plus staff transfer’ model (Miozzo and Grimshaw 2011: 910), but also, significantly, a disruption to the overseas IT and BPO providers, who relied on a ‘labor arbitrage business model’ (Lacity and Willcocks 2021: 9).

The promise of cost savings and headcount-reductions were seen as a critical factor that drove the roll-out and adoption of this new technology. According to the Institute for Robotic Process Automation (IRPA) a digital (bot) worker costs 1/5 of a traditional onshore FTE employee, and 1/3 of an offshore FTE employee; and it estimates that a digital software bot costs around $13K/per year (Wasser *et al.* 2015: 10). While the generic business case for RPA is based on cost and productivity advantages; it remains unclear what is the threshold; or under what conditions, it makes sense to automate a process. One rule of thumb that was followed by some of the early adopters, such as Telefónica/O2, was that ‘there’s no point in automating a process that saves you less than three FTEs’ (Lacity *et al.* 2015: 10). Apart from cost and productivity advantages, *scalability* is also a very attractive feature of RPA. *RPA* scalability can also be understood as another term for *robotic workforce flexibility*. In other words, the robotic workforce can be scaled up (e.g. doubled) almost instantly. All that is required is to purchase additional licenses from the vendors, since one ‘robot’ equals one RPA vendor software license (Lacity *et al.* 2015: 4).

What is less emphasised in the extant ‘strategic’ literature on the topic (Lacity and Willcocks 2021; Willcocks 2020) is how RPA is also reinforcing the adoption of ‘lean production’ principles (Miozzo and Walsh 2006: 100–1; Rubery and Grimshaw 2003: 58–61; Smith and Vidal 2021) in service organisations. While vendors undertake the automation of existing processes, a detailed codification and overhaul of existing processes is required, that eventually leads to an elimination of wasteful processes. Hence, the cost and productivity advantages of RPA are realised through multiple channels, for instance, by reducing errors and defects; improving accuracy; removing ‘bottlenecks’, achieving faster turnaround times; and ensuring compliance and managing risks. These features strongly echo the adoption of lean production in manufacturing settings.

This is in sharp contrast to the traditional computerisation of previous decades. In the past, the underlying processes never really changed, they were just digitized. For example, when service organisations started using MS Excel (cf. Figure 1), this software just replaced paper-based ledgers, and digitized them to electronic-based ledgers. By contrast, RPA presupposes that in the process of automation, some tasks will become redundant, and therefore, eliminated. This is termed by the practitioners as 'process orchestration' and RPA suppliers or other consultants may undertake it.

Figure 2: Gartner's 'Magic Quadrant' for RPA Suppliers.

Source: Gartner (2020: 4).

The market of RPA suppliers has evolved significantly in the last decade, as the technology has matured. In 2010 there were only very few suppliers (vendors) of RPA solutions. According to Lacity et al (2015: 7) when Telefonica-O2 issued a call for proposals for automation; the responses to the call included automation available through standard IT solutions; but the only truly RPA solution was at the time available via the vendor Blue Prism. Since then, the RPA suppliers have proliferated (Figure 2).

Interestingly, the RPA market not only includes IT sector heavyweights such as Microsoft and SAP. In addition, some of the 'platform leaders' (Gawer and Cusumano 2014) in the RPA market are specialised Vendors such as Blue Prism and Automation Anywhere.

Another observation is that the RPA suppliers are not only coming from the LME-type 'radical innovation' national contexts such as the US and the UK, which are known for their relative comparative advantage in IT sectors (Donnelly *et al.* 2011; Hall and Soskice 2001). In addition, RPA suppliers are also coming from CME-type national contexts, such as Germany and Japan, or even 'advanced emerging economies' (Witt *et al.* 2018) such as Israel, South Korea, and Singapore. This information is summarised in Table 3.

Table 3: List of RPA Suppliers - clustered by home-country context.

Business System	HQ	RPA Suppliers
LMEs	United States	Automation Anywhere, UiPath, Pegasystems, Microsoft, Workfusion, Kofax, Helpsystems, Jacada; OpenSpan
	United Kingdom	Blue Prism, EdgeVerve Systems
CMEs	Germany	SAP, Servicetrace, Another Monday
	Netherlands	Be Informed BV, Redwood Software
	Japan	NTT
Advanced Emerging Economies	Israel	NICE Systems, Kryon Systems
	South Korea	Samsung SDS
	Singapore	Antworks

Source: Authors' elaboration of HQ from various sources; business system types from Witt et al (2018: 23).

4. The Effects of Robotic Process Automation on Skills, Jobs and Organisational Boundaries

4.1 Automation and Skills: Deskilling or Reskilling and Redeployment?

In a seminal contribution Alice Lam (2000) argued that workplace knowledge that underpins workers' skills comprises two dimensions: its mode of expression and its locus. The locus refers to whether the knowledge is held by individuals or groups in organisations, whereas the mode of expression refers to the distinction between *codified* (explicit) knowledge and *tacit* knowledge. The latter distinction has important implications for how knowledge can be transmitted in organisations; for instance, codified knowledge can be transmitted by written words and manuals, whereas tacit knowledge is usually passed person to person (Lam and Marsden 2018) – what has been colloquially termed as '*sitting-with-Nellie*'.

This distinction has also knock-on effects on the balance between standardisation and customisation of organisational processes; and how technology affects the 'skill mix' of employees (Grimshaw *et al.* 2002). From the earlier discussion it follows that knowledge of a process should be codified (well documented, rules-based, etc.); and then can be automated; otherwise, RPA is not suitable for 'tacit knowledge'. Instead, tacit knowledge remains important for employees dealing with troubleshooting and handling exceptions. This draws attention to how knowledge structures the division of labour between bots and humans and reinforces their potential complementarity (Shestakofsky 2017).

Zysman and Nitzberg (2020: 16) suggest that the current developments in AI and intelligent systems explicitly call for ‘investments in labor, workforces, skills, and software to facilitate human-computer complementarity’. In other words, apart from deciding which processes can be automated, organisations are also facing the familiar *make vs. buy* dilemma (Cappelli and Crocker-Hefter 1996) regarding the skill formation that facilitates the introduction of intelligent automation.

Organisations may train existing employees, nurturing their RPA skills and hence develop in-house capabilities as part of ‘internal labour markets’ (Grimshaw *et al.* 2001). Alternatively, they may bring in new skills from IT suppliers or recruit away those skills – assuming these are offered in the external labour market through the training system. Although the automation platforms are simple to use, one needs to consider that some training will be required and the various training options that are available. For instance, Blue Prism has been offering their training online for some time (Lacity *et al.* 2015).

Overall, the effects of RPA on skills should be facilitated by management practices (possibly in conjunction with trade unions or works council representatives) and organisational processes that include training and human resource development. IBM’s Digital Badge Learning Program is a case in point: it mirrors the mix of skills needed for IBM professionals to adapt to intelligent technologies, changes in product mix, and evolving customer needs (Qin and Kochan 2020). Reskilling, therefore, should reflect a ‘strategic choice’ of employers to provide re-training for existing staff affected by automation or to redeploy them in new posts within the organisation. This is illustrated by Deutsche Bank’s automation initiatives (Box 2).

Box 2: RPA and Reskilling at Deutsche Bank.

Deutsche Bank faced many operational hurdles following a period of rapid growth. Silos of data and unlinked systems meant wasted time for employees moving information manually. Mountains of paper and electronic forms required employees to process files and fact-check by hand. Digitizing more work would improve services. More importantly, digital offered the potential to positively change the work culture at Deutsche Bank by facilitating cross-functional cooperation.

Deutsche Bank selected software companies BluePrism for attended robotic process automation and WorkFusion for unattended intelligent automation. Attended automation refers to a digital helper app on the desktop to automate repetitive tasks. When machines execute tasks and make decisions on their own, then it is called unattended intelligent automation. BluePrism allows for data sharing and collection between a bank system and Excel to be automated and controlled. On a simple level, it mimics humans, completing tasks at scale in a controlled, approved manner. The control framework is a clear set of guidelines and a vetting process for the bank to evaluate candidate processes automation. It ensures that employees can proceed with automation at their discretion while forcing regular collaboration. The agile development approach is how the bank teaches employees to think about automating processes, so everyone uses the same project management language and metrics. The bank standardized with a suite of digital tools that do not require the average employee to be a programmer.

Reskilling employees on how to use digital in their daily jobs is a top priority for Deutsche Bank. In late 2019, the bank held a Robotics Process Automation (RPA) fair in India, where over 1,000 employees attended. The bank taught classes and gave demonstrations on automation to attendees. It is a highly collaborative process, explains Ranganathan Krishnan, Head of process automation platforms for the group chief information office. "We use a citizen-led model for RPA, where operations and the business take ownership of the automation, while technology provides the tools, platforms, and framework. As a first step, we educate our employees through a hands-on lab, which introduces them to the basics and shows the possibilities of automation as well as the key controls we need to follow."

"Automation is a real force multiplier when many people know how to use it," Matthews [Mark Matthews, Head of operations for the corporate bank] says. "These advances in software mean that operations employees can do sophisticated computer programming with little IT experience within a controlled development environment." Most automation workflow is process-based, so it makes sense for operations staff to lead these efforts. In recognition of this, the bank launched a new "operations engineer" career path. The role builds skill sets in process re-engineering, digital automation and data analytics. The curriculum includes a mixture of classes, online learning, and workshops taught in-house and by outside specialists. The online curriculum, called BOOST, is available to any employee.

(…) Using robotic process automation, the bank streamlined the manual pieces of the money laundering processes. The bank saved 210,000 hours of work that employees would typically do by hand. The automation process checked over 3.4 million positions, automatically closed 380,000 accounts, and migrated 80,000 accounts for Brexit, according to Matthews.

Source: Extract from *Forbes* (Edwards 2020).

Although the more visible impact of RPA is reskilling and redeployment, we cannot completely rule out that RPA might also lead to some 'deskilling' since RPA contributes to the implementation of lean practices, and implicitly or explicitly pushes for greater standardisation of tasks. But more generally, new technology is likely to lead to a re-combination of job roles, tasks and responsibilities (Barley 2020) that usually goes hand-in-hand with some increase in autonomy and discretion (Petrakaki and Kornelakis 2016). As Thompson and Smith (2009: 919) point out 'autonomy might appear to be distinct from skill, [but] discretion in tasks is a core feature of the capacity of employees to utilize their skills'.

Therefore, the elimination of routine tasks by RPA is likely to lead to some task replacement, removing the more monotonous and mundane tasks from jobs. This may potentially improve job quality by freeing up time and enlarging their content in tasks that require increased autonomy and human problem-solving skills (Rani and Grimshaw 2019). The tasks that require discretion appear quite difficult to be automated even by the most advanced AI. High-discretion tasks incorporate skills such as: analytical thinking and innovation, emotional intelligence, creativity, originality and initiative, critical thinking, persuasion, negotiation, and understanding needs or values (Spencer *et al.* 2021: 35).

The prospect of redeployment is also in line with the 'upskilling' hypothesis, which suggests that technology may confer expertise or technical specialisation in high-skilled professionals that brings greater control over narrower but also more esoteric knowledge (Barley 2006). Indeed, there are some empirical studies confirming this increase in autonomy in the last few decades because of computerisation (see Menon *et al.* 2020). Importantly, this process could be facilitated through practices of redeployment of employees, job enlargement and redesign, leading to changing job roles and new job descriptions (Box 3).

Box 3: Redeployment and New Job Roles at Co-operative Bank.

The excess queue procedure at The Co-operative Bank is carried out daily to accept, reject and return direct debits, checks and standing orders, as a result of the customer having insufficient funds to meet payments. Overnight BACS processing results in a daily "queue" of customers with payments due to leave their accounts and with insufficient funds to meet these payments.

A team in the bank would have the daily responsibility of manually reviewing approximately 2,500 higher risk accounts. They would then make a decision to either return or process the payments depending on the account profile of each customer. Due to the manual and time-consuming process of reviewing each account, it was determined that the excess queue procedure should be automated.

The business case for the project was to redeploy staff from manual roles into customer-facing account management roles, to alleviate the daily time pressure of having to complete all processing by a 3 p.m. deadline and to manage all customer accounts with the same degree of accuracy and consistency.

The Co-operative Financial Services completed its automation project using Blue Prism's connected-RPA platform. The automation of the entire procedure means that the bank now has Digital Workers completing the workloads by 11 a.m. each day instead of a team of employees working to meet a 3 p.m. daily processing deadline.

Employees previously engaged in manual processing have been released to work on proactive customer account management. Outbound customer calls can now be made every day of the week where previously they were confined to Saturday when there was no activity required on the excess queue.

More staff are now working on outbound customer calls, and they are able to quickly identify customers in financial difficulty and proactively call them to discuss their accounts, rather than reacting too late, enhancing our overall customer service. Prior to automation, employees would work beginning at 7:30 a.m. to clear the queue. On high-volume days they would struggle to meet the 3 p.m. deadline for payment processing. With 80% of the process already automated, the team members have been moved across to customer- facing roles.

Source: Extract from Blue Prism(2019).

4.2 Automation and Jobs: Robo-Apocalypse or Job Creation?

The standard expectation from automation is that it will lead to the widespread replacement of workers by technology, in other words, increasing the probability of 'technological unemployment' – a situation referred to as '*Robo-Apocalypse*' (Willcocks 2020) or '*Robo-calypse'* (Waldman-Brown 2020). The prospect of replacement is consistent with recent findings in the 'job polarisation' literature that suggest that many, especially routine middle-skill, occupations disappeared due to 'routine-biased' technological change (Goos *et al.* 2014).

On the broader topic, one widely cited (although now highly disputed) study estimated that 47% of jobs are characterized by a 'high risk' of disappearance in the next 10-20 years due to automation and computerisation (Frey and Osborne 2017). Alternative analyses estimated that the risk of automation is much lower. Employing a task-based approach, the jobs with a high risk of automation (i.e. those jobs with at least 70% of tasks being automated) are estimated to be 9% across the OECD countries (Arntz *et al.* 2016: 8).

Following from this 'task-based' approach, the alternative expectation is rather than being a 'job killer', automation is likely to change the jobs of those workers who perform mostly repetitive and standardised tasks, leading to task displacement or replacement. However, as discussed in the previous section, those workers may be reskilled and/or redeployed into jobs that incorporate complex tasks requiring human judgement and problem-solving skills (Rani and Grimshaw 2019). Moreover, another alternative expectation is that automation is likely to create new job roles. In the context of RPA, these may be focused on exception handling and troubleshooting of problems that cannot be handled by bots. Indeed, new jobs have already appeared such as: RPA Developer, RPA Manager and Automation Consultant. This prospect is also evident by the recent automation processes in professional services firms (Box 4).

Box 4: Automation and Jobs in the Big 4 Accounting Firms.

Participants at all of the Big 4 firms discussed the importance of accountants understanding the capabilities of RPA software. Although software engineers have the technical background to write complex computer programs, they do not have the institutional accounting knowledge needed to properly identify use cases for automation or an understanding of the regulatory environment in which accountants operate. Additionally, an understanding of RPA allows accountants to communicate better with clients regarding how RPA can provide them with better services.

The consensus from participants is that Big 4 accounting firms' RPA implementation programs focus on training accountants at all levels, from interns to partners, to understand how bots operate, identify use cases for automation, and program RPA software. This allows the firms to more efficiently automate business processes as well as communicate the potential benefits of RPA to their clients.

(…) there appears to be some uncertainty regarding how RPA will affect future hiring practices at public accounting firms. Although the majority of our participants do not anticipate a change in hiring practices, and even suggest that employees may enjoy more work-life balance as a result of automation, there is potential for a reduction in hiring at the staff level. Career paths are also expected to change because of the implementation of RPA. Multiple participants commented that automation expands the types of careers available to employees within accounting firms. In particular, they reported that the increased use of technology in public accounting has led to the need to hire computer programmers and software engineers to help with implementing RPA because of the combined skill sets needed to build the bots that are used in the Big 4's professional service practices.

(…) A key question asked by many about automation is the effect that it will have on jobs held by humans. (…) The majority of participants indicated that they did not expect their accounting firms to reduce the number of new employees hired as a result of implementing bots. They do not generally view RPA software as a job replacement. Rather, they consider it to be a tool that allows accounting firms to reallocate employees to more value-added activities, increasing the overall quality of the professional services provided to clients. One participant even expressed the opinion that RPA will result in job creation, rather than job replacement. Additionally, participants discussed how they expect the efficiency gains possible through automation to lead to more work-life balance for employees.

Source: Extracts from Cooper et al. (2019: 21–32).

4.3 Automation and Organisational Boundaries: From IT Outsourcing to Capabilities?

Automation is not only expected to have knock-on effects on skills and jobs, but is also expected to reconfigure organisational boundaries, to reshape organisational forms and to transform the character of inter-organisational relationships. Automation is likely to reshuffle the mix between IT outsourcing and in-house capabilities, based on considerations such as costs and control (Benassi and Kornelakis 2021). While large KIBS firms used to have long-term IT supplier relationships or in-house IT Departments, RPA seems to create new relationships and ecosystems.

From a broader viewpoint, this is not a completely new change. KIBS, such as financial services, have been affected by organisational changes and a crumbling of internal labour markets (Grimshaw *et al.* 2001), as well as technological changes such as the advent of online and mobile banking (Kornelakis *et al.* 2021; Stuart and Martinez-Lucio 2008: 7–8). These changes in KIBS have been pushing a reconfiguration of organisational boundaries and reinforced and intensified the trend of the last few decades, driven primarily by outsourcing and externalisation, organisational politics, and changing cost structures (Bidwell 2012; Doellgast *et al.* 2016).

In the broader context of IT outsourcing, Miozzo and Grimshaw (2005) applied the concept of modularity in their comparative study of KIBS organisations in Germany and the UK. KIBS firms (clients) retained some rudimentary IT functions, but core IT functions were likely to be outsourced in a modular way to IT suppliers. The new client-supplier relationships were governed by service level agreements and close monitoring. Outsourcing to IT suppliers was favoured because of their capabilities to standardise processes and skills acquisition could take place via staff transfer from the client to the supplier. This pattern of IT outsourcing was based on transforming or integrating 'legacy' IT systems and therefore modularity was advantageous for the transformation.

In the era of intelligent automation, however, it appears that KIBS firms may no longer be reliant (solely) on IT suppliers for capabilities but are instead seeking to develop their own in-house capabilities by establishing RPA Centres of Excellence (CoE). CoEs is a new organisational form that governs automation as an umbrella unit, which cuts across different departments and functional units. The following case from HSBC shows the role of those new capabilities (Box 5).

Box 5: RPA Capabilities Development at HSBC.

HSBC has been deploying robotic process automation (RPA) since 2016 to eliminate manual processing. In 2019 it brought its RPA capabilities in-house, rather than rely on external vendors. Now it is planning to deploy RPA-plus, adding elements of self-learning to the software so that it can tackle even bigger problems, says a bank executive involved with HSBC's global transformation team.

The job of the operations centre is to save the bank money by using technology to eliminate headcount. It uses the term FTE, or "full-time employee", as its unit of measurement. In the past year the centre has notched close to 200 FTE "saves" in China, and far more globally. A bank can reduce headcount by training operations people how to automate the tasks they would normally require IT people to resolve. In HSBC's case more than 170 operations people in China have been trained to use RPA tools so far and learned they can digitize their workflows by themselves. "We have confirmation that the FTE is demised," said the source, jargon for full-time employees. In other words, the bank is able to cut, not reshuffle, costs.

Banks have been automating processes for years, especially at the infrastructure level: the plumbing, connecting systems and databases. But there have remained "exceptions processing", often the smaller tasks that fall between the cracks, and which have been too minor for IT teams to bother addressing. But added up, exceptions processing represents a towering amount of dull but necessary work. RPA automates repetitive human activity at the front end, that is, where a human interacts with the automated plumbing.

At its most basic level, RPA is a rules-bound algorithm designed to handle specific tasks. It is designed to be relatively simple, like an app on your mobile phone – simple enough that a non-tech person can learn how to use it. Although HSBC is deploying RPA to shed excess IT headcount, the use of RPA also frees its core IT teams to focus on big, transformative projects, instead of having to help operations teams sort out pesky workflows. Blue Prism, a UK-based RPA software and integration vendor, has been working with HSBC since 2016. The bank also relied on consultants such as EY to run its first RPA solutions, before bringing that in-house last year. But it relies on Blue Prism's software support, upgrades, and analytics.

Source: Extract from *DigFin Blog* (DiBiasio, 2020).

In a nutshell, RPA departs from the old model of modular IT outsourcing, because it has a fundamental difference from previous decades. In previous decades, the 'integration' of different IT systems was a headache for organisations, and the introduction of new technology typically stumbled upon the incompatibilities of the 'legacy' systems. Instead, RPA seems to represent a relatively novel approach that goes around the traditional 'systems integration' phase of technological change (Miozzo and Walsh 2006), as RPA bots seamlessly integrate with legacy systems. The discussion of the nature and effects of RPA has several implications for the theoretical literature, but also for practice, policy, and further research.

Interestingly, during the early days of RPA, some practitioners even spoke about the *'end of outsourcing'* (see Casale 2014). Although it is doubtful that RPA represents the end of outsourcing, it does seem to depart from earlier trends. The first wave of shifting organisational boundaries covered outsourcing of IT functions to IT vendors, creating new client-supplier relationships in the 'outsourcing plus staff transfer' model (Miozzo and Grimshaw 2005; Miozzo and Grimshaw 2011). In parallel, a second wave, covered offshoring to low-cost locations for IT and customer services centres relying on the 'labor arbitrage' model (Lacity and Willcocks 2016; Lacity and Willcocks 2021). RPA is perhaps part of a third wave in the reconfiguration of organisational boundaries, due to its 'business model' cost and productivity advantages (see section 3.3). Initial evidence suggests that there is a trend towards *reshoring* of previously outsourced work (Cooper *et al.* 2019), however, in the form of bot workers.

While we cautiously propose that RPA signifies a new model, this does not mean that there are no continuities with earlier ones. For instance, the concept of 'modularity' may still be applicable, since RPA does not always automate whole processes end-to-end. Indeed, in some of versions of RPA automation, 'modularisation' goes hand in hand with 'process orchestration' and human workers need to be integrated in specific tasks of the end-to-end process that bots cannot handle. Finally, process orchestration also incorporates 'lean production principles' of waste elimination, removing bottlenecks and zero errors.

5. Conclusion and Questions for Future Research: Institutional Effects

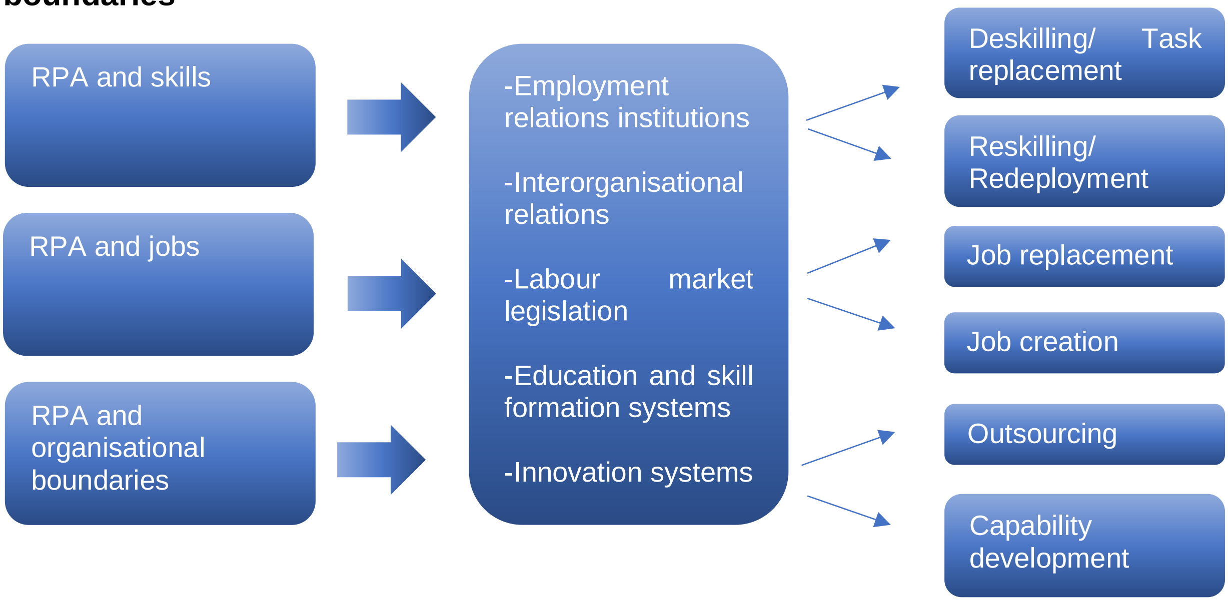
This paper deployed a comparative institutional perspective to develop a framework to analyse the emergence of Robotic Process Automation (RPA) in the context of sectoral systems of skill-formation, employment, and innovation. Drawing on different strands of academic literature on innovation, technology, and employment studies, it discussed the theory and preliminary evidence on the nature of automation; the RPA business model; RPA's effects on the jobs, roles, and workers' skill-mix. This approach resonates with calls for research that crosses disciplinary silos and incorporates systems of innovation and experimentation to analyse changes in job quality, skills, digitalisation, and productivity (Grimshaw and Miozzo 2021; Warhurst *et al.* 2018).The paper also illustrated the emerging trends by offering mini (vignette) case studies of KIBS organisations which are undergoing significant automation of front- and back-office operations. It was argued that RPA is impacting traditional models of outsourcing through reconfiguration of organisational boundaries.

The introduction of a robotic workforce has broader implications for workers, besides the immediate effects on their jobs. It can be construed as another example of 'institutional toying' (Benassi and Kornelakis 2021). It gives firms the ability to circumvent institutional constraints, by reducing costs and enhancing their control over the labour process. Indeed, the regulatory framework creates a loophole in which RPA bots are not subject to any 'working time' restrictions, since they can be used 24/7. The employers are not liable to pay non-wage labour costs (e.g. social insurance contributions) for every RPA bot they 'hire'.

The discussion suggests that RPA has advantages that simulate the advantages of the 'labor arbitrage' model. RPA bots are not subject to any EPL restrictions. Instead, they can be very flexibly 'hired' or 'fired' (through scalability up or down), by just altering the licencing agreements with RPA vendors. For this reason, it remains an important question whether there is a role for institutions and key actors in different country contexts to shape the adoption of RPA.

As such, a final remark, and extending the above analysis of the possible effects of RPA on skills, jobs, and organisational boundaries to include a critical consideration of diverse country and sector-level institutions, Figure 3 highlights the mediating effects of innovation systems, employment relations and skill formation systems.

Figure 3. Institutions and the effects of RPA on skills, jobs and organisational boundaries



This framing of the relationship (building on the insights set out in sections 2-4) generates three broad propositions for future research, as follows:

I. The enhanced resources for social actors, combined with more developed coordinating functions, that are characteristic of CME type countries enables more stable adjustments of employment that support reskilling and sustain (and even improve) job quality (especially worker autonomy) in the context of new investments in RPA, when compared to LME type countries;

II. CME type countries, with strong workplace-level voice mechanisms, are more able to prevent large-scale RPA-induced job displacement, while LME type countries are likely to experience processes of job polarisation; and

III. While both types of economies will experience changes in sectoral and organisational boundaries resulting from RPA investments, CME type countries experience parallel development of in-house capabilities while LME type countries emphasise 'arms-length' inter-firm reliance on contractors/platforms and external RPA consultants.

Future investigation of these propositions will illuminate the potentially wide-ranging effects of RPA and shed light on the potential for country varieties within sectors at the centre of these transformations, such as the finance, IT and telecommunications sectors, among others. There is much at stake in terms of improving our understanding of the implications for skills, jobs and business organisation.

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